The University of Toronto
Chemical Library

Presented
to
The University of Toronto Library
by
William Lash Miller, B.A., Ph.D., C.B.E.
Professor Emeritus of Physical Chemistry
for
A Departmental Library to be under
the control of the Professor of
Chemistry according to the conditions
set out in a letter from the Librarian
of the University dated March 21st
1938.

[Munroe, Charles Edward & Chatard, T. M.]

Twelfth Census of the United States.

CENSUS BULLETIN.

No. 210. WASHINGTON, D. C. June 25, 1902.

MANUFACTURES.

CHEMICALS AND ALLIED PRODUCTS.

Hon. WILLIAM R. MERRIAM,
Director of the Census.

SIR: I transmit herewith, for publication in bulletin form, the statistics of chemicals and allied products, prepared under my direction by Charles E. Munroe, Ph. D., professor of chemistry, Columbian University, Washington, D. C., and by T. M. Chatard, Ph. D., his associate, acting as expert special agents of the division of manufactures.

The unusually exhaustive and valuable character of the work is described in the introduction to this report by the expert special agents. Nothing approaching it in any particular has ever before been presented at any census of the United States.

The statistics are presented in 9 tables: Table 1 is a summary of the statistics for the entire industry, by states, 1900; Table 2 is a summary for fertilizers, by states, 1900; Table 3 is a summary for dyestuffs and tanning materials, by states, 1900; Table 4 is a summary for paints, by states, 1900; Table 5 is a summary for varnishes, by states, 1900; Table 6 is a summary for explosives, by states, 1900; Table 7 is a summary for essential oils, by states, 1900; Table 8 is a summary for chemicals, by states, 1900; and Table 9 is a summary for bone, ivory, and lampblack, by states, for 1900.

In drafting the schedules of inquiry for the census of 1900 care was taken to preserve the basis of comparison with prior censuses. Comparison may be made safely with respect to all the items of inquiry except those relating to capital, salaried officials, clerks, etc., and their salaries, the average number of employees, and the total amount of wages paid. Live capital, that is, cash on hand, bills receivable, unsettled ledger accounts, raw materials, stock in process of manufacture, finished products on hand, and other sundries, was first called for at the census of 1890. No definite attempt was made, prior to the census of 1890, to secure a return of live capital invested.

Changes were made in the inquiries relating to employees and wages in order to eliminate defects found to exist on the form of inquiry adopted in 1890. At the census of 1890 the average number of persons employed during the entire year was called for, and also the average number employed at stated weekly rates of pay, and the average number was computed for the actual time the establishments were reported as being in operation. At the census of 1900 the greatest and least numbers of employees were reported, and also the average number employed during each month of the year. The average number of wage-earners (men, women, and children) employed during the entire year was ascertained by using 12, the number of calendar months, as a divisor into the total of the average numbers reported for each month. This difference in the method of ascertaining the average number of wage-earners during the entire year may have resulted in a variation in the number, and should be considered in making comparisons.

At the census of 1890 the number and salaries of proprietors and firm members actively engaged in the business or in supervision were reported, combined with clerks and other officials. In cases where proprietors and firm members were reported without salaries, the amount that would ordinarily be paid for similar services was estimated. At the census of 1900 only the number of proprietors and firm members actively engaged in the industry or in supervision was ascertained, and no salaries were reported for this class. It is therefore impossible to compare the number and salaries of salaried officials of any character for the two censuses.

Furthermore, the schedules for 1890 included in the wage-earning class, overseers, foremen, and superintendents (not general superintendents or managers), while the census of 1900 separates from the wage-earning class such salaried employees as general superintendents, clerks, and salesmen. It is possible and probable that this change in the form of the question has resulted in eliminating from the wage-earners, as reported by the present census, many high-salaried employees included in that group for the census of 1890.

In some instances, the number of proprietors and firm members, shown in the accompanying tables, falls short of the number of establishments reported. This is accounted for by the fact that no proprietors or firm members are reported for corporations or cooperative establishments. The number of salaried officials, clerks, etc., is the greatest number reported employed at any one time during the year.

The reports show a capital of $238,529,641 invested in the manufacture of chemicals and allied products. This sum represents the value of land, buildings, machinery, tools, and implements, and the live capital utilized, but does not include the capital stock of any of the manufacturing corporations of the state. The value of the products is returned at $202,582,396, to produce which involved an outlay of $11,340,385 for salaries of officials, clerks, etc.; $21,799,251 for wages; $14,825,112 for miscellaneous expenses, including rent, taxes, etc.; and $124,043,837 for materials used, mill supplies, freight, and fuel. It is not to be assumed, however, that the difference between the aggregate of these sums and the value of the products is, in any sense, indicative of the profits in the manufacture of the products during the census year. The census schedule takes no cognizance of the cost of selling manufactured articles, or of interest on capital invested, or of the mercantile losses incurred in the business, or of depreciation in plant. The value of the product given is the value as obtained or fixed at the shop or factory. This statement is necessary in order to avoid erroneous conclusions from the figures presented.

Very respectfully,

S. N. D. North

Chief Statistician for Manufactures.

CHEMICALS AND ALLIED PRODUCTS.

By Charles E. Munroe and Thomas M. Chatard.

The publication of special reports relating to the manufacture of chemicals, which was begun in the Tenth Census, was a feature of the Eleventh Census, although, as stated in the report on "chemicals and allied products" of the latter census (Eleventh Census, Manufacturing Industries, Part III, page 275), "owing to changes in the form of inquiry and the inclusion of certain allied industries not reported as chemicals at the census of 1880, and the exclusion of others that were included under this head at the Tenth Census, a true comparison is impossible."

The same may be said of the report on chemicals and allied products for the Twelfth Census, now presented. Pharmaceutical preparations, included as chemicals by the Eleventh Census, have been excluded from the present report, while "bone, ivory, and lamp black," previously reported elsewhere, is here included. Still, the data for so many of the industries included in the classification are comparable that a fairly correct idea of the growth of the combined industries as a whole, during the past decade, may be obtained.

The total number of active establishments included in this inquiry, as set forth in this report, is 1,827. Thirty-six establishments were reported as idle, making the total number of establishments 1,863. The report on "chemicals and allied products" for 1890 covered 1,626 establishments, including those making pharmaceutical preparations as the principal product, but the latter are not considered in the present report. The Census Office classifies an establishment according to the nature of its principal product, this being determined by its value as compared with that of any other product which may be made therein. The special schedules for the various industries call for the main products of the industry with sufficient detail, while subordinate products are, in most cases, brought together under the caption "all other products." Hence, chemical products made by works belonging to other categories can not, in most cases, be ascertained from the returns and do not appear in this report except in a few specified instances. The amount so lost to this inquiry is, however, not so large as to materially affect these returns, and as the value of such products is included in the figures of the other categories, the final total value of all manufactures is not affected. Moreover, establishments whose products during the census year were valued at less than $500 are not included in the general tabulations, but are taken into consideration in this special report.

Owing to the hearty cooperation of most of the leading chemical works it is believed that the figures here presented are as nearly correct as the difficulties attending the collection of the information have permitted. In probably no branch of the census work is the need of a permanent, trained force more keenly felt than in this particular inquiry, the wide range of which is shown by the character of the "Special Schedule, No. 17," used in the collection of these returns. The products were classified under 19 groups, as follows: Group 1, Acids; II, Sodas; III, Potashes; IV, Alums; V, Coal-Tar Products; VI, Cyanides; VII, Wood Distillation; VIII, Fertilizers; IX, Bleaching Materials; X, Chemicals produced by the aid of Electricity; XI, Dyestuffs; XII, Tanning Materials; XIII, Paints, Pigments, and Varnishes; XIV, Explosives; XV, Plastics; XVI, Essential Oils; XVII, Compressed and Liquefied Gases; XVIII, Fine Chemicals; and XIX, General Chemicals. In the course of the work it was found necessary to form a subgroup, XIX A, to classify certain establishments whose main products were not originally included in "chemicals." A final group named "miscellaneous" includes a number of products not chemical but made by works belonging to the category of "chemical industries." By bringing such products together their nature, quantity, and value are given and the figures may be used to supplement the returns elsewhere given for such substances so far as they may be separately reported.

Separate tabulations have been made of the data for Group VIII, Fertilizers; Groups XI and XII, Dyestuffs and Extracts; Group XIII, Paints; also Group XIII, Varnishes; Group XIV, Explosives; and Group XVI, Essential Oils. The data for the remainder of the groups are included in the general tabulation of "chemicals." There is also a tabulation of "bone, ivory, and lamp black," but as results showed that the product was exclusively hydrocarbon black or lampblack, the figures may be properly included in those for "paints," and are so treated in the special group report. These tabulations are continued from previous censuses and are necessary in order that the condition of the manufactures of states, cities, etc., may be promptly shown with sufficient detail, but for the proper presentation of the chemical industries of the United States a certain reclassification of products became needful. For example, a certain large establishment made paints, acids, and general chemicals, its paint product being the largest in value; the establishment was classified under "paints," the other products being there reported as subproducts. In another instance a large fertilizer works, making its own acid, had such an extensive business in the manufacture of cottonseed products that, although it was really a chemical works of much importance, it could not be put in this category, but had to go elsewhere. So far as possible, the chemical products of this latter class of works have been taken into consideration in the special group reports, but separately noted, so that any duplication may be made evident.

In the special group reports, all of the products belonging to the group are brought together. When the main product of a works belongs to the group under consideration, the establishment is a "main" one and belongs to Class A. When the group product is a minor one for an establishment, this is counted in, but as a "sub" works and placed in Class B. The chemical product of an establishment not belonging to the category of "chemical industries," as noted above, is also taken into account, but the establishment and its chemical product are placed in a third class, C. By this system each group report can present its special operations and products in any desired detail; and while the figures of product may differ from and often exceed those of the general tabulations, no confusion can result if it is clearly understood that the purpose of the special group reports is to give as clear and complete a presentation of the American chemical industry as the available information may permit.

The following table gives, first, the totals for establishments, capital, labor, cost of materials, and value of products as shown in the tabulations, and second, for purposes of comparison, the total values for the same classes of products as shown by the reclassified figures of the group reports:

COMPARISON OF TABULATION VALUES WITH GROUP VALUES: 1900.

TABULATION.	Number of establishments.	Capital.	WAGE-EARNERS.		Materials, cost.	Products, value.	Reclassified products, value.
			Average number.	Total wages.			
Total	1,740	$238,529,641	46,766	$21,799,251	$124,043,837	$202,582,396	$221,217,217
Chemicals	459	89,091,430	19,054	9,401,467	34,564,137	62,676,730	[1] 78,414,840
Dyestuffs[2]	77	7,839,034	1,648	787,942	4,745,912	7,350,748	7,767,226
Essential oils	70	612,657	199	69,100	596,112	850,093	859,401
Explosives	97	19,465,846	4,502	2,383,756	10,334,974	17,125,418	[3] 16,950,976
Fertilizers	422	60,685,753	11,581	4,185,289	28,958,473	44,657,385	45,911,382
Paints and varnishes[4]	615	60,834,921	9,782	4,971,697	44,844,229	69,922,022	71,313,392

[1] Including miscellaneous, $4,175,656 from all tabulations.
[2] Including tanning materials.
[3] Excluding miscellaneous.
[4] Including bone, ivory, and lamp black.

Taking the table of "principal products, their quantity and value, 1890," given on page 275 of the above-mentioned special report of the Eleventh Census, and comparing the returns for the same products as given by the figures of the Twelfth Census, the following results are shown:

COMPARISON OF THE QUANTITIES AND VALUES OF THE PRINCIPAL PRODUCTS REPORTED: 1890 AND 1900.

PRODUCTS.	1890		1900	
	Quantity.	Value.	Quantity.	Value.
Total		$163,547,685		$221,217,217
Alum, pounds	93,998,008	1,616,710	179,467,471	2,446,576
Coal-tar products		687,591		1,421,720
Dyeing and tanning extracts and sumac, pounds	187,906,911	8,857,084	169,525,536	7,767,226
Gunpowder and other explosives, pounds	125,645,912	10,993,131	215,590,719	16,950,976
Fertilizers, tons	1,898,806	35,519,841	3,091,717	45,911,382
Paints, colors, and varnishes		52,908,252		71,313,392
Potash and pearlash, pounds	5,106,939	197,507	3,864,766	178,180
Sodas, pounds	333,124,375	5,432,400	1,279,082,000	10,237,944
Sulphuric acid, 50°, pounds	1,009,863,407	4,307,067	1,906,878,903	7,965,832
Sulphuric acid, 60°, pounds	20,379,908	122,940	34,023,131	246,284
Sulphuric acid, 66°, pounds	354,533,657	3,249,466	754,558,455	6,035,069
Wood alcohol and acetate of lime		1,885,469		5,775,290
Chemicals (including all acids, bases, and salts not heretofore enumerated)		24,751,974		[1] 40,791,690
All other products		13,018,253		4,175,656

[1] Including essential oils, $859,401.

This table shows that while the chemical industries of the United States have greatly advanced in quantity of product, the value per unit of product has much decreased, a tendency of much importance to those industries which use these products as materials for their own operations.

Each of the groups into which products are classified represents a special form of establishment, sometimes two or more forms, even though a single establishment may, and often does, furnish products belonging to two or more groups. Hence it is practically impossible to construct for this special branch of inquiry a single schedule which, by the wording of the interrogatories and the indications as to the proper nature of the replies, will enable the Census Office to elicit the desired information from all alike. The difficulties experienced in collecting the statistics have, however, indicated improvements needed for future work, and, with a permanent Census Bureau, there is every reason to expect that at the next census the statistics of chemical manufactures will show results of much wider scope than it has been possible to present even at the census of 1900.

The willingness of the manufacturers, notably of the great combinations, to furnish information has been most gratifying, and when difficulties have occurred in most cases they have been due to the fact that the establishments did not have such records as would give the information desired. The absence of such records has generally been regretted by the manufacturers, who have recognized the value such information would have been to them in their business. In the few cases where information was at first refused on the ground of interference with private business, a courteous letter of explanation rarely failed to elicit a pleasant reply, giving everything desired so far as it could be furnished.

While the groups above mentioned cover most of the products usually recognized as chemicals, inspection of the index of any standard work on chemical technology will show that the subjects considered as belonging to this domain are far more numerous. The reason for this becomes evident when it is remembered that every form of industry must be either physical or chemical or a combination of both. The manufacture of pig iron or the tanning of a hide is a chemical process, while the rolling of a rail or the making of a shoe is a physical process, but many manufacturing processes in which chemical reactions occur can not be sharply classified, since, while the products are the results of chemical action, the practical success of the operations depends upon the correct arrangement of the mechanical plant, a good example of this being the ammonia-soda process. Modern industrial chemistry tends to develop itself more and more along engineering lines; hence the increasing demand for the chemical engineer—a mechanical engineer with a special equipment of chemical science and technology.

A list of the topics treated of in Wagner's Chemical Technology is here given as an example of what the term "chemical technology" as a rule embraces, to which is added a list of the special schedules and bulletins issued by the Census Office showing how far these topics are the subject of special inquiries and reports at the census of 1900, thus facilitating the obtaining of a comprehensive view of this industrial complex.

COMPARISON OF THE TOPICS OF CHEMICAL TECHNOLOGY WITH THE CLASSIFICATIONS OF THE CENSUS OF 1900.

TOPICS.	Special schedule number.
Fuel:	
Charcoal (chemical manufactures)	17
Coke	7
Gas, illuminating and fuel	(no number)
Oil, mineral (petroleum refining)	8
Paraffin, etc (petroleum refining)	8
Metallurgy:	
Iron and steel	21 and 23
Copper	24
Lead	25
Zinc	26
Other metals, general schedule	3

COMPARISON OF THE TOPICS OF CHEMICAL TECHNOLOGY WITH THE CLASSIFICATIONS OF THE CENSUS OF 1900—Continued.

TOPICS.	Special schedule number.
Chemical manufactures, inorganic:	
Common salt	9
Acids, bases and salts Fertilizers Explosives Compressed gases Electrolytic products Paints and varnishes (chemical manufactures)	17
Chemical manufactures, organic:	
Alcohols and ethers Organic acids Organic coloring matters Coal-tar products and colors (chemical manufactures)	17
Glass:	
Pottery and fire-clay products	6
Bricks	5
Cements and mortar, general schedule	
Food, beverages, etc.:	
Starch, general schedule	
Sugar, general schedule	
Fermentation	
Brewing, general schedule	
Wine making, general schedule	
Spirits, general schedule	
Flour and grist products	31
Meat products (slaughtering and meat packing)	33
Milk, butter, and cheese	32
Fibers:	
Preparing, bleaching, dyeing, printing, and finishing	12
Silk	16
Wool	14 and 15
Cotton	11
Hemp, flax, and jute	13
Paper	34
Miscellaneous:	
Tanning (leather, tanned and curried)	18
Glue, size, gelatine, general schedule	
Bone distillation—	
Bone charcoal, general schedule	
Bone oil	
Fats, oils, soaps, general schedule	
Stearin and glycerin, general schedule	
Resins, general schedule	
Essential oils (chemical manufactures)	17
Wood preservation, general schedule	

While some of these topics may at first appear to the laymen to have but a very slight connection with chemistry, as, for example, the manufacture of flour or bricks, yet flour and bricks, as well as all of the other chemical substances named, are chemical substances, and they have been the subject of extended chemical study by specialists, through which there has resulted great improvement in the quality and cheapness of the products. In such industrial chemical investigation Germany leads all other countries, and its present preeminence in the field of chemical manufacture has been deservedly won by its work, although it has been materially aided by the character of the patent laws of England and of the United States.

The German chemical manufacturer is far in advance of those of all other nations in recognizing the value of specialized chemical skill in the conduct of the works and in employing trained chemists in laboratory investigations. Thus McMurtrie[1] points out that the Fabriken der Actien-Gesellschaft Farbewerke Meister Lucius und Bruning in Höchst, who were in 1890 making between 1,700 and 1,800 different colors, numbered

---

[1] The Relations of the Industries to the Advancement of Chemical Science, by William McMurtrie, Proc. A. A. A. S., Vol. 44, page 79, 1895.

among their 3,000 employees 70 chemists and 12 engineers. Green[1] states that in 1900 the six largest coal-tar color firms in Germany employed about 500 chemists and 350 engineers and technical men, while Sir Henry Roscoe[2] states that at the German works which he had visited, highly trained chemists were employed in original researches with a view to new discoveries. "One employee, who received £1,000 a year, worked for several years without producing any results; but eventually he made a discovery which repaid the firm ten times over, and placed an entirely new branch of manufacture in their hands."

Owing to the extended discussions going on in England and America relative to the tremendous growth of the chemical industries of Germany during the past twenty years, in which many have attributed much of this growth to the extensive employment of doctors of philosophy in chemistry and other university-bred chemists in the German technical works, a census has been taken of the establishments in the United States which are the subject of this report, with the following result:

CHEMISTS EMPLOYED IN THE ESTABLISHMENTS TREATED OF IN THIS REPORT.

GROUP NUMBER.	Group name.	Number of chemists.
I	Acids	28
II	Sodas	9
III	Potashes	....
IV	Alums	11
V	Coal-tar products	7
VI	Cyanides	8
VII	Wood distillation	3
VIII	Fertilizers	10
IX	Bleaching materials	4
X	Electro-chemicals	9
XI	Dyestuffs	13
XII	Tanning materials	7
XIII	Paints and varnishes	53
XIV	Explosives	32
XV	Plastics	5
XVI	Essential oils	2
XVII	Liquefied gases	9
XVIII	Fine chemicals	25
XIX	General chemicals	41
	Total	276

When, in German works, the results of the investigations of the expert chemists indicate commercial possibilities, practical working tests follow, and, in the end, one more patent is added to those which hamper the development of chemical industry in countries which, like the United States, give the foreigner the monopoly of a patent without requiring that the protected article shall be made where the patent is issued. The effect is that since it is often more profitable to make the higher grade chemicals abroad than in the United States, foreign labor and capital are protected to the injury of the labor and capital of this country. Hence, while the manufacture of acids, alkalies, fertilizers, and other heavy chemicals has greatly increased in the United States, this is mainly because of transportation costs. The tariff on alkalies has certainly added much in the development of this branch because it has been to the interest of the foreign patentees to establish alkali works here either by their own capital or by granting licenses to others. When, as in the case of dyestuffs and other high-grade chemicals, the transportation cost is a minor consideration, the tariff has little effect in inducing the domestic manufacture of a foreign article protected by a local patent. So long as the demand for his article insures a sufficient price, the foreign patentee can make it abroad and ship it here, paying whatever duty may be demanded; by simply refusing to grant a license for manufacture here, he is secured from all competition. Other countries may have refused to grant him a patent, which may even have become void in the original country, and the article be made by others; yet under our laws, he, and he alone, may vend the article here. The English, who are suffering from a similar condition of their patent laws, are bestirring themselves to have the situation ameliorated, and a special committee of the Society of Chemical Industry has lately made a report upon this subject.[3] The effects of granting British patents to foreigners without requiring domestic operation are thus stated:

> 1. We foster foreign labor and assist in the development of foreign industries.
>
> 2. As the introduction of a new article generally replaces another article hitherto in use, we throw out of employment a certain number of our own workpeople.
>
> 3. Very frequently the foreign patentee has either not succeeded in getting a patent in his own country or such patent has already run its course there, whilst his British monopoly remains in full force. The result is that we stifle invention and increase the prices of a number of articles by closing the doors to our own inventors and manufacturers, whilst our foreign competitors may make and vend abroad the patented article without any restriction or payment of royalty.

Several examples are given of the practical working of the English patent laws. Artificial alizarine was invented in Germany but no patent was granted there. English patents were, however, granted, with the result that the patentees, having the monopoly of the English market anyhow, simply made it in Germany, as being cheaper so to do, and built up an enormous trade which was the foundation of Germany's present supremacy in the manufacture of coal-tar dyestuffs. Again, the production of artificial indigo is destroying the natural indigo industry of India and producing much distress there. England, which is thus a heavy loser, can do nothing to offset this loss, because the patent monopoly granted to the foreigner enables him to supply the English market on his own terms.

Every country, save England and the United States, has a provision in its patent laws that a patent can be revoked if not worked in the country granting the patent. Moreover, the French patent law has, in addi-

---

[1] The Coal-tar Industry, by A. G. Green, Science, Vol. 14, page 663; 1901.

[2] J. Soc. Chem. Ind., Vol. 16, page 570, 1897.

[3] J. Soc. Chem. Ind., 1902, pages 212 to 301.

tion, the following provision, article 32, section 3, "The patent shall be revoked if the patentee has introduced into France articles of manufacture made abroad and similar to those which are protected by the patent." In this way France provides that, in giving to anyone the protection of her patent laws, her domestic industry shall be fostered, and not, as in England and the United States, often injured and sometimes destroyed. Instances have occurred in this country where chemical substances once made here are no longer produced, because the foreign manufacturer, protected by his American patent, has been able to make the domestic manufacture unprofitable.

The report under consideration states that "There is but one remedy for this vexed question which is both simple and efficacious, viz, to enact that 'A patent may be revoked if it be proved that an article patented is worked abroad and not in the United Kingdom, the onus of proof that the patent is worked, bona fide, in this country, resting with the patentee or licensee.'" Some such provision as this in the laws of the United States would materially aid the development of our American chemical industry.

In order to bring out the relations existing between the growth of the chemical industry and of the patents which have been granted in this country covering inventions in this industry, an abstract has been made of all chemical patents issued from the founding of the United States Patent Office up to the year 1900, and this Digest of Chemical Patents is given as an appendix to this report. It was prepared by Mr. Story B. Ladd, M. E., whose experience as a patent attorney especially fitted him for this duty, and he elsewhere shows the effect which the granting of these monopolies has produced on the industries of the United States.

The Nineteenth century, the closing year of which is marked by the taking of the Twelfth Census, will always be a notable one in the history of chemical manufacture, since practically all of its present working processes have had their origin and development during this period. Indeed, chemical manufacture, as such, can hardly be said to have existed until the continuously working chamber process for sulphuric acid was introduced, about 1810, while the Leblanc soda process, although discovered by him in 1789, failed to get a footing until 1814, when it was introduced into England by Losh. Thereafter the development of chemical technology proceeded rapidly, and now, at the end of the century, we find that the great Leblanc process is approaching extinction through the inroads of the later ammonia-soda process and the electrolytic chlorine process, while the chamber process for sulphuric acid appears to be about to meet a formidable competitor in the recently developed contact process.

As the nature and working conditions of this process have been only lately made public, and as its general introduction will have such a profound effect upon industrial chemistry, especial attention is given to it in the next section. Moreover, contact action or catalysis continually occurs in chemical operations, has already numerous applications, and the number is continually increasing.

By catalysis in meant that peculiar action of a substance by which it can, when in contact with two or more substances capable of reacting upon each other, either cause the reaction, or, if the reaction is already occurring, greatly diminish the time required for its completion. At the same time, the catalytic substance, so far as respects the nature of the ultimate products, appears to have undergone no change. Hence, Ostwald's definition, "A catalytic agent is such material as affects the velocity of a chemical reaction without itself appearing in the final product." A very familiar example of catalytic action is the effect of adding manganese peroxide to potassium chlorate when making oxygen. Either of the substances gives off oxygen when heated to a temperature sufficiently high, but when mixed the reaction is effected at a much lower temperature and with much less danger of explosion. When the reaction is completed, examination of the residue shows that only the chlorate has lost its oxygen, becoming chloride, the peroxide being apparently unchanged. It is probable that the latter has taken full part in the reaction, giving off oxygen and taking it up again, but, looking only at the final result, it appears to have been effective merely by its presence.

The action of the niter gas in the sulphuric acid chamber is also catalytic. The union of sulphur dioxide and atmospheric oxygen can and does take place without the help of the niter gases, but the unassisted reaction is very slow and incomplete. The niter gases are oxygen carriers; the oxygen which they contain is in a much more active condition than that of the air, so that they oxidize the sulphur dioxide but replace the loss by taking up oxygen from the accompanying air. As water, in the form of steam, is always present in this reaction, the final product is sulphuric acid, which, in theory at least, is free from oxides of nitrogen, the niter gas remaining in its original active condition. In practice, however, a certain amount of this gas is reduced to inactive forms and this loss must be made up by addition of fresh gas, so that for every hundred parts of acid produced, a certain quantity of niter is used up, but this quantity, being theoretically nothing, depends upon the care of the management and other conditions.

Other applications of catalysis are met with in the Deacon chlorine process, the manufacture of chlorates, aldehydes (the formaldehyde lamp for disinfection being an example), acetone, carbon tetrachloride, and many other organic products, the entire subject being one of great and increasing importance.

GROUP I.—ACIDS.

Sulphuric Acid.—The manufacture of sulphuric acid has practically doubled during the past decade, the increase of product resulting more from the expansion of works than from an increase in their number. The following table gives a comparison between the output for the census year of 1900 and that for 1890. The figures for quantity and value of 50° acid include acid made and consumed in the works in the production of fertilizers and other products.

COMPARISON OF SULPHURIC ACID PRODUCED IN 1890 AND 1900.

STRENGTH, BAUMÉ.	1900—127 ESTABLISHMENTS.			1890—105 ESTABLISHMENTS.		
	Acid produced.			Acid produced.		
	Pounds.	Value.	Value per ton.	Pounds.	Value.	Value per ton.
Total..	2,695,460,489	$14,247,185	....	1,384,776,962	$7,679,473	....
50°........	1,906,878,903	7,965,832	$8.35	1,009,863,407	4,307,067	$8.53
60°........	34,023,131	246,284	14.47	20,379,908	122,940	12.06
66°........	754,558,455	6,035,069	16.00	354,533,657	3,249,466	18.33

The figures of quantity and value of the 50° acid for both periods include the amount of this acid made at certain works and consumed there in the manufacture of fertilizers. In addition there is given the quantity and value of the acid consumed at works in 1900 for making mixed acids for explosives and for other purposes. The acid used for fertilizers was really 50° or chamber acid. The rest of the acid included for 1900 was of various strengths, but for purposes of comparison these have been reduced to 50°. In reducing 66° acid to 50°, the quantity is multiplied by 1.50, and for 60° acid, multiplied by 1.25, these factors being closely approximate to the usual strengths.

	1900.		1890.	
	Pounds.	Value.	Pounds.	Value.
Total	2,097,268,570	$8,819,526	581,536,200	$2,480,495
Fertilizers	1,578,718,000	6,591,147	581,536,200	2,480,495
Other purposes	518,550,570	2,228,379	(1)	(1)

[1] Not given.

The census report for 1890 also gave the total acid production reduced to a uniform strength of 50°. Doing this for the acid production of the present census gives the following comparison:

Total acid as 50°:

1900	3,081,245,500
1890	1,567,138,777
Gain, practically 100 per cent	1,514,106,723

The census of 1870 was the first at which separate figures were given for sulphuric acid, but only the number of establishments and the total value of product were given. In 1880 the total quantity in pounds was given, but no separation into the various strengths was made, so that the returns are not strictly comparable. Even with these restrictions a comparison is interesting as showing the growth of this branch of manufacture.

YEAR.	Number of works.	Quantity of products.	Value of products.
1870	4	(1)	$212,150
1880	49	308,765,432	3,661,876
1890	105	1,384,776,972	7,679,473
1900	127	2,695,460,489	14,247,185

[1] Not given.

The first manufacturer of sulphuric acid in the United States appears to have been Mr. John Harrison, of Philadelphia, who in 1793 had a lead chamber capable of producing 300 carboys of acid per annum.[1] The business proving very remunerative, he built, in 1807, a lead chamber 50 feet long, 18 feet wide, and 18 feet high. This was a large chamber for the time, and was capable of making nearly half a million pounds of sulphuric acid annually, the price of the acid being then as high as 15 cents a pound. Mr. Harrison was also the first person in the United States to use a platinum still for the concentration of the acid, this having been up to then done in glass, a very precarious and dangerous operation. This first still was made in 1814 by Dr. Eric Bollman, and was at once put in use. It weighed 700 ounces, had a capacity of 25 gallons, and was in continuous use for fifteen years.

Powers & Weightman, of Philadelphia, report that they began the manufacture of sulphuric acid in 1825, while a letter from Mr. Nicholas Lennig, containing much valuable information, states that about 1829 his father, the late Mr. Charles Lennig, erected a sulphuric-acid plant which "was so successful that the then existing New York Chemical Company went into liquidation, and put the funds realized therefrom into a banking company now well known as the Chemical National Bank."

It also appears that, in 1829, the manufacture of sulphuric acid was begun in Baltimore by two companies, the Maryland Chemical Works and the Baltimore Chemical Manufactory. The industry extended, and the figures given at the census of 1870 of 4 works, with a total product of the value of $212,150, are undoubtedly erroneous. Of the works reporting acids as principal products at the census of 1900, 16 reported starting in business prior to 1870, while some of the fertilizer factories were making acid prior to that time. While nothing positive can now be said on this subject, it is not unlikely that in 1870 there were at least 25 sulphuric acid works in operation, with a product of over a million dollars in value. Such a supposition is certainly more reasonable when compared, as above, with the figures of subsequent censuses, since everyone, at all conversant with this subject, is well aware that between 1870 and 1880 there was no such outburst of energy in this branch of industry, as would be indicated by the

---

[1] Catalogue, Harrison Brothers & Company, Incorporated, Philadelphia, 1902.

figures of the respective years. Moreover, the figures of value for the total chemical industry, so far as they can be compared, were, for 1870, \$60,998,214, and for 1880, \$89,388,172; while the figures for 1890 were \$161,067,190. The comparatively small increase of the figures of total value of product for 1880 over those for 1870 is what would be expected in the slow uphill course of business between 1873 and 1880, while the next decade opened with a revival which, with occasional backsets, held good until 1893.

The total number of sulphuric-acid works reporting at the census of 1900 was 127. Of these, 31 burned brimstone only, 79 burned pyrites only, while 17 reported that they used both brimstone and pyrites.

Brimstone Plants.—Seven brimstone-burning plants made 66° acid, burning 18,042,072 pounds of brimstone and producing 51,204,775 pounds of 66° acid, or an average of 279 parts of 66° acid (equivalent to 419 parts of 50° acid) to 100 brimstone, the figures for each plant running from 308 to 260 parts of acid. Thirteen brimstone plants, making 50° acid only, used 35,955,680 pounds of brimstone and produced 140,534,027 pounds of 50° acid, an average of 391 parts of acid to 100 parts of brimstone, the figures running from 446 to 321 parts of acid for 100 parts of brimstone. Two works reporting, respectively, a yield of 321 and 334 parts, stated that they were using a very low grade of brimstone, which was obtained under advantageous conditions. Taking the 20 works together and the whole product as 50° acid, it is found that the grand average is 402 parts of acid for each 100 parts of brimstone.

Pyrites Plants.—Nine pyrites plants, making 66° acid only, consumed 248,026,399 pounds of pyrites and produced 311,924,674 pounds of 66° acid, an average of 133.8 parts of acid (equivalent to 200.7 parts of 50° acid), for 100 parts pyrites. Thirty pyrites plants, making 50° acid only, consumed 425,050,296 pounds of pyrites and produced 889,222,560 pounds of 50° acid, an average of 209 acid to 100 pyrites, the figures running from 234 to 160 parts. The grand average for the 39 works is 206 acid to 100 pyrites.

The figure 160 is given by 3 works burning low grade domestic pyrites, while the highest figure, 234 parts acid, is furnished by a new model plant burning pyrites with an average content of 50.05 per cent of sulphur and using 1.26 parts of nitrate of soda to every 100 parts of pyrites. Other works give, per 100 pyrites, 224 acid, 1.66 niter; 213.4 acid, 2.13 niter, while a large combination reports that it allows 2.5 parts of niter and expects a yield of 225 parts of 50° acid. The brimstone works show approximately a consumption of 4.29 parts of niter per 100 brimstone. In considering these figures, it must be remembered that the 66° acid does not average more than 93 per cent of H_2SO_4, corresponding to 65.6° B. Similarly, the 50° acid runs from 52° to 48° B., and even lower, and the chamber acid made and used in fertilizer works is usually under 50°. The continued use of brimstone in this industry in the United States is remarkable, as practically no brimstone acid is now made in England or on the continent of Europe.

The Contact Process.—In 1900, at the meeting of the German Technical Chemists at Hanover, Clemens Winkler, the founder of the contact process, as we now have it, delivered an address entitled "The Development of the Sulphuric Acid Industry During the Nineteenth Century." In this paper, published in Zeitschrift fur Angewandte Chemie, 1900, page 731, he gives a short review of the history and present status of the chamber process, and then shows the lines he followed in his celebrated research upon contact action in the production of sulphur trioxide, which he made public in 1875. He then speaks of the subsequent development of this process, and concludes by impressively stating that the contact process has already demonstrated its ability to compete with and finally to supersede the chamber process. The subject is so important that a summary of this paper is given here, and, following it, an abstract of the very valuable paper by Knietsch upon the development of the contact process in the works of the Badische Anilin und Soda Fabrik to which Winkler calls attention. This paper is very recent, having been published in the "Berichte der Deutschen Chemischen Gesellschaft" for December, 1901, and is so full of valuable information that its presentation here, in abstract, seems appropriate.

Winkler stated that the only acid known to the ancients was vinegar, and that the first indication of the recognition of any other acid is when Geber, in the Eighth century, speaks of the "spirit" which can be expelled from alum and which possesses solvent powers. Albertus Magnus, Thirteenth century, speaks of a "spiritus vitrioli Romani" which can only have been sulphuric acid, while Basilius Valentinus, Fifteenth century, describes its preparation not only from copperas, but also by burning together sulphur and saltpeter, pointing out very distinctly not only that sulphur, in burning, produced some sulphuric acid, but also that the yield is much increased if saltpeter is added.

> Dornaeus, in 1570, described its properties accurately; Libavius, 1595, recognized the identity of the acids from different processes of preparation; Angelus Sala, 1613, pointed out the fact, which had sunk into oblivion since Basilius, that sulphuric acid can be made by burning sulphur in moist vessels; after that time it was prepared by the apothecaries in that way.[1]

The addition of saltpeter was introduced by Lefevre and Lemery, 1666, and Ward, in London, 1740, began to make sulphuric acid on a large scale in glass vessels. The lead chamber was first used by Roebuck, of Birmingham, who, in 1746, erected such a chamber 6 feet square. The first chamber erected in France was at Rouen, in 1766. At this place, in 1774, De la Follie introduced the important improvement of the intro-

---

[1] Lunge: Sulphuric Acid and Alkali, 1891, Vol. I, page 7.

duction of steam into the chambers during the combustion of the brimstone. In 1793 Clement and Desormes showed that the chambers could be fed by a continuous current of air, by which much saltpeter could be saved. By this time the general principles of sulphuric-acid making were established, and by the end of the century there were already six or eight works in Glasgow alone, while the price of a kilogram (2.2 pounds), which, in 1740, in Germany, was about $1.12, sank in 1799 to 22 cents, and is now (1900) about three-fourths of a cent.

Lampadius (Grundriss d. tech. Chemie, Freiberg, 1815, p. 3) has given a description of a sulphuric-acid works and the manner of operation at the beginning of the Nineteenth century. From this it is learned that a mixture of five parts of sulphur and one part of niter was burned in successive charges in the lead chamber, steam being admitted at the same time and air being let in when deemed necessary. The acid obtained was weak and had to be concentrated in glass retorts up to about 1.80 sp. gr., while the yield was less than half of what would be obtained at present.

The proper construction of lead chambers involved great difficulties, it being almost impossible to make them gas-tight, until Debassyns de Richemont invented autogenic soldering. The chamber described by Lampadius contained about 300 cubic meters (10,594 cubic feet), but the dimensions have been increased until now the biggest chambers contain 4,000 to 5,000 cubic meters (140,000 to 176,000 cubic feet). The last figures appear to be too large, and the present practice is not to increase the chamber space, but to supplement the surface by means of other devices, such as the Lunge-Rohrmann plates.

Finally, in the earlier years of the Nineteenth century, the chamber process became a continuously working one, and thus was enabled to be what it now is, the foundation of the chemical industry and the measure of its extent. Improvements rapidly followed. The investigations of Gay-Lussac, on the recovery of the nitrogen oxides from the escaping gases, have given us the tower which bears his name, while the form of tower invented by Glover furnishes an efficient denitrator for the acid flowing from the Gay-Lussac tower. The simultaneous use of these two towers is a necessity in any modern, rationally managed establishment.

The use of pyrites, in place of brimstone, was first introduced in 1836, on a manufacturing scale, by Wehrle, in Nussbaum, near Vienna, and by Brem, in Bohemia. In 1862, Spanish pyrites began to be used in England, and by 1868 the use of brimstone in English works had almost entirely ceased, and now very little brimstone is used in any country of Europe for the manufacture of sulphuric acid, while the consumption in the United States for this purpose is still quite large, amounting, in the census year 1900, to 128,427,000 pounds, or about one-tenth of the total weight of the pyrites so used.

Attempts to use the roaster gases from smelting works were made in 1856–1858, and in 1859 a set of chambers using such gases was started at Oker. At present the smelting works in Germany produce (1899) 186,000 tons of H_2SO_4, about 22 per cent of the total production. As elsewhere, the principal use of this acid is in the manufacture of superphosphate, of which 500,000 tons were made in Germany in 1899.

The methods of concentration of the weaker acids have been greatly improved, the increasing cost of platinum making it necessary to exercise the greatest economy. Platinum, which in 1870 cost about $150 per kilogram, cost in 1900 over $700 per kilogram, and the price is now little less than that of gold. Heræus, in 1891, introduced the use of gold-plated platinum stills, which were found to be a great improvement.

Fuming sulphuric acid, or Nordhausen acid, as it is also called, is a mixture of sulphur trioxide (or sulphuric anhydride), with a varying proportion of monohydrated sulphuric acid. When the relation is about one part of SO_3, to one part of H_2SO_4, it is solid at ordinary temperatures, melting at 35° C., and is the "solid sulphuric acid" of the trade. As it is obtained by heating copperas, alum, or other metallic sulphates, it was the first form of sulphuric acid known, and the Pilsen acid works are already mentioned in 1526. This industry was destroyed during the Thirty Years War, but was revived at Nordhausen. In 1778 Starck reestablished the industry in Bohemia, where, on account of the cheapness of labor and of the necessary vitriol stone, his successors enjoyed a practical monopoly of this substance, until the increasing demand for it, in the manufacture of alizarin, and for many other purposes, led to researches which have given methods by which it can be made far more cheaply than by the distillation of vitriol stone, since when this is used only small charges can be worked, because the larger the charge, the higher the heat required, and the greater the loss of acid through the consequent splitting up of sulphur trioxide into sulphur dioxide and oxygen.

That these two gases could be made to recombine by the contact action of platinum and other substances, had long been known and methods of utilization proposed, but nothing of importance had been accomplished until Clemens Winkler published, in 1875, the results of his researches. In the beginning of his work, Winkler heated the vitriol stone in much larger quantities, without regard to the decomposition of the trioxides, passed the gases over platinized asbestos, thus recombining the SO_2 and O, and then absorbed the trioxide in strong sulphuric acid. The results were very satisfactory, but it was necessary to find a material cheaper than the vitriol stone. As the course of the work indicated that, for the best results, the SO_2 and O should be in stochiometrical proportions, sulphuric acid was used, because when heated sufficiently high it breaks up thus:

$$H_2SO_4 = SO_2 + O + H_2O.$$

The water vapor was easily removed and the residual gases remained in the exact proportion needed.

The need of a still cheaper material than sulphuric acid becoming manifest, Winkler began to experiment with the roaster gases of the Freiberg Smelting Works, and in time it was found that in this way two-thirds up to three-fourths of the SO_2 in these gases could be converted into SO_3. Still there were many difficulties in the way of commercial success, such as purification of the gases, etc., so that Winkler was unable to publish his further results for many years.

In the meantime the matter was taken up by the Badische Anilin und Soda Fabrik at Ludwigshafen on the Rhine, and after years of unwearied scientific investigation, in which no expense was spared, this great corporation has succeeded in solving the problem and has reaped a rich pecuniary reward.

What the commercial success of the contact process means for the future of industrial chemistry may best be expressed in the words of Winkler, who, having stated that at Ludwigshafen the new process can compete with the lead-chamber acid, goes on to say: "Therefore we can anticipate that, in no distant time, the lead chambers of to-day will be dispensed with, a condition amounting to a complete revolution in the domain of sulphuric-acid manufacture." Such a statement from so authoritative a source is a sufficient warrant for the presentation in this place of the following abstract of Knietsch's paper:

THE CONTACT PROCESS FOR THE MANUFACTURE OF SULPHURIC ACID.[1]

I. *Historical.*—The production of sulphuric acid is a matter of the greatest importance, as it is not only the foundation of the inorganic heavy-chemical industry and is used for many other purposes, but also has lately become a most important material in the organic dye-stuff industry, especially in the production of alizarine colors and of synthetic indigo. The contact process is causing a complete revolution in the methods of manufacture of sulphuric acid; hence an account of its historical development and present status should be of great interest. The historical development of this process may be divided into four periods.

First period: Phillips, in 1831, discovered the catalytic action of platinum in hastening the union of SO_2 and O to form SO_3.

Second period: Wohler and Mahla, in 1852, showed that many other substances besides platinum possess catalytic properties, and explained the character and course of the reaction.

Third period: Winkler used definite gas mixtures for the production of sulphuric anhydride, as it was then considered that only in this way could good quantitative yields be obtained.

Fourth period, the present one, is noted by the successful use of the furnace gases directly.

The investigations of the third period were directed toward the production of fuming sulphuric acid, which was then very expensive, while the investigations of the first and second periods had the same end as the work of the present time, that is, the replacement of the chamber process by improved methods.

The catalytic action of platinum was discovered by Humphry Davy in January, 1818, who showed that platinum wire, when warmed and then introduced into a mixture of oxygen (or air) with H, CO, ethylene, or cyanogen, became incandescent, and that the gas mixture oxidized, usually gradually, but often rapidly.

Edmund Davy, in 1820, discovered that finely divided precipitated platinum, when moistened with alcohol and exposed to the air, becomes incandescent and the alcohol burns.

Doebereiner, in 1822, found that finely divided platinum, obtained by heating ammonio-platinic chloride, acted in the same manner, and, in 1824, that such platinum could ignite a stream of hydrogen, when this impinged upon it in contact with air, and utilized this discovery in his celebrated "lighting machine."

The honor of having first utilized this catalytic action, for the production of sulphur trioxide, is due to Peregrine Phillips of Bristol, England, who, in 1831, took out an English patent for his discovery, and, in 1832, Doebereiner and Magnus each confirmed the observations of Phillips. Although this discovery attracted much attention, nothing practical followed until 1848, when Schneider exhibited a working model of an apparatus, which produced sulphuric acid through the contact action of a specially prepared pumice. This alleged discovery was presented with great claims, but never was able to show a success, although wonderful results were confidently predicted. The same may be said of the method of Richard Laming, who also used a contact mass of pumice, prepared by boiling it in concentrated sulphuric acid, washing it in ammoniacal water, drying, and then impregnating it with about 1 per cent of manganese dioxide, finishing by heating the mass in a retort to 600° and allowing it to cool out of contact with the air. Here we note for the first time, the use of another contact substance which, like platinum, can exist in various grades of oxidation, namely, manganese.

Especially noteworthy in this connection is the English patent of Jullion, 1846, because here, for the first time, the use of platinized asbestus as a contact mass is claimed. In 1849, Blondeau passed a current of a mixture of sulphur dioxide, steam, and air through a highly heated tube containing ferruginous, argillaceous sand and obtained sulphuric acid, while, in 1852, Wohler and Mahla found that oxides of iron, copper, and chrome also work catalytically upon a mixture of SO_2 and O, a mixture of cupric and chromic oxides being especially efficacious. These investigators gave, moreover, a correct explanation of this catalytic action; they found, namely, that cupric and ferric oxide, when heated in a current of sulphur dioxide free from oxygen, became

---

[1] R. Knietsch, Ber. d. d. Gesell, 1901, page 4069.

reduced to cuprous and ferroso-ferric oxides with simultaneous formation of sulphuric acid which, however, ceased as soon as the reduction of the oxides was completed. On the other hand, chromic oxide, under similar conditions, remained entirely unaltered and no sulphuric acid was produced, while metallic copper, in spongy form, exerts no action upon a mixture of 2 vol. SO_2 + 1 vol. O at ordinary temperatures, but, when heated, cupric oxide is first formed, and then sulphuric acid.

They also call attention to the fact that this union of SO_2 and O can take place in the complete absence of H_2O.

Upon these important discoveries are based the later researches of Lunge and others upon the catalytic action of pyrites cinder in causing the formation of SO_3. Quartz has also been recommended for this purpose, as have also platinized asbestus, platinized pumice, and even platinized clay.

Hundt, 1854, passed the hot roaster gas through a flue, filled with quartz fragments and heated by the gas, expecting to convert the greater part of the SO_2 into sulphuric acid with further treatment of the residue. The work of Schmersahl and Bouk, 1855, followed the same lines, as did also the method of Henry Deacon, which was patented in 1871, and may be considered as closing the second period.

So far, not only had all attempts to supersede the chamber process failed, but also no practical method for the production of fuming sulphuric acid had been devised. In 1875, Clemens Winkler published his celebrated researches upon the formation of sulphuric anhydride, for which industrial chemistry must always be greatly indebted to him, as originating successful methods for the economical production of the fuming sulphuric acid for which, as it has become cheaper, many new uses have been discovered.

Winkler concluded, as a result of his experiments, that the SO_2 and O should always be present in the molecular proportion of 2:1, any excess of either gas having a deleterious influence upon the completeness of the reaction, and he obtained this desired proportion by simply breaking up ordinary hydrated sulphuric acid into H_2O, SO_2, and O, removing the H_2O, and then recombining the SO_2 and O by means of appropriate contact substances, the preparation of which he greatly improved by utilizing the reducing action of formic acid. All subsequent work in this branch continued to follow the lines laid down by Winkler; hence, while little progress was made toward superseding the lead chamber, the manufacture of fuming sulphuric acid became highly developed.

II. *Knietsch's Work—Purification of the Gas.*—This work was undertaken by the Badische Anilin und Soda-Fabrik to determine if a complete conversion of the SO_2 in roaster gas was as practically feasible as it is theoretically possible.

It is well known that the outgoing gases of the chamber process still contain 6 volume per cent of oxygen, and that the roaster gas employed in the contact work contained a similar excess. Hence it was difficult to understand why, in the latter process, the yields were not nearer that of the former.

Experiments showed that when pure SO_2 was used the yield was close to the theoretical, even when a very large excess of O was present, which was contrary to the accepted views of Winkler.

When roaster gas was used in laboratory experiments, it was found that when this was carefully cooled, washed with sulphuric acid, and completely purified before it was allowed to enter the catalytic tube, the results were very satisfactory, nor could any diminution of the efficiency of the contact mass be noted even after several days' use. It was therefore supposed that the problem had been solved, and arrangements were made to carry on the process on full working scale.

It was, however, soon found that in practice the contact mass gradually lost all of its efficiency, no matter how carefully the gases were cooled and purified. Extended laboratory investigations were undertaken to determine the cause of this inefficiency, and it was ultimately discovered that there are substances which, when present in the gas, even in excessively small quantities, injure the catalytic properties of platinum to an extraordinary degree. Of all of the substances which may be found in roaster gas, arsenic is by far the most deleterious, next mercury, while Sb, Bi, Pb, Fe, Zn, etc., are injurious only so far as they may coat the contact mass.

It was also found that as the white cloud of sulphuric acid which was present in the gas contained arsenic, the complete removal of this was necessary, although such removal had always been considered an impossibility. This was, however, finally accomplished after an enormous expenditure of time, labor, and money, so that, in the end, by extended washing and filtration, the gases were obtained in a condition absolutely free from all impurities. (D. R. P. 113933, July 22, 1898.)

Slow cooling of the gas was found to be absolutely necessary as a preliminary to its purification. It is a fact, the cause of which is not yet clearly known, that the removal of the white cloud is rendered far more difficult if the gas is rapidly cooled.

To insure slow cooling, a system of iron tubes was used because it was supposed that, as the sulphuric acid in the gas was in a so highly concentrated condition, any action upon the metal would yield SO_2 only. It was now found that although the contact mass remained active for a much longer period, it still gradually lost its power, no matter how carefully the gas was purified. The cause of this was ultimately found to be a gas containing arsenic, probably hydrogen arsenide, produced by the action of the acid upon the iron by which hydrogen was evolved, although the formation of this gas under such conditions had always been considered impossible. As soon as the cooling apparatus was so arranged that no condensed acid could attack the iron, the trouble from this source entirely ceased.

A final difficulty occurred in the occasional formation of a faint cloud of unburnt sulphur which contained arsenic. The cure for this was found to be a proper mixing of the hot gases, thus insuring complete combustion, and this mixing was effected by means of steam, which is also beneficial, by diluting the strong sulphuric acid present in the gas, so that it did not condense in the iron pipes of the first portion of the cooling apparatus, and attack them; when condensing in the lead pipes of the remainder of the apparatus, the acid was too weak to injure the lead. The use of steam also prevented the formation of hard dust crusts, which tend to stop up the pipes.

III. *Cooling of the Gases.*—The next important element in the successful carrying out of the contact process is the effective and economical utilization of the heat developed by the reaction which is exothermic.

$$SO_2+O=SO_3+22600 \text{ cal.}$$

The utilization of this heat had been suggested by Lunge, but only in the case of the use of a mixture of pure SO_2 and air, containing about 25 per cent of the former. On the other hand, it was universally considered that it was necessary to employ extra heat when the much weaker roaster gases are to be treated. Hence the apparatus used in this work was furnished with special heating arrangements so that the tubes could be kept at red heat, the tubes being arranged vertically like those of an upright boiler. Small, vertical tubes are much superior to the larger, horizontal ones, originally employed, as economizing the expensive platinized asbestus and insuring a more certain contact of the gases with the mass. The proper filling of the tubes with the asbestus is a matter of importance; it must be so done that no portion of the gas can pass through a tube without coming in contact with the mass, while the mass must not offer much resistance to the passage of the gas. Owing to the nature of the asbestus, this latter difficulty is likely to occur, but can be avoided by the simple device of packing the asbestus in successive layers, separated by perforated diaphragms sliding upon a central rod, but kept apart at regular intervals. In this way all of the tubes can be similarly and evenly packed.

As soon as this apparatus was started in the ordinary way at low red heat, the surprising discovery was made that not only was the output of acid increased, but that the strength of the gas current could be made greater when the tubes, instead of being heated artificially, were, on the contrary, cooled by the admission of cold air. This discovery, a contradiction of what had been considered correct practice, gave a rational method of work; i. e., the apparatus must be systematically cooled to obtain the maximum effect and production. As now operated, the tubes are cooled by the cold, purified gases, which thus become heated to the proper temperature for the reaction. In this way the following advantages are gained:

First. Overheating of the apparatus is avoided, and thus a yield of 96 per cent—98 per cent of the theoretical—is obtained.

Second. The iron parts of the apparatus are protected by this cooler working, and are therefore more durable.

Third. The contact mass does not become overheated and its efficiency remains unimpaired.

Fourth. The absolute efficiency of the contact mass, and of the entire apparatus, is greatly increased because the rapidity of the gas stream can be increased, and the contact mass be maintained at the most efficient temperature.

Another important discovery is that the reaction proceeds at atmospheric pressure, since it was formerly supposed that compression of the gases was necessary to overcome the hindrance of the indifferent gases present. In fact, if the other conditions are right the reaction proceeds almost quantitatively at atmospheric pressure. This is very important since, if this method is to compete with the chamber process, every unnecessary expense must be avoided.

IV. *Absorption of the Produced Anhydride.*—The affinity of sulphuric anhydride for water is greater than for concentrated sulphuric acid, as shown by the relative amount of heat developed during the absorption; hence it might be expected that the easiest and most complete absorption of anhydride from the contact process would be effected by the use of water. It is found, however, that oil of vitriol containing 97–99 per cent of H_2SO_4 is much more effective than either water or sulphuric acid of any other strength. The absorbing power of the acid at this degree of concentration is so great that a single absorption vessel is sufficient for the removal of the SO_3 from a very rapid current of gas, provided that the strength of the acid be kept uniformly between the above limits by a steady inflow of water or weak acid, and a proportional outflow of the excess of strong acid thus produced.

Sulphuric acid, at this particular degree of concentration, possesses certain marked qualities. Its boiling point is a maximum, so that if a weaker acid is evaporated, it loses water or weak acid until the residue attains a strength of 98.33 per cent H_2SO_4, at which point it distills without further change at a constant temperature of about 330°. Similarly, a stronger acid gives off anhydride until this constant strength is reached. Again, at this particular degree, the vapor pressure is at its minimum, the specific gravity is at the maximum, the electrical resistance suddenly rises, while the action on iron decreases considerably.

When fuming sulphuric acid is to be made, one or more absorption cells must precede the regular apparatus. For these, cast iron, which is quite suitable as the material for the other vessels, becomes unavailable, because, although it is only slowly attacked, it, what is worse, becomes fragile and even explodes. This appears to be due to the fuming acid diffusing into the iron and then breaking up into SO_2 and H_2S, thus causing a condition of internal stress. Wrought iron is attacked by fuming acid containing less than 27 per cent of SO_3, but when the contents of anhydride exceeds this, the acid has practically no action upon wrought iron, and vessels of this material can be used for years without sensible corrosion.

V. *Theory of the Contact Process.*—The results of many experiments showing the influence upon the reaction of variations in the temperature, the composition of the gases, the rate of flow (or the proportion of contact substance over which the gas passes) are given in the form of curves, and discussed, yielding the following results:

1. Complete conversion of the SO_2 into SO_3 occurs only when there is at least twice as much oxygen present as the reaction formula indicates. When using the gas obtained from the roasting of pyrites, and which contains about 7 vol. per cent of SO_2, 10 vol. per cent of O, and 83 vol. per cent of nitrogen, the nitrogen is absolutely without influence upon the reaction, except as diluting the gas and reducing the output.

2. The completeness of the reaction depends solely upon the temperature and not upon the nature of the contact substance. The reaction begins at about 200°. As the temperature rises, so does the degree of conversion, until, at about 400°, a nearly complete (98 to 99 per cent) conversion of the SO_2 is feasible. Any further rise in temperature is injurious, the degree of conversion falling so that at about 700° only about 60 per cent can be converted, while at about 900° the reaction ceases entirely.

3. The nature of the contact substance has no influence upon the completeness of the reaction, but, for practical results, a substance must be employed which shows a high degree of efficiency at the proper temperature of 400°. Substances, which require a higher temperature to develop their greatest efficiency, are evidently unsuited, since, as shown above, the degree of conversion falls with the rise in temperature. Up to the present time only one substance fulfilling the necessary conditions is known, and that is platinum. None of the other metals of the platinum group approaches it in efficiency.

This valuable paper concludes with a series of tables, giving the results of exhaustive sets of determinations of the following properties of sulphuric acid, and of fuming sulphuric acid of various strengths from 1 to 100 per cent of SO_3:

1. Melting point. 2. Specific gravity. 3. Specific heat. 4. Heat of solution. 5. Electrical resistance. 6. Action upon iron. 7. Boiling point. 8. Vapor pressure. 9. Viscosity. 10. Capillarity. 11. Table giving the percentage of free SO_3 in a fuming sulphuric acid when the total contents of SO_3 is known.

Production of Sulphur Trioxide.—The growth and present magnitude of the operations of this process in the works of the Badische Anilin-und-Soda-Fabrik are shown by the following figures:

Sulphur trioxide produced in—	Tons.
1888	18,500
1894	39,000
1899	89,000
1900	116,000

It will be seen from the foregoing, that this process has long passed the experimental stage, and now that the general conditions of successful operation are known, its speedy adoption in this country is to be expected. The advantages are many: First, no expense of construction and maintenance of the entire chamber system, including the Gay-Lussac and Glover towers and the steam and niter plant. Second, no expense for niter and for the sulphuric acid used therewith; although the resulting niter cake can be utilized, it is rarely a desirable product. Third, the acid produced is pure, strong oil of vitriol, requiring no concentration for sale or use. Concentration of chamber acid to high strengths requires the use of platinum stills, which thereby lose in weight, the dissolved platinum being irrevocably lost. The rate of loss is much reduced by previous purification of the acid, but is always a considerable item of cost. Fourth, the contact acid is also free from arsenic, lead, or iron salts. The fundamental difference in the character of the reactions in the chamber process and of those in the contact method indicates the possibility of substantial improvements in the methods of roasting. Fifth, although the 50 degree acid, as it comes from the chambers, is desirable for many purposes—for example, in making superphosphates—it is held by some authorities that it can be made more cheaply by diluting the strong acid with the needed proportion of cold water, than by introducing this water into the chambers in the form of steam. This, however, is denied by others, and it is probable that the chamber process will continue to exist, though in a more restricted field.

On the other hand, this new process appears to require a well planned and carefully managed system of purification for the roaster gases, and will need, for its successful operation, a higher order of chemical engineering skill than has usually been deemed necessary for the operation of an acid plant. This, however, should hardly be considered an obstacle in this country, where all other branches of engineering manufacture have reached such a height, mainly because the works have demanded and made liberal use of the highest order of trained ability, and have not hesitated to "scrap" expensive plant where it failed to give satisfactory results. In this connection the Badische Anilin-und-Soda-Fabrik is an instructive example. Its chemical force numbers over 100 men, many of whom are engaged solely upon researches, the results of which, when promising, are at once put into operation on a sufficiently large scale to determine their practical value. That such a course pays in a strict business sense is shown by the enormous dividends paid by this company, and by the practical monopoly which it has long maintained in certain lines, simply because it has been a little ahead of its competitors in knowing just how a given thing should be done, and then at once protecting the discovery by patents.

In addition to sulphuric acid, reports have been received regarding the production of the acids enumerated in the following table:

ACIDS, OTHER THAN SULPHURIC, BY KIND, QUANTITY, AND VALUE: 1900.

KIND.	Number of establishments.	Quantity.	Value.
		Pounds.	
Nitric	34	30,961,501	$1,454,909
Mixed	9	42,368,819	1,111,258
Muriatic	31	116,848,001	1,020,574
Boric	3	2,384,935	198,212
Acetic	12	26,660,565	426,892
Lactic and citric	3	3,886,382	335,297
Tartaric	4	2,677,004	781,603
Tannic	5	282,515	135,662
Gallic	3	141,291	20,275

It is to be understood that the quantities and values given in this table represent only the acids sold as such, or produced for sale in the establishments, for the actual production, in many cases, is much greater than that given above. Thus the first item on the list, nitric acid, is used in the making of the "mixed acids," which is the second item on the list. This mixed acid is not only manufactured in the acid factories and sold to explosive works, to manufacturers of pyroxylin for use in the making of plastics and of varnishes, and to other manufacturers, but many of the larger works now make the nitric acid which they consume in this manner. There is thus made and consumed more nitric acid than is sold as such, the production as reported amounting to 62,473,295 pounds, which is probably less than the total amount actually made for use and sale. Theoretically, 74.13 parts of nitric acid monohydrate can be made from 100 parts of pure sodium nitrate, but in practice, only 95 per cent of this is condensed, while 5 per cent passes to the towers. From this, then, there would be required 43,841 tons of nitrate of soda and 47,348 tons of sulphuric acid to produce the above-given quantity of nitric acid, and there would result as a by-product 52,609 tons of niter cake. It is to be borne in mind that nitric acids of various degrees of strength, ranging from single aquafortis of specific gravity 1.22, and double aquafortis of specific gravity 1.36, to the strongest nitric of 1.50 specific gravity, and red fuming of 1.60 specific gravity are to be found in the market, and that no attempt has been made to separate them as to quantity, or to reduce them to a common basis, so that the data must be regarded as of average value.

Nitric acid was manufactured at Philadelphia in 1834 by Carter & Scattergood. The most notable recent advance made in its manufacture is in the form of apparatus employed, which is due to Edward Hart and Oscar Guttman. It is used in the manufacture of nitrates like silver nitrate, or nitrites like sodium nitrite; in making "mixed acids" and aqua regia; in making nitrosubstitution compounds, like nitrobenzene, nitronaphthalene, and picric acid; organic nitrates, such as gun cotton and nitroglycerin; as an oxidizing agent in many chemical processes; and for the etching of metals.

By "mixed acids" is meant mixtures of nitric and sulphuric acids which are employed in "nitrating" organic substances such as glycerin, cellulose, and carbolic acid. The commercial use of such a mixture began with the manufacture of nitrobenzene and picric acid, but it received its greatest impetus about 1862 when the commercial manufacture of nitroglycerin began. Originally the users of this mixed acid purchased the sulphuric and nitric acids and mixed them in the desired proportions for use, the acids being transported in separate carboys of glass. These not infrequently became broken during transportation, and as the nitric acid rapidly reacts with and "fires" such organic matter as is used as packing for carboys, its transportation gave rise to many serious accidents, which led to restrictive legislation. It is not known to whom the credit is due for the discovery that mixed acids of the highest concentration did not act upon iron, but for upward of twenty years manufacturers have been making the desired mixtures at the acid works and shipping them in iron drums, old glycerin drums having been first employed. With the increase in the production in works, attention has naturally been given by chemists to the utilization of the residues, and large economies have resulted from the regaining of the "spent acids" by which the sulphuric acid has been obtained of a strength sufficient for reuse in the ordinary course of manufacture, and the nitric acid, though recovered in a weak state, has been of value in other arts.

Owing to the necessity of having concentrated nitric acid to mix with this regained sulphuric acid, and to the fact that the transportation charges on nitric acid are very high, and the necessary regulations governing its transportation are vexatious to the consumers, many of the larger establishments have erected nitric-acid plants. In considering the magnitude of this industry there is to be noted not only the mixed acid sold as such, 42,368,819 pounds, the mixed acid produced and consumed in chemical works, 8,902,371 pounds, and the mixed acid reported produced and consumed in explosive works, 12,000,000 pounds, making in all 63,271,190 pounds, but there is also to be taken into account this repeated reuse of the acid. From the products reported of all kinds, nitroglycerin and dynamite; gun-cotton; pyroxylin for varnishes, for smokeless powder, for plastics, and for photography; and the nitrosubstitution compounds, it is safe to say that 65,000 tons of mixed acids were employed during the year 1899–1900.

Hydrochloric acid, commercially known as muriatic acid, is made by acting on common salt with sulphuric acid. The ordinary muriatic acid of commerce is an aqueous solution containing about 40 per cent by weight of dry hydrogen chloride. For the amount of hydrochloric acid reported on this standard there would be required for its production 37,000 tons of common salt and 39,000 tons of sulphuric acid of 60° Baumé, and there would be obtained in addition to the muriatic acid 47,000 tons of salt cake, which consists of sodium sulphate, together with some undecomposed common salt, and an excess of sulphuric acid. A new development in this trade is in the use of wooden barrels as containers in place of the glass carboys in which it was formerly transported.

Carter & Scattergood manufactured muriatic acid in Philadelphia in 1834, and Charles Lennig began its manufacture by modern methods in Philadelphia in 1869. Hydrochloric acid is used in the preparation of many organic and inorganic chlorides. Mixed with nitric acid it forms aqua regia, which is used in dissolving the precious metals. It has largely been used as a source of chlorine in the manufacture of bleaching powder and potassium chlorate. It is used in the manufacture of acetic acid and gelatin, in the manufacture of soda, and in a multitude of minor arts. The salt cake is used in the Le Blanc process for the manufacture of soda, for glass making, for ultramarine, in dyeing and coloring, and for the production of Glauber's salts.

Acetic acid as treated of under "chemicals" does not include vinegar, which is a very dilute acetic acid made largely by fermentation, but it covers such acid as is produced by chemical action from acetates, principally the calcium and sodium acetates. Calcium acetate is obtained in the destructive distillation of wood. The acetic acid is obtained from it by treatment with hydrochloric acid and distillation. This may be purified by rectification with potassium dichromate. A better product is obtained by converting the acid into a sodium salt and evaporating to dryness to destroy tarry matters and then distilling with hydrochloric or sulphuric acids. Acetic acid, varying in strength from 28 per cent to 90 per cent, is sent to the market in barrels holding on an average 425 pounds. Acetic acid is used in the preparation of metallic acetates, which are extensively used in dyeing and printing; or of organic acetates, such as ethyl and amyl acetates, which are used as solvents and flavors; in the manufacture of white lead; and the preparation of organic compounds. As an example of its use Lachman[1] states that in the preparation of the chloracetic acid used by the Badische Anilin-und Soda-Fabrik in the manufacture of synthetic indigo in 1900 there were used 4,500,000 pounds of glacial acetic acid, requiring 26,000 cords of wood for its production.

Lactic acid, citric acid, and tartaric acids are used in dyeing and in calico printing. Lactic acid is prepared by fermenting a sugar solution by means of certain bacteria, neutralizing the acid with calcium carbonate, and decomposing the calcium lactate thus formed with sulphuric acid. Lactic acid was manufactured by the Avery Chemical Company at Littleton, Mass., in 1882.

Citric acid occurs in the free state in the juices of all the plants of the genus *Citrus*, such as limes, lemons, and sour oranges. Good lemons yield about 5½ per cent of the crystallized acid. It is obtained by neutralizing the juice of the fruit with chalk and decomposing the resulting calcium citrate with an equivalent amount of sulphuric acid. This acid was manufactured by Carter & Scattergood at Philadelphia in 1834.

Tartaric acid occurs free or combined in many plants, but the only source from which it is commercially obtained is the grape. During the fermentation of grape juice, as the alcohol increases in quantity the calcium and potassium tartrates present in the juice are precipitated out, together with a quantity of organic coloring matter, forming what is known as argols. After purification it is treated with chalk and calcium sulphate to convert it into calcium tartrate, and this when decomposed with sulphuric acid yields free tartaric acid. This acid was manufactured by Carter & Scattergood in Philadelphia in 1834.

The foreign commerce in acids is exhibited in the following tables, compiled from the publications of the Bureau of Statistics, of the United States Treasury Department:

---

[1] J. Am. Chem. Soc., vol. 23, page 912: 1901.

IMPORTS FOR CONSUMPTION DURING THE YEARS ENDING JUNE 30, 1891–1900.

YEAR.	[1]SULPHURIC ACID OR OIL OF VITRIOL (N. E. S.).		[1]SULPHURIC ACID.		BORACIC ACID.						CHROMIC ACID.		CHROMIC AND LACTIC ACID.	
					Commercial.		Pure.		All kinds.					
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1891	15,377	$836	....	....	152,093	$7,975	39,394	$2,906	475,378	$30,138	 506	$1,587 155	....	....
1892	8,277	478	8,735	$339	....	....	....	....	701,625	39,418	426	156	....	....
1893	634	43	8,735	1,033	....	....	....	....	771,775	40,568	3,318	609	....	....
1894	17,053	405	400	32	....	....	....	....	292,990	19,282	5,048	824	....	....
1895	12,574	186	7,459	461	....	....	....	....	925,154	42,056	4,461	707	....	....
1896	36,798	475	48,759	1,606	....	....	....	....	555,769	21,899	2,440	409	....	....
1897	3,200	43	59,729	4,074	....	....	....	....	548,603	19,494	2,708	430	....	....
1898	25,350	786	2,725	40	134,707	4,053	244,073	7,994	....	45,265	6,720	906	64,066	$4,917
1899	40,175	1,874	....	....	....	....	436,958	14,303	....	56,428	....	....	23,969	4,843
1900	34,944	972	....	....	....	....	466,879	17,467	....	53,625	....	....	34,741	6,044

YEAR.	CITRIC ACID.		TARTARIC ACID.		OXALIC ACID.		SALICYLIC ACID.		ACID, TANNIC OR TANNIN.		ALL OTHER ACIDS.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1891	45,197	$15,482	1,511	$468	2,743,222	$200,595	....	....	659	$239	1,350,710	$380,054
1892	80,034	27,461	10	5	2,209,940	150,529	....	....	564	216	1,024,580	347,510
1893	13,315	4,633	130	39	2,464,443	143,194	260,027	$254,022	1,443	597	685,677	175,637
1894	5,502	1,810	113	32	2,783,876	159,026	252,332	231,946	794	287	835,215	134,665
1895	8,895	2,480	355	88	2,889,513	189,506	196,974	140,197	1,500	597	1,798,417	228,430
1896	39,671	12,521	212	66	3,164,969	219,630	335,354	138,018	1,745	681	1,027,235	240,522
1897	73,133	18,158	225	71	3,602,124	246,200	616,187	201,980	3,144	1,296	3,040,325	223,458
1898	4,323	1,108	455	128	3,747,041	242,276	92,943	28,688	2,335	927	....	45,265
1899	65,190	16,659	23,298	5,737	3,981,768	246,027	185,358	57,192	3,697	1,371	....	56,428
1900	60,354	14,213	954	252	4,990,123	275,747	240,687	89,175	1,415	671	....	53,625

[1] From the value given this would appear to be fuming sulphuric acid.

GROUP II.—SODA PRODUCTS.

The great increase in this branch noted in the Census report for 1890 has continued during the past decade. The number of establishments making soda products as the main part or as a subsidiary of their business has increased from 32 to 50, while the products have increased as shown in the following table. To these figures for 1900 must be added "other soda products," not otherwise specified, produced by these works and valued at $143,432, and also 11,756,000 pounds of borax, valued at $541,160, made by seven borax works. These items were not included in the report for 1890 and are therefore not taken into the comparison. Where the figures of this table show an increase over the figures for the same items in other tables of this census, the difference is due to the inclusion here of all such products made by works belonging to other groups, for example, the caustic soda produced by electrolysis, which is included in the products of that group and not separately reported. This table shows the total actual production of the United States for the census year from all sources; and while the figures differ, there is no discrepancy.

SODA PRODUCTS, BY QUANTITY AND VALUE, 1890 AND 1900.

	1900		1890	
	Pounds.	Value.	Pounds.	Value.
Total	1,279,082,000	$10,237,944	333,124,375	$5,432,400
Soda ash	781,306,000	4,859,656	94,801,200	1,179,720
Sal soda	126,498,000	875,243	144,641,705	1,581,766
Bicarbonate of soda	137,712,000	1 332,765	60,678,750	2,009,800
Caustic soda	233,566,000	3,170,280	33,002,720	661,114

The decrease in the production of sal soda is noteworthy and is due to the increasing use of soap powders and other specially prepared washing materials. A comparison of these totals with the corresponding figures for 1880 is interesting.

SODA PRODUCTS, BY DECADES, 1880 TO 1900, WITH PERCENTAGES.

YEAR.	Number of establishments.	TOTAL PRODUCT.		PER CENT OF INCREASE.	
		Pounds.	Value.	Quantity.	Value.
1880	3	40,259,938	$866,560	....	....
1890	32	333,124,375	5,432,400	727.4	526.9
1900	50	1,279,082,000	10,237,944	284.0	88.5

There are no figures for soda products anterior to 1880, except that at the census of 1860, 11 establishments were reported manufacturing saleratus, with a total value of $1,176,000, while at the census of 1870, only 4 were reported, with a value of products of $231,647, a decrease which is remarkable in view of the general development of other industries during that decade.

Although the production has almost quadrupled during the past decade, the value per unit has fallen greatly. Taking the customary unit of 100 pounds, we find the following decrease of values:

YEAR.	Soda ash.	Sal soda.	Bicarbonate of soda.	Caustic soda.
1890	$1.24	$1.09	$3.31	$2.00
1900	.62	.77	.97	1.35
Decrease	.62	.32	2.34	.65
Percentage	50.00	29.35	70.69	32.50

This great increase in domestic production has resulted in a corresponding diminution of importations. The Treasury report of importations for 1890 gives soda ash and sal soda together as 332,733,952 pounds, valued at $3,493,288; caustic soda, 80,125,732 pounds, valued at $1,470,335; and bicarbonate of soda, 917,034 pounds, valued at $16,319; while the same report for 1900 gives soda ash, 78,571,870 pounds, valued at $648,450; sal soda, 6,624,194 pounds, valued at $31,072; and caustic soda, 11,429,989 pounds, valued at $177,857; but does not report bicarbonate separately. A comparison of these quantities shows what progress has been made toward supplying the home market.

YEAR.	Soda ash and sal soda, pounds.	Caustic soda, pounds.
1890	332,733,952	80,125,732
1900	85,196,064	11,429,989
Decrease	247,537,888	68,695,743
Percentage	74.39	85.73

The ratios of quantities of these materials imported to the domestic production are as follows:

YEAR.	SAL SODA AND SODA ASH.		CAUSTIC SODA.	
	Foreign.	Domestic.	Foreign.	Domestic.
1890	100	72	100	41
1900	100	1,075	100	1,979

Some of the imported soda ash and caustic has undoubtedly been used to make a part of the soda products reported at the census of 1900, but the quantity so used can not be ascertained and is in any case not large. The remainder, so far as concerns works making soda products from purchased soda ash, etc., was drawn from domestic sources, hence to this extent there is a duplication of quantities and values. This duplication is unavoidable. Had there been no imported stock on hand at the beginning of the census year and no importations during it, there would have been no difficulty in making any deductions needed to make the totals of quantities and values given in the table of soda products by quantity and value, 1890 and 1900, quite accurate. The returns for 1900 have been sufficiently studied to show that this duplication is proportionally small, that the totals given above are fairly correct, and that the real growth and present condition of the industry is substantially as shown. Most of the soda ash and bicarbonate reported are products of the ammonia-soda process, the cryolite process being limited by the supply of the mineral, and the natural soda industry restricted by cost of transportation to markets.

Natural Soda.—The manufacture of soda products from the natural soda of the West has increased from 10,964,390 pounds, valued at $124,783, in 1890, to 20,420,000 pounds, valued at $106,600, in 1900. This increase is very small, because, although the raw material is available in inexhaustible quantities (and with a well-arranged plant, soda ash can be delivered f. o. b. cars at the works at a cost less than one-half of that of ash at any ammonia-soda works in this or any other country), the distance from large eastern markets and consequent high freight rates have precluded successful commercial competition, especially in the face of steadily falling prices of the product. Of late the economic conditions have materially changed and will continue to improve. The past two years have seen great enlargements in the industries and commerce of the Pacific states, while the recent political occurrences in the Pacific and in Asiatic countries have profoundly altered trade conditions and indicate an enormous increase in our Pacific commerce in the near future. In supplying the demands of this commerce our natural soda deposits, when properly developed, can distance all rivals.

Although the operations so far carried on have been on a comparatively small scale, the subject has been carefully studied and much valuable information obtained. For example, at Owens Lake, California, the cost of making a ton of soda ash under local conditions is fairly well ascertained, and the lines to be followed to reduce manufacturing cost clearly indicated. Again, the extent of land suitable for evaporating vats is, in this locality, the measure of the possible development of the industry, and this is known. Many other important data have thus been secured, and as a general conclusion it may be safely stated that at Owens Lake alone there is space for works large enough for a production of soda ash more than equivalent to the entire demand of this country for soda products. All this is unquestioned by anyone having a practical acquaintance with the matter, and only the limited radius of profitable marketing has retarded the development of this locality. This industry is therefore not a hypothetical one, but based on solid fact and experience, and because of this and the prospects for the future, it has been deemed advisable to devote especial attention to it in this report.

The report on chemical products for the census of 1880 gave an interesting résumé of the existing information concerning the occurrences of natural soda, and later the subject was investigated, the result being published in "Natural Soda, its Occurrence and Utilization," T. M. Chatard, Bulletin No. 60, United States Geological Survey, 1888. An extensive abstract of this paper was made by Prof. George Lunge and published in the Zeitschrift für Angewandte Chemie, 1893, pages 3–11, because, as he states, he considered the existence of such enormous quantities of natural soda a most important factor in the future of the alkali industry. This same eminent authority, in The Mineral Industry for 1892, page 64, also says:

> There can be no doubt that the immense quantities of "natural soda" shown by Dr. Chatard and other authorities of the United States Geological Survey to exist in the Californian and other soda

lakes, will not be allowed to lie dormant any longer. If these lakes are once worked with the energy which is otherwise not wanting in America, the days are numbered when Liverpool soda will rule in the New York market.

In 1892 Dr. Lunge visited Owens Lake, California, the most important natural soda locality, and, while confirming the general conclusions given in the above-mentioned bulletin, placed the cost of product at a much lower figure than there stated.

In the same volume of "The Mineral Industry" there is an article on "Natural Soda" which gives additional data and suggestions as to the lines to be followed in the commercial development of this industry.

Natural soda is the residue obtained by the evaporation of natural alkaline waters without the aid of artificial heat. It is composed of sodium carbonate and bicarbonate in varying proportions, mixed with other salts, mainly sodium sulphate and chloride. It is found to some extent in all dry regions, such as Hungary, Egypt, and the deserts of Africa and Asia, but in no other country does it occur in such enormous quantities as in the region lying east of the Sierra Nevadas. It forms the white incrustations of the alkali plains, but these are rarely of sufficient thickness and extent for prospective utilization, particularly as the "sinks," or lakes without outlet, in which nature has collected and concentrated the leachings and drainage of the alkaline districts, already contain more sodium carbonate than would suffice to supply the entire world demand for generations. That this is no exaggeration is made evident by considering only three of these lakes, the dimensions of which are known and the waters of which have been repeatedly and carefully analyzed.

In southeastern Oregon is Abert Lake; area 40 square miles, average depth 10 feet. In Mono County, Cal., we find Mono Lake; area 85 square miles, average depth 60 feet. In Inyo County, Cal., lies Owens Lake, with an area of 110 square miles and an average depth of over 17 feet. In computing the volume of water the usual unit is an acre-foot, which is equal to 43,560 cubic feet, and as the analysis tells the amount of the sodium carbonate, Na_2CO_3, and bicarbonate, $NaHCO_3$, in a given volume, we get the following results for these three lakes:

	Acre-feet.	Na_2CO_3, tons.	$NaHCO_3$, tons.
Abert Lake	256,000	3,428,352	1,560,000
Mono Lake	3,264,000	75,072,000	17,936,000
Owens Lake	1,088,000	39,875,200	8,431,000
Total		118,375,552	27,927,000

These are the largest occurrences, but there are many others, aggregating probably a far greater amount.

In addition to these two carbonates the waters of these lakes contain much sodium sulphate and chloride, with smaller proportions of sodium borate, potassium chloride, and other salts. The valuable constituents are the two carbonates, and the method of separating them from the other salts is based on fractional crystallization, which means the methodical stoppage of a crystallizing process by drawing off the mother liquor from the "crop" of crystals so far formed. This "first crop" may be either the desired material in a purer condition than it was in the original solution, or else may consist mainly of impurities which we wish to remove, this depending upon the proportions of the substances in solution or their relative solubilities under the conditions.

Now, all solutions of natural soda contain both sodium carbonate and bicarbonate, and it is upon the property of these two salts when in solution to unite to form a compound more soluble than bicarbonate but less soluble than carbonate, that the method of extraction is founded. If a solution of the two salts be exposed to spontaneous evaporation, there will be formed, at a certain degree of concentration, a crop of acicular crystals which have a composition corresponding to 46.90 per cent of Na_2CO_3, 37.17 per cent of $NaHCO_3$, and 15.93 per cent of H_2O (water). The scientific name of this salt is urao, but it is usually called "summer soda." The amount of this salt thus obtained will depend upon the amount of bicarbonate present, as every 37.17 parts of bicarbonate will, in crystallizing, take with it 46.90 parts of Na_2CO_3. If more bicarbonate is present than is needed to form summer soda, the excess will crystallize out before the summer soda forms. If too little is present, the excess of carbonate remains in solution.

If a sample of water be evaporated from any of these lakes to a certain concentration point (sp. gr. 1.260 for Owens Lake water), crystallization will begin, the crystals being crude summer soda. Owing to the presence of so much sulphate and chloride in the solution, the crop becomes more and more contaminated with these salts as the concentration proceeds. Hence, to obtain an article of a fair degree of purity, the process must be interrupted at some definite degree of specific gravity and the mother liquor drawn off. If the mother liquor be further evaporated, successive crops can be obtained, the earlier ones, in the case of Owens Lake, being principally sulphate and the later ones chloride. Finally remains a mother liquor rich in potash salts, from which, on cooling to a low temperature, the ordinary sal soda ($Na_2CO_3.10H_2O$) crystallizes.

While all of these localities can produce summer soda in the manner described, the proportion of bicarbonate present is, in each case, insufficient to give the largest possible yield. To obtain this, it is necessary to increase the proportion of bicarbonate, which can be done in several ways but most economically, probably, by utilizing the carbonic acid driven off in the process of furnacing to convert the urao into soda ash. When summer soda is heated to a moderate degree (about 150° C., 300° F.) it loses its water and excess of carbonic acid; 100 parts yielding 70.35 parts ash, 9.74 parts gas, and 19.91 parts of water. This furnacing must be done in any case to reduce weight and save transportation charges; hence, if the gas can be economically used, there is a clear gain in so doing. While the refining work in which the crude product is converted into various marketable forms requires special training and use of improved machinery, arranged and handled to save labor and fuel, the production of the crude material is comparatively simple and can be done on a large or small scale with probably equal advantage. At the "little lake" at Ragtown, Nev., two men, in 1886, made 300 tons and could have made much more had the conditions of the locality permitted. The product of the "big lake," made under very adverse conditions, required but little more labor in proportion. The entire product was hauled 16 miles to the railroad and shipped to San Francisco where it was refined. Notwithstanding these heavy transportation costs, the operations were profitable and the works have been running steadily ever since.

These examples show that in the development of this industry the innumerable small localities can be utilized quite as well as the larger ones, if transportation to the refining point be not too expensive. An intelligent, industrious man, working a small but well-situated pool, can produce, with only occasional outside aid, an amount of summer soda which a refining works can take at a price advantageous to itself and remunerative to him. Furnacing before shipping to the refinery is not always advantageous, since, although the reduction in weight is about 25 per cent, the saving in transportation will rarely pay for the cost of furnacing when this is done on a small scale. Moreover, refiners prefer unfurnaced material, and by devoting attention exclusively to the production of summer soda, regularity of composition, which is very important, can be better assured. Such work can therefore be made a "poor man's job," a thing much needed in that region, and in time there would be a large direct consumption of the crude materials.

Borax and Other Soda Products.—Seven establishments manufactured borax during the census year, with a combined production of 11,756,000 pounds, valued at $541,160. No figures for borax were given at the census of 1890, so that no comparison can be instituted. The present number of borax works is undoubtedly smaller than it was ten years ago, because it has been found more economical to ship the crude material to central points for treatment than to work it up locally, as was formerly done.

"Other soda products," valued at $143,432, represent the total value of products so reported by many establishments. As they are not otherwise specified, no further distribution is possible.

The following table gives the geographical distribution of the soda industry, states having less than three establishments being grouped:

SODA PRODUCTS, BY STATES, ARRANGED GEOGRAPHICALLY: 1900.

STATES.	Number of establishments.	Value of products.
United States	55	$10,922,536
North Atlantic division	28	6,559,295
New Jersey	3	105,507
New York	12	4,699,481
Pennsylvania	9	861,195
Massachusetts, Rhode Island, Maryland, and Virginia	4	893,112
North Central division	16	3,694,436
Illinois	4	353,429
Michigan	3	2,814,969
Wisconsin	4	173,101
Indiana, Missouri, and Ohio	5	352,937
Western division	11	668,805
California	6	647,175
Nevada	5	21,630

The foreign commerce in soda products is set forth in the following table, compiled from the reports of the Bureau of Statistics of the United States Treasury Department:

SODA ASH IMPORTED DURING THE YEARS ENDING JUNE 30, 1891 TO 1900.

YEAR.	Pounds.	Value.
1891	[1] 354,744,335	$4,382,917
1892	[1] 339,057,006	4,496,597
1893	388,910,183	4,855,098
1894	256,293,395	2,520,921
1895	300,599,257	2,367,109
1896	251,067,856	1,950,981
1897	162,585,074	1,241,321
1898	87,809,619	589,714
1899	45,444,305	310,742
1900	78,571,870	648,450

[1] Includes sal soda for 1891 and 1892.

SAL SODA IMPORTED DURING THE YEARS ENDING JUNE 30, 1893 TO 1900.

YEAR.	Pounds.	Value.
1893	27,531,554	$238,029
1894	16,893,760	120,794
1895	28,761,108	167,325
1896	17,966,996	84,423
1897	18,875,029	82,695
1898	8,851,011	40,266
1899	4,224,680	20,905
1900	6,624,314	31,072

CAUSTIC SODA IMPORTED DURING THE YEARS ENDING JUNE 30, 1891 TO 1900.

YEAR.	Pounds.	Value.
1891	78,743,976	$1,874,700
1892	64,741,106	1,598,903
1893	57,485,106	1,344,525
1894	38,987,832	850,753
1895	57,653,959	1,044,809
1896	61,713,044	1,071,169
1897	66,476,152	1,147,763
1898	29,697,185	476,032
1899	18,405,272	252,297
1900	11,429,989	177,857

ALL OTHER SALTS OF SODA IMPORTED DURING THE YEARS ENDING JUNE 30, 1891 TO 1900.[1]

YEAR.	Pounds.	Value.
1891	18,136,888	$118,718
1892	22,348,570	167,634
1893	47,664,938	297,761
1894	14,829,622	104,800
1895	11,803,171	141,070
1896	9,090,367	149,248
1897	3,919,339	67,684
1898	21,400,585	225,628
1899	23,891,135	317,032
1900	23,632,374	314,425

[1] 1893 to 1900 includes bicarbonate of soda.

Group III.—Potashes.

This classification was intended to include not only potash, which is an impure potassium carbonate, but also pearlash, which is the refined potassium carbonate, yet, though returns for the census year 1900 were received from 67 establishments, producing 3,864,766 pounds of potash, valued at $178,180, no pearlash was reported manufactured. Of these 67 establishments, 12 produced products valued at less than $500.

The burning of wood and the lixiviation of the ash to extract the potash, though of minor importance so far as the monetary value of the product is concerned, is one of the oldest of the purely chemical industries. Cognizance was taken of it in the census reports of the United States as early as 1850, so that the data is at command for comparing the condition of the industry in this country for each decade since 1850, as set forth in the following table:

TOTAL PRODUCTION OF POTASHES, BY DECADES: 1850 TO 1900.

YEAR.	Number of establishments.	PRODUCT.		Average price per pound (cents).
		Pounds.	Value.	
1850	569	....	$1,401,533	....
1860	212	....	538,550	....
1870	105	....	327,671	....
1880	68	4,571,671	232,643	5.09
1890	75	5,106,939	197,507	3.86
1900	67	3,864,766	178,180	4.82

This table shows that there has been a constant decrease in the value of the product, though the quantity has varied somewhat. Starting with 1880, for which year both quantity and value were reported, it appears that the increase in the quantity of product for 1890 over that for 1880 was 11.7 per cent, but the decrease in the value for 1890 compared with that for 1880 was 15.1 per cent. In 1900 the decrease in the quantity as compared with that of 1890 was 24.3 per cent, while the decrease in the value was 9.8 per cent. The establishments reported were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF POTASH FACTORIES: 1900.

STATES.	Number of establishments.	Average number of wage-earners.	Capital.	Value of product.	Per cent of total.
United States	67	92	$70,899	$178,180	100.0
Michigan	44	52	25,851	79,642	44.7
Ohio	15	25	20,050	35,519	19.9
Indiana	3	4	2,275	6,560	3.7
Maine, Wisconsin, and Illinois	5	11	22,723	56,459	31.7

There were reported as having been used in this manufacture 812,399 bushels of wood ashes, valued at $40,191. The yield of potash per bushel of ashes, as reported, varied from 2.4 to 7 pounds. In the product given above there is included potash packed in cans, amounting to 820,000 pounds, having a value of $53,349. Excluding this, as being in the nature of a duplication, it appears that the total production of potash for 1900 was 3,044,766 pounds, and that therefore the average yield of potash per bushel of wood ashes, as shown by the entire returns, was 3.75 pounds. Pelouze and Fremy[1] give the yield by weight as 10 per cent, and this appears in other text-books; but all returns for ashes received at the census of 1900 were given in bushels.

As stated, potash is prepared by dissolving out the soluble contents of wood ashes and evaporating the solution to dryness. The process as carried out on a commercial scale is described by Muspratt,[2] as follows:

> The American process for the extraction of potashes is thus described by Morfit. The incineration of the plant is effected in dry pits sunk into the ground to a depth of 3 or 4 feet. The plant is thrown in in portions, and burned until the pit is nearly full of ashes. The latter are then removed, mixed with about 5 per cent of lime, and drenched with successive portions of fresh water. The ash tubs or vats employed in this operation are usually formed from tar barrels, by cutting them in half. A number of these are furnished with two crossbeams, upon which rests a false cullendered bottom covered with straw, and below this is a cock for the removal of the lye. The first liquor running through, being saturated, is passed at once to the evaporating pan; while the second or third runnings, being weaker, are reserved and poured upon fresh ash until completely saturated. The evaporating pans are broad and shallow, and made of iron, with corrugated bottoms, to produce greater extent of heating surface; and as evaporation progresses, new supplies of strong liquor are poured in, and the heat is continued until a sirupy consistence is attained, when the fire is gradually slackened and the contents of the pan, becoming solid, are dug out and placed aside as *crude potashes*. By subjecting this mass to the heat of a reverberatory furnace, most of the sulphur (*sic*) and all excessive water and empyreumatic matters are expelled, causing a loss of 10 to 15 per cent. This modified product is white, with a bluish tinge; contains more carbonic acid than the original crude product, and takes the name of *pearlash*. The process em-

---

[1] Traité de Chimie, 1865, Vol. II, page 225.

[2] Chemistry as Applied to Arts and Manufactures, Vol. II, page 729.

ployed in Russia and northern Europe is the same in principle as that above described, and is conducted in a similar manner, except that no lime is used in the lixiviation process.

According to Mendeléeff:[1]

For the extraction of potash, which was formerly carried on extensively in the east of Russia (before the discovery of the Stassfurt salt), the ash of grasses and the green portions of potatoes, buckwheat, etc., are taken and treated with water (lixiviated), the solution is evaporated, and the residue ignited in order to destroy the organic matter present in the extract. The residue thus obtained is composed of raw potash. It is refined by a second dissolution in a small quantity of water, for the potash itself is very soluble in water, whilst the impurities are sparingly soluble. The solution thus obtained is again evaporated, and the residue ignited, and this potash is then called refined potash, or pearlash.

According to Wiley:[2]

The composition of the ash of woods is extremely variable. Not only do different varieties of trees have varying quantities of ash, but in the same variety the bark and twigs will give an ash quite different in quantity and composition from that furnished by the wood itself. In general, the hard woods, such as hickory, oak, and maple, furnish a quality of ash superior for fertilizing purposes to that afforded by the soft woods, such as the pine and tulip trees. The character of the unleached wood ashes found in the trade is indicated by the subjoined analyses. The first table contains the mean, maximum, and minimum results of the analyses of 97 samples by Goessmann.[3]

	MEAN COMPOSITION OF WOOD ASHES.		
	Means.	Maxima.	Minima.
Potash	5.5	10.2	2.5
Phosphoric acid	1.9	4.0	0.3
Lime	34.3	50.9	18.0
Magnesia	3.5	7.5	2.3
Insoluble	12.9	27.9	2.1
Moisture	12.0	28.6	0.7
Carbon dioxide and undetermined	29.9	....	....

The data obtained in sixteen analyses made at the Connecticut station are given below:[4]

	Means.	Maxima.	Minima.
Potash	5.3	7.7	4.0
Phosphoric acid	1.4	1.8	1.9

In fifteen analyses of ashes from domestic wood fires in New England stoves the following mean percentages of potash and phosphoric acid were found:

Potash	9.63
Phosphoric acid	2.32

In leaching, ashes lose chiefly the potassium carbonate and phosphate which they contain. Leached and unleached Canada ashes have the following composition:

	Unleached (per cent).	Leached (per cent).
Insoluble	13.0	13.0
Moisture	12.0	30.0
Calcium carbonate and hydroxide	61.0	51.0
Potassium carbonate	5.5	1.1
Phosphoric acid	1.9	1.4
Undetermined	6.6	3.5

In the wood ashes of commerce, therefore, it is evident that the proportion of the potash to the lime is relatively low.

The number of parts by weight of the chief ingredients of the ash in 10,000 pounds of woods of different kinds is given in table below, together with the percentage composition of the pure ash; that is, the crude ash deprived of carbon and carbon dioxide.

POUNDS OF THE INGREDIENTS NAMED IN 10,000 POUNDS OF WOOD.

	Dogwood (*Cornus Florida*).	Sycamore (*Platanus Occidentalis*).	Post oak (*Q. obtusiloba*).	Ash (*F. Americana*).	Red oak (*Quercus rubra*).	Hickory (*Carya tomentosa*).
Potash	9.02	18.06	16.85	14.94	13.95	13.80
Phosphoric acid	5.72	9.55	6.96	1.15	5.98	5.83
Lime	6.41	24.73	35.61	7.60	27.40	18.40
Magnesia	14.67	0.49	5.28	0.10	3.05	4.86

	White oak (*Q. alba*).	Magnolia (*M. grandiflora*).	Georgia pine (*P. palustris*).	Yellow pine (*P. mitis*).	Black pine (*Picea nigra*).	Chestnut (*Castana vesca or sativa*).	Old field pine (*P. mitis*).
Potash	10.60	7.13	5.01	4.54	3.02	2.90	0.79
Phosphoric acid	2.49	3.19	1.24	0.96	0.92	1.09	0.73
Lime	7.85	14.21	18.04	15.16	12.46	7.93	12.12
Magnesia	0.90	2.94	2.03	0.74	0.10	0.34	1.17

The pure ashes of the woods contain the following per cents of the ingredients named:

	Dogwood (*Cornus Florida*).	Sycamore (*Platanus Occidentalis*).	Post oak (*Q. obtusiloba*).	Ash (*F. Americana*).	Red oak (*Quercus rubra*).	Hickory (*Carya tomentosa*).
Potash	28.04	23.17	21.92	46.04	24.66	28.60
Phosphoric acid	8.51	12.23	9.00	3.58	10.55	11.97
Lime	38.93	31.62	46.39	23.57	48.26	37.94
Magnesia	6.80	0.62	6.88	0.60	5.38	10.04

	White oak (*Q. alba*).	Magnolia (*M. grandiflora*).	Georgia pine (*P. palustris*).	Yellow pine (*P. mitis*).	Black pine (*Picea nigra*).	Chestnut (*Castana vesca or sativa*).	Old field pine (*P. mitis*).
Potash	42.16	19.54	15.35	19.70	14.30	18.10	3.85
Phosphoric acid	9.48	8.75	3.82	4.18	4.33	6.76	4.11
Lime	29.85	38.94	55.24	65.53	58.98	49.18	67.73
Magnesia	3.43	8.05	6.25	3.20	0.50	2.11	6.54

From the data for production given above it is evident that, although the average price of potash for 1900 was higher than for 1890, the industry was not remunerative,

---

[1] Principles of Chemistry, 1897, Vol. I, page 548.

[2] Principles and Practice of Agricultural Analysis, 1895, Vol. II, pages 251 to 253.

[3] Annual report, Massachusetts agricultural experiment station, 1888, page 202.

[4] Annual report, Connecticut agricultural experiment station, 1890, page 110.

and that consequently the quantity and value of the product decreased. Indeed, owing to the competition of foreign potash, the industry can now exist only in localities where wood is very cheap and where there is a local demand for the product. In such places the product is of domestic manufacture and is an article of trade at the country stores, but with the increasing value of timber, the field of operations is continually being contracted.

The cost of producing a barrel of 650 pounds of potash is stated in a private communication from a Michigan manufacturer to be as follows:

Ashes, 150 bushels, at 3 cents	$4.50
Hauling ashes	6.00
Fuel	2.00
Labor	3.00
Barrel, cost of	1.25
Repairs, interest, etc	1.50
Total cost	18.25
Selling price at works	25.00
Gross profit per barrel	6.75

The ashes therefore yielded 4⅓ pounds of potash per bushel, and the potash sold at 3.85 cents per pound. It will be noted that the weight of a barrel of potash is given above as 650 pounds. From the returns it appears that the net weight of a barrel of this material varies from 650 pounds to 740 pounds, the average being about 700 pounds.

Competition with the ashes of wood as a source of potash is found in beet-root molasses and residues; wool scourings, known as suint; and the potash salts mined at Stassfurt and elsewhere abroad. In the case of the beet-root molasses and residues, and of the suint, the mass is calcined and the potassium carbonate extracted, as is done for wood. The potassium exists in the Stassfurt and other mineral salts as chlorides and sulphates in combination with magnesium and calcium, and after the potassium chloride is extracted from them, it is converted into pearlash by the Le Blanc process, or it may be converted into carbonate by the Solvay process, using trimethylammonium carbonate. Mendeléeff[1] states that about 25,000 tons of potash annually are now (1897) prepared from KCl at Stassfurt. Other proposed sources of potash salts are sea water; the mother liquor of salt works and mineral springs; the residues from seaweeds; and the feldspars and similar rocks.

There are, moreover, some industries which produce considerable quantities of wood ashes as a by-product, from which potash may be extracted with profit. For example, the wood-distillation industry uses hard wood and consumes much of the charcoal produced as fuel under the retorts. Hard-wood ashes are richer in potash than soft-wood ashes, and as the extra cost of obtaining the potash should be very trifling in connection with the other operation, considerable quantities of it might be obtained from this source.

As potassium carbonate crystallizes with difficulty, it can not well be purified by the method often employed for purifying salts. The pure material must, therefore, be obtained by indirect means. Among other methods in vogue, one is to purify cream of tartar, obtained from grapes, by repeated crystallization, and then, by burning it, obtain the refined potash. When the cream of tartar is ignited by contact with air there is left a mixture of finely divided charcoal and potassium carbonate, and this comes into the market under the name of "black flux," and is used in smelting operations as a reducing agent.

Potash is used in the manufacture of soft soap; in making potassium salts, such as potassium chromate; in making caustic potash; and, in the form of pearlash, in the making of glass.

The potassium found in wood ashes is extracted from the soil by the plant during its growth, the presence of potassium compounds in the soil being essential to the growth of vegetation. Consequently, wood ashes are a valuable fertilizing material. Wiley[2] says of this:

> The beneficial effects following the application of ashes, are greater than would be produced by the same quantities of matter added in a purely manurial state. The organic origin of these materials in the ash has caused them to be presented to the plant in a form peculiarly suited for absorption. Land treated generally with wood ashes becomes more amenable to culture, is readily kept in good tilth, and thus retains moisture in dry seasons and permits of easy drainage in wet. These effects are probably due to the lime content of the ash, a property, moreover, favorable to nitrification and adapted to correcting acidity. Injurious iron salts, which are sometimes found in wet and sour lands, are precipitated by the ash and rendered innocuous or even beneficial. A good wood-ash fertilizer, therefore, is worth more than would be indicated by its commercial value calculated in the usual way.

From the census returns for 1900 it appears that the leached ashes have a certain manurial value and the returns show that the establishments reported above sold 87,040 bushels of leached ashes to be used as a fertilizer at a total value of $3,268, or, on an average, at 3.75 cents per bushel. It is stated by the manufacturers that wood ashes in leaching gain one-third in bulk; one manufacturer specifically stating that his 15,000 bushels of raw ashes yielded 20,000 bushels of leached ashes.

From Wagner's Chemical Technology, 1892, page 299, it appears that "the yearly production of potash, according to H. Grüneberg, is from

	Tons.
Wood ashes, Russia, Canada, United States, Hungary, and Galicia	20,000
Beet sugar ash, France, Belgium, Germany	12,000
Mineral salts, Germany, France, England	15,000
Suint, Germany, France, Belgium, Austria	1,000
Total from all sources	48,000

"These conditions differ strikingly from those which existed thirty [thirty-eight] years ago, when wood ash was in exclusive use and Russia potash ruled the mar-

---

[1] Principles of Chemistry, 1897, Vol. I, page 549.

[2] Principles and Practice of Agricultural Analysis, Vol. II, page 254.

ket. The potash extracted from wood ashes amounts to scarcely one-half of the total production; it decreases year by year, and the time when it will disappear from the market seems within measurable distance." This agrees with the data shown in the table above for the "Total Production of Potashes by Decades, 1850 to 1900."

The foreign commerce in potashes for the United States is exhibited in the following tables compiled from "The Foreign Commerce and Navigation of the United States for the years ending June 30, 1891–1900, Vol. II."

DOMESTIC EXPORTS OF ASHES, POT AND PEARL: 1891 TO 1900, INCLUSIVE.

YEAR.	Pounds.	Value.	YEAR.	Pounds.	Value.
1891	430,582	$24,432	1896	969,874	$41,208
1892	1,307,634	99,566	1897	511,830	21,727
1893	634,421	31,775	1898	869,841	33,202
1894	650,261	29,205	1899	745,433	29,676
1895	664,876	30,188	1900	1,273,905	49,566

IMPORTS OF ASHES, WOOD AND LYE OF, AND BEETROOT ASHES, FOR CONSUMPTION: 1891 TO 1900, INCLUSIVE.

YEAR.	Value.	YEAR.	Value.
1891	$42,624	1896	$67,393
1892	54,855	1897	66,423
1893	76,306	1898	62,206
1894	74,050	1899	59,970
1895	77,708	1900	66,453

IMPORTS OF POTASH, CARBONATE OF, OR FUSED, FOR CONSUMPTION: 1891 TO 1894, INCLUSIVE.

YEAR.	Pounds.	Value.
1891		$39,980
1891	6,207,419	219,557
1892	8,745,268	309,585
1893	10,115,017	329,895
1894	8,130,975	262,818

IMPORTS OF POTASH, CARBONATE OF, CRUDE OR BLACK SALTS, FOR CONSUMPTION: 1895 TO 1900, INCLUSIVE.

YEAR.	Pounds.	Value.
1895	11,602,272	$364,506
1896	12,439,180	401,819
1897	7,501,497	229,029
1898	15,844,374	471,919
1899	16,018,889	437,675
1900	21,191,258	625,922

LITERATURE.

Chemistry as Applied to the Arts and Manufactures, by Sheridan Muspratt, Glasgow, 1860.

Traité de Chimie, by Pelouze and Fremy, Vol. II, Paris, 1865.

A Manual of Chemical Technology, by Rudolf von Wagner, translated by William Crookes, New York, 1892.

Principles and Practice of Agricultural Analysis, by Harvey W. Wiley, Vol. II, Easton, Pa., 1895.

The Principles of Chemistry, by D. Mendeléeff, New York, 1897.

Group IV.—Alums.

During the census year 1900 there were 13 establishments engaged in the manufacture of alums either as a principal or subordinate product. The comparison with previous censuses is as follows:

PRODUCTION OF ALUMS, BY DECADES: 1880 TO 1900, INCLUSIVE.

YEAR.	Number of establishments.	PRODUCT.		PER CENT OF INCREASE.	
		Pounds.	Value.	Quantity.	Value.
1880	6	39,217,725	$808,165		
1890	10	93,998,008	1,616,710	139.7	100.0
1900	13	179,467,471	2,446,576	90.9	51.3

There are no census statistics of production anterior to 1880, and the census of 1900 is the first one at which the various alums were separately reported, as shown in the table which follows:

KINDS OF ALUM PRODUCED IN 1900.

KIND.	Number of establishments.	Pounds.	Value.
Total		179,467,471	$2,446,576
Ammonia alum	4	6,580,373	102,308
Potash alum	5	14,200,393	215,004
Burnt alum	6	16,028,464	403,100
Concentrated alum	10	103,016,815	1,062,547
Alum cake	4	4,048,655	34,047
Other alums	7	35,592,771	629,570

The legend "other alums" is as reported on the schedules, and no doubt under it are included some of the kinds named in the list above, but it has not been possible to separate them. However, there are in the classification 1,526,000 pounds of aluminum hydroxide (hydrate of alumina), valued at $31,500. There are included under "burnt alum" 9,399,550 pounds of material, with a value of $228,500, returned as "soda alum" from 4 establishments. In addition, there were reported 3,928,160 pounds of ammonia alum, valued at $58,922, and 1,149,666 pounds of aluminum sulphate, valued at $10,922, as having been produced and consumed in the manufacture of other products.

It should be said that of the 13 establishments reported above but 2 of them were reported as producing alum only, the others being engaged in the manufacture of many other chemical substances. Taking the ratio of value which the alum bears to the total value of products for these last-mentioned establishments as a guide, it appears that these 13 establishments employed 802 wage-earners and a capital of $3,888,445 in the production of alum, and that there were consumed 34,000 tons of bauxite, having a value of $230,000; 5,000 tons of cryolite, of a value of $110,000; 2,000 tons of sodium sulphate, in the form of salt cake or niter cake, of a value of $4,100; 360 tons of ammonium sulphate, of a value of $21,900; 477 tons of potassium sulphate, of a value of $19,600; and 61,424 tons of sulphuric acid, there being used for this acid 3,323 tons of sulphur, of a value of $66,000; 49,081 tons of pyrites, of a value of $107,000; and 513 tons of sodium nitrate, of a value of $18,000.

The geographical distribution of these establishments is set forth in the following table:

GEOGRAPHICAL DISTRIBUTION OF ALUM FACTORIES: 1900.

STATES.	Number of establishments.	Average number of wage-earners.	Capital.	Value of product.	Per cent of total.
United States	13	802	$3,888,445	$2,446,576	100.0
Pennsylvania	6	530	2,747,482	1,411,652	57.7
Massachusetts	3	74	255,930	306,754	12.5
Illinois, New York, and Michigan	4	198	885,033	728,170	29.8

Alum was known to the ancients and was used by them in dyeing, tanning, and in making medicine. Aluminum sulphate, mixed with more or less iron sulphate, occurs as efflorescences on rocks and as the mineral *feather alum*, and it was this limited natural supply that was the source of the material used. The manufacture of alum is of oriental origin and was introduced into Europe about the Thirteenth century, the materials used being the mineral *alunite* or alum stone, which has the formula $K_2SO_4.Al_2(SO_4)_3.4Al(OH)_3$ mixed with compounds of iron. This mineral is insoluble in water, but by calcining it and exposing it in heaps, with occasional moistening, the mass weathers, and after some months a potassium alum may be dissolved out which crystallizes in cubes and contains inclosed iron oxides which give it a red color. Such alum is known as "Roman alum" from its having been extensively manufactured at Tolfa, near Rome. Later, alum slates and shales, clay, bauxite, and cryolite have been employed as the raw materials of the alum manufacture, and the last-named two are the substances which are now almost exclusively used for this purpose.

When the minerals—clay, in its purer form of *kaolin* ($Al_2Si_2O_7.2H_2O$), or *bauxite*, which is aluminum hydroxide mixed with ferric, silicic, and other oxides in varying proportions, are used as the source of alumina, the process consists in decomposing the mineral with sulphuric acid and evaporating the solution of aluminum sulphate formed until, when cool, it sets to a stone-like mass. This cake contains impurities in the form of silica, ferric sulphate, and free sulphuric acid, there being usually from 2 to 3 per cent of the latter present. When but little iron is present, the substance is known as "alum cake;" when much iron is present it is known as "alumino-ferric cake." *Bauxite* is especially liable to yield this last-named product.

A purer aluminum sulphate is made from *bauxite* by calcining it with soda ash until sodium aluminate is formed. This is dissolved, the solution filtered, and carbon dioxide passed through it, by which the aluminum is precipitated as hydroxide. This purified hydroxide is dissolved in hot sulphuric acid and the solution formed run into leaden pans to cool, when it forms a crystalline mass much used in the arts under the name of "concentrated alum," and having the composition $Al_2(SO_4)_320H_2O$, though the separate crystals have but 18 molecules of water of crystallization. Manufacturers specify that bauxite for use in the manufacture of alum shall contain not more than 3 per cent of ferric oxide nor less than 60 per cent of aluminum oxide.

Cryolite is used not only as a source of alum, but also for the manufacture at the same time of caustic soda, calcium or sodium fluorides, and hydrofluoric acid. This mineral, which in commercial quantities is found only in southern Greenland, is a double fluoride of sodium and aluminum, having the formula $AlF_3(NaF)_3$. By calcining cryolite with powdered limestone and lixiviating the frit, or by boiling cryolite with milk of lime, sodium aluminate is obtained as one of the products of the reaction, and this may be converted into "concentrated alum" by the means above described. A modification of this consists in boiling sodium aluminate liquor with powdered cryolite, through which the sodium in each molecule is converted into sodium fluoride and the aluminum into alumina, and then producing "concentrated alum" by dissolving the alumina in sulphuric acid.

When "concentrated alum" is dissolved in water and mixed with a solution of potassium sulphate, the solution, on concentration, deposits beautiful, transparent, colorless, octahedral crystals, which have a vitreous luster and the composition $K_2Al_2(SO_4)_4.24H_2O$. This substance is known as "potassium alum" or "potash alum," and was the first complex alum recognized. It was the first to be manufactured commercially, since by this means the easily soluble aluminum sulphate was separated from the iron sulphates, and a very superior article for use in dyeing was obtained. Since purer raw material has been found, and improved methods for purification have been devised, concentrated alum has largely displaced the complex alums in dyeing as well as in the other arts.

Crystallized potassium alum of the composition given above is the type of a large number of complex alums which may be produced by mixing a solution of aluminum sulphate with a solution of an alkaline sulphate and crystallizing out the double salt. Among these we have in commerce crystallized ammonium and crystallized sodium alum, though the latter is not common, owing to its being difficult to crystallize and to the fact that the crystals, when formed, readily effloresce. When these crystallized alums are heated, the water of crystallization, and usually a little of the sulphuric acid, is driven off and the material falls to a white powder known as "burnt alum," which is used in pharmacy. A similar sodium alum which is largely used in baking powders is prepared by mixing concentrated solutions of sodium sulphate and aluminum sulphate, allowing them to set in a cake, and roasting the alum to drive off the water, or by mixing the sulphates in the solid condition and heating them. By varying the proportions of the sulphates and the temperature, various desired properties are imparted to the burnt alum, and these preparations are sold under various trade names.

Effloresced sodium alum is sometimes known under the name of "porous alum," but this name, in the trade, is given to porous alum cake containing a little sodium alum and basic aluminum sulphate, which is made by stirring into alum cake, just before it sets, a desired quantity of soda ash. As the aluminum sulphate possesses an acid reaction it reacts with the sodium carbonate and the carbon dioxide evolved puffs up the mass and leaves it in a condition so that it may be readily dissolved.

Alums may be formed with selenic and other acids in place of the sulphuric acid of ordinary alum. Moreover, chromic, ferric, manganic, and other sulphates form double salts with the alkali sulphates, and though these compounds contain no aluminum whatever, they are called alums because they crystallize in the same form, have the same crystalline habit, the same oxygen ratio, and the same number of molecules of water of crystallization as the double sulphates of alumina and the alkali metals. None of these numerous alums has any commercial importance except "chrome alum," which has the formula $K_2Cr_2(SO_4)_4.24H_2O$.

Potash and ammonia alums were made by Charles Lennig, of Philadelphia, in 1837, and concentrated alum was manufactured by him in 1859. Harrison Bros. & Co., of Philadelphia, began the manufacture of crystal alum about 1840, and they began the manufacture of concentrated alum from *bauxite* in 1877. The Pennsylvania Salt Manufacturing Company began the manufacture of concentrated alum at Natrona, Pa., in 1876, and they were the first to manufacture porous alum.

Alums are used in dyeing, printing, tanning, paper making, in making lakes and other pigments, in purifying water and sewage, as a constituent of baking powder, in medicine, in stucco work for hardening plaster, in photography for hardening films, in rendering wood and fabrics non-inflammable, in "carbonizing" wool, in bleaching, and in the preparation of various aluminum compounds.

The foreign commerce in alums is shown in the following table, compiled from the reports of the Bureau of Statistics of the United States Treasury Department:

IMPORTS OF ALUMS FOR CONSUMPTION: 1891 TO 1900, INCLUSIVE.

YEAR.	Pounds.	Value.	YEAR.	Pounds.	Value.
1891	4,652,985	$58,863	1896	5,525,825	$86,371
1892	4,140,916	59,336	1897	5,301,544	96,529
1893	4,572,923	73,806	1898	2,787,639	36,099
1894	1,838,728	30,831	1899	1,601,829	14,244
1895	2,983,682	46,815	1900	2,186,266	19,354

And in the following tables, obtained from the same source, are shown the quantities and values of the raw or partly manufactured materials so far as they were set forth:

IMPORTS OF CRYOLITE FOR CONSUMPTION: 1891 TO 1900, INCLUSIVE.

YEAR.	Tons.	Value.	YEAR.	Tons.	Value.
1891	7,129	$95,405	1896	7,024	$93,198
1892	8,298	76,350	1897	3,009	40,056
1893	8,459	111,796	1898	10,788	144,178
1894	12,756	170,215	1899	5,529	79,455
1895	8,685	116,273	1900	5,878	78,658

IMPORTS OF BAUXITE FOR CONSUMPTION: 1897 TO 1900, INCLUSIVE.

YEAR.	BAUXITE, CRUDE.		ALUMINUM HYDRATE, OR REFINED BAUXITE.	
	Pounds.	Value.	Pounds.	Value.
1897	8,722,074	$14,915	....	....
1898	....	....	2,092,082	$60,194
1899	7,722,000	14,168	2,955,339	92,019
1900	6,850,000	11,413	3,474,421	109,574

LITERATURE.

Outlines of Industrial Chemistry, F. H. Thorp: Macmillan, New York, N. Y., 1898.

Manufacture of Alum, Lucien Geschwind: D. Van Nostrand, New York, N. Y., 1901.

Manual of Chemical Technology, Rudulf von Wagner: D. Appleton & Co., New York, N. Y., 1892.

Watts, Dictionary of Chemistry, Vol. V, Longmans, Green & Co., London, 1869.

Group V.—Coal-Tar Products.

Notwithstanding that as early as 1815 Accum had devised a process for obtaining a volatile oil from coal tar for use as a substitute for spirits of turpentine; that in 1845 A. W. Hofmann had discovered that this body contained benzene; that in 1856 a great impetus was given to tar distilling by the discovery of anilin colors by Perkin, since the benzol, which is the raw material for their manufacture, was exclusively derived from coal tar, and that from 1806, when coal gas was introduced for lighting by David Melville at Newport, R. I., coal tar had been a by-product of the industry in this country; yet it was not until 1880 that any mention was made in the United States Census Reports of these bodies, and they are apparently given there in two classifications, as follows: On page 1001 of Statistics of Manufactures there are reported 344,114 pounds of anthracene of a value of $99,242, and in the table of specified industries on page 20 of the same report, it is stated that three works produced "coal tar" having a value of $466,800, from which it is inferred that as the original coal tar was being produced in the several hundred gas works then existing, the three works enumerated were engaged in producing coal-tar products. On pages 288 and 289 of Part III, Census of Manufacturing Industries, 1890, there are reported coal-tar products of a value of $687,591. The establishments were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF FACTORIES FOR COAL-TAR PRODUCTS: 1890.

STATES.	Value of products.	Per cent of total.
United States	$687,591	100.0
New Jersey	330,200	48.0
Pennsylvania	168,180	24.5
New York	138,324	20.1
District of Columbia	20,000	2.9
Georgia	20,000	2.9
Massachusetts and Tennessee	10,887	1.6

At the census of 1900 there were reported 14 establishments devoted to the manufacture of coal-tar products, which amounted in value to $1,322,094, and 8 establishments in which this manufacture was of secondary importance, with a value of $99,626, the total value being $1,421,720. These establishments were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF FACTORIES FOR COAL-TAR PRODUCTS: 1900.

STATES.	Number of establishments.	Average number of wage-earners.	Capital.	Value of products.	Per cent of total.
United States	22	466	$1,448,622	$1,421,720	100.0
Missouri	3	155	381,969	415,600	29.2
Pennsylvania	6	177	651,482	396,759	27.9
New York	3	33	25,457	44,016	3.2
Louisiana, Tennessee, Ohio, California, Minnesota, Massachusetts, and New Jersey	10	101	389,724	565,345	39.7

Of these products, chemicals having a value of $205,047 were obtained from further action on the distillate of the coal tar. In addition, these factories produced tarred felt and tarred paper (in which part of the material from the coal tar was consumed), having a value of $442,529.

Coal tar, as its name implies, is obtained from coal, and it is produced by the destructive distillation of coal out of contact with the air, the other products being gas, coke, and ammoniacal liquor. From the beginning of the Nineteenth century the chief commercial source of the coal tar was found in the manufacture of coal gas for illuminating purposes, but to-day it is also obtained from the by-product coke ovens, while gas producers, blast furnaces, and water-gas plants furnish tars which now find commercial uses, though they differ in composition from coal tar. In the special report on coke for the census of 1900, it is reported that the production of tar from the by-product coke ovens for 1899 amounted to 104,687,330 pounds, or 52,344 tons. Although the returns for gas for 1900 are given in the special report on gas for the census of 1900, no separate returns are therein presented for the by-product of tar. This may, however, be estimated as follows: In Table 8 of that report it is stated that the total production of gas was 67,093,553,471 cubic feet, and in Table 9 that over 75 per cent of the gas manufactured during the census year was water gas. Putting the coal gas at 20 per cent, we have 13,418,710,694 cubic feet of coal gas.

The average yield of gas per ton of gas coal is 10,000 cubic feet, and dividing the volume of gas by this there results 1,341,871 tons of coal as having been used for making coal gas. The yield of tar per ton of coal is about 5 per cent by weight, which gives from the above figure 67,094 tons of tar. The total quantity of coal tar from the by-product coke ovens and the coal-gas industry in 1900 was, then, approximately 119,438 tons. The quantity of "water-gas tar" may also be estimated from the quantity of oil consumed, which is given in the special report on gas as 194,857,296 gallons. According to Douglas,[1] about 25 per cent of the oil is recovered as tar, which gives for the oil recorded above 48,714,324 gallons of tar. As, according to A. H. Elliott,[2] "water-gas tar" has a specific gravity of 1.1, a gallon will weigh 9.15 pounds, and therefore the total weight of "water-gas tar" obtained in the United States for 1900 as derived from the data given above is 222,868 tons. No tar is reported from any other source, though it is known that abroad the blast furnaces and gas producers are utilized as sources of this material. The total computed production of coal tar and water-gas tar for the United States for the census year 1900 is therefore 342,306 tons. It is worth noting that though the first by-product coke oven in the United States was erected in 1892,[3] yet the industry has grown so fast that the yield of coal tar from this source closely approaches that from coal gas making.

In connection with these estimates it is interesting to compare the following statement made by Lunge[4] in the recent edition of his standard work: "White and Hess (Jour. Soc. Chem. Ind., 1900, page 509), quote a number of analyses, from which they conclude that American coal tars are not well adapted to distillation for the recovery of benzol, etc., as they are inferior in

---

[1] J. of Gas-Lighting, page 1130. 1891.

[2] Am. Chem. J., page 248. 1884.

[3] J. D. Pennock, J. Am. Chem. Soc., vol 21, page 681. 1899.

[4] Coal Tar and Ammonia, 3d ed., Appendix, page 917.

quality to European tars except as regards anthracene. Their estimate of the production of coal tar in the United States, 400,000 tons, is probably much too high, since by far the greater portion of illuminating gas made there is (carburetted) water gas. Probably the quantity of 120,000 tons, which I gave as the production of coal tar in the United States in 1886, is not much, if at all, exceeded at the present time." The amount of coal tar reported as consumed in the United States in the census year 1900 was 22,004,650 gallons, which at 10 pounds per gallon gives 110,023 tons.

The yield of tar from the manufacture of gas in Europe in 1898 is given by Lunge[1] from data supplied by Dr. Bueb, as follows:

TAR PRODUCED IN MAKING GAS IN EUROPE IN 1898.

COUNTRY.	Tons.	COUNTRY.	Tons.
Total	1,120,000	Belgium	20,000
		Italy	16,650
Great Britain	666,650	Russia	16,650
Germany	166,650	Holland	15,000
France	135,000	Denmark	13,500
Austria-Hungary	41,500	Switzerland	6,750
Scandinavia	21,650		

The data of the census of 1900 places the United States fourth in the list of countries in the amount of tar produced in the distillation of coal for the manufacture of gas.

It is of historical interest that the first English patent referring to the destructive distillation of coal (that of John Joachum (sic) Becher and Henry Serle, dated August 19, 1681) does not treat of the manufacture of illuminating gas, but of "a new way of makeing pitch and tarre out of pit coale, never before found out or used by any other," and this German chemist, Johann Joachim Becher, appears to have been the originator of the coal-tar industry, he having employed the coal tar as a substitute for "Swedish tar from firwood" in tarring wood and ropes. The French metallurgist de Gensanne[2] describes a furnace in use before 1768 at Sulzbach, near Saarbrücken, for coking coal and recovering tar, the light oil from the tar being used for burning in lamps.

Notwithstanding the various inventions for producing coal tar, it is, according to Lunge[3]—

> Certain that the manufacture of coal tar was never carried out on any extensive scale until it appeared as a necessary by-product in the manufacture of illuminating gas from coal, the idea of which seems to have occurred toward the end of the last century at the same time to the Frenchman Lebon and the Englishman William Murdoch. The former had already recommended the use of tar for preserving timber; but it was the latter who, along with his celebrated pupil Samuel Clegg, really laid the foundation of the enormous industry of gas making. The first private gas works was erected in 1798 at the engineering works of Bolton & Watts; the first public gas works in London in the year 1813; in Paris, 1815, and in Berlin, 1826.
>
> The tar formed in the manufacture of coal gas necessarily forced itself upon the notice of the gas manufacturer, since it could not be thrown away without causing a "nuisance." It was probably from the first burnt under the retorts, but the method of doing this without giving very much trouble was not understood then. Other quantities, no doubt, were used, in lieu of wood tar, as a cheap paint for wood or metals, but it must have been soon found out that in the crude state it is not well adapted for this purpose. * * * It was also quickly perceived that in this respect tar is improved by boiling it down to some extent, and as early as 1815 Accum showed that if this boiling down is carried out in closed vessels (stills) a volatile oil is obtained which may be employed as a cheap substitute for spirits of turpentine. But this does not seem to have been carried out to any great extent, and coal tar remained, for more than a generation from the first introduction of gas lighting, a nuisance and hardly anything else.
>
> In Germany the first more extensive employment of gas tar was for making roofing felt, for which purpose it has to be deprived of water and the more volatile constituents. Instead of condensing these, they were at first almost everywhere, and later on in many cases, removed by evaporating the tar in open vessels, thus creating a considerable risk from fire. In Germany, Brönner, of Frankfort, was the first (in 1846) to condense the more volatile tar oils, from which he prepared a detergent, long after known by his name, and consisting principally of benzene.
>
> In England, where the manufacture of illuminating gas originated, and where it has always been, and still is, carried on to a very much greater extent than on the Continent, a more extensive industrial employment for coal tar was first opened out by the invention of Bethell (1838) for preserving timber, especially railway sleepers, by impregnation with the heavy oil distilled from gas tar. From that time dates the introduction of tar distilling on a large scale. The light oils may have been lost even here in some cases, but more usually they were condensed and employed as "coal-tar naphtha" for burning and for dissolving india rubber.
>
> The day of the light tar oils came after A. W. Hofmann (1845) had shown the presence of benzene in them, but especially when Mansfield, in his patent specification (1847), for the first time accurately described the composition of these oils, along with a process for preparing benzene in a pure state and on a large scale, and with proposals for utilizing the tar oils of lowest boiling point for lighting purposes. The industrial preparation of benzene was soon followed by that of nitrobenzene, at that time only employed as a substitute for the essential oil of bitter almonds, and known by the French fancy name of "essence de Mirbane." But all these applications produced only a limited demand for the light oils which could be made from the rapidly increasing quantities of gas tar; so that the latter, except in a few instances locally, did not attain any considerable commercial value. But a sudden impetus was given to tar distilling in 1856 by the discovery of the anilin colors, the material which forms their starting point, benzol, being exclusively derived from coal tar.

Coal tar is an extremely complex mixture of chemical compounds, some of which have not yet been even isolated. As before stated, the tars from other processes than the destructive distillation of coal contain other constituents, and varying quantities of similar constituents, from those existing in coal tar. Likewise, coal tar will vary in its composition with the coal which is distilled and the manner in which the distillation is carried out. The "products" are obtained from the coal tar by fractional distillation, and the first products are crude naphtha and light oils of a specific gravity below 1.000, distilling over below 180° C.; dead oils and

---

[1] Coal Tar and Ammonia, 3d ed., page 17; ibid., page 4.

[2] De Gensanne, "Traité de la fonte des Mines," Paris, 1770, Vol. I, ch. 12.

[3] Coal Tar and Ammonia, pages 11–13.

creosote oils of a specific gravity above 1.000, distilling over between 180° C. and 270° C.; green or anthracene oils, distilling over between 270° C. and 360° C.; and soft pitch, which is left in the still.

The proportions of yields from different coals is shown in the following tables given by J. D. Pennock,[1] chemist in charge of the oldest by-product coke-oven plant in the United States:

ANALYSES OF COAL.

	A	B
	Per cent.	Per cent.
Volatile matter	34.20	32.68
Fixed carbon	57.15	59.40
Ash	8.65	7.92
Sulphur	0.93	1.19

ANALYSES OF TAR.

	A	B	I	II
Specific gravity	1.163	1.203	1.205	1.231
	Per cent.	Per cent.	Per cent.	Per cent.
Water	2.40	2.70	1.40	1.10
Light oil	4.60	2.03	3.12	1.63
Creosoting oil	1.26	0.50	0.29	0.34
Dead oil	22.81	16.40	25.09	19.23
Naphthalene	6.00	Trace.	0.20	1.72
Anthracene	0.60	Trace.	0.19	0.24
Soft pitch	68.80	70.50	67.40	74.14

Tars A and B, made from Coals A and B, whose analyses are given above, show what differences may exist in tars made from coals very similar in composition as shown by proximate analysis. Tars I and II represent two tars from gas works. They also vary greatly in composition. As a usual thing, they are found to be of much higher specific gravity and to contain less light oils than tars from the by-product coke oven, making them inferior as sources of benzene and for the manuture of tarred paper.

To obtain the desired commercial products, the distillate must be subjected to further treatment. Thus the light oil on fractional distillation, gives "benzol" to the extent, for the coke-oven practice, of from 0.6 to 0.9 per cent of the weight of the coal used. According to Lunge,[2] "the final products of general trade into which the crude benzol should be split up without residues, are the following:

	FURNISHES DISTILLATE PER CENT UP TO—					Specific gravity.
	100°.	120°.	130°.	160°.	200°.	
90 per cent benzol	90					0.885
50 per cent benzol	50	90				0.880
Solvent naphtha			20	90		0.875
Heavy naphtha					90	0.880

"Ninety per cent benzol" is a product of which 90 per cent by volume distills before the thermometer rises above 100° C. A good sample should not begin to distill under 80° C., and should not yield more than from 20 to 30 per cent at 85° C., or much more than 90 per cent at 100° C., but it should distill completely below 120° C. A 90 per cent benzol of good quality contains about 70 per cent of benzene, 24 per cent of toluene, including a little xylene, and from 4 to 6 per cent of carbon disulphide and light hydrocarbons.

"Fifty per cent benzol," often called 50/90 benzol, is a product of which 50 per cent by volume distills over at a temperature not exceeding 100° C., and 40 per cent more (making 90 per cent in all) below 120° C. It should wholly distill below 130° C. It contains a larger proportion of toluene and xylene than the 90 per cent benzol. It is nearly free from carbon disulphide, and contains comparatively little of the light hydrocarbons. It is employed for producing the heavy anilin used in manufacturing rosaniline or magenta.

"Thirty per cent benzol" is a product of which 30 per cent distills below 100° C. and about 60 per cent more passing over between 100° and 120° C. It consists chiefly of toluene and xylene with smaller proportions of benzene and cumene.

"Solvent naphtha" consists of xylene, pseudocumene, and mesitylene and is used in dissolving caoutchouc in the manufacture of waterproof materials and other articles.

From these "light oils," by fractional distillation and purification with sulphuric acid, water, milk of lime, and caustic soda, pure benzene, C_6H_6, toluene, C_7H_8, and xylene, C_8H_{10}, may be obtained, the benzene being crystallized out.

According to Pennock[3] the light oil obtained is from 6.6 pounds to 8.5 pounds per long ton of coal and it varies with the percentage of volatile matter in the coal. The light oil contains from 58 to 63 per cent of benzene, divided thus:

	Per cent.
90 per cent benzol	57
50 per cent benzol	2
Solvent naphtha	4

The dead oils and creosote oils which compose the material that is collected from the coal-tar distillate between 180° and 270° C. contain the "middle oil," and this fraction on further treatment yields crystallized carbolic acid, cresols, heavy solvent naphtha, pyridine bases, and naphthalene. In practice this is divided into further fractions, the fraction between 240° and 270° C. furnishing the creosote oil, which is a commercial source of naphthalene, coal-tar creosote, and the cresols. The naphthalene, which exists to the extent of 40 per cent or more in the creosote oil, is removed by chilling the oil, which causes the naphthalene to crystallize out, leaving the cresols. The crystals are

---

[1] J. Am. Chem. Soc., vol. 21, page 696. 1899.

[2] Coal Tar and Ammonia, 3d ed., page 588.

[3] J. Am. Chem. Soc., vol. 21, page 703.

then drained and pressed and purified further by sublimation.

The heavy coal-tar oil is used not only as a source of the more valuable products obtained by rectification or by "breaking" in red-hot tubes, but also for "pickling" timber; softening hard pitch; preparing varnishes; preparing cheap mineral paints, where the heavy oil is used in place of linseed oil; as an antiseptic; in the blue steaming of bricks; in carburetting gas; in the manufacture of lampblack; and by burning, as a source of heat and light.

The fraction between 150° and 200° furnishes the carbolic acid, it being obtained by treating the oil with caustic soda, through which sodium phenolate is formed, which separates from the oil. The sodium phenolate is drawn off and then decomposed by sulphuric acid or carbon dioxide and the carbolic acid set free. The crude carbolic acid is now purified by distillation or other means and the pure carbolic acid, or phenol, which crystallizes in colorless crystals, obtained. Pure carbolic acid is used in the manufacture of the dyestuffs, picric acid, and corallin, and of some azo dyes, also in the manufacture of salicylic acid, but most of the carbolic acid, both pure and crude, is used for antiseptic purposes. The oil drawn off from the sodium phenolate contains some of the higher homologues of benzene, and naphthalene with pyridine bases. In commerce it furnishes principally naphthalene, pyridine bases, and solvent naphtha of various degrees, the treatment being determined by the products sought. The pyridine bases are used in the manufacture of pharmaceutical preparations and in denaturizing grain alcohol for use in the arts.

The anthracene oil, which is the portion of the coal-tar distillate passing over above 270° C., is known also as green oil, green grease, and red oil, and it contains naphthalene, methyl naphthalene, anthracene, phenanthrene, acenaphthene, diphenyl, methyl anthracene, pyrene, chrysene, retene, fluoranthene, chrysogen, benzerythrene, carbazol, and acridine, together with a mixture of liquid high-boiling oils, of whose composition nothing is yet known, the whole forming a mass rather thinner than butter, filled with crystalline scales of a greenish-yellow color. The anthracene oil is treated by cooling and pressing, the liquid portion being sent to the heavy oil to be reworked with it. The solid portion is either sold as rough anthracene or it is further purified by washing with solvents which dissolve the impurities. On oxidation anthracene yields anthraquinone, which is used for the production of alizarine and other coal-tar colors. According to Pennock[1] there is as yet no market for anthracene in this country, but it is necessary that some anthracene should be present in coal tar pitch in order to produce a pitch of the right consistency for roofing purposes.

As indicated, the naphthalene is accumulated in the creosote oil and extracted from it in the crude condition by freezing and pressing, when it is purified by sublimation. It is used in the manufacture of artificial colors and as a substitute for camphor in protecting goods from the ravages of moths.

The coal-tar pitch, which forms the residue in the still, is used in the manufacture of roofing compositions and tarred felt and tarred paper; incorporated with coal or coke dust, it is fashioned into briquettes for use as fuel; dissolved in creosote oil or other solvents, it is used as a paint for iron and woodwork; and it is used as a substitute for asphalt in street pavements.

Benzene is employed as a solvent in the manufacture of nitrobenzene and dinitrobenzene, which are used in several arts and in the manufacture of many benzene derivatives. One important product is anilin, which is obtained by the reduction of mononitrobenzene. The anilin of commerce, which is known as anilin oil, is obtained from benzol, and this, as before stated, is a mixture of different cyclic hydrocarbons, the particular mixture used being determined by the color which it is sought to produce. In this case, as with pure benzene, the mixture is nitrated by exposure to a mixture of nitric and sulphuric acids, and the nitrosubstitution compounds that are produced are reduced by exposure to tin and hydrochloric acid or some other source of nascent hydrogen. Benzol is also used as a cleansing agent and as a vehicle in paint.

The nitrosubstitution compounds, and amido bodies, like anilin oil, represent in this group the "chemicals made from coal-tar distillery products."

The foreign commerce in coal-tar products is set forth in the following tables, compiled from the reports of the Bureau of Statistics of the Treasury Department on imported merchandise entered for consumption into the United States:

IMPORTS FOR CONSUMPTION OF COAL TAR DURING THE YEARS ENDING JUNE 30, 1891 TO 1896.

YEAR.	COAL TAR, CRUDE, AND PITCH.	
	Barrels.	Value.
1891	89,313	$263,593
1892	117,056	302,791
1893	102,136	244,291
1894	96,068	218,514
1895	112,536	247,957
1896	139,976	288,750

IMPORTS FOR CONSUMPTION OF COAL-TAR PRODUCTS, NOT MEDICINAL AND NOT COLORS OR DYES,[1] DURING THE YEARS ENDING JUNE 30, 1898 TO 1900.

YEAR.	Value.
1898	$228,037
1899	393,602
1900	397,780

[1] These preparations are known as benzol, toluol, naphthalene, xylol, phenol, cresol, toluidine, xylidine, cumidine, binitrotoluol, binitrobenzol, benzidine, tolidine, dianisidine, naphthol, naphthylamine, diphenylamine, benzaldehyde, benzyl chloride, resorcin, nitrobenzol, and nitrotoluol.

---

[1] J. Am. Chem. Soc., vol. 21, page 697.

IMPORTS FOR CONSUMPTION OF PREPARATIONS OF COAL TAR, EXCEPT MEDICINAL, AND PRODUCTS OF, NOT SPECIALLY PROVIDED FOR, FOR THE YEARS ENDING JUNE 1, 1895 TO 1900.

YEAR.	Value.
1895	$187,378
1896	313,943
1897	
1898	184,416
1899	221,101
1900	274,946

Literature.

A Treatise on Chemistry, by H. E. Roscoe and C. Schorlemmer, Vol. III: New York, 1887.

The Rise and Development of Organic Chemistry, by Carl Schorlemmer: London, 1894.

A Handbook of Industrial Organic Chemistry, by Samuel P. Sadtler: Philadelphia, 1895.

The Retort Coke Oven and the Chemistry of its By-Products, by J. D. Pennock, J. Amer. Chem. Soc., 21, 678–705. 1899.

The Spirit of Organic Chemistry, by Arthur Lachman: New York, 1899.

Coal Tar and Ammonia, by George Lunge: 3d ed. New York, 1900.

Group VI.—Cyanides.

In this classification are included potassium ferrocyanide, potassium ferricyanide, potassium and ammonium sulphocyanates (known commercially as sulphocyanides), and potassium, sodium, and other cyanides. No separate account was taken of the cyanides at any census previous to 1900. At the census of 1900 returns were made only for potassium ferrocyanide and for potassium cyanide. Twelve establishments were reported in which the cyanides were the principal products, the value being $1,466,061, and 6 establishments in which they formed secondary products, the value being $12,844. These 18 establishments employed $1,322,719 of capital and 391 wage-earners and produced $1,595,505 of product. They were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF CYANIDE FACTORIES: 1900.

STATES.	Number of establishments.	Average number of wage-earners.	Capital.	Value of product.	Per cent of total.
United States	18	391	$1,322,719	$1,595,505	100.0
New Jersey	6	166	533,001	1,053,472	66.0
Pennsylvania	4	107	317,816	303,245	19.0
Ohio	3	43	71,750	86,852	5.5
Maryland, Massachusetts, and Missouri	5	75	400,252	151,936	9.5

Of the products reported, 6,165,407 pounds, having a value of $994,014, were potassium ferrocyanide, and 2,317,280 pounds, having a value of $601,491, were the so-called potassium cyanide. There were consumed in this manufacture 9,315,080 pounds of potassium carbonate, having a value of $279,602; 3,456 tons of hoofs and of horn waste, having a value of $87,502; 19,417 tons of scrap leather, having a value of $150,213; 1,200 tons of spent iron oxide from the gas works, having a value of $3,000; 300,000 pounds of sodium, having a value of $93,183; 2,400 bushels of lime, having a value of $480; $9,520 worth of scrap iron, and 2,401,180 pounds of potassium ferrocyanide.

Potassium ferrocyanide (ferrocyanide of potassium; yellow prussiate of potash; blood-lye salt) was discovered by Macquer in 1752, through acting upon prussian blue with an alkali. It is made by fusing potassium carbonate in cast-iron vessels and adding to the fused mass a mixture of nitrogenous organic matter, such as horns, hair, blood, wool waste, and leather scraps, with from 6 to 8 per cent of iron turnings or borings, until the mixture added equals about 1¼ parts of the potash. The fused mass, when cooled, contains, among other substances, potassium cyanide, carbonate, and sulphide, iron sulphide, metallic iron, and separated carbon. This mass is broken up and digested with water at 85° C. for several hours, during which reactions take place by which the potassium ferrocyanide is formed. The solution is clarified and the potassium ferrocyanide purified by crystallization, when it appears in fine large yellow crystals, having the formula $K_4Fe(CN)_6.3H_2O$.

Potassium ferrocyanide is also prepared from the spent oxide of iron from gas works' purifiers, thereby utilizing the nitrogen compounds that have been taken up or formed during the process of purification. In this operation the oxide is lixiviated with warm water to remove the ammonium sulphocyanate and other ammonium compounds, and the residue is mixed with quicklime and heated by steam in closed vessels to 100° C., through which calcium ferrocyanide is formed, and separated by lixiviation. By treating this with potassium chloride, the difficultly soluble calcium potassium ferrocyanide is formed, and by decomposing this with potassium carbonate the potassium ferrocyanide results.

Potassium ferrocyanide was manufactured on a commercial scale by Carter & Scattergood in Philadelphia, before 1834. It is used largely for making prussian blue, potassium cyanide and ferricyanide, prussic acid, in calico printing, in dyeing, for case-hardening iron, and in white gunpowder and pyrotechnics.

Potassium ferricyanide (ferricyanide of potassium; red prussiate of potash) was discovered by Leopold Gmelin in 1822,[1] and is formed by passing chlorine gas through a solution of potassium ferrocyanide until the solution will no longer give a blue reaction with a ferric salt. Or the salt may be formed by exposing dry powdered ferrocyanide to the action of chlorine gas; or by acting on a calcium and potassium ferrocyanide solution with potassium permanganates; or, according to

---

[1] Schw. J., vol. 34, page 325.

Lunge,[1] by boiling a solution of the ferrocyanide with lead peroxide, while a stream of carbon dioxide is passed through the solution. Potassium ferricyanide crystallizes without water of crystallization in blood-red prisms. It is very soluble, yielding an intensely yellow solution which forms the blue pigment, known as Turnbull's blue, with ferrous salts.

Carter & Scattergood were manufacturing red prussiate of potash on a commercial scale at Philadelphia in 1846. When in solution with caustic potash, it is a powerful oxidizing agent, and as such is used in calico printing as a "discharge" on indigo and other dyes. It also forms a part of the sensitive coating for photographic "blue-print" papers, and has been recommended for use with potassium cyanide in the extraction of gold from its ores.

Ammonium sulphocyanate (sulphocyanate of ammonium; ammonium thiocyanate; ammonium sulphocyanide), the acid of which was first observed by Bucholz in 1799, is prepared by heating carbon disulphide and ammonium hydroxide to 125° C. in an autoclave until the pressure rises to 15 atmospheres, when the ammonium dithiocarbamate is formed. The pressure is now released and the autoclave heated to 110° C., when the dithiocarbamate is decomposed and the products distilled over. The ammonium sulphocyanate produced is obtained by evaporating the liquid remaining in the still in tin vessels and crystallizing out.

As pointed out above, ammonium sulphocyanate is also obtained by lixiviating the spent iron oxide used in purifying illuminating gas. The salt crystallizes in colorless plates which are very soluble in water and alcohol. It is used as a source of other sulphocyanates and in dyeing, to prevent the injurious action of iron on the color.

Among the sulphocyanates produced from it is the barium sulphocyanate which results from heating ammonium sulphocyanate with barium hydroxide solution under slight pressure; and this barium salt is used generally for the manufacture of potassium and aluminum sulphocyanates, which are used in textile dyeing and printing.

Potassium cyanide (cyanide of potassium) has been generally prepared by fusing potassium ferrocyanide with potassium carbonate until the evolution of gas ceases. Potassium cyanide, potassium cyanate,[2] carbon dioxide, and metallic iron are formed. The metallic iron sinks to the bottom of the crucible and the fused mixture of cyanide and cyanate is run off. Part of the cyanate may be reduced to cyanide by adding powdered charcoal to the fused mass, or it may be reduced by metallic zinc or sodium; or the cyanide may be extracted from the mass by a solvent such as alcohol, acetone, or carbon disulphide. By fusing the potassium ferrocyanide with sodium carbonate a mixture of sodium and potassium cyanide known under the name of "cyansalt" may be produced. An almost pure cyanide can be obtained by heating the ferrocyanide *per se* according to the following equation:

$$K_4Fe(CN)_6=4\ KCN+N_2+FeC_2$$

but this method entails the loss of one-third of the nitrogen in the ferrocyanide, and to avoid the waste of nitrogen Erlenmeyer proposed to add the proper amount of an alkali metal to the melted ferrocyanide, giving for sodium the following reaction:

$$K_4Fe(CN)_6+2\ Na=4\ KCN+2\ NaCN+Fe$$

and it is in this way that most of the so-called chemically pure potassium cyanide now sold is made, though it consists of a mixture of potassium and sodium cyanides. It also contains a considerable quantity of potassium carbonate, which is added to it during the course of manufacture to reduce its strength, for the combined cyanides produced as above described have a higher percentage of cyanogen than chemically pure potassium cyanide could possibly have. The carbonate is added in sufficient amount to reduce the cyanogen contents to from 39 to 40 per cent, which is equivalent to from 98 to 100 per cent potassium cyanide.

Other processes have been devised for using sodium in making cyanides. One is to first convert the sodium into sodamine, thus: $2\ Na+2\ NH_3=2\ NaNH_2+H_2$ by heating it in contact with ammonia gas, and then heating the amine with carbon to form the cyanide thus: $NaNH_2+C=NaCN+H_2$. Another and later method by which it is claimed a better yield is obtained, is to form a stable cyanamid, at a temperature of about 400° C., from the sodamine and carbon, thus:

$$2\ NaNH_2+C=Na_2N_2C+2\ H_2,$$

and then reacting on the cyanamid with a further quantity of carbon at a temperature of 800° C. to form the cyanide according to the equation:

$$Na_2N_2C+C=2\ NaCN.$$

Each of these methods requires a large amount of expensive sodium for a given output of cyanide. J. D. Darling has lately devised a process of using sodium in the synthetic production of sodium cyanide, which gives good results and in which the larger portion of the metallic base is furnished in the form of caustic soda, and but a small amount of sodium is needed to finish the process. It is claimed that by this process a moderate-sized sodium plant can produce enough metal to manufacture a large amount of cyanide.

Potassium cyanide has been commercially manufactured by passing nitrogen over an intensely heated mixture of charcoal and potassium carbonate. Cyanides have also been produced by conducting ammonia

---

[1] Ding. poly. J., vol. 238, page 75.

[2] Gmelin, vol. 7, page 413.

gas through vertical retorts, heated to a red heat, and containing a mixture of charcoal and alkali carbonates. Potassium cyanide is sometimes obtained in considerable quantity from blast furnaces, being formed from the potassium carbonate in the ash of the fuel.[1] Because of this reaction between carbon and nitrogen in the presence of alkaline salts numerous efforts have been made to utilize the reaction in making the atmospheric nitrogen available.

Potassium cyanide was commercially manufactured by the H. V. Davis Chemical Works, at New Bedford, Mass., in 1852. As it is a powerful reducing agent, potassium cyanide is used as a flux in assaying and in metallurgy; as a solvent of silver sulphide it is used in cleaning silver articles; it has been used as a fixing solution in photography; for the preparation of Grénat soluble and potassium isopurpurate in dyeing; and, as it forms a soluble double cyanide with silver, gold, copper, and other metals, it is much used in electroplating; but its largest use is now found in the cyanide process for the extraction of gold from its ores.

The foreign commerce in the cyanides is set forth in the following tables, compiled from the publications of the Bureau of Statistics of the Treasury Department of the United States:

IMPORTS FOR CONSUMPTION DURING THE YEARS ENDING JUNE 30, 1891 TO 1900.

YEAR.	YELLOW PRUSSIATE OF POTASH.		RED PRUSSIATE OF POTASH.	
	Pounds.	Value.	Pounds.	Value.
1891	2,223,154	$368,366	35,826	$10,650
1892	1,302,632	232,058	35,933	11,111
1893	1,047,910	206,259	16,679	5,743
1894	599,103	114,826	11,135	3,339
1895	878,727	161,009	26,703	7,593
1896	1,056,562	157,457	30,390	8,579
1897	3,252,931	359,037	59,087	14,893
1898	1,340,305	132,508	77,246	18,674
1899	1,809,089	204,974	62,697	15,211
1900	1,771,394	224,274	53,716	12,954

IMPORTS FOR CONSUMPTION DURING THE YEARS ENDING JUNE 30, 1897 TO 1900.

YEAR.	CYANIDE OF POTASH.	
	Pounds.	Value.
1897	16,232	$4,190
1898	549,697	120,252
1899	1,102,780	253,613
1900	2,064,974	444,703

LITERATURE.

Handbook of Chemistry, by Leopold Gmelin, Vol. VII: London, 1852.

Encyclopédie chimique, by M. Fremy, vol. 2: Paris, 1886.

On the Fixation of Atmospheric Nitrogen, by A. A. Breneman, J. Am. Chem. Soc., 11, 2–48. 1889.

A Dictionary of Chemistry, Henry Watts, vol. 2: London, 1870.

Manual of Chemical Technology, by R. von Wagner: London, 1892.

Outlines of Industrial Chemistry, by F. H. Thorp: New York, 1898.

The Cyanide Process for the Extraction of Gold, by M. Eissler: London, 1898.

Die Cyan-Verbindungen, by F. Feuerbach: Leipzig, 1896.

Manufacture and Uses of Metallic Sodium, by J. D. Darling, J. Frk. Inst., 153, 65–74. 1902.

The Composition of Commercial Cyanide of Potassium, by Russell W. Moore, J. Soc. Ch. Ind., 21, 391–392. 1902.

Group VII.—Wood Distillation.

Wood distillation as now classified for census purposes deals solely with that treatment of wood by which wood alcohol, acetic acid, acetate of lime, pyroligneous acid, and charcoal, or any of these, are produced. This interpretation was given to it in 1880, the first census at which separate returns were set forth for the industry. The manufacture proceeds in two stages: First, the production of crude wood alcohol or wood spirits and crude acetate of lime; second, the refining of the alcohol, and the refining of the acetate of lime, or the production therefrom of acetic acid or acetone. The refining processes are usually carried out at other works than those in which the crude materials are produced, but while in the census reports the alcohol refineries remain identified and classified with the wood distillation works, the factories where the acetate of lime is treated are classified with "chemicals, acids." With this preface it can be stated that 99 establishments were reported as producing some of the crude substances enumerated above during the census year 1900. Of these, 84 were regular wood-distilling establishments and produced of crude alcohol 4,191,379 gallons, having a value of $1,660,061; of acetate of lime 81,702,000 pounds, having a value of $926,358; and of charcoal 14,428,182 bushels, having a value of $612,009.

These works employed $4,858,824 of capital, and 1,268 wage-earners. There were 9 establishments reporting the production of the crude material and the refining of the alcohol in the same factory; and these establishments produced of refined alcohol 637,856 gallons, having a value of $370,513; of acetate of lime 5,124,000 pounds, having a value of $54,928; and of charcoal 2,726,120 bushels, having a value of $114,663. They employed $760,156 of capital and 254 wage-earners. Besides these there were 9 establishments engaged in refining wood alcohol only, producing 2,400,284 gallons of refined alcohol, having a value of $1,926,385, and employing $1,098,719 of capital, and 52 wage-earners. Finally, there were 6 other establishments engaged in the production of pyroligneous acid or pyrolignite of iron as incidental to other manufacturing processes, the total quantity of pyroligneous acid reported from all sources being 182,446 gallons, valued at $9,481; of dye liquors 308,400 gallons, valued at $29,440, and of sundries, such as wood creosote,

---

[1] Bloxam's Chemistry, page 619. 1890.

wood oil, ashes, tar, and the like, amounting in value to $71,452.

At the first census of this industry in 1880 only crude materials were reported. At the census of 1890 refined wood alcohol was reported for the first time, and it was then stated that the total output of crude alcohol was found by adding to that produced at the “acid factories” that which was produced and refined in the same establishment. Proceeding in this way for the 9 establishments reported above for 1900 as producing the crude alcohol and refining it in the same establishment, and converting the refined 97 per cent alcohol into crude 82 per cent alcohol at a value of 42 cents per gallon, a total is obtained for these establishments of 754,584 gallons of crude alcohol having a value of $316,925. By taking, in these instances, the per cent of the total value for all products added in the refining of the alcohol, the proportion of capital and labor devoted to the production of the crude material is found to be, for these 9 establishments, $641,052 of capital and 219 wage-earners. There were, therefore, 93 factories producing crude alcohol, in which $5,499,876 of capital and 1,487 wage-earners were employed. The total output thus ascertained is compared with the returns for the previous censuses in the following table:

WOOD DISTILLATION, CRUDE MATERIAL PRODUCED: 1880 TO 1900.

YEAR.	Number of establishments.	WOOD ALCOHOL.		ACETATE OF LIME.		CHARCOAL.	
		Gallons.	Value.	Pounds,	Value.	Bushels.	Value.
1880	17	....	$86,274	6,593,009	$156,892	....	$31,770
1890	53	1,116,075	688,764	26,778,415	315,430	....	....
1900	93	4,945,963	1,976,986	86,826,000	981,286	17,154,302	726,672

The increase of 1890 over 1880 in acetate of lime was 306.2 per cent in quantity and 101 per cent in value. The increase for 1900 over 1890 was 224.2 per cent in quantity and 211.1 per cent in value. The increase for 1890 over 1880 in wood alcohol was 698.3 per cent in value. The increase for 1900 over 1890 was 343.2 per cent in quantity and 187 per cent in value.

These establishments were distributed as follows:

WOOD DISTILLATION, GEOGRAPHICAL DISTRIBUTION OF WORKS PRODUCING CRUDE PRODUCTS: 1900.

STATE.	Number of establishments.	Average number of wage-earners.	Value of products.	Per cent of total.
United States	93	1,487	$3,833,266	100.0
Pennsylvania	58	878	2,339,536	61.3
New York	24	354	786,252	20.3
Michigan	5	169	505,069	13.2
North Carolina	3	12	18,409	0.4
New Jersey, Indiana, and Massachusetts	3	74	184,000	4.8

Only the number of refineries and quantity of products were reported for 1890, and only with these can the present condition of the refined wood-alcohol industry be compared, but this is sufficient to show how marked the growth has been.

PRODUCTION OF REFINED WOOD ALCOHOL: 1890 AND 1900.

YEAR.	Number of establishments.	Gallons.	Value.
1890	4	166,342	....
1900	18	3,038,140	$2,296,898

The increase of 1900 over 1890 is more than seventeenfold.

Although wood is usually spoken of as consisting of cellulose, it really consists of cellulose associated with a great variety of other organic substances, the kind differing with the different species of wood, and it is only necessary to recall the various gums, resins, tannins, sugars, and coloring matters found in commerce, which are obtained by simple processes of extraction from wood, to make this fact especially apparent. When subjected to heat out of contact with the air, the constituents of the wood are decomposed into liquids, gases, and a solid residue, and this process has been resorted to for ages as a means for obtaining charcoal. During the middle ages it became known that wood vinegar or pyroligneous acid could be obtained by distilling wood, but the identity of the acetic acid present with that obtained by the fermentation of alcohol was not known until 1802, when it was established by Thènard. The presence of wood spirit in the distillate from wood was discovered by Robert Boyle, in 1661, but its analogy to grain alcohol was first recognized by Taylor in 1812, and its composition was definitely fixed by Dumas and Peligot in 1831. Although charcoal, acetic acid, and methyl alcohol are the principal commercial products of the wood distillation industry, there is also produced, besides methyl alcohol, other alcohols, acetic acid and other acids, furfural and other aldehydes, acetone and other ketones, methyl acetate and other esters, methylamine and other amines, wood-tar creosote containing guaiacol and other phenols, and various hydrocarbons.

Originally wood was treated for charcoal alone by charring it in heaps or in kilns, thus allowing all the other products named above to go to waste. This process is still carried on, but before the middle of the Nineteenth century the process of distillation in retorts, by which the acetic acid in the form of pyroligneous acid, pyrolignite of iron, or acetate of lime, and the wood spirits were recovered, was well established in Europe. The manufacture of pyroligneous acid was begun in the United States by James Ward in 1830, at North Adams, Mass. The manufacture of acetate of lime and methyl alcohol was started in the United States about 1867 by James A. Emmons and A. S.

Saxon, in Crawford County, Pa., and in 1874 George C. Edwards established the Burcey Chemical Works at Binghamton, N. Y.,[1] to refine the crude wood spirit produced by the various acetate manufacturers. In 1876 Dr. H. M. Pierce obtained the first of a series of United States letters patent relating to inventions in this industry, which he was the first to apply to the recovery of the by-products from the smoke of the charcoal kilns in Michigan, where charcoal was being produced for use in blast furnaces. From that time he was most active in the promotion of the wood distillation industry, and largely contributed to the revolution which has since been effected in our foreign commerce in the products of this industry.

The wood used for the making of wood alcohol and acetate of lime is hard wood, preferably oak, maple, birch, and beech. It is cut in 50-inch lengths, so that a cord of wood in this industry measures 48 by 48 by 50 inches. It should be seasoned two and one-half years before "burning," to get the best results. The wood is burned in retorts, in ovens, or in kilns. The retorts are cylindrical, are made of three-eighths inch steel, 9 feet long by 50 inches in diameter, and are provided with a large, tightly fitting door at one end and an outlet pipe about 15 inches in diameter at the other end. The retorts are set horizontally in pairs in brickwork, and batteries of from 6 to 16 pairs are common. The cord wood is fed through the door and carefully stacked so as to completely fill the retort. The ovens consist of rectangular iron chambers set in pairs in brickwork and provided with large doors at one end and three or more delivery pipes on the side of each oven. They are usually 27 feet long, 6 feet wide, and 7 feet high inside, and rails are laid upon the floor of the oven by which steel cars loaded with cord wood may be run in. These cars each hold 2½ cords of wood, and an oven of the above dimensions will receive two such cars. Ovens, however, are in use in this country that are from 48 to 50 feet in length and capable of receiving four cars at one charge. The retorts are heated from beneath by burning wood, coal, or charcoal, supplemented by the tar, red oil, and gas, which are by-products of the industry. A very large part of the charcoal made in retorts is thus consumed. This furnishes another example of a chemical industry in which the former by-products have now become the principal products. The ovens are heated by natural gas.

When the wood is heated the moisture is driven out, but no decomposition occurs until the temperature approaches 160° C. Between this and 275° C. a thin, watery distillate, known as pyroligneous acid, is chiefly formed; from 275° to 350° C. the yield of gaseous products becomes marked; and between 350° and 450° C. liquid and solid hydrocarbons are most extensively formed. The quantity and character of the yield depend upon the character and age of the wood and the temperature and rate at which the charge is heated. In the ovens the wood is heated for twenty-four hours and then the cars containing the charcoal are drawn and immediately run into iron sheds where, when the doors are closed and luted, the charcoal is allowed to cool. The volatile portions, from retorts or ovens, are carried to condensers where the pyroligneous acid and tar are condensed and the gases are carried off to be burned under the boilers for generating steam, or under the retorts.

The yield of pyroligneous acid is about 30 per cent and of tar about 10 per cent of the weight of the dry wood. The acid averages about 10 per cent of acetic acid, 1 per cent of methyl alcohol and 0.1 per cent of acetone. As acetone is produced by the heating of acetates the yield of these two bodies will vary with the manner in which the heating is carried on. The pyroligneous acid is a dark red-brown liquid, having a strong acid reaction and a peculiar empyreumatic odor, and its density varies between 1.02 and 1.05 specific gravity. It is used to a limited extent in the manufacture of an impure acetate of iron, known as "black iron liquor," or "pyrolignite of iron," but it is usually treated to separate the methyl alcohol, acetone, and acetic acid from it. This is done by distillation, the alcohol being concentrated by dephlegmators, as is done in the manufacture of grain alcohol, to 82 per cent, when it is shipped to the refinery in iron drums holding about 110 gallons each, or in barrels holding from 45 to 46 gallons each. The acetic acid is recovered in two forms, viz, as "gray acetate of lime" or as "brown acetate of lime;" the first being produced when vapors from the distillation are passed through milk of lime, while the second is produced when the pyroligneous acid is neutralized with lime before distilling off the alcohol, and the resulting acetate of lime is thus contaminated with considerable tar.

The crude wood alcohol is sent to the refinery to be purified and rectified, which is accomplished by further distillation from lime or caustic alkalies. The acetone can not be separated by simple distillation, but it may be converted into chloracetones of high boiling points and thus removed, or the separation may be effected by crystallizing out the methyl alcohol with calcium chloride, or the acetone may be converted into chloroform and volatilized by distilling the mixture with chloride of lime. Most of the methyl alcohol of commerce contains acetone in varying quantities, even as much as 15 per cent, and such acetone containing alcohols are especially desired in several arts, as they serve for the purpose to which they are put better than pure methyl alcohol. A pure methyl alcohol is now produced in very considerable quantity which is of 100 per cent strength as it leaves the works, but it soon absorbs water on exposure so as to reduce its alcohol strength to 98 or 97 per cent.

---

[1] Tenth Census of the United States, Manufactures, general folio 1013.

In the Pierce process, as described by Landreth, the charring of the wood is effected in circular, flat-top, brick kilns holding 50 cords of wood each. The wood is charred by the heat produced by gas burned in a brick furnace under the kiln, into and through which the products of combustion pass. The gaseous products of the dry distillation of the wood pass from the kiln to condensers, where the tarry and liquid products are condensed and the gas sent back to the kiln. Thus none of the charcoal produced is burned to carbonize other wood, as in the common pits or ovens. The gas which elsewhere is wasted is here not only sufficient to effect the carbonizing of the wood, but furnishes fuel for the boilers required about the works.

The wood used is as thoroughly seasoned as the conditions of maintaining a year's supply in advance, cost of storage room, and interest on capital invested in stock render economical. If not thoroughly dry when placed in the kilns, the carbonization of the wood is automatically deferred, by the absorption of the heat in the evaporation of the sap and other moisture, until the seasoning process is complete. This seasoning commences at the top of the kilns and proceeds regularly downward, by a definite plane of seasoning. When this plane reaches the bottom and the seasoning is complete, which is indicated by a sudden change in the color of the escaping vapors, the process of charring begins at the top and proceeds downward precisely like the seasoning process.

The watery vapors driven off during seasoning are not preserved, but are allowed to escape through vents temporarily left open around the base of the kilns and through the top of the kiln chimneys, which, during this stage, are open at the top, but which, so soon as the watery vapor has escaped, are connected with a suction main. The time required for the several stages in the cycle of operations in producing a kiln of charcoal is as follows:

	Days.
For charging one kiln with wood	2
For completing the seasoning of the wood	1
For carbonizing the wood	7
For cooling the charcoal	6
For drawing the charcoal	2
Total length of cycle	18

As one 60-ton blast furnace requires 5,000 bushels of charcoal daily, or the output of 2 kilns, the total number of kilns in a plant to furnish a continual supply of fuel must be equal to twice the number of days in a cycle plus a margin for relays, for repairs, and unusual delays; the margin is usually chosen at one-sixth the effective number of kilns, so that the total number of kilns comprising a plant $= 2(18) + \frac{1}{6}(36) = 42$, of which at any one time—

4 kilns are being charged and closed.
2 kilns are being seasoned.
14 kilns are being carbonized.
12 kilns are being cooled.
4 kilns are being drawn.
6 kilns are idle or acting as relays.
42

These 42 kilns are arranged in 2 distinct batteries of 21 kilns each. Each battery has its own condensers and suction main carrying the products of distillation to the condensers, and its own gas main leading the noncondensable gases back to the kiln furnaces.

The condensers are composed of tall wooden tanks, 5 feet square by 20 feet high, through which the products of distillation pass, each inclosing 99 vertical copper pipes, 2 inches in diameter, through which the condensing water flows. The condensed products are trapped out at the bottom of each condenser, of which 10 comprise a battery, and conveyed to cooling tanks, where the tar is separated from the pyroligneous acid liquor by cooling. The tar is used to coat the kilns to render them impervious to air, and for this purpose one coating of tar suffices for four burnings, while the usual coating of lime whitewash has to be repeated after each burning. The circulation of the gaseous products through the system is maintained by exhaust fans, which draw the noncondensed gases through the condensers and force them through the gas main back to the kilns, when they are injected into the furnaces by a steam jet from a one-sixteenth-inch orifice playing in the center of an inch nozzle on the gas pipe. The minimum amount of air necessary to effect the perfect combustion of the gases is admitted through regulating dampers in the front of the furnace.

From the liquor coolers the pyroligneous acid liquor is conveyed to the distilling house, where the acetic acid in the liquor is converted into acetate of lime; the liquor is then sent to the fractional distillation system, which comprises 8 primary stills and condensers, 4 intermediate stills and condensers, and 2 final or shipping stills and condensers. The stills are circular tanks each holding about 2,500 gallons and are heated by steam coils of 2-inch copper pipe. The several stills of each of the 3 series are operated abreast. The distillation is not carried on continuously, but each series is charged and the distillation carried on until all of the alcohol available is evaporated, when the stills are emptied and recharged with new liquor. The degree of concentration attained in each series of stills is as follows:

The liquor entering the primary stills contains 1½ per cent of alcohol.

The distillate from the primary stills contains 15 per cent of alcohol.

The distillate from the intermediate stills contains 42 per cent of alcohol.

The distillate from the final stills contains 82 per cent of alcohol.

The yields of products differ with the different works and with the different processes employed. According to Landreth the yields by the Pierce process with brick kilns are as follows:

DRY WOOD.	Volume per cord of wood.	Mass per cord.	Per cent.
Resulting charcoal	50.6 bush	1,012 lbs	25.30
Resulting methylic alcohol	4.4 gals	30 lbs	0.75
Resulting acetic acid	4.6 gals	40 lbs	1.00
Resulting tarry compounds	16.5 gals	160 lbs	4.00
Resulting water	220.7 gals	1,838 lbs	45.95
Resulting noncondensable gases	11,000.0 cu. ft	920 lbs	23.00
Total		4,000 lbs.	100.00

Though 1 factory reports as high as 12.93 gallons of alcohol per cord of wood, yet the yields from the retort and oven processes average about 10 gallons of alcohol, 200 pounds of acetate of lime, and 50 bushels of charcoal per cord of wood in addition to the gas, tar, and chemical oil, all of which are burned. The yield of brown acetate of lime is about one-third larger than that of gray. As has been said, where retorts are used much of the charcoal is burned. Where coal is used, four-tenths of the charcoal produced is burned under the retorts. Where no coal is used six-tenths of the charcoal produced is thus consumed. In all of the works the whole of the gas, tar, and chemical or red oil is burned by the aid of steam, but it is probable that investigation will show that the tar and red oil are too valuable to be thus consumed.

The methyl alcohol is used for domestic fuel, as a solvent in varnishes, as a solvent in the manufacture of pyroxylin plastics, in the production of formaldehyde, in the making of methylated spirit, and in the manufacture of anilin colors.

The acetate of lime is used for the manufacture of acetic acid, acetone, "red liquor," and, when purified, as a mordant in dyeing.

Acetone is employed in the manufacture of chloroform, iodoform, and sulphonal, for denaturating grain alcohol, in making smokeless powder, and as a solvent in several of the arts.

A complete treatment of the wood distillation industry should include the production of turpentine, rosin, and tar by the distillation of the wood of the long-leaved pine, but this is made the subject of special report No. 126, issued January 11, 1902, entitled "Turpentine and Rosin."

The factories for the production of the crude products of this industry must be located near an abundant supply of hard wood and where there is a sufficient supply of water for cooling the condensers and charging the steam-generating boilers, this steam being employed in distilling the liquors, evaporating the acetate solutions, drying the acetate, and operating the pumps by which the liquors are raised from one level to another. In some cases, however, the acetate pans are placed over the retorts so that the heat radiated from them may be usefully employed. The total amount of wood reported as consumed in this industry for 1900 was 490,939 cords, having a value of $1,241,972, which gives an average value for it of $2.53 per cord as laid down at the works. Assuming one man to average one and one-half cords of wood per day, the cutting of the wood used would give employment to 3,273 men for one hundred days each. Comparing this total quantity of wood reported with the total quantities of crude wood alcohol, acetate of lime, and charcoal the average yields per cord of wood for all processes are found to be 10 gallons of alcohol, 176 pounds of acetate of lime, and 35 bushels of charcoal.

It is alleged in the "trade" that the importations of acetate of lime into the United States before the introduction of the by-product processes amounted to as much as 3,000,000 pounds annually. The only statistics discoverable in the records of the Treasury Department relative to this, is that in 1880 there were 38,000 pounds imported, having a value of $76. On the other hand, the following table, compiled from "The Foreign Commerce and Navigation of the United States for the Year Ending June 30, 1900," shows that the United States is exporting large quantities of both acetate of lime and wood alcohol:

EXPORTS, WOOD ALCOHOL AND ACETATE OF LIME: 1898 TO 1900, INCLUSIVE.

YEAR.	WOOD ALCOHOL.		ACETATE OF LIME.	
	Gallons.	Value.	Pounds.	Value.
Total	1,653,799	$934,411	134,274,564	$2,014,269
1898	385,938	199,230	37,496,288	537,856
1899	727,062	414,875	48,987,511	700,900
1900	540,799	320,306	47,790,765	776,413

From the same source is the following record of imports of charcoal and pyroligneous acid:

IMPORTS, CHARCOAL: 1891 to 1898, INCLUSIVE.

YEAR.	Value.	YEAR.	Value.
1891	$56,020	1895	$20,272
1892	48,029	1896	42,970
1893	51,634	1897	32,106
1894	40,249	1898	2,404

IMPORTS, FOR CONSUMPTION, ACETIC OR PYROLIGNEOUS ACID: 1891 TO 1900, INCLUSIVE.

YEAR.	Pounds.	Value.
1891	10,946	$1,036
1892	12,280	2,302
1893	18,421	2,795
1894	22,244	3,959
1895	92,889	8,938
1896	....	....
1897	....	....
1898	127,949	9,776
1899	202,838	14,467
1900	292,891	19,189

LITERATURE.

Acetic Acid, Chemistry of Arts and Manufactures, by Sheridan Muspratt, Vol. 1, *1–48*. 1860.

The Economical Production of Charcoal for Blast Furnace Purposes, by O. H. Landreth, Proc. A. A. A. S., 27, *145–151*. 1888.

Outlines of Industrial Chemistry, by F. H. Thorp: New York, 1898.

Handbook of Industrial Chemistry, S. P. Sadtler: Philadelphia, 1895.

The Distillation of Pine Wood in the South, by Franklin S. Clark, School of Mines Quarterly, 9, *163–166*. 1888.

Charcoal Production and Recovery of By-Products, by Consul-Gen. Frank H. Mason, U. S. Consular Reports, 66, *253–261*. 1901.

The Manufacture of Charcoal in Kilns, by T. Egleston, Trans. Amer. Inst. of Mining Engineers, May, 1879.

The Composition of Wood Oil, G. S. Fraps, Amer. Chem. Jour., 25, *26–54*. 1901.

Commercial Organic Analysis, Alfred H. Allen, revised by Henry Leffmann, 3d ed., Vol. 1: Philadelphia, 1898.

GROUP VIII. FERTILIZERS.

The term "fertilizer," as used in this report, includes all manufactured products which are intended to promote the growth of plants and which can be, and customarily are, so used without needing any further factory treatment. Under this definition raw phosphate rock, even if finely ground, can hardly be included, nor can crude cottonseed, ordinary tankage, nor unground bone. All of these have fertilizing properties, but require further treatment, usually chemical, if the full effect is to be economically obtained. The term "fertilizer works" should, strictly speaking, be confined to establishments producing "finished fertilizers," such as superphosphate, with or without ammoniates; "complete fertilizers," by which is meant a mixture of superphosphate with both potash and ammoniates; and "all other fertilizers," including bone meal and similar substances. But under the principle governing the classification of industries at the census of 1900 there can be included in fertilizer works all factories of which the main product, though not a finished fertilizer, was, nevertheless, a fertilizer material—say, tankage—in a condition of advanced manufacture, such products being included in "all other fertilizers."

The total number of establishments thus classified as fertilizer works, and forming Class A, is 422. In addition there are 18 small establishments, each of which reported a value, for all products, of less than $500, and hence are not included in the regular census tabulations. As the total fertilizer product of the 18 establishments amounted to but 46 tons of complete fertilizer, valued at $1,047, and 213 tons of "all other fertilizers," valued at $3,489, it will be seen that the omission to tabulate establishments under $500 is of small consequence.

Under Class B are included 10 establishments whose main product places them in some one of the 19 groups of "chemical industries," but which made more or less fertilizers as a subordinate, though sometimes very important, part of the product. The total fertilizer product of this class amounted to superphosphate, tons 1,810, value $20,417; complete fertilizer, tons 17,707, value $350,077; and "all other fertilizers," tons 7,983, value $98,510.

Class C includes 28 works, none of which belongs to "chemical industries," yet at which were made a certain amount of fertilizers. The importance of taking this class into consideration, if a full presentation of the industry is desired, is evident, since the total product of this class was superphosphate, tons 12,000, value $100,000; ammoniated superphosphate, tons 750, value $13,500; complete fertilizer, tons 24,391, value $521,825; and "all other fertilizers," tons 27,409, value $443,147.

Class D includes such by-products of "slaughtering and meat packing," "garbage reduction," "glue," and similar industries as were reported as "fertilizers." So far as known, such materials are bones, bone tankage, ammoniates, and the like, utilized in the preparation of ammoniated and complete fertilizers. While included here for the sake of completeness, it must be remembered that the amounts and values of these products, as well as those of Class C, are elsewhere reported in the census tables of their respective industries, and their presence here is a not unnoticed duplication. Of this class, 10 "garbage-reduction" works produced such materials aggregating 17,809 tons, value $256,322, while the report for "slaughtering and meat packing" gives "fertilizers," tons 160,962, value $3,326,119, and "glue" gives tons 15,942, value $331,268, a total of 204,713 tons, and a value of $3,913,709.

Included in "all other fertilizers" is fish scrap, the residue after the oil is pressed out of the fish, amounting to 27,035 tons, of a reported value of $448,602, in addition to which certain establishments made 1,942 tons which were consumed in works in making fertilizers. The fish oil reported from the 25 establishments engaged in this industry amounted to 1,135,264 gallons, valued at $222,929. The returns of scrap and oil per thousand fish, the customary unit of measure, naturally vary considerably, according to the condition of the fish, whether fat or lean, the lean fish yielding little oil in proportion to the scrap. In one case of a large and well-managed factory having good fish, the yield per thousand fish was given as 4.17 gallons of oil and 185 pounds of scrap, while another large works, having very lean fish, reported a yield of only 1.87 gallons of oil and but 140 pounds of scrap. The general average for all reports was, 2.98 gallons of oil and 149.2 pounds of scrap per thousand fish. After the scrap leaves the press in which the oil is expressed, it must be protected from decomposition, as this not only produces a local nuisance but results in serious pecuniary loss. In one case where 500 tons of good scrap were valued at $10,000, 500 tons of decomposed scrap were valued at only $3,000. In order to prevent this decomposition the laws of several states, for example, Massachusetts and Connecticut, require that the daily output of scrap shall be sprinkled with sulphuric acid, as this prevents the lighting of flies upon it and the consequent development of maggots. When acid is so used, finely ground phosphate is often mixed with the scrap before shipment, thus taking up the excess of acid and hindering the rotting of the bags in which the scrap is shipped.

The use of fish as a fertilizer was known to the aborigines of New England before the arrival of the whites, since it is stated in the records of the Plymouth colony that Squantum, a friendly Indian, showed the colonists how to manure their corn by putting a fish into each hill. It would seem, therefore, that the colonists were ignorant of the fertilizing value of fish, which is rather surprising, since the value of barnyard manure has been known since a very early period in the history of agriculture, and marl, a phosphatic lime earth, was used in England, at least, prior to this period. It is possible, however, that the value of marl was considered to lie in its improving the physical condition of the soil rather than as furnishing any plant food, as the advantage of mixing clay with sandy soils or sand with clayey soils was known to the Romans.

As soon as the true action of fertilizers became known, it was seen that the presence of grease or oil in a fertilizer was harmful, as hindering the conversion of the fertilizing ingredients into the soluble forms into which they must pass before they can be assimilated by the plant. Hence by extracting the oil from fish a valuable substance was obtained and the residue of scrap became more quickly efficient. The same thing occurs in the cottonseed industry, the oil and "linters," valuable for other purposes, containing very little fertilizer material, while the cake and hulls are in much better condition for utilization as feed or fertilizer than in their original condition as part of the seed.

Little is known about the beginnings of the fish-oil industry, but it is stated that the Herreshoffs, of Rhode Island, were making fish oil and scrap as early as 1863. The fish generally used for this purpose is the menhaden or mossbunker, which appears on the Atlantic coasts in the summer in large schools and is a very oily fish, in no demand for edible purposes. The number reported as caught during the census year is 458,963,200, and yielded the quantities of oil and scrap noted above.

The most available statistics of this industry are those given by Eugene G. Blackford in One Hundred Years of American Industry, 1895, page 394. These are here presented with the statistics derived from reports classified at the census of 1900 as chemical industries, group "fertilizers," and may therefore not include all of the reports received from this industry. It is believed, however, that the showing is substantially complete, although the figures show an enormous reduction in capital invested and number of men employed, from the figures given for 1894. It is true that in some cases where complete fertilizers are also made, the men reported as employed are those engaged at the factory only, those employed in fishing being represented only by the cost of the fish as covering wages, supplies, and maintenance of vessels. Still the total capital, $497,760, bears a fair relation to total value of product, which is $703,866, made up of oil, $222,929; scrap sold, $448,602; and scrap used in works, 1,942 tons, of a calculated value of $32,237; and the general statistical position of the industry bears out the statements of some of those engaged in the industry to the effect that in 1900 there was little profit in it.

MENHADEN INDUSTRY, SEASONS OF 1874, 1880, 1890, 1894, AND 1900.

YEAR.	Factories.	Sail vessels.	Steamers.	Men employed.	Capital invested.	Number of fish caught.	Gallons of oil made.	Tons of scrap.
1874.....	64	283	25	2,438	$2,500,000	492,878,000	3,372,847	50,976
1880.....	79	366	82	3,261	2,550,000	776,000,000	2,035,000	19,195
1890.....	28	27	52	4,368	1,750,000	553,686,156	2,939,217	21,173
1894.....	44	30	57	2,560	1,737,000	540,361,900	1,999,505	27,782
1900.....	25	......	....	500	497,760	458,963,200	1,135,264	28,977

"Slaughtering and meat packing" furnishes a large quantity of fertilizer materials, because, in the large packing establishments of the present day nothing utilizable is allowed to go to waste. The blood is carefully collected and dried, making a high-priced ammoniate, and the gelatin, glue, grease, etc., of the horns, hoofs, and other bones and other offal extracted. The residues from this part of the work are sold as bones, tankage (which is meat offal dried and ground), and as "bone tankage" (which is tankage containing bone fragments). Dried blood, tankage, and all of the like materials, which are called "ammoniates," are valuable by-products of the packing industry, and are the most expensive constituents of a complete fertilizer.

The final aggregate of the reported amounts and values of the fertilizer products for 1900 from all sources so far as found, superphosphate and other products made but consumed in the works in the making of mixed fertilizers not being included, is as follows:

FERTILIZER PRODUCTS: KINDS, QUANTITY, AND VALUE, 1900.

	Number of establishments.	SUPERPHOSPHATE.		AMMONIATED SUPERPHOSPHATE.		COMPLETE FERTILIZER.		ALL OTHER FERTILIZERS.	
		Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
Class A	422	923,198	$8,471,943	142,898	$2,349,388	1,436,682	$25,446,046	291,917	$4,178,284
Under $500	18	....	....	....	....	46	1,047	213	5,489
Class B	10	1,810	20,417	....	....	17,707	350,077	7,983	98,510
Class C	28	12,000	100,000	750	13,500	24,391	521,825	27,409	443,147
Total	478	937,008	8,592,360	143,648	2,362,888	1,478,826	26,318,995	327,522	4,723,430
Class D	....	....	....	....	....	....	....	204,713	3,913,709
Final total	478	937,008	8,592,360	143,648	2,462,888	1,478,826	26,318,995	532,235	8,637,139

The total product, by classes, is as follows:

	Tons.	Value.
Class A	2, 794, 695	$40, 445, 661
Under $500	259	4, 536
Class B	27, 500	469, 004
Class C	64, 550	1, 078, 472
Total	2, 887, 004	42, 097, 673
Class D	204, 713	3, 913, 709
Final total	3, 091, 717	46, 011, 382

The total number of establishments in Classes A, B, and C, the only ones which can properly be denominated fertilizer works, is 476. This shows a considerable increase—392—over the figures for the census of 1890 but falls short of the estimates for 1898 made by the author of "The Fertilizer Industry."[1] The estimated number given by him, is "about 700." It is evident that this figure was too high, because while the business, as a whole, has much increased, the tendency, as in all other branches of manufacture, is to concentrate the industry into the hands of larger companies or combinations, who by reason of greater facilites in, and control of, the market can, if necessary, undersell competitors and work on a closer margin of profit. The author of the interesting bulletin just noted complains of the indifference, even "positive unwillingness of manufacturers to furnish the information desired." The experience of the Census Office with this group has been much more satisfactory. With but one exception, every establishment that was reached, either by the field force or by correspondence, endeavored to give a correct statement of the operations. From the large combinations and firms, reports were often received which were most valuable, and offers of any further information which might be needed. In other cases the reports, owing to the deficiencies of a hastily assembled field force were sometimes unsatisfactory, but correspondence brought the information, if existing. In the case of the positive refusal above mentioned, a little local inquiry enabled us to construct a satisfactory report, because the nature, quantity, and value of the product of the establishment were known, and from correct reports from establishments in the vicinity the quantities of ingredients and their cost could be fairly estimated. Such editing work must be done with great caution if the results are to have real value, and it is satisfactory to be able to state that, owing to the cheerful cooperation of manufacturers, such work has been reduced to a minimum.

"Fertilizers" appears as a special item for the first time in the census report for 1860. The condition of the industry then and its growth since are shown by the following comparison, the percentage of gain for each decade over the preceding one being also given:

FERTILIZER MANUFACTURE, BY DECADES: 1860 TO 1900.

YEAR.	Number of establishments.	Per cent of increase.	Product (tons).	Per cent of increase.	Value.	Per cent of increase.
1860	47				$891, 344	
1870	126	168			5, 815, 118	552
1880	278	120	727, 453		19, 921, 400	242
1890	[redacted]	41	1, 898, 806	161	35, 519, 841	78
1900	478	21	2, 887, 004	52	41, 997, 673	18

These figures are fairly in accordance with what is otherwise known of the history of the development of this industry. Of the 422 establishments in Class A only 7 stated that they manufactured fertilizers prior to 1860, 3 of these being in Baltimore, Md., where, so far as is known, the manufacture of fertilizers began. In 1840 Liebig published his classical researches on plant nutrition, in which he asserted that "the food of all vegetation is composed of inorganic or mineral substances." This was contrary to the then prevailing view, which was that the humus of the soil was the support of plant life, the mineral substances, the ash of the plant, being considered of subordinate importance. The researches of Wiegman and Polstorf showed, however, that a luxuriant plant growth could be obtained by planting the seeds in soil which had, by burning, been deprived of the last trace of humus or other organic matter, and then watering them with dilute solutions of the needed inorganic salts. Other investigators continued this line of research, and a rational agriculture was then developed. It was found that a plant derives its carbon from the air directly by means of its leaves, and also, but in a minor degree, through its roots by the absorption of water containing carbonic acid. On the other hand, while the plant can to a small extent supply its demand for nitrogen from the ammonia of the atmosphere by means of its leaves, this supply is quite inadequate for healthy growth. The deficiency, as also the demand for mineral salts, must be supplied through the roots. As these can only take up such substances when dissolved in water, it follows that not only the nitrogen which is taken up by the plant must be in soluble forms which are now considered to be nitrates, which are always soluble, but also the mineral constituents such as phosphoric acid, silica, lime, potash, iron, etc., must be in forms soluble in water to be available for the nourishment of the plant.

The importance of phosphoric acid being early recognized, the manufacture of superphosphate began. According to Kerl the first scientifically planned fertilizer works in Germany were erected in 1850. A letter from Dr. R. W. L. Rasin, of Baltimore, states that—

> The manufacture of chemical fertilizers in the United States began about 1850. In that year Dr. P. S. Chappell, and Mr. William Davison, of Baltimore, made some fertilizer in an experimental way. About the same time Professor Mapes was experimenting. Later De Burg utilized the spent bone black derived from the sugar refineries and made quite a quantity of "dissolved bone black"

---

[1] Miscellaneous Bulletin No. 13, United States Department of Agriculture, 1898, page 5.

> (superphosphate). In 1853 or 1854 Mr. P. S. Chappell commenced the manufacture of fertilizers, as did B. M. Rhodes, both of Baltimore. In 1855 Mr. John Kettlewell, recognizing the fact that Peruvian guano (then becoming quite popular), and containing at that time 18 to 21 per cent of ammonia, was too stimulating and deficient in plant food (phosphates), conceived the idea of manipulating the Mexican guano, containing no ammonia but 50 to 60 per cent of (bone) phosphate of lime, and called his preparation "Kettlewell's manipulated guano."
>
> While in 1856 the sales of Peruvian guano had increased to 50,000 tons and of Mexican guano to some 10,000 tons, there was not at that date 20,000 tons of artificial fertilizers manufactured in the entire country. Baltimore was not only the pioneer but the principal market for fertilizers until some time after the Civil War. The 50,000 tons of Peruvian guano referred to was bought and sold in this market, and there was little demand for that or the Mexican guano in any other market unless the inspection brand of the guano inspector of Baltimore was upon the package. The Peruvian Government agent, who received and disposed of all importations, was located here, and all other markets were supplied from Baltimore. At that time no fertilizers were sold west of Pennsylvania.

Owing to the exhaustion of the sources of supply the importation of guano has almost ceased. In 1900 but 1,150 tons, value $15,543, were imported from Peru, the total amount of guano imported being 4,756 tons, value $56,956. Much of this is, however, practically phosphate rock, requiring chemical treatment before using. The original guano of Peru was produced from the excrements and remains of sea birds deposited upon islands in a very arid region. Its agricultural value was well known to the ancient Peruvians, whose wise laws forbade the killing or molestation of the birds. Owing to the scarcity of rain the ammoniacal salts developed in the deposits remained in the guano, while in less arid regions the soluble salts were leached out, and where the underlying rock was a limestone this became altered to a certain depth, becoming a more or less pure tricalcic phosphate, usually called bone phosphate of lime. The guanos of Sombrero, of Navassa, and of many other places are examples, and all require chemical treatment.

The importation of phosphate rock for 1900 amounted to 110,065 tons, value $504,092, coming mainly from Germany and Spain. The term "phosphorite" is used to cover all of the varieties of phosphate rock which range from the crystallized apatite of Canada to the comparatively amorphous rock of South Carolina, but was originally applied to the fibrous phosphate from Estremadura, Spain, which occurs in large quantities and is extensively exported. The German phosphate from the Lahn region and other places is usually concretionary in appearance. This concretionary structure is very characteristic of phosphorites, as shown in many places in Florida and in the so-called coprolites of England and other localities.

By treating phosphate rock or bones with sulphuric acid, superphosphate or acid phosphate is formed. The works making this, mix more or less of it with ammoniates, or potash or both, producing the various grades of ammoniated superphosphate, superphosphates with potash, or complete fertilizer. The remainder is sold as such, being bought by establishments that make various mixtures to suit local demands, while a very large quantity goes directly into consumption, being bought by farmers, who make their own composts.

Of the 422 fertilizer works belonging to Class A, 76 made sulphuric acid. The total quantity of acid thus made amounted to 642,938 tons of chamber acid of 50° Baumé, of which 571,831 tons were consumed by the works producing it in making superphosphates, while the remainder, 71,107 tons, was sold elsewhere mainly as chamber acid, only 5,360 tons being concentrated to higher strengths before sale. Thirty acid-making works did not make enough for their own demand and supplied the deficiency from other sources. In Classes B and C, 3 works made 12,028 tons of 50° acid and consumed it in making superphosphate, making a total of 583,859 tons thus made and consumed by 79 works.

Of the 478 works producing fertilizers, 76 made superphosphate, but purchased the needed acid, while 208 bought the superphosphate; in each case the final product sold was mixed fertilizers. The remaining works, 115 in number, as well as all of Class D, produced the fertilizer materials above mentioned and placed under "all other fertilizers." In so far as any of these products are purchased by other fertilizer works and used in making mixed fertilizers, the quantities and values of such purchases reappear in the mixed fertilizers, and to that extent there is a duplication. The extent of this duplication can only be estimated, since a considerable quantity of the products included in "all other fertilizers" consists of bone meal and other substances, which are used for composting or put on the land without further treatment. On the other hand, it is certain that "all other fertilizers"—tons 532,235, value $8,637,139—falls far short, both in quantity and value, of the real production of such materials. For example, the establishments under Class A report using 37,868 tons of cottonseed meal, and those in Class C, 3,608 tons, a total of 41,476 tons. These figures evidently represent only a fraction of the amounts actually used for fertilizer purposes, since the total product of cotton seed meal for 1900 was 884,391 tons, value $16,030,576, a very large proportion of which, amounting to 638,638 tons, was used in composting, as shown by the large quantity of superphosphate which goes into consumption as such.

The figures for superphosphate, ammoniated superphosphate, and complete fertilizer are quite close to the truth, as an examination of the complete returns will show. The total quantity of superphosphates reported as made and sold as such by all of the classes A, B, and C is 937,008 tons. The quantity of superphosphate purchased for mixing purposes is, for Class A, 286,918 tons; Class B, 240 tons; Class C, 9,402 tons; a total of 296,560 tons. Deducting this from the total, 937,008 tons, leaves the residue of 640,448 tons which was sold as such to the ultimate consumer. To this amount must be added the superphosphate in the mixed fertilizers to obtain the total quantity produced for the census year. The returns show great variations in the proportions of superphosphate in the products of the various establishments, but comparisons show that ammoniated superphosphate will average 70 per cent of superphosphate and complete fertilizer 50 per cent, giving the following result:

Superphosphate, sold as such, total tons	937, 008
Superphosphate, purchased, total tons	296, 560
Difference, equals finally consumed as such, tons	640, 448
In ammoniated superphosphate, 70 per cent of 143,648 tons	100, 553
In complete fertilizer, 50 per cent of 1,478,826 tons	739, 413
Total superphosphate produced, tons	1, 480, 414

The total product of superphosphate may also be ascertained from the amount of sulphuric acid reported as being used in its manufacture. Comparison of the returns at the census of 1900 fully confirms the current statement that in making superphosphate from a standard phosphate such as South Carolina rock the practice is to mix equal weights of phosphate and chamber acid. Reaction at once sets in, the mixture becoming quite hot and giving off vapors consisting of steam and volatile ingredients of the phosphate, such as carbon dioxide, fluorine, and chlorine. This volatilization loss amounts, for South Carolina rock, to 10 per cent of the total weight of the ingredients. Other phosphates, such as high-grade Florida rock, bones, etc., will of course require other proportions of acid and the volatilization loss will also differ, but the general average of all returns shows that every ton, 2,000 pounds, of phosphatic material required 2,000 pounds of chamber acid, lost 10 per cent, 400 pounds, by volatilization, and yielded 3,600 pounds of superphosphate. Taking all of the sulphuric acid reported as consumed in works and that purchased the results are as follows:

	SULPHURIC ACID.	
	Consumed (tons).	Purchased (tons).
Class A	571, 831	231, 528
Class B	5, 028	268
Class C	7, 000	200
Total	583, 859	231, 996
Add total, consumed		583, 859
Total acid used		815, 855
Add phosphate rock, equal amount		815, 855
		1, 631, 710
Deduct 10 per cent loss		163, 171
Total superphosphate produced, tons		1, 468, 539

Comparing the final quantity with that reported above, namely, 1,480,414 tons, the difference is found to be only 11,875 tons, or 0.80 per cent. This agreement is surprisingly close, since, under the conditions, a much larger difference would have been sufficient to demonstrate the general correctness of the returns.

The quantity of phosphate rock estimated above as used is 815,855 tons. Class A reported the purchase of 806,445 tons; Class B, 4,810 tons, and Class C, 7,700 tons; a total of 818,955 tons, or a difference of only 3,100 tons. This close agreement is, however, only fortuitous. Many of the larger works undoubtedly had more or less phosphate rock in stock at the beginning and end of the census year, and it is not always clear that the quantity reported is the amount actually used or only that which was purchased during the year. A part of the superphosphate estimated above as contained in the mixed fertilizers was made from bones, spent boneblack, and other materials, but how much can not be ascertained, because, although Class A reported the consumption of 96,679 tons of bones, part of this was used to make boneblack, part was disposed of as bone meal, and part mixed with the compounded fertilizers without any special addition of acid. Again, part of the tankage bought by the works is "bone tankage," containing considerable quantities of crushed bone, so that it is impossible to determine how much of the acid used actually went to make bone superphosphate.

Examination of the reports shows that only a comparatively small quantity of "concentrated phosphate" is made, although it would seem that there ought to be a considerable demand for this product which is so largely made in England, France, and Germany. It is made by treating phosphate rock with an amount of sulphuric acid sufficient to entirely decompose it, converting all of the lime into sulphate, allowing this to settle, and drawing off the solution of phosphoric acid. "The solution is then evaporated in lead pans to a density of 45° Baumé, at which strength the solution contains nearly 45 per cent P_2O_5. During this concentration the iron and aluminum phosphates separate and are removed. The strong solution of phosphoric acid is then treated with finely ground phosphate rock to form mono-calcium phosphate, which is dried and disintegrated."[1]

The phosphoric acid solution may be made from any form of phosphate, and low-grade material too poor for the manufacture of superphosphate can be used for this purpose. The phosphate rock added in the second stage of the process should, however, be high grade, if the best results are to be attained. For this reason, the Florida rock which contains up to 80 per cent or more of phosphate is mainly shipped abroad to supply the foreign demand for this purpose, while our own manufacturers, making only ordinary superphosphate, mainly use South Carolina rock containing about 60 per cent phosphate. The manufacture of superphosphate from South Carolina rock is a much simpler process and

---

[1] Thorp, Outline of Industrial Chemistry, page 144; 1898.

the product is a satisfactory one, although its contents in soluble phosphoric acid is low, ranging from 20 to 24 per cent as compared with concentrated phosphate or "double super," which may contain up to 47 per cent.

The further development of this industry in this country will depend upon transportation conditions as well as upon the advance of agricultural knowledge, but it would seem that there is a field for this work in the phosphate regions where much poor rock occurs for which there is no present demand, but which might be utilized in the local manufacture of "double super."

The use of tetrabasic phosphate, or slag phosphate, appears to have almost completely ceased in the United States, while its use is continually extending in Europe. The reasons assigned for this situation need not be given here, but doubtless in time this valuable material will assume the importance it deserves.

The following table shows the total fertilizer product of the United States, arranged geographically:

	STATES.	Number of establishments.	TOTAL.		SUPERPHOSPHATE.				
			Tons.	Value.	Tons.	Value.	Per cent of product.	Per cent of value.	Value per ton.
1	United States	478	2,887,004	$42,097,673	937,008	$8,592,360	32.5	20.4	$9.17
2	North Atlantic division	155	685,893	11,978,666	139,232	1,316,208	20.3	11.0	9.45
3	Maine	3	1,828	27,902	....	....	....	....	....
4	Massachusetts	10	83,733	2,108,575	1,282	12,820	1.5	0.6	10.00
5	Connecticut	9	11,077	313,610	....	....	....	....	....
6	New York	37	164,266	2,610,435	9,810	105,645	6.0	4.0	10.77
7	New Jersey	30	247,144	3,820,189	105,165	887,470	42.6	23.2	8.44
8	Pennsylvania	66	177,845	3,097,955	22,975	310,273	12.9	10.0	13.59
9	South Atlantic division	198	1,531,688	19,462,816	622,614	5,302,997	40.7	27.3	8.52
10	Delaware	11	49,942	634,213	2,385	28,250	4.8	4.5	11.84
11	Maryland	42	386,133	5,213,925	124,696	1,178,367	32.3	22.6	9.45
12	District of Columbia	7	3,859	76,480	....	....	....	....	....
13	Virginia	42	258,474	3,325,542	120,633	1,024,893	46.7	30.8	8.49
14	North Carolina	20	139,582	1,727,270	60,820	497,397	43.6	28.8	8.17
15	South Carolina	24	388,572	4,657,275	173,183	1,404,569	44.6	30.2	8.12
16	Georgia	45	278,982	3,331,469	131,503	1,075,581	47.1	32.3	8.17
17	Florida	7	26,144	496,642	9,394	93,940	35.9	18.9	10.00
18	North Central division	63	258,726	4,349,157	62,945	814,300	24.3	18.7	12.93
19	Ohio	28	103,814	1,562,638	24,728	285,698	23.8	18.3	11.55
20	Illinois	12	104,120	1,842,300	26,108	313,850	25.1	17.0	12.02
21	Indiana	16	11,668	238,161	365	10,006	3.1	4.2	27.41
22	Missouri	4	8,753	156,115	2,766	44,248	31.6	28.3	16.00
23	Kansas	3	30,371	549,943	8,978	160,498	29.6	29.2	17.11
24	South Central division	39	352,778	5,053,564	110,649	1,140,376	31.4	22.5	10.30
25	Kentucky	4	17,315	295,520	....	....	....	....	....
26	Tennessee	5	93,054	1,464,788	35,959	456,568	38.6	31.2	12.70
27	Alabama	21	139,282	1,944,283	38,246	369,587	27.5	19.0	9.70
28	Mississippi	3	37,704	492,772	7,200	50,400	19.1	10.2	7.00
29	Louisiana	6	65,423	856,201	29,244	263,821	44.7	30.8	9.00
30	Western division	9	22,131	636,687	....	....	....	....	....
31	California	9	22,131	636,687	....	....	....	....	....
32	All other states[1]	14	35,788	616,783	1,568	18,479	4.4	3.0	11.80

---

[1] Includes establishments distributed as follows: Iowa, 1; Michigan, 1; Minnesota, 1; Nebraska, 1; Oregon, 1; Rhode Island, 1; Texas, 2; Washington, 1; West Virginia, 2.

ARRANGED GEOGRAPHICALLY: 1900.

AMMONIATED SUPERPHOSPHATE.					COMPLETE FERTILIZERS.					ALL OTHER FERTILIZERS.					
Tons.	Value.	Per cent of product.	Per cent of value.	Value per ton.	Tons.	Value.	Per cent of product.	Per cent of value.	Value per ton.	Tons.	Value.	Per cent of product.	Per cent of value.	Value per ton.	
143,648	$2,462,888	5.0	5.9	$17.14	1,478,826	$26,318,995	51.2	62.5	$17.79	327,522	$4,723,430	11.3	11.2	$14.42	1
21,429	574,251	3.1	4.8	26.79	431,521	8,899,584	62.9	74.3	20.62	93,711	1,188,623	13.7	9.9	12.68	2
....	....	....	....	....	828	21,602	45.3	77.4	26.09	1,000	6,300	54.7	22.6	6.30	3
....	....	....	....	....	78,171	1,988,605	93.4	94.8	25.44	4,280	107,150	5.1	5.1	25.03	4
1,000	23,000	9.0	7.3	23.00	7,325	205,931	66.1	65.7	28.11	2,752	84,679	24.9	27.0	30.84	5
10,300	338,400	6.3	13.0	32.85	87,862	1,623,638	58.5	62.2	18.48	56,294	542,752	34.3	20.8	9.64	6
7,283	159,580	3.0	4.2	21.91	125,839	2,629,511	51.0	68.8	20.90	8,857	143,628	3.6	3.8	16.22	7
2,846	53,271	1.6	1.7	18.71	131,496	2,430,297	78.9	78.5	18.48	20,528	304,114	11.5	9.8	14.81	8
71,661	1,056,542	4.7	5.4	14.74	701,361	11,307,083	45.8	58.1	16.26	136,052	1,796,194	8.9	9.2	13.20	9
....	....	....	....	....	17,180	283,873	34.4	50.8	16.52	30,377	322,090	60.8	44.8	10.61	10
48,608	690,671	12.6	13.2	14.21	184,095	2,985,015	47.7	57.3	16.21	28,734	359,872	7.4	6.9	12.52	11
....	....	....	....	....	3,410	69,800	88.4	91.3	20.47	449	6,680	11.6	8.7	14.87	12
4,300	72,100	1.7	2.2	16.72	106,828	1,820,771	41.8	54.8	17.41	26,713	407,778	10.3	12.3	15.26	13
3,400	51,000	2.4	3.0	15.00	61,017	981,569	43.7	56.8	16.08	14,345	197,304	10.3	11.4	13.75	14
....	....	....	....	....	207,875	3,147,202	53.5	67.6	15.14	7,514	105,504	2.0	2.3	14.04	15
15,353	242,771	5.5	7.3	15.81	105,521	1,641,318	37.8	49.3	15.55	26,605	371,799	9.5	11.2	13.98	16
....	....	....	....	....	15,435	377,535	59.0	76.0	24.46	1,315	25,167	5.0	5.1	19.13	17
34,840	565,281	13.5	13.0	16.22	105,358	1,891,260	40.7	43.5	17.95	55,583	1,078,316	21.5	24.8	19.40	18
23,805	380,936	23.0	24.4	16.00	43,351	700,606	41.8	44.8	16.21	11,930	195,398	11.5	12.5	16.39	19
4,150	58,100	4.0	3.2	14.00	43,483	835,335	41.8	45.3	19.21	30,379	635,015	29.2	34.5	20.90	20
27	500	0.2	0.2	14.81	5,750	116,280	49.3	48.8	20.22	5,526	111,375	47.4	46.8	20.16	21
....	....	....	....	....	2,774	39,039	31.7	25.0	14.07	3,213	72,828	36.7	46.7	22.67	22
6,858	125,745	22.6	22.9	18.33	10,000	200,000	33.0	36.4	20.00	4,535	63,700	14.9	11.6	14.05	23
15,037	256,599	4.3	5.1	17.06	199,609	3,242,648	56.6	64.2	16.75	27,483	413,941	7.8	8.2	15.06	24
....	....	....	....	....	17,315	295,520	100.0	100.0	17.07	....	....	....	....	....	25
....	....	....	....	....	36,695	704,220	39.4	48.1	19.22	20,400	304,000	21.9	20.8	14.90	26
2,000	35,000	1.4	1.8	17.50	92,253	1,433,355	66.2	73.7	15.42	6,783	106,341	4.9	5.5	15.70	27
....	....	....	....	....	30,504	442,372	80.9	89.8	14.50	....	....	....	....	....	28
13,037	221,599	20.0	25.9	17.00	22,842	367,181	34.9	42.9	16.07	300	3,600	0.5	0.4	12.00	29
....	....	....	....	....	19,570	591,187	84.4	92.9	32.08	2,561	45,500	11.6	7.2	17.76	30
....	....	....	....	....	19,570	591,187	84.4	92.9	32.08	2,561	45,500	11.6	7.2	17.76	31
681	10,215	1.9	1.7	15.02	21,407	387,233	59.8	62.8	18.08	12,132	200,856	33.9	32.6	16.55	32

The establishments of the above table have been grouped according to the customary census divisions. Of the total product of the United States, 2,887,004 tons, valued at $42,097,673, superphosphate, sold as such, amounted to 32.5 per cent of quantity, and 20.4 per cent of value, the average value per ton being $9.17; ammoniated superphosphate, to 5 per cent quantity, 5.9 per cent value, and $17.14 per ton; complete fertilizer, 51.2 per cent quantity, 62.5 per cent value, and $17.79 per ton; and all other fertilizers, 11.3 per cent quantity, 11.2 per cent value, and $14.42 per ton. It must be remembered that while the quantities given in this table and elsewhere in this report are substantially correct, the values given in the reports are in most cases far below the market prices, since freight and other expenses must be added so that the final price to the consumer is very much higher. Moreover, as already stated, of the 937,008 tons of superphosphate, sold as such, 296,560 tons, or 31.7 per cent, were bought by other works and used for making mixed fertilizers, leaving 640,448 tons, or 68.4 per cent, which went directly into final consumption. At the average value of $9.17 per ton, the 296,560 tons would be worth $2,719,755, and, from one point of view, might be deducted, leaving superphosphate 640,448 tons, valued at $5,872,605, and the total product of the country 2,590,444 tons, valued at $39,377,918. Such a presentation, while possibly nearer the truth as regards ultimate consumption, would, however, be incorrect in a census report of manufactures which deals with capital, labor, materials, and products. The production of the 296,560 tons of superphosphate required capital, labor, and materials, and the figures of these demands are included in the general tables for this industry. The establishments purchasing this material saved the capital and labor required to produce it, so that if the deduction were made from the product, it would be necessary to make a corresponding deduction on the other side, which is plainly impossible.

On examining this table it will be noted that the South Atlantic division leads in quantity and value of product, the North Atlantic division being second. The average fertility of the Atlantic coast states is not high, and rational farming requires the continued application of fertilizer, much of it of high grade. The general status of agriculture in the various states in these two divisions is well shown by the figures. When the size of the average farms is small and most of these devoted to the growth of vegetables, fruit, and such products, as is the case in New England, the fertilizers demanded are high priced, as the requirements of the soil must be carefully studied and supplied if profits are sought. Proceeding southwardly, agriculture is on a larger individual scale and of a simpler character, until, in the cotton states, we find practically only a single market product, requiring a simpler fertilizer, low in price, and to be applied with judgment. Any excess of fertilizer acts injuriously upon the crop by stimulating a growth which can not resist the inevitable drought of the region. Moreover, a too liberally stimulated cotton plant runs to stems and foliage, with but little fruit, as may be seen in plants grown in gardens. For convenience in picking, the cotton plant should not be more than 3 feet high, nor more than an average arm's length to the center. and the bolls should open nearly simultaneously.

When a plant is grown in the rich soil of a garden, as is frequently done, for its beauty, it may reach a height of seven, eight, or more feet, with corresponding diameter, but, while quite beautiful, the yield of cotton is comparatively small, and costly to gather. The possibilities in cotton culture become evident when it is considered that for upland cotton the average yield of lint cotton is from 150 to 250 pounds per acre, while careful cultivation under favorable weather conditions has been known to bring up this yield to 1,000 pounds. Indeed, although a yield of 1,500 pounds has never been attained, it is the goal which many intelligent planters consider can be reached by careful selection of seed, and proper methods of planting, fertilizing, and tending. While it is not feasible, here, to make an extended comparison between the quantities and values of the fertilizers used in the different states in relation to the character of the agriculture and products, such a study will disclose that, while each state can show poor farming, yet in the main, what is done is best suited to local conditions so far as understood. The methods which may enrich a farmer in Massachusetts would impoverish him in South Carolina, while the methods which insure a good cotton crop are quite inapplicable to truck growing.

In comparing the various states it will be noted that South Carolina leads in quantity of product, 388,572 tons, while Maryland leads in value, $5,213,925. In the production of superphosphate, sold as such, South Carolina leads with 173,183 tons, valued at $1,404,569, Georgia being second with 131,503 tons, and Maryland third with 124,696 tons. The Maryland product is, however, valued at $1,178,367, thus exceeding the Georgia valuation of $1,075,581. In the proportion of such superphosphate to the total production of the state, Georgia is first as it disposes of 47.1 per cent of its total product in this form, and is followed by Virginia, Louisiana, South Carolina, North Carolina, New Jersey, and Maryland, in the order given. This large sale of superphosphate in these states is due to the numerous manipulators who mix special brands for local consumption, and also to the demands of farmers for home composting. This latter kind of work is naturally most frequent in the cotton states where the cottonseed and cottonseed cake furnish a large local supply of ammoniates, while the extensive truck farming of New Jersey and Maryland causes a similar demand.

The value of the superphosphate per ton ranged from

$7 in Mississippi to $27.41 in Indiana. The Mississippi valuation is very low, the average for the United States, $9.17, being about the price for superphosphate made from rock. The high value of this product in Indiana and other states of the North Central division is due to its having been made from raw bone and being practically an ammoniated superphosphate. Indeed, this value is higher than that given by any state for its product of "ammoniated super," with the exception of New York, which rates this product at $32.85, the average for the United States being only $17.14. In the production of "ammoniated super," Maryland leads all of the states, with a production of 48,608 tons, valued at $690,671, which is, however, only $14.21 per ton.

In the production of complete fertilizer South Carolina leads both in quantity and value, producing 207,875 tons, valued at $3,147,202, but the value per ton is low, $15.14. Leaving out California, the high valuation of whose fertilizer, $32.08, is due to the high cost of materials, it is found that the North Atlantic division, especially the New England states, makes the most expensive complete fertilizers. Connecticut leads with $28.11 average value per ton, followed by Maine with $26.09, and Massachusetts with $25.44. The Maryland product, next in quantity and value to South Carolina, being 184,095 tons, valued at $2,985,015, is quoted at only $16.21 per ton.

"All other fertilizers" amounts, for the United States, to 327,522 tons, valued at $4,723,430, being 11.3 per cent of the total product, 11.2 per cent of the total value, and averaging $14.42 per ton. As might be expected, New York leads in quantity, with a production of 56,294 tons, of an average value of $9.64 per ton. This low value shows the nature of the product, which is mainly garbage tankage, made by the garbage-reduction works near the large cities. Illinois, next in tonnage, 30,379 tons, is first in value, $635,015, or $20.90 per ton, while Missouri gives a value of $22.67 per ton; the reason in both cases being that the product is largely made from slaughterhouse offal, which yields high-grade products. The "fertilizers" of Class D, 204,713 tons, valued at $3,913,709, show an average value of $19.12 per ton, and belong to this category.

So far as it is possible to show the capital employed, also the labor and other elements of cost in the production of fertilizers, the statistics are given in the special tabulation of Class A for this industry. It is, however, not possible to do this for the other classes, since fertilizers form only a subordinate part of the product, and the capital employed and the costs can not be separated from the general operations of the works.

The importations of fertilizer materials for the census years 1890 and 1900, as given by the United States Treasury Department in "The Foreign Commerce and Navigation of the United States," 1890, pages 1150 to 1151; 1900, page 102, is as follows:

IMPORTS FOR IMMEDIATE CONSUMPTION FOR THE YEARS ENDING JUNE 30, 1890 AND 1900.

YEAR.	PHOSPHATES, CRUDE OR NATIVE.		KIESERITE, KYANITE OR CYANITE, AND KAINITE.		GUANO.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1890..........	31,179	$309,764	62,871	$422,225	8,432	$111,811
1900..........	14,075	86,763	133,244	762,493	4,765	58,474

YEAR.	BONE DUST OR ANIMAL CARBON AND BONE ASH, FIT ONLY FOR FERTILIZING PURPOSES.		APATITE.		ALL OTHER SUBSTANCES NOT ELSEWHERE SPECIFIED.	
	Tons.	Value.	Tons.	Value.	Tons.	Value.
1890..........	3,219	$59,059	126	$1,297	21,277	$333,109
1900..........	1,968	30,189	333	4,019	99,169	745,724

The literature of the fertilizer industry is very voluminous, and it is difficult to make a selection. The books giving the most useful information are probably The Phosphates of America, by Francis Wyatt, Scientific Publishing Company; Principles and Practice of Agricultural Analysis, Vol. II, Fertilizers, H. W. Wiley, Chemical Publishing Company, 1895; and the articles on Fertilizers in Muspratt—Kerl, Technical Chemistry, Wagner's Technology, and The Mineral Industry, the yearbook published by the Engineering and Mining Journal.

GROUP IX.—BLEACHING MATERIALS.

Although bleaching materials of various kinds have been long in use and bleaching by chlorine or hypochlorites has been in vogue since the latter part of the eighteenth century, no separate returns have been secured for this industry at any previous census. Chlorine production has practically been, until recently, incidental to the manufacture of soda by the Le Blanc process, and as this process has not secured a foothold in the United States, the production of chlorine bleaches has heretofore undoubtedly been insignificant in quantity and value. As pointed out in the treatment of Group X, with the introduction of electricity as an agent in effecting chemical transformations, common salt and other chlorides are being electrolyzed on a commercial scale with the result that the production of chlorine and hypochlorites is assuming importance. The chlorine thus produced is converted into bleaching powder by means of lime, but other hypochlorites, and notably sodium hypochlorite, are made from imported bleaching powder. In addition there are produced and used in bleaching, disinfection, or as a preservative, hydrogen dioxide, sodium dioxide, sulphurous acid, sodium, calcium, and potassium bisulphites, and many special compositions.

In considering this industry in its entirety there must be discussed, not only those bodies specifically reported as bleaching materials produced by the older processes, but also such bleaching agents as have been produced by the aid of electricity, or sent out for use in the compound or liquefied state, and also those which are the subordinate products of establishments whose principal products classify them with other industries. Combining these there were 26 establishments in 7 states, producing 26,794,338 pounds of material having a value of $592,658, and employing a capital of $672,969 and 216 wage-earners. These establishments were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF FACTORIES PRODUCING BLEACHING MATERIAL: 1900.

STATES.	Number of establishments.	Average number of wage-earners.	Capital.	Product.	Per cent of total.
United States	26	216	$672,969	$592,658	100.0
New York	10	126	529,746	407,327	68.7
Pennsylvania	6	4	25,853	15,878	2.7
New Jersey	3	10	14,500	39,171	6.6
Illinois	3	12	15,039	42,399	7.2
Missouri, Michigan, and Ohio	4	64	87,831	87,883	14.8

Among the principal products were 10,979 tons of hypochlorites of a value of $462,949; 588,335 pounds of hydrogen dioxide of a value of $63,754; 350,585 pounds of sulphur dioxide of a value of $4,826, and 1,461 tons of bisulphites of a value of $34,486. There were consumed in this manufacture 15,000 tons of salt brine, equivalent to 1,574 tons of salt, or, together with the other salt consumed, 9,055 tons of salt of a value of $19,105; 158,561 bushels of lime of a value of $20,532; 168 tons of caustic soda of a value of $7,618; 92,600 pounds of metallic sodium; 93,000 pounds of black oxide of manganese of a value of $1,325; 227 tons of muriatic acid of a value of $4,325; 974 tons of soda ash of a value of $23,368; 7 tons of potash of a value of $420; 171 tons of sulphur of a value of $4,000; 74 tons of barium dioxide of a value of $16,540; 74,490 pounds of phosphoric acid of a value of $14,898; and 44 tons of bleaching powder of a value of $1,570.

Sulphur Dioxide (sulphurous acid gas; sulphurous anhydride; SO_2).—This substance has been used as a bleaching agent from ancient times. It results from the burning of sulphur or sulphur-containing bodies in air or oxygen. In the presence of water it bleaches wool, hair, straw, and other tissues; but the bleaching is not permanent. Sulphur dioxide is used also as a disinfectant and germicide; in ice machines as a refrigerating agent; in the preparation of bisulphites; to a small extent in the leather and glucose industries; and as the first product in the manufacture of sulphuric acid. Next to its use in making sulphuric acid, the largest consumption of sulphur dioxide is undoubtedly in the sulphite process for converting wood into wood pulp for the purpose of making paper. As it is made and consumed in the works no returns are available to determine how much of the gas is produced in this industry.

Bisulphites.—There is returned as having been manufactured during the census year bisulphites of sodium, calcium, and potassium. They are manufactured by saturating a solution of sodium carbonate, milk of lime, or potassium carbonate with sulphur dioxide and crystallizing out the salt formed. Or the solution may be used as made. These bodies are employed as antichlors in bleaching to remove the excess of chlorine from the fibers of the goods which have been bleached by hypochlorites, and thus prevent this chlorine from rotting the fiber. They are thus used to treat wood pulp in paper making, and it is probable that much of the material used in this art is not included here. The bisulphites are also employed in chrome tannage, in brewing, in glucose and starch making, and as preservatives.

Hydrogen Dioxide (hydrogen peroxide, H_2O_2).—Hydrogen dioxide is made by treating barium dioxide, or sodium dioxide in suspension or solution in water, with a dilute acid, and keeping the temperature at a low point by means of ice. Hydrochloric, hydrofluoric, sulphuric, nitric, or even carbonic acid may be employed. The hydrogen dioxide is set free as a gas, which dissolves in the water present. This solution is decanted off or filtered, phosphoric acid is added to it, and it is diluted, if necessary, so as to contain 3 per cent of H_2O_2, when it is sent into commerce, and is then known as a 10-volume solution. Hydrogen dioxide is a powerful oxidizing agent, and it is used in bleaching hair, silk, wool, feathers, bone, and ivory. It has been quite extensively used for toilet purposes; also as an antiseptic and disinfectant in surgery; as an antichlor; as a reducing agent in chrome tannage; and as a preservative for milk, beer, wine, and other fermentable liquids. The Oakland Chemical Company began the manufacture of hydrogen peroxide in Brooklyn, N. Y., in 1881.

Sodium Dioxide (sodium peroxide, Na_2O_2).—Sodium dioxide is made by heating metallic sodium in aluminum trays, in a specially contrived furnace, to 300° C. while purified air is being passed over it. It is a yellowish white very hygroscopic powder, and is chiefly used as a bleaching agent, being a very powerful one, as it gives off 20 per cent of its weight of active oxygen. Its solution is too strongly alkaline for silk or wool bleaching, and for this purpose it should be converted into magnesium dioxide, which is easily effected by adding a solution of magnesium sulphate to the solution of sodium peroxide.

Hypochlorites.—There have been returns made for bleaching powder (which, according to Lunge, is a compound containing in the same molecule calcium attached to chlorine and to a hypochlorous acid residue) and sodium hypochlorite. The bleaching powder is made by passing chlorine gas into absorption chambers so as to come into contact with lime which has been so slaked as to contain from 24.5 to 25.5 per cent of water. The lime is exposed to the action of the gas until the test shows that the product contains from 36 to 37 per cent of available chlorine. The yield from 100 pounds of good lime is 150 pounds of bleaching powder. Bleaching powder is but partly soluble in water and when treated with water forms a milk-like fluid. It is an efficient bleaching, deodorizing, and disinfecting agent. To liberate the chlorine for bleaching purposes, an acid should be employed. The carbon dioxide of the atmosphere will effect this result, but in practice a dilute mineral acid is usually employed, the cloth first being saturated in the bath of bleaching-powder emulsion, called the "chemic," and then in the bath of dilute acid, called the "sour." Bleaching liquors may be made by passing chlorine gas into the milk of lime, and it was in this form that it was first used.

The emulsion of bleaching powder reacts with magnesium sulphate to form magnesium hypochlorite, with alum to form aluminum hypochlorite, with zinc sulphate to form zinc hypochlorite, and with sodium carbonate to form sodium hypochlorite. They are all efficient bleaching agents and are especially desirable because they are completely soluble in water. Potassium hypochlorite and sodium hypochlorite have been sold under the respective names of Eau de Javelle and Eau de Labarraque, they having been prepared by passing chlorine gas through a solution of potassium carbonate for the first, and sodium carbonate for the second. Sodium hypochlorite is still used for domestic purposes in removing spots from linen and also, together with oxalic acid, as an ink eradicator.

Bleaching by chlorine was first suggested and applied by Berthollet in 1785, and its adoption revolutionized the textile industry. He employed solutions of chlorine gas in water, but Tennant in 1798 patented a liquid bleach consisting of a solution of calcium or sodium hypochlorite prepared by passing the gas into milk of lime or a solution of caustic soda. This liquid bleach is difficult to transport and keep, and Tennant introduced a marked improvement by the invention of bleaching powder in 1799. Bleaching powder was made in this country at Bridesburg, Pa., by Charles Lennig in 1847. The Mathieson Alkali Works, at Niagara Falls, N. Y., and the Dow Chemical Company, of Midland, Mich., began the manufacture of bleaching powder from electrolytic chlorine in 1898.

Bleaching powder is still imported in very large quantities. The extent is shown in the following table, compiled from Volume II of the Foreign Commerce and Navigation of the United States for the years ending June 30, 1891 to 1900:

IMPORTS OF LIME, CHLORIDE OF, OR BLEACHING POWDER: 1891 TO 1900, INCLUSIVE.

YEAR.	Pounds.	Value.	YEAR.	Pounds.	Value.
1891	107,475,715	$1,429,509	1896	104,058,877	$1,579,358
1892	110,748,289	1,839,640	1897	99,274,188	1,375,560
1893	120,811,918	2,213,121	1898	114,232,578	1,421,920
1894	81,610,463	1,507,076	1899	118,107,250	1,159,271
1895	100,456,774	1,644,835	1900	136,403,151	1,464,019

LITERATURE.

Die Bleichmittel, Beizen und Farbstoffe, by J. Herzfeld, Volume I: Berlin; 1889.

Pharmacopœia of the United States. 1890.

The Chemistry of Paper Making, by R. B. Griffin and A. D. Little: New York, 1894.

A Theoretical and Practical Treatise on the Manufacture of Sulphuric Acid and Alkali, by George Lunge, Volume III: London, 1896.

Bleaching and Calico Printing, by George Duerr: London, 1896.

Outlines of Industrial Chemistry, by Frank Hall Thorp: New York, 1898.

Practical Treatise on the Bleaching of Linen and Cotton Yarn and Fabrics, by L. Tailfer: London, 1901.

GROUP X.—CHEMICAL SUBSTANCES PRODUCED BY THE AID OF ELECTRICITY.

In no prior census has any mention been made of this art. As a fact, as shown in the historical account which follows, this industry has practically been developed since the census of 1890 was taken. Nevertheless, it has already grown to such magnitude in these ten years as to effect serious inroads on the older processes, and it will undoubtedly in the future assume a greater importance. Already it is found that sodium and other metals, caustic soda, bleaching powder and other bleaching agents, bromine and potassium bromide, potassium chlorate, litharge, graphite, calcium carbide, carborundum, carbon disulphide, and phosphorus are reported as being produced on a commercial scale, the total value of the output for 1900 being reported at $2,045,535. It is particularly to be noted that the Le Blanc soda process, which has for a century been a standard process for chemical manufacture, is now endangered not only by the Solvay ammonia process, but that the last prop on which it relied for profit has been thrown down by the development of economic methods for the electrolytic production of bleaching powder. It is to be regretted that statistics of the electrical energy efficiency, and other data which are essential to a full understanding of this art are not at present accessible. But it can be stated that, apart from works producing aluminum (which is not included in the chemical industries), there are 14 establishments in the United States belonging in Group X, and that these employ $9,173,060 of capital and 739 wage-earners. These establishments were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF ELECTRO-CHEMICAL FACTORIES: 1900.

STATES.	Number of establishments.	Average number of wage-earners.	Capital.	Value of products.	Per cent of total.
United States	14	739	$9,173,060	$2,045,535	100.0
New York	10	614	8,311,538	1,836,606	89.8
Maine, Michigan, Connecticut, and New Hampshire	4	125	861,522	208,929	10.2

It is to be observed that the total value of the product given here differs from that given in the tabulation of "Chemicals" under the legend "Electro-chemicals," because caustic soda is classed with Group II, bleaching powder with Group IX, and the like; while there is gathered here the value of everything in all the classes which has been reported as having been produced by the use of the electric current. It is evident that while in the tabulation the value for a substance appears but once, by this method of treatment the value of a given substance will appear each time that it is treated of in a different group, and that therefore the value of that caustic soda which was produced electrolytically will not only appear in the total value given for Group X, now under consideration, but also under Group II, when the caustic-soda industry is considered as a whole. For this reason, as well as because the establishments devoted to the manufacture by electricity of any particular product are too few to be discussed under the rules separately, the statistics will be found combined with other statistics in the treatment of other groups.

Sodium.—The remarkable experiments conducted by Sir Humphry Davy in 1807, which resulted in the isolation of sodium[1] and of potassium, not only added to the list of known chemical elements two of its most interesting and important members, but the method devised by him and used here for the first time, in which an element was isolated by the passage of an electric current through its fused electrolyte and in which also the vessel used to contain the fused electrolyte and in which the fusion was effected was made of conducting material and served simultaneously as a container, and as one pole of the decomposing cell, has been largely applied in recent times, since easily controlled supplies of electrical energy at reasonable cost have been at command. Unfortunately no adequately cheap source of electrical energy was available until the dynamo was invented in 1867.[2] In the meantime, and subsequent to Davy's discovery, Gay-Lussac and Thénard found that sodium could be displaced from fused caustic soda by metallic iron at a high temperature, and later Brunner discovered that this reduction could be effected under these circumstances by carbon also. Upon this discovery, and making use of the condenser of Donny and Maresca, Sainte-Claire Deville based the method of manufacture which he devised, and this was for many years the only one employed in the commercial production of this metal. In practicing this process a mixture of sodium carbonate, lime or chalk, and charcoal were heated in iron retorts, and the displaced sodium distilled off and condensed, the reaction taking place being represented by the equation:

$$Na_2CO_3 + 2\ C = 2\ Na + 3\ CO.$$

Darling says, "Deville —— brought its manufacture to a high degree of perfection, reducing the cost of a kilo from 2,000 francs, in 1855, to 10 francs, in 1859."[3]

About 1886, H. Y. Castner, an American, greatly simplified the manufacture by acting on sodium hydroxide with iron and carbon, or iron carbide, effecting the following reaction:

$$6\ NaOH + FeC_2 = 2\ Na_2CO_3 + Fe + 2\ Na + 3\ H_2$$

by fusing the mass in steel or iron crucibles and passing the vapors into condensers opening under high-test petroleum. According to Mendelèeff,[4] "At present (1897) a kilogram of sodium may be purchased for about the same sum (2 shillings sterling) as a gram cost thirty years ago."

In 1890 Castner devised an electrolytic process which completely superseded the chemical processes for the isolation of sodium, and this has since been, until recently, the only process in use in this country or abroad for the commercial production of this metal. The electrolyte consists of fused caustic soda, which is melted in a cylindrical steel crucible with a contracted neck at the bottom, so set in a flue that as the crucible is heated from the outside the body of it only becomes heated while the neck remains cool, so that the caustic soda which fills the crucible remains solid in the neck and protects the joint between the cathode and the crucible at that point. There is a perforation in the bottom of the crucible at the neck, through which the cathode is passed up vertically and sealed by the solid caustic soda, as described above. The electrodes are of iron, and the anode, which may be cylindrical in form, is inserted from above so as to surround the end of the cathode. Encircling the cathode within the anode, and depending from a collecting pot above, is a cylinder of iron-wire gauze which serves to prevent the sodium, as it is liberated, from passing into the anode compartment. The inverted collecting pot above the cathode is filled with hydrogen, which is one of the products of the electrolysis, and this protects the sodium, as it collects, from chance oxidation. The sodium is baled from the collecting pot as soon as it has accumulated in sufficient quantity. More recently Darling has devised a process by which sodium is obtained from sodium nitrate.

Metallic Sodium and Nitric Acid from Fused Sodium Nitrate.—The Darling process, as carried out in the works of Harrison Bros. & Co., of Philadelphia, Pa., is characterized by the kind of diaphragm used. A cast-iron pot, set in a brick furnace and containing the nitrate to be decomposed, acts as the anode or positive electrode. A 6-inch layer of refractory insulating material is placed in the bottom of the pot and the porous cup rests centrally upon this, leaving a 3-inch space between the cup and the pot. This space is then filled with sodium nitrate and the cup itself nearly filled with melted sodium hydroxide. The cathode, or negative electrode, consisting of a short length of 4-inch wrought-iron pipe, provided with proper elec-

---

[1] Phil. Trans., vol. 98, page 1. 1808.

[2] Borcher, Electric Smelting and Refining, page 104.

[3] J. Frk. Inst., vol. 153, page 65. 1902.

[4] The Principles of Chemistry, D. Mendelèeff, vol. 1, page 535: London, 1897.

trical connections, is suspended inside the cup, reaching nearly to the bottom, and bridges made of wrought-iron pipe support these cathodes in a row of porous cups. When external heat is applied to the furnace, the electrolytes melt, and, permeating the walls of the cup, allow the passage of the current which, when of suitable strength, causes the decomposition of the sodium nitrate into sodium, nitrogen dioxide, and oxygen. The nitrogen dioxide and oxygen are liberated as gases at the positive electrodes, escape through a hole in the cover provided for that purpose and are utilized.

The positive sodium ions pass through the walls of the cup and on through the molten sodium hydroxide to be ultimately liberated in the metallic state at the cathodes. The first sodium liberated is absorbed by or combined with the sodium hydroxide, hydrogen gas being evolved and sodium monoxide, probably, being formed. After some time, metallic sodium rises to the top of the electrolyte in the cups and at intervals of about one hour is dipped off with a spoon and preserved under mineral oil. This style of porous cup and furnace gives excellent results. The use of two electrolytes of different character, yet having a common base, allows of the sodium being liberated in a neutral medium away from all danger of oxidation by the nitrate from which it is obtained. At first the sheet-metal walls of the porous cup had a very short life, being quickly eaten away by the local action caused by the secondary effects of the current. This trouble was overcome by shunting about 5 per cent of the current directly through the metal walls of the cup, making them positive. This plan reduced the local action and increased the life of the cup about ten times. The material now used for the porous cup is a mixture of ground dead-burnt magnesite and Portland cement, and it makes a very satisfactory diaphragm.

The nitrogen dioxide and oxygen evolved at the positive poles are conducted by means of earthenware pipes to a number of receivers or Woulff bottles connected together and containing water. The nitrogen tetroxide which is produced on coming in contact with the water combines to form nitric acid, $3\,N_2O_4+2\,H_2O=4\,HNO_3+N_2O_2$. The N_2O_2 takes up a molecule of oxygen to again form N_2O_4, and more nitric acid is formed. If it is desired to make a very strong acid for use in the manufacture of high explosives, a system of towers that automatically brings the strength of the acid up to a high degree is used.

Each furnace takes a current of about 400 amperes at an average E.M.F. of 15 volts. External heat is used only when starting up and when changing the cups, which have a life of from 425 to 450 hours; at other times during the operation the heat generated by the resistance to the passage of the current is sufficient to keep the electrolytes melted.

It is interesting to note, in connection with this process, that in December, 1902, the supply of metallic sodium on hand and in storage at these works had become so great that the city authorities, fearing accidents, compelled the operation of the process to cease.[1]

Up to some ten years ago, about the only use for sodium outside of the laboratory was in the isolation of aluminum, and when the electrolytic method for the production of aluminum was developed it looked as if the isolation of sodium on any large scale would cease. It was only when electricity was also applied to the isolation of sodium that it could be obtained cheaply enough to permit of its use in fields that had hitherto been closed to it on the score of cost. Chief among these new uses is the manufacture of alkaline cyanides, which are so largely used in the extraction of gold from low-grade ores and tailings; for "quickening" mercury in gold amalgamation; for electroplating; in photography; and other minor uses. Large amounts are also converted into sodium peroxide to be used in bleaching wool, silk, and feathers, and thereby replacing the more expensive hydrogen peroxide. It is also used in making certain anilin colors and organic compounds, and wherever a powerful reducing agent is needed.

Caustic soda and hypochlorites.—When common salt is electrolyzed it is separated into its constituents, sodium and chlorine, and this electrolysis may be effected by passing a proper current through fused sodium chloride, or through an aqueous solution of the salt; but in the latter case the sodium set free at the cathode immediately reacts with the water present, forming sodium hydroxide and liberating hydrogen. As shown in the discussion in Group II, the soda industry is one of the most important of the chemical industries, and as common salt is used in the Le Blanc, Solvay, and the other established processes of soda manufacture as the raw material of the art, it is not surprising that since, as stated above, common salt is readily electrolyzed, numerous processes and devices have been invented for effecting this on a commercial scale. Among them are the Vautin, Hulin, and the Borchers processes, in which fused sodium chloride is the electrolyte, and the Holland and Richardson, Hargreaves-Bird, Castner or Castner-Kellner, Solvay, Le Sueur, and the Dow, in which an aqueous solution of common salt, which in some instances is native brine, is used as the electrolyte. According to Blount,[2] the Castner-Kellner process is the only one which in 1900 was being worked in England on a large scale and in a profitable manner, but while this process is carried on in the United States, the Le Sueur and Dow processes are also in active operation here.

The difficulties in making the simple electrolysis of common salt a commercial success have been various. In the fused electrolyte processes they have been

---

[1] Science, vol. 15 (N. S.), page 129, Jan. 24. 1892.

[2] Practical Electro-Chemistry, page 309.

largely due to the corrosive action which fused salt exerts on most materials that can be used for making the vessels in which the electrolysis can be conducted, while, since the melting point of sodium chloride is 800° C., and metallic sodium begins to distill below 900° C., the metal comes off mostly as a vapor, which greatly increases the difficulties of collecting it. In the dissolved electrolyte processes, among other difficulties, trouble has arisen from the evolved chlorine wandering into the cathode compartment and reacting with the previously formed sodium hydroxide, or vice versa, to form hypochlorites and chlorates, while the complete separation of the caustic soda from the sodium chloride was not at first easily effected.

C. L. Parsons,[1] writing in 1898, says:

> Ernest A. Le Sueur enjoys the distinction of having invented the first electrolytic process for the commercial decomposition of sodium chloride, which became a regular contributor to the markets of the world. Since February, 1893, caustic soda and bleaching powder have been manufactured at Rumford Falls, Me., on a commercial scale.

It appears that Le Sueur began his experiments in the winter of 1887–1888, and after associating with him Charles N. Waite, who afforded him valuable assistance and some facilities at his chemical works in Newton, Mass., they together ran an experimental cell from October, 1890, to May, 1891, in a paper mill at Bellows Falls, Vt. In 1892 an association was formed, which in August of that year began the erection of a plant at Rumford Falls, and in February, 1893, began the manufacture of caustic soda and bleaching powder, using to generate the required current one 200-kilowatt dynamo of the Thompson-Houston pattern. The success of the venture was such that three more dynamos of the same capacity were installed in the fall of 1894, and the Electro-Chemical Company was organized.

Parsons describes the Le Sueur cell as follows:

> The cell as now used is contained in a tank 5 by 9 feet and 1½ feet deep, and made of one-quarter inch boiler steel. Excepting the asbestos, which composes the diaphragm, the wire netting of the cathode, and the materials of the positive electrode, it is built entirely of spruce, red brick, Portland cement, sand, and slate. These substances are so disposed in the cell as to be practically permanent, the wood being exposed to no action except that of the caustic solution, which has little effect upon it. The anodes are introduced from the top of the cell and may be removed singly without interrupting the process. Troublesome joints are closed with a specially prepared plastic cement. The diaphragm is tipped somewhat from the horizontal for the purpose of permitting the easy egress of the hydrogen bubbles. The foundation of the cell within the tank consists of an oblong frame of spruce, 8 feet 4 inches by 4 feet 10 inches, outside measurement, and 8 inches less on both dimensions inside. This frame is 11 inches deep, only the side pieces, however, resting upon the floor of the tank. The end pieces consist of four 4-inch timbers, whose upper surfaces are 10 inches above the floor of the tank and 1 inch below the top surface of the longer side. The frame is divided transversely by a timber, similar to each of the end timbers, which crosses the middle of the frame at the same level as the end pieces. This center beam forms a bridge over which the flat iron ribs supporting the cathode are hung. The cell is thus divided into two equal spaces merely for mechanical convenience. The ribs referred to consist of four parallel pieces of flat iron, three of them being 1½ by three-eighths inch, and the fourth, twice as wide. This wider piece is fastened at both ends to the containing tank, so as to receive from the latter the electric current, which enters through the material of the tank and communicates the current to the cathode, which rests upon these iron ribs. The diaphragm rests directly upon the cathode. The depth of the trough formed by the slanting ribs is 4 inches. There is an adequate arrangement at the ends of the bridge pieces by means of which the hydrogen, finding its way to this higher level, is delivered to exit pipes communicating with the atmosphere, or with any system of piping to which it is desired to deliver it. The inch of space between the tops of the cross timbers and the side pieces is utilized to take a piece of slate 4 feet long by 4 inches wide by 1 inch thick. This presses down upon the diaphragm and the cathode netting and keeps all solid. On top of the sides and ends of the frame there are four courses of common brick laid in clear cement. There is a coating of cement applied to the inside walls of the portion of the cell forming the anode compartment, and this includes not only the brick walls, but the small portion of the wooden sides above the cathode, which would otherwise come in contact with the anode liquid. The ceiling of the cell consists simply of pieces of slate, 2 feet by 1 foot, and suitably supported by transverse strips of slate, 1 inch thick by 4 inches wide. Through the ceiling plates pass the glass tubes to which the anodes are attached.
>
> The anodes which are now used are made from an alloy of iridium and platinum, and are so constructed that a very large anode surface is presented at an almost incredibly small cost, when it is considered that it is not at all of the nature of a plated surface, but is an anode of solid metal. Sixty anodes on an average are used to each cell, and each anode costs 73 cents at the present market price of platinum. They are acted upon chemically but slightly, if at all. If the glass holders break there is no loss of platinum, and a new anode can immediately be put in place. The total cost for the anodes of a plant producing, per month, 200 tons of bleaching powder, is approximately $5,000, or $40 for a cell producing 55 pounds of sodium hydroxide and 50 pounds of chlorine per day; and this allows for a very low cell efficiency. The total cost for the renewal of the platinum, including labor, is less than half the cost of the bare carbon alone, as it was formerly used. Besides, it must be remembered that carbon anodes are certain to give more or less carbon dioxide if hypochlorite be present, while with these iridio-platinum anodes no carbon dioxide can possibly be produced.
>
> At Rumford Falls, the Electro-Chemical Company obtains power at a very low cost, so that it pays to obtain a maximum of work from each cell by using a higher current density in proportion to the anode surface than might be tenable under other conditions. As the cells are now constructed, a current of 1,000 amperes is passed through each cell under a pressure of six and one-half volts. I am aware that this voltage is high, and from a statement in Lunge[2] he would probably, at first thought, condemn the process on this ground alone. But it will readily be understood how this increased voltage can be economically employed when it is considered that at $8 per electrical horsepower per year, which is the cost of power to the company at Rumford Falls, the extra cost per pound of product, on an average efficiency of 80 per cent, is but $0.00015 for each extra volt used. This high voltage is by no means an essential of the process, and each cell can be run on a lower amperage, when of course less pressure would be required. It is simply a fact that at Rumford Falls it is economical to run the cells on this voltage, forcing through them all the current they can take without undue heating. Under these conditions, the renewal of the cell is usually made necessary only on account of the deterioration of the diaphragm. The diaphragms have an average life of seven weeks, and have been used twenty-four consecutive weeks

---

[1] J. Am. Chem. Soc., vol. 20, page 868. 1898.

[2] Alkali Industry, vol. 3.

without renewal. The cathodes are but little acted upon, and the steel tanks are practically indestructible.

The cells are arranged so that twenty-two are in series, and three series are run in parallel on two dynamos. The hydrogen is used only for working platinum, the larger part being allowed to escape into the atmosphere. The chlorine is conducted by earthenware pipes to lead chambers and absorbed by lime in the usual manner, although at present a part is used for manufacture of potassium chlorate. The caustic solution is concentrated by evaporation in *vacuo*, and is separated from the major part of the undecomposed salt by centrifugals. Any chlorate is now readily removed, and the solution is then boiled down in cast-iron kettles to a first-quality caustic soda, analyzing about 74 per cent sodium oxide. The recovered salt is converted into brine and is used in the cathode compartment of the cells, nothing but fresh brine and some hydrochloric acid ever being added to the anode side. Whole bays of twenty-two cells have shown daily averages of over 90 per cent chlorine efficiency, and weekly averages of 87 per cent. If the anode compartment could be kept constantly acid, as can be done with single cells, a chlorine efficiency approaching very closely to the theoretical may be reached. The efficiency, reckoned upon the sodium hydroxide produced, is not quite so high.

One great field for electrolytic processes is the production of bleaching liquors and caustic solutions for bleacheries, paper mills, and the like. Large economies might be introduced by companies of this kind by making their own solutions electrolytically instead of by the usual method of first transporting the chlorine in the form of bleaching powder and the alkali in the solid state. This is almost self-evident when one considers that the final evaporation of the caustic soda, which is quite costly, is done solely for purposes of transportation; that the absorption of chlorine by milk of lime is a very simple operation, and the bleach liquors so produced are much more efficient per unit of chlorine than bleaching powder; and that the raw material (salt) is easily and cheaply obtained and transported without deterioration, while a small plant can be run almost as economically as a large one. In fact, the Electro-Chemical Company has sold a great deal of chlorine in the form of bleach liquors to pulp mills at reasonable distances from the works, that preferred to take this liquid carrier of chlorine on account of its ready-settled solution, ease of manipulation, and its greater efficiency, although the cost of transportation might be somewhat greater. In works which do not require caustic soda, the process would also be highly economical, for under such conditions the cathode liquor can be directly used to absorb the chlorine, in excellent condition for bleaching purposes, thus doing away entirely with the cost and use of lime. I do not hesitate to predict that we shall yet see many Le Sueur plants established in connection with mills now using bleaching powder. In fact, one of our largest American sulphite pulp mills has already made arrangements for a trial of the Le Sueur plant, with a view of bleaching to a very large extent.

Parsons points out that the chief difficulty of the process from the outset has been to keep the sodium hydroxide in its proper compartment, for with the best of diaphragms a limited amount of diffusion into the anode compartment goes on, and sodium hypochlorite is formed, which is oxidized to sodium chlorate either before diffusion into the outer space or during evaporation of the cathode solution, and is eventually recovered as a by-product in the form of potassium chlorate. In addition, the diffusing sodium hydroxide is partly electrolyzed, and, if carbon anodes are used, the oxygen liberated will attack them, forming carbon dioxide. The sodium hypochlorite may also be electrolyzed, giving rise to nascent oxygen and increasing the amount of carbon dioxide produced, and this formation of carbon dioxide is a very serious matter, for unless removed from the chlorine gas, it renders the manufacture of a standard grade of bleaching powder impossible. Le Sueur has overcome many of these difficulties, first, by having the liquid in the anode compartment at a higher level than that of the cathode, thus diminishing the entrance of sodium hydroxide by diffusion; second, by using platinum-iridium anodes; and third, by adding hydrochloric acid to the anode compartment so as to keep the solution slightly acid. This acid, so added, at once decomposes any hypochlorite, and is itself oxidized so that all of its chlorine is regained in the form of that gas. No chlorine is lost by this operation, for the chlorine obtained as bleaching powder is greater than the equivalent of the sodium hydroxide by the amount of chlorine in the added hydrochloric acid. This use of hydrochloric acid is a matter of some expense, for an equivalent of chlorine at Rumford Falls costs more in the form of hydrochloric acid than it is worth as bleaching powder, but in other localities, and especially near the Le Blanc soda factories, such use of hydrochloric acid may prove a positive advantage from the standpoint of economy. Parsons points out that while in 1892, when the Rumford Falls plant was built, bleaching powder sold in Boston for $45 per ton and caustic soda for $74 per ton, in 1898 the prices were $30 and $36, respectively.

According to Chandler,[1] all the difficulties enumerated above were completely overcome by the Castner process, in which the usual porous diaphragm is avoided, and a moving cathode of quicksilver is used in its place which absorbs the metallic sodium as fast as it is produced and removes it at once from the decomposing cell to a neighboring one, where the sodium is withdrawn electrolytically and converted into sodium hydroxide. The operation is accomplished in what is known as the "tipping cell," which is so arranged that once a minute it is rocked upon its support just enough to cause the mercury cathode in the bottom to flow back and forth under the partition to and from the neighboring cell, where the sodium hydroxide is produced free from chlorine. The metallic sodium never exceeds more than 0.2 per cent of the mercury, and consequently there is very little loss from the recombination of sodium and chlorine in the decomposing cell.

An important adjunct to the tipping cell is Castner's graphitized anode. With the ordinary carbon anodes, such as have been previously employed, it was found that the combined action of the chlorine and other substances resulting from the electrolysis of sodium chloride, together with the chemical reactions which occurred at or near the surface, disintegrated them rapidly. By converting the anodes after they have been shaped and baked into the graphitic form, they are of much greater durability, and the graphitizing process

---

[1] The Mineral Industry, vol. 9, page 765. 1901.

has been regularly employed on a large scale for this purpose. Other modifications and improvements in the details of construction of the tipping cells have been made which facilitate the production and have increased the efficiency of the process. The Castner process yields pure caustic soda and pure chlorine, and has been in successful operation for several years in England, on the Continent, and at Niagara Falls, N. Y. At the last-named locality the company now using it is extending its plant.

According to Blount,[1] the Castner-Kellner process is at work in England, at Weston Point, in Lancashire, where a plant of about 1,000 horsepower is in use and where a second plant of equal size is now being put down. Another plant of 2,000 horsepower (also about to be doubled), belonging to the Mathieson Alkali Company, is running at Niagara, using current supplied by the Niagara Falls Power Company. The output of this company is stated to be 10 tons of caustic soda and 24 tons of bleaching powder per day of twenty-four hours; the current efficiency, from 85 to 90 per cent; the pressure required, 3.5 volts—i. e., the energy efficiency is from 55.6 to 58.9 per cent. These statements are found to be concordant if we assume that the joint efficiency of the transformers and dynamos is 80 per cent.

This is not an unreasonable loss, inasmuch as the current has not only to be let down in voltage, but has to be transformed from an alternating to a direct current. The current comes from the power house at a pressure of 2,200 volts; it is transformed down in stationary transformers to a pressure of 120 volts. At this pressure the current, (which is, of course, still alternating,) passes to motor transformers, which transform it to a direct current delivered at a pressure of 200 volts, this being a convenient voltage for working a group of electrolytic cells.

The anodes used are ordinary "squirted" carbons; they are subjected to a "special treatment," designed to render them more refractory, and are said to last a year. Connection is made with them by means of a lead cap cast on one end. The caustic soda solution obtained is fairly concentrated, e. g., about 20 per cent strength. Much is sent in liquid form in tank wagons to soapmakers in Buffalo, about 20 miles from Niagara. Some is boiled down and sold in the solid state to the Electro-Chemical Company, whose works are close to those of the Mathieson Alkali Company.

The Dow process, as set forth in United States patent No. 621908, of March 28, 1899, has for its object the production of the chlorine and sodium hydroxide from common brine, consisting of sodium chloride, calcium chloride, and magnesium chloride in aqueous solution, and the invention is in the peculiar kind of diaphragm employed and its method of formation. To form this diaphragm a quantity of metallic iron is introduced into the brine in the neighborhood of the anode. On the electric current being passed through the solution the first actions that take place are the decomposition of the electrolytic solution near the anode and cathode, free chlorine being formed at or near the anode, and free sodium, calcium, and magnesium being formed at the cathode. These latter in turn react with the water of the electrolyte to form sodium, magnesium, and calcium hydroxides, this formation also taking place near the cathode, thus $2Na+2H_2O=2NaOH+H_2$. Part of the chlorine at the anode combines with the iron and forms iron chloride ($3Cl_2+2Fe=2FeCl_3$). The sodium, calcium, and magnesium hydroxides and the iron chloride diffuse toward the middle of the cell and meet between the electrodes. On such meeting the iron is precipitated as iron hydroxide, which forms part of the diaphragm,

$$3NaOH+FeCl_3=Fe(OH)_3+3NaCl,$$
$$3Ca(OH)_2+2FeCl_3=2Fe(OH)_3+3CaCl_2,$$
$$3Mg(OH)_2+2FeCl_3=2Fe(OH)_3+3MgCl_2.$$

Calcium and magnesium hydroxides are precipitated by the sodium hydroxide from the calcium and magnesium chlorides,

$$2NaOH+CaCl_2=Ca(OH)_2+2NaCl,$$
$$2NaOH+MgCl_2=Mg(OH)_2+2NaCl.$$

The diaphragm begins to form and build up from these precipitates, consisting of iron, calcium, and magnesium hydroxides. The chlorine diffusing toward the cathode on passing into the diaphragm, is absorbed by the calcium and magnesium hydroxides, forming calcium and magnesium hypochlorites, thus preventing the contamination of the cathode solution by the chlorine. These hypochlorites, whose formulæ are not positively known, decompose very rapidly, probably into chloride and oxygen. In actual working these hypochlorites are not found present. The iron hydroxide being inert so far as the chlorine is concerned, is not disturbed, so that eventually the side of the diaphragm near the anode is almost completely depleted of calcium and magnesium hydroxide by the action of the chlorine, and only iron hydroxide is left, while the cathode side consists mainly of calcium and magnesium hydroxides. The iron hydroxide prevents to a great extent the chlorine of the anode compartment from being consumed by the parts of the diaphragm with which it will combine. As the pores of the diaphragm contain iron, calcium, and magnesium chlorides, the sodium hydroxide of the cathode side upon entering the diaphragm is absorbed by these chlorides before it can diffuse to the anode side, so that the sodium hydroxide can not contaminate the anode solution.

Thus the products of electrolysis are effectually prevented from passing into and contaminating the opposite solutions. The precipitation and formation of the diaphragm will take place most rapidly where the diffusion is the greatest, and should any portion become

---

[1] Practical Electro-Chemistry, pages 313–314.

detached or mutilated diffusion will be greater at the mutilated point, and the consequent greater precipitation at this point will mend the break. It is thus seen that the diaphragm will thicken evenly. While one or more sheets of porous material—such as paper, cloth, asbestus, and the like—might be placed as a nucleus upon which the two essential layers of the diaphragm would be precipitated in the practical working of the cell, such a procedure has not been found necessary or advantageous, the diaphragm being readily produced in the proper place without such foundation. The physical qualities of the mixed hydroxides when made into a diaphragm in this manner are such that they form a coherent and self-supporting mass offering very little resistance to the passage of the electric current, but at the same time they offer a high resistance to the diffusion of the products of electrolysis and the electrolyte.

In the Dow process carbon electrodes are used. In all the processes bleaching powder is produced by absorbing the chlorine in dry slaked lime kept at a temperature below 46° C. The yield of bleaching powder from 100 pounds of good lime is 150 pounds.

Chlorates.—Chlorates have heretofore been prepared by passing chlorine into alkaline solutions maintained at a temperature at or above 100° C. In making potassium chlorate, which is the salt most largely used, the chlorine was first passed into a hot milk of lime, and after this had become saturated with chlorine and had acquired a density of 25° to 30° Twaddle, the solution was run off to settle. When clear, potassium chloride in calculated quantity was added, which, by reacting with the calcium chlorate, gave rise to calcium chloride and potassium chlorate.

As noted above, sodium chlorate may be obtained as a secondary product in the Le Sueur and other processes of electrolyzing common salt, and by metathesis with potassium chloride the potassium chlorate results. Since potassium chloride occurs native, and is mined at Stassfurt, it would appear to be a simple matter to electrolyze a hot solution of this salt directly to the chlorate, using a vessel without any diaphragm, but this is found feasible only up to a small concentration. Kellner has proposed to add to a saturated potassium chloride solution about 3 per cent of a sparingly soluble hydroxide, such as slaked lime or magnesia, and to keep the whole in agitation as the current is passed. The lime or magnesia assists in the formation of the chloric acid and serves to bring about the transfer of the potassium from its combination as a chloride to that as a chlorate. By concentration of the solution the potassium chlorate formed crystallizes out. As shown by United States patent 493023, of March 7, 1893, Gibbs and Franchot make use of a cathode of copper oxide in electrolyzing the potassium chloride. The theoretical yield of potassium chlorate is 164 parts for every 100 parts of potassium chloride used.

Potassium chlorate is used in manufacturing explosives, fireworks, fuse compositions, safety and parlor matches, and as an oxidizing agent in color works, in dyeing, and in other arts.

Lead Oxides.—Under Salom's process these are produced by the oxidation of spongy metallic lead, which is obtained by the electrolytic reduction of galena. Dilute sulphuric acid is used as the electrolyte, and sheets of lead are employed for electrodes. As neither the galena nor the lead reduced from it is soluble in the electrolyte, there is no ionization of the lead compounds or conveyance of the lead, but the latter is left as a porous mass, having the form of the original mass from which it was obtained, while the sulphur is evolved as hydrogen sulphide, and in this regard this process differs from all other electrolytic processes in use or proposed for use. The porous lead heats up on exposure to air, and is readily converted to oxides, or may be employed in the Dutch process of making white lead, where its porous condition constitutes an advantage in promoting the speed of corrosion. The lead may also be directly compressed into grids for secondary batteries.

Graphite.—Graphite is distinguished by being the first substance existing in nature as a mineral which has been commercially produced in the electric furnace. Its existence as a mineral under the names plumbago and black lead has long been known, and its employment in pencils is described in a work written by Conrad Gessner in 1565, but it was not until 1779 that its identity was established by Scheele and it became recognized as one of the allotropic forms of carbon. Several methods for the artificial production of graphite have been discovered, and that it is obtained from other forms of carbon by exposure to high temperatures, such as obtain in the electric furnace, has long been known, but the discovery that this is brought about through the formation first of carbon compounds, such as silicon carbide, and their subsequent decomposition is due to E. G. Acheson, and he has reduced this discovery to practice, producing graphite in quantity. An interesting feature of his discovery is that the phenomenon of the conversion is a progressive one and that a small portion of the other constituent of the carbide acts, as he says, "by catalysis" to convert a large mass of the amorphous carbon into graphite. This conversion is effected in a similar furnace to that used in the manufacture of carborundum, and the methods employed are similar.

The factory for working this process and making graphite from coke, bituminous coal, or other amorphous forms of carbon was established at Niagara Falls in 1899, and is to-day the only factory in the world, and the material has been here produced in several forms. One is an intimate mixture of pure amorphous carbon and graphite in fine powder for use as paint and for foundry facings. Another consists of articles previously molded from amorphous carbon which contains the catalytic agent. Among them are electrodes for use in alkali processes, like the Castner process, and carbon plates for use as brushes in dynamos and motors; and the life as well as the efficiency of these articles is much increased by being graphitized. It is expected that this process may utilize much of the fine refuse from the coke ovens.

Graphite is used in the manufacture of pencils, crucibles, stove polish, foundry facing, paint, motor and dynamo brushes, antifriction compounds, electrodes for metallurgical work, conducting surfaces in electrotyping and for glazing powder grains.

As pointed out, the chief source of graphite is from mines, and the extent of its production from this source in the United States will be shown when the census of the mining industry is taken. The amount imported is, however, very large, as shown by the following table, compiled from Vol. II of the Foreign Commerce and Navigation of the United States, for the year ending June 30, 1900:

IMPORTS OF PLUMBAGO, 1891 TO 1900, INCLUSIVE.

YEAR.	Tons.	Value.	YEAR.	Tons.	Value.
1891	10,135	$509,809	1896	11,891	$384,554
1892	13,511	726,648	1897	12,459	321,355
1893	14,207	866,309	1898	11,154	472,401
1894	7,935	410,819	1899	15,970	1,081,859
1895	7,051	208,935	1900	20,597	2,345,294

Calcium Carbide, CaC_2, was prepared in 1862 by Woehler, by heating an alloy of zinc and calcium with an excess of carbon, and in 1893, by Travers, by heating a mixture of calcium chloride, carbon, and sodium. Its commercial production began in the United States at Spray, N. C., in 1894, when Thomas L. Willson produced it by heating lime and coke together in an electric furnace, and out of this has grown the large industry which exists to-day. The furnace employed by Willson was of the simplest kind, as it consisted merely of a rectangular fire-brick box lined with carbon, to serve as one electrode, into which a stout carbon rod or bundle of rods dipped vertically to serve as the other electrode. The charge of mixed lime and coke was piled about the vertical electrode, which, after making contact to establish the arc, was raised as the mass was caused to react. Since the reaction is effected solely by the high temperature attained in the electric furnace, and not through electrolysis, either an alternating or a direct current can be employed, and as the former can be brought from a distance at a high voltage and transformed on the spot where it is to be used, by a stationary transformer, it is generally to be preferred.

As carried on at Spray, the operation was a discontinuous one, since, when the movable electrode had been raised to its greatest height and a prismatic mass of the carbide had been formed between the electrodes, the current had to be cut off, the furnace cooled, and the carbide removed, before a fresh charge could be put in. Besides, a very large part of the charge of coke and lime failed to be heated to the reaction temperature, and yet its presence was necessary to protect the walls of the furnace from the high temperature of the arc.

Through the invention of Charles S. Bradley, this process has now been made continuous. He prefers to employ a rotary wheel or annulus, into which projects at one side an electrode; the wheel being provided with means for preventing the material from spilling; with means for supplying fresh material to be acted upon by the current; and with facilities for removing the product; the whole being so arranged that the operation may be carried on in an uninterrupted manner, as the furnace is constantly forming fresh additions to the product and permitting the latter to be removed as frequently as may be necessary. The wheel is preferably turned by power-driven machinery, and is provided with a hollow periphery, to which (over an arc covering the lower part of the wheel) buckets are attached, forming throughout the arc a closed receptacle for the material to be operated upon. These buckets are arranged to be withdrawn or opened when they reach the discharge-end of the wheel-arc. The material, in the form of powder or granules, is supplied to the side of the wheel which contains the electrode or electrodes. The electric arc, or the limits of the space within which the electric action on the material takes place, is wholly within the mass of pulverized material, so that a wall of unchanged or unconverted material will surround the product of the furnace, and the motion of the wheel is in such direction as to keep the converted material surrounded by a body of unconverted material, and thus to exclude air until the converted mass has become sufficiently cool to permit of its removal and further treatment for packing for shipment or storage.

In the formation of the calcium carbide, the intimate mixture of ground lime and ground carbon is supplied to that side of the wheel-arc into which the current is introduced and is here fused and forms a pool of liquid carbide within the wheel rim, the pool being surrounded by a mass of the uncombined mixed carbon and lime which acts as an efficient heat insulator and keeps the walls of the receptacle comparatively cool. As the wheel turns, the pool is withdrawn from the neighborhood of the arc, or region of electrical activity, so that the liquid carbide cools and solidifies under a superincumbent and surrounding mass of material, which prevents access of air and thus prevents wasteful consumption of carbon by combustion. Thus a core of solid calcium carbide is formed within a granular or pulverized mass of material, the core growing in length as the receptacle recedes from the electrode until it emerges from the other end of the wheel-arc, when the removable sections of the wheel rim may be taken off one at a time, which permits the pulverized material to fall away from the solid core of carbide, so that the latter may be broken off or otherwise removed periodically. Thus the formation of carbide goes on continuously without any necessary interruption for recharging or removal of the product.

The wheel used is formed in sections which are bolted together, and it has a horizontal axis mounted in boxes at or near the floor level. The rim of the wheel is concave in cross section and is provided at intervals with pivoted latches to engage studs on semicylindrical sections of plate iron and thereby support them on the wheel. Auxiliary plates of thin sheet iron may be bent around the joint between the sections on the inside of the wheel rim, to prevent the pulverized material from sifting through the cracks at the joints. The wheel may with advantage be made about 15 feet in diameter, and the rim and plate-iron sections of such proportions as to form a circular receptacle of 36 inches in diameter. The inner wall of the wheel rim is provided with holes at intervals to receive copper plugs connecting with the several plates of a commutator on which bears a brush, connecting with one pole of an electric generator. The other pole of the generator connects with a carbon electrode about 4 inches in diameter, mounted in a sleeve and provided with a screw thread on the outside, which engages an internally threaded sleeve secured to a bevel gear, on the axis of which is a crank for adjusting the electrode. The electrode and its regulating mechanism are mounted on a framework adjacent to the wheel pit, so that the electrode may be fed into the receptacle formed by the wheel rim and the rim sections when partly consumed.

A feed hopper is provided with a spout projecting into the wheel rim and a gate for regulating the supply of mixed material to be acted upon. The wheel pit is preferably provided with sloping sides, so that any powdered material which drops from the wheel at its discharging end or elsewhere may slide by gravity to a conveyor, the buckets of which return it to the feed hopper, to again pass through the furnace.

The wheel is preferably connected with an electric motor by speed-reducing gearing. The motor shaft carries a worm, acting on a spur gear, on the shaft of which is secured another worm, meshing with another gear, on the shaft of which is a third worm, meshing with a gear on the wheel shaft. By this mechanism, a very slow speed of the wheel may be maintained, a complete revolution being made once in five days. In using the apparatus, the rim sections are latched over the wheel rim above an arc covering the lower part of the wheel, and the gate of the feed hopper is opened. A charge of intimately mixed carbon and lime, in proper proportions to form calcium carbide, falls into the receptacle around the wheel rim and accumulates until the top of the electrode is immersed therein. The circuit of the electric machine may then be closed and the electric motor thrown into operation. As the charge is moved away from the electrode, intense heat is created and the refractory material fuses. As the wheel turns, the pool gradually recedes from the electrode and slowly cools while inclosed within walls of refractory, uncombined material on all sides, and the cool product forms a bottom for the liquid compound. Thus a continuous core of the product is formed, new rim sections being added by the workman at intervals of a few hours.

The electrode, at starting, should project well into the receptacle, and, as the wheel turns, the electrode rises relatively to the charge, and when it reaches a point near the top of the rim section, a new rim section is hung on the wheel by means of the next set of supports, and a strip of sheet iron is bent around the joint between the rim sections. The gate of the hopper is then opened and the rim filled, or partly filled, with material. As this material in its powdered state is a very poor conductor of electricity as well as of heat, the immersion of the electrode does not interfere with the heating action. When a new rim section is added on the electrode side of the wheel, one is removed at the other side. Thus the process continues until the solid core of the furnace product appears at the discharge end of the wheel, when a rim section is taken off and the powdered material falls into the pit, leaving a pillar of solid product projecting vertically, which may be broken off or otherwise removed. Solid calcium carbide is a conductor of electricity, and the copper plugs make a good contact with it, thereby constituting the carbide itself one of the electrodes. The action of the commutator leads the current to a point of the carbide core close to the electrode, and prevents unnecessary resistance, which would intervene if the plugs were more widely spaced. The conducting plugs which are remote from the arc help to carry the current, and thus the heating of any one contact with the carbide core is reduced.

Calcium carbide is used in generating acetylene gas, the reaction taking place when it is brought in contact with water at the ordinary temperature. As the manufacture of calcium carbide is a fairly efficient process, and as it may be produced wherever a head of water is available, as the energy is stored in it in a compact form, and as this energy may be readily made available again by generating the acetylene and burning it, calcium carbide is looked upon as a material by means of which the energy of remote waterfalls that is now going to waste may be made useful to man.

Carborundum (Silicon carbide, SiC), the production of which is covered by E. G. Acheson in United States patent No. 492767, of February 28, 1893, is made in the United States only, and is made by heating a mixture of 34.2 per cent of coke, 54.2 per cent of sand, 9.9 per cent of sawdust, and 1.7 per cent of common salt in an electric furnace. The furnace is built up of bricks put together without any binding material, because of the necessity of permitting the gases generated during the process to freely escape, and because the furnace must be pulled down at the end of each run. At each end of the bin-shaped furnace, which is about 15 feet long, 7 feet high, and 7 feet wide, is a heavy bronze casting to which the leads are attached, which carries, on its inner surface, a bundle of sixty 3-inch carbon rods, each of which is 2 feet in length. These electrodes project into the furnace and are discontinuously connected by a cylindrical mass of coarsely powdered coke which forms a core about 9 feet long by 2 feet in diameter in the center of the furnace. The charge of the above-described mixture, weighing about 10 tons, is packed all about this core.

When the current is turned on, heating proceeds slowly until, after about two hours, carbon monoxide is evolved at all the openings in the brickwork and from the upper surface of the charge, where it burns with a blue flame. After some twelve hours the outside of the charge becomes red hot, and after twelve hours more the reaction has proceeded as far as practicable. After cooling, the furnace walls are pulled down, when the charge is now found to be separated into several layers, viz.; an outer one consisting of about 11 per cent salt, 56 per cent silica, and 33 per cent of carbon, which represents the portion of the charge which has not been heated sufficiently high to be converted into carbide. Within this outer layer is a layer of greenish-colored material, concentric with the core and consisting of amorphous silicon carbide, mixed with raw materials. It is not hard enough for use as carborundum, and is reworked in the next charge. The third layer, which is about 10 inches in thickness, consists of crystallized silicon carbide, the crystals being small on the outside and increasing in size toward the core. This is the carborundum. Within this layer is the portion about or within the core, which has been converted into graphite. The 10-ton charge yields about 2 tons of carborundum, though the theoretical yield of a charge of this size, consisting of silica and carbon mixed in equivalent proportions is about 4.2 tons. The energy used is about 1,000 horsepower.

Although pure silicon carbide is colorless, the crystals obtained in the commercial manufacture are blue, black, or dark brown, and are iridescent; and as they possess an almost adamantine luster, they are very beautiful. They are hard enough to scratch ruby and very permanent. Carborundum is largely used as an abrasive, the crystals being crushed in edge runners, washed with water and acid, dried, and graded by sieving. In this condition it is molded in a great variety of forms. It is also employed in the manufacture of steel as a substitute for ferro-silicon, and in the manufacture of graphite.

Carbon Disulphide.—One of the most ingenious as well as one of the most recent chemical applications of electricity is in the manufacture of carbon disulphide (carbon bisulphide; bisulphide of carbon; CS_2), a substance which was discovered by Lampadius in 1796, and which has been heretofore manufactured by passing the vapors of sulphur over coke or charcoal which has been heated to a "cherry red" in retorts made of cast iron or glazed earthenware. The further steps in the process are for the purpose of purifying the carbon disulphide by removing uncombined sulphur, hydrogen sulphide, sulphur dioxide, and other foreign bodies which may be present, and this is accomplished by condensation in towers, washing in water, treatment with chemicals, such as lead acetate, caustic soda, milk of lime or anhydrous copper sulphate, mercury or mercuric chloride, and redistillation. For certain uses the presence of certain of the impurities adds to the efficiency of the material, and in such cases the methods of purification alluded to are dispensed with. Owing to the corrosive action of the heated sulphur vapors and their products, but few materials can be employed in the construction of retorts, and those which have been used have been short lived, so that the manufacture has not only been conducted in a discontinuous manner, but the renewal account has been large.

In the electric process of Edward R. Taylor, which was put into operation in 1900 at Torrey, N. Y., several sets of carbon electrodes are introduced into the base of a stack furnace and connected by a bridge consisting of broken coke or other conductive carbon, while the body of the stack is filled with charcoal. Sulphur is fed in by suitable ports so as to cover the electrode faces when, as the current is passed through, it becomes melted and vaporized. At the same time the charcoal is heated above the electrodes, and reaction with the sulphur occurs. From the construction of the furnace, the heat radiated through the walls of the stack is utilized in heating the sulphur to the melting point, and the heat resident in the carbon disulphide vapors is largely utilized in heating up the charcoal as the latter descends the stack. The process is a continuous one, and the current may be regulated either by the amount of conductive carbon introduced into the furnace or by reducing the working surfaces of the electrodes by partly submerging them in the molten sulphur.

Carbon disulphide is extensively used as a solvent and extractive agent, as it dissolves sulphur, phosphorus, iodine, rubber, camphor, wax, tar, resins, and nearly all oils and fats. It is a germicide and insecticide and is very largely used by transportation and storage companies for the destruction of weevils in wheat, and other insect pests, and by farmers for exterminating mice, rats, prairie dogs, gophers, and other subterranean animals that damage the crops. It is employed in the manufacture of thiocyanates, carbon tetra-chloride, sulpho-carbonates, viscose, rubber cement, and in organic preparation work, and for prisms.

Phosphorus.—Heretofore phosphorus has been produced from burnt bone or mineral phosphates by treating them with sufficient sulphuric acid to convert part or all of the calcium present into calcium sulphate and the phosphorus contents into calcium metaphosphate or eventually into phosphoric acid, and reducing these products by charcoal.

Quite long ago Wöhler suggested that the manufacture be carried out by heating the calcium phosphate, such as exists in burned bones or rock phosphates, with sand and carbon, by which a reaction of the following nature may be realized:

$$2Ca_3(PO_4)_2+6SiO_2+10C=6CaSiO_3+10CO+P_4;$$

but until recently it has been impracticable to use this simple process on account of the high temperature required. This difficulty is now met in the electric furnace, and at present the electric production of phosphorus is on a profitable basis. In the continuous process of Readman, Parker, and Robinson, 100 parts of calcium phosphate, 50 parts of sand, and 50 parts of coke are intimately mixed and heated in a tightly covered electric furnace provided with an outlet pipe leading to a condenser and a tap hole. The phosphorus volatilizes as it is liberated, and, together with the carbon monoxide, passes to the condenser, where the phosphorus condenses and is collected in water. The residue of calcium silicate and foreign bodies fuses to a slag and is tapped off at intervals, fresh charges of the phosphate mixture being introduced into the furnace without interrupting the electric current.

The phosphorus as first produced is contaminated with sand, carbon, clay, and other impurities, and this crude phosphorus is purified by melting under warm water and straining through canvas, or by redistillation from iron retorts. For final purification it is treated, when molten, with a mixture of potassium dichromate and sulphuric acid, or by sodium hypobromite. Theoretically, 100 parts of $Ca_3(PO_4)_2$ should yield 20 parts of phosphorus, but in practice with the electric furnace only about 17 parts are recovered. This is, however, much more than the yield given by the older process, in which part of the phosphate was converted into calcium metaphosphate; there the maximum yield on the original phosphate was but 11 parts in 100.

Phosphorus is used in the manufacture of friction matches and fuse compositions; for making rat poison; and as a source of phosphoric acid and other phosphorus containing compounds that are used in medicine and in the arts. As phosphorus is a very active reducing agent, it has found some application in the precipitation of the precious metals and in electrotyping.

Other Products.—As an evidence of what may be expected in the future, attention is called to the fact that hydrogen sulphide (which may be burned to produce sulphuric acid), white lead, chromic acid from chromium sulphate, and lampblack from acetylene are being made by the aid of electricity. Especial activity is to be looked for in the field of organic chemistry. So long ago as 1849 Kolbe[1] electrolyzed alkaline salts of fatty acids, obtaining hydrocarbons, and since then halogen derivatives of the hydrocarbons have been made from organic salts or alcohols and haloid compounds; chloral from alcohol and potassium chloride; mono and dichloracetones and monobrom acetone from acetone and hydrochloric or hydrobromic acid; azoxybenzene, azobenzene, hydrazobenzene, benzidine, and anilin from the reduction of nitrobenzene; piperidine by the reduction of pyridine in acid solutions; and vanillin and heliotropine from the ozonization of eugenol or oil of cloves; and many other laboratory reactions. According to Swan[2] the manufacture of iodoform, vanillin, chloral, azo and hydrazo compounds, oxidation products of fusel oil, dyestuffs of the triphenylmethane type, anilin blue, anilin black, Hofmann's violet, alizarin, Congo red, oxidation products of the alcohols, sulphonic acids, piperidine, dihydroquinone, benzidine, and amidophenol have already been produced abroad by electrochemical means, and that at least the first five are being so produced on a commercial scale.

LITERATURE.

Electric Smelting and Refining, W. Borchers: Philadelphia, 1897.

Practical Electro-Chemistry, Bertram Blount: New York, 1901.

Notes on Electro-Chemistry, by Charles F. Chandler. The Mineral Industry, vol. 9, 763–772. 1901.

Manufacture and Uses of Metallic Sodium, James D. Darling, J. Frk. Inst., 153, 65–74. 1902.

The Le Sueur Process for the Electrolytic Production of Sodium Hydroxide and Chlorine, Charles Lathrop Parsons, J. Am. Chem. Soc., 20, 868–878. 1898.

Production of Phosphorus and Chlorides of Carbon by means of the Electric Furnace, Sci. Am., 74, 180. 1901.

Lighting by Acetylene, William E. Gibbs: New York, 1898.

Carbon Disulphide in the Electric Furnace, Elect. World and Engineer, 38, 1028. 1901.

Graphite; Its Formation and Manufacture, E. G. Acheson, J. Frk. Inst., June, 1899.

Some Electrolytic Processes for the Manufacture of White Lead, Sherard Cowper-Cowles. The Electro-Chemist and Metallurgist and Metallurgical Review, 1, 145–147. 1901.

Applications of Electrolysis to Organic Compounds, J. T. Hewitt. The Electro-Chemist and Metallurgist, 1, 34–35, 99–100, 120–122, 170–172. 1901.

Chemical and Technical Education in the United States, Charles F. Chandler, J. Soc. Chem. Ind., 19, 591–620. 1900.

Electro-Chemical Industry, Jos. W. Swan, J. Soc. Chem. Ind., 20, 663–675. 1901.

GROUP XI.—DYESTUFFS.

Under the classification "dyestuffs and extracts" reports have been rendered for the two previous censuses. As the sources of much of the natural raw materials of the two industries and the methods for their treatment are in many respects similar, both dyestuffs and tanning materials were embraced in this

---

[1] Liebig's Annalen, vol. 69, page 259. 1849.

[2] J. Chem. Soc., vol. 20, page 668; 1901.

classification. Combining the returns of the census of 1900 in the same manner we have the following comparison:

COMPARISON OF DYESTUFF AND EXTRACT FACTORIES: 1880 TO 1900.

YEAR.	Number of establishments.	Capital.	Wage-earners.	Value of product.
1880	41	$2,363,700	992	$5,253,038
1890	62	8,645,458	2,302	9,292,514
1900	77	7,839,034	2,094	7,350,748

This comparison shows a gain of 76.9 per cent in the value of the product for 1890 over that for 1880, and a loss of 20.9 per cent in the value of the product for 1900 as compared with that of 1890. Considering the general character of trade conditions in 1900 and the activity of the dyeing and tanning industries, it is believed that this falling off is not real, but that it is due to a difference in rulings as to the category in which certain of the products reported should be put. For instance, the chromium compounds are used in dyeing, in tanning, for paints, and as chemicals in many arts. Where shall they be classified? Again, citric, lactic, tartaric, and other acids are used in calico printing and in other arts. Shall they be classified under acids or under dyestuffs? Questions like these continually arise, and they will necessarily be settled, to a certain extent, in different ways in the different censuses. The endeavor in the present report has been to classify substances as chemicals in the categories of acids, sodas, potashes, alums, cyanides, and fine or heavy chemicals unless they very distinctively belonged in one of the other categories in the scheme of classification.

Another cause might arise from an extension of the work and an increase in the output of an establishment, if that increase took place in another industry, for the return would be classified under the principal product. Thus, if in 1890 an establishment were grinding sumac leaves part of the time and wheat part of the time, and the value of the ground sumac in 1890 exceeded that of the flour, the establishment would in that year have been classified under "dyestuffs and extracts;" but if in 1900 the value of the flour exceeded that of the sumac, the returns would be classified under "food and kindred products." As a rule these variations tend to balance one another and to give a result that is a close approximation to the true one, but in certain instances this may not be the case, though in each census they all appear in the final summation.

Taking the returns thus assembled, the geographical distribution of the dyestuff and extract industry is presented in the following table:

GEOGRAPHICAL DISTRIBUTION OF DYESTUFF AND EXTRACT FACTORIES: 1900.

STATES.	Number of establishments.	Capital.	Wage-earners.	Value of product.	Per cent of value.
United States	77	$7,839,034	2,094	$7,350,748	100.0
New York	19	2,548,136	562	2,111,811	28.7
Massachusetts	10	592,510	56	1,320,881	18.0
Pennsylvania	12	1,778,173	361	1,269,246	17.3
New Jersey	10	591,916	172	502,798	6.9
Virginia	8	385,904	271	479,372	6.5
West Virginia	5	272,192	98	245,754	3.3
California, Connecticut, Florida, Illinois, Kentucky, Maine, Michigan, Rhode Island, and Tennessee	13	1,670,203	574	1,420,886	19.3

A clearer idea of the dyestuffs industry may be obtained by separating the statistics for this industry from those rendered for tanning materials and by combining with them the data from those schedules in which dyestuffs have appeared as a minor product and which have therefore been sunk in another classification. There have been 72 establishments found in which such manufacture is carried on and the product is shown in the following table:

TOTAL PRODUCTION OF DYESTUFFS IN THE UNITED STATES: 1900.

CHARACTER OF PRODUCT.	Number of establishments.	Quantity (pounds).	Value.
Total	72	61,209,231	$5,868,006
Natural dyestuffs	21	48,245,628	3,435,808
Artificial dyestuffs	32	7,698,435	2,280,899
Mordants	6	734,000	85,466
Iron liquor	5	3,344,568	32,065
Red liquor	5	707,040	7,340
Other products	3	479,560	26,428

There were consumed in the manufacture 51,955 tons of logwood, of a value of $1,084,746; of fustic 3,104 tons, of a value of $51,586; of cutch 798,508 pounds, of a value of $61,697; of indigo 109,034 pounds, of a value of $125,069; of yellow oak bark 4,907 tons, of a value of $29,451; of anilin dyes 1,734,717 pounds, of a value of $840,229; of alizarine and other coal tar colors 1,417,325 pounds, of a value of $333,317; of logwood extract 2,364,792 pounds, of a value of $163,408; and of wood for the manufacture of iron liquor 2,838 cords, of a value of $9,629; besides small amounts of nicwood, quercitron, turmeric, quassia, persian berries, myrabolans, gambier, sumac, nutgalls, quill-bark and oils, and other materials for assistants and mordants.

Coloring matter obtained from vegetable or animal substances have been used in coloring textiles from prehistoric times, and as they were supposed to exist ready formed in the organism, they became known as natural dyestuffs. Prominent among natural dyestuffs is the coloring matter obtained from logwood and known as "hæmatein." The color-forming substance (or chromogen), hæmatoxylin, exists in the logwood partly free and partly as a glucoside. When pure, hæmatoxylin forms nearly colorless crystals, but on oxidation, especially in the presence of an alkali, it is converted into the coloring matter hæmatein, which forms colored lakes with metallic bases, yielding violets, blues, and blacks with various mordants. Logwood comes into commerce in the form of logs, chips, and extracts. The chips are moistened with water and exposed in heaps so as to induce fermentation, alkalies and oxidizing agents being added to promote the "curing" or oxidation. When complete and the chips have assumed a deep reddish-brown color, the decoction is made which is employed in dyeing. The extract offers convenience in transportation, storage, and use. It is now usually made from logwood chips that have not been cured. The chips are treated in an extractor, pressure often being used, but a pressure above 15 pounds to the square inch is to be avoided, as it may cause a decrease in the coloring power of the product. The liquor is settled to remove fibers and resin, and evaporated in a vacuum pan to a density of about 50° Tw., or it may be continued until a solid extract is obtained on cooling. The yield of solid extract produced with pressure is about 20 per cent and without pressure about 16 per cent. The extract is sometimes adulterated with chestnut, hemlock, and quercitron extracts, and with glucose or molasses. Reynolds & Innis made "dyestuffs" at Poughkeepsie, N. Y., in 1816. Browning and Brothers made extracts in Philadelphia in 1834.

Fustic is the heart wood of certain species of trees indigenous to the West Indies and tropical South America. It is sold as chips and extract, yields a coloring principle which forms lemon-yellow lakes with alumina, and is chiefly used in dyeing wool. Young fustic is the heart wood of a sumac native to the shores of the Mediterranean, which yields an orange-colored lake with alumina and tin salts.

Cutch, or catechu, is obtained from the wood and pods of the *Acacia catechu*, and from the betel nut, both being native in India. Cutch appears in commerce in dark brown lumps, which form a dark brown solution with water. It contains catechu-tannic acid, as tannin and catechin, and is extensively used in weighting black silks, as a mordant for certain basic coal-tar dyes, as a brown dye on cotton, and for calico printing.

Indigo, which is obtained from the glucoside indican existing in the indigo plant and in woad, is probably one of the oldest known dyestuffs. It is obtained from the plant by a process of fermentation and oxidation, the yield being from 0.2 to 0.3 per cent of the weight of the plant. Indigo appears in commerce in dark blue cubical cakes, varying very much in composition as they often contain indigo red, and indigo brown (which affect the color produced by the dye), besides moisture, mineral matters, and glutinous substances. Thus Java[1] indigo contains from 70 to 80 per cent of the pure color; Bengal, 60 to 70 per cent; and Kurpah, 30 to 55 per cent. It has been found that "lots" of natural indigo sold as one quality varied in themselves, and that samples drawn from the same chest and identical, so far as appearances went, differed as much as 7 to 8 per cent in their contents of pure indigo. Powdered indigo dissolves in concentrated fuming sulphuric acid, forming monosulphonic and disulphonic acids. On neutralizing these solutions with sodium carbonate and precipitating the indigo carmine with common salt there is obtained the indigo extract, soluble indigo, and indigo carmine of commerce. True indigo carmine is the sodium salt of the disulphonic acid, and when sold dry it is called "indigotine." Alexander Cochrane made extract of indigo at Lowell, Mass., in 1849.

One of the most important of the recent achievements of chemistry is the synthetic production of indigo on a commercial scale. For some years approaches have been made, as in the case of what was known as "propiolic paste," containing about 25 per cent of o-nitrophenylpropiolic acid, which was used for a time in calico printing, but abandoned because of the unpleasant odor which was developed in the process, and which persistently adhered to the goods, and because the blue color produced was slightly gray in shade, and in the case of Kalle's artificial indigo prepared from o-nitrobenzene chloride. The synthetic indigo now made by the Badische Anilin und Soda Fabrik is manufactured by the Heumann[2] process (D. R. P. 91202). Starting with naphthalene, the cheapest and most abundant of the coal-tar products, by treatment with highly concentrated sulphuric acid, phthalic acid is obtained. This phthalic acid is converted into phthalimide by the use of ammonia; the phthalimide is converted to anthranilic acid by means of sodium hypochlorite; the anthranilic acid is united with chloracetic acid to form phenylglycocollorthocarboxylic acid; by fusing this last mentioned acid with caustic soda, indoxyl or indoxylic acid is formed, according to the existing conditions, and when these are oxidized by air, in the presence of alkalies, they pass into indigo. In this manufacture 10,000 tons of naphthalene, over 1,200,000 pounds of ammonia, 4,500,000 pounds of glacial acetic acid, and 10,000,000 pounds of salt are consumed. The recovery of the 40,000 tons of sulphur dioxide, which occurs as a by-product in the treatment of the naphthalene with sulphuric acid (which is the first step in the process of making indigo) is an important matter, and the recently perfected contact process for its conversion into sulphuric acid for reuse comes in most opportunely.

---

[1] J. Frk. Inst., vol. 153, page 50. 1902.

[2] J. Am. Chem. Soc., vol. 23, page 911. 1901.

Lachman says:[1]

> The present annual production of synthetic indigo has not been given to the public, but from the data obtainable it can not be far from 3,000,000 pounds, about one-fourth of the world's supply. It is going to be a question of business rather than of manufacture when the indigo factories will have supplanted the indigo fields. Some of the above calculations will give a faint idea of the purely commercial side of this stupendous undertaking. The 'Badische' has already invested over $4,500,000 in the plant and the preliminary experiments.

Although mineral dyes such as prussian blue, chrome yellow, orange and green, and iron buff, or nankin yellow, have long been used, artificial dyestuffs assumed preponderating importance with the discovery of the lilac color *mauve* by Perkin in 1856, and *fuchsine* or magenta by Verguin in 1859, for with each succeeding year other colors have been discovered, until at the present time there are several thousand artificial organic dyes or colors on the market. Since the first of these were prepared from anilin or its derivatives the colors were known as "anilin dyes," but as a large number are now prepared from other constituents of coal-tar than anilin they are better called "coal-tar dyestuffs." There are many schemes of classification. Benedikt-Knecht[2] divides them into I, aniline or amine dyes; II, phenol dyes; III, azo dyes; IV, quinoline and acridine derivatives; V, anthracene dyes; and VI, artificial indigo.

Of the anthracene dyes, the alizarin is the most important, since this is the coloring principle of the madder. The synthesis of alizarin from anthracene was effected by Gräbe and Liebermann in 1868, but a commercial process for its production was not developed until some years later, when it was worked out by the above-named chemists in conjunction with Caro, though the process was discovered simultaneously by Perkin. Schorlemmer[3] said in 1894: "Gräbe and Liebermann's discovery produced a complete revolution in calico printing, turkey-red dyeing, and in the manufacture of madder preparations sooner than was expected. Madder finds to-day only a very limited application in the dyeing of wool. Twenty years ago the annual yield of madder was about 5,000,000 tons, of which one-half was grown in France, while ten years ago the whole export from Avignon was only 500 tons."

It is to be observed that the quantities of substances like indigo, coal-tar dyes, alizarin, and the like reported as consumed in the United States in the further manufacture of dyestuffs are less than the amount of these articles that is imported; but this follows naturally from the fact that a large, and in some instances the largest, part of this material goes directly to the dye works and print works, while there is recorded here only such as is the subject of further manufacture before being offered for sale. As much of the material is made up in the dye and print works into other compositions of matter before being used, a complete summary of the dyestuff manufacture of the country would embrace also the manufacture at this point of consumption, but such data are not at command.

In textile dyeing and printing, substances called mordants are largely used, either to fix or to develop the color on the fiber. Substances of mineral origin, such as salts of aluminum, chromium, iron, copper, antimony, and tin, principally, and many others to a less extent, and of organic origin, like acetic, oxalic, citric, tartaric, and lactic acid, sulphonated oils, and tannins are employed as mordants. In all technologies and treatises on dyeing and printing the mordants are regarded as of equal importance with the coloring matters, and from this standpoint they are properly included in a census of the dyestuffs industry; but in the larger scheme of the chemical industries, such as is now under consideration, the point of view will necessarily be different, and therefore when a substance like alum or copperas or tannic acid is a distinctively chemical substance and is applied to other uses than in dyeing or printing, it is classified in its proper category under acids, bases, or salts, but when a substance is a composition of matter and is used exclusively or principally as a mordant it is embodied under that heading in the table given above.

Iron liquor, known as black liquor or pyrolignite of iron, is made by dissolving scrap iron in pyroligneous acid. It is sold as a dirty olive-brown or black liquid, having a density of about 25 Tw. (1.12 sp. gr.) and consists mainly of ferrous acetate with some ferric acetate and tarry matters. It is used as a mordant in dyeing silks and cotton and in calico printing. It was manufactured by James Ward, at North Adams, Mass., in 1830.

Red liquor is a solution of aluminum acetate in acetic acid, and is produced by acting on calcium or lead acetate solutions with aluminum sulphate or the double alums, the supernatant liquid forming the red liquor. The red liquor of the trade is often the sulpho-acetate of alumina resulting when the quantity of calcium or lead acetate is insufficient to completely decompose the aluminum salt. Ordinarily the solutions have a dark-brown color and a strong pyroligneous odor. It is called red liquor because it was first used in dyeing reds. It is employed as a mordant by the cotton dyer and largely by the printer.

---

[1] Loc. cit.

[2] Chemistry of Coal-tar Colors.

[3] Rise and Development of Organic Chemistry, page 248.

IMPORTS FOR CONSUMPTION DURING THE YEARS ENDING JUNE 30, 1891-1900.

YEAR.	LOGWOOD.		EXTRACTS AND DECOCTIONS OF LOGWOOD AND OTHER DYEWOODS.		CAMWOOD.		FUSTIC.		ALL OTHER DYEWOODS.		CUDBEAR.	
	Tons.	Value.	Pounds.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.	Pounds.	Value.
1891	84,381	$1,842,954	3,282,227	$275,802	3	$220	9,100	$132,841	1,002	$28,969	402,241	$37,899
1892	60,297	1,233,592	4,227,017	325,576	29	3,339	8,490	125,067	2,527	50,131	276,690	24,597
1893	56,404	1,218,934	3,757,259	287,723	26	3,745	10,293	165,807	479	8,978	320,348	25,317
1894	58,709	1,313,376	2,817,451	196,397	70	5,770	7,765	126,309	347	4,426	151,121	12,666
1895	60,683	1,478,618	3,565,277	261,762	23	1,676	6,299	89,696	553	12,386	148,024	13,129
1896	66,074	1,522,069	4,910,176	287,120	50	8,748	6,832	90,389	1,155	18,583	118,517	9,256
1897	33,462	611,010	5,459,302	277,798	....	....	7,918	102,472	639	8,327	66,804	4,902
1898	46,977	744,135	3,664,623	232,986	....	....	9,923	137,666	2,726	33,475	66,795	4,795
1899	37,518	547,334	3,113,558	207,406	....	....	9,198	121,665	8,834	103,276	36,487	2,919
1900	48,190	628,464	3,420,276	227,527	1	161	4,440	60,886	20,967	205,351	61,305	3,944

YEAR.	GAMBIER OR TERRA JAPONICA.		CRUDE INDIGO.		INDIGO CARMINE.		EXTRACTS OR PASTES OF INDIGO.		SUBSTITUTE INDIGO.	MADDER AND MUNJECT, OR INDIAN MADDER, GROUND OR PREPARED.		ORCHIL OR ORCHIL LIQUID.
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Value.	Pounds.	Value.	Value.
1891	27,610,594	$1,343,604	2,089,500	$1,600,865	28,175	$33,145	881,969	$58,288	$416	673,260	[illegible]	$81,974
1892	25,808,495	1,069,043	2,460,635	1,772,506	23,600	28,636	826,887	58,845	....	518,786	52,063	68,779
1893	35,762,646	1,305,468	3,226,314	3,137,511	29,687	35,304	1,317,835	101,347	2,793	653,779	61,720	64,928
1894	26,408,458	981,328	1,717,635	1,218,580	12,504	16,907	829,380	68,474	1,587	262,563	17,576	43,235
1895	29,022,603	963,255	3,411,539	1,940,250	26,173	33,405	605,750	57,317	187	329,477	18,541	59,317
1896	32,343,256	1,108,611	2,707,928	1,571,018	34,967	42,369	590,664	55,361	....	318,313	15,746	62,831
1897	31,349,555	959,501	3,010,005	1,586,309	52,192	59,182	469,729	51,153	....	292,462	12,963	38,965
1898	42,333,486	1,021,288	3,058,787	1,807,336	25,671	26,642	396,760	59,001	....	246,218	11,816	56,755
1899	38,123,478	754,497	3,127,182	1,698,583	17,505	17,172	254,531	23,324	....	280,081	12,298	45,494
1900	38,857,515	906,282	2,747,048	1,446,490	18,204	15,767	251,538	20,094	....	120,736	5,869	47,134

YEAR.	SAFFLOWER AND EXTRACT OF, SAFFRON AND SAFFRON CAKE.	COCHINEAL.		OIL OF ANILINE.		SALTS OF ANILINE.	ALIZARIN, NATURAL OR ARTIFICIAL AND DYES COMMERCIALLY KNOWN AS ALIZARIN YELLOW, ORANGE, GREEN, BLUE, BROWN, AND BLACK, INCLUDING EXTRACT OF MADDER.		COAL-TAR COLORS OR DYES NOT SPECIALLY PROVIDED FOR.	ALIZARIN ASSISTANT OR SOLUBLE OIL, OR OLEATE OF SODA, OR TURKEY-RED OIL.		ALIZARIN ASSISTANT, ETC., ALL OTHER.	
	Value only.	Pounds.	Value.	Pounds.	Value.	Value only.	Pounds.	Value.	Value only.	Gallons.	Value.	Pounds.	Value.
1891	$44,598	86,797	$19,935	1,489,908	$299,662	$713,732	3,443,167	$674,101	$1,632,642	653	$437	1,325	$717
1892	55,391	230,039	55,883	1,428,070	253,248	536,477	4,838,220	1,029,122	1,640,024	....	....	3,997	2,262
1893	27,697	215,512	52,572	1,211,818	163,539	432,134	5,729,221	1,125,506	2,322,258	....	....	2,901	1,157
1894	24,341	104,284	28,124	951,671	115,141	395,575	3,960,079	722,919	1,429,101	....	....	1,153	577
1895	16,462	130,205	37,285	1,315,934	143,426	548,110	5,287,720	870,383	2,739,933	92,158	25,735	....	....
1896	33,765	160,422	50,988	1,364,674	164,238	662,459	6,154,156	994,395	2,918,332	82,376	24,626	....	....
1897	38,022	137,261	41,943	....	....	812,884	6,169,018	1,023,425	3,163,182	....	....	....	....
1898	52,482	158,055	45,762	....	....	1,087,704	5,871,962	886,349	3,723,388	....	....	....	....
1899	32,477	97,563	23,207	....	....	743,130	5,226,452	700,786	3,900,099	....	....	....	....
1900	44,502	158,911	31,408	....	....	537,812	6,009,552	771,336	4,792,103	....	....	....	....

LITERATURE.

A Practical Handbook of Dyeing and Calico Printing, by William Crookes: London, 1874.

History of Anilin and Allied Coloring Matters, by W. H. Perkin: London, 1879.

Chemistry of the Coal-Tar Colors, by R. Benedikt: London, 1889.

Chemistry of the Organic Dyestuffs, by R. Nietzki: London, 1892.

The Rise and Development of Organic Chemistry, by C. Schorlemmer: London, 1894.

Systematic Survey of the Organic Coloring Matters, by G. Schultz and P. Julius: London, 1894.

Handbook of Industrial Organic Chemistry, by S. P. Sadtler: Philadelphia, 1895.

Dyeing and Calico Printing, by Antonio Sansom, London, Vol. I, 1895; Vol. II, 1896; Vol. III, 1897.

Outlines of Industrial Organic Chemistry, by F. H. Thorp: New York, 1898.

GROUP XII.—TANNING MATERIALS.

The making of leather is one of the older arts. From the best records attainable, according to Robert H. Foerderer,[1] it appears that the first tannery in this country was operated about the year 1630 in Virginia. A year or two later the first tannery in New England was established in the village of Swampscott, Lynn, Mass., by Francis Ingalls, and the vats used by him remained until 1825. With the establishment of the tanning industry necessarily came the gathering of the tanning materials from forest and field, and subsequently their preparation for use, but the first mention of this industry in census reports appears under the head of "sumac" in the report for 1850, and from this time, except in 1880, separate returns for tanning materials have been made in each census report, though the methods of statement have been so varied as to make comparison, except in certain items, almost impossible. Thus in 1850, 1860, and 1870 there are the classifications "sumac," "sumac bark and prepared sumac," and "ground sumac;" in 1860 and 1870 also, "ground

---

[1] One Hundred Years of American Commerce, Vol. II, page 495.

bark;" in 1870, also "hemlock-bark extract;" in 1890, "dyeing and tanning extract," and "chipped wood and other products of this group."

In this report for the census of 1900 there are included, under "tanning materials," the ground, chipped, and other comminuted materials, and the extracts obtained from oak bark and wood, hemlock, sumac, and palmetto root, together with the chrome solutions that are employed in tanning. Under this classification, and taking into account establishments not in the chemical classification of the census, but which produce tanning materials in addition to other products, like drugs or leather, 39 establishments were reported, employing $2,107,040 of capital and 700 wage-earners, and producing $1,899,220 of product. They were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF FACTORIES PRODUCING TANNING MATERIALS: 1900.

STATES.	Number of establishments.	Capital.	Wage-earners.	Value of product.	Per cent of total.
United States	39	$2,107,040	700	$1,899,220	100.00
Virginia	8	385,904	271	479,372	25.33
Pennsylvania	8	566,869	103	357,462	18.82
New York	4	341,870	90	295,356	15.55
West Virginia	4	270,192	90	232,365	12.23
New Jersey	6	94,762	27	181,800	9.57
Massachusetts, Maryland, Florida, Tennessee, Kentucky, Illinois, Michigan, and California	9	447,443	119	352,865	18.50

There were 23 establishments employing $1,055,665 of capital and 351 wage-earners in the manufacture of tanning materials from the oak. There were used of oak and chestnut oak 36,897 cords of bark, of a value of $265,557, and 34,871 cords of wood, of a value of $92,252, and there were produced of ground bark 29,948,237 pounds, having a value of $186,381, and of extract, 34,673,997 pounds, having a value of $661,119.

There were 10 establishments employing $586,681 of capital and 156 wage-earners engaged in the manufacture of tanning materials from the hemlock. There were used of hemlock bark 43,566 cords, having a value of $210,930, and there were produced 35,591,329 pounds of extract, of a value of $572,882, whereas in 1870 (the only previous record at command) 2 establishments were reported employing $85,000 of capital and 37 wage-earners, and having a product valued at $185,300.

There were reported 11 establishments employing $333,648 of capital and 105 wage-earners engaged in the manufacture of tanning materials from sumac. There were used of sumac leaves 11,538 tons, having a value of $214,353, and there were produced 9,528,800 pounds of ground sumac, valued at $114,660, and 8,102,742 pounds of sumac extract, valued at $215,677. This output is compared with data accessible in previous census reports in the following table:

PRODUCTION OF SUMAC, BY DECADES: 1850, 1860, 1870, AND 1900.

YEAR	Number of establishments.	Capital.	Wage-earners.	Value of product.
1850	9	$15,550	25	$36,731
1860	4	11,700	12	16,850
1870	19	167,450	85	267,180
1900	11	333,648	105	330,337

There was produced of chrome tannage solution, as reported, 1,837,134 pounds, of a value of $52,516, but it is probable that much of this material produced and consumed in tanneries is not accounted for. Besides these materials there was a quantity of tannic acid from nutgalls and other sources reported, but this is more properly classified and treated of under acids.

The sources of tannin in nature are very numerous. Bernadin, in his book,[1] treats of 350 different vegetable sources. Mineral salts have also been employed as tanning agents, while more recently still the electric current and organic compounds, such as formaldehyde, have been employed to convert hides or skins into leather. The tannin which exists in or is produced from vegetation varies with the genus and the species, and even, it is believed, with the part of the plant from which it is obtained. Trimble[2] classifies the tannins as follows: Group *a*, gallo-tannic acid; chestnut-wood tannin; chestnut-bark tannin; pomegranate-bark tannin; sumac tannin. Group *b*, oak-bark tannin; mangrove tannin; canaigre tannin; rhatany tannin; kino tannin; cetechu tannin; tormentil tannin. According to the prevailing views, tannin is a glucoside and the tannic acid obtained from it is digallic acid. Gallnuts are the richest in tannin contents of any vegetable source, amounting to upward of 50 per cent, but the sources of tanning materials reported as used in tanning in the United States are oak and hemlock barks, oak wood, sumac leaves, and palmetto root.

Oak and Hemlock.—The bark and the wood are chipped fine and sold in this form for making the tan liquor, or they are treated to extract the tannin and other principles, and this extract is put upon the market. For making leather it has been found essential that the aqueous extract shall contain sugars, gums, resins, and coloring matters as well as tannin, since the above-mentioned substances play an important part in the conversion of the hides into leather. According to Hough,[3] the yield of bark is 3 cords per acre, and 4 to 6 trees yield a cord of bark.

Sumac.—The sumac stands next in importance to the hemlock as a source of tanning material in the United States. It is obtained from several species of the *Rhus*, but chiefly from the *R. glabra* and *R. tyhina.*

---

[1] See Literature at the end of this group.

[2] The Tannins, Vol. II, page 132.

[3] Report upon Forestry, page 145.

The sumac best suited for tanning and dyeing purposes grows wild in a belt of country extending from Maryland down through the Atlantic states to Georgia, Alabama, Mississippi, Louisiana, and Texas, and in portions of Kentucky and Tennessee. The northern climate appears too cool for developing the tanning properties of this plant to the best advantage, although in the past large quantities of the leaves gathered in Pennsylvania and New York have been sold to tanners of goatskins, who put them in vats to strengthen and keep the sewed skins from leaking, and they have been used by many tanners to brighten the color of their leather.

According to Hough,[1] in 1877 the state of Virginia led in the production of sumac, and the business of collecting, grinding, and packing was carried on at Richmond, Fredericksburg, Alexandria, Culpeper, Winchester, and perhaps other places. According to Bernadin,[2] in 1880, 6,000 tons of American sumac were annually brought into the market, principally from Alabama, Tennessee, Kentucky, and, above all, Virginia. Sumac leaves contain 24 per cent of tannin, but a sample of *Rhus glabra* from Georgetown, D. C., went as high as 26.10 per cent in tannin contents.

The season for picking sumac begins about the first of July and ends the last of September, or with the first frost, for when the leaves turn red in the autumn they are no longer of value. The tanning properties of the sumac reside in the leaves, and only these should be gathered. The differences existing in various samples of sumac is found often to be due to the care with which the leaves were gathered and dried. The blossoms and berries, as well as the stems, should be thrown out and the leaves should be dried in the shade. When cured, the sumac is ground in mills under heavy wooden wheels, revolving in circles, at the ends of axles attached horizontally to a vertical shaft. These grinding wheels are inclosed in a tight covering to prevent the escape of the dust, which arises quite abundantly. John G. Hurkamp began grinding sumac at Fredericksburg, Va., in 1847.

Palmetto Root.—The palmetto root is a source of tannin which has attracted attention in recent years in the South. It is found abundantly in Florida, and grows in Alabama, Louisiana, and Tennessee. It shows 10 per cent of tannin and the root can be cut up like bark. The tannin from this source produces tough grain and strong, durable leather. It tans rapidly, giving a pleasing light color, toughness, and pliability, and is a good filler of leather. There was but one factory reporting palmetto extract at the census of 1900. The extract is put up in barrels containing 52 gallons, and a gallon weighs about 10¼ pounds.

Tanning Extracts.[3]—"The use of extracts in tanning has grown to large proportions during the past fifteen years. There are many advantages in the use of such extracts. The liquids are always under perfect control; that is, by putting in so much extract the quantity of tanning material is known. It does away with the storing of large quantities of bark, as 1 barrel of extract is equivalent to about 1 cord of bark—128 cord feet. Where space costs money, this is quite an item, and it also saves interest and insurance on the bark.

"There is no difference in the fiber produced by bark liquors and pure tanning extracts, as properly prepared extract is nothing more than concentrated liquor. Tanning extracts in common use in the United States are made from chestnut oak bark, chestnut oak wood, chestnut wood, hemlock bark, quercitron bark, canaigre, and sumac. Black oak bark extract is used to give a bloom to leather, and coloring or dyeing extracts are made from logwood, fustic, and from a large number of other materials.

"The chestnut tree, after it is felled is peeled of the bark, which is objectionable on account of the coloring matter which it contains. The chestnut oak tree is used as it comes from the stump. The chestnut tree and the chestnut oak tree are cut into suitable lengths, say about 4 feet long, in the forest. These pieces are then carried to the factory, where they are further reduced by 'chipping' by a machine built especially for the purpose. This machine is a cast-steel disk 4 feet in diameter, revolving rapidly, and carrying a suitable arrangement of knives, which cut the wood into small chips. These chips are carried to the leaches and leached or extracted as is usual in tanneries. No chemicals should be used in the leaches. The liquor is then run into settling tanks, and next passed through 10 wire-cloth strainers of the finest meshes to clarify it, after which the liquor goes to the vacuum pan and is concentrated under diminished pressure at a temperature of between 120° and 140° F.

"The above-described method of settling and straining is the one in common use in the United States, and it produces a liquor which is pure and transparent enough to be made into an extract suitable for tanneries.

"When the degree of heat has been carried too high in the leaches, such liquor can only be clarified sufficiently by first lowering the temperature below the coagulating point of blood and adding blood; second, raising the temperature of the liquor sufficiently high to coagulate the blood, which gathers up the fine suspended matter and settles to the bottom of the vat or tank, and is then still further strained. It is then concentrated as usual.

"Extract, however, made from a liquor which has been produced at too high a degree of heat, although clarified by blood albumen, will not produce a satisfactory article; that is, such an extract is not, strictly speaking, a concentrated liquor.

---

[1] Report upon Forestry, page 153.

[2] Classification de 350 matieres tannantes, page 23.

[3] The Manufacture of Leather, by Charles T. Davis, pages 74-77.

"The extract maker, it is true, obtains a larger yield or number of pounds of finished extract from his material, but it is at the expense of the tanner. The excessive degree of heat in the leaches extracts not only nontanning substances, which are objectionable, but destroys also certain bodies which act favorably in the production of leather.

"In the concentration of the liquor in the vacuum pan, extreme caution must be observed as to the degree of heat. A temperature of over 140° F. or thereabouts produces a change in the tanning substances and in its allied nontanning substances which is very objectionable, and which produces an undesirable leather, not only in color but in quality. In other words, a liquor, although carefully made, when subjected in the pan to a degree of heat in excess of 140° F., or thereabouts, yields an extract which, when diluted with water, is not what it was before concentration It is on this account that the multiple vacuum pans—that is, more than one pan—can not successfully be used in the concentration of liquors or the making of extracts.

"In the use of extracts the tanner should always be on the lookout for only the pure article, free from adulterations of any kind. Extract is now being extensively used for sole, upper, belting, harness, union, enameled, and patent leather, and in nearly all the cases which have fallen under our observation giving good results in both tannage and weight.

"There are various methods followed in the preparation of hemlock extract, but that used by a prominent extract company in Pennsylvania is a good one. The bark is ground in the old-fashioned mill and is very carefully leached in the old-fashioned way and boiled down in the vacuum pan under the least degree of heat that can be employed. No chemicals whatever are used. They do not press or crush their bark to get from it a larger yield, but are doing their best to give a pure article which will produce a pure, strong, old-fashioned liquor. They take a good, fresh 10° barkometer liquor and boil it down to 27½° Baumé in vacuum. There is no other description than this, for this is all they do.

"The manufacture of tanning extracts now closely resembles the process for extracting sugar; the sliced wood is exhausted by diffusion in autoclaves under slight pressure, and the liquor is filter-pressed and evaporated in some cases in triple-effect apparatus which differs from those used at the sugar works merely in being constructed entirely of copper and bronze, to the exclusion of iron, and in being worked at a higher vacuum than sugar pans are. Most manufacturers decolorize the liquor before concentration, either by the addition of some metallic salt or with albumen and bisulphite of soda. In the former case the acid of the salt remains in the extract, and in the latter, sulphate of soda and noncoagulable albuminoids are retained, whilst in both cases tannin is necessarily precipitated. The presence of salts in tanning extracts is much to be deprecated, since they accumulate in the tan pits to the detriment of the leather.

"Roy has shown that the so-called decolorizing processes are beneficial to the extract, not because they eliminate coloring matters, for they do this in a very minor degree, the color of the liquor after treatment being but slightly diminished if estimated on the basis of equality of tannin content, but because they precipitate together with the first portions of tannin, certain earthy and metallic bases, such as lime, magnesia, manganese, iron, and copper, derived from the wood and from the apparatus. It is these foreign matters combined with tannin, which are taken up, by the leather, imparting bad color and harsh and brittle grain. By substituting an aqueous solution of potassium ferrocyanide for the precipitate previously used, Roy has succeeded in removing these metallic compounds without appreciably decolorizing the extract, and finds that the leather produced by the treated extract is in every way comparable with that prepared with oak-bark liquor made in the tanyard.

"It follows that tanning extracts must be examined for salts of the alkalies and the alkaline earths and for metallic compounds, and valued in accordance with their content of these, as well as with their content of tannin."

John H. Heald & Co. began the manufacture of hemlock-bark extracts at Baltimore, Md., in 1860; at Elmira, N. Y., in 1862; and at Lynchburg, Va., in 1869.

Chrome Solution.—As far back as 1856 the system of tanning, or tawing, by the use of chromium compounds was discovered by a German chemist,[1] but all the early experiments failed because the tannage could not be made permanent. A remedy was finally found in the subsequent use of hyposulphite of soda by which the tannage was made lasting. The discovery of the remedy and its successful application were made in Philadelphia, and the use of hyposulphite of soda for this purpose is covered by United States letters patent of June 28, 1888, granted to William Zahn. According to Foerderer[2] the consequence of this invention was the creation in Philadelphia of what is to-day the largest and best equipped leather factory in the world. In carrying out the process, the skin is first dipped in a solution of a chromium salt, such as potassium dichromate, acidified with hydrochloric acid, and subsequently in a solution of sodium thiosulphate or a bisulphite acidified with hydrochloric or sulphuric acid. It appears that for 100 pounds of skins 4 to 5 pounds of potassium dichromate, 2.5 to 4.5 pounds of hydrochloric acid, 8 to 10 pounds of sodium "hyposulphite," and 0 to 1.5 pounds of sulphuric acid are consumed. Of course any equivalent chromium salt may be used, and latterly the use of other metallic radicals as coagulants has been tried.

Considering leather as a chemical product (and it is always treated as such in the full chemical technologies) a notable example of the application of electricity is found in its use in the tanning of hides and skins to con-

---

[1] One Hundred Years of American Commerce, Vol. II, page 497.

[2] Ibid.

vert them into leather. There have been many such electric processes invented, some employing tannin solutions, but most of them referring to the use of mineral tannage, with chromium, aluminum, tin, and other metallic salts, on light skins, such as calf, goat, and sheep. One of these electric processes, "the Groth system of rapid tannage by electricity," has, according to Davis,[1] "so far been demonstrated in the United States at Kansas City, Mo., where good results are claimed for it." Further on, in discussing electric and other rapid tannage systems, Davis[2] says:

> The bark methods of tanning are passing away with great rapidity, extracts and chrome are taking their place, and in the larger establishments the chemist has become an invaluable part of the personnel of the tannery, and he is kept busy making investigations and suggestions.

The foreign commerce in tanning materials is set forth in the following tables, compiled from the publications of the Bureau of Statistics of the United States Treasury Department.

IMPORTS FOR CONSUMPTION DURING THE YEARS ENDING JUNE 30, 1891 TO 1900.

YEAR.	SUMAC, EXTRACT OF.		SUMAC, GROUND.		SUMAC, UNMANUFACTURED.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1891	2,399,028	$77,152	11,412,297	$235,729	2,953,202	$65,802
1892	1,902,089	68,853	10,822,614	225,891	2,841,200	60,657
1893	2,880,210	108,447	14,363,922	289,953	3,817,568	70,152
1894	1,277,609	54,535	8,315,551	191,333	970,207	21,427
1895	1,604,024	53,260	12,242,216	236,541	2,203,645	40,021
1896	2,472,923	78,504	13,349,233	231,324	1,027,824	24,861
1897	2,907,521	84,150	18,530,104	245,992	2,117,439	30,554
1898	1,266,542	48,399	8,336,117	121,461	3,754,307	62,553
1899	1,133,662	38,709	14,156,344	202,605	3,011,810	42,297
1900	1,419,827	50,295	10,644,001	233,846	1,048,955	20,800

IMPORTS OF TANNING MATERIALS FOR CONSUMPTION DURING THE YEARS ENDING JUNE 30, 1891 TO 1896.

YEAR.	HEMLOCK BARK.		HEMLOCK EXTRACTS.		OTHER THAN HEMLOCK.		Hemlock and other, value.	Other articles in crude state used in tanning not specially provided for, value.
	Cords.	Value.	Pounds.	Value.	Pounds.	Value.		
1891	57,254	$274,426	768,710	$14,958	3,310	$229	....	$2,603
1892	53,018	256,346	....	....	12,973	408	....	1,918
1893	50,688	241,244	....	....	672	71	....	8,361
1894	46,173	212,350	....	....	....	....	....	10,630
1895	47,286	230,943	....	....	....	....	$3,470	16,629
1896	43,964	214,891	....	....	....	....	19,045	23,499

DOMESTIC EXPORTS OF BARK AND EXTRACTS FOR TANNING DURING THE YEARS ENDING JUNE 30, 1891 TO 1900.

YEAR.	Value.	YEAR.	Value.
1891	$241,382	1896	$354,007
1892	239,708	1897	241,979
1893	232,269	1898	329,994
1894	271,236	1899	369,693
1895	290,362	1900	376,742

LITERATURE.

Report upon Forestry, by Franklin B. Hough: Washington, Government Printing Office, 1878.

Classification de 350 matieres tannantes, by M. Bernadin: Paris, 1880.

The Tannins, by Henry Trimble, Philadelphia, Vol. I, 1892; Vol. II, 1894.

One Hundred Years of American Commerce; Hides and Leather, by Robert H. Foerderer, Vol. II, pages 494-497: New York, 1895.

The Manufacture of Leather, by Charles Thomas Davis: Philadelphia, 1897.

Organic Chemistry, V. Von Richter, Philadelphia, Vol. I, 1899; Vol. II, 1900.

GROUP XIII.—PAINTS (INCLUDING VARNISHES, AND BONE, IVORY, AND LAMP BLACK).

Although paints (including pigments), varnishes, and bone, ivory, and lampblack have been separately tabulated, a large proportion of the establishments of the first two classes make both classes of products, and the product of the last class belongs entirely to pigments; hence it is advisable to consider them together in this special treatment.

The following table gives a summary of the principal totals of the three tabulations, with a final column giving the value of that portion of the products which really belongs to this group, the remainder belonging to other groups and being there considered. To the total of this column is added the value of the paint and varnish products from other groups, Class B, and also from other categories, Class C, so far as known, the values of these last being of course reported elsewhere under their respective classes, although usually not separately.

---

[1] The Manufacture of Leather, page 526.

[2] Ibid., page 530.

CLASS.	Number of establishments.	Capital.	SALARIED OFFICERS, CLERKS, ETC.		WAGE-EARNERS.		Miscellaneous expenses.	Cost of materials.	Value of products.	Products belonging to this group.
			Number.	Salaries.	Average number.	Wages.				
Total	615	$60,834,921	3,731	$5,040,301	9,782	$4,971,697	$5,122,381	$44,844,229	$69,922,022	$67,376,641
Paints	419	42,501,782	2,512	3,077,318	8,151	3,929,787	3,430,061	33,799,386	50,874,995	48,440,780
Bone, ivory, and lampblack	15	782,247	21	23,650	85	46,107	75,678	105,712	359,787	359,787
Varnish	181	17,550,892	1,198	1,939,333	1,546	995,803	1,616,642	10,939,131	18,687,240	18,576,074
Total	647									71,313,392
Class B	10									541,892
Class C	22									3,394,859

The importance of considering, in this connection, the products of Class C is shown by the following list of their kinds, quantities, and values:

KIND.	Quantity.	Value.
White lead, dry, pounds	6,968,000	$289,897
Oxides of lead, pounds	11,626,033	312,403
Oxide of zinc, pounds	60,235,154	2,212,787
Dry colors, pounds	1,394,595	55,450
Paints in oil, in paste, pounds	2,594,824	255,566
Paints, ready mixed, gallons	[1]479,998	268,756
Total		3,394,859

[1] Quantities not always given; in such cases, calculated from the average value of product.

There were 23 establishments of Class A and 2 establishments of Class C reported as making white lead and oxides of lead. Including the figures of Class C, the total quantity of white lead reported as having been sold dry was 123,070,316 pounds, valued at $4,501,078, in addition to which 131,621,628 pounds were reported as having been consumed in the manufacture of other paint products, making a total of 254,691,944 pounds. The total quantity of oxides of lead reported as sold as such is 62,385,656 pounds, valued at $2,862,743, in addition to which 2,080,374 pounds were reported as being consumed, making a total of 64,466,030 pounds. The entire paint and varnish products, sold as such, from all sources are as follows:

KIND.	Quantity.	Value.
White lead, pounds	123,070,316	$4,501,078
Oxides of lead, pounds	62,385,656	2,862,743
Oxide of zinc, pounds	60,235,154	2,212,787
Lamp black, pounds	7,519,345	420,037
Fine colors, pounds	4,080,902	1,028,754
Iron oxides and other earth colors, pounds	33,772,256	324,902
Dry colors, pounds	169,128,836	4,483,478
Pulp colors, sold moist, pounds	20,060,935	861,531
Paints in oil, in paste, pounds	310,072,689	17,858,693
Paints, ready mixed, gallons	17,380,348	15,139,431
Varnishes—		
Oil and turpentine, gallons	14,286,758	14,337,461
Alcohol, gallons	563,212	943,069
Pyroxylin, gallons	204,069	237,012
Liquid dryers, etc., gallons	6,564,370	3,085,254
Putty, pounds	17,287,323	238,427
All other products		2,778,725
Total		71,313,392

While it is not possible to give an equally complete list of materials, since the reports frequently give merely an aggregate of "all other materials" or report only one or two constituents separately, the following list may be of interest:

KIND.	Quantity.	Value.
Gums, pounds	36,533,632	$3,470,695
Alcohol, grain, gallons	78,309	175,907
Alcohol, wood, gallons	310,059	285,510
Dry colors, pounds[1]		7,002,913
White lead, pounds	39,689,235	1,970,614
Whiting, pounds	10,690,441	55,157
Linseed oil, gallons	16,157,117	7,495,196
Turpentine, gallons	6,519,408	2,965,051
Benzine, gallons	10,081,945	1,045,488
Total		24,466,531

[1] Dry colors includes zinc oxide, barytes, earth colors, and other dry paint materials not otherwise specified.

The growth of this industry as shown by previous census reports is as follows, the same chemicals being included for each census as far as comparable, although the Census Report for 1850 has some remarkable figures. This report gives 51 establishments making white lead with 1,508 employes, combined capital of $3,124,800, and a total product valued at $5,242,213, while only 4 paint works and 3 varnish works are reported, with a total force of 26 employees, capital $14,550, and product valued at $92,375. These figures seem to be erroneous, unless the "white-lead works" were really paint works, although each may have corroded lead for its own use, but this too is doubtful. This view seems to be borne out by the figures of the next census, that of 1860, which gives white lead 36 establishments with 994 employees, capital $2,453,147, product $5,380,347; paints 50 establishments; varnish 48; total employees 991; and capital $3,711,450; product $286,675. Included in paints for 1860 is an establishment reported as making zinc paints, with a capital of $1,000,000, employing 100 people, the product being valued at $250,000. Also 4 establishments making zinc oxide, with a combined capital of $1,228,000, employing 141 people, the total product amounting to only $226,860. These remarkable cases show that even at that early date overcapitalization was not unknown, at least in the zinc industry, unless, as is probable, the entire capitalization of the New Jersey zinc-mining companies, which were then the sole producers, was entered as being employed in the manufacture of this by-product.

PAINT AND VARNISH: 1850 TO 1900.

YEAR.	Number of establishments.	Capital.	Wage-earners.	Value of products.
1850	68	$3,217,100	1,579	$5,466,052
1860	164	7,402,697	2,216	11,107,342
1870	224	13,949,740	8,504	22,512,860
1880	325	17,333,392	5,056	29,111,941
1890	522	45,318,146	10,588	54,233,681
1900	615	60,834,921	13,518	67,876,641

In order to make the figures for 1900 fairly comparable with those of the preceding censuses, only the establishments of Class A are taken into account, the capital, value of products, and total number of employees, office force as well as factory workers, being given. The table at the beginning of this special group report gives the true statistical position of this industry, but so far as can be learned no attempt was made in any former census to separate the products there given under Classes B and C.

The paint and varnish industry in this country had its beginning in the early part of the last century. In 1804 Samuel Wetherill & Son began the manufacture of white lead in Philadelphia, followed in 1806 by Mr. John Harrison, the founder of the present firm of Harrison Brothers & Co., of Philadelphia. At that time all of the white lead used in this country was imported, but was greatly adulterated and very high priced. A letter from Mr. W. H. Wetherill, of Wetherill & Brother, the successors of Samuel Wetherill & Son, states that the American manufacture of white lead was much opposed by the agents of the foreign manufacturers and that the factory started in 1804 was shortly after destroyed by fire and that "evidence was not wanting" that this was done "by an incendiary sent to this country for this purpose." In 1808 operations were again started against heavy foreign competition, which lasted until the War of 1812 which enabled the domestic manufacturers to get a solid footing. From that time the business rapidly increased.

According to an article by W. P. Thompson in One Hundred Years of American Commerce, 1895, page 436, by 1830 there were 12 establishments in the country, of which 8 were east of the Alleghenies. This author gives the white-lead production of the country by decades as follows:

WHITE-LEAD PRODUCTION: 1810 TO 1890.

YEAR.	Tons.	YEAR.	Tons.
1810	369	1860	15,000
1820	....	1870	35,000
1830	3,000	1880	50,000
1840	5,000	1887	65,000
1850	9,000	1890	75,000

The manufacture of oxides of lead appears to have begun at about the same time as that of white lead, since by 1812 there were at least three establishments in Philadelphia. Both processes were very simple, litharge and red lead being made from the metal by regulated heating in a reverberatory furnace, while the white lead was made by the so-called Dutch process, which is still the favorite, the product being considered to be superior in quality to that made by any other process. While, as in everything else, skill is required to make a good grade of product in an economical manner, the process itself is so simple that the large number of white lead works reported for the census of 1850 may be explained by the development of the lead regions of Missouri and Illinois during the forties, as furnishing cheaper material, together with the idea, then probably prevalent, that anyone could make it, since it appeared to require only pots, lead, a little vinegar, and some spent tan bark.

The mixing of paints for sale naturally preceded the making of white lead, but there is no information available as to the beginning of such work. The first varnish factory, according to an article by D. F. Tiemann,[1] was founded by P. B. Smith, in New York in 1828, another early manufacturer being Christian Schrack, of Philadelphia, who began business as a maker of paints in 1816. The quality of the American varnishes proved so satisfactory that as early as in 1836 an export trade began. In 1857 D. F. Tiemann & Co. began making carmine from cochineal, and in 1860 soluble laundry blue and quicksilver vermilion, these products not having previously been made here. At present, American paint and varnish products enjoy a large and increasing foreign demand, and although the census returns for 1900 show that the great increase in the cost of materials during the census year has decreased profits, still the general condition seems to be a satisfactory one.

The foreign commerce in paints and varnishes for the United States is exhibited in the following tables, compiled from "The Foreign Commerce and Navigation of the United States," for the years ending June 30, 1891–1900.

PAINTS, PIGMENTS, AND COLORS: IMPORTS AND DOMESTIC EXPORTS, FOR THE YEARS ENDING JUNE 30. 1891–1900.

YEAR.	Imports, value.	Exports,[1] value.	YEAR.	Imports, value.	Exports,[1] value.
1891	$1,439,127	$690.698	1896	$1,309,041	$880.841
1892	1,372,052	709,857	1897	1,387.353	944,536
1893	1,466,761	700,308	1898	1,065,088	689,797
1894	980,715	825,987	1899	1,207,440	938,736
1895	1,246,924	729,706	1900	1,535,461	1,213,512

[1] Includes carbon black, gas black, lamp black, and oxide of zinc, prior to 1898

---

[1] One Hundred Years of American Commerce, 1895, Vol. II, page 621.

VARNISHES, SPIRITS, AND ALL OTHER, IMPORTS AND DOMESTIC EXPORTS FOR THE YEARS ENDING JUNE 30, 1891–1900.

YEAR.	IMPORTS.		EXPORTS.	
	Gallons.	Value.	Gallons.	Value.
1891	35,073	$97,298	153,365	$203,285
1892	38,737	101,692	215,266	293,059
1893	41,216	111,675	210,067	258,400
1894	20,337	54,746	226,760	282,278
1895	39,095	106,927	256,890	303,959
1896	40,644	105,551	335,979	362,975
1897	62,665	159,024	409,569	431,761
1898	32,848	79,702	398,841	422,693
1899	33,227	79,461	436,817	463,547
1900	43,743	103,985	588,545	620,104

GROUP XIV.—EXPLOSIVES.

This industry, which, as measured by the value of the output, is the fifth in importance among the industries classified under chemical products, has shown a most promising growth during the last decade, as presented by the returns of the Census of 1900, for 97 regular establishments in 21 different states were engaged in the production of explosives. These establishments employed $19,465,846 of capital and 4,502 wage-earners, and produced 215,590,719 pounds, having a value of $16,950,976. They were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF EXPLOSIVES FACTORIES: 1900.

STATES.	Number of establishments.	Value of products.	Per cent of total.
United States	97	$16,950,976	100.0
Maine, Massachusetts, Connecticut, and Vermont	5	654,862	3.9
New York, New Jersey, Pennsylvania, Delaware, Virginia, and West Virginia	54	6,846,212	40.4
Alabama, Tennessee, Missouri, and Kansas	6	1,447,100	8.5
Iowa, Indiana, Illinois, Ohio, Michigan, and Wisconsin	25	3,728,249	22.0
California	7	4,274,553	25.2

These factories were most numerous in the sections where mining or engineering operations were carried on most extensively. Though Pennsylvania had 36 factories and the largest output was in the Middle Atlantic states, yet California alone manufactured over one-fourth of the entire annual output, and was much the largest producer in the United States. In addition to these establishments 5 were reported idle, 1 in operation with less than $500 in value of products, and 2 belonging to the United States Government that were in active operation during the census year, making 80,000 pounds of explosives, having a value of $60,506.

The growth of this industry may be shown by a comparison of the returns at the various censuses for which reports have been recorded. In compiling this data it was observed that the different methods of collecting and reporting the statistics would not permit of a comparison in every detail, yet so far as it can be made it is very instructive. It was also borne in mind that while up to 1860 the data of the explosives industry were for gunpowder alone, in that year blasting powder was included, in 1870 nitroglycerine, in 1880 dynamite, in 1900 smokeless powder, and for several of these decades, variable small amounts of guncotton, fulminate of mercury, and perhaps other explosives. The returns for seven decades are as follows:

TOTAL PRODUCTION AND VALUE OF EXPLOSIVES, BY DECADES: 1840 TO 1900.

YEAR.	Number of establishments.	Capital.	Average number of wage-earners.	PRODUCTS.	
				Pounds.	Value.
1840	137	$875,875	496	8,977,348	....
1850	54	1,179,223	579	....	$1,590,332
1860	58	2,305,700	747	....	3,223,090
1870	[illegible]	4,099,900	973	....	4,237,539
1880	54	6,585,185	1,340	....	5,802,029
1890	69	13,539,478	2,353	98,645,912	10,993,131
1900	97	19,465,846	4,502	215,980,719	[1] 16,950,976

[1] This value is for the explosive substances only. When materials of all kinds produced in these establishments are included the value is $17,125,418.

A better idea of the industry may be had by the discussion of each of the products so far as the statistics will permit. This is done for gunpowder (blasting powder being included in this term) in the following table:

PRODUCTION AND VALUE OF GUNPOWDER, BY DECADES: 1840 TO 1900.

YEAR.	Number of establishments.	Capital.	Average number of wage-earners.	PRODUCT.	
				Pounds.	Value.
1840	137	$875,875	496	8,977,348	....
1850	54	1,179,223	579	....	$1,590,332
1860	58	2,305,700	747	....	3,223,090
1870	33	4,060,400	939	....	4,011,839
1880	33	4,983,560	1,011	....	3,348,941
1890	37	9,609,975	1,622	95,019,174	6,740,099
1900	47	8,297,773	1,708	123,314,103	5,310,351

Gunpowder.—Although since the Eleventh Census smokeless powder has come to be used for military and sporting purposes, 1 pound, speaking roughly, replacing 3 pounds of black gunpowder, yet the amount of black gunpowder produced and consumed is still large, and it bids fair to be so for some years to come. This is due to several causes, among which are the following: First, because in ordnance it is necessary to use a priming charge of black gunpowder with which to fire the smokeless powder. Second, because smokeless powder can not be efficiently substituted for black gunpowder in the older forms of small arms that are widely scattered over the country. Third, because black powder is most suitable for use in fuses and in pyrotechnics. Fourth, because smokeless powder is too expensive, and in no way superior to black gunpowder for saluting purposes. From the returns it is found that in the census year there were 10 establishments in 9 different states making black gunpowder, and that they employed $3,397,288 of capital, and 556 wage-earners, and produced 25,638,804 pounds of powder, having a value of $1,452,377. In making this there were consumed 8,614 tons of potassium nitrate (India saltpeter), 174,810 bushels of charcoal, and 1,282 tons of refined sulphur. About 6,800 tons of the potassium nitrate were made by conversion of sodium nitrate with potassium chloride, consuming 5,700 tons of sodium nitrate (Chile saltpeter). The wood employed for the making of the charcoal was willow, alder, or dogwood, and the yield of charcoal was about 25 per cent by weight of the air-dried wood.

While the composition of gunpowder may vary somewhat, the formula usually followed for black gunpowder is 75 per cent of potassium nitrate, 15 per cent of black charcoal, and 10 per cent of sulphur. In recent years brown prismatic powder has been used in heavy ordnance of the general composition of 78 per cent of potassium nitrate, 20 per cent of charcoal, and 3 per cent of sulphur, in which the "charcoal" was underburned charcoal from peat or rye straw, or in which carbohydrates were used, but such gunpowder has been almost, if not completely, displaced.

The manufacture of gunpowder is a very old one, this material having been used as a propellant in cannon at the battle of Crecy in 1346. It was manufactured in the United States prior to and during the Revolutionary War by means of stamp mills which consisted of mortars and pestles of wood and bronze by which the ingredients were pulverized and mixed, the damp material being grained by rubbing through sieves. This method produced not only a very coarsely made and irregularly acting powder but it was very dangerous, as, for instance, according to Chaptal, in France about one-sixth of the total stamps at work blew up annually. In 1787, Cossigny introduced at the Isle de France the practice of pulverizing and mixing the ingredients in wheel mills. In 1791, Carny devised the method of pulverizing in drums, wheel mills being used for incorporating the mass. During the latter part of the Eighteenth century the manufacture of gunpowder was brought to a high degree of perfection in France by the eminent chemist Lavoisier, who had supervision of the Government powder works.

The modern methods of manufacture in the United States began with the founding of the works at Wilmington, Del., in 1802, by Eleuthére Irenée du Pont de Nemours, who had learned powder making from Lavoisier, and who obtained from France the most approved machinery; and these works, constantly growing, have been in regular operation up to the present time, and the methods and kinds of machinery employed have been introduced into the mills subsequently erected elsewhere in this country.

The more recent improvements have been in the introduction of retorts for burning the charcoal, the manufacture of the saltpeter by conversion, and the devising of various forms of press mills. The method of manufacturing potassium nitrate from sodium nitrate by metathesis with potassium chloride was suggested by Longchamps, Anthon, and Kuhlmann in 1859, and was adopted at the Dupont works about 1868. With the large deposits of sodium nitrate available in Chile and potassium chloride accessible at Stassfurt, in Germany, this artificial source for saltpeter successfully competed with the native sources in India, where the supply is limited. This method of manufacture of potassium nitrate has also so reduced the cost of the article as to remove all temptation to continue the vicious system of niter plantations, which robbed the soil of one of its most valuable plant foods.

Blasting powder.—This industry, which is a development of the last century, was pursued during the last census year in 37 different establishments, located in 13 different states, the state of Pennsylvania alone having 19 separate works. There was employed $4,900,485 of capital, and 1,153 wage-earners, and the product amounted to 97,744,237 pounds of powder, having a value of $3,880,910. In the manufacture of this powder there were consumed 38,000 tons of sodium nitrate (Chile saltpeter), 746,000 bushels of charcoal, and 5,100 tons of sulphur.

Between 1802 and 1840 two large gunpowder factories, as well as a few smaller ones, were established in the United States. The active construction of canals and the exploitation of mines caused a considerable and growing demand for gunpowder for use in blasting, which eventually became so marked that to meet it the powder makers placed a "blasting powder" upon the market, which contained the same ingredients as black gunpowder except that they were not so carefully purified and the powder was less carefully made. In 1856 the material now commonly known as blasting powder was made, and it differs from the older blasting powder chiefly in the fact that the expensive potassium nitrate (India saltpeter) of the latter is replaced by the cheap sodium nitrate (Chile saltpeter). For some years prior to the above date, the idea of using sodium nitrate had obtained, but the fact that it was a deliquescent substance had proved an obstacle; yet the difficulties which were supposed to be insurmountable were overcome, and in 1856 its manufacture was begun on a large scale by the leading powder makers. A patent for a gunpowder containing sodium nitrate was granted to L. Dupont in 1857, and upon this an enormous industry, not only in the United States but throughout the world, has been built, and through it an additional impetus has been given to engineering and mining operations. Furthermore, this increased consumption of Chile saltpeter led to an increased development of the enormous deposits of this salt in the desert of Tarapaca, which so cheapened the nitrate as to benefit and stimulate the nitric acid, fertilizer, and many other industries in which this material is used.

The proportions of the ingredients in blasting powder may vary widely. Thus the census returns for 1900 showed gunpowders composed of 67.3 per cent of sodium nitrate, 22.9 per cent of carbon, and 9.4 per cent of sulphur, up to powder composed of 77.1 per cent of sodium nitrate, 8.6 per cent of carbon, and 14.3 per cent of sulphur. Guttman, in his "Manufacture of Explosives," gives a powder consisting of 60.19 per cent of sodium nitrate, 21.36 per cent of charcoal, and 18.45 per cent of sulphur. From a large number of returns we find the average composition to be 74 per cent of sodium nitrate, 16 per cent of charcoal, and 10 per cent of sulphur.

Blasting powder is usually put upon the market in corrugated iron kegs, holding 25 pounds each.

Nitroglycerin.—Nitroglycerin appeared for the first time among the chemical products of the United States in the census returns for 1870, but in 1890 it disappeared under the legend "high explosives," which term usually includes dynamite, gun cotton, nitrosubstitution explosives, and fulminates. While the larger part of the nitroglycerin made is subsequently consumed in the manufacture of dynamite, blasting gelatine, and smokeless powder, there is still a quantity made and sold as such. For the census year 1900 there were 22 establishments located in 6 different states, employing $293,881 of capital and 105 wage-earners. The product amounted to 3,618,692 pounds and had a value of $783,299. There were consumed in its manufacture 1,897,448 pounds of glycerin and 12,134,869 pounds of mixed acids.

In addition to the nitroglycerin produced and sold as such, 31,661,806 pounds were made and consumed, and there were required to make it 15,043,483 pounds of glycerine and 96,092,451 pounds of mixed acids. The total production of nitroglycerin, therefore, for the census year was 35,482,947 pounds, and there were used as materials 16,983,918 pounds of glycerin and 108,227,320 pounds of mixed acids. Although all but two of the factories purchased their sulphuric acid originally, many of them regained their spent acids and some of them manufactured their nitric acid. The quantity of acid reported as regained was 15,916,907 pounds, and of nitric acid manufactured, 26,058,779 pounds. There were consumed in the manufacture of this nitric acid 19,817 tons of nitrate of soda and 28,177,000 pounds of 66° sulphuric acid, but much of the latter was regained acid.

The production of nitroglycerin for 1900 as compared with that reported in previous decades is set forth in the following table:

PRODUCTION OF NITROGLYCERIN FOR THREE DECADES, 1870, 1880, AND 1900.

YEAR.	Number of establishments.	Capital.	Average number of wage-earners.	PRODUCT.	
				Pounds.	Value.
1870	3	$39,500	34	....	$225,700
1880	19	1,601,625	329	3,039,722	1,830,417
1900	22	293,881	105	3,618,692	783,299

Nitroglycerin was discovered by Ascanio Sobrero in Turin, Italy, in 1847, and it is interesting to note that upwards of 7 ounces of the first nitroglycerin made by Sobrero are still kept at the Nobel dynamite factory at Avigliana, in Italy, and are tested every year. Its commercial manufacture seems to have been begun by Alfred Nobel, in Sweden, in 1862, and in 1863 he received his first patent in this art for a mixture of ordinary gunpowder with nitroglycerin, he having at first employed gunpowder as a means of exploding the nitroglycerin. In 1863, however, he discovered that nitroglycerin could not only be exploded with certainty by means of a copper capsule containing mercuric fulminate (now known as a blasting cap or detonator), but that the power developed by the nitroglycerin was enormously greater than could be obtained from it by any other means, and this discovery marked an epoch, not only in the history of nitroglycerin, but in that of all high explosives, since it revealed the method of inducing explosion by detonation.

So near as can be ascertained, the manufacture of nitroglycerin in the United States began at the Giant Powder Company's works in California, in 1867, using Nobel's methods. In 1867 George M. Mowbray also began the manufacture, by independent methods, at North Adams, Mass. Mr. Dupont says:[1]

> There are two engineering works which indicate very well the era of the introduction of high explosives in this country. In the year 1870 the Nesquehoning tunnel, near Wilkesbarre, was excavated in very hard rock by the use of black powder only. The engineers in charge were unwilling to introduce the then new and untried explosive. The work was, however, completed in good form and very quickly, owing largely to the extensive use of compressed air drills. About the same time the Hoosac tunnel was completed, nitroglycerin alone being used in the work. This explosive was principally manufactured upon the ground, and was much used in the liquid state. This work was a greater one than the tunnel first mentioned, but the two serve to mark the transition period in the practical use of explosives. One of the greatest of modern engineering works, the Chicago drainage canal, is now (1895) being carried on largely by high explosives. It is an example of the magnitude of the work that is attempted with explosives.

Nitroglycerin is manufactured by mixing glycerin with a mixture of nitric acid and sulphuric acid. Each of the materials used is the most concentrated that can be made, and the demand for large quantities of nitric and sulphuric acids and glycerin of the highest grades which has been created by the high-explosives industry has had a marked effect on the development of the acid and glycerine industries. The acids are usually mixed in the proportion of 3 parts by weight of sulphuric acid to 2 parts by weight of nitric acid, and they should contain 61.9 per cent of H_2SO_4 and 34.5 per cent of HNO_3, with not more than 0.7 per cent of N_2O_3. These previously mixed acids are sent out from the acid works in iron drums holding about 1,500 pounds, and this weight of mixed acids makes a convenient charge for one run in the nitroglycerin converter, from 210 to 230 pounds of glycerin being there mixed with it.

---

[1] One hundred years of American Commerce, Vol. I, page 192.

The reaction goes on between the glycerin and the nitric acid, the sulphuric acid present serving chiefly to take up and retain the water which is one of the products of the reaction. When the reaction is completed the materials are run into a tank, where they rest until, owing to their differences in specific gravity, the nitroglycerin and spent acids form into separate layers; then the nitroglycerin is run off into washing and purifying tanks, and the acids are run off to be reworked. The dilute nitric acid thus obtained is sometimes used in the manufacture of ammonium nitrate for use in dynamite dopes. The diluted sulphuric acid is sometimes used in the manufacture of nitric acid, but it is more often concentrated in iron pans, and, after being mixed with strong nitric acid, again used in making nitroglycerin. This spent acid averages in composition 72 per cent of sulphuric acid, 10 per cent of nitric acid, and 18 per cent of water. Theoretically, 100 parts by weight of glycerin should yield 246 parts of nitroglycerin, but in practice the yields are from 200 to 220 parts.

Nitroglycerin is used directly in torpedoes, which are cylinders holding 20 quarts each, for "shooting" oil wells. It also is used in medicine as a heart stimulant. The principal use of nitroglycerin is in making dynamite and blasting gelatin.

Gun Cotton or Pyroxylin.—By the returns for the census of 1900 there were 10 establishments in 3 different states engaged in the manufacture and sale of cellulose nitrates, for various uses and they employed $255,343 of capital and 163 wage-earners. There were produced 922,799 pounds of the various cellulose nitrates, having a value of $486,773, and there were consumed 691,115 pounds of cotton and 8,247,668 pounds of mixed acids. Besides these there were produced and consumed in other establishments 2,739,834 pounds of cellulose nitrates, making a total product for the year of 3,662,633 pounds.

Gun cotton, or pyroxylin, is the name given to various cellulose nitrates which were discovered by Schönbein in 1846, and which result from the reaction between nitric acid and cellulose. There is a considerable number of cellulose nitrates; authorities differ as to their number. In fact, there is still doubt as to the real constitution of cellulose, and therefore nothing can be pronounced with certainty as to the constitution of the nitrates produced from it. However, it is generally accepted that the formula of cellulose is some multiple of $C_6H_{10}O_5$, and that the nitrates are produced by replacing one or more atoms of the hydrogen present by NO_2. It is also accepted, following Vieille, that, taking the formula as $C_{24}H_{40}O_{20}$, there may be at least 8 different cellulose nitrates in which from 4 to 11 groups of NO_2 have been introduced into the molecule. In the following table these different nitrates are so named as to indicate the number of NO_2 groups present, and there is also shown the per cent of N present in each.

CELLULOSE NITRATES.	Per cent of nitrogen.	Weight obtained from 100 parts of cellulose.
Cellulose endecanitrate	13.47	176.4
Cellulose decanitrate	12.75	169.4
Cellulose enneanitrate	11.96	162.5
Cellulose octonitrate	11.11	155.7
Cellulose heptanitrate	10.18	148.6
Cellulose hexanitrate	9.15	141.7
Cellulose pentanitrate	8.02	134.7
Cellulose tetranitrate	6.76	127.8

In addition to these nitrates containing different per cents of nitrogen, there are undoubtedly isomers of many of them. According to their difference in nitrogen contents, or in intermolecular arrangement, these nitrates exhibit different degrees of solubility toward organic solvents, and are in consequence put to different commercial uses. Thus the higher ones are, under ordinary conditions, insoluble in a mixture of 2 parts of strong ethyl ether and 1 part of strong ethyl alcohol, and such cellulose nitrate is called gun cotton. On the other hand, the lower nitrates are soluble in the mixed solvent named under these conditions, and these cellulose nitrates are called pyroxylin. It should be said that later researches tend to show that, according to the conditions under which they are nitrated or the conditions under which they are exposed to the solvent, the higher nitrations are acted upon by the ether-alcohol solvent.

Cellulose nitrates are prepared by immersing purified cotton in mixtures of nitric and sulphuric acid. In making gun cotton, the acid mixture consists of 1 part, by weight, of nitric acid of 1.5 specific gravity to 3 parts, by weight, of sulphuric acid of 1.845 specific gravity, and 1 pound of steam-dried cotton is immersed in and digested for twenty-four hours with 12 pounds of this acid mixture. The acid is then wrung out and the gun cotton is pulped, washed, and compressed into blocks for use. The spent acids which are thrown out in the wringing have been found to contain 79.91 per cent of H_2SO_4, 9.52 per cent of HNO_3, 1.04 per cent of N_2O_4, and 9.65 per cent of water, and they are reworked to be used again. In making the lower cellulose nitrates weaker acids are used, the strength being determined by the use to which the nitrate is to be put. Examples of such acid mixtures are given under smokeless powder and under pyroxylin plastics.

Cellulose nitrates are used for many purposes in the arts. Finely pulped, compressed material, consisting principally of the highest nitration, is known as gun cotton and is used in military mines and torpedoes, and for destructive purposes generally in military operations. Owing to the discovery by E. O. Brown, of Woolwich, in 1868, that it can be detonated when wet, it is now stored and used while saturated with water. In 1847 or 1848 Doctor Maynard, of Boston, discovered that pyroxylin was soluble in ether-alcohol and that the liquid, called "collodion," could be used as a vehicle for medicine and as a substitute for sticking plaster. In 1851 Frederick Scott Archer invented the process of coating photographic plates with collodion. In 1869 John W. Hyatt, Jr., and Isaiah S. Hyatt, of Albany, N. Y., invented the process for manufacturing "celluloid" from cellulose nitrate. Still later, Frederick Crane invented pyroxylin varnishes, and Chardennot invented a process for making artificial silk from pyroxylin. A large use for cellulose nitrates is in the manufacture of smokeless powder, explosive gelatine, and gelatine dynamite. By the use of pyroxylin solutions a form of artificial leather is obtained.

Dynamite.—This explosive first appears in the report of the census of 1880, and then amounted in value to but one-third of that for the nitroglycerin produced. According to the census of 1900, there were 31 different establishments, located in 8 different states, employing $7,551,121 of capital, and 1,758 wage-earners engaged in the manufacture of dynamite. There were produced 85,846,456 pounds, having a value of $8,247,223, and there were consumed in making it, 31,661,806 pounds of nitroglycerin, 20,090 tons of sodium nitrate, 9,934,360 pounds of wood pulp, 82,558 pounds of pyroxylin, and 483,975 pounds of ammonium nitrate.

The production and value of dynamite for 1900, compared with that reported in previous decades, is set forth in the following table:

PRODUCTION OF DYNAMITE, BY DECADES: 1880 to 1900.

YEAR.	Number of establishments.	Capital.	Average number of wage-earners.	PRODUCT.	
				Pounds.	Value.
1880	2				$622,671
1890	32	$3,929,503	731	30,626,738	4,253,032
1900	31	7,551,121	1,758	85,846,456	8,247,223

Dynamite was invented by Alfred Nobel in 1866, and its manufacture began shortly after at the various works established by him. In his testimony before the select committee on explosive substances of the British Parliament, in 1874, Nobel testified that there were then 13 factories, in which he was interested, engaged in this manufacture, 2 of them being in America, while there were many independent works in addition. The returns for dynamite were not so rendered in the prior census reports that the growth of this important industry can be readily ascertained, but some general idea of its growth may be gained from the following table, given by George McRobert, setting forth the annual sales of dynamite for each of sixteen years, from the factories with which Nobel was associated.

McROBERT'S TABLE.

YEAR.	Sales, tons.	YEAR.	Sales, tons.
1867	11	1875	3,500
1868	78	1876	4,300
1869	184	1877	5,500
1870	424	1878	6,200
1871	785	1879	7,000
1872	1,350	1880	7,500
1873	2,050	1881	8,500
1874	3,120	1882	9,500

Dynamite is a material of most variable composition. It consists of a solid porous absorbent which holds the liquid nitroglycerin, and its invention was a necessity, since so many frightful accidents due to the liquid state of nitroglycerin led to legislation in Europe which forbade the transportation and use of the latter explosive. Kieselguhr (known as infusorial silica) was largely used at first, and is still much used in Europe, as the absorbent, but this "dope," as the absorbent base is called, is almost entirely replaced in this country by an explosive dope, which is most frequently a mixture of wood pulp and sodium nitrate, with a very small percentage of calcium or sodium carbonate to act as a neutralizer to any acid present. Such a dynamite is known as a straight dynamite, but there are others which contain a dope of coarsely made gunpowder or of resinous compositions. In 1875 Nobel invented an explosive made by dissolving pyroxylin or soluble cellulose nitrate in nitroglycerin until, when the mixture was cool, it set to a jelly-like mass which is known as explosive or blasting gelatin. This is often mixed with wood meal or wood pulp, and then gelatin dynamite is produced. As may be inferred, dynamites vary greatly in their nitroglycerin contents, and they may be found on the market containing from 5 per cent, as in a bank blasting powder, up to 94 per cent, as in a blasting gelatin. The grade which is probably the most extensively used is that known as 40 per cent dynamite, and analysis has shown a straight dynamite of this grade to contain of nitroglycerin 39.8 per cent, sodium nitrate 46.1 per cent, wood pulp 11.5 per cent, calcium carbonate, 0.7 per cent, moisture 1.9 per cent. It can be safely assumed that 40 per cent is the average nitroglycerin content of the dynamites of all kinds put on the market.

Dynamite as sold is usually loaded into paraffined paper cases, thus making it into "sticks" or "cartridges." These sticks may vary much in size, but the average stick will be 8 inches in length by 1¼ inches in diameter, and they are packed in sawdust in boxes holding 50 pounds each.

Smokeless Powder.—At the time the Eleventh Census was taken no smokeless powder was reported, nor was there then any factory in operation for its regular production, while for the census year 1900 there was an output of 3,053,126 pounds of powder having a value at the works of $1,716,101. This industry, which is wholly a growth of the last ten years, embraced 9 factories, having $2,153,958 of capital, gave employment to 730 wage-earners, and consumed 14,000,000 pounds of mixed acids, 1,600,000 pounds of cotton, 2,600,000 pounds of alcohol, 1,400,000 pounds of ether, 143,000 pounds of acetone, and 88,000 pounds of nitroglycerin. There is little doubt that the growth will be much more rapid in the immediate future, as smokeless powder is rapidly supplanting black gunpowder for military and sporting purposes, and, as a large part of the time during the last ten years has been spent in the invention of machinery for handling the materials, in planning works so as to secure the maximum of safety with the maximum of speed and economy in manufacture and in the devising of means for the recovery and renewal of the spent acids and solvents.

The very earliest manufacture of smokeless powder in the United States was carried on by Charles Lennig, at Philadelphia, Pa., about 1850. His small-arm charges were made of long staple, fibrous gun cotton, and, as elsewhere, they were found to be so dangerous that their use was soon abandoned. The next factory to be started was erected by Carl Dittmar, at Quincy, Mass., about 1870, where a soft, granulated powder was made, but this was also abandoned.

The first of the factories erected for the manufacture of modern smokeless powder was planned, erected, and operated at the United States Naval Torpedo Station at Newport, R. I., in 1890, by Charles E. Munroe, under the direction of Commander Theodore F. Jewell, United States Navy, inspector of ordnance, in charge of the station, and it is to-day in regular operation, having been much enlarged. Following this, 4 factories were erected in 1891, 1 in 1895, 1 in 1898, and 2 in 1900, all of which were producing during at least a part of the census year. These factories were scattered through 7 states, 3 of them being in New Jersey and 2 of them being factories belonging to and operated by the United States Government. The Government factories produced military powder only, 4 of the private factories produced sporting powder only, while the remaining private works, though manufacturing largely for military purposes, produced some sporting powder also.

The earliest recorded attempt to use a smokeless explosive as a propellant is found in the experiments of Howard, who in 1800 attempted to use mercury fulminate in place of gunpowder in a firearm, with the result that he burst the piece. Immediately after the discovery of gun cotton by Schönbein in 1846, extensive trials of it as a propellant were made in Germany, France, England, and the United States, but as it was then used in the ordinary fluffy or thread-like condition of cotton it proved too violent. In 1866 Frederick A. Abel devised a method for granulating gun cotton by introducing pulped nitrocellulose containing water and a small quantity of a binding material into a vessel to which a vibrating motion was imparted, thereby producing soft grains, but this does not seem to have come into vogue.

The first person to realize any considerable degree of success was Captain Schultze of the German army, who, in 1862, made a soft-grained powder from well-purified and partly nitrated wood. The first nitrocellulose powder to approach modern requirements was the E. C. powder, invented by Reid and Johnson in 1882, in which the soft grains, produced by rolling pulped nitrocellulose containing water in barrels were superficially hardened or waterproofed after granulation. The first successful military smokeless powder was made in France by Vieille, and it consisted of a hard, dense-grained flake, or fagot powder, made from nitrocelluloses mixed with a nitrate, like barium nitrate, and with or without picric acid. This was followed in 1888 by the ballistite of Nobel, and in 1889 by the cordite of Abel and Dewar, each of which was composed of mixtures of nitrocelluloses with nitroglycerine and a restrainer of some kind. The whole was worked, by admixture with suitable solvents and by use of the proper machinery, into grains which were hardened throughout. In 1889 Richard Von Freeden discovered that gelatinized nitrocellulose, still containing the solution employed for its gelatinization, on being exposed to certain liquids, or the vapors thereof, undergoes a kind of coagulation and division into small lumps, which latter is promoted by stirring, and upon this he based a method of manufacture by which small-grained powders that are hardened throughout could be produced, and the method is now quite extensively followed.

Up to this time all gunpowders throughout the world, both black and smokeless, were made of mixtures of various ingredients, even the smokeless powders, which were made from nitrocellulose only, being made from mixtures of cellulose nitrates of different degrees of nitration; but in 1889 Charles E. Munroe proposed that smokeless powders be made of a single chemical substance in a state of chemical purity, and he pointed out that cellulose nitrate, of uniform nitration, then offered the best material from which to produce such a powder, and this is the principle which to-day governs the manufacture of military smokeless powders, at least in the United States.

Although up to 1898 the United States Army proposed to use smokeless powder composed of nitrocelluloses and nitroglycerin, the United States Navy adopted in 1890 a cellulose powder of uniform nitrogen contents, and the Army followed in 1898. As made to-day, the nitrocellulose used contains from 12.45 to 12.80 per cent of nitrogen. Such cellulose nitrate is made by dipping 1 pound of cotton (free from oil and mechanical impurities and containing about 57 per cent of moisture) in 19 pounds of "mixed acids," containing about 57 per cent of H_2SO_4, 28.2 per cent of HNO_3, and not more than 2 per cent of N_2O_4. The acid has an initial temperature of 25° C., and the crock containing the mixed acids and cotton is heated to 36° C., the cotton being exposed at this temperature, with one turning over of the cotton, for sixty minutes. After purification by wringing, washing, and steaming to remove the acid, the nitrocellulose is freed from the water remaining in it by extraction with alcohol, and it is converted into a gelatinous mass by kneading or stirring in a Werner and Pfleiderer mixing machine with a mixture of ethyl ether and ethyl alcohol, 2 parts by weight of ether and 1 part by weight of alcohol being used for every 3 parts by weight of nitrocellulose. The subsequent processes have for their object the more intimate mixing of the material and straining off of the unconverted portions, the shaping of the mass into grains, and the drying of the grains. The finished grains still contain some of the solvent, particularly alcohol, the amount varying with the thickness of the walls of the grains. In the very smallest grains this amounts to about one-half of 1 per cent, while in the larger grains there may be as much as 4 per cent of solvent present.

It is not easy to check the data in this manufacture, and for this reason round numbers are given. It may be said, however, that 100 pounds of perfectly dry cotton will yield 169 pounds of this nitrocellulose, but the cotton as used may contain as much as 7 per cent of moisture, while the final product may contain from one-half of 1 per cent to 2 per cent of solvents. The quantities of acids can not well be checked, because the spent acid is "rebuilt" and used again. The difficulty is even greater with the solvents, since most of the works manufacture the ether used from part of the alcohol purchased or supplied to them besides reusing the recovered solvents. An additional complication in comparing costs arises from the fact that, when the powder is being made in private works for the United States Government, the manufacturer is permitted to use tax-free alcohol, while if he be making such powder for other parties he must use tax-paid alcohol. Where the Government supplies the alcohol, the weight of alcohol allowed is 1.4 times the weight of the finished powder.

The foregoing description is for military powder, and though picrates and metallic salts, such as nitrates and bichromates, are used to some extent in sporting powders, yet they are to so large an extent composed of nitrocellulose that they may be regarded for purposes of census classification as composed wholly of this material. The methods of manufacture are as a rule quite different from those employed in the making of military powders, and the gelatinizing agents used are ethyl acetate, amyl acetate, and the like, in place of ether-alcohol. It is to be noted that a small portion of the smokeless powder reported for the census year was a nitrocellulose-nitroglycerin powder which had been gelatinized by acetone. Smokeless powder is usually sold in metal canisters holding 1 bulk pound each.

Fulminates.—Although charges of dynamite and other high explosives are invariably fired by detonators or blasting caps charged with mercuric fulminate, and, although percussion caps, friction primers, and fixed ammunition are also charged with this explosive, yet the amount of this most important and essential explosive which is returned as manufactured in the United States was quite insignificant. On the other hand, as shown by the following table, compiled from the records of the Bureau of Statistics of the United States Treasury Department, the importation of fulminate is assuming greater and greater importance as our home industry in other explosives grows, and this is shown even more markedly if to the values for the fulminates there be added those for the blasting caps, percussion caps, and cartridges that are also imported:

IMPORTS, FOR CONSUMPTION, OF FULMINATES, FULMINATING POWDERS, AND LIKE ARTICLES: 1884 TO 1900, INCLUSIVE.

YEAR.	Value.	YEAR.	Value.
1884	$487	1893	$48,509
1885	5,577	1894	42,567
1886	10,647	1895	65,891
1887	10,099	1896	77,197
1888	20,984	1897	76,515
1889	10,717	1898	46,703
1890	19,460	1899	108,741
1891	44,403	1900	105,999
1892	36,278		

The fact that, notwithstanding the dangers attendant on the transportation of this violent explosive substance, its home manufacture has been almost completely superseded by the foreign product, is explained on stating that it is manufactured from grain alcohol, mercury, and nitric acid; that for every 12 parts by weight of mercury fulminate produced 110 parts by weight of 95 per cent alcohol are consumed; and that the tax levied in the United States on alcohol makes the foreign commerce in this article a very profitable one, and home competition practically impossible.

Wage-earners and wages.—There were employed in the entire explosives industry 4,349 men, 117 women, and 36 children under 16 years of age. The wages for the men varied from $365 per annum in New Jersey to $790 per annum in California, the average for the whole country being $539 per annum. The average wage for women was $263 per annum, and for children $169 per annum.

Power.—The total horsepower reported as being employed in these factories was 22,920 horsepower, of which 5,674 horsepower was supplied by 190 water wheels, 13,242 horsepower by 315 steam engines, 2,885 horsepower by 177 electric motors, and 279 horsepower from other sources. The returns are chiefly interesting in marking changes in methods, for, formerly, in erecting black gunpowder works especial care was taken to secure a location for the works where there was an abundant water supply and plenty of wood for charcoal making; whereas, in the manufacture of the modern explosives, while a sufficient isolation to obtain security for the works and limit the damage resulting from accidental explosions is sought, yet readiness and convenience in transportation of the materials used and the goods manufactured are regarded as of the first importance. The improvements in the methods for generating, conveying, and transforming the energy in steam or electricity have now rendered it relatively safe to employ these sources of energy.

Imports and Exports.—A more nearly correct idea of the condition of this industry may be obtained if there be added to the census statistics those for the imports and exports of explosives. The imports of fulminates have already been considered, and attention is now called to the statistics for the foreign commerce in all explosives as compiled from "The Foreign Commerce and Navigation of the United States for the year ending June 30, 1900," Vol. II.

IMPORTS OF GUNPOWDER, FULMINATES, AND ALL LIKE ARTICLES: 1891 TO 1900, INCLUSIVE.

YEAR.	GUNPOWDER.		All other explosives, fulminates, etc., value.	Total value.
	Pounds.	Value.		
1891	34,312	$19,148	$124,528	$143,676
1892	81,111	29,533	100,977	130,510
1893	78,306	68,974	124,661	193,635
1894	85,481	71,285	67,342	138,627
1895	104,990	84,882	96,940	181,822
1896	68,993	49,857	77,192	127,049
1897	87,921	63,722	98,727	162,449
1898	98,708	79,992	65,123	145,115
1899	44,405	29,824	160,620	190,444
1900	31,212	15,835	169,073	184,908

DOMESTIC EXPORTS OF GUNPOWDER AND OTHER EXPLOSIVES: 1891 TO 1900, INCLUSIVE.

YEAR.	GUNPOWDER.		All other explosives, value.	Total value.
	Pounds.	Value.		
1891	733,834	$88,676	$906,870	$995,546
1892	903,077	108,276	752,079	860,355
1893	885,263	105,547	755,966	861,513
1894	495,566	66,839	935,287	1,002,126
1895	972,271	102,885	1,174,396	1,277,281
1896	1,159,935	124,823	1,256,279	1,381,102
1897	1,086,465	118,001	1,437,317	1,555,318
1898	1,202,971	139,644	1,255,762	1,395,406
1899	1,504,624	181,642	1,350,247	1,531,889
1900	1,612,822	197,438	1,694,166	1,891,604

LITERATURE.

Powder and Explosives, by Francis G. Du Pont. One Hundred Years of American Commerce, I, 192.

The Manufacture of Explosives, Oscar Guttmann: Macmillan & Co., New York, 1895.

Report and Proceedings of the Select Committee on Gun Cotton, etc., 1871–1874: London, 1874.

Ascanio Sobrero, by Vincenzo Fino: Turin, 1889.

On the Manufacture of Dynamite, G. E. Barton. Jour. Amer. Chem. Soc., 19, 500–509. 1897.

Notes on Nitroglycerine, Dynamite, and Blasting Gelatine, George McRoberts. Philosophical Soc. of Glasgow, April 25, 1883.

Lectures on Chemistry and Explosives, Charles E. Munroe: Torpedo Station Print, 1888.

On the Development of Smokeless Powder, Charles E. Munroe. Jour. Amer. Chem. Soc., 18, 819–846. 1896.

Specifications for United States Navy Smokeless Powder. Proceedings U. S. Naval Inst., 24, 477–480. 1898.

Smokeless Powder, Lieut. Joseph Strauss, U. S. N. Proceedings U. S. Naval Inst., 27, 733–738. 1901.

Geschichte der Explosivstoffe, S. J. Von Romocki: Berlin, 1895.

Christian Friedrich Schönbein 1799–1868, by Kohlbaum & Schaer. Monographieen aus der Geschichte der Chemie IV Heft 1900, VI Heft 1901, Leipzig.

GROUP XV.—PLASTICS.

During the census year 8 establishments manufactured cellulose plastics and also engaged in the further manufacture of these plastics into articles of various sorts. The value of the plastics produced was $2,099,400. The total value of the plastics and of the finished articles was $3,063,673. There were employed a capital of $7,558,720, and 1,221 wage-earners. The growth of the industry can be shown only for the pyroxylin plastics, including the finished article as displayed in the following table:

PRODUCTION OF PYROXYLIN PLASTICS, BY DECADES, 1880 TO 1900, INCLUSIVE.

YEAR.	Number of establishments.	Capital.	Number of employees.[1]	Value of products.
1880	6	$1,214,000	736	$1,261,540
1890	12	3,158,187	1,023	2,575,736
1900	7	7,210,548	1,176	2,864,044

[1] For 1900 this means wage-earners only.

Pyroxylin Plastics.—The best known of all the pyroxylin plastics is "celluloid." The art of making pyroxylin plastics was begun in England when Alexander Parkes discovered, in 1855, that a solution of pyroxylin, mixed with other substances, could, after the solvent was evaporated, be made into a substance having the qualities of horn or ivory, and could then be easily molded or worked or colored as desired. He entered vigorously upon the manufacture of this substance, which he called "parkesine," and put on exhibition various articles made from it, but the enterprise did not succeed and was abandoned in 1867. About this time Daniel Spill began the making of what he styled "zylonite" from pyroxylin or zyloidin by treatment with solvents and admixture with other materials, but owing to the fact that quite fluid solutions were employed, and to the difficulty of getting rid of the excess of the solvents, the operations were not commercially practicable.

In 1869, John W. Hyatt, Jr., and Isaiah S. Hyatt, of Albany, N. Y., made the important discovery that camphor by itself is a solvent for pyroxylin, if, after the camphor has been mixed with the pyroxylin, the mixture be heated to from 150° to 200° F. and subjected at the same time to a heavy pressure, and that the product can be worked like rubber. To this discovery, for which United States Patent No. 105338, July 12, 1870, and its reissues were granted, to the process which those inventors based on it, and to the knowledge and skill which were developed by its practice, is due the present commercial success of pyroxylin plastics.

The Hyatt Brothers began the manufacture of celluloid in a small way at Albany, N. Y., in 1869, but capital was soon interested in the venture, and in 1870 the business was removed to Newark, N. J., where the Celluloid Manufacturing Company has since remained in active operation. It had so expanded in 1896 that the floor space occupied at the factory was nearly eight acres in extent, and it is claimed that over 6,000 persons throughout the country were employed, either in producing the celluloid, or shaping the product of this factory into various articles.

The manufacturing operations at the factory involve the production of the pyroxylin, its conversion into celluloid, and the manufacture of part of the product into wearing apparel and toilet and fancy articles. According to Field, the pyroxylin is made by dipping cotton or tissue paper into a mixture of sulphuric acid 66 parts, nitric acid 17 parts, and water 17 parts, 100 pounds of the acid mixture being used for 1 pound of the paper, and the immersion being continued from twenty to thirty minutes at 30° C. The pyroxylin used in this art is of low nitration, containing about 10.18 per cent of nitrogen.[1] The purified pyroxylin is mixed with camphor by sprinkling it with a solution of camphor in wood alcohol, and incorporating the mass with other desired ingredients on steam-heated maxillating rolls. The solid celluloid which is thus obtained, and which is a composition of pyroxylin with camphor, an ant-acid, and coloring matter, is then shaped by cutting into sheets, stuffing through die plates, molding under pressure while hot, turning, and the like, into various objects.

Celluloid is used in making collars and cuffs; piano and organ keys; billiard balls; paper cutters; combs; backs for brushes and hand mirrors; handles for canes, umbrellas, whips, and cutlery; mouthpieces for pipes, cigarette and cigar holders; chessmen; dolls' heads and other toys; electrotype plates, and a great variety of other articles of adornment and use.

Viscose.—This body represents the most recent development in the production of plastic bodies from cellulose, and was invented by C. F. Cross, E. J. Bevan, and C. Beadle, to whom United States Patent No. 520770, of June 5, 1894, was issued. In the manufacture, purified cotton is treated with an excess of a 15 per cent solution of sodium hydroxide and squeezed until it retains about three times its weight of the solution. It is then placed in a vessel with carbon disulphide, the quantity used being about 40 per cent of the weight of the cotton. After digestion for about three hours at the ordinary temperature, sufficient water to cover the mass is added and digestion allowed to proceed overnight, when, on stirring, a homogeneous liquid is obtained, which is a solution of cellulose thiocarbonate, or xanthate, and from which a jelly or coagulum of cellulose is produced by spontaneous decomposition, by precipitation with dehydrating agents, or by heating the solution. By incorporating viscose with mineral matters, hydrocarbons, and like substances, solid aggregates are produced which may be cast or molded into convenient forms, and after purification and sufficient aging made available for various structural uses. More recently these investigators have found the cellulose tetracetate to be especially suitable for the formation of viscose.

Other Plastics.—Many plastic substances are now made from caoutchouc, gutta-percha, casein, fibrin, gluten, and like bodies which act as gelatinizing or cementing agents, by which the zinc oxide, antimony sulphide, kaolin, and other fillers are held in solid aggregations which may be molded or shaped with lathes and other tools as desired.

The foreign commerce in the pyroxylin plastics, as compiled from the Foreign Commerce and Navigation of the United States for the year ending June 30, 1900, Vol. II, is set forth in the following table:

IMPORTS AND EXPORTS OF PYROXYLIN PLASTICS, 1891 TO 1900, INCLUSIVE.

YEAR.	Imports, value.	Exports, value.
1891	$10,595	....
1892	43,353	$39,004
1893	57,062	36,597
1894	96,977	85,234
1895	371,873	72,926
1896	337,862	146,354
1897	262,675	149,631
1898	160,836	155,444
1899	249,619	173,771
1900	378,583	174,310

LITERATURE.

Pyroxylin, Its Manufacture and Applications, by Walter D. Field, J. Am. Chem. Soc., vols. 15 and 16, 1893 and 1894.

Das Celluloid, by Fr. Böckmann, Leipzig, 1880.

Cellulose, by Cross and Bevan, London, 1895.

Researches on Cellulose, 1895–1900, by Cross and Bevan, London, 1901.

Group XVI.—Essential Oils.

Though one of the less important, as measured by the value of the product, this is one of the oldest of the chemical industries, and it received recognition as a distinct industry in census statistics so long ago as 1860. It appears, however, that there have been varying views at the several censuses as to what substances should properly be placed under this classification. For the census of 1900, there are included in this report, under this title, all those bodies reported as having been manufactured in the United States during the census year, that are usually included in the text-books and treatises under the legends "volatile oils" or "essential oils," except vanillin, and oil or spirits of turpentine, which was made the subject of a special census report, while in addition witch-hazel is included. In this classification, then, there are, for the year ending June 1, 1900, 100 establishments in 14 states, engaged wholly or chiefly in the production or refining of these oils. Of these, 30 establishments produced a product of less than

---

[1] See Explosives: Gun Cotton or Pyroxylin, ante, page 73.

$500 in value. These 100 establishments employed $622,385 of capital and 201 wage-earners, and the value of their products was $850,133. In addition, there were 3 establishments which produced $9,268 of essential oils as a subordinate product. As pointed out, there is included here the refined natural oils and the crude natural oils, and in addition the artificial oils. These last named are manufactured by 4 establishments, employing $33,720 of capital and 13 wage-earners, and they reported $54,450 in value of products. The vanillin industry, which is classified with "fine chemicals," returned 124,874 ounces of the product, having a value of $113,050. This was manufactured in 4 establishments, and gave employment to 26 wage-earners and $65,689 of capital. The product of refined natural oils for 1900 amounted in value to $370,500. The establishments for the production of the crude natural oils were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF CRUDE ESSENTIAL OIL FACTORIES: 1900.

STATES.	Number of establishments.	Average number of wage-earners.	Capital.	Product.	Per cent of total.
United States	97	167	$426,892	$434,451	100.0
Connecticut	5	8	65,500	45,530	10.5
New York	11	15	183,675	249,150	57.3
Virginia	15	31	15,149	38,165	8.9
Indiana	10	14	20,050	14,893	3.4
Michigan	28	91	107,509	70,126	16.1
New Hampshire, Vermont, Massachusetts, Pennsylvania, North Carolina, Florida, Tennessee, Illinois, Wisconsin, and California	28	8	35,009	16,587	3.8

This tabular view shows that though this industry was widely distributed, it did not attain to any magnitude except in the states of New York, Michigan, Connecticut, and Virginia, and that in these states, as elsewhere, it was carried on by a large number of persons in a very small way. In fact it is usually carried on as an employment accessory to farming, the farmers taking advantage of the idle time between seasons to gather roots, herbs, bark, and leaves, and by means of a simple and often portable still (which is frequently erected for the time being in the woods near where the material is gathered) extracting their essential oils. This accounts for the small number of wage-earners in proportion to the number of establishments reported, as the farmer, in a large number of instances, carries out all the operations without hired labor. The character of the industry and the methods employed are especially illustrated by the great variety of products reported, for there are, among others, returned and combined in the values given in the table, the natural oils of peppermint, spearmint, erigeron (fleabane), pennyroyal, wormwood, tansy, fireweed, golden rod, wintergreen, black birch, sassafras, spruce, cedar, juniper, and witch-hazel.

The peppermint-oil industry was confined principally to Michigan, Indiana, and New York, there having been 95,000 pounds produced in these three states; the sassafras-oil industry was located principally in Virginia, where 104,931 pounds of this oil were produced; the wintergreen-oil industry was located chiefly in Pennsylvania, where 2,075 pounds were reported as having been produced; and the witch-hazel industry was located chiefly in Connecticut and New York, where 110,260 gallons of this substance, having a value of $54,649, were produced.

As previously stated, the methods of classifying this industry, as well as the methods used for collecting the statistics, have varied somewhat in the different censuses, but they have been sufficiently consistent for the last three decades to admit of the comparison made in the following table:

TOTAL PRODUCTION OF ESSENTIAL OILS (CRUDE) BY DECADES, 1880 TO 1890, INCLUSIVE.

YEAR.	Number of establishments.	Capital.	Average number of wage-earners.	Value of product.
1880	124	$67,755	278	$248,858
1890	67	102,223	191	255,847
1900	97	426,892	167	434,451

The increase in the value of the product for 1890 over the value for 1880 was but 2.8 per cent, while the increase for 1900 over 1890 was 69.8 per cent. It is not possible to state how great a part of this increase for 1900 is due to a more complete collection of the returns for this rural industry. There is an apparent falling off in the number of wage-earners, but if, since these operations are usually conducted by the owner of the establishment, there were added one man for each establishment to the number of wage-earners, there would be a total of 264, which is probably not far from the truth. Another method of reckoning the number of wage-earners would be to take into account those engaged in the cultivation of the herbs, like mint, which are grown for the production of essential oils, and it is probable that at the census of 1870, where the number of hands employed is reported as 2,365, a method such as this has been followed. It is necessary to recall that the essential-oil distilleries would, as a rule, be in operation but a part of each year.

The *essential oils* are those volatile oils which exist ready formed in animal and vegetable organisms, and they are called essential because they possess, in a concentrated form, certain of the characteristic properties of the plants from which they are derived. They are also known as the *volatile oils*, because they are easily evaporated, and as *distilled oils*, from the method by which a number of them are usually extracted from the plant. They exist in all odoriferous vegetation, sometimes pervading the plant, and in other cases being confined to a single part of the plant. In some instances the oil is contained in distinct cells, where it is preserved after desiccation of the part, while in others, as in flowers, it is secreted on or near the surface, and exhaled so soon as formed. Occasionally two or more different oils are formed in different parts of the same plant, as in the orange tree, which contains one kind of oil in its leaves, another in its flowers, and a third in the rind of its fruit. Some essential oils are formed during distillation from substances of a different nature preëxisting in the plant, as in the case of oil of bitter almonds, which is produced by the action of water on the amygdalin which exists in the bitter almond. These oils are compound substances, or mixtures of compound substances, consisting of carbon and hydrogen alone, or of these elements combined with oxygen, sulphur, or nitrogen. These compounds are found among the derivatives of both the acyclic and cyclic series, and in addition to the various hydrocarbons there have been found among them alcohols, aldehydes, acids, esters, ketones, phenols, phenol-ethers, lactones, quinones, oxides, sulphides, nitrils, and isothiocyanates. In the mixed oils the oxygenated bodies are often of greater importance than the hydrocarbons because they are usually the possessors of the characteristic odor of the oil in which they are contained. Latterly these oils have been concentrated for sale by the removal of the nonfragrant hydrocarbons, this concentrate representing from 2 to 30 volumes of the original oil. Thus, 1 volume of the concentrated oil represents 2 volumes of the oils of anise, cassia, fennel, gingergrass, *mentha crispa*, *mentha piperita*, cloves, sassafras, and star anise; 2½ volumes of the oils of bergamot, caraway, and lavender; 4 volumes of cumin and rosemary; 5 volumes of thyme; 6 volumes of coriander; 8 volumes of calamus; 10 volumes of absinthe (wormwood); 20 volumes of juniper; 30 volumes of angelica, lemon, and orange. It is asserted that these concentrated oils are more permanent, more soluble in alcohol and water, have a finer odor, and a more nearly constant composition than the original oils. They are undoubtedly superior to the ordinary essential oils both in odor and strength, and they are now offered in the market under the name of "terpeneless volatile oils."

The natural essential oils as ordinarily obtained are of a thin, oily consistency at ordinary temperatures. They partly rise in vapor at ordinary temperatures, diffusing their peculiar odors, and are wholly volatile at higher temperatures; they have a characteristic and generally pungent odor; they are sparingly soluble in water, but readily soluble in alcohol and ether, and most of them are optically active. In the later works, solid camphor-like bodies and vanillin are included with the essential oils.

The essential oils are recovered by several different processes, depending upon the nature of the plant in which the oil exists and the nature of the oil. Thus, oils such as those of peppermint, sassafras, wintergreen, and the like, are obtained by distillation; oils, such as those from the orange and lemon peel may be recovered by expression; and oils, such as those existing in blossoms and constituting their perfumes, may be obtained by the process of enfleurage.

The process of distillation is well described in a circular issued by Albert M. Todd, of Kalamazoo, Mich., entitled "The Essential Oil Industry of Michigan," of which the following is an abstract:

The essential-oil industry of Michigan was inaugurated in St. Joseph county in 1835, being confined for many years to the production of oil of peppermint by the crude and primitive apparatus brought from the East, consisting of a copper kettle containing water in which the plants were placed, to which heat was directly applied, this being connected with a rude form of worm for condensation of the distillate.

As the area under cultivation increased, the need for better appliances was felt, and Michigan's genius gave to the world the greatest invention of the century in the distillation of essential-oil plants—the *steam distillery*—by which the rate of distillation was increased from about 15 pounds to over 100 pounds of essential oil per day. The increased rapidity of distillation now secured was unfortunately not followed by a corresponding advance in quality, for no true system of tests was known by which the quality of the oil could be established, and weedy, resinous, or adulterated oil continued to be the rule. Beginning in 1868, Mr. Todd labored to advance the standard, the result being that a system of tests was established, and a process of steam rectification, with elaborate appliances, was perfected for bringing the crude oil to a uniform state of purity and excellence.

The manufacturing system is as follows: The plants having been carefully cultivated are cut when in full bloom, usually during the months of August and September, and after being partially dried are placed in large wooden vats having a capacity of from 2,000 to 3,000 pounds dried plants each, which, after being filled, are closed with steam-tight covers. A pipe from the steam-generating boiler is connected with the distilling vats, entering them at the bottom under the plants. As the steam enters it is diffused evenly and forced upward through the plants. The heat of the steam expands the globules of oil, which are contained in the minute cells of the leaves, causing them to burst, and the oil being thus freed is carried off in the current of steam. This steam, now charged with the essential oil, having passed through the mass of plants to the top of the vat, escapes through a "changing valve" to the primary condenser, which consists of a series of tin-coated pipes about 6 inches in diameter and 12 feet long, over which a large supply of cold water is made to flow evenly through a perforated trough from above.

The steam of the distillate, consisting of oil and water, is condensed in a primary condenser, but, for the purpose of reducing to a uniform temperature, it is conveyed to a large block-tin worm, supplied constantly with cold water. The distillate, after traversing this worm, falls into the receiver, a vessel about 3 feet in height and 10 inches in diameter, having an exterior pipe leading from the bottom to a height nearly equal to that of the receiver. As the distillate flows into the receiver, the water, being heavier than the oil of peppermint, sinks to the bottom of the vessel, and is forced from thence upward and out through the pipe mentioned. The essential oil collects upon the top of the receiver and is dipped off. The same separation occurs with spearmint, wormwood, tansy, and the other oils lighter than water. With wintergreen and sassafras, which are heavier, the system is reversed; the water rising to the top and being returned from thence to the boiler, while the oil sinks to the bottom. As the water of the distillate does not throw off the entire amount of essential oil contained, it is returned to the boiler and reconverted into steam and continuously used. Many of the distillers, however, allow this water to run to waste, and the amount wasted in America (which in England was formerly bottled and sold) amounted, until recently, to not far from 5,000,000 pounds. The vats in the largest distilleries in the United States require about 3,000 pounds of the dried plants for a charge. If the plants are properly dried, and an adequate supply of steam is at command, the oil may be distilled from the charge in forty-five minutes. As thus distilled from the plants the product obtained is the *natural oil*, which, even though pure plants are used, always contains an insoluble resin, and it is in this form that oil is usually sold.

For the purpose of rendering the oil of absolute purity and the highest possible concentration, aroma, solubility, and therapeutic value, and freeing it from any foreign substances contained therein, it is placed in special refining stills, by means of which fresh steam is diffused through the oil in numerous jets, evaporating the most valuable and aromatic portions. This steam is generated at a distance from the refiners, so that no direct heat is used, and by this process the scorching of the oil or formation of any empyreumatic product is rendered absolutely impossible. The supply of steam admitted and the consequent rate of distillation is carefully regulated. The first fraction is distilled very slowly, so that any foreign hydrocarbons present are eliminated. Afterwards the pure aromatic essential oil is volatilized, the speed of distillation being increased. After the aromatic oil has been recovered, there remains an oleo-resin (the bitter and insoluble principle), which is cast away. This in old and oxidized oil, sometimes is found to the extent of over 25 per cent. The refined essential oil thus obtained has the pure and sweet odor of its true plant in a high degree, is of the greatest strength, unusual solubility, brilliant and limpid, and is absolutely pure.

The method of enfleurage consists in the absorption of the perfume exhaled from fresh blossoms by a neutral fat or oil. For this purpose pans are filled with fresh lard or beef fat and thickly covered with fresh petals, this covering being renewed until the fat is saturated with the perfume. The fat is then pressed through a sieve, and the thick substance which is expressed and which contains the odoriferous principle is styled pomade; or plates of glass are smeared with fresh lard, or cotton wool is coated with fresh olive oil, and the perfume is allowed to pass over these surfaces, and when the fat or oil is saturated the perfume is extracted from them by solution in alcohol.

The oil of peppermint, which is commercially among the more important of the natural oils produced in the United States, is obtained from several varieties of mint, all classified under the species *Mentha piperita*, which are cultivated in Europe and North America. The plant from which Japanese oil of peppermint is obtained belongs to another species. It is not known that any of the mints referred to in the *Liber de arte distillandi*[1] were peppermint. The oldest known specimens of this plant were those collected by John Ray in Hertfordshire, England, in 1696, and to which, in his *Historia Plantanum*, published in 1704, he gave the name of peppermint. These specimens are still preserved in the herbarium of the British Museum, and they correspond in all essential characteristics with the peppermint which is to-day cultivated in England. The commercial history of this industry dates from about the year 1750, when the cultivation of peppermint was begun in a very small way at Mitcham, Surrey county, England, and by the year 1800 the area under cultivation had reached 100 acres. The industry in England reached its maximum about 1850, when 500 acres were under cultivation, but from that time it diminished, owing to American competition.

According to a private communication from Leander S. Drew, of Lodi, Wis., the records of his establishment show that oil of peppermint was produced in Connecticut before 1812, and that his grandfather, Daniel Drew, made oil of peppermint in Corinth, Orange county, Vt., before 1814, and redistilled oil bought near Cleveland, Ohio, in 1819. Further, he states that Leander Drew, M. D., his father, began the distillation of oils of wormwood, peppermint, spearmint, erigeron, and dittany, in Wisconsin, in 1843. The distillation of pepperment oil began in Wayne county, N. Y., in 1816, and later this became the most important center of its production in the United States. As stated, the cultivation of peppermint was begun in St. Joseph county, Mich., in 1835 and this state has since rivaled New York in this industry.

Formerly it was supposed that a larger yield of oil was obtained from the use of fresh plants in the still, but Todd has shown experimentally, and experience

---

[1] Brunschwig, 1500.

has verified the showing, that the yield is equally large from the dried as from the fresh material, while a larger quantity of the dried material may be placed in a given still for a single charge, and oil may be displaced from it with threefold the rapidity that it can be from the fresh mint. In addition, as it is the practice of the local distillers to treat not only their own crop but that of their neighbors (one distillery, on an average, serving for about ten planters), the cost of transportation is reduced by previously drying the mint, since the shrinkage in weight is over 49 per cent. Gildemeister and Hoffman,[1] however, suggest that the known difference in solubility of the English and American oils may be due to the fact that the former is distilled from the fresh herb and the latter from the dried herb. The charge for treatment by the distillers is about 25 cents for each pound of oil produced.

Peppermint plants are propagated from roots or runners, the "sets" being planted out in the spring. There are therefore "old or second-crop" plants of previous plantings, which mature usually in August, and the "new crop," which matures in September. The proper time for cutting the mint is when the plants are full blown. The average yield of essential oil varies greatly, depending largely on the extent to which the plants are covered with leaves and blossoms, as it is these which contain the oil. The average yield of oil from green plants is about one-third of 1 per cent, or 6⅔ pounds of oil for each 2,000 pounds of plants. Todd[2] has obtained 18 pounds of oil from 2,000 pounds of well-leaved plants, and but 1½ pounds from a like quantity of coarse plants devoid of leaves. The average yield of oil per acre for the first and second year's crop is 11 pounds.

According to Todd,[3] the average annual production of peppermint oil for the ten years prior to 1886 was about 100,000 pounds. According to Gildemeister and Hoffman,[4] the largest yearly production of peppermint oil in the United States was in 1897 and was distributed as follows:

	Pounds.
Michigan:	
Eastern	13,000
Western	79,000
Northern	25,000
Southern	55,000
Total	172,000
Indiana	32,000
New York	37,000
Other localities	10,000
Total United States	251,000

The consequence of this enormous production was an entirely unexpected drop in price, which has since restricted production.

A by-product of the mint distillation industry is found in the mint hay. After the distillation is completed this is lifted from the steam vat in the form of a large cylindrical cake, and when dried it is eaten with great relish by horses and cattle, or it is composted and returned to the fields as a fertilizer.

Peppermint oil is used as a flavor in food, drink, and confectionery, and in medicine. It is also used as a source of menthol, or peppermint camphor. This menthol separation differs according to the oil used. The Japanese oil is so rich in menthol that it forms a crystalline mass, saturated with the oil, at ordinary temperatures. The American oil solidifies completely in a freezing mixture. The English and Saxon oils very often show crystalline separations only after standing for a long while in the freezing mixture.

Spearmint Oil.[5]—The American spearmint oil is distilled in New York and Michigan from the fresh herb of *Mentha viridis, L.* The herb is cultivated to a not inconsiderable extent, as much as 12,000 pounds being obtained in the two states mentioned. The oil is colorless, yellowish or greenish yellow, is liquid, and possesses the characteristic penetrating and disagreeable odor of spearmint. With age and on exposure to the air the oil becomes viscid and darker. It has a specific gravity of 0.92 to 0.94 and is soluble in equal parts of 90 per cent alcohol, but the solution is rendered turbid by the addition of more solvent. An oil distilled by Fritsche Brothers had somewhat different properties. The spearmint had been cultivated on the factory grounds at Garfield, N. J., and was just in blossom when distilled. The yield was just 0.3 per cent. The oil had a specific gravity of 0.98 with an odor quite different from the commercial oil. It is possible that in the distillation of the commercial oil a part of this heavy oil is lost, thus accounting for the lower specific gravity. After the first harvest, toward the close of July, a second was made early in October. The yield from the fresh herb was only 0.18 per cent. The odor of this oil was somewhat less delicate, its specific gravity and rotatory power were lower, 0.961, but it was still heavier than the commercial oils, though never heavier than water.

Oil of Wormwood.[6]—*Artemisia absinthium, L.*, is indigenous to many European countries. It has been introduced into North America and is frequently cultivated for commercial purposes. The distilled oil of wormwood was known to Porta about 1570, who called attention to its blue color. It is named in the price ordinances of Frankfort in 1587, and was first examined by Hoffman in 1722 and recommended by him for medicinal purposes.

Whereas, the French oil formerly controlled the market, it is now largely replaced by the cheaper American oil from New York, Michigan, Nebraska, and Wiscon-

---

[1] Volatile Oils, page 641.
[2] Amer. Phar. Assn., page 121. 1886.
[3] Ibid.
[4] The Volatile Oils, page 636.
[5] The Volatile Oils, page 636.
[6] Ibid., page 684.

sin. The consumption of wormwood oil has decreased considerably, due possibly to the toxic properties of the oil to which attention has been directed. The fresh herb cultivated in Germany yields one-half per cent of oil, which at first is colored dark brown but changes to green after long exposure to the air.

Oil of Erigeron.[1]—*Erigeron canadensis, L.*, is a very common weed, which is known in America as fleabane, horseweed, or butterweed. It is frequently found in peppermint fields. The fresh herb yields upon distillation 0.2 to 0.4 per cent of oil, which finds limited medical application in the United States, and which was made official in the United States Pharmacopœia of 1890.

Oil of Sassafras.[2]—The sassafras tree is widely distributed in North America, from Canada to Florida and Alabama, and westward as far as Kansas and the northern part of Mexico. The older bark and wood are odorless; the green parts of the tree, when crushed, smell faintly aromatic, but not of safrol; the wood of the roots, and especially the root bark, are more rich in oil cells.

Next to turpentine oil the oil of sassafras was the first volatile oil distilled in a primitive fashion in North America. On account of the pleasant aroma the root bark was chewed by the aborigines, who called it *pavame.* It was also mixed with smoking tobacco (Rafinesque) and added as an aromatic to refreshing beverages and was used as a remedy. On account of its marked characteristics the sassafras tree is said to have attracted the attention of the Spaniards at their first landing in Florida under Ponce de Leon in 1512; also under De Soto in 1538. They are said to have regarded it as a kind of cinnamon tree. As late as the first half of the Nineteenth century the bark, leaves, and buds were used in the Middle and Central states as a substitute for Chinese tea. As early as 1582, sassafras wood and bark became known in Germany as a new American drug and were used under the name of *Lignum pavanum* (German, Fenchelholz). The bark and wood were apparently first distilled by Angelus Sala in 1620, who mentions that the oil is heavier than water. Schroeder's *Pharmacopœia medicochymica*, published in Frankfort-on-the-Main in 1641, is the first pharmacopœia that gives directions for the distillation of the oil, whereas the municipal price ordinance of Frankfort-on-the-Main of 1587 already enumerates *Oleum ligni sassafras.* Schoepf, who was a careful observer, and who traveled through the Atlantic states in 1783 and 1784, repeatedly refers to the sassafras tree, but does not mention the oil. Evidently the distillation of the oil did not become an industry until the close of the Eighteenth or the early part of the Nineteenth century.

The original process of distillation seems to have been generally very primitive, but it is now conducted in a somewhat more rational manner. The stills, made of 3-inch planks, are from 4 to 5 feet high, about 12 feet square, and strengthened by iron bands. One of the sides is provided with two close-fitting doors, an upper one for charging the still, and a lower one for removing the exhausted material. The wood is split or sawed into thin pieces. The steam, generated in a boiler, enters the still at the bottom, and the distillate is cooled in a coiled condenser and collected in a large copper flask of 20 gallons capacity. About 2 inches from the bottom this flask is provided with a stopcock, through which the oil is drawn off from time to time. The exhausted wood is dried and used as fuel. Such a still has a capacity for 20,000 pounds of wood, and the distillation of this quantity lasts from about forty-eight to fifty hours. The root bark yields from 6 to 9 per cent of oil, and the wood part of the root less than 1 per cent. According to W. H. Phelps,[3] Big Island, Va., 35 pounds of oil per ton of 2,000 pounds of sassafras is a good average yield. The yield from all the factories in Virginia, by the returns, average 23 pounds per ton.

Up to the middle of the Nineteenth century the oil was distilled principally in Pennsylvania, Maryland, and Virginia, and Baltimore and Richmond were the principal commercial centers. In 1860, just prior to the Civil War, not less than 50,000 pounds of sassafras oil were sold annually in Baltimore alone (Sharp). Since the sixties considerable quantities of the oil have also been distilled in New Jersey, New York, Ohio, Indiana, Tennessee, and the New England states, but the practical extinction of the tree has rendered the industry unprofitable.

Wintergreen Oil.[4]—Wintergreen, *Gaultheria procumbens, L.* (Family Ericaceæ) grows from the New England states to Minnesota and south as far as Georgia and Alabama. On account of the peculiar odor and taste which develop when the plant is chewed, it was early used by the natives. The distillation of the oil was probably begun in the first decades of the Nineteenth century along with that of sassafras bark and birch bark in the states of Pennsylvania, New Jersey, and New York. At first these aromatics were used for chewing, later for the preparation of refreshing beverages and home remedies, and especially for the much-used "blood purifiers." When the preparation of the volatile oils became successful, these were often used instead of the aqueous extract of the drug. This use is of considerable importance in the history of the introduction of wintergreen and sassafras oils, as both of these were used as popular remedies in the United States since the beginning of the Nineteenth century under the title of patent medicines. The preparation and use of these remedies soon became general, and with these came a greater demand for the oils. Wintergreen oil was especially in demand for the prepara-

---

[1] The Volatile Oils, page 668.

[2] Ibid., page 395.

[3] Private communication.

[4] The Volatile Oils, page 585.

tion of one of the oldest known remedies in the United States, namely, Swaim's Panacea, introduced in 1815, which at that time had an enormous sale and in the efficiency of which great confidence was placed.

Wintergreen oil does not appear to have been used at that time for any other purpose. The first mention of it in literature is found in a botanical work by Bigelow, a physician of Boston, published in 1818. In it Gaultheria oil is mentioned as a staple article of the drug stores, and it is also stated that this oil occurs not only in *Gaultheria*, but also in *Spiræa ulmaria*, the root of *Spiræa lobata*, and especially in the bark of *Betula lenta.* The oil first appeared in pharmacopœias in the United States Pharmacopæia of 1820. The medicinal use of the oil did not become general until after 1827, when the New York Medical Society made known its use in the preparation of the popular specific mentioned above.

Although the similarity of the volatile oil from *Gaultheria procumbens*, *L.*, with that from the bark of *Betula lenta*, *L.*, was known before 1818, the identity of their principal constituent was shown scientifically about the same time by William Proctor, jr., of Philadelphia, in 1842 and Cahours in 1844. From that time on, the oil was no longer distilled exclusively from wintergreen, but often from this, together with birch bark, or from the latter only. The oil came more and more into use as an aromatic for pharmaceutic and cosmetic preparations, for beverages and medicinal remedies, and thus became an article of commerce. In recent time, however, it is often adulterated with kerosene and alcohol. Methyl salicylate has been prepared on a large scale and brought into the market as *artificial oil of wintergreen* since 1886 by Schimmel & Co. It is official in the United States Pharmacopœia.

The preparation of oil of wintergreen has always been carried on in a primitive manner, the distillation being conducted by the smaller farmers at the place where the plant grows. This was first done in the New England states and later in the mountain and forest districts of the states of New York, New Jersey, Pennsylvania, Virginia, and Maryland. Usually old copper whisky stills of various sizes, mostly from 200 to 400 gallons capacity, serve as stills. Sometimes the distillation is done in boxes of oak wood about 8 feet long, 4 feet high, and from 4 to 5 feet broad; mostly, however, in larger alcohol barrels, held together by strong iron hoops, the perforated bottom of which is fitted as tightly as possible into a suitable cast-iron kettle, which is filled with water for distillation. On the upper part of the barrel is placed a copper helm, which is connected with a condensing worm in a large wooden tub.

In the distillation, which is carried on for only a few months in the year, the still, barrel, or box is filled with finely chopped, well-wetted plants. The charge is allowed to stand over night and firing begun in the morning. The distillation is usually complete in eight hours. About 90 per cent of the oil passes over during the first two or three hours, the remaining 10 per cent in the course of the next three or four hours. The crude oil is colored dark by the iron of the condenser. The small producers sell the crude oil obtained to wholesale druggists, who purify it by rectification.

Sweet-birch oil (wintergreen oil).[1]—Cherry birch, or sweet or black birch (*Betula lenta*, *L.*, family Betulaceæ) is a tree which grows on good forest soil throughout southern Canada and the northern United States, westward as far as Minnesota and Kansas, and to the south as far as Georgia and Alabama. When chewed, its reddish bronze-colored bark develops a peculiar fragrance and taste, and on this account has been used by the natives for chewing and in the preparation of refreshing and medicinal beverages. Next to turpentine oil, the oils of sassafras, wintergreen, and birch bark were among the first oils obtained by distillation in the United States. The similarity in odor and taste of birch-bark oil, with true oil of wintergreen from *Gaultheria procumbens*, was shown before 1818 (Bigelow). The chemical identity of the principal constituent of both was demonstrated by Proctor in 1843. As the demand for wintergreen oil increased, sweet-birch bark was distilled indiscriminately with wintergreen leaves, or even distilled alone, as a substitute, so that the commercial oil is at present obtained almost exclusively from the bark of sweet birch (*Betula lenta*, *L.*).

For purposes of distillation the young trunks and branches were formerly used. These were cut into pieces from 1 to 4 inches in length, which were macerated for twelve hours previous to distillation. For the latter operation stills like those described under wintergreen oil were used. The bark of the trunk and larger branches is now used, being peeled off in late summer, and either cut or torn by means of toothed rollers, and freshly distilled with water from copper stills. If wintergreen grows abundantly in the neighborhood, it is added to the bark in the still. Preference is given to the one which is the more abundant and more conveniently gathered. According to Kennedy, maceration for twelve hours is considered indispensable to a good yield. A ton of 2,240 pounds of birch bark yields about 5 pounds of oil, which amounts to 0.23 per cent. A like amount of wintergreen yields about 18 pounds of oil. By rational distillation, however, as much as 0.6 per cent of oil can be obtained from the bark.

Proctor recognized, in 1843, that the oil does not preexist in the bark, but results from the interaction of two of the constituents present with water in a similar way to that attending the formation of the oils of bitter almonds, mustard, etc. According to more recent investigations by Schneegans, these substances are Betulase, a ferment, and Gaultherin, a glucoside, which crystallizes with one molecule of water.

---

[1] The Volatile Oils, page 331.

Oil of Red Cedar Wood.[1]—The Virginia or red cedar is a shrub or tree which is distributed throughout the United States. Its wood is used in the manufacture of cigar boxes, lead pencils, and small ornaments. It is adapted to this purpose on account of its uniform structure, its mild sandalwood odor, and because it is not attacked by insects. For the distillation of the oil, the waste from the lead-pencil manufactory is used, yielding from 2.5 to 4.5 per cent. The exhausted chips are then utilized by the furriers in the preparation of skins. A very inferior oil is obtained in this country as a by-product from the drying chambers of the lead-pencil factories. These chambers are so constructed that the escaping vapors from the cedar wood can be condensed. In this case, however, the high-boiling constituents of the wood remain behind and only the more volatile constituents are obtained. The oil thus obtained is more mobile and its odor is both less fine and less permanent than that of the normal, making it unserviceable for use in perfumery.

Hemlock or spruce needle oil.[2]—The needles and young twigs used in the distillation of this oil seem to be contributed by three different species: The hemlock or spruce, which occurs throughout North America from Canada to Alabama and westward as far as the Pacific; the white spruce; and the black spruce. They are equally widely distributed. In the collection of the leaves and twigs it seems highly probable that no distinction is made between these three species, so that a commercial oil may contain variable amounts of the oils from all three. In fact, the oils, being regarded as identical, are brought into the market under the common name of hemlock or spruce oil. Inasmuch as they are alike in properties and composition, quantitatively, the confusion in this case may be regarded as being of little or no consequence.

Witch-hazel[3] (*Hamamelis virginiana, L.*).—Witch-hazel is a shrub indigenous to and growing in almost all sections of the United States. It is the only species of the genus found in eastern North America. The bark has a bitter, astringent, somewhat sweetish and pungent taste, but no odor. Walter B. Cheney examined witch-hazel bark and found in it tannin, resin, and an extractive, but no indication of an alkaloid or other crystalline principle.[4] It contains a trace of volatile oil, however. Dr. John Marshall, of the University of Pennsylvania, found that hamamelis root contains tannic acid and a trace of volatile oil, but no other active substance.[5]

The bark of the witch-hazel is said to have first attracted attention on account of its use by the North American Indians as a sedative application to external inflammations. It was many years ago strongly recommended by Dr. James Fountain and Dr. N. S. Davis for hemorrhage of the lungs and stomach.[6] Of late years professional attention has been very strongly directed to witch-hazel on account of the enormous sale of a proprietary remedy said to have been made by distilling the bark with very dilute alcohol (6 per cent), and used externally for sprains and bruises and internally for many diseases.

The preparation known as witch-hazel extract, or witch-hazel water, is obtained by digesting 100 parts by weight of Hamamelis shoots and twigs with 200 volumes of water and 15 volumes of alcohol for twenty-four hours. The mixture is then distilled by applying direct heat, but better by means of steam, until 100 volumes of the distillate have been obtained. The preparation should be made from the fresh young twigs of the Hamamelis only, and these are preferably to be collected in the late autumn when the plant is in flower. The returns for 1900 show that 13,248 gallons of alcohol, having a value of $31,606, were consumed in this industry during the census year.

Artificial Essential Oils.—One of the greatest achievements of modern chemistry is the production in the laboratory of chemical substances, such as have been previously known only as the results of vital processes going on in vegetable or animal organs, and this achievement is especially marked in the production of those essential oils which are used as flavors or perfumes. The first step in this development was the discovery by analysis of the compound or compounds which constituted the odorous or fragrant principle existing or produced from the natural substance, as in the recognition by Woehler and Liebig of the existence of benzaldehyde in the oil of bitter almonds; the next was the discovery of a method or methods by which this chemical substance could be artificially produced. Sometimes, however, bodies have been discovered which, while unlike the natural principle, possess an odor which resembles that of the naturally occurring body. There is an example of this in the mono-nitrobenzene, which in its odor resembles oil of bitter almonds and which, together with mono-nitrotoluene, is sold for scenting soap under the name of oil-of-mirbane. In addition to the above, there have long been known and used, amyl acetate as essence of Jargonelle pear, amyl valerate as essence of apple, cinnamic aldehyde as oil of cinnamon, cumic aldehyde as oil of cumin, and many others.

One of these synthetic flavors that has especially attracted attention is *vanillin*, which is the active odorous ingredient of the vanilla pod, in which it exists to the extent of about 2 per cent, appearing on the surface of the bean as a fine white crystalline efflorescence. It was found to be methyl protocatechuic aldehyde, and it was first prepared artificially by Tiemann from coniferin, which is a glucoside occurring in the cambium of various coniferous woods. Later, Tiemann, and

---

[1] The Volatile Oils, page 276.

[2] Ibid., page 263.

[3] U. S. Dispensatory, 18th ed.: 1899.

[4] Am. Jour. Phar., page 418. 1886.

[5] Therap. Gaz., vol. 11, page 295.

[6] N. Y. Jour. Med., Vol. X, page 208; Trans. Amer. Med. Assoc., Vol. I, page 350.

simultaneously De Laire, discovered that it could be produced by the oxidation of eugenol, the chief constituent of oil of cloves, and this is now the principal source of artificial vanillin, which is manufactured on a considerable scale both in this country and abroad.

Another artificial principle is *coumarin*, which is the chief ingredient in the favorite perfume known as "new mown hay." This body is in nature the active, odorous principle of the Tonquin (Tonka or Tonco) bean, and it is found chemically to be the d-lactone of coumarinic acid. Perkin[1] pointed out that if salicylic aldehyde be heated with acetic anhydride and sodium acetate, and the melt be treated with water and again heated, coumarin and acetic acid are formed.

The odorous body present in the heliotrope blossom finds its likeness in the methylene ether of protocatechuic aldehyde, which is also known to chemists under the name of heliotropin and also piperonal. It was originally made from piperine extracted from pepper, but it is now commercially prepared by the oxidation of safrol or iso-safrol.

The odor of may blossom. or hawthorn, is fairly well reproduced by anisic aldehyde, which, chemically speaking, is the methyl ether of para-oxybenzaldehyde. It can be prepared from carbolic acid by a series of reactions, but it is more easily obtained by oxidizing aniseseed oil.

The much-desired perfume of the violet finds its synthetic rival in the chemical ionone, which Tiemann and Krüger succeeded in producing in 1893, after years of patient research. This is produced by the condensation of citral with acetone in the presence of alkalis, by which pseudo-ionone is formed, and the subsequent heating of this pseudo-ionone with dilute sulphuric acid and a little glycerine or with alkalies. Citral, which is the aldehyde of geraniol, is found in lemon oil, orange oil, the oil of *Eucalyptus maculata* (var. *citriodora*), and lemon-grass oil, the last two named having a considerable proportion of it.

The production of artificial musk has aroused especial interest, since, while in the cases of the preceding chemicals their character had been ascertained from a careful study of the plants in which they naturally occurred, in the case of musk, which is the preputial secretion of the musk deer, the chemistry of the substance is yet unknown. There have been several artificial musks produced, but practically the only one used is manufactured under the patents of Albert Baur and is known as "musk Baur." The patents cover several nitro-derivatives of tertiary butyl-xylene, each of which has the odor of musk.

The synthetic nerolin is prepared by heating b-naphthol with methyl alcohol and sulphuric acid, while the artificial neroli oil is a mixture of geraniol and linalol with their acetic esters and the methyl ester of anthranilic acid. Artificial lilac is terpineol prepared from oil of turpentine, and this body is used in mixtures for the preparation of other perfumes, such as artificial hyacinth. Cinnamyl alcohol and benzyl alcohol have the odor of hyacinth; methyl benzoate the odor of niobe oil; linalyl acetate the odor of bergamot oil; while secondary styrolyl acetate has a marked odor of jasmine oil.

It has already been noted that methyl salicylate has been prepared on a large scale and brought into the market since 1886 as artificial oil of wintergreen. Yet this enumeration of synthetic chemicals used as flavors, or as perfumes, by no means exhausts the list, and it is easily believable that the number of these substances and the quantity of the product will greatly increase. It should be especially noted that these artificially prepared substances are often purer and better than those which are extracted from plants or animal substances.

Foreign Commerce in Essential Oils.—The extent of this commerce is displayed in the following tables, compiled from "The Foreign Commerce and Navigation of the United States" for the year ending June 30, 1900:

IMPORTS OF OILS, VOLATILE OR ESSENTIAL AND DISTILLED, 1891 TO 1900, INCLUSIVE.

YEAR.	Pounds.	Value.	YEAR.	Pounds.	Value.
1891	3,459,533	$1,523,491	1896	....	$1,554,289
1892	3,451,519	1,676,064	1897	....	1,885,523
1893	4,022,117	1,654,036	1898	....	1,511,078
1894	2,861,875	1,102,108	1899	....	1,691,257
1895	....	1,398,956	1900	....	1,859,184

EXPORTS OF OILS, VOLATILE OR ESSENTIAL AND DISTILLED: 1891 to 1900, INCLUSIVE.

YEAR.	PEPPERMINT OIL.		All other, value only.	YEAR.	PEPPERMINT OIL.		All other, value only.
	Pounds.	Value.			Pounds.	Value.	
1891	45,321	$120,831	$65,104	1896	85,290	$174,810	$102,487
1892	54,987	156,418	68,501	1897	162,492	257,484	146,569
1893	99,629	267,422	79,920	1898	145,375	180,811	201,497
1894	80,225	209,722	64,907	1899	117,462	118,227	162,358
1895	87,633	194,616	190,798	1900	89,558	90,298	166,424

LITERATURE.

Watts's Dictionary of Chemistry, 4, 182–191. 1868.

The Volatile Oils, Gildemeister and Hoffmann, trans: Ed. Kremers, Milwaukee, 1900.

Essential Oils and Resins, Wagner's Chem. Tech., Crookes & Fischer. Pages 935–938; 1892.

United States Dispensatory; Volatile Oils (18th ed.), pages 904–910; 1899.

The Treatment and Distillation of Peppermint Plants, A. M. Todd, Am. Druggist, July, 1888.

The Oil of Peppermint, A. M. Todd, Proc. Am. Phar. Assn., 34, 121. 1886.

Semiannual Report of Schimmel & Co. (Fritzsche Brothers), April, 1895–October, 1901, Miltitz, London and New York.

Scientific and Industrial Bulletin of Roure-Bertrand Fils, of Grasse, Semiannual from March, 1900, Evereux, France.

Piesse's Art of Perfumery, Charles H. Piesse, London, 1891.

A Practical Treatise on the Manufacture of Perfumery, by C. Deite: Philadelphia, 1892.

Odorographia, by J. Ch. Sawer, London: 1892.

The Chemistry of Essential Oils and Artificial Perfumes, by Ernest J. Parry: London, 1899.

---

[1] J. Chem. Soc., vol. 21, pages 53 to 181.

Group XVII.—Compressed and Liquefied Gases.

In the report of the Eleventh Census, Part III, page 279, it is stated that "the use of compressed ammonia gas has reached large proportions in the last decade, and has proved a valuable aid in the preservation of food, the refrigeration of malt liquors, and the manufacture of ice. The introduction of the use of anhydrous ammonia has given great impetus to the manufacture of special machinery adapted to its employment in the departments named. Taken as a whole, its manufacture may be classed as a distinct industry." Although Prof. A. C. Twining,[1] of New Haven, Conn., had in 1850 received a patent for an ice machine using ethyl, ether, or other compressed gas, and had in 1855 a machine of 1 ton capacity in operation in Cleveland, Ohio,[2] and although in 1867, and probably earlier, the ammonia ice machines of Ferdinand Carré were in active operation, this seems to have been the first allusion in the census reports to compressed gases, and no data are there given for them. At the census of 1900 returns were made not only for compressed or liquefied ammonia (known technically as anhydrous ammonia), but also for sulphur dioxide, carbon dioxide, nitrogen monoxide (known technically as nitrous oxide), oxygen, and liquid air, the manufacture being carried on during the census year in 30 different establishments regularly devoted to this business. In addition there were 6 establishments reported in which liquefied gases were produced as a subordinate part of the product, the major part of the product being in some instances other than chemicals. Besides, 1 idle establishment was reported. Taking the returns together, it is found that there were 37 establishments devoted to this manufacture, producing $1,220,297 of products and giving employment to 251 wage-earners and $2,185,535 of capital. These establishments were distributed as follows:

GEOGRAPHICAL DISTRIBUTION OF ESTABLISHMENTS FOR COMPRESSING AND LIQUEFYING GASES: 1900.

STATES.	Number of establishments.	Capital.	Average number of wage-earners.	Product.	Per cent of total.
United States	37	$2,185,535	251	$1,220,297	100.0
New York	9	631,143	68	238,882	19.6
New Jersey	7	232,542	30	144,276	11.8
Pennsylvania	5	457,720	47	239,713	19.6
Ohio	3	52,980	18	53,085	4.3
Illinois	3	285,435	35	180,350	14.8
Missouri, Michigan, Delaware, California, Massachusetts, Vermont, and Wisconsin	10	525,715	53	363,991	29.9

Of these establishments 19, employing 181 wage-earners and $1,650,094 of capital, were engaged in producing liquefied carbon dioxide, and the output for the census year amounted to 12,196,061 pounds, of a value of $708,864. In addition, 1 establishment using carbon dioxide in manufacture reported having produced and consumed 165,000,000 pounds of this gas during the year; but, though it was compressed, it was not liquefied for use. There was employed in the manufacture of the liquefied carbon dioxide reported above, 7,027 tons of magnesite, 2,011 tons of limestone, 774 tons of coke, and 4,771 tons of sulphuric acid, and among other products there were obtained 3,095,000 pounds of Epsom salts, 3,278 tons of calcined magnesite, and 5,000 bushels of lime. About 3,500,000 pounds of the carbon dioxide reported came from fermentation or from effervescent springs.

Ten establishments employing 52 wage-earners and $453,328 in capital were engaged during the census year in producing anhydrous ammonia, and the output for the year amounted to 2,443,729 pounds, having a value of $448,157, and there were consumed in this manufacture 2,148 tons of ammonium sulphate, 4,199,708 pounds of aqua ammonia, and 83,402 bushels of lime.

Carbon Dioxide (carbonic acid gas, CO_2).—Carbon dioxide was liquefied by Faraday in glass tubes as early as 1823, through the pressure resulting from the gas being set free from combination. In 1834 Thilorier operated this method on a much larger scale by the use of wrought-iron cylinders in place of the glass tubes. He discovered that by allowing the liquid to rapidly evaporate the reduction in temperature was so great that a portion of the CO_2 became solid. By moistening this solid CO_2 with ethyl ether he obtained a temperature of −100° C. In 1837 Dr. John Torrey, of New York, liquefied this compound in tubes and applied the liquid to guns as a propellent. In 1844 Natterer invented a pump by which very high pressures were obtained, and through which the liquefaction of carbon dioxide could be better accomplished than by the self-compression method previously used. In all these cases when liquefying carbon dioxide the gas was not only subjected to pressure, but it was also cooled. In 1869 Prof. W. N. Hill, at the United States naval torpedo station, Newport, R. I., proposed the use of liquefied CO_2 in torpedoes. In June-August, 1873,[3] he made more than 500 pounds of the material, and the manufacture was continued at the station at intervals for some years.

In a private communication from John B. Stobaeus, of Charles Cooper & Co., Newark, N. J., it appears that he began the liquefaction of carbon dioxide on a commercial scale in the United States in July, 1884, and put the product on the market. The gas was generated from magnesite imported from Greece, by reaction with sulphuric acid, and the by-product was Epsom salts. The material was sent to the trade in steel tubes weighing about 27 pounds each, and these tubes were fitted with a valve having a conical seat, which was invented by Mr. Stobaeus. The books of this firm show that 1,188

---

[1] Barnard's Report on Paris Exposition of 1867, pages 368 to 386.

[2] Refrigerating and Ice-Making Machinery, page 24.

[3] Liquid Carbonic Acid, page 4.

cylinders, containing 14,256 pounds of CO_2, were produced in 1885, and 10,704 cylinders, containing 128,448 pounds of CO_2, in 1891. The manufacture has since been taken up by others, and in addition to the method used by Mr. Stobaeus the carbon dioxide is now obtained by burning magnesite, by which magnesia is obtained as the by-product; or dolomite, by which a cement is obtained as the by-product; or marble or limestone, by which quicklime is obtained as the by-product; by treating marl with sulphuric acid; and by burning coke. The carbon dioxide issuing from effervescent mineral springs, and that produced in the fermenting tubs during the brewing of beer, is also collected and liquefied. In all of these processes the gas is washed and otherwise purified before compression.

From the data given by Mr. Stobaeus it appears that the cylinders supplied by his firm held 12 pounds of CO_2 each. The American Carbonate Company, of New York, advertise to supply cylinders in two sizes, containing 10 and 20 pounds of CO_2, respectively, representing 600 and 1,200 gallons of gas, the net weight of the cylinders being 27 and 70 pounds. Several of the companies announce that the cylinders are tested for a pressure of 3,700 pounds per square inch.

Compressed carbon dioxide is used in charging soda water, mineral waters, cider, beer, and other effervescent drinks. By attaching a charged cylinder of the gas, governed by a proper regulating valve, to a barrel of beer or other beverage the liquid is not only continuously charged with the gas, but by the gas pressure the liquid is forced to the point where it is desired to serve it. By its use the old art of "Kraeusen," which consisted in adding to stored beer, as it was being casked or bottled, some beer in the first stages of fermentation, has been displaced. Carbon dioxide is used in the manufacture of salicylic acid and of many carbonates. It is proposed for use as a medicinal agent by inhalation and in baths; for raising dough in the manufacture of aerated bread; as a refrigerating medium; as a buoyant material in raising wrecks or preventing disabled ships from sinking; and for extinguishing fires, R. Ogden Doremus having found that but 20 per cent of CO_2 in the air of the locality where fire exists is sufficient to arrest the progress of the flames. It has been used by the Government as a motive power for automobile torpedoes.

Anhydrous ammonia.—This material is the chemical substance ammonia (NH_3) in a pure and dry condition and in a compressed and liquefied state, and it is manufactured by the distillation of the ordinary 26° ammonia of commerce in a suitable apparatus. This apparatus, which should be of sufficient strength to stand a pressure of 65 pounds to the square inch, comprises a still, a condenser, three separators, and a drier or dehydrator. The still is heated by a suitable steam coil to a temperature of about 212° F., when the ammoniacal gas, together with a certain amount of water, passes off into the first separator, which latter is usually situated on the top of, and forms an upward extension of, the still. In this first separator the greater portion of the watery particles carried over are eliminated by a series of perforated plates, through the perforations of which the gas has to pass, and are returned to the still through a dip pipe. From this first separator the partly dried gas passes through a water-cooled worm in the condenser, and then successively through the two other separators to the drier or dehydrator, where it is passed through a set of similarly perforated plates to those in the first separator, but having small-sized lumps of freshly burnt lime placed upon them, by which any moisture that may still remain in the gas is removed, and the completely anhydrous product can then be passed into the ammonia pump or compressor. It is found advisable to work the still at a pressure above 30 pounds to the square inch, so as to admit of the liquid being raised to a slightly higher temperature than the boiling point of water at atmospheric pressure, without causing the water to boil, the result of this being that the whole, or practically the whole, of the ammonia will be set free, while at the same time the least possible amount of the water will be vaporized and passed over with the ammonia gas.

Or it may be obtained from ammonium salts by heating them with lime and treating the gas as above described. The salt usually employed is ammonium sulphate. Aqua ammonia, or ammonia water, is of different strengths, according to the amount of NH_3 dissolved in it, but the standard strength has a specific gravity of 26° Beaumé, and it contains 38.5 per cent by volume, or 26.6 per cent by weight of anhydrous ammonia. Thus 3.76 pounds of 26° ammonia will be required to make 1 pound of anhydrous ammonia. An excellent table of the yields of anhydrous ammonia from 26° ammonia is given by Iltyd I. Redwood.[1] The ammonium sulphate or sulphate of ammonia of commerce is reckoned as containing 25 per cent of anhydrous ammonia.

It is believed that some at least of the owners of ice machines produce the anhydrous ammonia that they employ, either in originally charging their machines, or in making good any loss which may take place, but there are no returns on this point. It appears also that there is some anhydrous ammonia imported, the report on "The Foreign Commerce and Navigation of the United States" from the Treasury Department placing this at 14,210 pounds, having a value of $5,870 for the year 1891, but the data for such importations as may have occurred in other years of the past decade do not appear separately.

Although Fourcroy and Vauquelin and, at about the same time, Guyton de Morveau, announced that they had accomplished the liquefaction of ammonia gas, it is believed that, as they had no suitable means for drying the gas, they failed to obtain the anhydrous ammonia.

---

[1] Theoretical and Practical Ammonia Refrigeration, page 113.

It was first certainly liquefied by Faraday in 1823, and it was not long before it was being produced in considerable quantities. Larkin and Scheffer began the commercial manufacture in St. Louis, Mo., in 1879.

Anhydrous ammonia appears, as stated above, to have first been used for refrigeration by Ferdinand Carré in his absorption machine, but it was not long before it was employed in compression machines of the type invented by Perkins and Twining, based on the refrigerating principle, which was demonstrated by Doctor Cullen in 1755, and although it has had to compete with ethyl ether, carbon dioxide, sulphur dioxide, and air, it is to-day the material which is most largely used in ice machines, and this is the principal use for this substance, though recent researches indicate that other uses will soon be found for it in chemical manufacture and in other arts.

Sulphur Dioxide (sulphurous acid gas, SO_2).—This substance is produced by burning sulphur in air or oxygen, 1 pound of sulphur giving 2 pounds of sulphur dioxide. It was liquefied by Monge and Clouet about the beginning of the Nineteenth century. The liquefied sulphur dioxide is now a regular article of commerce, and is sent into the trade in glass "siphons" and in iron flasks, as being a convenient means of transportation and storage of the substance for use in chemical laboratories and in manufacture. The liquid has found some use in ice machines. The substance is used as a reducing agent, as a bleaching agent, and as a disinfectant. Hardin[1] states that at present (1899) "about 4,000,000 kilograms of this liquid are being prepared annually."

Nitrogen Monoxide (hyponitrous oxide, nitrous oxide, laughing gas, N_2O).—This body is prepared by heating ammonium nitrate to a temperature not exceeding 258° C., when the gas is evolved. It is carefully purified, well washed, and then compressed in steel cylinders. This gas was first liquefied by Faraday in 1823. The Lennox Chemical Company began the liquefaction of the gas for the trade at Cleveland, Ohio, in 1883. The exhilarating properties of the gas were discovered by Sir Humphry Davy, who was the first to inhale it, in 1809, and it then received the name of laughing gas. It is now used as an anaesthetic agent in minor surgical operations, especially in dentistry, its use for this purpose having been suggested by Dr. Horace Wells, and it was first applied to him in the extraction of a tooth at Hartford, Conn., December 11, 1844.

Oxygen.—This gas, as commercially supplied in the compressed condition, is produced by heating potassium chlorate mixed with black oxide of manganese. It is sold in the market for use in medicine by inhalation, when it is usually mixed with nitrous oxide, essential oils, and other bodies which are believed to possess therapeutic qualities. Liquid oxygen is not known to be produced commercially except as referred to under liquid air, but it was the first of the so-called permanent gases to be liquefied, this having been independently effected by Pictet and Cailletet in 1877.

Liquid Air.—Atmospheric air is a mixture of approximately 21 per cent of oxygen and 78 per cent of nitrogen by volume, with ninety-four one-hundredths of 1 per cent of argon, about four one-hundredths of 1 per cent of carbon dioxide, and variable quantities of water vapor, ammonia, and other bodies, according to locality and conditions. After 1823, when Perkins[2] erroneously believed that he had liquefied air, numerous unsuccessful attempts were made to accomplish this result, but in 1877 Raoul Pictet and Louis Cailletet, working independently in Switzerland and in France, achieved the result on a small laboratory scale, and it was later repeated by Wroblewski, Olzewski, and Dewar, who improved the methods so as to notably increase the yields, and in 1893 Dewar froze air into a clear, transparent solid. The liquefaction of air on an industrial scale began about this time with the invention of the machines of Linde, Hampson, and Tripler, and later those of Ostergren and Burger, Dewar, Kuhn, Chase, Code, O'Doherty, Johnson, and others.

The methods may be classified as the cascade method of Pictet, Cailletet, Wroblewski, and Onnes; the self-intensive motor method of Siemens, Kuhn, and Johnson; the countercurrent free-expansion system of Linde, Hampson, Tripler, and Ostergren, and Burger; and the self-intensive work method of the American Liquid Air Company, known as the Ala system. Emmens[3] states that the principal features of the method by which the liquefaction of air can be effected on a commercial scale was clearly described in the specifications of British patent No. 2064, granted to Charles William Siemens in 1857.

Owing to the complex composition of air, several different products are obtained by its liquefaction, notably liquid oxygen and nitrogen and solid carbon dioxide. Pictet has invented a separator by which these bodies may be rapidly separated for use, and there is thus drawn off at −70° F., solid carbon dioxide; at −290° F., commercial oxygen gas of 50 per cent purity; at −296° F., oxygen gas of 99 per cent purity; at −300° F., liquid oxygen and nitrogen gas of 95 per cent purity; at −310° F., nitrogen gas of 99 per cent purity; at −312° F., liquid air; and at −316° F., liquid nitrogen.

While many commercial uses for liquid air have been proposed, it is not known to be so used at present. It may, however, be now looked upon as a source of oxygen which promotes combustion and enables man to obtain high temperatures and high illuminating power, but it is not yet proved that this method of

---

[1] The Rise and Development of the Liquefaction of Gases, page 234.

[2] Annals of Philosophy, vol. 6, page 66.

[3] Liquefied Air, page 2.

heating and lighting can compete economically with electricity. Liquid air does enable man to readily obtain low temperatures, which can be usefully employed in chemical operations, and a continually extending use may be looked for in this direction. Elihu Thomson has pointed out that it may possibly find a useful application in increasing the efficiency of conductors of electricity.

Chlorine.—This gas, which may be produced by the action of muriatic acid on black oxide of manganese or by the electrolysis of common salt, is produced commercially abroad in the liquid state, but no returns are made of it in this country. It is used in chemical manufactures and for bleaching and disinfection. It is sent out to the trade in iron cylinders.

LITERATURE.

Reports of the United States Commissioners to the Paris Universal Exhibition, 1867, Volume III. Machinery and Processes of the Industrial Arts, and Apparatus of the Exact Sciences, by F. A. P. Barnard: Washington, 1870.

Liquid Carbonic Acid, Its Preparation and the Construction of Vessels to Contain It, by Walter N. Hill, United States Torpedo Station. 1875.

Encyclopédie Chimique, by M. Fremy, 2, Section 1: Paris, 1885.

Compressed Carbonic Acid Gas. American Carbonate Company, New York, 1887.

No More Kraeusen; Carbonating of Beer: The Universal Carbonating Company, New York, 1897.

Refrigerating and Ice-Making Machinery, by A. J. Wallis-Tayler: London, 1897.

Theoretical and Practical Ammonia Refrigeration, by Iltyd I. Redwood: London, 1898.

The Rise and Development of the Liquefaction of Gases, by Willet L. Hardin: New York, 1899.

Liquid Air and the Liquefaction of Gases, by T. O'Conor Sloane: New York, 1899.

Liquefied Air; an address delivered by the president of the American Liquid Air Company, by Stephen B. Emmens: New York, 1899.

Liquid Air: the Separation of Its Constituent Gases and Their Commercial Application, by Raoul Pictet and Moritz Burger: Philadelphia, 1900.

The Experimental Study of Gases, by Morris W. Travers: London, 1901.

GROUP XVIII.—FINE CHEMICALS.

Under this classification are grouped the chemically pure chemicals manufactured for sale, the chemical substances which are made for use in laboratories and in pharmacy, and those in which, like the salts of silver and of gold, the price of the unit of measure is relatively very high. It is to be noted that though this term is used in the market the dividing line between "fine chemicals" and "heavy chemicals" is by no means sharply drawn or constant. The statistics for fine chemicals, 1900, are:

FINE CHEMICALS, BY KIND, QUANTITY, AND VALUE: 1900.

KIND.	Number of establishments.	Unit of measure.	Quantity.	Value.
Acetone	3	Pounds	1,638,715	$178,666
Acids, C. P	8	Pounds	2,847,575	148,971
Alkaloids	5	Ounces	3,387,522	1,743,264
Ammonia, C. P	3	Pounds	254,952	18,131
Ether	8	Pounds	263,238	129,876
Esters	7	Pounds	576,571	66,675
Gold salts	7	Ounces	8,591	90,145
Iodides	3	Pounds	20,714	32,831
Pepsin	3	Pounds	19,030	76,120
Phosphorus	3	Pounds	487,690	150,100
Platinum salts	3	Ounces	7,312	54,600
Rare earths	3	Pounds	5,373	28,200
Silver salts	9	Ounces	1,252,604	499,345
Vanillin	4	Ounces	124,874	113,050

In this table only those fine chemicals that were produced in notable quantity and in more than two different establishments are enumerated. How large the list is may be understood when it is stated that the total value of all the products classified under this legend is $4,216,744 while the total value of those enumerated in the table, excluding such as appear also in other classifications, is $3,148,974.

Under the term alkaloids is included caffeine, morphine, pilocarpin, quinine and the other alkaloids from the cinchona barks, and strychnine. To the quantity of ether given in the table should be added 1,400,000 pounds of ether used in the explosive industry, much of which was made from tax-free alcohol and known as "Government ether." Among the esters manufactured for sale were ethyl acetate, ethyl butyrate, amyl acetate, and amyl butyrate. Under the legend "phosphorus" are included upward of 300,000 pounds which were produced by electro-chemical processes. Under "rare earths" there were reported cæsium zirconate, cerium oxide, didymium oxide, lanthanum oxide, radioactive barium, thorium nitrate, and thorium oxide. The gold and platinum salts were chlorides and the silver salts consisted of the nitrate. The vanillin was synthetic.

In addition, as showing the variety of this manufacture, it may be remarked that there were returned reports on acetanilide, bromine, chloral, chloroform, chloride of sulphur, coumarin, ethyl chloride, formaldehyde, and glycosine. Many fine chemicals are undoubtedly lost to this group from having been reported under the head of "pharmaceutical preparations" or drugs, and thus passed to another classification outside of the "chemical industry."

Acetone is produced by the dry distillation of calcium acetate or other acetates, the other product of the reaction being a metallic carbonate. A commercial source of it is therefore found in the treatment of the residue left after manufacturing anilin by the distillation of nitrobenzene with acetic acid and iron. E. R. Squibb,

M. D.,[1] has developed a commercial process for its manufacture from acetic acid. It occurs largely in some varieties of wood spirit.

Formerly all nitrogen-containing bodies occurring in plants and possessing basic characters or the derivatives of these, from which bases could be isolated were designated as alkaloids, but with the better knowledge of their constitution which modern organic chemistry has furnished, these bodies have been distributed among various classes of organic compounds. Thus caffeine is a uric acid derivative; piperine, a pyridine derivative; quinine, a quinoline derivative; and morphine, an isoquinoline derivative. In the commercial treatment of these bodies, however, it has seemed best to use the term alkaloid with its old significance because, that substances of a similar nature have been found in animals, we must more properly speak of these as vegetable alkaloids; all of the bodies returned in this census being from this source. As they occur in plants they are generally combined with acids such as malic, citric, or tannic and the like, and the commercial preparation of the alkaloids consists in their extraction from the bark, fruit, leaf, or root by means of suitable solvents, among which ether, chloroform, amyl alcohol, grain alcohol, petroleum ether, and benzene may be enumerated. By the use of alkalies the bases may be isolated, and by the use of sulphuric, or other acids, salts may be formed by which to facilitate the extraction and purification of the alkaloids.

In 1820 the separate alkaloids in cinchona bark (quinine, cinchonine, etc.) were determined, and, shortly after, Pelletier began their manufacture in France. About the same time John Farr started a quinine factory in Philadelphia, and was followed at a later day by John Currie, who built one in New York. From the correspondence it appears that the establishment of Rosengarten & Sons, of Philadelphia, manufactured sulphate of quinine in 1823, sulphate of morphine and acetate of morphine in 1832, piperine in 1833, strychnine in 1834, veratrine in 1835, and codeine in 1836. Extract of quinine was manufactured by John Farr,[2] of Philadelphia, in 1825.

Ether (ethyl ether, common ether, sulphuric ether) is the di-ethyl oxide and is made by the reaction of grain alcohol with sulphuric acid. The process invented for its manufacture by Williamson is a continuous one, and, theoretically, one portion of sulphuric acid will convert an unlimited quantity of alcohol into ether. As a fact, some of the sulphuric acid is reduced, and not only is there loss of acid and alcohol, but in consequence of this reduction the ether becomes contaminated with sulphur dioxide and must be purified for use. According to Squibb,[3] 360 pounds of concentrated sulphuric acid suffices to etherify 120 barrels of clean spirit. The acid charge must then be changed, as the mixture has become dark and tarry, and liable to froth in the still. The production of sulphur dioxide in the process may be prevented by using benzene-sulphonic acid in place of sulphuric acid in the still. Other ethers are also produced in the continuous process by substituting other alcohols for ethyl alcohol.

Ether was manufactured by Rosengarten & Sons at Philadelphia in 1823, and by Carter & Scattergood, of the same city, in 1834. It is used as an anæsthetic agent and as a solvent in many arts; but its largest use to-day is as a solvent in the manufacture of smokeless powder.

The esters known also as ethereal salts, were formerly styled compound ethers. They are compounds in which there is present both an alcohol radical and an acid radical. They are usually commercially prepared by treating an alcohol with sulphuric acid in the presence of a mineral salt containing the desired acid radical. Thus, ethyl acetate (known as acetic ether) is obtained by distilling dried sodium acetate with ethyl alcohol and sulphuric acid, and ethyl nitrite (which is the active principle of spirit of niter or spirits of nitrous ether) is prepared by distilling sodium nitrate with ethyl alcohol and sulphuric acid. Acetic ether and spirit of niter were manufactured at Philadelphia by Rosengarten & Sons in 1823.

According to Mr. John McKesson[4] it was an American surgeon, Beaumont, who made, between 1825 and 1833, the famous classical observations upon the phenomena of digestion in the living stomach, which revealed the functions of the gastric juice, and it is to Schwann that the discovery of the active principle of this juice in 1836 is due. Schwann named this principle pepsin, though he was unable to separate it. The history of American commerce in pepsin practically begins with the introduction of Scheffer's pepsin in 1872. To Scheffer is due the credit of the invention of the simple, practical, and widely adopted "salt" process for isolating the pepsin from the gastric juice of the stomachs of hogs. "Pepsin prepared by this method appeared in commerce principally as 'saccharated pepsin,' the ferment being incorporated with a large proportion of milk sugar. In 1879 Fairchild introduced the original form of pepsin in scales, 'free from added substance or reagents.' The appearance of this pepsin of phenomenal strength, with the recognition of the fallacy of administering the ferment in the largely diluted form then in vogue, was the signal for great activity in the manufacture and improvement of commercial pepsins. The obvious importance of stomach digestion naturally directed attention chiefly to the stomach ferments, and the medicinal use of the digestive ferments still remains popularly identified with pepsin; yet the other digestive ferments, especially those of the pancreas, possess far wider scope of activity

---

[1] J. Am. Chem. Soc., vol. 17, page 197. 1895.

[2] J. Phil. Coll. Pharm., Vol. I, No. 2. May, 1826.

[3] Ephemeris, vol. 2, page 590.

[4] One hundred years of American Commerce, Vol. II, page 610. 1859.

and are relatively of wider importance. Practical recognition and application of these pancreas ferments must fairly be attributed to Fairchild, who in 1880 introduced the *extractum pancreatis*, containing diastase for the conversion of starch, trypsin for the conversion of albumin, the emulsifying ferment for the digestion of fats, and the milk-curdling ferment.

"Pepsin now appears in a great number of popular as well as official forms, and is prepared generally by pharmaceutical manufacturers everywhere. We have in the United States the only house in the world engaged, in the manufacture of the digestive ferments and predigested foods, as an exclusive specialty. The digestive ferments occupy a brilliant position in modern therapeutics, and the progress of physiological chemistry suggests still further utilization of the animal organic principles as recently shown in the successful and important treatment of disease by the thyroid gland." The pancreatin, trypsin, and other ferments, except pepsin, mentioned above are included in the statistics for pharmaceutical preparations.

The statistics for the bromine production of the United States in 1900 were largely collected on the Salt schedule (No. 9), and were published in a special report of the census. Since this element is isolated from the mother liquors of salt works it is natural that the material should be returned as a minor product of that industry. There are instances, however, where the bromine collected as such, or in the form of bromide, is the chief or sole product of the industry, and these more naturally have been reported on the Chemical schedule (No. 17). Reducing the bromides thus produced to bromine and combining the data received on all the schedules, it appears that during the census year 1900 there were produced in the United States 480,742 pounds of bromine having a value of $111,121, which is the value at the works.

It may be of interest to compare this result with the following statistics from The Mineral Industry for 1899, page 68. The production of bromine in the United States, including the proportionate amount of bromine contained in potassium bromide, decreased during 1899, falling from 486,978 pounds to 433,003 pounds; the price, however, increased from 28 to 29 cents. The production of bromine in the world is still controlled by the association of American producers, and by the Leopoldshall-Stassfurt convention, which has several years longer to run.

PRODUCTION OF BROMINE IN THE UNITED STATES.

YEAR.	Michigan, pounds.	Ohio, pounds.	Pennsylvania, pounds.	West Virginia, pounds.	Total, pounds.	Metric tons.	Total value.
1895	30,280	152,360	104,647	107,567	394,854	179	$102,662
1896	42,000	212,850	152,600	149,835	559,285	249	143,074
1897	[1]147,256	124,972	116,967	97,954	487,149	221	136,402
1898	[1]141,232	106,860	119,998	118,888	486,978	221	136,354
1899	[1]138,272	82,368	111,150	101,213	433,003	196	125,571

[1] Including the bromine equivalent of the product recovered as potassium bromide.

The manufacture of bromine was begun in the United States in 1846 by Dr. David Alter,[1] of Freeport, Pa. In 1866 works were erected at Tarentum, Pa., and in 1868 at Pomeroy, Meigs County, Ohio. By the introduction of improved processes the price of this article has fallen from $6 per pound in 1856 to 28 cents per pound, which is the approximate price to-day.

Among the chemicals used as anæsthetic agents and as a solvent for organic substances, chloroform holds a high position. It was formerly manufactured by the action of bleaching powder on grain alcohol, but the latter is now largely replaced by acetone. Squibbs[2] says that if 58 pounds of acetone be used to 600 pounds of bleaching powder containing 35 per cent of available chlorine, the yield of chloroform will be 150 to 180 per cent of the weight of acetone employed.

The foreign commerce in fine chemicals is exhibited in the following tables, compiled from the publications of the Bureau of Statistics of the United States Treasury Department:

IMPORTS FOR CONSUMPTION FOR THE YEARS ENDING JUNE 30, 1891–1900.

YEAR.	ACONITE BARK, LEAF, AND ROOT.		NUX VOMICA.		ALL SALTS OF MORPHIA OR MORPHINE.		SULPHATE OF MORPHIA OR MORPHINE AND ALL ALKALOIDS OR SALTS OF.		ALL SALTS OF STRYCHNIA OR STRYCHNINE.		ETHERS, SULPHURIC.		FRUITS, ETHERS, OILS, OR ESSENCE.	
	Pounds.	Value.	Pounds.	Value.	Ounces.	Value.	Pounds.	Value.	Ounces.	Value.	Pounds.	Value.	Pounds.	Value.
1891	2,761	$266	1,394,013	$32,930	29,564	$42,269	....	....	230	$175	8	$1	....	....
1892	....	....	1,392,437	34,038	38,758	43,301	....	....	305	153	100	28	611	$1,540
1893	4,351	236	1,720,315	41,567	23,580	25,035	....	....	16,538	7,053	20	2	762	800
1894	1,329	108	1,720,056	39,821	29,076	36,452	....	....	566	259	145	32	1,148	2,285
1895	....	....	595,497	9,620	16,029	18,507	....	....	1,158	502	55	5	756	964
1896	3,034	197	1,275,500	15,668	896	1,083	....	....	8,766	3,405	191	24	1,132	1,731
1897	4,020	620	1,298,637	15,200	14,949	30,301	....	....	1,377	578	466	44	2,375	9.158
1898	....	....	2,026,465	29,529	2,382	2,832	13,409	$32,836	13,049	6,381	476	103	3,276	5,781
1899	1,392	120	1,636,152	28,995	....	....	13,081	35,357	15,394	6,570	187	35	2,290	3,669
1900	3,808	274	3,070,536	65,460	....	....	26,208	75,274	7,753	3,362	817	110	2.573	4,507

---

[1] Tenth Census of the Unites States, report on manufactures, page 1011.

[2] J. Am. Chem. Soc., vol. 18, page 244; 1896.

IMPORTS FOR CONSUMPTION FOR THE YEARS ENDING JUNE 30, 1891-1900—Continued.

YEAR.	ALKALOIDS OR SALTS OF CINCHONA BARK.						ALL OTHER ALKALOIDS OR SALTS OF CINCHONA.		PHOSPHORUS.		BROMINE.		IODINE.	
	Bark or other material from which quinine may be extracted.		Cinchonidia.		Sulphate of quinia.								Crude.	
	Pounds.	Value.	Ounces.	Value.	Ounces.	Value.	Ounces.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1891	2,672,364	$301,085	156,229	$3,856	3,079,000	$805,821	112,013	$23,977	151,166	$53,590			241,186	$382,069
1892	3,423,941	299,998	11,483	1,586	2,686,677	542,440	156,442	29,366	85,622	31,643	53,563	$7,094	164,185	167,893
1893	2,374,041	196,867	364,192	11,714	3,027,819	556,782	48,030	11,695	89,874	44,068	780	234	327,248	599,186
1894	2,502,224	143,194	313,640	7,177	2,141,130	470,816	40,850	10,991	20,757	11,927	20	11	401,501	587,127
1895	2,012,399	117,998	72,425	3,534	1,308,959	327,541	87,027	10,857	28,747	14,131				
1896	2,699,789	165,699	282,321	9,980	2,950,078	754,050	76,507	23,147	50,027	26,646				
1897					2,714,147	489,821	367,373	57,237	60,731	29,870				
1898			303,278	38,802	3,643,298	752,211	424,665	106,961	43,351	21,849			401,214	805,783
1899			233,885	34,932	2,788,663	665,819	985,180	252,141	12,399	7,366			315,476	573,469
1900			101,335	15,924	2,628,060	763,986	515,168	155,817	25,228	9,789			573,128	1,452,434

YEAR.	IODINE—continued.				CHLORAL HYDRATE.		CHLOROFORM.		IODOFORM.		HYDRIODATE, IODIDE, AND IODATE OF POTASH.		CALOMEL AND OTHER MERCURIAL MEDICINAL PREPARATIONS.	
	Crude and resublimed.		Resublimed.											
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1891			35	$106					1,242	$19,459	1,024	$935	7,801	$5,244
1892			4	14			35	$15	244	890	186	505	12,630	8,114
1893			6	25			11	14	175	649	187	475	13,495	7,941
1894			7	31			43	18	103	382	181	464	8,435	4,715
1895	31,374	$48,850			20,097	$10,976	239	164	158	583	235	561	8,290	4,209
1896	291,895	566,908			30,275	17,367	137	46	243	926	5,489	9,289	13,900	7,154
1897	391,551	872,526			63,360	35,138	91	18	115	437	2,774	5,032	12,349	6,053
1898			22	53	40,263	23,063	542	123	30	96	280	649	12,316	6,386
1899			43	146	12,370	7,562	227	72	52	163	2,168	3,607	21,963	11,848
1900			501	1,410	796	1,534	75	36	202	602	1,288	2,155	16,647	10,163

GROUP XIX.—CHEMICALS GENERAL (INCLUDING ALL CHEMICAL PRODUCTS NOT ESPECIALLY ENUMERATED ELSEWHERE).

This group includes a very large variety of products, and while they are enumerated here more in detail than has been feasible in any previous census report, it is not to be concluded that the presentation is complete.

The total number of establishments belonging to this group, and forming Class A, is 78, while 107 other establishments, forming Class B, made these products as a subordinate part of their industry. The great variety of products belonging to this group permits only a few general divisions, tabulated in table below, the amount of each product made in the works, but consumed there in the manufacture of other products, being entered separately so far as known. Classes A and B are combined for the sake of brevity.

CHEMICALS GENERAL, BY KIND, QUANTITY, AND VALUE: 1900.

PRODUCTS.	Number of establishments.	PRODUCTS.	
		Pounds.	Value.
Ammonia, aqua	A, 16; B, 12	26,758,068	$1,237,745
Ammonia, consumed		1,524,632	20,488
Ammonium, aqua sulphate	A, 2; B, 4	11,094,554	288,667
Ammonium, sulphate consumed		1,681,700	43,724
Ammonium salts, sundry	A, 2; B, 4	1,904,479	128,768
Ammonium salts, consumed		423,683	(1)
Antimony salts	A, 3; B, 3	211,956	22,778
Chrome products	A, 5; B, 5	15,407,882	1,130,257
Copperas	A, 1; B, 9	27,746,570	133,392
Copperas, consumed		1,987,000	7,948
Cream tartar	A, 8	11,286,680	2,130,104
Dyers' chemicals	A, 2; B, 8	6,653,247	105,896

(1) Not given.

CHEMICALS GENERAL, BY KIND, QUANTITY, AND VALUE: 1900—Continued.

PRODUCTS.	Number of establishments.	PRODUCTS.	
		Pounds.	Value.
Epsom salts	A, 2; B, 5	9,239,809	$75,066
Glauber's salts	A, 3; B, 15	31,314,255	160,065
Glycerin	A, 5; B, 5	15,383,798	2,012,886
Glycerin, consumed		4,000,000	480,000
Lead acetate	A, 3; B, 3	1,296,991	73,190
Saltpeter	A, 6	13,088,680	482,580
Silicate, sodium	A, 5; B, 3	65,302,901	416,005
Sulphur, refined	A, 4	25,998,638	393,548
Tin salts	A, 4; B, 9	6,247,205	603,937
Vitriol, blue	A, 2; B, 2	8,460,243	544,817
Zinc salts	A, 4; B, 10	9,511,909	353,902

The incompleteness of even this partial return is evident when it is noted that the ammonium sulphate produced by the gas and coke industries, the glycerin from soap and other works, and the metallic salts, such as blue vitriol, etc., produced in metallurgical works, are not included here. The difficulty of obtaining a fairly complete enumeration of chemical products is shown by the fact that the returns collected on Special Schedule No. 17 give a total value for "chemicals, not otherwise specified," of $2,142,419. In many cases it would not have been possible for the respective establishments to give these products in more detail, because this item is made up in part of small quantities of special chemicals made to fill certain orders, nor would the information have sufficient practical value to warrant the expenditure of the labor required to make more complete returns. In some instances, however, more definite information would have been desirable and could have been secured had circumstances permitted.

While 17 establishments reported a production of 26,506,818 pounds of niter cake, valued at $37,360, 15 establishments produced 81,191,424 pounds of salt cake, valued at $345,277, and 10 establishments produced 62,701 tons of pyrites cinder, valued at $105,631, it is at once evident that these figures are only a small portion of the actual product. Where an acid chamber is operated in connection with a fertilizer works, the niter cake is usually consumed in the manufacture of fertilizers. While there is usually no sale for the pyrites cinder, a few works report using pyrites, the cinder of which is returned to other works for special treatment, but, in most cases, the cinder is simply "dumped," in the hope that at some time in the future a market may be found for it.

The following table gives the quantities and values of the various chemical products enumerated in this group, the amounts designated by "C" being the figures collected from other branches of industry. As these are elsewhere reported, they must be so entered to prevent apparent duplication:

KIND.	Unit.	Quantity.	Value.
Acetate:			
Lead	Pound....	1,296,991	$73,190
Sodium	Pound....	708,360	21,193
Aluminum chloride	Pound....	903,118	12,724
Ammonia, aqua	Pound....	28,282,700	1,258,233
Ammonium carbonate	Pound....	1,351,389	97,808
Ammonium chloride	Pound....	516,410	26,742
Ammonium nitrate	Pound....	36,680	4,218
Ammonium sulphate:			
Class A and B	Pound....	11,094,554	288,668
Class C	Pound....	12,200,931	334,869
Antimony salts.	Pound....	211,956	22,778
Barium carbonate	Pound....	2,400,000	24,800
Barium chloride	Pound....	1,100,000	16,600
Barium sulphate (satin white)	Pound....	2,144,000	47,962
Bone ash	Pound....	2,596,500	55,130
Calcium chloride	Pound....	7,079,040	28,357
Carbon disulphide	Pound....	773,800	31,392
Chemicals not specified	Pound....	....	2,142,419
Chrome products	Pound....	15,407,882	1,130,257
Copper salts (see also vitriol blue)	Pound....	100,000	18,180
Copperas	Pound....	29,733,570	143,327
Cream of tartar	Pound....	11,286,680	2,137,104
Dyers' chemicals	Pound....	6,653,247	105,895
Epsom salts	Pound....	9,239,809	75,066
Fluorides (of alkalies)	Pound....	480,000	40,000
Fluoride, calcium residue	Pound....	9,906,900	7,000
Glauber's salts	Pound....	31,314,255	160,065
Glycerin:			
Class A and B	Pound....	15,383,798	2,012,886
Class C	Pound....	11,128,676	1,202,715
Iron salts (see also copperas)	Pound....	2,246,358	83,287
Magnesium salts (see also Epsom salts)	Pound....	26,312,000	134,700
Manganese salts	Pound....	30,000	1,000
Metals (sundry, by-products)	Pound....	....	503,548
Metallic oxides (sundry)	Pound....	48,000	15,000
Nitrite, sodium	Pound....	769,170	67,194
Niter cake	Pound....	26,506,818	37,360
Paris green	Pound....	674,650	80,958
Phosphate:			
Acid calcium	Pound....	2,510,694	95,307
Sodium	Pound....	4,231,160	121,796
Sundry	Pound....	1,221,150	70,343
Salt:			
Common (by-product)	Pound....	53,978,689	80,832
Scouring	Pound....	531,250	19,922
Salt cake	Pound....	81,191,424	345,277
Saltpeter	Pound....	13,088,680	482,580
Silicate, sodium	Pound....	65,302,901	416,005
Sulphur, refined	Pound....	25,998,638	393,548
Sulphur chloride	Pound....	10,000	3,500
Sulphate:			
Sodium	Pound....	6,467,744	29,659
Sodium bi-	Pound....	6,156,742	27,103
Sulphide sodium	Pound....	2,967,717	32,634
Sulphites:			
Sundry	Pound....	149,500	19,300
Sundry bi-	Pound....	2,922,850	34,486
Sulphite, sodium hypo-	Pound....	10,469,744	144,868
Sulphate, calcium, residues	Pound....	....	25,402
Tin salts	Pound....	6,247,205	603,937
Vitriol, blue:			
Class A and B	Pound....	8,460,243	544,817
Class C	Pound....	26,274,358	1,174,081
Zinc salts	Pound....	9,511,909	353,902
Sundries	Pound....	....	159,036

In considering the various items of this table, the quantities given for the lead and sodium acetates, as also for aluminum chloride, probably, fairly represent the total production of these articles, since they are made only in works which belong to "chemical industries," and which have given fairly detailed reports. Still, and this is true for all other cases, where these substances are made in small quantities, they may be, and usually are, included in "chemicals not specified," which aggregates so large a value.

The quantities of aqua ammonia and of the various ammonium salts enumerated are probably less than the true amounts, since these are made in many industries, some of which do not belong to the chemical category. It is, however, reasonable to suppose that these figures do cover the greater part of such product because, although it has not been possible to get direct figures for the quantity of ammonia liquors, produced by the gas works, still most of these sell their liquors to outside chemical works which have furnished figures of their own production. Similarly, while some of the makers of boneblack, and other industries producing ammonia liquors, were classified in other categories, most of their ammonia product was refined elsewhere, and appears in this tabulation.

The ammonium products reported, other than sulphate, and their contents in NH_3 (anhydrous ammonia) are as follows:

	Pounds.	Pounds.
Ammonia, anhydrous liquid	2,443,729=NH_3	2,443,729
Ammonia, aqua, 20 per cent	28,282,700=NH_3	5,656,540
All other ammonia salts	1,894,474=NH_3	531,387
	32,620,903	8,631,686

In addition to these figures, a certain amount of ammonium nitrate, picrate, etc., has been made and consumed in the explosive industry, and, moreover, it is likely that not all of these products have been so reported as to be identified and separated. It is, therefore, fair to assume that the total quantity of ammonium products, other than sulphate, made in the United States during the census year, and entering into consumption, is equivalent to 10,000,000 pounds of anhydrous ammonia.

The total reported quantity of ammonium sulphate is as follows:

	Pounds.	Pounds.
From chemical industry	11,094,554=NH_3	2,773,639
From chemical industry, consumed	1,681,700=NH_3	420,425
From coke industry	11,984,931=NH_3	2,996,283
From other categories	216,000=NH_3	54,000
	24,977,185=NH_3	6,224,347
Used by fertilizer industry	8,239,445=NH_3	2,059,061
Available for other purposes	16,737,740=NH_3	4,165,286
Deficit	NH_3	5,834,714
Total required	NH_3	10,000,000

To supply this deficit, the coke industry reports in addition, a production of ammonium liquor of 1,572,325 gallons which, at 8 pounds to the gallon and an average of 18 per cent NH_3, equals 2,517,720 pounds, leaving 3,316,994 pounds to be supplied either as ammonia liquor, or sulphate, by the gas industry and by such other industries as are not already included. Since the quantity contributed by this last class is comparatively very small, the 3,316,994 pounds may be taken as being furnished by the gas industry. The total amount of ammonia produced by it is undoubtedly much greater, but it must be remembered that, in many of the smaller works, the local conditions are such that the ammonia liquor can not be profitably utilized, and hence is run to waste. Despite the demand for ammonium sulphate for fertilizer purposes, it is not a simple matter to make a sulphate suitable for this use, since the crude salt contains sulphocyanate and other impurities which must be removed, as they are highly deleterious to vegetation. Such purification requires special skill and can not be profitably undertaken unless the supply of crude material is sufficiently large to warrant the erection of the proper plant.

Considerable quantities of ammonia liquor and sulphate are made in Europe as by-products from the gases of blast furnaces, and this production will undoubtedly increase with the extending use of gas-driven engines. This use requires that the furnace gases must be carefully cooled and systematically washed, so that the gas shall enter the engine with the minimum of impurities, as these rapidly destroy the working parts of the combustion chambers. Where the gas is used only for heating the stoves and for burning under boilers, such purification is not necessary, and so far, no serious attempt has been made here to produce ammonium salts in blast-furnace work.

In considering the other items of this list, the quantities of antimony salts and barium salts probably cover the entire product. The quantity of bone ash reported is undoubtedly less than the actual product, as is also the case with calcium chloride, since none is reported in the special census report on salt, although formerly a large quantity was produced as a by-product in the Ohio River salt region. The salt of this region contains calcium chloride in place of the calcium sulphate of the New York, Michigan, and other regions, and owing to its presence the salt when made is "soft salt," slightly deliquescent and quickly dissolved. The northern salt, which contains no calcium chloride, is "hard salt" and dissolves much more slowly. Owing to its ready solubility the "soft salt" was formerly preferred in the South for curing meats, as it "struck in" faster, hence there was a better chance of saving the meat in the comparatively warm climate, where ice was unattainable.

Calcium chloride is largely used in solution as the circulating medium in the manufacture of ice and in refrigeration; also, to a subordinate extent, as an air drier and in the manufacture of textile goods; also to some extent as the solution used in charging fire extinguishers. It recommends itself for this last-mentioned use because of the low freezing points of strong solutions of the salt. It is stated that a solution of calcium chloride of 1.25 specific gravity, and containing 27 per cent of the salt, freezes at 32.6° F., and that one at 1.175 specific gravity, freezes at zero. It is, therefore, an easy matter to prepare solutions which will not freeze at the lowest winter temperature of the locality where used, and hence be always ready for service in case of fire.

Chrome products, mainly bichromates of potash or soda, form a considerable item in this list. Ten establishments reported making such products during the census year. The industry has an especial interest, because the methods of manufacture have been largely developed in this country. The Baltimore Chrome Works, still the largest producer, began operations in 1845, which have been continued with great success up to the present time.

The copperas reported is only a portion of the total product, as the product of the metallurgical works is not included. It is made in large quantities by wire mills galvanizing works from the "spent pickle." Before wire rods can be drawn or iron can be galvanized the surface must be carefully cleaned, part of this work being the pickling or immersion of the steel or iron in a bath of moderately diluted sulphuric acid. This dissolves the rust and also some of the metal, so that in time the bath becomes spent, being then a solution of ferrous sulphate containing still much free acid. To neutralize this acid, and at the same time to utilize an otherwise waste material, the iron clippings and other iron scrap of the shops are added to the pickle which dissolves them. The solution is then evaporated and allowed to crystallize. The crystals are removed and the mother liquor used to make venetian red, by treating it with lime. This causes a precipitation of calcium sulphate mixed with hydrated oxide of iron, various shades of color being obtained by regulating the proportion of lime added and by subsequent treatment.

Cream of tartar, so extensively used in baking powders, is another large item. Eight establishments reported making it, but the bulk of the business is done by two of them.

This manufacture illustrates the refinements of which chemical manufacture on a large scale is capable; for the Tartar Chemical Co., at its works in Brooklyn, N. Y., is producing cream of tartar by the ton in a chemically pure condition.

The Epsom and Glauber's salts reported probably cover the production, but the figures for glycerine represent only a small part of the actual production, as the product of only a few of the soap-making establishments and other sources is here included.

Sodium silicate, or water glass, is produced in large quantities, as it is extensively used in soap making, calico printing, and fresco painting; for rendering cloth and other draperies noninflammable; as a preservative for timber and porous stone; in the manufacture of artificial stone and in making cements for glass and pottery.

Sulphur chloride is used in vulcanizing caoutchouc; sodium sulphide as a depilatory in tanning; and sodium hyposulphate in photography, dyeing, and calico printing, and for other purposes. The quantity of sulphites reported is only a very small part of that actually made, since the sulphite used in making paper pulp is usually made and consumed in the works, and is not separately reported.

The other items receive no special mention. The quantities given are believed to fairly represent the production of the country, and their methods of preparation and uses may be found in the standard works on technical chemistry.

Subgroup A.—In the course of this work schedules were received from 19 establishments, whose principal products were not originally classified in "chemicals," though the products were the result of operations of a chemical nature. As such establishments are more properly included in this category than in any other, and yet can not well be placed in any of the regular groups, it is deemed advisable to form a special subgroup, XIX A, in which all such are included. Their character and the extent of their operations are shown in the following list:

	Number of establishments.	Quantity.	Value.
		Pounds.	
Camphor, refined	3	598,708	$254,190
Casein	3	609,210	30,336
Dextrin and sizes	4	12,204,570	221,995
Milk sugar	4	1,395,290	110,247
Shellac, refined	3	1,123,752	187,333
Sundry products	2		176,928

In addition, a number of establishments classified under other groups report such substances as subproducts of their operations, the aggregate becoming considerable both in quantities and values, and also emphasizing the importance of care in the preparation and correlation of schedules and in the collection of returns.

At the beginning of this report a list has been given of the principal topics included in the field of "chemical technology," and it has been indicated how far these have been separately treated of in the present census. Referring to this list, it will be observed that no provision was made for taking special returns of establishments manufacturing certain important products, such as glue, soap, starch, etc., noted below, the general schedule for manufactures, No. 3, being used for this purpose.

The following list of the products included in this group, while fairly correct for the special industries enumerated above, must therefore, for all of the other items, be taken as representing only a portion of the total product of such articles throughout the country during the census year.

PRODUCTS INCLUDED IN SUBGROUP A.

	Number of establishments.	Unit.	Quantity.	Value.
Boiler compounds	1	Barrels	200	$6,400
Bone black	7	Tons	15,100	586,736
Brandy	3			14,561
Camphor, refined	4	Pounds	625,128	264,830
Caramel	3	Pounds	1,736,000	87,000
Casein	3	Pounds	609,210	30,954
Cement	2	Tons	10,150	82,500
Chemical compounds, sundry	5			$102,228
Cider	1			563
Dextrine, sizes, etc	5	Pounds	19,106,784	470,518
Disinfectants	2			1,865
Extracts, flavoring	1	Gallons	5,000	60,000
Filler, crown	1	Tons	2,963	36,931
Filler for fertilizing	1	Tons	14,677	35,000
Gelatine	1	Pounds	922,261	251,872
Glue	13	Pounds	11,079,408	701,596
Gum compound	1	Pounds	336,012	38,716
Gypsum, precipitated	2	Tons	1,264	1,264
Ink	3			41,000
Licorice extract	1	Pounds	1,178,226	89,610
Milk sugar, refined	4	Pounds	1,375,290	110,290
Oils for textile work	1	Pounds	133,300	7,000
Paste, or flour	4	Pounds		15,042
Pyrites cinder	11	Tons	62,701	105,631
Residues, factory	10			15,637
Shellac, refined	7	Pounds	1,832,290	317,585
Soaps, etc	11			207,716
Starch	1	Pounds	1,372,889	30,890
Wax, sealing	3	Pounds	111,500	12,400
				3,726,292

Miscellaneous.—The examination of schedules for tabulation has furnished a large amount of products which are not chemical, and therefore would not be included in our returns, except that they are side products of establishments belonging to this category. In addition, there are values such as "custom work," increasing the profits of an establishment, and the "bonus" paid by cities to garbage-reduction works, which is necessary to the existence of such works.

The following list shows the variety and value of these articles, quantities being given where possible, and may be useful as supplementing the returns for such products so far as these may be separately reported:

	Number of establishments.	Unit.	Quantity.	Value.
Apples, evaporated	1	Pounds	35,000	$1,100
Asphalt, paving	1	Pounds	47,000	1,364
Baking powder	2	Pounds	755,506	54,058
Bird seed	1	Case	13,718	30,865
Bluing	2	Pounds	200,000	7,500
Brushes	1	Dozens	350	3,000
Building materials	3			68,440
Candles	3	Pounds	1,792,075	181,475
Bones, garbage reduction	5			161,790
Containers	9			213,675
Corks	1			5,000
Cottonseed products	5			189,021
Custom work	12			79,940
Dental plaster	1		3,864,000	77,270
Fish, edible	1	Barrels	2,000	8,000
Flour	1			2,000
Graphite, ground	1	Tons	200	2,400
Grease, tallow, etc	61			1,034,248
Hides	17			158,198
Horns, hoofs, etc	13			22,443
Ice, manufactured	1	Tons	7,200	15,000
Hay, mint	6	Tons	2,100	6,356
Mirrors	1			74,218
Oils:				
Animal	20			655,363
Fish	25	Gallons	1,135,264	222,929
Linseed	1	Gallons	460,344	207,155
Cake	1	Pounds	6,051,400	60,514
Poultry foods	7	Pounds	2,265,352	31,528
Pottery, chemical	1	Pounds		462
Pickled goods	1	Pounds	112,894	5,515
Roofing materials	7			438,779
Sundries:				
Animal	3			62,859
Metallic	3			42,918
Mineral	2			12,400
Vegetable	6			34,123
Wax, modeling	1	Pounds	25,000	3,750
Total				$4,175,656

The foreign commerce, in substances treated of in this group, is set forth in the following tables, compiled from the publications of the Bureau of Statistics of the United States Treasury Department:

IMPORTS FOR CONSUMPTION FOR THE YEARS ENDING JUNE 30, 1891-1900.

YEAR.	AQUA, OR WATER AMMONIA.		AMMONIA, CARBONATE OF, MURIATIC OR SAL-AMMONIAC, AND SULPHATE OF.		POTASH, CHROMATE AND BICHROMATE.		SODA, BICHROMATE AND CHROMATE.		ARGAL OR ARGOL, OR CRUDE TARTAR.		ARGOLS, OR WINE LEES.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1891	276,756	$12,858	24,331,113	$740,567	1,234,085	$95,951	545,458	$31,565	21,579,102	$2,197,507		
1892		3,136	14,275,362	472,276	1,058,521	81,287	703,216	44,091	24,813,171	2,216,525		
1893		718	18,794,599	560,222	969,067	79,174	671,503	44,183	28,770,810	2,341,575		
1894			7,688,848	309,701	1,009,499	83,420	267,397	17,667	22,878,180	1,504,200		
1895			19,836,379	653,146	2,024,776	173,139	600,600	40,321	27,911,122	1,893,730		
1896			30,523,313	804,671	1,444,716	129,339	556,631	38,103	28,481,665	2,724,709		
1897			24,891,603	576,152	1,366,074	112,783	319,641	22,070	23,457,576	1,967,042		
1898			20,595,623	456,273	1,016,029	79,495	295,549	19,027	741,150	65,154	18,461,479	$1,525,873
1899			19,228,311	520,752	1,099,098	75,254	598,262	29,861			23,300,762	1,914,450
1900			22,185,935	684,904	645,183	41,449	474,654	21,982			27,339,489	2,388,693

YEAR.	NITRATE OF POTASH OR SALTPETER, CRUDE.		NITRATE OF SODA.		GLYCERIN.		CAMPHOR, REFINED.		DEXTRIN, BURNT STARCH, GUM SUBSTITUTE, OR BRITISH GUM.		IRON, SULPHATE OF, OR COPPERAS.	
	Pounds.	Value.	Tons.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1891	15,040,757	$459,084	100,428	$2,923,374	13,975,577	$996,686	63	$21	6,319,352	$212,968	896,937	$4,103
1892	14,254,514	435,839	109,863	2,976,816	14,197,549	831,810	56,820	17,361	3,275,326	187,408	495,596	2,597
1893	16,560,599	465,666	91,661	3,062,715	16,540,213	893,636	156,291	51,229	4,650,215	161,430	1,010,039	4,099
1894	9,671,217	251,418	88,079	2,785,048	8,321,853	519,296	137,882	44,233	3,988,361	121,963	927,162	3,619
1895	8,735,290	245,552	124,803	4,124,712	13,488,825	784,613	271,164	83,382			542,316	1,344
1896	14,758,974	389,524	127,557	3,870,724	21,158,829	1,472,302	153,912	68,785			1,123,443	4,161
1897	19,719,876	408,761	83,331	2,640,389	12,717,098	1,182,099	249,994	84,539	4,874,656	124,719	991,000	6,925
1898	12,920,986	270,291	125,081	2,729,750	12,274,987	774,709	170,406	54,602	3,737,575	108,919	250,270	1,087
1899	19,985,505	409,818	122,314	2,054,805	15,665,252	1,024,131	90,743	28,806	3,402,474	99,056	127,041	606
1900	10,332,836	269,739	184,247	4,786,807	27,943,106	2,155,414	109,971	42,901	5,950,487	169,470	2,700	111

YEAR.	LEAD.				MAGNESIA, SULPHATE OF, OR EPSOM SALTS.		MILK, SUGAR OF.		REFINED SULPHUR.		SULPHATE OF COPPER, OR BLUE VITRIOL.	
	Brown, acetate of.		White, acetate of.									
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Tons.	Value.	Pounds.	Value.
1891			13,279	$707	16,370	$206	251,408	$42,330	307	$6,579	3,432	[illegible]
1892	2,902	$123	1,220	101	31,742	360	236,869	34,304			2,189	156
1893			2,185	154	61,337	480	98,785	12,089	5	118	8,941	363
1894			3,217	220	59,294	402	31,846	3,499	48	1,255	2,470	140
1895	3,510	154	59,399	2,822	650	16	14,117	1,828	122	2,392	245,787	5,481
1896	30,154	934	48,060	1,873	100,859	691	16,365	2,162	305	5,338	876,401	28,792
1897	26,020	850	3,122	190	240,573	1,122	17,117	2,824	430	9,111	192,114	6,797
1898	6,008	257	3,594	231	91,137	614	1,844	270	55	1,542	12,302	518
1899	3,437	138	5,145	337	74,186	526	4,064	461	227	5,802	15,981	342
1900	18,192	711	4,093	269	377,274	2,163	2,378	399	186	4,470	2,134	113

YEAR.	HYPOSULPHITE OF SODA.		NITRITE OF SODA.		PHOSPHATE OF SODA.		SILICATE OF SODA, OR OTHER ALKALINE SILICATES.		SULPHATE OF SODA OR GLAUBER'S SALTS.		SULPHATE OF SODA, SALT OR NITER CAKE.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
1891							535,030	$6,429	274,784	$2,167	16,927,804	$85,368
1892							571,153	7,090	187,398	2,088	22,465,878	121,900
1893							608,228	6,991	489,798	4,012	44,180,349	221,846
1894							485,435	5,054	924,874	4,916	11,794,586	43,938
1895							492,207	4,562	49,414	4,497	37,248,332	107,459
1896							580,310	5,277	1,916,486	9,769	25,692,755	71,801
1897	6,965,581	$74,501			505,373	$9,045	600,132	5,468	612,026	3,366	7,748,600	36,590
1898	11,007,111	98,733	155	$37	1,436,171	24,599	417,476	3,971	732,094	7,120	5,228,000	20,652
1899	10,686,997	94,534	5,456	298	3,723,907	59,175	527,531	4,256	519,080	5,828	4,984,940	20,569
1900	8,676,351	78,591	308,386	15,838	2,226,835	43,817	1,306,782	9,536	1,028,240	8,892	6,382,260	29,086

TABLE 1.—FERTILIZERS:

		United States.	Alabama.	California.	Connecticut.	Delaware.
1	Number of establishments	422	17	8	[illegible]	11
	Character of organization:					
2	Individual	136	2	3	6	7
3	Firm and limited partnership	103	9		2	1
4	Incorporated company	183	6	5	1	3
	Capital:					
5	Total	$60,685,753	$1,407,323	$647,506	$382,518	$496,784
6	Land	$3,659,641	$18,118	$79,476	$30,000	$13,500
7	Buildings	$8,930,424	$225,500	$128,210	$48,669	$82,567
8	Machinery, tools, and implements	$7,092,354	$175,518	$59,314	$66,766	$103,639
9	Cash and sundries	$41,003,334	$988,187	$380,506	$237,083	$297,078
10	Proprietors and firm members	361	32	3	8	9
	Salaried officials, clerks, etc.:					
11	Total number	1,712	60	16	30	17
12	Total salaries	$2,124,972	$61,975	$20,148	$28,063	$16,685
	Officers of corporations—					
13	Number	243	10	4	[illegible]	3
14	Salaries	$662,741	$21,700	$7,500	$7,200	$5,000
	General superintendents, managers, clerks, etc.—					
15	Total number	1,469	50	12	26	14
16	Total salaries	$1,462,231	$40,275	$12,648	$20,863	$11,685
	Men—					
17	Number	1,381	48	11	21	13
18	Salaries	$1,420,596	$39,475	$12,168	$19,460	$11,205
	Women—					
19	Number	88	2	1	5	1
20	Salaries	$41,635	$800	$480	$1,403	$480
	Wage-earners, including pieceworkers, and total wages:					
21	Greatest number employed at any one time during the year	20,257	840	94	212	393
22	Least number employed at any one time during the year	7,202	260	58	92	59
23	Average number	11,581	439	70	133	148
24	Wages	$4,185,289	$94,965	$40,138	$53,708	$50,553
	Men, 16 years and over—					
25	Average number	11,435	439	70	113	148
26	Wages	$4,142,853	$94,965	$40,138	$48,319	$50,553
	Women, 16 years and over—					
27	Average number	131			20	
28	Wages	$39,463			$5,389	
	Children, under 16 years—					
29	Average number	15				
30	Wages	$2,973				
	Miscellaneous expenses:					
31	Total	$3,734,285	$92,704	$17,638	$19,754	$18,137
32	Rent of works	$96,605	$900	$1,430	$400	$50
33	Taxes, not including internal revenue	$288,006	$22,924	$1,403	$1,164	$1,043
34	Rent of offices, insurance, interest, and all sundry expenses not hitherto included.	$3,326,181	$68,880	$14,805	$18,190	$17,044
35	Contract work	$23,493				
	Materials used:					
36	Total cost	$28,958,473	$1,387,385	$482,818	$228,242	$399,642
37	Fish, thousands	4,589,632			17,560	200,000
38	Cost	$183,542			$25,189	$40,000
39	Kainit, tons	54,700	13,048		200	1,461
40	Cost	$520,833	$132,172		$7,500	$15,235
41	Limestone, tons	7.158				2,106
42	Cost	$7,322				$752
43	Phosphate rock, tons	806,445	23,940	1,156	17	2,062
44	Cost	$3,554,174	$244,216	$12,462	$143	$7,569
45	Pyrites, tons	288,778	9,520			
46	Cost	$1,466,285	$62,500			
	Acids—					
47	Sulphuric, tons	231,527	500	2,075	231	1,972
48	Cost	$1,355,382	$5,000	$32,000	$1,736	$11,824
49	Nitric, pounds	1,075				
50	Cost	$41				
51	Acid phosphate, tons	286,898	58,385	1,500	3,226	21,262
52	Cost	$2,176,245	$169,820	$25,000	$28,248	$154,292
	Ammonia—					
53	Aqua, pounds	2,620				
54	Cost	$681				
55	Sulphate, pounds	8,239,445		2,302,000		
56	Cost	$186,609		$60,709		
57	Bones, tankage, and offal	$9,766,735	$340,611	$176,955	$88,514	$51,708
58	Common salt, tons	481				
59	Cost	$2,211				
60	Cotton seed and meal	$167,410	$80,218			
61	Lime, bushels	13,130				
62	Cost	$887				
63	Nitrate of potash, tons	884				
64	Cost	$32,156				
65	Nitrate of soda, tons	19,518	252	999	409	58
66	Cost	$709,841	$9,800	$31,868	$14,112	$2,312
67	Potash salts	$3,098,400	$31,270	$98,484	$27,725	$38,861
68	Sulphur, tons	12,728	810	263		60
69	Cost	$268,670	$18,000	$6,102		$1,200
70	Tallow and fats	$28,500				
71	All other components of products	$1,029,163	$12,390	$6,425	$10,664	$4,368
72	Fuel	$797,639	$19,522	$7,707	$6,368	$7,150
73	Rent of power and heat	$17,603	$1,032	$1,112	$50	$262
74	Mill supplies	$175,507	$10,743	$2,077	$860	$2,790
75	All other materials	$2,213,182	$131,265	$21,917	$9,254	$29,613
76	Freight	$1,199.455	$118,826		$7,879	$31,706
	Products:					
77	Aggregate value	$44,657,385	$2,068,162	$670,517	$390,805	$738,703
	Acids—					
78	Sulphuric, 50 Baumé, tons	65,747	2,934			
79	Value	$380,691	$25,000			
80	Sulphuric, 60 Baumé, tons	1,388				
81	Value	$13,678				
82	Sulphuric, 66 Baumé, tons	2,417		634		
83	Value	$44,019		$12,680		
84	Other acids	$11,424				
	Sodas—					
85	Sal soda, tons	18				
86	Value	$277				
87	Other soda products	$1,245				

SUMMARY BY STATES, 1900.

District of Columbia.	Florida.	Georgia.	Illinois.	Indiana.	Kansas.	Kentucky	Louisiana.	
6	7	41	5	14	3	4	6	1
4	2	11	2	7	1			2
2	1	10	1	5				3
	4	20	2	2	2	4	6	4
$95,085	$733,369	$6,663,618	$1,682,505	$215,875	$229,733	$335,974	$1,290,162	5
$22,000	$92,164	$137,762	$200,200	$8,675	$19,000	$20,000	$46,894	6
$11,000	$135,185	$1,044,804	$213,200	$26,350	$66,450	$27,500	$292,356	7
$18,585	$109,748	$661,134	$84,810	$30,500	$44,448	$40,788	$181,420	8
$43,500	$396,272	$4,819,918	$1,184,295	$150,350	$99,835	$247,686	$769,492	9
8	4	39	4	19	1	2		10
7	29	114	52	18	5	16	27	11
$1,733	$26,731	$147,018	$74,960	$11,640	$6,300	$17,650	$51,107	12
	8	15	3	4		4	10	13
	$9,166	$42,375	$9,000	$4,900		$9,600	$30,000	14
7	21	99	49	14	5	12	17	15
$1,733	$17,565	$104,643	$65,960	$6,740	$6,300	$8,050	$21,107	16
7	18	97	47	12	5	10	17	17
$1,733	$16,265	$103,683	$65,000	$6,340	$6,300	$7,450	$21,107	18
	3	2	2	2		2		19
	$1,300	$960	$960	$400		$600		20
52	242	2,125	438	104	242	165	430	21
27	68	624	308	43	98	34	179	22
22	117	1,126	337	45	155	89	278	23
$9,051	$39,961	$294,887	$172,250	$18,640	$70,882	$39,738	$87,256	24
22	114	1,121	287	45	155	89	259	25
$9,051	$39,511	$293,887	$154,250	$18,640	$70,882	$39,738	$83,656	26
			50				19	27
			$18,000				$3,600	28
	3	5						29
	$450	$1,000						30
$2,617	$34,030	$405,936	$84,997	$9,602	$52,380	$16,508	$103,720	31
$1,210	$1,495	$4,261	$40	$1,100	$40	$2,400	$265	32
$100	$2,307	$36,174	$2,833	$1,389	$2,000	$2,938	$1,116	33
$1,307	$30,228	$365,376	$82,124	$7,118	$50,340	$11,170	$102,339	34
		$125						35
$50,273	$330,649	$2,349,635	$1,005,731	$159,089	$411,139	$166,215	$614,431	36
								37
								38
154	723	10,205					1,858	39
$1,552	$8,640	$98,181					$17,416	40
							21	41
							$54	42
	8,040	120,931	10,280			5,625	15,180	43
	$82,177	$417,037	$59,820			$17,804	$64,015	44
	3,177	37,879					2,457	45
	$17,473	$213,466					$13,033	46
	300	24,202	9,280	320	3,000	4,314		47
	$1,800	$133,207	$81,468	$4,100	$34,440	$32,187		48
								49
								50
1,550	5,547	30,305	5,366	1,105	750	1,910	17,419	51
$14,500	$48,447	$276,183	$48,352	$12,180	$7,110	$20,700	$154,627	52
								53
								54
	500,000	30,000	1,000,000					55
	$15,000	$900	$31,000					56
$24,128	$96,926	$534,781	$540,785	$123,705	$296,496	$56,059	$215,218	57
	6	40					140	58
	$48	$100					$560	59
		$78,192					$9,000	60
								61
								62
								63
								64
15	269	1,333	500			89	46	65
$675	$9,619	$50,035	$19,000			$4,600	$1,702	66
$3,530	$54,300	$136,905	$79,875	$1,628	$17,647	$5,400	$15,644	67
		350					2,627	68
		$8,750					$51,527	69
								70
$1,235	$5,828	$28,146	$7,407	$1,440	$3,875	$13,837	$636	71
$950	$6,249	$52,693	$48,190	$2,940	$15,700	$4,380	$17,970	72
$260	$350				$13,500			73
$205	$2,088	$11,461	$2,904	$846	$3,170	$1,350	$3,745	74
$2,250	$23,389	$192,417	$86,936	$8,375	$19,201	$4,561	$49,284	75
$993	$8,305	$117,181		$3,875		$5,337		76
$78,930	$500,239	$3,367,353	$1,855,160	$256,331	$549,943	$321,245	$909,551	77
	90	856						78
	$623	$5,436						79
							149	80
							$5,960	81
							208	82
							$8,736	83
	$210						$11,214	84
								85
								86
							$840	87

TABLE 1.—FERTILIZERS: SUMMARY

		Maine.	Maryland.	Massachusetts.	Mississippi.	Missouri.
1	Number of establishments	3	40	9	3	3
	Character of organization:					
2	Individual	1	11	4		1
3	Firm and limited partnership		12	2		
4	Incorporated company	2	17	3	3	2
	Capital:					
5	Total	$49,350	$7,003,376	$3,250,030	$353,497	$219,201
6	Land	$1,050	$713,011	$150,179	$17,322	$20,767
7	Buildings	$4,900	$965,287	$227,967	$40,000	$46,957
8	Machinery, tools, and implements	$26,400	$1,108,947	$396,601	$57,162	$37,607
9	Cash and sundries	$17,000	$4,216,131	$2,475,283	$239,013	$113,870
10	Proprietors and firm members	1	37	7		1
	Salaried officials, clerks, etc.:					
11	Total number	2	212	171	15	15
12	Total salaries	$3,400	$245,528	$186,685	$18,650	$12,907
	Officers of corporations—					
13	Number		42	2	6	4
14	Salaries		$98,892	$25,000	$6,150	$3,935
	General superintendents, managers, clerks, etc.—					
15	Total number	2	170	169	9	11
16	Total salaries	$3,400	$146,636	$161,685	$12,500	$8,972
	Men—					
17	Number	2	162	153	[illegible]	9
18	Salaries	$3,400	$143,389	$153,553	$12,500	$8,120
	Women—					
19	Number		8	16		2
20	Salaries		$3,247	$8,132		$852
	Wage-earners, including pieceworkers, and total wages:					
21	Greatest number employed at any one time during the year	87	1,983	349	172	81
22	Least number employed at any one time during the year	8	758	161	46	50
23	Average number	34	1,016	227	94	[illegible]
24	Wages	$6,990	$457,692	$115,083	$32,800	$27,986
	Men, 16 years and over—					
25	Average number	34	1,010	226	94	59
26	Wages	$6,990	$455,576	$114,619	$32,800	$27,590
	Women, 16 years and over—					
27	Average number		6	1		
28	Wages		$2,116	$464		
	Children, under 16 years—					
29	Average number					1
30	Wages					$396
	Miscellaneous expenses:					
31	Total	$2,120	$354,344	$199,787	$40,186	$36,449
32	Rent of works		$34,846	$4,126		$300
33	Taxes, not including internal revenue	$220	$35,054	$15,209	$6,067	$783
34	Rent of offices, insurance, interest, and all sundry expenses not hitherto included.	$1,900	$284,444	$180,452	$34,119	$30,714
35	Contract work					$4,652
	Materials used:					
36	Total cost	$22,190	$3,643,846	$1,115,818	$342,389	$137,306
37	Fish, thousands	5,000	12,000			
38	Cost	$1,500	$16,500			
39	Kainit, tons	150	6,895		3,234	40
40	Cost	$1,500	$58,547		$35,800	$400
41	Limestone, tons			38		
42	Cost			$133		
43	Phosphate rock, tons		123,562	18,722	9,000	630
44	Cost		$562,851	$131,734	$22,000	$1,819
45	Pyrites, tons		41,075	9,054	4,000	
46	Cost		$179,259	$43,459	$28,000	
	Acids—					
47	Sulphuric, tons		24,747	1,600	500	432
48	Cost		$146,009	$11,600	$5,000	$2,935
49	Nitric, pounds			1,075		
50	Cost			$41		
51	Acid phosphate, tons	330	29,571	6,553	7,892	175
52	Cost	$4,500	$237,541	$62,368	$67,178	$1,748
	Ammonia—					
53	Aqua, pounds					
54	Cost					
55	Sulphate, pounds		278,521	200,000		
56	Cost		$7,939	$5.500		
57	Bones, tankage, and offal	$5,580	$1,159,285	$402,020	$93,046	$64,690
58	Common salt, tons		140	12		
59	Cost		$700	$72		
60	Cotton seed and meal					
61	Lime, bushels					
62	Cost					
63	Nitrate of potash, tons			1		
64	Cost			$16		
65	Nitrate of soda, tons	38	2,658	3,120	150	
66	Cost	$1,500	$95,602	$112,176	$5,400	
67	Potash salts	$2,480	$436,219	$209,755	$18,560	$1,340
68	Sulphur, tons		6,277			
69	Cost		$141,281			
70	Tallow and fats					
71	All other components of products	$2,310	$81,853	$8,825	$8,280	$47,968
72	Fuel	$250	$56,762	$13,674	$3,375	$7,608
73	Rent of power and heat		$100			
74	Mill supplies	$265	$32,845	$7,322	$5,150	$439
75	All other materials	$1,430	$310,329	$92,993	$34,000	$8,359
76	Freight	$875	$120,224	$14,130	$16,600	
	Products:					
77	Aggregate value	$40,002	$5,481,905	$2,074,590	$492,772	$236,635
	Acids—					
78	Sulphuric, 50 Baumé, tons		19,912			
79	Value		$118,185			
80	Sulphuric, 60 Baumé, tons					
81	Value					
82	Sulphuric, 66 Baumé, tons					
83	Value					
84	Other acids					
	Sodas—					
85	Sal soda, tons					
86	Value					
87	Other soda products		$105			

BY STATES, 1900—Continued.

New Jersey.	New York.	North Carolina.	Ohio.	Pennsylvania.	South Carolina.	Tennessee.	Virginia.	All other states.[1]	
28	32	18	27	51	22	5	39	11	1
11	17	1	9	22	2	.....	9	3	2
8	3	7	9	16	1	2	12	.....	3
9	12	10	9	13	19	3	18	8	4
$5,690,270	$4,600,559	$2,818,921	$1,887,987	$3,802,794	$10,506,043	$950,397	$4,908,381	$515,545	5
$556,585	$452,071	$99,534	$98,762	$490,711	$109,441	$76,947	$164,328	$21,144	6
$608,382	$720,629	$403,281	$273,879	$681,345	$1,642,600	$313,519	$579,504	$120,383	7
$652,477	$1,012,378	$213,508	$336,053	$508,872	$487,117	$68,339	$483,462	$126,811	8
$3,872,826	$2,415,481	$2,102,598	$1,179,293	$2,121,866	$8,265,885	$491,592	$3,681,087	$247,207	9
[illegible]	24	16	26	43	5	4	35	3	10
155	192	51	80	167	85	45	112	[illegible]	11
$230,330	$211,207	$65,838	$103,608	$200,755	$164,716	$48,568	$141,872	$26,898	12
21	20	11	13	16	9	7	22	5	13
$88,130	$59,770	$29,823	$26,850	$57,708	$35,976	[illegible]	$54,266	$10,500	14
134	172	40	67	151	76	38	90	14	15
$142,200	$151,437	$36,015	$76,758	$143,047	$128,740	$29,268	$87,606	$16,398	16
126	158	40	62	140	75	37	89	13	17
$136,746	$144,867	$36,015	$74,098	$137,608	$128,500	$28,788	$87,156	$15,670	18
8	14	.....	5	11	1	1	1	1	19
$5,454	$6,570	.....	$2,660	$5,439	$240	$480	$450	$728	20
1,308	2,001	790	858	956	3,066	747	2,236	286	21
755	784	242	246	692	754	201	487	168	22
962	1,033	427	400	765	1,772	443	1,171	218	23
$441,177	$491,898	$109,192	$173,888	$351,873	$479,449	$94,101	$320,774	$110,357	24
929	1,033	426	394	764	1,772	443	1,171	218	25
$432,451	$491,898	$109,117	$171,768	$351,773	$479,449	$94,101	$320,774	$110,357	26
30	.....	.....	5	.....	.....	.....	.....	.....	27
$7,894	.....	.....	$2,000	.....	.....	.....	.....	.....	28
3	.....	1	1	1	.....	.....	.....	.....	29
$832	.....	$75	$120	$100	.....	.....	.....	.....	30
$312,500	$317,826	$108,209	$112,317	$238,324	$675,589	$110,953	$306,382	$61,276	31
$11,069	$7,410	$39	$1,044	$15,023	$1,050	.....	$6,187	$1,920	32
$18,429	$20,420	$17,535	$3,626	$10,414	$53,200	$2,713	$27,040	$1,905	33
$282,268	$289,846	$90,625	$107,447	$203,364	$621,339	$108,240	$272,844	$49,663	34
$734	$150	$10	[illegible]	$9,523	.....	.....	$311	$7,788	35
$3,146,022	$1,909,158	$1,044,267	$1,016,501	$2,584,272	$3,107,710	$790,101	$2,161,423	$352,221	36
14,118	.....	4,215,500	700	.....	.....	.....	104,754	20,000	37
$9,765	.....	$18,668	$2,800	.....	.....	.....	$57,451	$11,669	38
486	1,263	967	2,530	1,265	9,114	.....	1,107	.....	39
$4,382	$15,075	$9,587	$21,360	$11,479	$71,226	.....	$10,781	.....	40
.....	169	1,815	75	1,100	.....	.....	1,666	168	41
.....	$755	$2,400	$150	$350	.....	.....	$2,000	$728	42
85,293	20,834	38,858	28,515	33,413	141,464	36,431	82,482	10	43
$397,982	$142,701	$160,554	$114,172	$200,320	$555,861	$118,067	$290,778	[illegible]	44
14,064	5,940	16,684	5,000	.....	83,272	20,668	35,988	.....	45
$74,916	$30,611	$88,818	$13,000	.....	$399,010	$155,428	$147,312	.....	46
60,082	16,559	3,402	21,328	35,057	4,459	310	16,211	646	47
$252,099	$113,652	$19,051	$143,806	$193,759	$24,632	$2,412	$99,236	3,429	48
.....	.....	.....	.....	.....	.....	.....	.....	.....	49
.....	.....	.....	.....	.....	.....	.....	.....	.....	50
12,551	18,123	10,256	8.774	15,600	12,702	1,200	14,646	200	51
$119,061	$154,685	$87,276	$82,519	$137,548	$121,141	$9,000	$130,525	$1,696	52
.....	.....	.....	.....	.....	.....	.....	2,620	.....	53
.....	.....	.....	.....	.....	.....	.....	$681	.....	54
726,300	22,624	50,000	.....	.....	.....	.....	730,000	2,400,000	55
$20,246	$21,315	$1,500	.....	.....	.....	.....	$21,900	$600	56
$1,104,361	$588,924	$354,015	$344,183	$1,094,136	$1,061,977	$141,576	$557,892	$249,169	57
.....	84	.....	8	40	.....	.....	10	1	58
.....	$336	.....	[illegible]	$200	.....	.....	$85	[illegible]	59
.....	.....	.....	.....	.....	.....	.....	.....	.....	60
.....	1,343	.....	.....	11,430	.....	.....	357	.....	61
.....	$225	.....	.....	$600	.....	.....	$62	.....	62
.....	5	.....	1	.....	.....	.....	877	.....	63
.....	[illegible]	.....	$60	.....	.....	.....	$31,880	.....	64
2,097	1,199	745	336	657	2,169	489	1,774	116	65
$71,770	$41,884	$28,609	$11,650	$26,729	$82,569	$19,707	$64,901	$3,621	66
$525,341	$279,899	$105,866	$36,533	$329,619	$310,118	$114,224	$205,327	$11,850	67
600	1,740	.....	1	.....	.....	.....	.....	.....	68
$12,100	$29,680	.....	$30	.....	.....	.....	.....	.....	69
.....	.....	.....	$1,000	$27,500	.....	.....	.....	.....	70
$141,554	$79,737	$8,145	$46,456	$290,702	$99,455	$19,014	$73,424	$25,189	71
$49,966	$195,602	$23,703	$20,348	$54,414	$88,786	$17,071	$55,563	$20,698	72
.....	$97	$600	.....	$130	.....	.....	$100	.....	73
$14,989	$21,074	$13,683	$6,253	$14,101	$5,909	$2,643	$7,130	$1,365	74
$160,116	$185,769	$86,133	$96,158	$162,031	$223,276	$88,140	$170,017	$15,975	75
$187,374	$6,937	$35,659	$75,873	$40,654	$63,750	$102,819	$234,378	$6,080	76
$4,290,629	$3,147,894	$1,497,625	$1,657,058	$3,644,320	$4,882,506	$1,466,288	$3,415,850	$623,372	77
.....	610	.....	.....	.....	41,036	.....	309	.....	78
.....	$4,050	.....	.....	.....	$225,698	.....	$1,699	.....	79
.....	34	.....	.....	.....	.....	.....	1,205	.....	80
.....	$488	.....	.....	.....	.....	.....	$7,230	.....	81
.....	1,575	.....	.....	.....	.....	.....	.....	.....	82
.....	$22,603	.....	.....	.....	.....	.....	.....	.....	83
.....	.....	.....	.....	.....	.....	.....	.....	.....	84
18	.....	.....	.....	.....	.....	.....	.....	.....	85
$277	.....	.....	.....	.....	.....	.....	.....	.....	86
.....	.....	.....	.....	.....	.....	.....	.....	.....	87

---

[1] Includes establishments distributed as follows: Iowa, 1; Michigan, 1; Minnesota, 1; Nebraska, 1; Oregon, 1; Rhode Island, 1; Texas, 2; Washington, 1; West Virginia, 2.

TABLE 1.—FERTILIZERS: SUMMARY

		United States.	Alabama.	California.	Connecticut.	Delaware.
	Products—Continued.					
	Aggregate value—Continued.					
	Fertilizers—					
88	Total value	$40,445,661	$1,942,708	$586,687	$313,610	$634,213
	Superphosphates—					
89	From minerals, bones, etc., tons	923,198	38,246			2,385
90	Value	$8,471,943	$369,587			$28,250
91	Ammoniated, tons	142,898	2,000		1,000	
92	Value	$2,349,388	$35,000		$23,000	
93	Complete, tons	1,436,682	92,253	17,570	7,325	17,180
94	Value	$25,446,046	$1,433,355	$541,187	$205,931	$283,873
95	All other, tons	291,927	6,670	2,561	2,752	30,377
96	Value	$4,178,284	$104,766	$45,500	$84,679	$322,090
	Chemicals, not otherwise specified—					
97	Epsom salts, pounds	1,400,000				
98	Value	$10,500				
99	Value of all other products	$3,749,890	$100,454	$71,150	$77,195	$104,490
	Products consumed:					
100	Sulphuric acid, tons	571,831	22,020	538		
101	Acid phosphate, tons	88,964				
102	Charcoal, bushels	14,600				14,600
103	All other products consumed, pounds	36,512,386	18,200,000			
	Comparison of products:					
104	Number of establishments reporting for both years	329	11	8	7	9
105	Value for census year	$31,249,588	$1,762,700	$670,517	$344,605	$460,213
106	Value for preceding business year	$27,420,663	$1,527,287	$640,828	$354,160	$401,881
	Power:					
107	Number of establishments reporting	361	17	7	7	9
108	Total horsepower	39,521	1,450	415	334	775
	Owned—					
	Engines—					
109	Steam, number	591	27	8	6	19
110	Horsepower	37,121	1,360	340	245	705
111	Gas or gasoline, number	30		1		
112	Horsepower	410		15		
113	Water wheels, number	16			2	
114	Horsepower	359			66	
115	Electric motors, number	36			2	1
116	Horsepower	841			8	50
117	Other power, number	2				
118	Horsepower	90				
	Rented—					
119	Electric, horsepower	220	30	60	15	
120	Other kind, horsepower	480	60			20
	Establishments classified by number of persons employed, not including proprietors and firm members:					
121	Total number of establishments	422	17	8	9	11
122	No employees	9				
123	Under 5	81	1	1	1	
124	5 to 20	150	6	5	4	8
125	21 to 50	68	3	2	2	1
126	51 to 100	43	4		2	1
127	101 to 250	53	3			1
128	251 to 500	17				
129	501 to 1,000	1				

BY STATES, 1900—Continued.

District of Columbia.	Florida.	Georgia.	Illinois.	Indiana.	Kansas.	Kentucky.	Louisiana.	
$71,480	$496,642	$3,240,304	$1,721,760	$235,836	$549,943	$295,520	$866,201	88
.....	9,394	131,503	26,108	365	8,978	.....	29,244	89
.....	$93,940	$1,075,681	$313,850	$10,006	$160,498	.....	$263,821	90
.....	.....	14,603	4,150	27	6,858	.....	13,037	91
.....	.....	$229,271	$58,100	$500	$125,745	.....	$221,509	92
3,160	15,435	101,219	43,483	5,750	10,000	17,316	22,842	93
$64,800	$377,535	$1,563,653	$835,335	$116,280	$200,000	$295,520	$367,181	94
449	1,315	26,605	23,433	5,431	4,535	.....	300	95
$6,680	$25,167	$371,799	$514,475	$109,050	$63,700	.....	[illegible]	96
.....	.....	.....	.....	.....	.....	.....	.....	97
.....	.....	.....	.....	.....	.....	.....	.....	98
$7,450	$2,764	$121,613	$133,400	$19,495	.....	$25,725	$26,600	99
.....	7,065	78,655	.....	.....	.....	.....	17,718	100
.....	.....	.....	.....	.....	.....	.....	3,025	101
.....	.....	.....	.....	.....	.....	.....	.....	102
.....	380,000	.....	.....	.....	.....	.....	.....	103
6	7	20	3	13	3	4	5	104
$78,930	$500,239	$1,432,461	$514,660	$254,571	$549,943	$321,245	$896,351	105
$73,300	$438,292	$1,317,770	$392,860	$211,270	$421,923	$293,629	$617,632	106
2	5	32	4	14	2	4	6	107
85	412	3,823	1,315	565	620	483	826	108
1	8	54	9	16	2	7	11	109
65	400	3,795	1,315	528	320	483	795	110
.....	.....	.....	.....	2	.....	.....	.....	111
.....	.....	.....	.....	37	.....	.....	.....	112
.....	.....	.....	.....	.....	.....	.....	.....	113
.....	.....	.....	.....	.....	.....	.....	.....	114
.....	.....	2	.....	.....	.....	.....	2	115
.....	.....	28	.....	.....	.....	.....	31	116
.....	.....	.....	.....	.....	.....	.....	.....	117
.....	.....	.....	.....	.....	.....	.....	.....	118
.....	12	.....	.....	.....	.....	.....	.....	119
20	.....	.....	.....	.....	300	.....	.....	120
6	7	41	5	14	3	4	6	121
.....	.....	.....	.....	.....	.....	.....	.....	122
1	1	2	2	4	1	.....	.....	123
4	1	14	1	9	.....	.....	2	124
1	4	10	.....	1	.....	2	1	125
.....	.....	8	.....	.....	.....	2	1	126
.....	1	6	1	.....	2	.....	2	127
.....	.....	1	1	.....	.....	.....	.....	128
.....	.....	.....	.....	.....	.....	.....	.....	129

Table 1.—FERTILIZERS: SUMMARY

		Maine.	Maryland.	Massachusetts.	Mississippi.	Missouri.
	Products—Continued.					
	Aggregate value—Continued.					
	Fertilizers—					
88	Total value	$27,902	$5,174,357	$2,060,575	$492,772	$139,395
	Superphosphates—					
89	From minerals, bones, etc., tons		124,444	1,282	7,200	2,766
90	Value		$1,176,099	$12,820	$50,400	$44,248
91	Ammoniated, tons		48,608			
92	Value		$690,671			
93	Complete, tons	828	183,705	76,571	30,504	2,774
94	Value	$21,602	$2,977,015	$1,940,605	$442,372	$39,039
95	All other, tons	1,000	27,017	4,280		2,354
96	Value	$6,300	$330,572	$107,150		$56,108
	Chemical, not otherwise specified—					
97	Epsom salts, pounds					
98	Value					
99	Value of all other products	$12,100	$188,958	$14,015		$97,240
	Products consumed:					
100	Sulphuric acid, tons		94,490	18,590	9,000	
101	Acid phosphate, tons				9,000	
102	Charcoal, bushels					
103	All other products consumed, pounds		5,823,200			
	Comparison of products:					
104	Number of establishments reporting for both years	2	34	8	3	3
105	Value for census year	$28,002	$3,936,185	$2,073,910	$492,772	$236,635
106	Value for preceding business year	$28,500	$3,731,268	$1,517,852	$429,000	$234,176
	Power:					
107	Number of establishments reporting	3	32	7	3	2
108	Total horsepower	85	3,647	1,217	415	609
	Owned—					
	Engines—					
109	Steam, number	6	51	26	[illegible]	6
110	Horsepower	60	3,263	785	415	609
111	Gas or gasoline, number		4			
112	Horsepower		75			
113	Water wheels, number	1	2			
114	Horsepower	20	44			
115	Electric motors, number	1	7	8		
116	Horsepower	5	205	382		
117	Other power, number			1		
118	Horsepower			50		
	Rented—					
119	Electric, horsepower					
120	Other kind, horsepower		60			
	Establishments classified by number of persons employed, not including proprietors and firm members:					
121	Total number of establishments	3	40	9	3	3
122	No employees					
123	Under 5		4	5		2
124	5 to 20	1	15	1		
125	21 to 50	1	12	1	2	
126	51 to 100	1	2	1	1	1
127	101 to 250		6			
128	251 to 500		1	1		
129	501 to 1,000					

BY STATES, 1900—Continued.

New Jersey.	New York.	North Carolina.	Ohio.	Pennsylvania.	South Carolina.	Tennessee.	Virginia.	All other states.[1]	
$3,703,712	$2,444,420	$1,487,338	$1,562,518	$2,696,969	$4,656,808	$1,464,788	$3,328,479	[illegible]	88
105,135	9,810	48,820	24,728	22,975	178,183	35,969	[illegible]	40	89
$887,020	$105,645	$397,397	[illegible]	$310,273	$1,404,569	$456,568	$1,024,898	$780	90
7,288	10,800	3,400	23,805	2,846			4,800	681	91
$59,580	$338,400	$51,000	$380,936	$53,271			$72,100	$10,215	92
125,839	87,862	58,528	43,351	120,151	207,860	38,695	106,828	6,654	93
$2,629,511	$1,623,638	$841,632	$700,606	$2,165,825	$3,146,915	$704,220	$1,820,771	$107,645	94
8,039	44,035	14,845	11,918	10,467	7,497	20,400	26,637	9,510	95
$127,601	$376,737	$197,304	$195,278	$167,600	$105,324	$204,000	$405,715	$147,069	96
				1,400,000					97
				$10,500					98
$586,640	[illegible]	$10,292	$94,540	$936,851		$1,500	$83,442	$357,643	99
25,336	13,958	33,047	8,000		138,973	35,495	68,946		100
17,527		5,545	18,050	35,746		5,071			101
									102
957,186	9,400,000	1,000,000		752,000					103
26	26	13	20	50	7	4	29	8	104
$3,724,270	$2,523,752	$1,130,605	$1,071,155	$3,593,820	$865,429	$1,125,890	$2,129,981	$530,747	105
$3,649,571	$2,390,249	$1,062,897	$916,086	$3,064,029	$792,863	$609,394	$1,873,608	$480,338	106
22	27	16	26	48	18	5	33	10	107
2,778	2,461	1,292	2,168	3,835	3,940	943	4,240	788	108
41	40	29	36	59	36	14	59	16	109
2,638	2,436	1,153	1,993	3,682	3,940	943	4,065	788	110
2		16	3	1			1		111
40		56	175	10			2		112
				7			4		113
				123			106		114
9	1						3		115
100	5						27		116
							1		117
							40		118
	20	83							119
				20					120
28	32	18	27	51	22	5	39	11	121
	1	1	2	5					122
8	10	3	5	15	2		8	5	123
13	10	5	13	22	3	2	8	3	124
1	5	3	3	6	1		6		125
1		3	1	1	2	1	8	2	126
3	4	3	1	1	11		7	1	127
2	1		2	1	3	2	2		128
	1								129

---

[1] Includes establishments distributed as follows: Iowa, 1; Michigan, 1; Minnesota, 1; Nebraska, 1; Oregon, 1; Rhode Island, 1; Texas, 2; Washington, 1; West Virginia, 2.

TABLE 2.—DYESTUFFS AND EXTRACTS, SUMMARY BY STATES: 1900.

	United States.	Massachusetts.	New Jersey.	New York.	Pennsylvania.	Virginia.	West Virginia.	All other states.[1]
Number of establishments	77	10	10	19	12	8	5	13
Character of organization:								
Individual	28	7	3	7	4	4	1	2
Firm and limited partnership	19	1	2	3	3	3	2	5
Incorporated company	30	2	5	9	5	1	2	6
Capital:								
Total	$7,839,034	$592,510	$591,916	$2,548,136	$1,778,173	$385,904	$272,192	$1,670,203
Land	$1,027,908	$91,800	$121,000	$567,463	$121,450	$37,923	$17,850	$70,422
Buildings	$1,075,033	$68,000	$76,000	$345,504	$273,179	$54,350	$38,000	$220,000
Machinery, tools, and implements	$1,839,946	$60,973	$131,553	$436,703	$537,993	$72,100	$66,049	$534,575
Cash and sundries	$3,896,147	$371,737	$263,363	$1,198,466	$845,551	$221,531	$150,293	$845,206
Proprietors and firm members	61	11	7	7	5	12	7	12
Salaried officials, clerks, etc.:								
Total number	229	27	32	78	36	20	8	28
Total salaries	$312,109	$36,120	$33,783	$91,680	$60,686	$22,050	$7,930	$59,860
Officers of corporations—								
Number	43	3	8	11	12	2	3	4
Salaries	$118,880	$11,100	$17,100	$28,300	$39,900	$1,920	$4,780	$15,780
General superintendents, managers, clerks, etc.—								
Total number	186	24	24	67	24	18	5	24
Total salaries	$193,229	$25,020	$16,683	$63,380	$20,786	$20,130	$3,150	$44,080
Men—								
Number	163	21	18	60	21	18	5	20
Salaries	$181,750	$23,740	$14,817	$59,876	$19,057	$20,130	$3,150	$40,980
Women—								
Number	23	3	6	7	3	...	...	4
Salaries	$11,479	$1,280	$1,866	$3,504	$1,729	...	...	$3,100
Wage-earners, including pieceworkers, and total wages:								
Greatest number employed at any one time during the year	2,094	56	172	562	361	271	98	574
Least number employed at any one time during the year	1,485	35	71	517	286	174	90	312
Average number	1,648	49	88	538	257	201	74	441
Wages	$787,942	$28,226	$40,067	$300,832	$118.544	$58,588	$26,325	$215,360
Men, 16 years and over—								
Average number	1,607	48	78	538	251	183	74	435
Wages	$781,370	$27,626	$38,618	$300,832	$117,169	$56,988	$26,325	$213,812
Women, 16 years and over—								
Average number	36	1	10	...	5	15	...	5
Wages	$5,911	$600	$1,449	...	$1,250	$1,200	...	$1,412
Children, under 16 years—								
Average number	5	...	...	...	1	3	...	1
Wages	$661	...	...	...	$125	$400	...	$136
Miscellaneous expenses:								
Total	$458,212	$20,449	$49,482	$128,447	$158,252	$17,739	$15,320	$68,523
Rent of works	$23,052	$3,606	$3,745	$10,460	$1,785	$1,081	$400	$1,975
Taxes, not including internal revenue	$24.071	$1,910	$2,220	$10,432	$3,272	$1,955	$745	$3,537
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$410,870	$14,933	$43,517	$107,555	$153,134	$14,703	$14,017	$63,011
Contract work	$219	...	...	...	$61	...	$158	...
Materials used:								
Total cost	$4,745,912	$1,123,833	$282,332	$1,263,843	$661,444	$307,481	$144,068	$962,911
Gums	$325	...	...	...	...	...	...	$325
Wood, for extracts, tons	245,198	3,750	12,326	34,441	63,447	48,215	35,700	47,319
Cost	$2,393,179	$42,638	$207,867	$594,826	$514,266	$246,680	$106.900	$680,002
Acids—								
Sulphuric, tons	814	370	...	86	245	...	113	...
Cost	$16,757	$9,990	...	$1,297	$4,000	...	$1,470	...
Nitric, pounds	155,367	105,000	...	...	...	...	50,367	...
Cost	$5,434	$4,200	...	...	...	...	$1,234	...
Mixed, pounds	209,061	...	...	209,061	...	...	...	...
Cost	$3,763	...	...	$3,763	...	...	...	...
Ammonia, aqua, pounds	1,227,000	1,227,000	...	...	...	...	...	...
Cost	$73,620	$73,620	...	...	...	...	...	...
Alcohol, wood, gallons	1,000	...	...	...	...	...	...	1,000
Cost	$800	...	...	...	...	...	...	$800
Bones, tankage, and offal	$750	...	...	...	...	$750	...	...
Common salt, tons	2,254	...	100	2,154	...	...	...	...
Cost	$7,829	...	$447	$7,382	...	...	...	...
Dry colors	$447,649	$397,495	...	$40,500	$8,000	...	...	$1,654
Lead, tons	125	...	...	125	...	...	...	...
Cost	$11,140	...	...	$11,140	...	...	...	...
Lime, bushels	3,840	3,840	...	...	...	...	...	...
Cost	$800	$800	...	...	...	...	...	...
Tallow and fats	$9,000	...	...	...	$9,000	...	...	...
All other components of products	$1,175,402	$538,462	$26,589	$466,939	$38,768	$2,510	$5,115	$97,019
Fuel	$185,307	$8,265	$11,153	$31,193	$22,447	$14,090	$9,000	$87,159
Rent of power and heat	$4,153	...	$1,879	$373	...	$1,323	$578	...
Mill supplies	$71,613	$595	$1,015	$12,713	$4,508	$1,165	$1,670	$52,947
All other materials	$267,918	$43,653	$21,812	$82,177	$45,329	$23,363	$18,101	$33.483
Freight	$69,473	$4,115	$11,570	$11,540	$15,126	$17,600	...	$9,522
Products:								
Total value	$7,350,748	$1,320,881	$502,798	$2,111,811	$1,269,246	$479,372	$245,754	$1,420,886
Acids	$72,900	...	$72,900	...	...	...	...	...
Alums, pounds	1,500,000	1,500,000	...	...	...	...	...	...
Value	$90,000	$90,000	...	...	...	...	...	...
Fertilizers, tons	55	...	...	...	...	55	...	...
Value	$1,500	...	...	...	...	$1,500	...	...
Dyestuffs—								
Natural, pounds	46,662,023	3,532,000	6,160,000	7,880,048	23,831,150	...	...	5,258,825
Value	$2,521,682	$283,800	$206,240	$1,005,079	$816,135	...	...	$210,428
Artificial, pounds	6,581,850	2,123,816	267,100	2,457,162	425,800	...	1,292,360	15,612
Value	$1,806,730	$871,213	$41,858	$787,976	$50,400	...	$11,389	$43,894
Tanning materials—								
Natural—								
Ground or chipped, pounds	49,002,037	...	13,872,000	...	415,117	25,145,920	7,925,000	1,644,000
Value	$465,956	...	$98,600	...	$7,788	$180,158	$156,915	$22,500
Extracts, pounds	60,395,392	...	719,228	7,024,440	18,553,124	17,936,725	3,889,875	12,272,000
Value	$1,216,346	...	$46,684	$295,356	$339,518	$290,065	$75,450	$169,273
Artificial, pounds	1,837,134	376,470	1,460,664	...	...	...	...	...
Value	$52,516	$16,000	$36,516	...	...	...	...	...
Epsom salts, pounds	87,500	...	...	...	87,500	...	...	...
Value	$1,500	...	...	...	$1,500	...	...	...
Value of all other products	$1,121,618	$59,868	...	$23,400	$53,910	$7,649	$2,000	$974,791
Products consumed	$842,250	...	...	$842,250	...	...	...	...

[1] Includes establishments distributed as follows: California, 1; Connecticut, 2; Florida, 2; Illinois, 2; Kentucky, 1; Maine, 1; Michigan, 1; Rhode Island, 2; Tennessee, 1.

TABLE 2.—DYESTUFFS AND EXTRACTS, SUMMARY BY STATES: 1900—Continued.

	United States.	Massachusetts.	New Jersey.	New York.	Pennsylvania.	Virginia.	West Virginia.	All other states.[1]
Comparison of products:								
Number of establishments reporting for both years	66	10	9	17	8	8	3	11
Value for census year	$6,929,350	$1,320,881	$490,798	$1,958,086	$1,068,473	$479,372	$215,254	$1,396,486
Value for preceding business year	$6,240,273	$1,213,358	$441,617	$1,808,320	$1,012,812	$380,116	$169,569	$1,214,481
Power								
Number of establishments reporting	59	6	7	12	11	8	5	10
Total horsepower	11,518	347	859	4,203	2,818	785	455	2,051
Owned—								
Engines—								
Steam, number	144	6	10	48	27	14	6	33
Horsepower	10,458	297	795	4,148	2,432	470	415	1,901
Gas or gasoline, number	1				1			
Horsepower	300				300			
Water wheels, number	9	1				3		5
Horsepower	325	50				140		135
Electric motors, number	15		3	3	7		1	1
Horsepower	159		3	40	86		15	15
Rented—								
Electric, horsepower	20		5	15				
Other kind, horsepower	256		56			175	25	
Furnished to other establishments, horsepower	55							55
Establishments classified by number of persons employed, not including proprietors and firm members:								
Total number of establishments	77	10	10	19	12	8	5	13
No employees	1				1			
Under 5	12	3	3	2	1		1	2
5 to 20	33	7	5	7	3	4	3	4
21 to 50	14			3	5	1		5
51 to 100	12		2	4	1	3	1	1
101 to 250	2			1	1			
251 to 500	2			1				1
501 to 1,000	1			1				

---

[1] Includes establishments distributed as follows: California, 1; Connecticut, 2; Florida, 2; Illinois, 2; Kentucky, 1; Maine, 1; Michigan, 1; Rhode Island, 2; Tennessee, 1.

TABLE 3.—PAINTS: SUMMARY

		United States.	California.	Georgia.
1	Number of establishments	419	11	5
	Character of organization:			
2	Individual	120	5	2
3	Firm or limited partnership	109	2	1
4	Incorporated company	190	4	2
	Capital:			
5	Total	$42, 501, 782	$873, 378	$101, 300
6	Land	$5. 263, 179	$8, 300	$4, 000
7	Buildings	$5, 128, 578	$159, 588	$4, 500
8	Machinery, tools, and implements	$7, 068, 854	$117, 463	$11, 500
9	Cash and sundries	$25, 041, 171	$588, 027	$81, 300
10	Proprietors and firm members	293	10	3
	Salaried officials, clerks, etc.:			
11	Total number	2, 512	33	12
12	Total salaries	$3, 077, 318	$39, 922	$9, 170
	Officers of corporations—			
13	Number	324	4	2
14	Salaries	$814, 037	$5, 550	$1, 650
	General superintendents, managers, clerks, etc.—			
15	Total number	2, 188	29	10
16	Total salaries	$2, 263, 281	$34, 372	$7, 520
	Men—			
17	Number	1, 910	29	10
18	Salaries	$2, 130, 270	$34, 372	$7, 520
	Women—			
19	Number	278	...	...
20	Salaries	$133, 011	...	...
	Wage-earners, including pieceworkers, and total wages:			
21	Greatest number employed at any one time during the year	9, 514	179	34
22	Least number employed at any one time during the year	6, 971	153	30
23	Average number	8, 151	163	23
24	Wages	$3, 929, 787	$100, 444	$9, 844
	Men, 16 years and over—			
25	Average number	7, 357	154	19
26	Wages	$3, 711, 685	$97, 047	$8, 704
	Women, 16 years and over—			
27	Average number	744	9	1
28	Wages	$209, 540	$3, 397	$600
	Children, under 16 years—			
29	Average number	50	...	3
30	Wages	$8, 562	...	$540
	Miscellaneous expenses:			
31	Total	$3, 430, 061	$19, 165	$10, 905
32	Rent of works	$289. 366	$6, 300	$2, 720
33	Taxes, not including internal revenue	$200, 720	$1, 776	$1, 360
34	Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$2, 802, 642	$10, 972	$6, 825
35	Contract work	$137, 333	$117	...
	Materials used:			
36	Total cost	$33, 799, 386	$853, 231	$112, 474
37	Gums	$354, 660	...	$6, 400
38	Limestone, tons	18, 234	...	...
39	Cost	$50, 368	...	...
40	Pyrites, tons	20, 598	...	...
41	Cost	$122, 300	...	...
	Wood—			
42	For alcohol, cords	26	...	...
43	Cost	$52	...	...
44	For extracts, tons	11, 745	...	...
45	Cost	$68, 783	...	...
	Acids—			
46	Sulphuric, tons	1, 989	...	...
47	Cost	$13, 915	...	...
48	Nitric, pounds	68, 568	...	...
49	Cost	$3, 687	...	...
50	Mixed, pounds	1, 755, 822	...	...
51	Cost	$26, 002	...	...
52	Acid phosphate, tons	190	...	...
53	Cost	$1, 519	...	...
	Alcohol—			
54	Grain, gallons	9, 813	...	...
55	Cost	$16, 778	...	...
56	Wood, gallons	32, 488	...	...
57	Cost	$26, 806	...	...
58	Bones, tankage, and offal	$2, 278	...	...
59	Common salt, tons	458	...	...
60	Cost	$2, 250	...	...
61	Dry colors	$8, 758, 499	$130, 476	$48, 943
62	Glycerine, pounds	692	...	...
63	Cost	$87	...	...
64	Lead, tons	99, 052	1, 908	...
65	Cost	$8, 585, 688	$152, 650	...
66	Lime, bushels	33, 007	...	...
67	Cost	$6, 098	...	...
68	Linseed oil, gallons	11, 835, 174	172, 630	49, 551
69	Cost	$5, 431, 227	$99, 556	$29, 997
70	Nitrate of soda, tons	1, 086	...	...
71	Cost	$36, 395	...	...
72	Potash salts	$21, 675	...	...
73	Sulphur, tons	2, 764	...	...
74	Cost	$58, 088	...	...
75	Tallow and fats	$5, 700	...	...
76	All other components of products	$5, 929, 030	$342, 275	$8, 051
77	Fuel	$514, 372	$9, 070	$492
78	Rent of power and heat	$42, 672	$2, 690	$460
79	Mill supplies	$169, 090	$1, 435	$245
80	All other materials	$3, 234, 658	$99, 404	$7, 590
81	Freight	$316, 709	$15, 675	$10, 296
	Products:			
82	Aggregate value	$50, 874, 995	$1, 128, 643	$182, 279
	Acids—			
83	Sulphuric, 50 Baumé, tons	23, 964	...	...
84	Value	$201, 299	...	...
85	Sulphuric, 66 Baumé, tons	4, 053	...	...
86	Value	$89, 179	...	...
87	Nitric, pounds	749, 666	...	...
88	Value	$28, 112	...	...

BY STATES, 1900.

Illinois.	Indiana.	Iowa.	Kentucky.	Louisiana.	Maryland.	Massachusetts.	Michigan.	Minnesota.	
33	5	6	9	3	13	30	13	6	1
4		1	3		5	7	4	1	2
2		3	2	1	7	10		1	3
27	5	2	4	2	1	13	9	4	4
$3,387,850	$132,431	$207,485	$174,586	$140,491	$290,222	$1,300,708	$1,559,545	$325,063	5
$379,442		$7,242	$20,422	$21,500	$18,000	$80,476	$111,299	[illegible]	6
$228,439	$7,463	$22,550	$25,500	$18,600	$28,000	$207,241	[illegible]	$27,085	7
$436,989	$50,751	$20,813	$27,837	$32,499	$78,760	$202,269	$159,674	$44,874	8
$2,343,030	$74,217	$156,880	$100,827	$67,892	$165,462	$810,722	$1,057,608	$247,796	9
8	1	9	7	3	21	26	4	5	10
347	13	31	12	13	26	75	183	29	11
$460,379	$11,166	$23,480	$12,900	$14,242	$25,900	$102,784	$135,265	[illegible]	12
49	8	1	6	3	3	19	20	7	13
$111,184	$4,600	$2,400	$7,600	$6,460	$7,000	$39,700	$47,020	$10,258	14
298	10	30	6	10	23	56	163	22	15
$349,196	$6,566	$21,080	$5,300	$7,782	$18,900	$63,084	$88,245	$18,140	16
255	10	24	6	9	23	47	133	19	17
$325,242	$6,566	$19,380	$5,300	$7,002	$18,900	$59,026	$81,192	$17,160	18
43		6		1		9	30	3	19
$23,953		$1,700		$780		$4,058	$7,063	[illegible]	20
835	45	51	62	24	119	384	426	65	21
574	29	29	45	19	104	291	330	50	22
702	33	40	52	21	110	337	384	52	23
$348,674	$13,641	$14,739	$20,326	$10,116	$45,273	$176,101	$129,690	[illegible]	24
629	27	34	46	19	94	311	293	42	25
$324,862	$12,835	$13,510	$18,826	$9,544	$41,688	$166,473	$111,194	$17,557	26
72	6	6	6	2	9	26	80	10	27
$23,512	$806	$1,229	$1,500	$572	$2,585	$9,628	$16,837	$2,749	28
1					7		11		29
$300					$1,000		$1,659		30
$414,110	$17,330	$19,833	$7,848	$19,452	$22,172	$112,789	$220,482	$61,331	31
$41,435	$4,381	$20	$1,440		$5,407	$18,170	$5,504	$7,215	32
$21,822	$450	$783	$838	$815	$1,349	$11,591	$7,325	$778	33
$350,763	$10,999	$19,030	$5,570	$18,637	$15,416	$83,028	$207,653	$51,138	34
$90	$1,500							$2,200	35
$4,375,872	$111,015	$255,510	$263,952	$82,271	$265,743	$1,332,899	$1,153,783	$209,145	36
$16,375						$37,848	$46,030		37
									38
									39
									40
									41
									42
									43
									44
									45
					4	2			46
					$109	$40			47
						9,568			48
						$286			49
									50
									51
									52
									53
20									54
$54									55
11,710						600			56
$10,140						$750			57
									58
									59
									60
$1,764,935	$71,819	$84,170	$106,826	25,338	$84,074	$378,334	$431,054	$75,449	61
									62
									63
11,866						3,614			64
$991,042						$325,309			65
2,457				557		5,143			66
$149				$160		$2,708			67
1,640,240	54,908	182,856	221,140	65,691	102,650	390,248	597,415	154,519	68
$730,473	$22,226	$73,947	$93,506	$32,846	$50,080	$171,938	$260,300	$75,159	69
									70
									71
						$21,000			72
									73
									74
									75
$425,991	$4,022	$72,987	$32,252	$12,669	$90,231	$219,152	$182,454	[illegible]	76
$50,238	$717	$4,558	$1,590	$2,102	$6,477	$26,108	$10,917	$2,176	77
$10,956	$51		$1,101	$14	$200	$3,600	$813	$1,020	78
$7,752	$271	$640	$445	$272	$810	[illegible]	$3,219	$561	79
$346,033	$11,561	$15,156	$23,476	$7,062	$24,362	$128,365	$192,802	$12,608	80
$21,734	$348	$4,052	$4,756	$1,808	[illegible]	$14,252	[illegible]	$3,619	81
$5,987,548	$165,335	$336,867	$359,085	$132,102	$442,744	$2,005,982	$1,826,742	$357,816	82
									83
									84
									85
									86
									87
									88

TABLE 3.—PAINTS: SUMMARY

		Missouri.	Nebraska.	New Jersey.	New York.
1	Number of establishments	20	3	27	82
	Character of organization:				
2	Individual	2		7	29
3	Firm or limited partnership	5		7	17
4	Incorporated company	13	3	13	36
	Capital:				
5	Total	$3,078,899	$881,657	$2,507,867	$11,318,449
6	Land	$257,368	$60,000	$122,350	$2,129,678
7	Buildings	$352,018	$356,000	$357,206	$1,095,653
8	Machinery, tools, and implements	$402,858	$98,500	$404,697	$1,495,299
9	Cash and sundries	$2,066,655	$367,157	$1,623,614	$6,597,819
10	Proprietors and firm members	12		20	34
	Salaried officials, clerks, etc.:				
11	Total number	138	41	131	505
12	Total salaries	$213,626	$58,456	$178,228	$717,339
	Officers of corporations—				
13	Number	26	2	17	51
14	Salaries	$63,690	$9,000	$32,015	$178,420
	General superintendents, managers, clerks, etc.—				
15	Total number	112	39	114	454
16	Total salaries	$149,936	$49,456	$146,213	$538,919
	Men—				
17	Number	104	32	106	398
18	Salaries	$145,336	$46,420	$141,137	$512,815
	Women—				
19	Number	8	7	8	56
20	Salaries	$4,600	$3,036	$5,076	$26,104
	Wage-earners, including pieceworkers, and total wages:				
21	Greatest number employed at any one time during the year	577	105	729	2,521
22	Least number employed at any one time during the year	382	69	564	1,855
23	Average number	488	93	626	2,173
24	Wages	$225,830	$53,020	$317,786	$1,175,277
	Men, 16 years and over—				
25	Average number	456	82	558	1,975
26	Wages	$217,587	$49,590	$299,972	$1,125,011
	Women, 16 years and over—				
27	Average number	24	11	68	187
28	Wages	$6,924	$3,430	$17,814	$48,086
	Children, under 16 years—				
29	Average number	8			11
30	Wages	$1,319			$2,180
	Miscellaneous expenses:				
31	Total	$169,984	$70,405	$191,449	$815,946
32	Rent of works	$19,659	$480	$8,524	$99,494
33	Taxes, not including internal revenue	$15,827	$2,147	$10,564	$60,984
34	Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$134,498	$67,778	$158,290	$650,468
35	Contract work			$14,071	$5,000
	Materials used:				
36	Total cost	$3,234,423	$534,256	$2,519,447	$8,344,936
37	Gums	$78		$33,886	$116,527
38	Limestone, tons				8,734
39	Cost				$26,268
40	Pyrites, tons				
41	Cost				
	Wood—				
42	For alcohol, cords				
43	Cost				
44	For extracts, tons				293
45	Cost				$16,523
	Acids—				
46	Sulphuric, tons			119	1,400
47	Cost			$2,984	$2,160
48	Nitric, pounds				
49	Cost				
50	Mixed, pounds			330,000	1,425,822
51	Cost			$5,000	$21,002
52	Acid phosphate, tons				
53	Cost				
	Alcohol—				
54	Grain, gallons				769
55	Cost				$500
56	Wood, gallons			4,136	
57	Cost			$4,953	
58	Bones, tankage, and offal				
59	Common salt, tons			458	
60	Cost			$2,250	
61	Dry colors	$680,596	$92,510	$483,423	$2,210,230
62	Glycerine, pounds				692
63	Cost				$87
64	Lead, tons	15,447	2,901	3,000	24,083
65	Cost	$1,332,088	$242,666	$275,500	$2,124,948
66	Lime, bushels				4.000
67	Cost				$800
68	Linseed oil, gallons	1,155,791	213,779	402,636	2,632,319
69	Cost	$506,392	$102,773	$184,826	$1,248,756
70	Nitrate of soda, tons				20
71	Cost				$1,219
72	Potash salts				
73	Sulphur, tons			620	600
74	Cost			$18,500	$12,595
75	Tallow and fats				$5,700
76	All other components of products	$434,809	$24,471	$1,105,330	$1,573,151
77	Fuel	$26,614	$12,959	$55,810	$109,981
78	Rent of power and heat	$3,870		$550	$11,932
79	Mill supplies	$6,948	$1,505	$11,207	$56,535
80	All other materials	$236,679	$44,354	$296,694	$799,475
81	Freight	$6,349	$13,018	$38,534	$6,547
	Products:				
82	Aggregate value	$4,323,355	$838,151	$3,460,362	$12,543,825
	Acids—				
83	Sulphuric, 50 Baumé, tons				
84	Value				
85	Sulphuric, 66 Baumé, tons				
86	Value				
87	Nitric, pounds				
88	Value				

BY STATES, 1900—Continued.

Ohio.	Oregon.	Pennsylvania.	Rhode Island.	Tennessee.	Texas.	Washington.	Wisconsin.	All other states.[1]	
45	3	66	4	5	5	3	5	17	1
7	1	27	2	3	2		1	7	2
16	1	22	1		3	1	3	4	3
22	1	17	1	2		2	1	6	4
$4,306,499	$128,332	$10,263,515	$104,781	$73,545	$14,975	$65,932	$463,236	$901,016	5
$490,596	$5,000	$1,501,877	$5,000	$4,500		$5,500		$25,900	6
$474,905	$6,500	$1,333,868	$21,800	$6,000		$31,000		$133,693	7
$433,921	$18,247	$2,767,768	$16,700	$14,275	$2,925	$6,822	$39,414	$184,049	8
$2,907,077	$98,585	$4,660,002	$61,281	$48,770	$12,060	$22,610	$423,822	$457,974	9
41	2	47	4	3	10	2	6	15	10
395	7	405	13	8		4	43	48	11
$470,581	$8,880	$453,024	$16,164	$11,000		$4,620	$28,761	$53,033	12
55	2	36	2	4		2	3	7	13
$123,160	$4,800	$124,780	$5,000	$8,300		$3,000	$5,700	$12,750	14
340	5	369	11	4		2	40	41	15
$347,421	$4,080	$328,244	$11,164	$2,700		$1,620	$23,061	$40,283	16
297	[illegible]	329	8	3		1	30	[illegible]	17
$325,283	$3,600	$306,018	$10,124	$2,220		$1,200	$17,046	$37,411	18
43	1	40	3	1		1	10	8	19
$22,138	$480	$22,226	$1,040	$480		$420	$6,015	$2,872	20
919	41	1,862	21	51	19	13	103	329	21
601	39	1,430	15	36	14	10	80	222	22
733	39	1,649	18	45	13	10	78	269	23
$336,746	$22,836	$736,111	$9,998	$17,742	$6,600	$6,770	$28,117	$103,800	24
635	37	1,557	17	42	13	9	68	240	25
$303,493	$21,876	$711,635	$9,890	$17,142	$6,600	$6,620	$24,117	$95,912	26
98	2	87	1	3		1	10	25	27
$33,253	$960	$23,512	$108	$600		$150	$4,000	$7,288	28
		5						4	29
		$964						[illegible]	30
$618,050	$6,033	$511,533	$5,688	$5,160	$2,760	$1,082	$21,400	$85,154	31
$23,576	$2,100	$26,541	$1,259	$996	$1,240	$463	$5,400	$7,042	32
$32,090	$554	$23,298	$313	$291	$86	$140	$2,093	$3,446	33
$502,384	$3,379	$408,839	$4,116	$3,873	$1,434	$479	$13,907	$73,166	34
$60,000		$52,855						$1,500	35
$3,204,558	$86,680	$5,203,343	$106,376	$88,995	$22,032	$31,436	$675,711	$731,298	36
$58,115		$38,410					$225	$5,766	37
		9,500							38
		$24,100							39
		20,598							40
		$122,300							41
								26	42
								$52	43
		11,452							44
		$52,260							45
7		187						270	46
$168		$3,050						$5,404	47
14,000		45,000							48
$782		$2,619							49
									50
									51
		190							52
		$1,519							53
		8,839						185	54
		$15,808						$416	55
4,225		9,132					2,500	185	56
$6,173		$2,553					$2,075	$162	57
		$2,278							58
									59
									60
$907,584	$22,937	$622,542	$51,812	$47,902	$11,434	$11,279	$256,949	$157,883	61
									62
									63
9,831		26,402							64
$817,413		$2,324,072							65
50		17,100						3,400	66
$10		$1,200						$1,071	67
1,431,005	52,550	1,547,008	34,338	48,093	11,822	28,553	493,575	151,857	68
$722,229	$23,758	$637,216	$15,182	$24,047	$5,811	$9,097	$236,945	$74,167	69
		1,066							70
		$35,176							71
		$675							72
		1,544							73
		$26,993							74
									75
$340,791	$27,265	$537,264	$14,100	$4,754	$1,443	$3,914	$81,660	$351,441	76
$34,480	$720	$141,956	$963	$2,721	$252	$25	$2,523	$10,923	77
$1,625	$220	$1,378	$920		$72	$420		$780	78
$15,094	$100	$45,762	$479	$348	$55	$60	$1,008	$11,130	79
$271,532	$5,230	$533,864	$17,996	$8,687	$1,590	$3,328	$93,611	$53,199	80
$33,562	$6,450	$30,348	$4,924	$536	$1,875	$3,313	$715	$58,904	81
$5,165,001	$141,559	$9,137,970	$166,818	$150,790	[illegible]	$57,500	$881,767	$1,042,924	82
		23,964							83
		$201,299							84
		4,053							85
		$89,179							86
		749,666							87
		$28,112							88

---

[1] Includes establishments distributed as follows: Colorado, 2; Connecticut, 2; Delaware, 2; District of Columbia, 1; Kansas, 1; Maine, 2; Mississippi, 1; Nevada, 1; North Carolina, 2; Vermont, 2; Virginia, 1.

TABLE 3.—PAINTS: SUMMARY

		United States.	California.	Georgia.
	Products—Continued.			
	Aggregate value—Continued.			
	Acids—Continued.			
89	Acetic, pounds	1,715,007	...	...
90	Value	$30,569	...	...
91	Sodas	$39,614	...	...
92	Alums, pounds	25,445,612	...	...
93	Value	$342,969	...	...
94	Coal-tar distillery products	$16,716	...	...
	Wood distillation—			
95	Wood alcohol, refined, gallons	78	...	...
96	Value	$110	...	...
97	Charcoal, bushels	1,138	...	...
98	Value	$137	...	...
99	All other	$684	...	...
	Fertilizers—			
100	Complete, tons	465	...	...
101	Value	$10,497	...	...
102	All other, tons	685	...	...
103	Value	$1,878	...	...
	Dyestuffs—			
104	Natural, pounds	1,843,749	...	...
105	Value	$99,779	...	...
106	Artificial, pounds	650,000	...	...
107	Value	$390,000	...	...
	Tanning materials—			
108	Natural, extracts, pounds	554,896	...	...
109	Value	$10,161	...	...
	Paints, colors, and varnishes—			
110	Total value	$48,440,780	$823,224	$182,279
	Pigment—			
111	White lead, pounds	116,102,316	4,800,000	...
112	Value	$4,211,181	$237,180	...
113	Oxides of lead, pounds	50,759,623	500,000	...
114	Value	$2,550,340	$25,895	...
115	Lamp, and other blacks, pounds	1,065,000	...	...
116	Value	$60,250	...	...
117	Fine colors, pounds	3,325,252	...	...
118	Value	$736,796	...	...
119	Iron oxides and other earth colors, pounds	33,453,896	...	...
120	Value	$318,242	...	...
121	Dry colors, pounds	157,472,838	...	...
122	Value	$4,066,147	...	...
123	Pulp colors, sold moist, pounds	20,060,935	...	...
124	Value	$861,531	...	...
	Paints:			
125	Paints in oil, in paste, pounds	303,460,028	2,411,622	870,683
126	Value	$17,405,822	$207,797	$56,065
127	Paints already mixed for use, gallons	16,591,745	355,837	91,394
128	Value	$14,618,277	$349,352	$93,714
	Varnishes and japans—			
129	Oil and turpentine varnishes, gallons	1,373,603	...	...
130	Value	$1,236,861	...	...
131	Alcohol varnishes, gallons	46,369	...	...
132	Value	$71,707	...	...
133	Pyroxyline varnishes, gallons	16,291	...	...
134	Value	$16,225	...	...
135	Liquid dryers, japans, and lacquers	$303,495	...	$7,500
136	All other paints, colors, and varnishes	$1,983,906	$3,000	$25,000
137	Fine chemicals	$4,092	...	...
	Chemicals not otherwise specified—			
138	Copperas, pounds	5,786,400	...	...
139	Value	$29,346	...	...
140	Value of all other products	$1,139,073	$305,419	...
	Products consumed:			
	Acids—			
141	Sulphuric, tons	27,141	...	...
142	Nitric, pounds	611,427	...	...
143	Lead oxides, pounds	374,061	...	...
144	White lead, pounds	24,922,647	162,000	...
145	All other products consumed, pounds	15,997,525	...	...
	Comparison of products:			
146	Number of establishments reporting for both years	371	10	3
147	Value for census year	$48,884,792	$1,124,965	$84,000
148	Value for preceding business year	$43,348,494	$1,215,560	$92,000
	Power:			
149	Number of establishments reporting	342	8	4
150	Total horsepower	27,183	964	90
	Owned—			
	Engines—			
151	Steam, number	358	4	2
152	Horsepower	23,191	525	60
153	Gas or gasoline, number	18	2	...
154	Horsepower	345	21	...
155	Water wheels, number	24	...	...
156	Horsepower	845	...	...
157	Electric motors, number	65	19	...
158	Horsepower	839	350	...
159	Other power, number	3	...	...
160	Horsepower	300	...	...
	Rented—			
161	Electric, horsepower	771	3	30
162	Other kind, horsepower	892	65	...
163	Furnished to other establishments, horsepower	414	...	...
	Establishments classified by number of persons employed, not including proprietors and firm members:			
164	Total number of establishments	419	11	5
165	No employees	13	...	...
166	Under 5	120	6	1
167	5 to 20	148	4	4
168	21 to 50	79	...	...
169	51 to 100	35	...	...
170	101 to 250	19	1	...
171	251 to 500	4	...	...
172	501 to 1,000	1	...	...

BY STATES, 1900—Continued.

Illinois.	Indiana.	Iowa.	Kentucky.	Louisiana.	Maryland.	Massachusetts.	Michigan.	Minnesota.	
									89
									90
									91
									92
									93
						$15,000			94
									95
									96
									97
									98
									99
									100
									101
									102
									103
									104
									105
									106
									107
									108
									109
$5,939,702	$165,335	$335,367	$357,085	$132,102	$395,931	$1,938,582	$1,826,742	$357,816	110
11,037,475		250,000			80,000	110,496			111
$531,962		$21,750			$4,000	$5,525			112
						3,725,279			113
						$197,440			114
	365,000					700,000			115
	$18,250					$42,000			116
190,000						345,000			117
$31,000						$35,000			118
1,183,565						2,278,000			119
$14,617						$28,435			120
9,853,710		3,042,000			1,533,509	8,445,701	417,418		121
$300,789		$71,566			$33,505	$218,607	$40,737		122
10,000					558,300	739,312			123
$1,000					$31,042	$67,425			124
45,021,424	1,726,100	1,405,000	1,022,640	189,834	1,101,227	10,362,389	9,761,345	796,282	125
$2,634,159	$120,806	$74,150	$70,610	$50,686	$87,519	$633,551	$684,716	$100,084	126
2,586,440	25,112	181,485	387,575	94,017	232,544	479,011	547,206	298,661	127
$1,978,214	$26,279	$134,901	$282,525	$81,416	$205,740	$467,829	$974,318	$257,732	128
41,000					28,750	111,913	69,290		129
$26,250					$3,875	$95,772	$86,363		130
14,000						1,400	3,100		131
$16,000						$2,300	$6,940		132
16,000									133
$16,000									134
$36,511					$4,250	$16,483	$15,468		135
$353,200		$30,000	$3,950		$26,000	$128,215	$18,200		136
									137
2,086,400									138
$12,696									139
$35,150		$1,500	$2,000		$46,813	$52,400			140
						14,959			141
									142
									143
									144
									145
27	3	6	8	3	13	28	12	5	146
$5,889,568	$155,806	$336,867	$329,085	$132,102	$442,744	$1,953,047	$1,824,382	$339,031	147
$5,200,700	$130,000	$238,540	$300,457	$183,306	$367,193	$1,712,444	$1,643,346	$277,500	148
27	5	5	8	2	8	26	12	5	149
2,763	259	147	256	101	328	1,267	837	203	150
22	3	5	5	1	9	21	12	2	151
2,491	200	147	189	40	308	1,132	739	133	152
2	1		1	1					153
27	36		10	36					154
1									155
15									156
1						2	9		157
6						40	83		158
									159
									160
3	23		57			27	5	70	161
221				25	20	68	10		162
80							60		163
33	5	6	9	3	13	30	13	6	164
		2		1		1	1		165
8	1	1	5		5	6	4	1	166
8	3	1	3	1	5	16	3	3	167
10	1	2	1	1	3	5	1	2	168
4						2	2		169
3							2		170
									171
									172

Table 3.—PAINTS: SUMMARY

		Missouri.	Nebraska.	New Jersey.	New York.
	Products—Continued.				
	Aggregate value—Continued.				
	Acids—Continued.				
89	Acetic, pounds				
90	Value				
91	Sodas				
92	Alums, pounds				
93	Value				
94	Coal-tar distillery products				$716
	Wood distillation—				
95	Wood alcohol, refined, gallons				
96	Value				
97	Charcoal, bushels				
98	Value				
99	All other				
	Fertilizers—				
100	Complete, tons				
101	Value				
102	All other, tons				
103	Value				
	Dyestuffs—				
104	Natural, pounds				1,843,749
105	Value				$99,779
106	Artificial, pounds			650,000	
107	Value			$390,000	
	Tanning material—				
108	Natural, extracts, pounds				
109	Value				
	Paints, colors, and varnishes—				
110	Total value	$4,108,476	$838,151	$3,022,557	$12,225,159
	Pigments—				
111	White lead, pounds	4,942,814		14,471,171	39,109,000
112	Value	$243,681		$717,047	$547,440
113	Oxides of lead, pounds	3,581,604	1,125,262		12,426,000
114	Value	$183,189	$61,889		$663,176
115	Lamp, and other blacks, pounds				
116	Value				
117	Fine colors, pounds			1,135,284	1,192,466
118	Value			$190,893	$443,755
119	Iron oxides and other earth colors, pounds			500,000	15,458,000
120	Value			$25,000	$121,534
121	Dry colors, pounds	8,455,000		4,756,080	41,433,177
122	Value	$82,494		$441,580	$2,118,799
123	Pulp colors, sold moist, pounds			5,156,948	12,941,596
124	Value			$162,556	$580,623
	Paints—				
125	Paints in oil, in paste, pounds	45,782,816	8,850,306	8,545,256	68,997,820
126	Value	$2,267,924	$553,950	$517,159	$4,009,797
127	Paints already mixed for use, gallons	1,527,528	221,712	622,542	2,875,234
128	Value	$1,285,649	$219,712	$580,189	$2,862,426
	Varnishes and japans—				
129	Oil and turpentine varnishes, gallons	650		178,832	460,500
130	Value	$650		$148,245	$417,495
131	Alcohol varnishes, gallons			3,285	1,000
132	Value			$4,571	$1,000
133	Pyroxyline varnishes, gallons				
134	Value				
135	Liquid dryers, japans, and lacquers	$21,250		$23,857	$53,044
136	All other paints, colors, and varnishes	$23,639	$2,600	$211,460	$406,070
137	Fine chemicals				$4,092
	Chemicals not otherwise specified—				
138	Copperas, pounds				
139	Value				
140	Value of all other products	$214,879		$47,805	$214,079
	Products consumed:				
	Acids—				
141	Sulphuric, tons				
142	Nitric, pounds				
143	Lead oxides, pounds				
144	White lead, pounds		7,251,300		
145	All other products consumed, pounds			1,147,946	
	Comparison of products:				
146	Number of establishments reporting for both years	18	3	22	71
147	Value for census year	$4,161,355	$838,151	$2,490,554	$12,276,700
148	Value for preceding business year	$4,460,387	$758,424	$2,042,534	$11,743,756
	Power:				
149	Number of establishments reporting	15	3	23	63
150	Total horsepower	1,703	310	1,885	5,723
	Owned—				
	Engines—				
151	Steam, number	18	3	30	63
152	Horsepower	1,565	310	1,792	4,762
153	Gas, or gasoline, number	1			3
154	Horsepower	6			40
155	Water wheels, number			1	6
156	Horsepower			25	265
157	Electric motors, number	3		1	5
158	Horsepower	6		25	73
159	Other power, number				
160	Horsepower				
	Rented—				
161	Electric, horsepower	106			288
162	Other kind, horsepower	20		43	295
163	Furnished to other establishments, horsepower				76
	Establishments classified by number of persons employed, not including proprietors and firm members:				
164	Total number of establishments	20	3	27	82
165	No employees			1	2
166	Under 5	4		8	21
167	5 to 20	8	1	7	27
168	21 to 50	6		7	14
169	51 to 100	1	2	2	14
170	101 to 250			2	2
171	251 to 500	1			2
172	501 to 1,000				

BY STATES, 1900—Continued.

Ohio.	Oregon.	Pennsylvania.	Rhode Island.	Tennessee.	Texas.	Washington.	Wisconsin.	All other states.[1]	
...	...	1,715,007	...	...	...	...	...	...	89
...	...	$30,569	...	...	...	...	...	...	90
...	...	$39,614	...	...	...	...	...	...	91
...	...	25,445,612	...	...	...	...	...	...	92
...	...	$342,969	...	...	...	...	...	...	93
...	...	$1,000	...	...	...	...	...	...	94
...	...	...	...	...	...	...	...	78	95
...	...	...	...	...	...	...	...	$110	96
...	...	...	...	...	...	...	...	1,138	97
...	...	...	...	...	...	...	...	$137	98
...	...	...	...	...	...	...	...	$684	99
...	...	465	...	...	...	...	...	...	100
...	...	$10,497	...	...	...	...	...	...	101
...	...	685	...	...	...	...	...	...	102
...	...	$1,878	...	...	...	...	...	...	103
...	...	...	...	...	...	...	...	...	104
...	...	...	...	...	...	...	...	...	105
...	...	...	...	...	...	...	...	...	106
...	...	...	...	...	...	...	...	...	107
...	...	554,896	...	...	...	...	...	...	108
...	...	$10,161	...	...	...	...	...	...	109
$5,127,261	$96,131	$8,237,632	$166,818	$145,790	$39,830	$57,500	$881,717	$1,039,593	110
8,822,814	...	82,478,546	...	...	...	...	...	...	111
$383,475	...	$1,516,121	...	...	...	...	...	...	112
1,508,000	...	27,893,478	...	...	...	...	...	...	113
$79,792	...	$1,338,959	...	...	...	...	...	...	114
...	...	...	...	...	...	...	...	...	115
...	...	...	...	...	...	...	...	...	116
254,000	...	207,502	...	...	...	...	...	1,000	117
$19,900	...	$16,048	...	...	...	...	...	$200	118
80,000	...	6,294,331	...	7,660,000	...	...	...	...	119
$1,200	...	$96,816	...	$30,640	...	...	...	...	120
1,441,781	...	57,164,490	...	...	...	...	...	25,929,972	121
$95,010	...	$516,561	...	...	...	...	...	$146,499	122
...	...	594,379	...	...	...	...	60,400	...	123
...	...	$12,842	...	...	...	...	$6,043	...	124
30,595,967	30,576	56,313,415	629,800	142,000	241,429	...	6,000,000	2,662,097	125
$1,752,553	$7,644	$2,908,062	$70,775	$28,400	$15,600	...	$412,500	$141,315	126
2,574,468	78,991	1,994,333	35,554	106,073	26,200	48,500	430,000	471,329	127
$2,362,313	$88,487	$1,381,036	$33,829	$86,750	$23,930	$57,500	$387,550	$396,886	128
229,976	...	218,534	...	...	...	...	...	84,158	129
$237,237	...	$189,491	...	...	...	...	...	$31,483	130
1,505	...	17,829	1,250	...	...	...	2,500	500	131
$3,510	...	$31,612	$1,250	...	...	...	$3,324	$1,200	132
...	...	291	...	...	...	...	...	...	133
...	...	$225	...	...	...	...	...	...	134
$48,429	...	$57,902	...	...	[illegible]	...	$14,300	$4,201	135
$143,842	...	$171,957	$60,964	...	...	...	$58,000	$317,809	136
...	...	...	...	...	...	...	...	...	137
...	...	3,700,000	...	...	...	...	...	...	138
...	...	$16,650	...	...	...	...	...	...	139
$37,740	$45,428	$128,410	...	$5,000	...	...	$50	$2,400	140
...	...	12,182	...	...	...	...	...	...	141
...	...	611,427	...	...	...	...	...	...	142
...	...	374,061	...	...	...	...	...	...	143
...	...	17,509,347	...	...	...	...	...	...	144
...	...	14,846,296	...	...	...	...	...	3,283	145
39	3	65	4	5	5	2	5	11	146
$4,955,569	$141,559	$9,124,952	$166,818	$150,790	$39,830	$17,500	$881,767	$1,027,650	147
$3,934,070	$90,794	$7,365,106	$135,822	$131,600	$28,060	$15,100	$516,500	$765,295	148
37	2	62	1	2	4	2	5	13	149
2,350	35	6,267	108	122	30	50	367	1,018	150
26	1	108	2	1	3	...	5	12	151
2,033	30	5,492	100	100	25	...	367	651	152
4	...	1	...	1	...	...	...	1	153
92	...	50	...	22	...	...	...	5	154
1	...	11	...	...	...	...	...	4	155
1	...	210	...	...	...	...	...	329	156
12	...	12	...	...	...	...	...	1	157
120	...	127	...	...	...	...	...	9	158
...	...	3	...	...	...	...	...	...	159
...	...	300	...	...	...	...	...	...	160
47	5	28	...	...	5	50	...	24	161
57	...	60	8	...	...	...	...	...	162
28	...	155	15	...	...	...	...	...	163
45	3	66	4	5	5	3	5	17	164
2	...	...	...	1	...	...	1	1	165
9	...	23	2	1	3	2	2	7	166
18	2	22	1	2	2	1	1	5	167
11	1	11	1	1	...	...	...	1	168
2	...	5	...	...	...	...	...	1	169
2	...	4	...	...	...	...	1	2	170
1	...	...	...	...	...	...	...	...	171
...	...	1	...	...	...	...	...	...	172

---

[1] Includes establishments distributed as follows: Colorado, 2; Connecticut, 2; Delaware, 2; District of Columbia, 1; Kansas, 1; Maine, 2; Mississippi, 1; Nevada, 1; North Carolina, 2; Vermont, 2; Virginia, 1.

TABLE 4.—VARNISHES:

		United States.	California.	Connecticut.	Illinois.	Indiana.	Kentucky.
1	Number of establishments	181	3	[illegible]	19	3	3
	Character of organization:						
2	Individual	59	2	1	4		
3	Firm or limited partnership	41		2	2		
4	Incorporated company	81	1	5	13	3	3
	Capital:						
5	Total	$17,550,892	$148,500	$373,962	$2,344,728	$208,039	$187,749
6	Land	$1,573,916	$42,000	$22,400	$297,178	$11,556	$8,500
7	Buildings	$2,358,905	$21,000	$25,454	$348,279	$57,056	$25,775
8	Machinery, tools, and implements	$1,448,609	$11,000	$25,072	$180,996	$23,322	$13,807
9	Cash and sundries	$12,169,462	$74,500	$301,036	$1,518,275	$116,105	$139,667
10	Proprietors and firm members	119	1	6	10		
	Salaried officials, clerks, etc.:						
11	Total number	1,198	6	17	171	25	32
12	Total salaries	$1,939,333	$7,860	$21,550	$242,157	$32,480	$26,554
	Officers of corporations—						
13	Number	154	2	9	19	6	2
14	Salaries	$463,819	$2,700	$8,550	$66,104	$8,372	$2,150
	General superintendents, managers, clerks, etc.—						
15	Total number	1,044	4	8	152	19	30
16	Total salaries	$1,475,514	$5,160	$13,000	$176,053	$24,108	$24,404
	Men—						
17	Number	919	4	8	132	19	24
18	Salaries	$1,410,643	$5,160	$13,000	$166,616	$24,108	$22,650
	Women—						
19	Number	125			20		6
20	Salaries	$64,871			$9,437		$1,754
	Wage-earners, including pieceworkers, and total wages:						
21	Greatest number employed at any one time during the year	1,658	14	49	210	18	45
22	Least number employed at any one time during the year	1,485	12	26	163	17	45
23	Average number	1,546	14	32	187	18	41
24	Wages	$995,803	$7,316	$19,250	$124,688	$9,632	$19,940
	Men, 16 years and over—						
25	Average number	1,479	14	22	177	18	41
26	Wages	$976,174	$7,316	$16,250	$122,980	$9,632	$19,940
	Women, 16 years and over—						
27	Average number	62		10	9		
28	Wages	$18,878		$3,000	$1,552		
	Children, under 16 years—						
29	Average number	5			1		
30	Wages	$751			$156		
	Miscellaneous expenses:						
31	Total	$1,616,642	$4,850	$46,959	$138,423	$9,954	$3,841
32	Rent of works	$47,458	$120	$750	$5,611		$240
33	Taxes, not including internal revenue	$84,431	$380	$1,646	$10,498	$1,407	$1,061
34	Rent of offices, insurance, interest, and all sundry expenses not hitherto included.	$1,425,031	$4,350	$44,563	$120,584	$8,547	$2,540
35	Contract work	$59,722			$1,730		
	Materials used:						
36	Total cost	$10,939,131	$88,900	$234,474	$1,276,709	$143,514	$205,668
37	Gums	$2,947,060	$22,714	$107,499	$438,643	$48,872	$49,102
	Acids—						
38	Sulphuric, tons	2					
39	Value	$86					
40	Mixed, pounds	144,482					
41	Cost	$3,567					
	Alcohol—						
42	Grain, gallons	65,146	940	100	2,890	601	
43	Cost	$151,089	$2,150	$220	$5,491	$1,396	
44	Wood, gallons	274,221	2,773	690	88,206	591	
45	Cost	$255,354	$3,766	$1,400	$73,230	$591	
46	Dry colors	$260,317		$4,043	$7,302		
47	Lime, bushels	500					
48	Cost	$100					
49	Linseed oil, gallons	4,308,943	33,154	40,831	481,471	87,356	47,485
50	Cost	$2,056,469	$18,527	$21,772	$205,038	$37,589	$27,351
51	Potash salts	$609					
52	All other components of products	$3,713,681	$32,420	$78,984	$399,736	$38,516	$114,211
53	Fuel	$105,366	$715	$1,790	$17,235	$975	$994
54	Rent of power and heat	$4,741		$50	$50		
55	Mill supplies	$13,534	$5	$215	$994	$25	$135
56	All other materials	$1,261,952	$4,503	$15,569	$114,604	$11,235	$13,875
57	Freight	$165,206	$4,100	$2,932	$14,386	$4,315	
	Products:						
58	Aggregate value	$18,687,240	$130,805	$399,759	$2,190,265	$237,502	$334,978
	Cyanides—						
59	Potassium cyanide, pounds	25,945					
60	Value	$10,082					
61	Yellow prussiate of potash, pounds	25,000					
62	Value	$500					
63	Dyestuffs, artificial, pounds	40,000					
64	Value	$5,000					
	Paints, colors, and varnishes—						
65	Total value	$18,576,074	$130,805	$399,759	$2,190,265	$237,502	$315,978
	Pigments—						
66	Fine colors, pounds	81,000			11,000		
67	Value	$211,000			$1,000		
68	Dry colors, pounds	6,600,000					
69	Value	$304,000					
	Paints—						
70	Paints in oil, in paste, pounds	2,950,370				8,500	
71	Value	$195,637				$330	
72	Paints already mixed for use, gallons	287,850			8,034	9,500	
73	Value	$245,849			$17,196	$5,800	
	Varnishes and japans—						
74	Oil and turpentine varnishes, gallons	12,909,248	123,670	133,521	1,576,053	263,624	454,550
75	Value	$13,096,693	$120,392	$304,479	$1,594,904	$195,260	$314,603
76	Alcohol varnishes, gallons	503,442	2,670	175	134,943	1,210	100
77	Value	$833,522	$5,300	$404	$187,538	$3,569	$145
78	Pyroxyline varnishes, gallons	143,836		28,810		383	
79	Value	$162,601		$36,012		$594	
80	Liquid driers, japans, and lacquers	$2,781,115	$5,113	$43,104	$259,293	$21,949	$1,230
81	All other paints, colors, and varnishes	$745,657		$15,760	$130,334	$10,000	
82	Explosives, gun cotton, or pyroxyline, pounds	42,752					
83	Value	$45,959					

SUMMARY BY STATES, 1900.

Maryland.	Massachusetts.	Michigan.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[1]	
3	14	4	7	24	40	20	27	6	1
1	5	2	2	6	19	4	13	....	2
1	3	2	....	3	10	6	9	3	3
1	6	....	5	15	11	10	5	3	4
$48,604	$358,384	$934,370	$165,323	$3,949,265	$5,630,082	$1,195,885	$1,816,431	$189,570	5
....	$18,900	$28,500	$17,000	$300,548	$530,518	$90,081	$198,435	$8,300	6
$9,000	$36,088	$167,837	$8,660	$673,931	$617,937	$163,352	$186,138	$21,398	7
$9,456	$54,800	$53,796	$19,717	$364,641	$426,433	$84,519	$170,350	$10,700	8
$30,148	$248,596	$684,237	$119,946	$2,610,145	$4,055,194	$857,933	$1,261,508	$149,172	9
3	11	10	2	11	19	21	17	8	10
9	42	65	19	251	298	120	120	23	11
$7,264	$44,174	$150,400	$27,194	$372,559	$641,208	$165,317	$172,216	$28,400	12
2	11	....	2	31	33	20	12	5	13
$1,080	$22,423	....	$3,000	$99,470	$148,620	$58,050	$32,500	$10,800	14
7	31	65	17	220	265	100	108	18	15
$6,184	$21,751	$150,400	$24,194	$273,089	$492,588	$107,267	$139,716	$17,600	16
6	25	50	17	193	244	89	96	12	17
$6,100	$19,601	$141,600	$24,194	$257,424	$480,503	$101,645	$134,022	$14,020	18
1	6	15	....	27	21	11	12	6	19
$84	$2,150	$8,800	....	$15,665	$12,085	$5,622	$5,694	$3,580	20
13	57	108	29	235	554	120	181	25	21
11	46	103	23	212	527	111	164	25	22
12	51	106	27	221	537	109	167	24	23
$5,488	$31,595	$49,416	$17,361	$158,085	$343,558	$76,841	$119,428	$13,205	24
11	46	95	27	217	515	108	165	23	25
$5,254	$29,995	$46,736	$17,361	$157,173	$335,003	$76,541	$119,088	$12,905	26
1	5	11	....	2	21	1	1	1	27
$234	$1,600	$2,680	....	$612	$8,360	$300	$240	$300	28
....	....	....	....	2	1	....	1	....	29
....	....	....	....	$300	$195	....	$100	....	30
$3,994	$26,439	$262,401	$10,368	$197,258	$537,238	$165,960	$201,497	$7,460	31
$740	$5,976	$180	$2,990	$7,645	$13,202	$5,110	$4,054	$840	32
$197	$1,828	$10,296	$687	$15,564	$26,204	$8,494	$5,474	$695	33
$3,057	$18,635	$251,925	$6,691	$174,049	$497,332	$152,356	$134,477	$5,925	34
....	....	....	....	....	$500	....	$57,492	....	35
$34,734	$274,441	$814,857	$125,021	$1,306,244	$3,954,088	$910,910	$1,391,371	$178,200	36
$3,204	$101,632	$176,920	$28,551	$500,884	$1,041,516	$180,586	$209,530	$37,407	37
....	....	....	....	....	2	....	....	....	38
....	....	....	....	....	$86	....	....	....	39
....	....	....	....	144,482	....	....	....	....	40
....	....	....	....	$3,567	....	....	....	....	41
....	1,080	9,434	100	10,124	34,158	1,070	4,296	353	42
....	$2,604	$21,698	$245	$23,669	$80,080	$2,434	$10,303	$799	43
....	1,200	200	6,899	40,867	109,676	4,635	14,702	3,782	44
....	$1,100	$200	$4,112	$41,850	$103,880	$6,230	$13,850	$5,145	45
$4,400	$2,929	....	$4,041	$559	$1,534	$4,100	$217,075	$14,334	46
....	....	....	....	....	....	500	....	....	47
....	....	....	....	....	....	$100	....	....	48
9,726	99,091	315,607	45,925	441,705	1,567,095	375,066	675,611	88,820	49
$4,863	$47,958	$156,799	$20,240	$214,755	$721,707	$186,960	$348,312	$44,598	50
....	....	....	....	$609	....	....	....	....	51
$18,851	$95,600	$197,279	$58,207	$399,854	$1,417,212	$428,366	$375,533	$58,912	52
$614	$3,175	$3,705	$1,396	$11,768	$42,685	$8,940	$9,874	$1,500	53
....	$220	....	$50	$504	$2,955	$292	....	$620	54
$102	$194	$3,080	$85	$1,622	$4,563	$1,530	$884	$100	55
$1,950	$15,795	$155,176	$7,283	$101,307	$534,149	$81,423	$192,198	$12,885	56
$750	$3,234	$100,000	$811	$5,296	$3,721	$9,949	$13,812	$1,900	57
$64,521	$500,672	$1,561,150	$231,168	$2,753,562	$6,334,467	$1,538,623	$2,161,495	$248,273	58
....	....	....	....	25,945	....	....	....	....	59
....	....	....	....	$10,082	....	....	....	....	60
....	....	....	....	25,000	....	....	....	....	61
....	....	....	....	$500	....	....	....	....	62
....	....	....	....	....	40,000	....	....	....	63
....	....	....	....	....	$5,000	....	....	....	64
$64,521	$500,672	$1,561,150	$230,168	$2,731,726	$6,272,219	$1,535,623	$2,157,413	$248,273	65
....	....	....	....	....	70,000	....	....	....	66
....	....	....	....	....	$210,000	....	....	....	67
....	....	....	....	....	....	....	6,600,000	....	68
....	....	....	....	....	....	....	$304,000	....	69
....	40,000	....	14,107	127,655	2,000	....	2,758,108	....	70
....	$2,000	....	$15,000	$35,293	$100	....	$142,914	....	71
....	....	....	14,740	....	46,900	3,750	168,926	36,000	72
....	....	....	$9,600	....	$46,015	$3,625	$124,013	$39,600	73
27,050	324,619	1,563,673	109,519	1,486,013	4,467,708	1,015,589	1,190,122	173,537	74
$19,950	$346,828	$1,543,074	$126,990	$2,106,076	$4,248,219	$940,160	$1,047,181	$188,577	75
....	3,000	475	2,106	64,258	219,705	41,799	27,301	5,700	76
....	$9,060	$1,511	$3,277	$119,652	$400,428	$46,597	$46,041	$10,000	77
....	....	....	6,500	5,366	102,777	....	....	....	78
....	....	....	$16,000	$10,995	$99,000	....	....	....	79
$16,571	$122,910	$15,193	$59,301	$350,382	$1,021,069	$463,870	$401,034	$96	80
$28,000	$19,874	$1,372	....	$109,328	$247,388	$81,371	$92,230	$10,000	81
....	....	....	....	7,752	35,000	....	....	....	82
....	....	....	....	$10,959	$35,000	....	....	....	83

---

[1] Includes establishments distributed as follows: Louisiana, 1; Maine, 1; Minnesota, 1; Oregon, 1; Rhode Island, 1; Virginia, 1.

TABLE 4.—VARNISHES: SUMMARY

		United States.	California.	Connecticut.	Illinois.	Indiana.	Kentucky.
	Products—Continued.						
	Aggregate value—Continued.						
84	Fine chemicals	$5,000	....	....	....	....	....
85	Value of all other products	$44,625	....	....	....	....	$19,000
86	Products consumed	$748,624	....	$21,000	....	....	....
	Comparison of products:						
87	Number of establishments reporting for both years	162	3	8	18	3	2
88	Value for census year	$17,441,726	$130,805	$399,759	$2,137,765	$237,502	$285,700
89	Value for preceding business year	$15,510,030	$119,660	$435,113	$1,960,058	$209,676	$220,000
	Power:						
90	Number of establishments reporting	93	....	3	14	2	2
91	Total horsepower	4,192	....	62	482	67	140
	Owned—						
	Engines—						
92	Steam, number	102	....	1	12	2	4
93	Horsepower	3,699	....	35	422	50	140
94	Gas or gasoline, number	10	....	....	4	....	....
95	Horsepower	156	....	....	32	....	....
96	Water wheels, number	5	....	....	....	....	....
97	Horsepower	105	....	....	....	....	....
98	Electric motors, number	27	....	....	3	2	....
99	Horsepower	93	....	....	8	17	....
100	Other power, number	1	....	1	....	....	....
101	Horsepower	25	....	25	....	....	....
	Rented—						
102	Electric, horsepower	85	....	2	20	....	....
103	Other kind, horsepower	29	....	....	....	....	....
104	Furnished to other establishments, horsepower	120	....	....	75	....	....
	Establishments classified by number of persons employed, not including proprietors and firm members:						
105	Total number of establishments	181	3	8	19	3	3
106	No employees	5	....	....	....	....	....
107	Under 5	58	1	2	4	....	1
108	5 to 20	85	2	5	8	2	1
109	21 to 50	21	....	1	5	1	....
110	51 to 100	7	....	....	2	....	1
111	101 to 250	5	....	....	....	....	....

BY STATES, 1900—Continued.

Maryland.	Massachusetts.	Michigan.	Missouri.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[1]	
...	...	...	...	...	$5,000	...	...	...	84
...	...	...	$1,000	$295	$17,248	$3,000	$4,082	...	85
...	...	...	...	$546,000	$116,000	...	$65,624	...	86
3	13	3	7	20	35	19	22	6	87
$64,521	$492,672	$1,560,150	$231,168	$2,638,552	$5,644,005	$1,534,373	$1,836,481	$248,273	88
$72,686	$423,439	$1,252,354	$215,894	$2,400,716	$4,796,734	$1,436,418	$1,768,808	$198,474	89
2	6	1	3	11	24	10	14	1	90
52	430	250	48	475	1,136	230	795	25	91
1	6	1	2	10	32	9	22	...	92
40	325	250	13	458	1,036	205	725	...	93
1	...	...	1	...	2	...	2	...	94
12	...	...	25	...	27	...	60	...	95
...	1	...	...	...	4	...	...	...	96
...	100	...	...	...	5	...	...	...	97
...	...	...	...	2	17	2	1	...	98
...	...	...	...	2	41	15	10	...	99
...	...	...	...	...	...	...	...	...	100
...	...	...	...	...	...	...	...	...	101
...	3	...	...	15	10	10	...	25	102
...	2	...	10	...	17	...	...	...	103
...	...	25	...	...	20	...	...	...	104
[illegible]	14	4	7	24	40	20	27	6	105
...	...	1	...	1	1	...	2	...	106
...	5	1	3	6	14	7	13	1	107
[illegible]	9	1	4	12	15	10	8	5	108
...	...	...	...	3	6	2	3	...	109
...	...	...	...	1	2	1	...	...	110
...	...	1	...	1	2	...	1	...	111

[1] Includes establishments distributed as follows: Louisiana, 1; Maine, 1; Minnesota, 1; Oregon, 1; Rhode Island, 1; Virginia, 1.

TABLE 5.—EXPLOSIVES: SUMMARY BY STATES, 1900.

	United States.	California.	Illinois.	Indiana.	Michigan.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[1]
Number of establishments	97	7	3	6	5	10	5	9	36	16
Character of organization:										
Individual	10	....	....	....	1	....	....	1	8	....
Firm and limited partnership	11	....	....	....	....	....	1	1	9	....
Incorporated company	76	7	3	6	4	10	4	7	19	16
Capital:										
Total	$19,465,846	$3,283,928	$493,566	$876,146	$351,930	$4,283,307	$451,505	$1,972,451	$2,819,458	$4,933,555
Land	$1,168,753	$206,987	$32,474	$27,250	$9,680	$136,125	$40,000	$315,000	$110,466	$290,771
Buildings	$3,003,089	$909,985	$52,240	$181,825	$47,200	$502,664	$67,475	$365,786	$391,515	$484,399
Machinery, tools, and implements	$3,114,120	$394,029	$124,443	$78,114	$50,598	$556,104	$101,815	$373,000	$943,102	$492,915
Cash and sundries	$12,179,884	$1,772,927	$284,409	$588,957	$244,452	$3,088,414	$242,215	$918,665	$1,374,375	$3,665,470
Proprietors and firm members	23	....	....	....	1	....	2	3	17	....
Salaried officials, clerks, etc.:										
Total number	768	82	14	37	24	255	19	56	102	179
Total salaries	$914,447	$130,860	$14,133	$55,400	$42,580	$206,822	$18,003	$92,520	$130,394	$223,735
Officers of corporations—										
Number	161	13	5	6	4	33	10	17	28	45
Salaries	$349,371	$20,650	$10,180	$14,400	$9,200	$63,907	$9,180	$51,300	$61,280	$109,274
General superintendents, managers, clerks, etc.—										
Total number	607	69	9	31	20	222	9	39	74	134
Total salaries	$565,076	$110,210	$3,953	$41,000	$33,380	$142,915	$8,823	$41,220	$69,114	$114,461
Men—										
Number	558	64	7	28	18	208	9	32	66	126
Salaries	$544,421	$107,450	$3,560	$39,720	$32,020	$137,711	$8,823	$38,260	$65,139	$111,738
Women—										
Number	49	5	2	3	2	14	....	7	8	8
Salaries	$20,655	$2,760	$393	$1,280	$1,360	$5,204	....	$2,960	$3,975	$2,723
Wage-earners, including pieceworkers, and total wages:										
Greatest number employed at any one time during the year	5,352	1,047	115	291	136	1,348	145	378	727	1,165
Least number employed at any one time during the year	3,830	762	48	166	85	926	64	313	553	913
Average number	4,502	906	71	245	113	1,146	85	352	629	955
Wages	$2,383,756	$602,765	$32,064	$118,979	$66,282	$563,621	$52,288	$178,786	$320,362	$448,609
Men, 16 years and over—										
Average number	4,349	882	71	217	108	1,137	85	350	598	901
Wages	$2,346,887	$593,128	$32,064	$114,299	$64,749	$561,743	$52,288	$178,286	$312,357	$437,973
Women, 16 years and over—										
Average number	117	24	....	28	5	8	....	2	27	23
Wages	$30,781	$9,637	....	$4,680	$1,533	$1,732	....	$500	$7,405	$5,294
Children, under 16 years—										
Average number	36	....	....	....	....	1	....	....	4	31
Wages	$6,088	....	....	....	....	$146	....	....	$600	$5,342
Miscellaneous expenses:										
Total	$1,096,604	$255,278	$15,007	$43,546	$19,833	$215,621	$11,543	$103,756	$200,371	$231,649
Rent of works	$6,350	$1,600	....	$25	$200	....	....	$1,110	$3,215	$200
Taxes, not including internal revenue	$64,161	$10,178	$1,081	$3,081	$1,183	$8,326	$1,968	$9,198	$10,889	$18,257
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$1,018,435	$243,500	$13,926	$38,440	$14,250	$207,295	$9,575	$92,748	$186,267	$212,434
Contract work	$7,658	....	....	$2,000	$4,200	....	....	$700	....	$758
Materials used:										
Total cost	$10,334,974	$2,669,634	$143,937	$610,209	$501,584	$2,048,837	$201,331	$773,269	$1,500,252	$1,885,921
Wood, for alcohol, cords	600	....	....	....	....	....	....	....	....	600
Cost	$4,800	....	....	....	....	....	....	....	....	$4,800
Acids—										
Sulphuric, tons	7,864	140	....	2,005	406	4,954	....	....	342	17
Cost	$130,699	$2,296	....	$36,895	$9,748	$65,736	....	....	$15,728	$296
Nitric, pounds	467,587	319,987	....	....	....	....	....	....	113,600	34,000
Cost	$17,171	$13,359	....	....	....	....	....	....	$2,272	$1,540
Mixed, pounds	66,906,146	12,100,000	....	3,020,000	6,694,964	21,052,244	548,861	6,208,183	9,874,537	7,407,357
Cost	$1,505,754	$148,718	....	$86,449	$189,276	$372,403	$15,221	$164,207	$238,593	$290,887
Ammonia, aqua, pounds	649,703	....	....	120,703	140,000	340,000	....	....	48,640	360
Cost	$11,303	....	....	$3,438	$2,000	$3,400	....	....	$2,443	$22
Alcohol—										
Grain, gallons	122,516	7,712	....	....	....	113,753	....	....	1,051	....
Cost	$47,406	$17,350	....	....	....	$28,930	....	....	$1,126	....
Wood, gallons	14,004	....	....	....	....	13,604	....	....	400	....
Cost	$10,531	....	....	....	....	$10,166	....	....	$365	....
Glycerine, pounds	16,983,918	5,765,997	....	1,407,659	1,152,501	3,866,604	72,883	816,169	1,913,237	1,988,868
Cost	$2,016,557	$681,840	....	$157,945	$142,873	$434,101	$9,110	$109,304	$258,357	$223,027
Lead, tons	7	....	....	....	....	....	....	....	7	....
Cost	$910	....	....	....	....	....	....	....	$910	....
Nitrate of potash, tons	1,847	....	257	....	....	28	549	383	44	586
Cost	$150,544	....	$19,826	....	....	$2,780	$48,807	$31,282	$3,354	$44,495
Nitrate of soda, tons	88,524	22,503	2,182	4,735	2,203	14,513	1,883	8,379	14,876	17,250
Cost	$2,902,866	$700,396	$69,776	$164,567	$76,342	$485,704	$62,821	$277,529	$495,576	$570,155
Potash salts	$45,947	....	....	....	....	$20,902	....	....	$1,000	$24,045
Sulphur, tons	12,742	5,482	323	198	51	308	344	1,355	2,031	2,650
Cost	$317,382	$126,355	$7,004	$6,773	$1,002	$7,296	$11,035	$33,243	$57,872	$66,803
All other components of products	$1,056,602	$403,278	$8,503	$47,541	$18,138	$244,041	$9,070	$13,781	$70,582	$241,668
Fuel	$356,950	$110,645	$3,576	$18,209	$6,731	$82,763	$4,675	$24,168	$32,721	$73,462
Rent of power and heat	$5,500	$5,500	....	....	....	....	....	....	....	....
Mill supplies	$130,384	$53,611	$2,304	$1,747	$1,824	$23,458	$2,956	$12,260	$20,633	$11,591
All other materials	$1,258,883	$288,107	$20,161	$66,306	$27,995	$254,321	$36,351	$86,568	$228,748	$250,326
Freight	$364,784	$118,179	$12,787	$20,339	$25,655	$12,836	$1,285	$20,927	$69,972	$82,804
Products:										
Total value	$17,125,418	$4,283,818	$289,735	$976,247	$691,766	$3,549,216	$332,998	$1,330,489	$2,595,180	$3,075,969
Acids—										
Sulphuric, 50° Beaumé, tons	310	....	....	....	....	187	....	....	123	....
Value	$7,478	....	....	....	....	$5,428	....	....	$2,050	....
Nitric, pounds	1,507,126	....	....	140,706	....	1,366,420	....	....	....	....
Value	$22,054	....	....	$2,814	....	$19,240	....	....	....	....
Other kinds of acids	$2,111	....	....	....	....	$2,111	....	....	....	....
Explosives—										
Gunpowder, pounds	123,314,103	500,000	6,358,250	4,925,000	....	5,477,900	5,939,200	21,627,675	34,961,649	43,524,429
Value	$5,310,351	$80,000	$270,974	$214,324	....	$240,027	$263,594	$927,098	$1,507,807	$1,806,527
Nitroglycerine pounds	3,618,692	....	....	675,000	4,000	14,199	....	1,455,113	1,163,918	306,462
Value	$783,299	....	....	$118,750	$2,000	$2,191	....	$351,970	$256,289	$52,099
Guncotton, or pyroxyline, pounds	228,342	50,000	....	....	....	178,342	....	....	....	....
Value	$103,702	$30,000	....	....	....	$73,702	....	....	....	....
Dynamite, pounds	85 846,456	27,055 910	....	6,456,041	6,643,975	25,550,543	671,215	....	8,507,676	10,961,096
Value	$8,247,223	$2,895,703	....	$614,934	$652,174	$2,185,365	$69,404	....	$790,372	$1,039,271

[1] Includes establishments distributed as follows: Alabama, 2; Connecticut, 1; Delaware, 1; Iowa, 1; Kansas, 1; Maine, 1; Massachusetts, 2; Missouri, 1; Tennessee, 2; Vermont, 1; Virginia, 1; West Virginia, 1; Wisconsin, 1.

TABLE 5.—EXPLOSIVES: SUMMARY BY STATES, 1900—Continued.

	United States.	California.	Illinois.	Indiana.	Michigan.	New Jersey.	New York.	Ohio.	Pennsylvania.	All other states.[1]
Products—Continued.										
Total value—Continued.										
Explosives—Continued.										
Smokeless powder, pounds	2,973,126	1,361,000		68,938		1,477,633		61,555		4,000
Value	$1,655,948	$816,600		$22,936		$765,991		$49,021		$1,400
All other explosives	$850,453	$452,250	$18,761		$37,592	$175,000		$2,400	$16,900	$147,550
Value of all other products	$142,799	$9,265		$2,489		$80,161			$21,762	$29,122
Products consumed:										
Acids—										
Sulphuric, tons	32,366	25,200		3,605		3,561				
Nitric, pounds	14,558,135	3,600,000		1,986,740	586,105	8,385,290				
Mixed, pounds	12,000,000	12,000,000								
Charcoal, bushels	48,285									48,285
Ether, pounds	1,192,704	799,579				393,125				
Nitrate of ammonia, pounds	158,307			81,115	77,192					
Nitroglycerine, pounds	31,661,806	10,895,803		2,254,788	2,547,820	8,877,764	182,000	105,350	2,756,709	4,041,572
Pyroxyline, pounds	1,301,461			4,310		1,297,151				
All other products consumed, pounds	6,230,313	1,715,372				275,617				4,239,324
Comparison of products:										
Number of establishments reporting for both years	80	6	2	5	4	9	5	8	28	13
Value for census year	$16,218,540	$4,236,568	$272,578	$972,498	$603,426	$3,471,183	$332,998	$1,276,489	$2,078,731	$2,979,069
Value for preceding business year	$13,607,449	$3,573,032	$241,768	$774,203	$490,370	$2,553,693	$303,985	$1,144,097	$1,813,112	$2,718,189
Power										
Number of establishments reporting	93	7	2	6	5	9	5	9	34	16
Total horsepower	22,080	1,279	560	760	271	3,458	1,329	3,979	3,673	6,771
Owned—										
Engines—										
Steam, number	315	20	1	11	11	56	13	34	101	65
Horsepower	13,242	695	560	660	121	2,582	390	2,136	2,803	3,295
Gas or gasoline, number	7	2					2		1	2
Horsepower	72	9					32		15	16
Water wheels, number	190	7			6		33	11	46	87
Horsepower	5,674	200			150		817	602	853	3,052
Electric motors, number	177	18		22		55	6	52		24
Horsepower	2,885	220		100		826	90	1,241		408
Other power, number	4	2				1			1	
Horsepower	97	45				50			2	
Rented—										
Electric, horsepower	110	110								
Furnished to other establishments, horsepower	180							180		
Establishments classified by number of persons employed, not including proprietors and firm members:										
Total number of establishments	97	7	3	6	5	10	5	9	36	16
Under 5	7			1					6	
5 to 20	30	1		2	2	1	1	4	16	3
21 to 50	29	2	1	1	2	2	4	1	10	6
51 to 100	15	1	2	1	1	1		2	4	3
101 to 250	12	2		1		5		2		2
251 to 500	3					1				2
501 to 1,000	1	1								

---

[1] Includes establishments distributed as follows: Alabama, 2; Connecticut, 1; Delaware, 1; Iowa, 1; Kansas, 1; Maine, 1; Massachusetts, 2; Missouri, 1; Tennessee, 2; Vermont, 1; Virginia, 1; West Virginia, 1; Wisconsin, 1.

TABLE 6.—OIL, ESSENTIAL: SUMMARY BY STATES, 1900.

	United States.	Connecticut.	Indiana.	Michigan.	New York.	Virginia.	All other states.[1]
Number of establishments	70	5	7	22	14	13	9
Character of organization:							
Individual	47	2	7	17	7	7	7
Firm and limited partnership	17	1		5	3	6	2
Incorporated company	6	2			4		
Capital:							
Total	$612, 657	$65, 500	$18, 425	$227, 496	$256, 885	$13, 884	$30, 467
Land	$180, 331	$11, 700	$14, 235	$88, 246	$52, 220	$145	$13, 785
Buildings	$130, 401	$32, 100	$1, 020	$57, 390	$35, 910	$3, 120	$861
Machinery, tools, and implements	$78, 219	$11, 200	$1, 950	$25, 010	$29, 075	$4, 719	$6, 265
Cash and sundries	$223, 706	$10, 500	$1, 220	$56, 850	$139, 680	$5, 900	$9, 556
Proprietors and firm members	73	4	7	28	2	22	10
Salaried officials, clerks, etc.:							
Total number	42	2		13	24	2	1
Total salaries	$25, 523	$2, 000		$9, 290	$13, 318	$519	$396
Officers of corporations—							
Number	7				7		
Salaries	$3, 680				$3, 680		
General superintendents, managers, clerks, etc.—							
Total number	35	2		13	17	2	1
Total salaries	$21, 843	$2, 000		$9, 290	$9, 638	$519	$396
Men—							
Number	31	2		13	13	2	1
Salaries	$21, 343	$2, 000		$9, 290	$9, 138	$519	$396
Women—							
Number	4				4		
Salaries	$500				$500		
Wage-earners, including pieceworkers, and total wages:							
Greatest number employed at any one time during the year	505	17	80	263	63	60	22
Least number employed at any one time during the year	283	10	76	87	52	48	10
Average number	199	8	13	97	42	29	10
Wages	$69, 100	$2, 957	$2, 903	$28, 667	$24, 295	$6, 819	$3, 459
Men, 16 years and over—							
Average number	191	7	13	93	39	29	10
Wages	$67, 186	$2, 503	$2, 903	$28, 032	$23, 470	$6, 819	$3, 459
Women, 16 years and over—							
Average number	7	1		3	3		
Wages	$1, 839	$454		$560	$825		
Children, under 16 years—							
Average number	1			1			
Wages	$75			$75			
Miscellaneous expenses:							
Total	$49, 762	$2, 260	$366	$7, 368	$38, 411	$691	$666
Rent of works	$2, 720	$10		$10	$2, 427	$183	$90
Taxes, not including internal revenue	$3, 240	$235	$152	$1, 376	$1, 326	$51	$100
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$43, 398	$1, 615	$214	$5, 982	$34, 658	$457	$472
Contract work	$404	$400					$4
Materials used:							
Total cost	$596, 112	$29, 208	$2, 876	$124, 803	$412, 832	$21, 807	$4, 586
Gums	$440				$440		
Wood, for extracts—							
Tons	1, 441	692					749
Cost	$5, 726	$3, 003					$2, 723
Alcohol, grain—							
Gallons	13, 258	10, 000			3, 248		10
Cost	$31, 630	$23, 850			$7, 756		$24
All other components of products	$513, 188		$2, 307	$116, 723	$373, 894	$19, 194	$1, 070
Fuel	$16, 241	$250	$305	$1, 996	$11, 929	$1, 246	$515
Rent of power and heat	$543				$543		
Mill supplies	$2, 481	$78	$9	$1, 065	$1, 125	$170	$34
All other materials	$21, 604	$1, 925	$255	$4, 519	$13, 515	$1, 182	$208
Freight	$4, 259	$102		$500	$3, 630	$15	$12
Products:							
Aggregate value	$850, 093	$45, 530	$14, 180	$208, 568	$531, 000	$37, 772	$13, 043
Essential oils—							
Total value	$843, 731	$45, 530	$14, 180	$202, 258	$531, 000	$37, 772	$12, 991
Natural, pounds	881, 829	300	17, 683	218, 453	517, 462	117, 721	10, 210
Value	$737, 032	$480	$14, 180	$202, 258	$469, 351	$37, 772	$12, 991
Witch-hazel, gallons	110, 260	91, 000			19, 260		
Value	$54, 649	$45, 050			$9, 599		
Artificial, value	$52, 050				$52, 050		
Value of all other products	$6, 362			$6, 310			$52
Comparison of products:							
Number of establishments reporting for both years	56	3	7	21	11	7	7
Value for census year	$805, 605	$35, 480	$14, 180	$206, 768	$513, 030	$24, 643	$11, 504
Value for preceding business year	$763, 770	$25, 000	$16, 898	$204, 490	$482, 830	$23, 060	$11, 492
Power:							
Number of establishments reporting	52	5	2	17	11	13	4
Total horsepower	1, 048	137	8	252	432	193	26
Owned—							
Engines—							
Steam, number	63	4	2	22	18	14	3
Horsepower	980	87	8	252	417	193	23
Gas or gasoline, number	2				1		1
Horsepower	5				2		3
Water wheels, number	2	2					
Horsepower	50	50					
Rented—							
Electric, horsepower	8				8		
Other kind, horsepower	5				5		

[1] Includes establishments distributed as follows: California, 2; Florida, 1; Massachusetts, 1; North Carolina, 1; Pennsylvania, 2; Wisconsin, 2.

TABLE 6.—ESSENTIAL: SUMMARY BY STATES, 1900—Continued.

	United States.	Connecticut.	Indiana.	Michigan.	New York.	Virginia.	All other states.[1]
Establishments classified by number of persons employed, not including proprietors and firm members:							
Total number of establishments	70	5	7	22	14	13	9
No employees	5			1	1		3
Under 5	38	4	2	13	9	7	3
5 to 20	24	1	5	6	3	6	3
21 to 50	2			1	1		
101 to 250	1			1			

[1] Includes establishments distributed as follows: California, 2; Florida, 1; Massachusetts, 1; North Carolina, 1; Pennsylvania, 2; Wisconsin, 2.

TABLE 7.—CHEMICALS:

		United States.	California.	Connecticut.	Illinois.	Indiana.	Maine.
1	Number of establishments	459	21	3	26	7	5
	Character of organization:						
2	Individual	113	4		5		3
3	Firm and limited partnership	97	4		3	3	
4	Incorporated company	249	13	3	18	4	2
	Capital:						
5	Total	$89,091,430	$1,844,928	$311,399	$2,384,062	$1,076,390	$550,426
6	Land	$9,924,613	$248,752	$8,850	$449,938	$90,269	$2,335
7	Buildings	$14,447,998	$289,511	$21,000	$299,569	$206,398	$47,396
8	Machinery, tools, and implements	$25,173,778	$651,992	$146,849	$887,849	$478,601	$467,459
9	Cash and sundries	$39,545,041	$654,673	$134,700	$746,706	$301,122	$33,236
10	Proprietors and firm members	242	11		13	7	3
	Salaried officials, clerks, etc.:						
11	Total number	2,123	62	12	96	41	7
12	Total salaries	$2,923,033	$70,493	$9,068	$119,028	$53,077	$2,733
	Officers of corporations—						
13	Number	326	19	4	16	5	1
14	Salaries	$741,570	$21,300	$2,800	$30,125	$13,000	$1,000
	General superintendents, managers, clerks, etc.—						
15	Total number	1,797	43	8	80	36	6
16	Total salaries	$2,181,463	$49,193	$6,268	$88,903	$40,077	$1,733
	Men—						
17	Number	1,660	36	7	69	35	6
18	Salaries	$2,115,477	$44,543	$6,060	$84,458	$39,877	$1,733
	Women—						
19	Number	137	7	1	11	1	
20	Salaries	$65,986	$4,650	$208	$4,445	$200	
	Wage-earners, including pieceworkers, and total wages:						
21	Greatest number employed at any one time during the year	22,081	628	55	692	353	22
22	Least number employed at any one time during the year	16,603	263	40	505	299	20
23	Average number	19,054	390	45	579	297	12
24	Wages	$9,401,467	$230,395	$31,716	$309,286	$154,173	$4,928
	Men, 16 years and over—						
25	Average number	18,132	387	45	513	294	12
26	Wages	$9,141,804	$228,973	$31,716	$293,006	$153,408	$4,928
	Women, 16 years and over—						
27	Average number	856	3		48	2	
28	Wages	$248,011	$1,422		$13,187	$660	
	Children, under 16 years—						
29	Average number	66			18	1	
30	Wages	$11,652			$3,093	$105	
	Miscellaneous expenses:						
31	Total	$4,363,868	$89,823	$8,877	$90,293	$74,406	$2,991
32	Rent of works	$153,715	$1,280	$4,000	$11,100	$30	$500
33	Taxes, not including internal revenue	$306,696	$8,089	$608	$7,113	$5,183	$263
34	Rent of offices, insurance, interest, and all sundry expenses, not hitherto included.	$3,870,595	$80,454	$4,269	$72,080	$69,193	$2,228
35	Contract work	$32,862					
	Materials used:						
36	Total cost	$34,564,137	$1,406,425	$105,105	$1,175,571	$487,066	$16,758
37	Gums	$514,627			$16		
38	Limestone, tons	765,064	1,600		9,250		
39	Cost	$660,220	$8,000		$1,330		
40	Phosphate rock, tons	9,845	300		200		
41	Cost	$66,088	$3,900		$500		
42	Pyrites, tons	324,461	6,331	2,597	4,337	18,867	1,000
43	Cost	$1,512,490	$34,658	$13,585	$25,965	$108,789	$5,000
	Wood—						
44	For alcohol, cords	494,447				15,000	
45	Cost	$1,250,942				$40,000	
46	For extracts, tons	3,000	3,000				
47	Cost	$18,000	$18,000				
	Acids—						
48	Sulphuric, tons	37,832	746		6,797	245	
49	Cost	$429,903	$22,122		$66,525	$3,520	
50	Nitric, pounds	2,439,297			25,000		
51	Cost	$127,811			$1,000		
52	Mixed, pounds	550,500	398,500				
53	Cost	$21,047	$3,186				
54	Acid phosphate, tons	59	50				
55	Cost	$4,552	$2,000				
56	Argols	$2,204,800	$245,000				
	Ammonia—						
57	Aqua, pounds	415,609,303	89,158,596			7,000	
58	Cost	$1,051,703	$12,542			$350	
59	Sulphate, pounds	8,745,568	200,000	328	130,268		
60	Cost	$471,117	$4,250	$11	$4,056		
	Alcohol—						
61	Grain, gallons	120,474			400		
62	Cost	$263,472			$938		
63	Wood, gallons	3,371,090					
64	Cost	$1,457,854					
65	Bones, tankage, and offal	$543,898	$56,000		$62,998		
66	Common salt, tons	38,996	454	17	5,058	3,048	
67	Cost	$130,108	$1,639	$76	$19,120	$10,494	
68	Dry colors	$9,868					
69	Glycerine, pounds	17,651,212			617,195		
70	Cost	$1,402,762			$57,642		
71	Lead, tons	5,217					
72	Cost	$20,359					
73	Lime, bushels	7,378,408	3,509		2,002	18,432	
74	Cost	$434,367	$700		$397	$3,090	
75	Linseed oil, gallons	13,000					
76	Cost	$7,500					
77	Nitrate of potash, tons	3,353					
78	Cost	$117,499					
79	Nitrate of soda, tons	37,892	3,410	1,070	490	4,222	30
80	Cost	$1,250,520	$104,758	$35,692	$17,668	$148,631	$1,200
81	Potash salts	$725,187	$8,500		$1,200		$2,289
82	Sulphur, tons	55,296	4,454	1,655	2,265		
83	Cost	$1,080,716	$102,926	$32,104	$46,397		
84	Tallow and fats	$337,317					$3
85	Wood ashes, bushels	801,047				25,200	21,960
86	Cost	$39,507				$1,280	$2,044
87	All other components of products	$10,423,149	$406,743	$3,656	$577,112	$90,239	$30

SUMMARY BY STATES, 1900.

Maryland.	Massachusetts.	Michigan.	Missouri	Nevada.	New Jersey.	New York.	Ohio.	Pennsylvania.	Rhode Island.	Wisconsin.	All other states.[1]	
7	17	51	8	3	61	92	35	100	4	4	15	1
1	2	30	1	...	14	25	13	11	2	...	2	2
1	4	7	...	3	10	18	6	36	1	1	...	3
5	11	14	7	...	37	49	16	53	1	3	13	4
$1,806,272	$1,877,371	$7,503,853	$1,969,875	$48,075	$17,284,675	$22,105,837	$3,670,401	$22,756,656	$340,724	$288,455	$3,272,031	5
$551,000	$65,969	$1,047,560	$181,224	$5,000	$2,114,179	$1,159,611	$397,680	$2,030,346	$18,000	...	$1,553,900	6
$239,182	$343,314	$1,531,264	$294,389	$2,050	$2,797,240	$3,391,799	$518,045	$3,939,376	$42,500	...	$484,965	7
$505,465	$367,912	$3,258,405	$427,586	$7,025	$3,728,737	$5,484,870	$976,144	$6,709,182	$31,300	$154,995	$889,407	8
$510,625	$1,100,176	$1,666,624	$1,066,676	$34,000	$8,644,519	$12,069,557	$1,778,532	$10,077,752	$248,924	$133,460	$343,759	9
3	8	46	1	7	38	23	21	54	3	2	2	10
33	92	143	78	1	402	503	164	415	11	33	30	11
$51,424	$133,091	$215,999	$111,606	$600	$577,837	$718,831	$199,166	$572,846	$12,903	$43,050	$31,781	12
8	15	30	10	...	39	69	22	66	1	6	15	13
$22,650	$42,240	$64,690	$27,237	...	$132,060	$192,584	$32,710	$138,098	$2,500	$2,876	$15,700	14
25	77	113	68	1	363	434	142	349	10	27	15	15
$28,774	$90,851	$151,309	$84,369	$600	$445,277	$526,247	$166,456	$434,748	$10,403	$40,174	$16,081	16
22	66	106	62	1	348	404	126	323	9	27	13	17
$27,284	$86,244	$147,286	$81,032	$600	$438,358	$511,149	$158,424	$423,111	$9,983	$40,174	$15,161	18
3	11	7	6	...	15	30	16	26	1	...	2	19
$1,490	$4,607	$4,023	$3,337	...	$6,919	$15,098	$8,032	$11,637	$420	...	$920	20
584	747	3,409	366	48	3,419	5,332	745	4,551	151	70	909	21
408	529	2,341	336	35	2,541	3,856	551	4,101	76	55	647	22
475	622	2,897	340	20	3,048	4,531	609	4,278	100	64	747	23
$246,454	$338,716	$1,162,634	$162,351	$7,170	$1,575,132	$2,302,999	$340,332	$2,198,243	$43,204	$26,258	$267,476	24
472	580	2,851	277	18	2,755	4,429	583	4,055	85	49	727	25
$245,648	$328,631	$1,155,673	$150,557	$6,680	$1,473,582	$2,269,815	$333,063	$2,186,905	$40,804	$24,569	$263,846	26
8	39	46	37	2	289	102	24	211	15	15	20	27
$806	$9,476	$6,961	$7,152	$490	$100,918	$33,184	$7,000	$59,036	$2,400	$1,689	$3,630	28
...	3	...	26	...	4	...	2	12	...	...	...	29
...	$609	...	$4,642	...	$632	...	$269	$2,302	...	...	...	30
$103,388	$268,236	$503,732	$135,806	$2,086	$638,013	$1,142,851	$157,810	$931,869	$35,995	$57,549	$120,143	31
$4,037	$5,780	$3,085	$7,200	...	$17,337	$64,620	$7,587	$16,881	$4,125	$5,700	$453	32
$8,284	$16,791	$25,674	$16,775	$126	$52,403	$81,947	$16,744	$50,838	$2,866	$834	$12,158	33
$91,067	$240,665	$471,183	$111,831	$1,960	$549,796	$993,784	$132,877	$861,657	$29,004	$51,015	$107,532	34
...	$5,000	$3,790	...	...	$18,477	$2,500	$602	$2,493	...	...	...	35
$781,909	$1,080,826	$2,707,464	$1,335,798	$6,050	$6,994,508	$8,669,561	$2,083,721	$6,805,769	$117,828	$131,421	$658,357	36
...	$93,381	...	...	...	$163,902	$186,388	$1,200	$69,240	$500	...	...	37
...	...	315,690	...	...	...	316,016	100	51,829	...	...	70,579	38
...	...	$274,161	...	...	...	$289,722	$1,000	$49,659	...	...	$36,348	39
3,195	...	3,465	...	...	1,337	1,270	...	78	...	...	...	40
$19,775	...	$16,807	...	...	$12,016	$12,700	...	$390	...	...	...	41
14,107	25,840	5,238	...	...	71,718	48,439	37,421	76,981	4,183	...	7,402	42
$68,731	$104,011	$31,791	...	...	$315,729	$196,847	$181,025	$378,477	$25,470	...	$22,412	43
...	280	82,694	...	...	3,208	108,885	...	280,872	...	...	3,508	44
...	$1,680	$124,830	...	...	$12,364	$271,681	...	$791,417	...	...	$8,970	45
...	...	...	...	...	...	...	...	...	...	...	...	46
...	...	...	...	...	...	...	...	...	...	...	...	47
3,368	2,166	3,463	622	...	10,162	3,017	241	7,005	...	...	...	48
$18,540	$32,473	$38,173	$6,779	...	$115,806	$55,446	$3,359	$67,160	...	...	...	49
...	659,287	...	...	...	1,692,610	15,400	12,000	35,000	...	...	...	50
...	$26,889	...	...	...	$97,496	$656	$20	$1,750	...	...	...	51
...	...	...	...	...	...	...	...	52,000	100,000	...	...	52
...	...	...	...	...	...	...	...	$10,861	$7,000	...	...	53
...	...	...	...	...	...	4	...	5	...	...	...	54
...	...	...	...	...	...	$452	...	$2,100	...	...	...	55
...	...	...	...	...	$1,044,800	$915,000	...	...	...	...	...	56
...	436	29,291,188	41,049,931	...	98,949,132	180,000	43,017,000	105,392,150	...	...	8,563,870	57
...	$26	$488,162	$116,538	...	$52,740	$9,000	$25,810	$197,894	...	...	$148,641	58
200,000	...	...	1,133,931	...	4,299,424	557,758	19,549	1,062,458	14,128	...	1,127,729	59
$6,000	...	...	$136,561	...	$118,332	$143,189	$579	$29,468	$478	...	$28,193	60
...	15	...	36,837	...	36,747	14,250	5,675	24,150	2,400	...	...	61
...	$37	...	$81,841	...	$74,557	$34,628	$12,880	$53,091	$5,500	...	...	62
...	54,271	...	7,250	...	252,622	3,001,916	3,500	51,531	...	...	...	63
...	$43,470	...	$5,700	...	$147,689	$1,226,404	$4,000	$30,591	...	...	...	64
$1,700	...	$414,924	$125	...	...	$7,809	...	$342	...	...	...	65
50	1,568	1,462	509	...	5,989	11,475	5,226	4,020	...	...	120	66
$250	$2,310	$6,014	$2,124	...	$25,980	$30,643	$13,130	$17,968	...	...	$360	67
...	$5,631	...	...	...	$4,237	...	...	...	...	...	...	68
...	...	...	...	...	...	10,000,000	7,033,017	1,000	...	...	...	69
...	...	...	...	...	...	$830,000	$514,970	$150	...	...	...	70
...	27	...	...	...	...	5,181	...	9	...	...	...	71
...	$2,409	...	...	...	...	$16,845	...	$1,105	...	...	...	72
190,000	18,000	134,256	50,474	...	98,664	5,800,194	27,429	1,017,284	6,085	...	12,079	73
$22,000	$7,200	$22,452	$8,095	...	$15,467	$254,246	$4,303	$92,499	$1,826	...	$2,092	74
...	...	...	...	...	...	...	...	13,000	...	...	...	75
...	...	...	...	...	...	...	...	$7,500	...	...	...	76
...	...	...	...	...	...	79	...	3,274	...	...	...	77
...	...	...	...	...	...	$5,446	...	$112,053	...	...	...	78
1,011	2,067	...	58	...	14,666	4,561	5,870	...	113	...	324	79
$36,848	$70,799	...	$2,198	...	$468,808	$148,350	$197,457	...	$3,903	...	$14,208	80
$131,800	$4,858	$67,905	$5,400	...	$234,302	$58,032	$25,149	$185,752	...	...	...	81
937	3,309	...	1,003	...	15,482	12,302	2,460	10,381	937	...	111	82
$21,300	$61,291	...	$22,021	...	$273,429	$254,271	$48,602	$198,064	$18,186	...	$2,125	83
...	...	...	...	...	...	$4,000	$275,314	$60,000	...	...	...	84
...	...	584,617	...	...	...	...	169,270	...	...	...	...	85
...	...	$29,440	...	...	...	...	$6,743	...	...	...	...	86
$290,704	$344,721	$119,986	$849,244	$4,725	$2,808,375	$1,579,708	$547,697	$2,586,378	$39,251	$113,526	$61,054	87

---

[1] Includes establishments distributed as follows: Arizona, 1; Colorado, 2; Delaware, 1; District of Columbia, 1; Kentucky, 1; Nebraska, 1; New Hampshire, 1; North Carolina, 2; Tennessee, 1; Vermont, 2; Virginia, 1; West Virginia, 1.

TABLE 7.—CHEMICALS: SUMMARY

		United States.	California.	Connecticut.	Illinois.	Indiana.	Maine.
	Materials used—Continued.						
	Total cost—Continued.						
88	Fuel	$3,539,098	$147,200	$9,164	$81,056	$42,419	$1,635
89	Rent of power and heat	$222,356		$60	$300		$1,055
90	Mill supplies	$212,434	$6,333	$507	$8,860	$1,398	$127
91	All other materials	$2,991,156	$70,256	$10,250	$149,693	$36,176	$810
92	Freight	$1,021,710	$147,712		$52,798	$680	$2,565
	Products:						
93	Aggregate value	$62,676,730	$2,061,470	$290,320	$2,085,625	$1,037,832	$31,638
	Acids—						
94	Total value	$11,853,498	$654,760	$279,804	$407,263	$572,148	$17,542
95	Sulphuric, 50° Baumé, tons	97,858	3,537				402
96	Value	$427,393	$44,091				$3,214
97	Sulphuric, 60° Baumé, tons	16,829	2,369				1,034
98	Value	$242,879	$33,460				$14,328
99	Sulphuric, 66° Baumé, tons	409,547	5,437	9,126	12,450	19,419	
100	Value	$5,508,625	$103,444	$162,815	$224,130	$231,487	
101	Nitric, pounds	28,704,709	3,380,340	1,592,280	508,758	350,748	
102	Value	$1,404,743	$158,293	$79,871	$35,600	$15,530	
103	Mixed, pounds	36,468,819		1,466,044		6,434,418	
104	Value	$1,111,158		$36,600		$240,510	
105	Tartaric, pounds	997,004	90,000				
106	Value	$294,603	$27,000				
107	Acetic, pounds	14,641,673			867,920		
108	Value	$345,951			$11,120		
109	Other acids	$2,518,146	$288,472	$518	$136,413	$84,621	
	Sodas—						
110	Total value	$11,596,915	$666,025	$7,038	$303,771	$299,463	
111	Sal soda, tons	63,231	3,870		5,061	3,487	
112	Value	$779,166	$58,370		$67,489	$34,874	
113	Soda ash, tons	386,361	1,320				
114	Value	$4,768,383	$17,160				
115	Bicarbonate of soda, tons	68,185	225				
116	Value	$1,324,843	$9,000				
117	Caustic soda, tons	78,779	3		2,458		
118	Value	$2,917,955	$125		$221,325		
119	Borax, tons	5,637	5,502				
120	Value	$502,480	$490,330				
121	Other soda products	$1,304,088	$91,040	$7,038	$14,957	$264,589	
122	Potashes, pounds	3,764,806			820,000	135,200	88,290
123	Value	$174,476			$53,349	$6,350	$2,935
124	Alums, pounds	152,520,259			10,130,000		
125	Value	$2,013,607			$95,600		
	Coal-tar products—						
126	Coal-tar distillery products	$809,830	$11,415				
127	Chemicals made from coal-tar distillery products	$512,264	$19,217				
	Cyanides—						
128	Potassium cyanide, pounds	2,291,335					
129	Value	$591,280					
130	Yellow prussiate of potash, pounds	6,140,406					
131	Value	$993,514					
132	Other cyanides	$129					
	Wood distillation—						
	Wood alcohol—						
133	Crude, gallons	4,191,379					
134	Value	$1,660,061					
135	Refined, gallons	3,038,140				100,000	
136	Value	$2,296,898				$65,000	
137	Acetate of lime, tons	43,413				1,000	
138	Value	$981,286				$30,000	
139	Charcoal, bushels	17,154,302				750,000	
140	Value	$726,672				$30,000	
141	All other wood distillates	$9,534					
	Fertilizers—						
	Superphosphates—						
142	From minerals, bones, etc., tons	1,810					
143	Value	$20,417					
144	Complete, tons	17,242	2,000				
145	Value	$339,600	$50,000				
146	All other fertilizers, tons	7,243			1,900		
147	Value	$95,132			$33,145		
	Bleaching materials—						
148	Hypochlorites, tons	2,143			297		
149	Value	$115,608			$38,649		
150	Other bleaching agents	$376,478					
151	Electro-chemical products	$1,305,368					$9,631
	Dyestuffs—						
152	Natural, pounds	513,302					
153	Value	$36,547					
154	Artificial, pounds	3,896,458					
155	Value	$54,948					
	Tanning materials—						
	Natural—						
156	Extracts, pounds	1,062,500	1,050,000		12,500		
157	Value	$32,500	$30,000		$2,500		
158	Artificial, pounds	616,950					
159	Value	$12,639					
	Paints, colors, and varnishes—						
160	Total value	$541,892	$15,750			$490	
	Pigments—						
161	Fine colors, pounds	674,650					
162	Value	$80,958					
163	Iron oxides and other earth colors, pounds	318,360					
164	Value	$6,660					
165	Dry colors, pounds	3,661,403	2,100,000				
166	Value	$57,881	$15,750				
	Paints—						
167	Paints in oil, in paste, pounds	67,467					
168	Value	$1,668					
169	Paints, already mixed for use, gallons	20,755					
170	Value	$6,559					
	Varnishes and japans—						
171	Oil and turpentine varnishes, gallons	3,907					
172	Value	$3,907					

BY STATES, 1900—Continued.

Maryland.	Massachusetts.	Michigan.	Missouri.	Nevada.	New Jersey.	New York.	Ohio.	Pennsylvania.	Rhode Island.	Wisconsin.	All other states.[1]	
$90,013	$94,058	$838,706	$30,990	$475	$375,770	$959,487	$95,643	$563,672	$8,356	$2,687	$197,822	88
$50	$1,118		$1,881		$1,620	$212,997		$1,250	$25		$2,000	89
$33,609	$9,781	$18,287	$1,758	$120	$37,183	$47,847	$10,931	$28,397	$500	$275	$6,422	90
$40,589	$138,993	$157,768	$64,543	$730	$544,202	$858,458	$111,664	$668,400	$3,625	$11,517	$123,187	91
	$35,695	$58,058			$49,704	$59,364	$4,245	$600,141	$3,109	$3,416	$4,223	92
$1,271,410	$2,010,830	$5,364,724	$1,804,090	$20,950	$12,207,289	$15,994,366	$3,576,260	$13,034,384	$292,794	$254,196	$1,338,552	93
$176,569	$900,968		$81,830		$3,358,192	$1,712,961	$1,386,325	$2,038,652	$153,994		$117,490	94
31,643	37,395				8,936	816		15,101	28			95
$176,569	$35,110				$55,136	$11,000		$99,778	$2,500			96
						50		13,356	20			97
						$1,000		$193,799	$292			98
	27,634		2,869		123,236	59,296	40,147	97,590	7,092		5,251	99
	$414,211		$54,500		$1,474,011	$873,911	$527,944	$1,190,530	$148,952		$102,690	100
	3,082,046				12,890,260	4,100,541	1,377,291	1,222,445	20,000		180,000	101
	$86,741				$665,533	$222,740	$72,248	$55,887	$1,500		$10,800	102
					5,081,134	6,392,516	17,094,707					103
					$259,583	$159,800	$414,665					104
						720,000		187,004				105
						$208,000		$59,603				106
			652,573		6,478,443	4,127,162		2,515,575				107
			$10,650		$187,196	$95,170		$41,515				108
	$364,906		$16,680		$711,733	$141,040	$371,468	$397,545	$750		$4,000	109
$39,500	$118,182	$2,826,377	$30,129	$20,950	$170,363	$4,921,144	$122,820	$970,553	$1,800	$174,301	$924,499	110
2,500	232				34	28,095	4,100	12,756		3,096		111
$25,000	$2,900				$410	$357,303	$42,640	$132,990		$57,190		112
		188,165		600		167,552					28,724	113
		$2,158,969		$8,800		$2,066,122					$517,082	114
		10,000				43,812		7,700		23	6,425	115
		$150,000				$885,003		$154,000		$4,761	$122,079	116
		18,000	111		20	40,499		11,754			5,934	117
		$500,000	$8,679		$820	$1,518,464		$460,845			$207,697	118
				135								119
				$12,150								120
$14,500	$115,282	$17,408	$21,450		$169,133	$93,952	$80,180	$222,718	$1,800	$112,350	$77,691	121
		1,869,116					852,200					122
		$77,609					$34,233					123
	18,266,415	1,480,000				46,211,951		76,431,893				124
	$216,754	$39,500				$593,070		$1,068,683				125
	$12,513		$94,400		$227,400	$29,000	$243,000	$178,102			$14,000	126
			$300,000		$3,600	$14,300		$175,147				127
	50,000		24,099		2,210,000			7,236				128
	$13,020		$3,813		$572,400			$2,047				129
700,000			96,024		2,822,556		518,822	2,003,004				130
$120,700			$14,403		$470,490		$86,852	$301,069				131
								$129				132
		116,010				1,056,083		2,848,326			170,960	133
		$32,225				$431,064		$1,183,095			$13,677	134
	29,652	504,196			90,000	2,207,230	3,000	41,902			62,160	135
	$35,973	$319,553			$67,500	$1,762,812	$4,000	$34,600			$7,460	136
		3,396				11,285		27,732				137
		$43,265				$250,211		$657,810				138
	15,000	2,831,120			152,500	2,310,653		11,079,029			16,000	139
	$1,200	$119,063			$10,800	$103,390		$461,259			$960	140
	$1,200				$5,031	$632		$2,302			$369	141
252		1,528			30							142
$2,268		$17,699			$450							143
390		14,753						99				144
$8,000		$279,588						$2,012				145
717		2,727				1,779		120				146
$4,300		$55,321				$955		$1,411				147
		1,782			56			8				148
		$62,387			$12,972			$1,600				149
	$912		$21,196			$340,612	$3,500	$10,258				150
		$193,256				$1,102,481						151
	513,302											152
	$36,547											153
					2,929,808			736,650			230,000	154
					$29,970			$22,678			$2,300	155
												156
												157
						36,000		580,950				158
						$5,400		$7,239				159
$400		$3,881			$230,598	$262,636		$21,137	$5,000		$2,000	160
						674,650						161
						$80,958						162
130,000						144,000		24,360	20,000			163
$400						$5,600		$160	$500			164
					8,127	1,500,000		58,276				165
					$3,845	$38,000		$286				166
								67,467				167
								$1,668				168
								10,755			10,000	169
								$4,559			$2,000	170
					3,907							171
					$3,907							172

[1] Includes establishments distributed as follows: Arizona, 1; Colorado, 2; Delaware, 1; District of Columbia, 1; Kentucky, 1; Nebraska, 1; New Hampshire, 1; North Carolina, 2; Tennessee, 1; Vermont, 2; Virginia, 1; West Virginia, 1.

		United States.	California.	Connecticut.	Illinois.	Indiana.	Maine.
	Products—Continued.						
	Aggregate value—Continued.						
	Paints, colors, and varnishes—Continued.						
	Total value—Continued.						
	Varnishes and japans—Continued.						
173	Alcohol varnishes, gallons	13,401					
174	Value	$37,840					
175	Pyroxyline varnishes, gallons	43,942					
176	Value	$58,186					
177	Liquid dryers, japans and lacquers	$644					
178	All other varnishes, and japans	$287,589				$490	
	Explosives—						
179	Guncotton, or pyroxyline, pounds	98,405					
180	Value	$39,962					
	Plastics—						
181	Pyroxyline plastics	$1,970,387					
182	All other plastics	$129,013					
	Essential oils—						
183	Natural, pounds	725			32		
184	Value	$464			$100		
185	Artificial	$2,410			$10		
	Compressed and liquified gases—						
186	Anhydrous ammonia	$448,157	$20,488				
187	Carbon dioxide	$696,164	$24,000		$180,350		
188	Compressed and liquified gases, not otherwise enumerated	$70,690					
	Fine chemicals—						
189	Total value	$4,220,339			$100,060		
190	Alkaloids, ounces	3,387,522					
191	Value	$1,743,264					
192	Gold salts, ounces	8,594					
193	Value	$90,145					
194	Silver salts, ounces	1,252,604					
195	Value	$499,345					
196	Platinum salts, ounces	7,312					
197	Value	$54,600					
198	Chloroform, pounds	396,540					
199	Value	$98,070					
200	Ether, pounds	263,238					
201	Value	$129,876					
202	Acetone, pounds	1,638,715					
203	Value	$178,666					
204	All other fine chemicals	$1,426,373			$100,060		
	Chemicals, not otherwise specified—						
205	Total value	$5,148,646	$326,000		$169,695		
206	Glycerine, pounds	15,383,798			1,403,506		
207	Value	$2,012,886			$169,695		
208	Cream of tartar, pounds	10,620,000	1,610,000				
209	Value	$2,081,500	$326,000				
210	Epsom salts, pounds	6,072,309					
211	Value	$45,966					
212	Blue vitriol, pounds	7,500,000					
213	Value	$375,000					
214	Copperas, pounds	14,097,905					
215	Value	$58,581					
216	Phosphates of soda, pounds	3,478,350					
217	Value	$104,554					
218	Tin salts, pounds	4,677,471					
219	Value	$470,159					
220	Value of all other products	$12,799,405	$243,815	$3,478	$701,133	$34,381	$1,530
	Products consumed:						
	Acids—						
221	Sulphuric, tons	925,796	1,415	1,210	6,594	10,190	
222	Nitric, pounds	16,953,659		570,139	155,484	6,198,996	
223	Mixed, pounds	8,902,371				148,671	
224	Charcoal, bushels	1,656,790					
225	Ether, pounds	560					
226	Pyroxyline, pounds	662,884					
227	All other products consumed, pounds	484,925,323	1,659,503		1,317,031	428,729	
	Comparison of products:						
228	Number of establishments reporting for both years	394	19	3	23	5	4
229	Value for census year	$58,786,318	$1,697,235	$290,320	$2,061,551	$911,482	$22,007
230	Value for preceding business year	$49,462,554	$1,429,458	$241,880	$1,762,034	$928,123	$15,300
	Power:						
231	Number of establishments reporting	341	18	1	19	5	2
232	Total horsepower	92,381	984	25	1,606	782	1,411
	Owned—						
	Engines—						
233	Steam, number	1,091	31	2	29	15	1
234	Horsepower	69,560	982	25	1,298	562	6
235	Gas or gasoline, number	17	1		2		
236	Horsepower	361	2		80		
237	Water wheels, number	65					2
238	Horsepower	1,915					1,400
239	Electric motors, number	79			5	11	1
240	Horsepower	2,032			145	220	5
241	Other power, number	5					
242	Horsepower	30					
	Rented—						
243	Electric, horsepower	18,231					
244	Other kind, horsepower	252			83		
245	Furnished to other establishments, horsepower	106	40		6		
	Establishments classified by number of persons employed, not including proprietors and firm members:						
246	Total number of establishments	459	21	3	26	7	5
247	No employees	10					2
248	Under 5	90	3	1	3	1	1
249	5 to 20	178	9	1	14	1	2
250	21 to 50	105	5	1	6	3	
251	51 to 100	31	3		2	1	
252	101 to 250	30	1		1	1	
253	251 to 500	8					
254	501 to 1,000	2					
255	Over 1,000	5					

BY STATES, 1900—Continued.

Maryland.	Massachusetts.	Michigan.	Missouri.	Nevada.	New Jersey.	New York.	Ohio.	Pennsylvania.	Rhode Island.	Wisconsin.	All other states.[1]	
....	....	....	....	....	130	10,500	....	2,771	....	....	....	173
....	....	....	....	....	$520	$31,500	....	[illegible]	....	....	....	174
....	....	....	....	....	43,942	....	....	....	....	....	....	175
....	....	....	....	....	$58,186	....	....	....	....	....	....	176
....	....	....	....	....	....	....	....	$644	....	....	....	177
....	....	$3,881	....	....	$164,140	$106,578	....	$8,000	$4,500	....	....	178
....	....	....	....	....	98,405	....	....	....	....	....	....	179
....	....	....	....	....	$39,962	....	....	....	....	....	....	180
....	$111,641	....	....	....	$1,858,746	....	....	....	....	....	....	181
....	$119,868	....	....	....	$3,750	....	....	$5,395	....	....	....	182
....	....	....	....	....	....	....	....	693	....	....	....	183
....	....	....	....	....	....	....	....	$364	....	....	....	184
....	....	....	....	....	....	$2,400	....	....	....	....	....	185
....	....	$2,976	$79,742	....	$92,375	....	$47,905	$126,885	....	....	$77,786	186
....	$500	....	$62,844	....	$59,225	$173,962	....	$112,828	....	$79,455	$3,000	187
....	$13,200	....	....	....	....	[illegible]	$5,000	....	....	....	....	188
$12,000	$9,390	....	$234,056	....	$406,854	$475,498	$1,650	$2,930,831	$50,000	....	....	189
....	....	....	....	....	288,672	....	....	3,098,850	....	....	....	190
....	....	....	....	....	$98,213	....	....	$1,645,051	....	....	....	191
....	....	....	5,226	....	803	65	....	2,500	....	....	....	192
....	....	....	$53,448	....	$9,917	$780	....	$26,000	....	....	....	193
....	....	....	103,576	....	173,000	325,121	....	650,907	....	....	....	194
....	....	....	$37,719	....	$63,890	$120,104	....	$277,632	....	....	....	195
....	....	....	6,380	....	932	....	....	....	....	....	....	196
....	....	....	$46,678	....	$7,922	....	....	....	....	....	....	197
....	....	....	....	....	334,000	62,540	....	....	....	....	....	198
....	....	....	....	....	$66,800	$31,270	....	....	....	....	....	199
....	....	....	116,350	....	56,000	74,500	....	16,388	....	....	....	200
....	....	....	$56,211	....	$18,650	$45,700	....	$9,315	....	....	....	201
....	....	....	....	....	63,593	1,455,865	....	119,257	....	....	....	202
....	....	....	....	....	$6,359	$158,712	....	$13,595	....	....	....	203
$12,000	$9,390	....	$40,000	....	$135,103	$118,932	$1,650	$959,238	$50,000	....	....	204
$116,215	$30,191	....	$2,554	....	$1,120,977	$2,133,275	$726,211	$491,873	....	....	$31,655	205
....	....	....	....	....	....	8,000,000	5,607,874	....	....	....	372,418	206
....	....	....	....	....	....	$1,120,000	$691,536	....	....	....	$31,655	207
....	....	....	....	....	4,210,000	4,800,000	....	....	....	....	....	208
....	....	....	....	....	$795,500	$960,000	....	....	....	....	....	209
1,421,500	....	....	....	....	....	20,000	....	4,630,809	....	....	....	210
$14,215	....	....	....	....	....	$1,000	....	$30,751	....	....	....	211
....	....	....	....	....	....	....	....	7,500,000	....	....	....	212
....	....	....	....	....	....	....	....	$375,000	....	....	....	213
....	....	....	....	....	871,902	67,403	10,158,600	3,000,000	....	....	....	214
....	....	....	....	....	$5,231	$675	$34,675	$18,000	....	....	....	215
3,400,000	....	....	78,350	....	....	....	....	....	....	....	....	216
$102,000	....	....	$2,554	....	....	....	....	....	....	....	....	217
....	179,587	....	....	....	3,130,578	257,329	....	1,109,977	....	....	....	218
....	$30,191	....	....	....	$320,246	$51,600	....	$68,122	....	....	....	219
$791,458	$388,771	$1,292,024	$879,123	....	$3,470,634	$1,626,078	$914,764	$2,226,425	$82,000	$440	$143,356	220
3,750	11,756	10,205	744	....	33,878	20,165	2,314	822,975	....	....	600	221
....	855,500	....	8,074	....	5,402,401	2,469,682	953,422	339,961	....	....	....	222
....	8,734,700	....	....	....	19,000	....	....	....	....	....	....	223
....	....	267,825	....	....	....	294,000	....	939,500	....	....	155,465	224
....	....	....	....	....	....	....	....	560	....	....	....	225
....	239,842	....	....	....	423,042	....	....	....	....	....	....	226
....	5,215,478	55,817,010	306,576	....	18,152,321	389,476,640	1,463,080	8,648,455	....	....	2,440,500	227
4	17	47	6	3	45	80	28	90	[illegible]	2	14	228
$477,927	$2,010,830	$5,063,708	$1,404,687	$20,950	$11,008,452	$15,699,334	$3,537,317	$12,762,467	$292,794	$189,705	$1,335,552	229
$342,366	$1,492,996	$3,967,557	$1,238,897	$20,400	$9,193,571	$13,529,828	$3,032,065	$10,802,657	$272,369	$173,443	$1,019,610	230
5	12	15	8	2	48	82	20	91	1	[illegible]	9	231
460	2,169	21,999	344	50	8,362	34,690	1,280	13,112	125	205	4,777	232
17	28	130	10	3	174	324	50	225	4	4	44	233
445	2,144	21,967	317	48	8,028	15,595	1,280	11,903	125	205	4,630	234
....	....	....	....	1	1	2	....	10	....	....	....	235
....	....	....	....	2	7	127	....	143	....	....	....	236
....	....	....	....	....	1	24	....	38	....	....	....	237
....	....	....	....	....	5	114	....	396	....	....	....	238
1	....	6	....	....	4	31	....	20	....	....	....	239
5	....	32	....	....	215	740	....	670	....	....	....	240
....	....	....	....	....	1	....	....	....	....	....	4	241
....	....	....	....	....	5	....	....	....	....	....	25	242
....	....	....	17	....	....	18,094	....	....	....	....	120	243
10	25	....	10	....	102	20	....	....	....	....	2	244
....	....	....	....	....	10	50	....	....	....	....	....	245
7	17	51	8	3	61	92	35	100	4	4	15	246
....	....	3	....	....	3	....	2	....	....	....	....	247
1	8	29	1	....	11	10	12	6	1	....	2	248
....	3	7	1	2	18	43	15	49	1	2	10	249
2	3	5	4	1	14	23	5	30	....	2	1	250
1	....	2	....	....	5	8	....	6	2	....	1	251
2	2	2	2	....	7	5	1	6	....	....	....	252
1	1	1	....	....	2	2	....	1	....	....	....	253
....	....	....	....	....	....	....	....	1	....	....	1	254
....	....	2	....	....	1	1	....	1	....	....	....	255

---

[1] Includes establishments distributed as follows: Arizona, 1; Colorado, 2; Delaware, 1; District of Columbia, 1; Kentucky, 1; Nebraska, 1; New Hampshire, 1; North Carolina, 2; Tennessee, 1; Vermont, 2; Virginia, 1; West Virginia, 1.

TABLE 8.—BONE, IVORY, AND LAMPBLACK: SUMMARY BY STATES, 1900.

	United States.[1]
Number of establishments	15
Character of organization:	
Individual	2
Firm and limited partnership	8
Incorporated company	5
Capital:	
Total	$782,247
Land	$149,103
Buildings	$196,422
Machinery, tools, and implements	$300,571
Cash and sundries	$136,151
Proprietors and firm members	17
Salaried officials, clerks, etc.:	
Total number	21
Total salaries	$23,650
Officers of corporations—	
Number	5
Salaries	$6,360
General superintendents, managers, clerks, etc.—	
Total number	16
Total salaries	$17,290
Men—	
Number	15
Salaries	$16,990
Women—	
Number	1
Salaries	$300
Wage-earners, including pieceworkers, and total wages:	
Greatest number employed at any one time during the year	92
Least number employed at any one time during the year	80
Average number	[illegible]
Wages	$46,107
Men, 16 years and over—	
Average number	85
Wages	$46,107
Miscellaneous expenses:	
Total	$75,678
Rent of works	$6,625
Miscellaneous expenses—Continued.	
Total—Continued.	
Taxes, not including internal revenue	$2,260
Rent of offices, insurance, interest, and all sundry expenses not hitherto included	$65,902
Contract work	$891
Materials used:	
Total cost	$105,712
Components of products	$66,776
Fuel	$2,663
Mill supplies	$1,771
All other materials	$32,126
Freight	$2,376
Products:	
Total value	$359,787
Pigments—	
Lamp and other blacks, pounds	6,454,345
Value	$359,787
Comparison of products:	
Number of establishments reporting for both years	15
Value for census year	$359,787
Value for preceding business year	$250,816
Power:	
Number of establishments reporting	13
Total horsepower	365
Owned—	
Engines—	
Steam, number	18
Horsepower	345
Gas or gasoline, number	1
Horsepower	20
Establishments classified by number of persons employed, not including proprietors and firm members:	
Total number of establishments	15
Under 5	7
5 to 20	7
21 to 50	1

[1] Includes establishments distributed as follows: Pennsylvania, 12; Connecticut, 1; New York, 1; Ohio, 1.

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900.

STATES AND TERRITORIES.	ESTABLISHMENTS: NUMBER, AND CHARACTER OF ORGANIZATION.				CAPITAL.				
	Total number.	Individual.	Firm and limited partnership.	Incorporated company.	Total.	Land.	Buildings.	Machinery, tools, and implements.	Cash and sundries.
United States	1,740	515	405	820	$238,529,641	$22,947,444	$35,270,850	$46,116,451	$134,194,896
Alabama	19	2	9	8	1,514,791	20,118	239,050	212,824	1,042,799
California	53	16	7	30	6,807,440	590,615	1,509,294	1,236,298	3,471,233
Colorado	4	....	....	4	392,865	15,700	81,200	148,550	147,415
Connecticut	31	9	6	16	3,254,506	128,772	429,881	790,778	1,905,075
Delaware	15	8	1	6	2,139,856	95,100	238,467	223,814	1,582,475
District of Columbia	8	4	2	2	111,606	22,000	11,800	29,585	48,221
Florida	10	4	1	5	778,319	95,164	139,185	136,298	407,672
Georgia	46	13	11	22	6,764,918	141,762	1,049,304	672,634	4,901,218
Illinois	88	15	9	64	10,245,146	1,359 232	1,141,727	1,715,112	6,029,075
Indiana	42	14	8	20	2,527,306	151,985	480,112	663,238	1,231,971
Iowa	8	2	3	3	621,171	38,442	103,150	84,013	395,566
Kansas	5	2	....	3	291,278	24,000	74,450	57,648	135,180
Kentucky	18	3	2	13	740,484	50,522	82,975	98,546	508,441
Louisiana	10	....	2	8	1,439,153	70,394	313,956	215,419	839,384
Maine	13	5	2	6	1,107,261	71,585	76,594	528,459	430,623
Maryland	63	18	21	24	9,148,474	1,282,011	1,241,469	1,702,628	4,922,366
Massachusetts	83	25	21	37	7,887,795	467,045	979,209	1,149,955	5,291,586
Michigan	97	55	14	28	10,684,794	1,286,685	2,048,160	3,565,983	3,783,966
Minnesota	8	1	2	5	371,083	7,829	37,085	50,374	275,795
Mississippi	4	1	....	3	372,797	20,322	50,000	57,362	245,113
Missouri	39	[illegible]	5	28	6,256,327	496,359	742,024	948,877	4,069,067
Nebraska	5	....	....	5	945,517	70,500	382,319	111,576	381,122
Nevada	4	....	4	....	53,075	5,000	2,050	7,525	38,500
New Jersey	160	41	30	89	34,307,300	3,350,787	5,015,423	5,838,209	20,102,881
New York	285	104	56	125	46,913,165	4,931,561	6,274.907	8,986,573	26,720,124
North Carolina	23	2	9	12	2,878,088	110,269	411,432	228,823	2,127,564
Ohio	137	34	38	65	13,083,173	1,392,119	1,810,967	2,218,587	7,666,500
Oregon	5	2	2	1	176,332	5,000	6,500	21,247	143,585
Pennsylvania	306	89	102	115	43,964,862	4,602,488	6,979,953	11,928,088	20,454,333
Rhode Island	12	5	2	5	1,165,565	58,700	178,583	162,911	765,371
South Carolina	22	2	1	19	10,505,043	109,441	1,642,600	487,117	8,265,885
Tennessee	14	3	3	8	1,258,373	108.947	356,519	177,114	615,793
Texas	7	2	[illegible]	2	50,550	700	5,000	26,225	18,625
Vermont	5	2	....	3	316,422	8,200	34,685	82,132	191,405
Virginia	64	20	22	22	8,158,747	1,706,496	973,308	1,242,299	4,236,644
West Virginia	9	2	2	5	313,292	27,050	48,900	74,049	163,293
Wisconsin	12	3	4	5	817,341	18,000	8,500	208,759	582,082
All other states[1]	6	1	1	4	165,426	6,544	70,112	31,822	56,948

[1] Includes establishments distributed as follows: Arizona, chemicals, 1; New Hampshire, chemicals, 1. Washington, fertilizer, 1; paints, 3.

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	Proprietors and firm members, number.	SALARIED OFFICIALS, CLERKS, ETC.									
		Total.		Officers of corporations.		General superintendents, managers, clerks, etc.					
						Total.		Men.		Women.	
		Number.	Salaries.	Number.	Salaries.	Number.	Salaries.	Number.	Salaries.	Number.	Salaries.
United States	1,189	8,605	$11,340,385	1,263	$3,160,458	7,342	$8,179,927	6,637	$7,841,490	705	$338,437
Alabama	32	74	69,640	17	24,984	57	44,656	55	43,856	2	800
California	30	199	269,283	42	57,700	157	211,583	144	203,693	13	7,890
Colorado	....	18	20,520	8	8,300	10	12,220	9	11,500	1	720
Connecticut	20	108	164,481	29	68,200	79	96,281	71	93,586	8	2,695
Delaware	10	36	60,194	9	32,450	27	27,744	26	27,264	1	480
District of Columbia	8	9	5,433	1	2,500	8	2,938	8	2,933	....	....
Florida	6	33	31,031	8	9,166	25	21,865	22	20,565	3	1,300
Georgia	42	126	156,188	17	44,025	109	112,163	107	111,203	2	960
Illinois	37	683	912,841	93	227,373	590	685,468	511	645,656	79	39,812
Indiana	34	134	163,763	24	45,272	110	118,491	104	116,611	6	1,880
Iowa	10	34	28,980	1	2,400	33	26,580	27	24,880	6	1,700
Kansas	2	8	9,940	3	3,640	5	6,300	5	6,300	....	....
Kentucky	9	63	61,564	13	20,350	50	41,214	42	38,860	8	2,354
Louisiana	5	43	66,969	13	36,460	30	30,509	29	29,729	1	780
Maine	8	22	28,533	7	16,200	15	12,333	12	9,733	3	2,600
Maryland	64	280	330,116	55	129,622	225	200,494	213	195,673	12	4,821
Massachusetts	64	422	526,540	53	150,463	369	376,077	323	355,610	46	20,467
Michigan	90	431	558,934	55	123,910	376	435,024	322	413,788	54	21,236
Minnesota	8	32	31,878	7	10,258	25	21,620	21	20,160	4	1,460
Mississippi	1	18	20,714	6	6,150	12	14,564	12	14,564	....	....
Missouri	16	334	412,916	50	107,682	284	305,234	262	294,682	22	10,552
Nebraska	....	43	62,156	2	9,000	41	53,156	34	50,120	7	3,036
Nevada	9	1	600	....	....	1	600	1	600	....	....
New Jersey	106	1,226	1,599,059	149	432,682	1,077	1,166,377	999	1,126,193	78	40,184
New York	113	1,619	2,411,586	201	620,554	1,418	1,791,032	1,286	1,727,171	132	63,861
North Carolina	21	51	65,838	11	29,823	40	36,015	40	36,015	....	....
Ohio	112	820	1,036,692	128	293,570	692	743,122	609	701,410	83	41,712
Oregon	6	10	15,080	2	4,800	8	10,280	7	9,800	1	480
Pennsylvania	200	1,260	1,606,571	173	457,626	1,087	1,148,945	987	1,098,245	100	50,700
Rhode Island	8	46	72,941	7	17,000	39	55,941	31	51,277	8	4,664
South Carolina	5	85	164,716	9	35,976	76	128,740	75	128,500	1	240
Tennessee	9	67	84,243	18	45,800	49	38,443	47	37,483	2	960
Texas	10	2	3,900	....	....	2	3,900	2	3,900	....	....
Vermont	2	15	8,468	4	1,600	11	6,868	4	4,360	7	2,508
Virginia	71	153	182,861	29	64,586	124	118,275	121	117,325	3	950
West Virginia	8	10	9,830	5	6,680	5	3,150	5	3,150	....	....
Wisconsin	10	83	78,691	12	10,656	71	68,035	61	62,020	10	6,015
All other states	3	7	6,695	2	3,000	5	3,695	3	3,075	2	620

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	WAGE-EARNERS, INCLUDING PIECEWORKERS.									
	Total.				Men, 16 years and over.		Women, 16 years and over.		Children, under 16 years.	
	Greatest number employed at any one time during the year.	Least number employed at any one time during the year.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.	Average number.	Wages.
United States	61,553	37,939	46,765	$21,799,251	44,635	$21,214,066	1,952	$554,423	178	$30,762
Alabama	887	289	460	99,782	456	99,334	4	448		
California	1,973	1,259	1,547	982,378	1,511	967,922	36	14,456		
Colorado	91	54	67	31,430	63	30,200	4	1,230		
Connecticut	869	525	662	356,532	630	347,583	32	8,949		
Delaware	665	304	403	186,005	399	185,391	1	138	3	476
District of Columbia	57	32	27	11,298	27	11,298				
Florida	283	85	144	49,161	141	48,711			3	450
Georgia	2,159	654	1,149	304,731	1,140	302,591	1	600	8	1,540
Illinois	2,294	1,602	1,880	987,870	1,679	927,622	180	56,563	21	3,685
Indiana	891	630	651	317,968	614	311,717	36	6,146	1	105
Iowa	183	137	160	71,451	152	70,022	6	1,229	2	200
Kansas	318	135	197	95,644	197	95,644				
Kentucky	286	129	190	83,324	184	81,824	[illegible]	1,500		
Louisiana	456	200	300	97,827	279	93,655	21	4,172		
Maine	187	73	108	38,810	105	37,710	3	1,100		
Maryland	2,699	1,281	1,613	754,907	1,587	748,166	19	5,741	7	1,000
Massachusetts	1,669	1,101	1,337	117,043	1,257	693,670	75	22,531	5	842
Michigan	4,386	2,966	3,626	1,451,730	3,469	1,421,425	145	28,571	12	1,734
Minnesota	77	62	62	27,466	52	24,717	10	2,749		
Mississippi	176	50	98	35,200	98	35,200				
Missouri	1,315	991	1,143	513,293	1,018	485,588	75	17,915	50	9,790
Nebraska	199	137	174	100,686	163	97,256	11	3,430		
Nevada	50	37	22	8,670	20	8,180	2	490		
New Jersey	7,211	5,069	6,091	3,095,868	5,674	2,963,539	407	130,419	10	1,910
New York	11,180	7,657	8,940	4,691,897	8,615	4,599,067	313	90,455	12	2,375
North Carolina	805	256	441	113,860	440	113,785			1	75
Ohio	3,035	1,837	2,218	1,112,593	2,085	1,069,151	130	43,053	3	389
Oregon	48	46	46	26,136	43	24,876	3	1,260		
Pennsylvania	8,713	7,287	7,814	3,883,218	7,459	3,787,584	331	91,443	24	4,191
Rhode Island	330	218	258	132,205	242	129,697	16	2,508		
South Carolina	3,066	754	1,772	479,449	1,772	479,449				
Tennessee	922	310	594	143,619	582	142,019	3	600	9	1,000
Texas	88	26	48	18,376	48	18,376				
Vermont	121	44	73	28,809	50	22,271	23	6,538		
Virginia	3,452	1,379	2,154	626,159	2,114	620,809	33	4,350	7	1,000
West Virginia	111	103	87	33,469	87	33,469				
Wisconsin	232	190	165	65,440	140	59,751	25	5,689		
All other states	69	30	44	24,947	43	24,797	1	150		

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	AVERAGE NUMBER OF WAGE-EARNERS, INCLUDING PIECEWORKERS.											
	Men, 16 years and over.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
United States	45,847	47,271	48,974	46,876	43,598	42,520	40,620	42,231	43,880	43,344	45,065	45,384
Alabama	744	786	773	587	351	267	196	184	268	319	407	590
California	1,469	1,453	1,422	1,549	1,887	1,402	1,523	1,559	1,485	1,586	1,678	1,615
Colorado	56	55	56	53	52	52	85	67	68	72	63	67
Connecticut	520	570	617	659	700	676	665	649	683	642	624	546
Delaware	290	304	351	415	407	365	396	521	594	489	373	289
District of Columbia	21	23	31	36	36	23	29	29	30	24	19	19
Florida	182	220	242	142	126	119	115	105	100	94	109	128
Georgia	1,863	1,987	1,947	1,177	630	498	510	527	582	928	1,469	1,563
Illinois	1,648	1,692	1,751	1,758	1,805	1,683	1,600	1,691	1,759	1,583	1,605	1,567
Indiana	542	566	573	649	635	611	715	718	686	571	547	551
Iowa	142	203	140	139	141	154	144	156	153	150	148	141
Kansas	192	199	181	161	149	143	149	184	224	246	282	259
Kentucky	144	150	195	[illegible]	182	194	175	204	244	207	163	146
Louisiana	344	410	420	335	267	247	175	174	234	221	263	259
Maine	58	78	86	171	172	119	119	92	114	86	103	63
Maryland	1,395	1,407	1,525	1,677	1,597	1,456	1,526	1,828	2,199	1,631	1,423	1,407
Massachusetts	1,258	1,297	1,339	1,337	1,210	1,189	1,130	1,229	1,246	1,253	1,309	1,286
Michigan	3,435	3,460	3,559	3,777	3,668	3,767	3,236	3,285	3,382	3,250	3,283	3,584
Minnesota	52	57	55	56	58	57	52	48	49	47	48	48
Mississippi	176	176	161	109	57	39	31	41	51	88	111	139
Missouri	962	981	1,011	1,009	1,036	1,058	1,086	1,056	1,071	1,026	990	913
Nebraska	164	144	133	157	141	164	168	174	185	185	174	173
Nevada	30	16	22	19	14	19	18	18	17	36	17	14
New Jersey	5,537	5,528	5,907	6,000	5,764	5,701	5,479	5,711	5,723	5,578	5,578	5,564
New York	8,644	8,821	9,097	9,218	9,069	8,971	7,995	8,076	8,258	8,355	8,395	8,502
North Carolina	557	629	692	619	406	283	282	257	292	416	436	417
Ohio	1,883	1,946	2,116	2,191	2,103	2,028	2,039	2,307	2,374	2,049	1,983	2,011
Oregon	43	43	43	43	43	[illegible]	43	45	45	44	43	43
Pennsylvania	7,282	7,315	7,518	7,648	7,564	7,427	7,329	7,408	7,585	7,535	7,397	7,501
Rhode Island	234	236	239	241	234	231	201	261	263	261	247	254
South Carolina	2,876	2,993	2,985	1,537	808	776	744	741	787	1,443	2,756	2,824
Tennessee	675	772	868	656	464	444	331	520	887	614	365	384
Texas	32	29	38	42	35	47	59	81	57	57	50	48
Vermont	72	62	76	33	37	30	35	38	48	52	55	68
Virginia	2,036	2,375	2,500	2,186	1,958	1,982	1,993	2,000	1,930	1,984	2,278	2,149
West Virginia	85	83	84	83	87	88	88	86	87	85	104	83
Wisconsin	164	160	170	173	174	136	119	120	124	97	116	123
All other states	45	45	51	39	36	31	40	41	46	40	54	[illegible]

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	AVERAGE NUMBER OF WAGE-EARNERS, INCLUDING PIECEWORKERS—Continued.											
	Women, 16 years and over.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
United States	1,911	2,000	2,066	2,063	2,052	1,986	1,823	1,830	1,876	1,945	1,944	1,927
Alabama	2	2	2	3	3	4	4	5	[illegible]	7	7	5
California	36	36	36	37	37	37	37	37	37	36	[illegible]	36
Colorado	4	4	4	4	4	4	4	4	4	[illegible]	4	4
Connecticut	27	[illegible]	32	34	36	27	30	31	37	37	34	27
Delaware	1	1	1	1	1	1	1	1	1	1	1	2
District of Columbia												
Florida												
Georgia	3	2	2	2	1	1	1	1	1	1	1	1
Illinois	185	193	197	199	188	180	155	155	157	169	176	192
Indiana	29	29	33	37	41	43	44	41	41	40	30	27
Iowa	6	7	7	9	8	14	3	3	3	3	3	3
Kansas												
Kentucky	6	6	6	6	6	5	5	5	8	[illegible]	8	6
Louisiana	24	32	31	30	19	18	18	15	15	15	14	16
Maine	2	6	6	[illegible]	3	2	2	2	2	6	[illegible]	2
Maryland	19	19	19	19	20	24	21	20	20	17	16	17
Massachusetts	61	64	70	74	74	71	74	79	85	[illegible]	79	75
Michigan	169	175	173	176	151	125	113	103	106	137	152	[illegible]
Minnesota	10	11	11	11	11	11	8	7	8	8	11	11
Mississippi												
Missouri	73	72	73	72	74	75	82	80	81	79	68	70
Nebraska	11	11	11	11	11	11	11	11	11	11	11	11
Nevada	1	1	2	2	2	2	2	2	2	1	2	1
New Jersey	359	404	392	369	410	441	420	428	435	423	417	395
New York	308	320	336	350	354	323	294	291	303	298	300	288
North Carolina												
Ohio	122	131	153	174	157	129	98	105	110	135	117	117
Oregon	[illegible]	3	3	3	3	3	3	3	3	3	3	3
Pennsylvania	346	340	350	346	344	338	313	306	308	314	332	338
Rhode Island	18	17	18	17	15	13	1	11	15	16	24	27
South Carolina												
Tennessee	2	2	2	3	3	3	3	3	3	[illegible]	3	2
Texas												
Vermont	28	27	33	12	17	18	20	21	19	23	28	31
Virginia	30	30	35	31	31	36	30	35	30	35	35	35
West Virginia												
Wisconsin	26	26	26	26	26	26	26	25	25	25	24	20
All other states			2	2	2							

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	AVERAGE NUMBER OF WAGE-EARNERS, INCLUDING PIECEWORKERS—Continued.											
	Children, under 16 years.											
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
United States	177	180	191	186	178	174	174	183	180	165	166	182
Alabama	....	....	....	....	....	....	....	....	....	....	....	....
California	....	....	....	....	....	....	....	....	....	....	....	....
Colorado	....	....	....	....	....	....	....	....	....	....	....	....
Connecticut	....	....	....	....	....	....	....	....	....	....	....	....
Delaware	3	3	3	3	3	4	4	4	3	2	2	2
District of Columbia	....	....	....	....	....	....	....	....	....	....	....	....
Florida	9	8	10	2	2	2	1	1	1	1	1	2
Georgia	13	13	13	13	3	3	3	3	3	3	13	13
Illinois	15	18	18	20	21	21	21	27	24	21	19	31
Indiana	....	....	....	....	....	....	1	2	1	4	2	2
Iowa	2	2	2	2	2	2	2	2	[illegible]	2	2	2
Kansas	....	....	....	....	....	....	....	....	....	....	....	....
Kentucky	....	....	....	....	....	....	....	....	....	....	....	....
Louisiana	....	....	....	....	....	....	....	....	....	....	....	....
Maine	....	....	....	....	....	....	....	....	....	....	....	....
Maryland	7	7	7	7	7	7	7	7	7	7	7	7
Massachusetts	3	3	4	7	3	6	5	6	7	4	4	4
Michigan	12	9	13	12	15	15	14	13	13	8	7	7
Minnesota	....	....	....	....	....	....	....	....	....	....	....	....
Mississippi	....	....	....	....	....	....	....	....	....	....	....	....
Missouri	49	54	49	50	47	45	47	54	56	51	45	48
Nebraska	....	....	....	....	....	....	....	....	....	....	....	....
Nevada	....	....	....	....	....	....	....	....	....	....	....	....
New Jersey	9	9	11	11	11	11	11	9	9	9	9	9
New York	11	11	13	13	14	12	12	12	11	11	11	11
North Carolina	....	....	....	....	1	1	1	1	2	2	....	....
Ohio	4	4	3	4	5	4	4	4	2	1	1	1
Oregon	....	....	....	....	....	....	....	....	....	....	....	....
Pennsylvania	25	25	29	26	25	25	22	21	24	23	26	28
Rhode Island	....	....	....	....	....	....	....	....	....	....	....	....
South Carolina	....	....	....	....	....	....	....	....	....	....	....	....
Tennessee	9	9	9	9	9	9	9	9	9	9	[illegible]	9
Texas	....	....	....	....	....	....	....	....	....	....	....	....
Vermont	....	....	....	....	....	....	....	....	....	....	....	....
Virginia	6	5	7	7	10	7	10	8	6	7	8	6
West Virginia	....	....	....	....	....	....	....	....	....	....	....	....
Wisconsin	....	....	....	....	....	....	....	....	....	....	....	....
All other states	....	....	....	....	....	....	....	....	....	....	....	....

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	MATERIALS USED.												
	Aggregate cost.	Purchased in raw state.											
		Total cost.	Fish.		Gums.	Kainit.		Limestone.		Phosphate rock.		Pyrites.	
			Thousands.	Cost.	Cost.	Tons.	Cost.	Tons.	Cost.	Tons.	Cost.	Tons.	Cost.
United States	$124,043,837	$15,702,216	4,589,632	$183,542	$3,817,112	54,700	$520,833	790,456	$717,910	816,290	$3,620,262	633,837	$3,101,075
Alabama	1,428,452	438,888				13,048	132,172			23,940	244,216	9,520	62,500
California	5,502,254	100,360			22,714			1,600	8,000	1,456	16,362	6,331	34,658
Colorado	158,716	15,597			3,597							4,800	12,000
Connecticut	1,615,099	680,308	17,560	25,189	109,668	200	7,500			17	143	2,597	13,585
Delaware	738,041	63,556	200,000	40,000		1,461	15,235	2,106	752	2,062	7,569		
District of Columbia	55,050	1,552				154	1,552						
Florida	341,681	62,290				723	8,640			8,040	32,177	3,177	17,473
Georgia	2,462,109	735,084			6,400	10,205	98,181			120,931	417,037	37,879	213,466
Illinois	7,981,328	542,974			455,359			9,250	1,330	10,480	60,320	4,337	25,965
Indiana	1,513,769	197,661			48,872							18,867	108,789
Iowa	519,376												
Kansas	521,979												
Kentucky	659,350	79,506			49,102					5,625	17,804		
Louisiana	700,380	95,158			640	1,858	17,416	21	54	15,180	64,015	2,457	13,033
Maine	214,666	20,000	5,000	1,500	12,000	150	1,500					1,000	5,000
Maryland	4,726,232	908,867	12,000	16,500	3,204	6,895	58,547			126,757	582,626	55,182	247,990
Massachusetts	4,996,442	563,863			232,861			38	133	18,722	131,734	34,894	147,470
Michigan	5,362,671	714,539			222,950			315,690	274,161	3,465	16,807	5,238	31,791
Minnesota	235,787	2,337			2,337								
Mississippi	349,689	85,800				3,234	35,800			9,000	22,000	4,000	28,000
Missouri	5,496,347	30,848			28,629	40	400			630	1,819		
Nebraska	572,898												
Nevada	9,500												
New Jersey	16,297,390	1,733,693	14,118	9,765	698,672	486	4,382			86,630	409,998	85,782	390,645
New York	24,756,424	2,942,580			1,344,871	1,263	15,075	324,919	316,745	22,104	155,401	54,379	227,458
North Carolina	1,057,430	287,849	4,215,500	18,668		967	9,587	1,815	2,400	38,858	160,554	16,684	88,818
Ohio	8,006,959	568,408	700	2,800	234,901	2,530	21,360	175	1,150	28,515	114,172	42,421	194,025
Oregon	163,143	5,480			5,480								
Pennsylvania	18,230,605	2,462,198			317,180	1,265	11,479	62,429	74,109	33,491	200,710	97,579	500,777
Rhode Island	631,859	118,105			5,450			168	728			4,183	25,470
South Carolina	3,107,710	1,026,097				9,114	71,226			141,464	555,861	83,272	399,010
Tennessee	1,054,022	284,770								36,431	118,067	20,668	155,428
Texas	64,524	9,261	15,000	9,169						10	92		
Vermont	320,287	1,200											
Virginia	3,055,220	803,350	104,754	57,451	12,000	1,107	10,781	72,245	38,348	82,482	290,778	35,988	147,312
West Virginia	205,200	106,900											
Wisconsin	862,991	225			225								
All other states	68,257	12,912	5,000	2,500								2,602	10,412

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	MATERIALS USED—Continued.													
	Purchased in raw state—Continued.				Purchased in partially manufactured form.									
	Wood.				Total cost.	Acids.						Acid phosphate.		Argols.
	For alcohol.		For extracts.			Sulphuric.		Nitric.		Mixed.				
	Cords.	Cost.	Tons.	Cost.		Tons.	Cost.	Pounds.	Cost.	Pounds.	Cost.	Tons.	Cost.	Cost.
United States[*]	495,073	$1,255,794	261,384	$2,485,688	$87,323,152	280,028	$1,946,742	3,131,894	$154,144	69,566,011	$1,560,133	287,147	$2,182,316	$2,204,800
Alabama					702,434	500	5,000			433,266	11,844	58,585	169,820	
California			8,172	18,626	4,283,386	2,961	56,418	319,987	13,359	12,498,500	151,904	1,550	27,000	245,000
Colorado					110,743									
Connecticut			18,801	524,223	659,230	231	1,736					8,226	28,248	
Delaware					525,778	1,972	11,824					21,262	154,292	
District of Columbia					47,555							1,550	14,500	
Florida			3,300	4,000	234,591	300	1,800					5,547	48,447	
Georgia					1,334,190	24,202	133,207					30,305	276,183	
Illinois					6,383,225	16,077	147,993	25,000	1,000			6,366	48,352	
Indiana	15,000	40,000			1,082,731	2,570	44,515			3,020,000	86,449	1,105	12,180	
Iowa					406,239									
Kansas					444,986	3,000	34,440					750	7,110	
Kentucky			600	12,600	514,155	4,314	32,187					1,910	20,700	
Louisiana					522,265							17,419	154,627	
Maine					150,946							380	4,500	
Maryland					3,088,179	28,119	164,658					29,571	237,541	
Massachusetts	880	6,480	4,477	45,185	3,758,550	4,138	54,103	774,930	31,416			6,558	62,368	
Michigan	82,694	124,830	15,450	44,000	2,994,372	3,869	47,921			6,694,964	189,276			
Minnesota					208,681									
Mississippi					204,564	500	5,000					7,892	67,178	
Missouri					4,993,443	1,054	9,714			5,966,091	251,600	175	1,748	
Nebraska					487,039									
Nevada					7,806									
New Jersey	3,208	12,364	12,326	207,867	12,198,674	75,317	436,625	1,692,610	97,496	21,526,726	380,970	12,551	119,061	1,044,800
New York	108,885	271,681	34,734	611,349	17,479,548	21,064	172,641	15,400	656	2,183,744	39,986	18,127	155,137	915,000
North Carolina	3,134	7,822			605,982	3,402	19,051					10,256	87,276	
Ohio					6,409,486	21,576	147,333	26,000	802	6,208,183	164,207	8,774	82,519	
Oregon					137,533									
Pennsylvania	280,872	791,417	74,899	566,526	12,193,055	42,836	283,697	193,600	6,641	9,926,537	249,454	15,795	141,167	
Rhode Island			3,277	86,457	421,950	554	2,853			100,000	7,000	200	1,696	
South Carolina					1,699,892	4,459	24,632					12,702	121,141	
Tennessee			6,433	11,275	487,503	310	2,412					1,200	9,000	
Texas					45,139	92	576							
Vermont	400	1,200			300,792									
Virginia			48,215	246,680	1,378,984	16,498	104,936	34,000	1,540			14,646	130,525	
West Virginia			35,700	106,900	66,062	113	1,470	50,367	1,234	1,008,000	27,443			
Wisconsin					723,801									
All other states					34,664									

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	MATERIALS USED—Continued.										
	Purchased in partially manufactured form—Continued.										
	Ammonia.				Alcohol.				Bones, tankage, and offal.	Common salt.	
	Aqua.		Sulphate.		Grain.		Wood.				
	Pounds.	Cost.	Pounds.	Cost.	Gallons.	Cost.	Gallons.	Cost.	Cost.	Tons.	Cost.
United States	417,488,626	$1,137,307	16,985,013	$657,726	331,207	$510,375	3,692,803	$1,751,345	$10,313,661	42,189	$142,398
Alabama									340,611		
California	89,158,596	12,542	2,502,000	64,959	8,652	19,500	2,773	3,766	232,955	454	1,639
Colorado	90,000	4,050			185	416	185	162		120	360
Connecticut			328	11	10,100	24,070	690	1,400	88,514	17	76
Delaware	1,492,366	60,277	1,127,729	28,193					51,708		
District of Columbia	3,258,864	2,444							24,123		
Florida			500,000	15,000	10	24			96,926	6	48
Georgia			30,000	900					534,781	40	100
Illinois			1,130,268	35,056	3,310	6,483	100,916	84,170	603,783	5,058	19,120
Indiana	127,703	3,788			601	1,396	591	591	123,705	3,048	10,494
Iowa									1,000	1	60
Kansas									296,496		
Kentucky									56,059		
Louisiana					53	103			215,218	140	560
Maine							1,965	2,161	5,580		
Maryland			478,521	13,939					1,160,985	190	950
Massachusetts	1,227,436	73,646	200,000	5,500	1,095	2,641	56,071	45,320	402,020	1,580	2,382
Michigan	29,431,188	490,162			9,434	21,698	200	200	415,154	1,462	6,014
Minnesota											
Mississippi									93,046		
Missouri	41,049,931	116,538	1,133,931	136,561	36,937	82,086	14,149	9,812	64,815	509	2,124
Nebraska									15,770		
Nevada											
New Jersey	99,289,132	56,140	5,025,724	138,578	160,624	127,156	311,229	204,658	1,104,361	6,547	28,677
New York	180,000	9,000	580,377	164,504	52,425	122,964	3,111,592	1,330,284	596,733	13,713	38,361
North Carolina			50,000	1,500					354,015		
Ohio	43,017,000	25,810	19,549	579	6,745	15,314	12,360	16,403	344,183	5,234	13,180
Oregon					300	696	217	184	1,893		
Pennsylvania	105,440,790	200,337	1,062,458	29,468	38,336	80,328	75,765	47,359	1,096,756	4,060	18,168
Rhode Island			2,414,128	1,078	2,400	5,500	1,600	2,800	204,401		
South Carolina									1,061,977		
Tennessee	1,964,640	2,400							141,576		
Texas									25,875		
Vermont	360	22									
Virginia	536,620	64,851	730,000	21,900					558,642	10	85
West Virginia	1,224,000	15,300									
Wisconsin							2,500	2,075			
All other states											

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	MATERIALS USED—Continued.													
	Purchased in partially manufactured form—Continued.													
	Cotton seed and meal.	Dry colors.	Glycerine.		Lead.		Lime.		Linseed oil.		Nitrate of potash.		Nitrate of soda.	
	Cost.	Cost.	Pounds.	Cost.	Tons.	Cost.	Bushels.	Cost.	Gallons.	Cost.	Tons.	Cost.	Tons.	Cost.
United States	$167,410	$9,476,333	34,635,822	$3,419,406	104,401	$8,618,097	7,428,885	$442,252	16,157,117	$7,495,196	6,084	$300,199	147,020	$4,899,622
Alabama	80,218		63,119	8,058									490	19,236
California		130,176	5,765,997	681,840	1,908	152,650	3,509	700	205,784	118,083			26,912	837,022
Colorado		33,367					1,318	224	75,042	37,521			180	6,300
Connecticut		23,666							71,496	34,963			2,577	91,099
Delaware		11,096					7,080	1,213	10,400	4,660			2,616	78,831
District of Columbia		245					1,190	203	800	500			15	675
Florida													269	9,619
Georgia	78,192	48,943							49,551	29,997			1,333	50,035
Illinois		1,772,237	617,195	57,642	11,866	991,042	4,459	546	2,121,711	935,511	257	19,826	3,172	106,444
Indiana		71,819	1,407,659	157,945			18,432	3,090	142,264	59,815			8,957	313,198
Iowa		84,170							182,856	73,947			4,795	150,101
Kansas		445							3,500	1,400			1,759	68,253
Kentucky		106,826					1,854	315	268,625	120,857			89	4,600
Louisiana	9,000	25,338					557	160	66,604	33,302			46	1,702
Maine		37,054							30,168	15,729	[illegible]	6,000	1,468	44,700
Maryland		88,474					190,000	22,000	112,376	54,943			3,069	132,450
Massachusetts		784,389			3,641	327,718	27,283	10,708	489,339	219,896	492	38,511	5,187	182,975
Michigan		431,054	1,152,501	142,873			134,256	22,452	913,022	417,099			2,203	76,342
Minnesota		75,449							164,519	80,159				
Mississippi		3,500							6,000	3,600			150	5,400
Missouri		684,637	1,787,311	199,741	15,447	1,332,088	50,474	8,096	1,201,716	526,632			2,530	90,263
Nebraska		92,510			2,901	242,666			213,779	102,773				
Nevada									1,800	1,080				
New Jersey		488,219	3,866,604	434,101	3,000	275,500	98,664	15,467	844,341	399,581	28	2,780	31,276	1,026,282
New York		2,252,264	10,073,575	839,197	29,389	2,152,933	5,805,537	255,271	4,199,414	1,970,463	633	54,453	7,663	254,274
North Carolina		1,180							750	[illegible]			745	28,609
Ohio		911,684	7,849,186	624,274	9,831	817,413	27,979	4,413	1,806,071	909,189	884	31,342	14,585	486,636
Oregon		37,271							95,452	45,218				
Pennsylvania		847,617	1,914,237	258,507	26,418	2,326,087	1,045,814	94,299	2,235,619	993,028	3,318	115,407	16,599	557,481
Rhode Island		51,812					6,085	1,826	34,338	15,182			229	7,524
South Carolina													2,169	82,569
Tennessee		47,902							48,093	24,047			2,550	88,098
Texas		11,434							11,822	5,811				
Vermont		6,378					3,425	1,086						
Virginia		46,649					357	62	27,737	13,868	877	31,880	1,786	65,246
West Virginia			138,438	15,228			612	122						
Wisconsin		256,949							493,575	236,945			857	26,250
All other states		11,279							28,553	9,097			144	7,908

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	MATERIALS USED—continued.											
	Purchased in partially manufactured form—Continued.							Fuel.	Rent of power and heat.	Mill supplies.	All other materials.	Freight.
	Potash salts.	Sulphur.		Tallow and fats.	Wood ashes.		All other components of products.					
	Cost.	Tons.	Cost.	Cost.	Bushels.	Cost.	Cost.	Cost.	Cost.	Cost.	Cost.	Cost.
United States	$3,891,818	83,530	$1,724,857	$380,517	801,047	$39,507	$23,906,991	$5,515,636	$297,568	$779,814	$11,281,479	$3,143,972
Alabama	31,270	827	18,690				17,687	20,284	1,032	10,886	136,102	118,826
California	106,984	10,199	235,383				1,191,206	275,557	9,302	63,481	484,502	285,666
Colorado							28,343	5,980	780	950	12,802	11,864
Connecticut	27,725	1,997	43,487				294,235	95,995	160	60,557	80,751	38,098
Delaware	62,906	516	10,937				50,341	13,364	262	4,854	87,978	42,249
District of Columbia	3,530						1,335	2,056	260	255	2,379	993
Florida	54,300						8,427	9,749	360	2,488	23,866	8,337
Georgia	136,905	350	8,750				36,197	53,185	460	11,706	200,007	127,477
Illinois	81,075	2,588	53,401				1,419,544	200,325	11,306	22,814	718,979	101,705
Indiana	1,628	198	6,773		25,200	1,280	184,065	65,565	51	4,296	133,908	29,557
Iowa		694	13,198				83,763	22,552		1,652	58,292	30,641
Kansas	17,647	281	9,218				9,977	21,643	13,500	3,767	38,083	
Kentucky	5,400						167,211	8,647	1,101	2,305	43,543	10,095
Louisiana	15,644	2,627	51,527				15,084	20,072	14	4,017	56,846	2,008
Maine	4,769	250	5,000	3	21,960	2,044	23,406	4,468	1,055	3,368	27,048	7,781
Maryland	568,019	7,214	162,581				481,639	153,866	350	67,366	377,230	130,374
Massachusetts	235,613	3,358	63,010				1,211,334	150,780	4,938	21,252	426,915	75,144
Michigan	67,905	51	1,002		584,617	29,440	635,780	863,430	813	27,785	544,325	217,407
Minnesota							53,073	3,726	1,020	596	14,808	4,619
Mississippi	18,560						8,280	3,375		5,150	34,200	16,600
Missouri	6,740	1,003	22,021				1,448,228	81,316	5,801	10,915	366,864	7,160
Nebraska							33,320	22,414		2,055	48,372	13,018
Nevada							6,725	535		130	1,030	
New Jersey	781,154	17,010	311,325				4,725,743	587,230	4,553	89,474	1,378,452	305,314
New York	337,931	14,986	307,581	9,700			5,500,215	1,355,502	228,897	146,813	2,509,999	93,085
North Carolina	105,866						8,185	23,703	600	13,683	89,827	35,786
Ohio	61,682	3,816	81,875	274,314	169,270	6,743	1,389,591	184,879	1,917	46,368	651,345	144,556
Oregon	1,900						50,371	820	820	250	11,790	6,450
Pennsylvania	517,046	13,956	282,929	96,500			3,950,779	826,449	2,758	115,856	1,858,441	771,848
Rhode Island	9,950	937	18,186				92,142	29,692	965	2,428	41,786	16,933
South Carolina	310,118						99,455	88,786		5,909	223,276	63,750
Tennessee	114,224	419	12,164				45,680	34,279		4,975	118,248	124,247
Texas							1,443	1,822	72	355	6,500	1,375
Vermont							293,306	3,632		1,425	12,622	616
Virginia	205,327						133,473	252,736	1,423	13,848	315,673	289,206
West Virginia							5,265	9,528	578	1,702	20,401	29
Wisconsin		142	3,694				197,888	11,136		3,803	116,179	7,847
All other states		111	2,125				4,255	6,558	2,420	280	8,110	3,313

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS CONSUMED.											
	Acids.			Acid phosphate (tons).	Charcoal (bushels).	Ether (pounds).	Lead oxides (pounds).	Nitrate of ammonia (pounds).	Nitroglycerine (pounds).	Pyroxyline (pounds).	White lead (pounds).	All other products consumed (pounds).
	Sulphuric (tons).	Nitric (pounds).	Mixed (pounds).									
United States	1,557,134	82,123,221	20,902,371	88,964	1,719,675	1,193,264	374,061	158,307	31,661,806	1,964,345	24,922,647	545,121,097
Alabama	22,020								185,324			18,230,512
California	27,158	3,600,000	12,000,000			799,579			10,895,803		162,000	8,374,875
Colorado	600											
Connecticut	1,210	570,139			16,798							21,000
Delaware					29,200							2,647,281
District of Columbia												
Florida	7,065											380,000
Georgia	78,655											
Illinois	6,594	155,484										1,817,031
Indiana	13,795	8,185,736	148,671					81,115	2,254,788	4,310		428,729
Iowa												1,426,207
Kansas												
Kentucky												
Louisiana	17,718			3,025								
Maine												
Maryland	98,240											5,828,200
Massachusetts	45,305	855,500	8,734,700							239,842		6,215,478
Michigan	10,205	586,105			267,825			77,192	2,547,820			55,817,010
Minnesota												
Mississippi	9,000			9,000								
Missouri	744	8,074							3,906,248			306,576
Nebraska											7,251,300	
Nevada												
New Jersey	62,775	13,787,691	19,000	17,527		393,125			8,877,764	1,720,193		21,079,070
New York	34,123	2,469,682			294,000				182,000			399,834,890
North Carolina	33,047			5,545	155,400							1,003,283
Ohio	10,314	953,422		13,050					105,350			1,463,080
Oregon												
Pennsylvania	835,157	951,388		35,746	939,500	560	374,061		2,756,709		17,509,347	24,312,375
Rhode Island												
South Carolina	138,973											
Tennessee	35,495			5,071	16,887							40,500
Texas												
Vermont					65							
Virginia	68,946											2,400,000
West Virginia												
Wisconsin												
All other states												

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	MISCELLANEOUS EXPENSES.					PRODUCTS.							
	Total.	Rent of works.	Taxes.	Rent of offices, interest, etc.	Contract work.	Aggregate value.	Group 1.—Acids.						
							Total value.	Sulphuric.					
								50° Baumé.		60° Baumé.		66° Baumé.	
								Tons.	Value.	Tons.	Value.	Tons.	Value.
United States	$14,825,112	$625,891	$973,585	$12,963,054	$262,582	$202,582,396	$12,757,012	187,879	$1,016,861	18,217	$256,557	416,017	$5,641,823
Alabama	97,677	1,100	22,969	72,850	758	2,123,102	25,000	2,934	25,000	....	....	....	....
California	386,899	10,770	21,846	354,166	117	8,279,243	667,440	3,537	44,091	2,369	33,460	6,071	116,124
Colorado	28,649	1,370	3,749	23,530	....	299,954	74,800	....	....	....	....	3,000	60,000
Connecticut	175,944	5,160	10,439	159,945	400	2,544,714	279,804	....	....	....	....	9,126	162,815
Delaware	112,986	250	4,678	108,058	....	1,356,416	....	....	....	....	....	....	....
District of Columbia	3,521	1,560	138	1,823	....	88,137	....	....	....	....	....	....	....
Florida	34,890	1,545	2,397	30,948	....	533,789	833	90	623	....	....	....	....
Georgia	416,841	6,981	37,534	372,201	125	3,549,632	5,436	856	5,436	....	....	....	....
Illinois	743,905	58,636	43,353	640,096	1,820	12,422,227	407,263	....	....	....	....	12,450	224,130
Indiana	155,204	5,536	11,662	134,506	3,500	2,686,427	574,962	....	....	....	....	19,419	231,487
Iowa	49,311	20	3,402	45,889	....	696,022	....	....	....	....	....	....	....
Kansas	59,144	280	2,644	56,220	....	733,818	....	....	....	....	....	....	....
Kentucky	29,676	4,180	4,894	20,602	....	1,054,008	....	....	....	....	....	....	....
Louisiana	123,352	265	1,961	121,126	....	1,049,653	25,910	....	....	149	5,960	208	8,736
Maine	17,431	500	3,229	13,702	....	389,631	17,542	402	3,214	1,034	14,328	....	....
Maryland	483,898	45,030	44,884	393,984	....	7,260,580	294,754	51,555	294,754	....	....	....	....
Massachusetts	649,776	37,658	51,604	555,514	5,000	8,088,698	900,968	37,395	35,110	....	....	27,634	414,211
Michigan	1,015,881	8,979	46,059	952,853	7,990	9,757,084	....	....	....	....	....	....	....
Minnesota	64,650	7,415	843	54,192	2,200	403,101	....	....	....	....	....	....	....
Mississippi	40,866	....	6,647	34,219	....	505,972	....	....	....	....	....	....	....
Missouri	374,174	30,149	34,711	304,662	4,652	7,588,090	81,830	....	....	....	....	2,869	54,500
Nebraska	74,315	480	2,845	70,990	....	954,840	....	....	....	....	....	....	....
Nevada	2,382	96	176	2,110	....	27,225	....	....	....	....	....	....	....
New Jersey	1,604,323	48,320	107,506	1,415,215	33,282	26,763,856	3,452,871	9,123	60,564	....	....	123,236	1,474,011
New York	2,992,743	197,888	203,297	2,583,408	8,150	40,998,911	1,740,102	1,426	15,050	84	1,488	60,871	896,514
North Carolina	109,043	39	17,810	91,180	14	1,523,030	....	....	....	....	....	....	....
Ohio	1,165,268	40,027	70,327	993,412	61,502	13,307,431	1,386,325	....	....	....	....	40,147	527,944
Oregon	8,313	2,940	794	4,579	....	239,359	....	....	....	....	....	....	....
Pennsylvania	2,309,431	72,249	106,215	2,007,652	123,315	32,154,223	2,389,861	39,188	303,122	13,356	193,799	101,643	1,279,709
Rhode Island	104,859	8,319	5,116	83,636	7,788	1,127,329	153,994	28	2,500	20	292	7,092	148,952
South Carolina	675,589	1,050	53,200	621,339	....	4,882,506	225,698	41,036	225,698	....	....	....	....
Tennessee	143,653	996	3,942	138,715	....	1,917,985	....	....	....	....	....	....	....
Texas	4,089	1,540	215	2,334	....	125,170	....	....	....	....	....	....	....
Vermont	39,591	265	200	39,126	....	408,737	....	....	....	....	....	....	....
Virginia	421,586	12,325	37,871	369,579	1,811	5,059,465	8,929	309	1,699	1,205	7,230	....	....
West Virginia	15,990	410	870	14,552	158	334,003	....	....	....	....	....	....	....
Wisconsin	84,591	11,100	3,117	70,374	....	1,230,838	....	....	....	....	....	....	....
All other states	4,671	463	441	3,767	....	117,190	42,690	....	....	....	....	2,251	42,690

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.													
	Group I.—Acids—Continued.									Group II.—Sodas.				
	Nitric.		Mixed.		Tartaric.		Acetic.		Other.	Total value.	Sal soda.		Soda ash.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Value.		Tons.	Value.	Tons.	Value.
United States	30,961,501	$1,454,909	36,468,819	$1,111,158	997,004	$294,608	16,356,680	$376,520	$2,604,581	$11,638,051	63,249	$779,443	386,361	$4,768,383
Alabama														
California	3,380,340	158,293			90,000	27,000			288,472	666,025	3,870	58,370	1,320	17,160
Colorado	180,000	10,800							4,000	3,500				
Connecticut	1,592,280	79,871	1,466,044	86,600					518	7,038				
Delaware														
District of Columbia														
Florida									210					
Georgia														
Illinois	508,758	35,600					867,920	11,120	136,413	308,771	5,061	67,489		
Indiana	491,454	18,344	6,434,418	240,510					84,621	299,463	3,487	34,874		
Iowa														
Kansas														
Kentucky														
Louisiana									11,214	840				
Maine														
Maryland										89,905	2,500	25,000		
Massachusetts	3,082,046	86,741							364,906	118,182	232	2,900		
Michigan										2,826,377			188,165	2,158,969
Minnesota														
Mississippi														
Missouri							652,573	10,650	16,680	30,129				
Nebraska														
Nevada										20,950			600	8,800
New Jersey	14,256,680	684,773	5,081,134	259,583			6,478,443	187,196	786,744	170,640	52	687		
New York	4,100,541	222,740	6,392,516	159,800	720,000	208,000	4,127,162	95,470	141,040	4,921,144	28,095	357,303	167,552	2,066,422
North Carolina														
Ohio	1,377,291	72,248	17,094,707	414,665					371,468	122,820	4,100	42,640		
Oregon														
Pennsylvania	1,972,111	83,999			187,004	59,603	4,230,582	72,084	397,545	1,010,167	12,756	132,990		
Rhode Island	20,000	1,500							750	1,800				
South Carolina														
Tennessee														
Texas														
Vermont														
Virginia										920,999			28,724	517,032
West Virginia														
Wisconsin										174,301	3,096	57,190		
All other states														

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.													
	Group II.—Sodas—Continued.							Group III.—Potashes.		Group IV.—Alums.		Group V.—Coal-tar products.		
	Bicarbonate of soda.		Caustic soda.		Borax.		Other soda products.	Pounds.	Value.	Pounds.	Value.	Total value.	Coal-tar distillery products.	Chemicals made from coal-tar distillery products.
	Tons.	Value.	Tons.	Value.	Tons.	Value.	Value.						Value.	Value.
United States	68,185	$1,324,843	78,779	$2,917,955	5,637	$502,480	$1,344,947	3,764,806	$174,476	179,465,871	$2,446,576	$1,338,810	$826,546	$512,264
Alabama														
California	225	9,000	3	125	5,502	490,330	91,040					30,632	11,415	19,217
Colorado							3,500							
Connecticut							7,038							
Delaware														
District of Columbia														
Florida														
Georgia														
Illinois			2,458	221,325			14,957	820,000	53,349	10,130,000	95,600			
Indiana							264,589	135,200	6,350					
Iowa														
Kansas														
Kentucky														
Louisiana							840							
Maine								88,290	2,935					
Maryland							14,905							
Massachusetts							115,282			19,766,415	306,754	27,513	27,513	
Michigan	10,000	150,000	18,000	500,000			17,408	1,869,116	77,609	1,480,000	39,500			
Minnesota														
Mississippi														
Missouri			111	8,679			21,450					394,400	94,400	300,000
Nebraska														
Nevada					135	12,150								
New Jersey			20	820			169,133					231,000	227,400	3,600
New York	43,812	885,003	40,499	1,518,464			93,952			46,211,951	593,070	44,016	29,716	14,300
North Carolina														
Ohio							80,180	852,200	34,233			243,000	243,000	
Oregon														
Pennsylvania	7,700	154,000	11,754	460,845			262,332			101,877,505	1,411,652	354,249	179,102	175,147
Rhode Island							1,800							
South Carolina														
Tennessee												14,000	14,000	
Texas														
Vermont														
Virginia	6,425	122,079	5,934	207,697			74,191							
West Virginia														
Wisconsin	23	4,761					112,350							
All other states														

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.												
	Group VI.—Cyanides.						Group VII.—Wood distillation.						
	Total value.	Potassium cyanide.		Yellow prussiate of potash.		Other cyanides.	Total value.	Wood alcohol.				Acetate of lime.	
								Crude.		Refined.			
		Pounds.	Value.	Pounds.	Value.	Value.		Gallons.	Value.	Gallons.	Value.	Tons.	Value.
United States	$1,595,505	2,317,280	$601,362	6,165,406	$994,014	$129	$5,675,616	4,191,379	$1,660,061	3,038,218	$2,297,008	43,413	$981,286
Alabama													
California													
Colorado													
Connecticut													
Delaware													
District of Columbia													
Florida													
Georgia													
Illinois													
Indiana							125,000			100,000	65,000	1,000	30,000
Iowa													
Kansas													
Kentucky													
Louisiana													
Maine	120,700			700,000	120,700								
Maryland	13,020	50,000	13,020										
Massachusetts							38,607			29,652	35,973		
Michigan							514,106	116,010	32,225	504,196	319,553	3,396	43,265
Minnesota													
Mississippi	18,216	24,099	3,813	96,024	14,403								
Missouri													
Nebraska													
Nevada	1,053,472	2,235,945	582,482	2,847,556	470,990								
New Jersey							83,331			90,000	67,500		
New York							2,548,109	1,056,083	431,064	2,207,230	1,762,812	11,285	250,211
North Carolina	86,852			518,822	86,852		22,437	170,960	13,677	62,238	7,570		
Ohio							4,000			3,000	4,000		
Oregon	303,245	7,236	2,047	2,003,004	301,069	129							
Pennsylvania							2,339,066	2,848,326	1,183,095	41,902	34,600	27,732	657,810
Rhode Island													
South Carolina													
Tennessee													
Texas													
Vermont							960						
Virginia													
West Virginia													
Wisconsin													
All other states													

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.											
	Group VII—Continued.			Group VIII—Fertilizers.								
	Charcoal.		All other products in this group.	Total value.	Superphosphates.				Complete.		All other.	
					From minerals, bones, etc.		Ammoniated.					
	Bushels.	Value.	Value.		Tons.	Value.	Tons.	Value.	Tons.	Value.	Tons.	Value.
United States	17,155,440	$726,809	$10,452	$40,914,685	925,008	$8,492,360	142,898	$2,349,388	1,454,389	$25,796,143	299,910	$4,276,794
Alabama				1,942,708	38,246	369,587	2,000	35,000	92,253	1,433,355	6,670	104,766
California				636,687					19,570	591,187	2,561	45,500
Colorado												
Connecticut				313,610			1,000	23,000	7,325	205,931	2,752	84,679
Delaware				634,213	2,385	28,250			17,180	283,873	30,377	322,090
District of Columbia				71,480					3,160	64,800	449	6,680
Florida				496,642	9,394	93,940			15,435	377,535	1,315	25,167
Georgia				3,240,304	181,503	1,075,581	14,603	229,271	101,219	1,563,653	26,605	371,799
Illinois				1,754,905	26,108	313,850	4,150	58,100	43,483	835,335	25,333	547,620
Indiana	750,000	30,000		235,836	365	10,006	27	500	5,750	116,280	5,431	109,050
Iowa				3,075							155	3,075
Kansas				549,943	8,978	160,498	6,858	125,745	10,000	200,000	4,535	63,700
Kentucky				295,520					17,315	295,520		
Louisiana				856,201	29,244	263,821	13,037	221,599	22,842	367,181	300	3,600
Maine				27,902					828	21,602	1,000	6,300
Maryland				5,188,925	124,696	1,178,367	48,608	690,671	184,095	2,985,015	27,734	334,872
Massachusetts	15,000	1,200	1,434	2,060,575	1,282	12,820			76,571	1,940,605	4,280	107,150
Michigan	2,831,120	119,063		353,608	1,528	17,699			14,753	279,588	2,767	56,321
Minnesota				7,285							1,471	7,285
Mississippi				492,772	7,200	50,400			30,504	442,372		
Missouri				139,395	2,766	44,248			2,774	39,039	2,354	56,108
Nebraska				58,914					4,532	58,914		
Nevada												
New Jersey	152,500	10,800	5,031	3,704,162	105,165	887,470	7,283	59,580	125,839	2,629,511	8,039	127,601
New York	2,310,653	103,390	632	2,445,375	9,810	105,645	10,300	338,400	87,862	1,623,638	45,814	377,692
North Carolina	1,138	137	1,053	1,487,333	48,820	397,397	3,400	51,000	53,528	841,632	14,345	197,304
Ohio				1,562,518	24,728	285,698	23,805	380,936	43,351	700,606	11,918	195,278
Oregon				6,500							120	6,500
Pennsylvania	11,079,029	461,259	2,302	2,712,767	22,975	310,273	2,846	53,271	120,715	2,178,334	11,272	170,889
Rhode Island				105,755			681	10,215	2,097	48,231	2,938	47,309
South Carolina				4,656,808	173,183	1,404,569			207,860	3,146,915	7,497	105,324
Tennessee				1,464,788	35,959	456,568			36,695	704,220	20,400	304,000
Texas				69,800	40	780			25	500	4,036	68,520
Vermont	16,000	960										
Virginia				3,324,979	120,683	1,024,893	4,300	72,100	106,828	1,820,771	26,692	407,215
West Virginia				5,400							350	5,400
Wisconsin												
All other states				8,000							400	8,000

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.									
	Group IX.—Bleaching materials.				Electro-chemical products.	Group XI.—Dyestuffs.				
	Total value.	Hypochlorites.		Other bleaching agents.		Total value.	Natural.		Artificial.	
		Tons.	Value.	Value.	Value.		Pounds.	Value.	Pounds.	Value.
United States	$492,086	2,143	$115,608	$376,478	$1,306,368	$4,914,686	49,019,074	$2,658,008	11,168,308	$2,256.678
Alabama										
California										
Colorado										
Connecticut						36,825	806,175	36,825		
Delaware										
District of Columbia										
Florida						5,650	59,825	5,650		
Georgia										
Illinois	38,649	297	38,649			13,894			11,200	13,894
Indiana										
Iowa										
Kansas										
Kentucky										
Louisiana										
Maine					9,631	30,000			4,412	30,000
Maryland										
Massachusetts	912			912		1,191,560	4,045,302	320,347	2,123,816	871,213
Michigan	62,387	1,782	62,387		193,256					
Minnesota										
Mississippi										
Missouri	21,196			21,196						
Nebraska										
Nevada										
New Jersey	12,972	56	12,972			668,068	6,160,000	206,240	3,846,908	461,828
New York	340,612			340,612	1,102,481	1,897,834	9,723,797	1,104,858	2,497,162	792,976
North Carolina										
Ohio	3,500			3,500						
Oregon										
Pennsylvania	11,858	8	1,600	10,258		889,213	23,831,150	816,135	1,162,450	73,078
Rhode Island						168,453	4,391,325	168,453		
South Carolina										
Tennessee										
Texas										
Vermont						2,300			230,000	2,300
Virginia										
West Virginia						11,389			1,292,360	11,389
Wisconsin										
All other states										

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.						
	Group XII.—Tanning materials.						
	Total value.	Natural.				Artificial.	
		Ground or chipped.		Extracts.			
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
United States	$1,790,118	49,002,037	$465,956	62,012,788	$1,259,007	2,454,084	$65,155
Alabama							
California	31,500	300,000	1,500	1,050,000	30,000		
Colorado							
Connecticut							
Delaware							
District of Columbia							
Florida	20,000			1,050,900	20,000		
Georgia							
Illinois	2,500			12,500	2,500		
Indiana							
Iowa							
Kansas							
Kentucky	21,000	1,344,000	21,000				
Louisiana							
Maine							
Maryland							
Massachusetts	16,000					376,470	16,000
Michigan	100,684			8,444,600	100,684		
Minnesota							
Mississippi							
Missouri							
Nebraska							
Nevada							
New Jersey	181,800	13,872,000	98,600	719,228	46,684	1,460,664	36,516
New York	300,756			7,024,440	295,356	36,000	5,400
North Carolina							
Ohio							
Oregon							
Pennsylvania	364,701	415,117	7,783	19,108,020	349,679	580,950	7,239
Rhode Island							
South Carolina							
Tennessee	48,589			2,776,500	48,589		
Texas							
Vermont							
Virginia	470,223	25,145,920	180,158	17,936,725	290,065		
West Virginia	232,365	7,925,000	156,915	3,889,875	75,450		
Wisconsin							
All other states							

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.									
	Group XIII.—Paints, colors, and varnishes.									
	Aggregate value.	A.—Pigments.								
		Total value.	White lead.		Oxides of lead.		Lamp and other blacks.		Fine colors.	
			Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
United States	$67,918,533	$13,824,773	116,102,316	$4,211,181	50,759,623	$2,550,340	7,519,345	$420,037	4,080,902	$1,028,754
Alabama										
California	969,779	278,825	4,800,000	237,180	500,000	25,895				
Colorado	188,500									
Connecticut	579,334	7,840					224,000	7,840		
Delaware	82,873	200							1,000	200
District of Columbia	2,500									
Florida										
Georgia	182,279									
Illinois	8,129,967	880,868	11,037,475	531,962					201,000	32,000
Indiana	403,327	18,250					365,000	18,250		
Iowa	335,367	96,316	250,000	24,750						
Kansas	4,875									
Kentucky	673,063									
Louisiana	140,102									
Maine	117,991									
Maryland	460,852	68,947	80,000	4,000						
Massachusetts	2,439,254	594,432	110,496	5,525	3,725,279	197,440	700,000	42,000	345,000	35,000
Michigan	3,391,773	40,737								
Minnesota	395,816									
Mississippi	13,200									
Missouri	4,338,644	509,364	4,942,814	243,681	3,581,604	183,189				
Nebraska	838,151	61,889			1,125,262	61,889				
Nevada	3,875									
New Jersey	5,984,881	1,540,921	14,471,171	717,047					1,135,284	190,893
New York	18,762,564	4,812,435	39,109,000	547,440	12,426,000	663,176	15,000	2,550	1,937,116	734,713
North Carolina	2,468									
Ohio	6,702,884	619,377	8,822,814	383,475	1,508,000	79,792	550,000	40,000	254,000	19,900
Oregon	186,931									
Pennsylvania	10,725,579	4,111,190	32,478,546	1,516,121	27,893,478	1,338,959	5,665,345	309,397	207,502	16,048
Rhode Island	181,818	500								
South Carolina										
Tennessee	147,790	30,640								
Texas	39,830									
Vermont	401,077									
Virginia	201,972	146,499								
West Virginia										
Wisconsin	881,717	6,043								
All other states	57,500									

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.										
	Group XIII.—Paints, colors, and varnishes—Continued.										
	A.—Pigments—Continued.						B.—Paints.				
	Iron oxides and other earth colors.		Dry colors.		Pulp colors, sold moist.		Total value.	Paints in oil, in paste.		Paints already mixed for use.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.		Pounds.	Value.	Gallons.	Value.
United States	33,772,256	$324,902	167,734,241	$4,428,028	20,060,935	$861,531	$32,473,812	306,477,865	$17,603,127	16,900,350	$14,870,685
Alabama	....	....	....	....	....	....	....	....	....	....	....
California	....	....	2,100,000	15,750	....	....	557,149	2,411,622	207,797	355,837	349,352
Colorado	....	....	....	....	....	....	160,000	83,330	10,000	153,325	150,000
Connecticut	....	....	....	....	....	....	99,385	1,428,868	68,009	34,020	31,376
Delaware	....	....	....	....	....	....	21,876	215,846	8,496	16,725	13,380
District of Columbia	....	....	....	....	....	....	2,500	....	....	1,000	2,500
Florida	....	....	....	....	....	....	....	....	....	....	....
Georgia	....	....	....	....	....	....	149,779	870,683	56,065	91,394	93,714
Illinois	1,183,565	14,617	9,853,710	300,789	10,000	1,000	4,629,569	45,021,424	2,634,159	2,594,474	1,995,410
Indiana	....	....	....	....	....	....	153,215	1,734,600	121,136	34,612	32,079
Iowa	....	....	3,042,000	71,566	....	....	209,051	1,405,000	74,150	181,485	134,901
Kansas	....	....	....	....	....	....	4,875	....	....	6,500	4,875
Kentucky	....	....	....	....	....	....	353,135	1,022,640	70,610	387,575	282,525
Louisiana	....	....	....	....	....	....	132,102	189,834	50,686	94,017	81,416
Maine	....	....	....	....	....	....	60,406	822,600	47,133	13,000	13,273
Maryland	130,000	400	1,533,509	33,505	558,300	31,042	293,259	1,101,227	87,519	232,544	205,740
Massachusetts	2,278,000	28,435	3,445,701	218,607	739,312	67,425	1,103,380	10,402,389	635,551	479,011	467,829
Michigan	....	....	417,418	40,737	....	....	1,659,034	9,761,345	684,716	847,205	974,318
Minnesota	....	....	....	....	....	....	357,816	796,282	100,084	298,661	257,732
Mississippi	....	....	....	....	....	....	13,200	....	....	12,000	13,200
Missouri	....	....	8,455,000	82,494	....	....	3,578,173	45,796,923	2,282,924	1,542,268	1,295,249
Nebraska	....	....	....	....	....	....	773,662	8,850,306	553,950	221,712	219,712
Nevada	....	....	....	....	....	....	3,375	....	....	2,700	3,375
New Jersey	500,000	25,000	4,764,207	445,425	5,156,948	162,556	1,132,641	8,672,911	552,452	622,542	580,189
New York	15,602,000	127,134	42,933,177	2,156,799	12,941,596	580,623	6,918,338	68,999,820	4,009,897	2,922,134	2,908,441
North Carolina	....	....	....	....	....	....	2,377	2,803	2,377	....	....
Ohio	80,000	1,200	1,441,781	95,010	....	....	4,118,491	30,595,967	1,752,553	2,578,218	2,365,938
Oregon	....	....	....	....	....	....	135,731	30,576	7,644	114,991	128,087
Pennsylvania	6,318,691	96,976	63,817,766	820,847	594,379	12,842	4,562,252	59,138,990	3,052,644	2,174,014	1,509,608
Rhode Island	20,000	500	....	....	....	....	104,604	629,800	70,775	35,554	33,829
South Carolina	....	....	....	....	....	....	....	....	....	....	....
Tennessee	7,660,000	30,640	....	....	....	....	117,150	142,000	28,400	116,073	88,750
Texas	....	....	....	....	....	....	39,530	241,429	15,600	26,200	23,930
Vermont	....	....	....	....	....	....	170,207	108,650	5,300	232,059	164,907
Virginia	....	....	25,929,972	146,499	....	....	....	....	....	....	....
West Virginia	....	....	....	....	....	....	....	....	....	....	....
Wisconsin	....	....	....	....	60,400	6,043	800,050	6,000,000	412,500	430,000	387,550
All other states	....	....	....	....	....	....	57,500	....	....	48,500	57,500

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.											
	Group XIII.—Paints, colors, and varnishes—Continued.									Group XIV.—Explosives.		
	C.—Varnishes and japans.								All other products in this group.	Total value.	Gunpowder.	
	Total value.	Oil and turpentine varnishes.		Alcohol varnishes.		Pyroxyline varnishes.		Liquid dryers, japans, and lacquers.				
		Gallons.	Value.	Gallons.	Value.	Gallons.	Value.	Value.	Value.		Pounds.	Value.
United States	$18,602,796	14,286,758	$14,337,461	563,212	$943,069	204,069	$237,012	$3,085,254	$3,017,152	$17,036,897	123,314,108	$5,310,351
Alabama										54,940	247,525	8,511
California	130,805	123,670	120,392	2,670	5,300			5,113	3,000	4,274,553	500,000	80,000
Colorado	28,500	30,000	28,500									
Connecticut	390,092	137,679	307,462	175	404	28,810	36,012	46,214	82,017	312,400	7,282,750	312,400
Delaware	2,200			500	1,200			1,000	8,597	443,971	8,794,779	443,971
District of Columbia												
Florida												
Georgia	7,500							7,500	25,000			
Illinois	2,186,496	1,617,053	1,621,154	148,943	203,538	16,000	16,000	295,804	488,534	289,735	6,358,250	270,974
Indiana	221,372	263,624	195,260	1,210	3,569	383	594	21,949	10,490	970,944	4,925,000	214,324
Iowa									30,000	353,315	12,618,400	353,315
Kansas										179,000	4,477,575	179,000
Kentucky	315,978	454,550	314,603	100	145			1,230	3,950			
Louisiana	8,000	8,310	7,904					96				
Maine	46,000	50,000	46,000						11,585	170,000	4,000,000	170,000
Maryland	44,646	55,800	23,825					20,821	54,000			
Massachusetts	593,353	436,532	442,600	4,400	11,360			139,393	148,089	171,062	1,227,775	147,330
Michigan	1,668,549	1,632,963	1,629,437	3,575	8,451			30,661	23,453	691,766		
Minnesota	28,000	27,754	28,000						10,000			
Mississippi												
Missouri	227,468	110,169	127,640	2,106	3,277	6,500	16,000	80,551	23,639	992,842		
Nebraska									2,600			
Nevada									500			
New Jersey	2,826,391	1,668,752	2,258,228	67,673	124,743	49,308	69,181	374,239	484,928	3,498,197	5,477,900	240,027
New York	6,271,755	4,928,208	4,665,714	231,205	432,928	102,777	99,000	1,074,113	760,036	367,998	5,939,200	263,594
North Carolina	91							91				
Ohio	1,739,803	1,245,565	1,177,397	43,304	50,107			512,299	225,213	1,330,489	21,627,675	927,098
Oregon	51,200	32,000	51,200									
Pennsylvania	1,779,950	1,408,656	1,236,672	47,901	88,473	291	225	459,580	272,187	2,571,368	34,961,649	1,507,807
Rhode Island	11,250			6,950	11,250				65,464			
South Carolina												
Tennessee										220,318	2,500,000	100,000
Texas	300							300				
Vermont									230,870	1,400		
Virginia	55,473	55,473	55,473							3,500		
West Virginia										52,099		
Wisconsin	17,624			2,500	3,324			14,300	58,000	92,000	2,375,625	92,000
All other states												

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.											
	Group XIV.—Explosives—Continued.									Group XV.—Plastics.		
	Nitroglycerine.		Gun cotton, or pyroxyline.		Dynamite.		Smokeless powder.		All other explosives.	Total value.	Pyroxyline plastics.	All other products in this group.
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Value.		Value.	Value.
United States	3,618,692	$783,299	369,499	$189,623	85,846,456	$8,247,223	2,973,126	$1,655,948	$850,453	$2,099,400	$1,970,387	$129,013
Alabama					496,861	46,429						
California			50,000	30,000	27,055,910	2,895,703	1,361,000	816,600	452,250			
Colorado												
Connecticut												
Delaware												
District of Columbia												
Florida												
Georgia												
Illinois									18,761			
Indiana	675,000	118,750			6,456,041	614,934	68,938	22,936				
Iowa												
Kansas												
Kentucky												
Louisiana												
Maine												
Maryland												
Massachusetts									23,732	231,509	111,641	119,868
Michigan	4,000	2,000			6,643,975	652,174			37,592			
Minnesota												
Mississippi												
Missouri					10,464,235	992,842						
Nebraska												
Nevada												
New Jersey	14,199	2,191	284,499	124,623	25,550,543	2,185,365	1,477,633	765,991	175,000	1,862,496	1,858,746	3,750
New York			35,000	35,000	671,215	69,404						
North Carolina												
Ohio	1,455,113	351,970					61,555	49,021	2,400			
Oregon												
Pennsylvania	1,163,918	256,289			8,507,676	790,372			16,900	5,395		5,395
Rhode Island												
South Carolina												
Tennessee									120,318			
Texas												
Vermont							4,000	1,400				
Virginia									3,500			
West Virginia	306,462	52,099										
Wisconsin												
All other states												

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.														
	Group XVI.—Essential oils.						Group XVII.—Compressed and liquefied gases.				Group XVIII.—Fine chemicals.				
	Total value.	Natural.		Witch-hazel.		Artificial.	Total value.	Anhydrous ammonia.	Carbon dioxide.	Compressed and liquefied gases not otherwise enumerated.	Total value.	Alkaloids.		Gold salts.	
		Pounds.	Value.	Gallons.	Value.	Value.		Value.	Value.	Value.		Ounces.	Value.	Ounces.	Value.
United States	$846,605	882,554	$787,496	110,260	$54,649	$54,460	$1,215,011	$448,157	$696,164	$70,690	$4,229,431	3,387,522	$1,743,264	8,594	$90,145
Alabama															
California	2,490	3,330	2,490				44,488	20,488	24,000						
Colorado															
Connecticut	45,530	[illegible]	480	91,000	45,050										
Delaware							77,786	77,786							
District of Columbia															
Florida	500	400	500												
Georgia															
Illinois	110	32	100			10	180,350		180,350		100,060				
Indiana	14,180	17,683	14,180												
Iowa															
Kansas															
Kentucky															
Louisiana															
Maine															
Maryland											12,000				
Massachusetts	4,395	2,930	4,395				13,700		500	13,200	9,390				
Michigan	202,258	218,453	202,258				2,976	2,976							
Minnesota															
Mississippi															
Missouri							142,586	79,742	62,844		234,056			5,226	53,448
Nebraska															
Nevada															
New Jersey							151,600	92,375	59,225		406,854	288,672	98,213	803	9,917
New York	533,400	517,462	469,351	19,260	9,599	54,450	226,452		173,962	52,490	484,590			65	780
North Carolina	500	500	500												
Ohio							52,905	47,905		5,000	1,650				
Oregon															
Pennsylvania	2,595	1,993	2,595				239,713	126,885	112,828		2,930,831	3,098,850	1,645,051	2,500	26,000
Rhode Island											50,000				
South Carolina															
Tennessee															
Texas															
Vermont							3,000		3,000						
Virginia	37,772	117,721	37,772												
West Virginia															
Wisconsin	2,875	1,750	2,875				79,455		79,455						
All other states															

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.										
	Group XVIII.—Fine chemicals—Continued.										
	Silver salts.		Platinum salts.		Chloroform.		Ether.		Acetone.		All other.
	Ounces.	Value.	Ounces.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Value.
United States	1,252,604	$499,345	7,312	$54,600	396 540	$98,070	263,238	$129,876	1,638,715	$178,666	$1,435,465
Alabama											
California											
Colorado											
Connecticut											
Delaware											
District of Columbia											
Florida											
Georgia											
Illinois											100,060
Indiana											
Iowa											
Kansas											
Kentucky											
Louisiana											
Maine											
Maryland											12,000
Massachusetts											9,390
Michigan											
Minnesota											
Mississippi											
Missouri	103,576	37,719	6,380	46,678			116,350	56,211			40,000
Nebraska											
Nevada											
New Jersey	173,000	63,890	932	7,922	334,000	66,800	56,000	18,650	63,593	6,359	135,103
New York	325,121	120,104			62,540	31,270	74,500	45,700	1,455,865	158,712	128,024
North Carolina											
Ohio											1,650
Oregon											
Pennsylvania	650,907	277,632					16,388	9,315	119,257	13,595	959,238
Rhode Island											50,000
South Carolina											
Tennessee											
Texas											
Vermont											
Virginia											
West Virginia											
Wisconsin											
All other states											

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.													
	Group XIX.—Chemicals not otherwise specified.													
	Total value.	Glycerin.		Cream of tartar.		Epsom salts.		Blue vitriol.		Copperas.		Phosphates of soda.		
		Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	
United States	$5,189,992	15,383,798	$2,012,886	10,620,000	$2,081,500	7,559,809	$57,966	7,500,000	$375,000	19,884,305	$87,927	3,478,350	$104,554	
Alabama														
California	326,000			1,610,000	326,000									
Colorado														
Connecticut														
Delaware														
District of Columbia														
Florida														
Georgia														
Illinois	182,391	1,403,506	169,695							2.086,400	12,696			
Indiana														
Iowa														
Kansas														
Kentucky														
Louisiana														
Maine														
Maryland	116,215					1,421,500	14,215					3,400,000	102,000	
Massachusetts	30,191													
Michigan														
Minnesota														
Mississippi														
Missouri	2,554											78,350	2,554	
Nebraska	31,655	372,418	31,655											
Nevada														
New Jersey	1,120,977			4,210,000	795,500					871,902	5,231			
New York	2,133,275	8,000,000	1,120.000	4,800,000	960,000	20.000	1,000			67,403	675			
North Carolina														
Ohio	726,211	5,607,874	691,536							10,158,600	34,675			
Oregon														
Pennsylvania	520,523					6,118,309	42,751	7,500,000	375,000	6,700,000	34,650			
Rhode Island														
South Carolina														
Tennessee														
Texas														
Vermont														
Virginia														
West Virginia														
Wisconsin														
All other states														

TABLE 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	PRODUCTS—continued.			COMPARISON OF PRODUCTS.			POWER.							
	Group XIX.—Chemicals not otherwise specified—Continued.		All other.	Number of establishments reporting for both years.	Census year 1900.	Preceding business year	Number of establishments reporting.	Total horsepower.	Owned.					
	Tin salts.								Engines.				Water wheels.	
									Steam.		Gas or gasoline.			
	Pounds.	Value.	Value.		Value.	Value.			Number.	Horsepower.	Number.	Horsepower.	Number.	Horsepower.
United States	4,677,471	$470,159	$19,003,538	1,473	$180,675,706	$156,604,049	1,354	198,338	2,682	158,646	86	1,669	311	9,273
Alabama	...	...	100,454	13	1,817,640	1,562,913	19	1,630	34	1,515	...	...	...	...
California	...	...	629,649	18	7,863,041	6,981,138	42	3,653	65	2,553	6	47	7	200
Colorado	...	...	33,154	4	299,954	190,952	[illegible]	199	6	167	...	...	...	...
Connecticut	...	...	970,673	26	2,485,964	2,313,213	21	2,692	38	1,731	...	...	33	911
Delaware	...	...	167,573	13	1,077,926	1,098,490	12	2,602	30	1,360	...	...	40	1,082
District of Columbia	...	...	14,157	7	85,637	83,855	3	94	1	65	...	...	1	[illegible]
Florida	...	...	10,164	10	533,789	469,492	7	527	10	515	...	...	...	...
Georgia	...	...	121,613	23	1,516,461	1,409,770	36	3,913	56	3,855	...	...	...	...
Illinois	...	...	869,683	74	10,886,616	9,567,420	66	6,726	76	6,086	8	139	1	15
Indiana	...	...	56,365	36	2,546,039	2,270,170	34	2,441	49	2,008	3	73	...	...
Iowa	...	...	4,265	8	696,022	566,051	7	753	22	753	...	...	...	...
Kansas	...	...	...	4	728,943	554,593	4	1,105	6	730	1	[illegible]	...	...
Kentucky	...	...	64,425	15	953,730	829,686	15	969	17	902	1	10	...	...
Louisiana	...	...	26,600	9	1,036,453	808,938	8	927	12	835	1	36	...	...
Maine	...	...	13,630	10	366,000	374,600	8	2,644	10	196	...	...	17	2,420
Maryland	...	...	1,027,229	54	4,921,377	4,513,513	47	4,487	78	4,056	5	87	2	44
Massachusetts	179,587	30,191	515,106	79	8,027,083	6,526,099	60	6,190	89	4,890	1	10	6	470
Michigan	...	...	1,300,784	89	9,362,568	7,664,301	52	23,774	179	23,494	...	...	6	150
Minnesota	...	...	...	6	377,031	310,500	6	271	4	201	...	...	...	...
Mississippi	...	...	...	4	505,972	441,000	3	415	4	415	...	...	...	...
Missouri	...	...	1,192,242	35	7,026,687	6,868,038	29	2,805	49	2,599	3	37	...	...
Nebraska	...	...	26,120	5	954,840	841,650	5	380	4	360	...	...	...	...
Nevada	...	...	2,400	4	27,225	25,900	3	59	5	57	1	2	...	...
New Jersey	3,130,578	320,246	4,185,535	131	23,823,809	20,281,702	120	17,817	321	16,293	3	47	2	30
New York	257,329	51,600	2,557,133	246	38,930,455	35,058,082	224	49,974	538	28,784	10	228	67	1,201
North Carolina	...	...	10,292	15	1,152,111	1,084,357	16	1,292	29	1,153	16	56	...	...
Ohio	...	...	1,050,044	115	12,414,903	10,501,736	103	10,017	156	7,657	7	267	12	603
Oregon	...	...	45,928	5	239,359	158,794	4	90	2	60	...	...	...	...
Pennsylvania	1,109,977	68,122	3,371,440	277	30,791,552	26,031,791	272	30,855	559	27,372	17	598	102	1,582
Rhode Island	...	...	465,509	12	1,127,329	999,561	5	730	15	647	...	...	2	60
South Carolina	...	...	...	7	865,429	792,863	18	3,940	36	3,940	...	...	...	...
Tennessee	...	...	22,500	13	1,577,587	971,818	11	2,105	23	1,833	1	22	6	250
Texas	...	...	15,540	5	39,830	28,060	6	180	6	175	...	...	...	...
Vermont	...	...	...	3	404,337	267,368	4	380	6	380	...	...	...	...
Virginia	...	...	91,091	47	3,756,967	3,129,320	57	9,782	127	9,292	1	2	7	246
West Virginia	...	...	32,750	7	303,503	257,168	8	550	8	500	...	...	...	...
Wisconsin	...	...	490	9	1,074,347	694,383	11	1.090	11	1,087	1	3	...	...
All other states	...	...	9,000	5	77,190	74,764	4	280	1	130	...	...	...	...

Table 9.—CHEMICALS AND ALLIED PRODUCTS: DETAILED STATEMENT BY STATES AND TERRITORIES, 1900—Continued.

STATES AND TERRITORIES.	POWER—continued.							FACTORIES.									
	Owned—Continued.				Rented.		Furnished to other establishments.	Total number of establishments.	No employees.	Under 5.	5 to 20.	21 to 50.	51 to 100.	101 to 250.	251 to 500.	501 to 1,000.	Over 1,000.
	Electric motors.		Other power.														
	Number.	Horsepower.	Number.	Horsepower.	Electric, horsepower.	Other kind, horsepower.	Horsepower.										
United States	399	6,849	15	542	19,445	1,914	875	1,740	43	413	655	319	143	122	34	6	5
Alabama	1	25			30	60		19		1	6	5	4	3			
California	37	570	2	45	173	65	40	53		12	28	9	4	4		1	
Colorado			3	15	15	2		4			2	1	1				
Connecticut	2	8	1	25	17			31		9	13	4	3	1	1		
Delaware	5	140				20		15		1	10	1	1	1	1		
District of Columbia						20		8		3	4	1					
Florida					12			10	1	1	1	6		1			
Georgia	2	28			30			46		3	18	10	8	6	1		
Illinois	9	159			23	304	161	88		19	31	22	10	5	1		
Indiana	35	337			23			42		9	22	7	2	2			
Iowa								8	2	2	1	2		1			
Kansas	3	70				300		5		2			1	2			
Kentucky					57			18		6	6	3	3				
Louisiana	2	31				25		10	1		4	2	1	2			
Maine	3	19			9			13	2	2	5	3	1				
Maryland	8	210				90		63		10	23	17	3	8	2		
Massachusetts	26	645	1	50	30	95		83	1	27	37	10	4	2	2		
Michigan	15	115			5	10	140	97	6	48	19	10	5	6	1		2
Minnesota					70			8		1	5	2					
Mississippi								4			1	2	1				
Missouri	3	6			123	40		39		10	13	10	2	2	2		
Nebraska					20			5			2		3				
Nevada								[illegible]		1	2	1					
New Jersey	74	1,171	2	55	20	201	10	160	5	36	56	27	12	18	5		1
New York	63	989			18,435	337	146	285	[illegible]	67	106	56	28	14	6	2	1
North Carolina					83			23	3	4	7	3	3	3			
Ohio	66	1,376			57	57	208	137	6	33	61	22	6	6	3		
Oregon					30			5		1	3	1					
Pennsylvania	40	893	4	302	28	80	155	306	9	70	126	66	17	13	2	2	1
Rhode Island	1	15				8	15	12		4	3	1	3	1			
South Carolina								22		2	3	1	2	11	3		
Tennessee								14	1	1	5	3	2		2		
Texas					5			7		3	3		1				
Vermont								5		1	3			1			
Virginia	3	27	1	40		175		64		15	20	7	11	8	2	1	
West Virginia	1	15	1	10		25		9		4	4		1				
Wisconsin								12	1	3	4	3		1			
All other states					150			6		2	3	1					

APPENDIX.

CONTENTS.

DIGEST OF UNITED STATES PATENTS RELATING TO THE CHEMICAL INDUSTRIES.

(Products and processes.)

GROUP I.—ACIDS.

GROUP II.—SODAS.

GROUP III.—POTASH.

GROUP IV.—ALUMS.

GROUP V.—COAL-TAR PRODUCTS

See group XVIII, Fine chemicals.

GROUP VI.—CYANOGEN COMPOUNDS.

GROUP VII.—WOOD DISTILLATION.

GROUP VIII.—FERTILIZERS.

GROUP IX.—BLEACHING MATERIALS AND BLEACHING PROCESSES.

GROUP X.—CHEMICAL SUBSTANCES PRODUCED BY THE AID OF ELECTRICITY.

GROUP XI.—DYESTUFFS AND EXTRACTS.

GROUP XII.—TANNING.

GROUP XIII.—PAINTS, COLORS, AND VARNISHES.

GROUP XIV.—EXPLOSIVES.

GROUP XV.—PLASTICS.

GROUP XVI.—ESSENTIAL OILS.

GROUP XVII.—COMPRESSED AND LIQUEFIED GASES.

GROUP XVIII.—FINE CHEMICALS.

GROUP XIX.—CHEMICALS NOT OTHERWISE ENUMERATED.

DIGEST OF UNITED STATES PATENTS.

Prepared by STORY B. LADD, under the direction of CHARLES E. MUNROE.

GROUP I.—ACIDS.

SULPHURIC ACID.

8,808—August 26, 1851. E. L. SEYMOUR. *Improvement in process of reducing ores by zinc compounds.*

Sulphurous gas from the calcination of sulphuret ores with air and steam is passed through feldspathic rock, magnesian limestone, sulphurets of metals or the like, converting the same into their sulphates, and the surplus gas is converted into dilute sulphuric acid. The gases remaining or evolved are combined with crude or raw ammonia or other alkaline substance producing fertilizers; or the sulphurous gases of the first operation are passed into water in the presence of metallic zinc, forming sulphate of zinc, which is converted into white oxide of zinc.

41,647—February 16, 1864. J. SMITH AND J. R. SAVAGE. *Improvement in the manufacture of sulphuric acid.*

Sulphuric acid is heated for concentration by steam coils in leaden pans and still.

42,985—May 31, 1864. L. CHANDOR. *Improvement in the manufacture of sulphuric acid.*

Columns of stoneware or clay flasks are used in lieu of lead chambers, and the sulphurous acid is passed through masses of porous bodies, such as coke or pumice stone.

43,157—June 14, 1864. R. G. LOFTUS. *Improved process of recovering the acid used in refining petroleum.*

The spent acid is, first, diluted with 50 per cent of water, subjected to agitation and then repose in a leaden-lined tank, and the oily matters subsequently drawn off; second, the diluted acid is concentrated by evaporation to from 1.650 to 1.700 and subjected to further dilution and repose; third, the clear liquid is siphoned off from the heavier impurities and again concentrated to from 1.650 to 1.700; and, fourth, it is concentrated in glass, porcelain, or other suitable vessels to a specific gravity of 1.845.

52,090—January 16, 1866. A. H. TAIT AND J. W. AVIS. *Improved apparatus for desulphurizing ores.*

Air heated to from 260° to 315° C. is forced through sulphuret ore in a closed chamber under a pressure of 20 to 40 pounds. The admission of a small quantity of nitric oxide gas is advantageous.

62,919—March 19, 1867. D. ASHWORTH AND R. B. EATON. *Improvement in concentrating sulphuric acid.*

A series of glass retorts is used in combination with a heating apparatus.

78,352—May 26, 1868. D. ASHWORTH AND R. B. EATON. *Improved apparatus for concentrating sulphuric acid.*

The hot concentrated acid is cooled and the fresh acid heated by flowing the latter through an encasing jacket of a vessel of the former. It also relates to structural details.

86,881—February 9, 1869. A. H. TAIT. *Improvement in the manufacture of sulphuric acid.*

Sulphurous acid is freed from nitrogen by liquefying the sulphurous acid and allowing the nitrogen gas to escape. Arsenic is removed by refrigerating the sulphurous-acid vapors. Sulphurous-acid gas is exposed to the action of nitric oxide, air, and steam under pressure, forming sulphuric acid, which is concentrated by injecting hot air.

97,182—November 23, 1869. L. S. FALES. *Improved mode of recovering the spent acid from oil refineries.*

To effect the separation of the tarry matter from the spent acid of oil refineries, etc., the spent acid, either with or without the addition of sulphate of potash or of ammonia, and diluted with water, is subjected to the action of ammoniacal vapors from gas liquor, and then allowed to stand, when the tarry matter is removed, leaving a clear solution, which is then concentrated by evaporation, sulphate of soda being first added.

127,350—May 28, 1872. J. HUGHES. *Improvement in the manufacture of acids and paints from the materials used to purify gas.*

Saturated or spent gas-purifying materials are used as a base for the manufacture of acids. The resultant oxide, in the case of iron materials, is available as a base for paints.

129,204—July 16, 1872. W. ARCHDEACON. *Improvement in preparing wooden vessels for holding acids.*

The interior of the vessel is impregnated with a composition of glue 1 part and beeswax 3 parts, applied under pressure.

137,692—April 8, 1873. J. KIRCHER. *Improvement in obtaining sulphur, sulphuric acid, and sulphurets of sodium and potassium from gas lime, etc.*

Saturated gas-purifying material—lime or iron—is heated with superheated steam to evolve sulphureted hydrogen for the manufacture of sulphuric acid. Flowers of sulphur is produced by mixing gas lime with loam and sublimating the excess of sulphur; lac sulphur by mixing the gas lime with water and acid; sulphuret of sodium or potassium by subjecting the gas lime to the action of caustic soda or other alkali or salt.

143,202—September 23, 1873. E. THOMSON AND W. H. GREENE. *Improvement in the manufacture of sulphuric acid.*

It relates to details of structure and arrangement, including subjecting the nitrous gases evolved from the reaction of sulphurous acid and nitric acid to the action of cold water and air currents in a chamber with porous packing, to form nitric acid.

144,928—November 25, 1873. J. SAUNDERS. *Improvement in the manufacture of sulphuric acid.*

Hollow glass balls with one or more openings are used for filling sulphuric-acid condensing towers.

150,095—April 21, 1874. H. SPRENGEL. *Improvement in the manufacture of sulphuric acid.*

Very fine spray or mist of water or acidified aqueous solutions are used in place of steam. Sulphuric acid is sprayed to absorb the nitrous fumes in the gases from the sulphuric-acid chambers, and the acid containing the absorbed fumes is sprayed in the leaden chambers.

175,734—April 4, 1876. W. H. NICHOLS. *Improvement in sulphuric-acid packages.*

They are made of sheet iron, with the surfaces and edges coated with lead and united by melted lead.

204,244—May 28, 1878. A. PÉNISSAT. *Improvement in processes for recovering waste sulphuric acid.*

Sulphuric acid is recovered from the refuse in the treatment of coal oil by washing the acid from the tar, evaporating down to about 60° Baumé, and then vaporizing, condensing, and producing the white sulphuric acid and concentrating.

206,309—July 23, 1878. F. F. FARRAR AND F. P. GILL. *Improvement in processes and apparatus for recovering waste sulphuric acid.*

Acid is reclaimed from the residuum tar of refineries by mixing the tar with hot water and steeping with heat, then allowing it to cool and settle, when the acid and tar are drawn off from below. The acid water is then heated and the purer liquor withdrawn from the bottom and the water evaporated.

223,571—January 13, 1880. J. A. W. WOLTERS. *Manufacture of anhydrous sulphuric acid.*

Anhydrous sulphuric acid is obtained by the distillation of a mixture of anhydrous bisulphate of soda (or potash) and anhydrous sulphate of magnesia, or compounds of the other so-called vitriols and alkaline earths.

230,171—July 20, 1880. H. BOWER. *Process of and apparatus for treating residuum from petroleum refineries.*

Sulphuric acid is recovered by washing the sludge acid with water in covered tanks, mechanically separating the sulphuric-acid solution and carbonaceous matters from the oily ingredients, as by centrifugal machines (for redistillation), separating the acid solution from the carbonaceous matters by heating in a series of concentrators, and finally concentrating and distilling the separated sulphuric-acid solution.

232,685—September 28, 1880. E. CLARK. *Recovering sulphuric acid from sludge acid.*

In the recovery of sulphuric acid from the sludge acid of oil refineries, the offensive vapors are conducted off by an exhaust produced by an induced steam blast while the sludge is being agitated by steam.

233,680—October 26, 1880. E. C. E. AND L. L. LABOIS. *Manufacture of carbon bisulphide and sulphuric acid from pyrites, and apparatus therefor.*

A limited proportion of sulphur is first extracted from a determined quantity of pyrites and combined with carbon in a separate retort, while the hot pyritic residue is conducted to a separate furnace for the manufacture of sulphuric acid.

240,248—April 19, 1881. J. GRIDLEY. *Process of and apparatus for concentrating sulphuric acid.*

A strong heat is applied to the under surface of a thin body of dilute acid, and at the same time a blast of superheated steam or hot air is applied to the upper surface, and the vapors removed as they rise.

246,396—August 30, 1881. C. KOLBE AND T. LINDFORS. *Apparatus for concentrating sulphuric acid.*

A series of platinum retorts is arranged on a plane and connected by pipes from the bottom of one to a higher point of the next, giving an equilibrium of level in all the retorts.

250,416—December 6, 1881. F. BENKER AND H. LASNE. *Manufacture of sulphuric acid.*

Nitrous compounds are economized, in the manufacture of sulphuric acid, by mixing sulphurous-acid gas with the gases which enter the Gay-Lussac tower.

252,287—January 10, 1882. H. WURTZ. *Process of treating mineral pyrites and sulphides for the manufacture of sulphurous and sulphuric acids.*

A new product for use in the manufacture of sulphuric acid is made by granulating sulphurets and mixing same with comminuted metallic iron and forming into cakes or lumps. The iron in the lumps is oxidized by moistening with a saline solution. Asbestus or mica may be incorporated as a binder.

265,495—October 3, 1882. J. GRIDLEY. *Process of and apparatus for concentrating sulphuric acid.*

A small stream of dilute acid from the evaporating pan, of about 60° Baumé, is continuously introduced into a large quantity of acid of 66° Baumé in a concentrating pan and kept at the boiling point, with a proportionate constant discharge therefrom. The pan of cast iron has its walls above the weak acid line protected.

267,582—November 14, 1882. R. N. R. PHELPS AND W. A. CLARK, JR. *Process of treating the waste pickle liquor of ironworks.*

Ferric oxide, sulphuric acid, and other products are recovered from pickle liquor by evaporating the liquor, drying and pulverizing the crystals of sulphate of iron, heating them in a retort, say to 710° C., with air in regulated quantities, and condensing the sulphuric and sulphurous acid vapors.

268,793—December 12, 1882. E. HAWORTH. *Manufacture of sulphuric acid.*

Sulphurous-acid gas—as from lead smelters—is first passed through water, which dissolves the gas and condenses any metallic fumes. The water is then passed to a heating tank and the sulphurous-acid gas there evolved conveyed to a leaden chamber while the water is returned to the dissolving chamber.

291,821—January 8, 1884. M. A. WALSH. *Process of concentrating sulphuric acid.*

Monohydrated sulphuric acid is produced by first concentrating up to 93 per cent of monohydrated acid in the usual way and then transferring it, while hot, to an iron or steel vessel and therein completing the concentration.

306,897—October 21, 1884. R. M. BREINIG. *Process of the treatment of sludge acid.*

A soap compound adapted to unite with the sludge tar is mixed with the sludge, and the free acid is then readily separated from the tarry mass.

310,147—December 30, 1884. A. B. NOBEL AND G. FEHRENBACH. *Manufacture of anhydrous sulphuric acid.*

Sulphuric anhydride is produced by subjecting sulphuric acid to the dehydrating influence of hydrated phosphoric acid.

314,548—March 24, 1885. G. THOMSON AND W. KEMP. *Purifying sulphuric acid.*

Sulphuric acid is purified by treating with ammonium sulphide, filtering, and finally concentrating by heat.

323,583—August 4, 1885. E. D. KENDALL. *Process of recovering sulphuric anhydride.*

Sulphuric anhydride is recovered from a compound containing an excess of fuming sulphuric acid by heating the compound in a partial vacuum and condensing the volatilized sulphuric anhydride.

325,262—September 1, 1885. J. McNAB. *Process of manufacturing sulphuric acid.*

Sick or pale acid chambers are restored by injecting thereinto nitrous vapors.

339,552—April 6, 1886. J. HUGHES. *Apparatus for concentrating acids.*

An evaporating pan is made of porcelain with a transparent glass cover.

342,785—June 1, 1886. U. CUMMINGS. *Manufacture of sulphuric acid.*

Sulphuric acid is produced by calcining a mixture of clay and sulphate of lime, the proportions being such as will give hydraulic cement as a by-product.

345,140—July 6, 1886. J. HUGHES. *Process of making sulphuric acid.*

Hot sulphur and nitric fumes from a sulphur furnace are projected through a spray of water, in an intermediate chamber, and then passed into a condensing chamber.

357,107—February 1, 1887. H. J. P. SPRENGEL. *Obtaining sulphuric acid by the aid of waste steam.*

The exhaust steam from the engine is employed for the leaden chambers. The engine boiler pressure may be raised—say 10 pounds—for the leaden chambers, and the engine exhaust provided with a corresponding back pressure.

357,528—February 8, 1887. J. B. F. HERRESHOFF. *Process of concentrating sulphuric acid.*

Sulphuric acid is first concentrated to about 86 per cent, then concentrated in a separate vessel to about 95 per cent, and this is evaporated in another vessel to produce a residual strong acid of 98 per cent and a condensed pure acid of 93.5 per cent.

378,774—February 28, 1888. H. DE GROUSILLIERS. *Process of treating sludge acid.*

Sulphuric acid is recovered from sludge acid by first removing the petroleum or tarry impurities by floating them, then adding to the waste sulphate of soda or potash and precipitating the bisulphate formed by boiling and evaporation, then depriving the precipitate of its aqueous substance by heating to a moderate red heat, and finally vaporizing and condensing the sulphuric acid.

384,841—June 19, 1888. E. HÄNISCH AND M. SCHROEDER. *Process of producing sulphuric anhydride.*

Sulphuric anhydride is produced by reducing the volume of a gaseous mixture of sulphurous acid and oxygen (air 75 per cent, SO_2 25 per cent) by compression and subjecting the mixture under pressure to the converting action of a suitable contact surface, as a platinized substance, at red heat.

469,439—February 23, 1892. R. S. PENNIMAN. *Apparatus for the final concentration of oil of vitriol.*

A continuous-process apparatus has a series of coupled glass retorts with the contents agitated by injected air or otherwise.

475,586—May 24, 1892. P. MAURO. *Process of solidifying liquid acids.*

Liquid acids are solidified by adding thereto a soluble salt adapted to crystallize with the water, as sulphate of sodium or of calcium for sulphuric acid, or chloride of calcium or of magnesium for hydrochloric acid. The mixture is preferably heated and agitated, and then cooled.

484,546—October 18, 1892. E. J. BARBIER. *Process of treating bisulphate of soda.*

Neutral sulphate of soda and sulphuric acid are obtained from bisulphate of soda (35° to 45° Baumé) by refrigerating the bisulphate to about 10° C. until decomposition takes place, separating the crystalized neutral sulphate from the sulphuric acid and concentrating the same.

509,664—November 28, 1893. H. HOWARD. *Method of and apparatus for concentrating sulphuric acid.*

The flow of sulphuric acid to the still is governed by an automatic valve controlled by the specific gravity of the distillate.

514,983—February 20, 1894. W. WOLTERS. *Process of concentrating sulphuric acid.*

Sulphate of lead is added to the acid during concentration to prevent corrosion of the leaden vessels..

535,882—March 19, 1895. E. J. BARBIER. *Process of and apparatus for making sulphuric acid.*

The vapor of sulphurous acid circulates through a series of towers in succession wherein it is subjected to the action of a divided stream of sulpho-nitric, or diluted nitric acid, in the upper part of each tower, and to the action of nitrous and aqueous vapors in the lower part.

541,041—June 11, 1895. F. J. FALDING. *Process of and apparatus for making concentrated sulphuric acid.*

The hot sulphurous gases are conducted through a concentrating tower, and a denitrating tower to the lead chambers, and the acid there formed is returned in downward flow through the denitrating tower and the concentrating tower and from thence to storage tanks, whereby the denitrated acid is exposed to the action of the hot sulphurous gases.

541,597—June 25, 1895. J. D. DARLING. *Method of and apparatus for manufacturing sulphuric acid and by-products.*

See Group X, Electro-chemistry.

546,596—September 17, 1895. N. P. PRATT. *Process of and apparatus for making sulphuric acid.*

In the manufacture of sulphuric acid the gases in the acid chamber are commingled and agitated by withdrawing a portion of the gases at one point and reintroducing them at another.

590,826—September 28, 1897. J. D. DARLING. *Porous diaphragm for electrolytic apparatus.*

See Group X, Electro-chemistry.

591,730—October 12, 1897. W. BAIN. *Process of and apparatus for electrolyzing.*

See Group X, Electro-chemistry.

598,351—February 1, 1898. A. STAUB. *Apparatus for making sulphuric acid.*

The towers are filled with acid-resisting bodies, each having an inverted cup or open depression on the under side.

636,924—November 14, 1899. M. SCHROEDER. *Process of combining gases by contact process.*

Sulphuric acid or sulphuric anhydride is recovered from gases containing SO_2 and O by passing said gases through a mass comprising a catalytic agent and soluble salts. When the efficiency of the mass has become impaired by the action of the impurities the soluble carried salts are dissolved out. The catalytic mass is formed by evaporating a mixture of a liquid, a platinum salt, and a suitable soluble salt, and then reducing the platinum salt to the metallic state.

636,925—November 14, 1899. M. SCHROEDER. *Catalytic material.*

It consists of a catalytic substance, as platinum, distributed through a mass of one or more soluble salts, which, serving as a carrier therefor, are stable in the presence of hot sulphuric anhydride. An alkali salt is dissolved in water, mixed with a platinum salt solution, evaporated, and the resulting salt crusts dried and granulated. (See 636,924.)

640,037—December 26, 1899. J. V. SKOGLUND. *Apparatus for making acids.*

A tower or chamber for acid vapors is coated on the inside with an acid-resisting material and silicate of potash or soda, and treated with an acid to remove from the silica any alkaline material.

641,276—January 16, 1900. J. D. DARLING. *Porous diaphragm for cells employing fused electrolytes.*

See Group X, Electro-chemistry.

642,390—January 30, 1900. F. P. VANDENBERGH. *Process of making sulphuric acid.*

See Group X, Electro-chemistry.

643,578—February 13, 1900. W. WARING AND J. E. BRECKENRIDGE. *Process of purifying sludge acids.*

About 4 per cent of sodium nitrate is mixed with sludge acid, at a temperature between 60° and 180° F., to purify it and permit the recovery of the sulphuric acid. One per cent of sodium nitrate suffices to remove offensive odors.

652,119—June 19, 1900. R. KNIETSCH. *Method of making sulphuric anhydride.*

A gas containing sulphur dioxide and oxygen is passed through a contact substance, as platinized asbestus, while maintaining therein a temperature, at the hottest part, between the composing and decomposing temperature of sulphuric anhydride. The inflowing gas is heated by contact with the catalytic chamber and the latter cooled, and the temperature is regulated by adjustments of the gas and air currents, without external heating, except in special cases.

NITRIC ACID.

94,969—September 21, 1869. G. W. MOWBRAY. *Purifying nitric acid.*

Warm air is passed through nitric acid to purify it of the red fumes of nitrous acid.

125,635—April 9, 1872. C. W. VOLNEY. *Improvement in apparatus for the treatment of liquids with nitric acid.*

Liquids, as alcoholic substances, to be treated with nitric acid are repeatedly withdrawn from the vessel where nitric acid is added, cooled, and returned.

176,813—May 2, 1876. R. E. ROGERS. *Improvement in methods of recovering nitric acid used in separating gold and silver.*

Nitric acid is recovered from nitrate of silver solutions by precipitating the silver with hydrochloric acid in liquid or gaseous form.

198,776—January 1, 1878. B. C. MOLLOY. *Improvement in recovery of waste nitrous gases.*

A hot-water spray is used in towers or other suitable apparatus to absorb peroxide of nitrogen and recover nitric acid from its lower oxides.

477,375—June 21, 1892. J. LANG. *Process of making nitric acid.*

The mixed vapors of nitric acid, nitrous acid, and impurities are passed from the generator into a receiver and subjected to a heat high enough to keep the impurities vaporized, but not so high as to keep the pure nitric acid vaporized (for concentrated nitric acid the temperature should be at least 80° C.), and the vaporized impurities with any nitric-acid vapor are then passed into a cooler kept at a temperature low enough to condense the nitric-acid vapors (40° to 60° C.), which flow back into the receiver, while the vaporized impurities pass off uncondensed.

491,481—February 7, 1893. O. GUTTMANN. *Process of making nitric acid.*

An air blast is introduced into the tube between the distilling chamber and the condenser, to act upon the gaseous nitric acid and convert the low oxides before condensation.

500,786—July 4, 1893. C. O. VOLZ. *Process of making nitric acid.*

Pure and highly concentrated nitric acid is produced by placing the raw materials, as saltpeter and sulphuric acid, in an air-tight receptacle, establishing a vacuum, and condensing the vapor. Action is accelerated by heating the retort to 85° C.

514,124—February 6, 1894. G. LUNGE. *Process of making nitric acid and caustic alkali.*

An alkaline nitrate is mixed with crude ferric oxide in sufficient quantity to maintain the porosity of the mass, as two parts of ferric oxide to one of sodium nitrate, and the heated mass is subjected to the action of heated air and steam at a temperature sufficient to convert the whole of the alkaline base into an alkaline ferrite, with the evolution of nitrous fumes convertible into nitric acid. The alkaline ferrite is decomposed with hot water to recover the caustic alkali and ferric oxide.

517,001—March 20, 1894. J. D. DARLING. *Mode of producing nitric acid and metals from nitrates.*

See Group X, Electro-chemistry.

517,098—March 27, 1894. H. A. FRASCH. *Process of making concentrated nitric acid.*

Nitric-acid vapors are exposed to the action of sulphuric acid, or other dehydrating agent, and hot air at a temperature above the condensation point of the nitric acid to be obtained.

526,116—September 18, 1894. M. PRENTICE. *Process of making nitric acid.*

A mixture formed by dissolving sodium nitrate in sulphuric acid by heat is successively passed through a series of heated compartments and the vapors collected and condensed, whereby nitric acid is continuously produced. The liquid matter under distillation seals the passages between the series of chambers.

527,718—October 16, 1894. M. PRENTICE. *Still for obtaining nitric acid, etc.*

Still for process No. 526,116.

577,523—February 23, 1897. G. J. ANDERSSON AND J. C. DITTRICH. *Process of manufacturing ozone and by-products.*

See Group X, Electro-chemistry.

590,143—September 14, 1897. W. GARROWAY. *Process of making alkaline silicates and nitric acid.*

See Group II, Sodium Compounds, Silicates.

591,087—October 5, 1897. J. V. SKOGLUND. *Process of manufacturing nitric acid.*

Nitric-acid vapors are conveyed into a chamber packed with pieces of acid-proof material, the temperature of the chamber being maintained equal to or higher than the boiling point of the nitric acid and at a point that the watery materials will be condensed; the vapors are condensed and the nitric acid is allowed to run in thin films over the pieces of acid-proof material, being exposed to oxidizing action of air.

599,743—March 1, 1898. E. A. STARKE. *Compound nitrate and method of making same.*

A new product, a fused compound consisting of an alkaline-earth-metal nitrate with an alkaline-metal nitrate, and suitable for the manufacture of nitric acid and explosives, is formed by converting an alkaline-earth-metal salt into a nitrate, as by contact with waste nitric acid and vapors of various manufacturing processes, and then dehydrating the nitrate by fusing with an alkaline-metal nitrate.

603,508—May 3, 1898. E. HART. *Apparatus for distilling acids.*

The still has a series of small distillation tubes, closed at bottom, depending from the receiver and presenting an extended heated surface. They may be of glass.

632,394—September 5, 1899. H. K. BAYNES. *Process of decomposing alkali nitrates.*

A pulverulent mixture of alkali nitrate and ferric oxide is furnaced at about 650° C. in a revolving inclined cylinder retort, which is subjected to intermittent jarring and has longitudinal ribs to lift and shower the charge, the nitrous fumes being led off; whereby, in a continuous operation, the material is subjected in streams or films to repeated contact with heated surfaces and the solid products are carried out of the path of the undecomposed particles. The alkaline ferrite is subsequently converted into ferric oxide and caustic alkali.

648,322—April 24, 1900. J. F. WHITE. *Process of making nitric acid.*

In the manufacture of nitric acid from sodium nitrate and sulphuric acid, the weak nitric acid is converted into strong nitric acid by adding it to the succeeding charge of sodium nitrate and sulphuric acid, preferably by mixing it with the sulphuric acid.

MIXED ACIDS.

164,260—June 8, 1875. P. CASTELLANOS. *Improvement in the manufacture of nitrosulphuric acid for manufacturing nitroglycerine.*

A mixture of nitric acid and sulphuric acid is produced by condensing vaporized nitric acid in liquid sulphuric acid.

164,261—June 8, 1875. P. CASTELLANOS. *Improvement in recovering acids from residuum of nitroglycerine manufacture.*

The dilute residuum, dropped in small quantities through a heated column filled with obstructions, is treated with sulphurous-acid gas, the resulting nitric acid collected, and the sulphuric acid drawn off.

164,262—June 8, 1875. P. CASTELLANOS. *Improvement in apparatus for recovering acids from the residuum of nitroglycerine manufacture.*

Apparatus for process No. 164,261.

251,938—January 3, 1882. F. V. POOL. *Process of removing flocculent matter from spent acids.*

Flocculent matter, in spent acid used in the treatment of soluble fiber, is removed by introducing powdered barium sulphate—30 pounds per 650 gallons of solution—and permitting it to stand from thirty-six to seventy hours.

284,742—September 11, 1883. F. JENSSEN. *Separation of nitric acid from a mixture of nitric and sulphuric acid.*

A continuous stream of the mixed acids is passed through a connected series of retorts to which are given separate degrees of heat, and the nitric acid is distilled over from each retort into separate receivers, the acid in each of the receivers being of a different strength.

306,519—October 14, 1884. F. V. POOL. *Manufacture of soluble nitrocellulose.*

See Group XIV, Explosives.

336,822—February 23, 1886. F. V. POOL. *Art of manufacturing nitrocellulose.*

See Group XIV, Explosives.

343,850—June 15, 1886. F. V. POOL. *Art of making nitrocellulose.*

See Group XIV, Explosives.

350,497—October 12, 1886. G. M. MOWBRAY. *Manufacture of pyroxyline.*

See Group XIV, Explosives.

350,498—October 12, 1886. G. M. MOWBRAY. *Manufacture of pyroxyline.*

See Group XIV, Explosives.

479,988—August 2, 1892. H. MAXIM. *Method of restoring nitrating acids.*

See Group XIV, Explosives.

526,752—October 2, 1894. R. C. SCHUPPHAUS. *Process of nitrating cellulose.*

See Group XIV, Explosives.

HYDROCHLORIC ACID.

240,196—April 12, 1881. E. SOLVAY. *Preparation of hydrochloric acid.*

Hydrochloric acid is obtained in a dry state by absorbing it, or the vapors thereof, in a solution of calcium chloride, and then vaporizing the acid which is alone evolved.

299,830—June 3, 1884. L. MOND. *Process of obtaining hydrochloric acid from the residues of ammonia-soda manufacture.*

The liquors obtained in the manufacture of soda by the ammonia process are evaporated, and after separating therefrom the chloride of sodium, which salts out, the remaining product is treated with sulphuric acid yielding hydrochloric-acid gas, which is condensed or utilized, and, as a secondary product, sulphate of ammonia.

308,511—November 25, 1884. L. MOND. *Process of making hydrochloric acid.*

Chloride of ammonium is treated with an excess of sulphuric acid—say with double the quantity necessary to form the neutral sulphate—and the mixture heated until all of the hydrochloric acid is disengaged.

316,300—April 21, 1885. E. SOLVAY. *Manufacture of hydrochloric acid.*

For the manufacture of hydrochloric acid a composition is used of chloride of calcium, silicious clays, and the residuum from the manufacture of hydrochloric acid by a previous operation.

361,026—April 12, 1887. G. RUMPF. *Process of obtaining muriatic acid.*

For the production of hydrochloric acid metallic oxides are chloridized by passing vapors of ammonic chloride through them in a heated state, and then subjecting the metallic chlorides to a mixed current of air and steam. When the metallic chlorides are decomposed the operation is repeated.

379,487—March 13, 1888. L. MOND. *Obtaining ammonia and hydrochloric acid.*

See Group XIX, Ammonia and Ammonium Salts.

453,986—June 9, 1891. E. SOLVAY. *Process of distilling hydrochloric acid.*

A current of dehydrating material—as sulphuric acid—is caused to flow in a continuous circuit through a distilling apparatus and an evaporator, the solution of hydrochloric acid being fed into the dehydrating solution within the still, whereby hydrochloric acid is liberated and after passing off is condensed.

503,557—August 15, 1893. E. SOLVAY. *Apparatus for the distillation of hydrochloric acid.*

Apparatus for process No. 453,986.

474,539—May 10, 1892. W. WALKER. *Process of and apparatus for making silicates and hydrochloric acid.*

Hydrochloric acid is obtained as a by-product in the production of pure silicates for glass making by mixing chloride of sodium and lime with pulverized sand, and heating the mass in the presence of moisture to drive off the hydrochloric acid, which is collected, and form a silicate of soda and lime.

605,369—June 7, 1898. J. R. WYLDE AND J. W. KYNASTON. *Process of making hydrochloric acid.*

Hydrochloric acid free from arsenic is made from gases, wherein hydrochloric-acid gas is present contaminated with arsenic, by cooling the gases and then passing them in the presence of chlorine through or in contact with coke in a "dry tower," in which the arsenic is retained, and thence to a wet tower, in which the hydrochloric acid is condensed.

612,009—October 11, 1898. G. B. BALDO. *Process of and apparatus for electrolyzing sea water.*

See Group X, Electro-chemistry.

618,772—January 31, 1899. H. S. BLACKMORE. *Process of making alkali aluminates.*

See Group XIX, Aluminates.

PHOSPHORIC ACID.

14,722—April 22, 1856. E. N. HORSFORD. *Improvement in preparing phosphoric acid as a substitute for other solid acids.*

"Pulverulent phosphoric acid" is produced by treating burned bones with diluted sulphuric acid for several days, then leaching the pasty mass and concentrating the extract to 25° Baumé, and adding perfectly white bone ashes and concentrating to one-half its original bulk. Flour or farinaceous material is then added, and the material is passed through a sieve and dried.

156,181—October 20, 1874. J. E. SIEBEL. *Improvement in recovering phosphoric acid and purifying ammonia.*

A solution of phosphate of lime, obtained in the treatment of bones, is saturated with ammonia, forming a solution of phosphate of ammonia, which is evaporated, heated in a retort, and the ammonia recovered as well as the phosphoric acid. Crude ammonia thus repeatedly used is purified.

194,050—August 14, 1877. N. B. RICE. *Improvement in processes of recovering phosphoric acid used in manufacture of gelatine.*

In obtaining gelatine from bone, etc., by means of phosphoric acid, the acid phosphate of lime is treated to recover the phosphoric acid by subjecting each lot to the action of sulphuric acid and then leaching a part or the whole of the next lot through the sediment.

229,705—July 6, 1880. E. N. HORSFORD. *Pulverulent preparation of phosphoric acid.*

Pulverulent phosphoric acid is formed by treating the acid liquor to bring it into the condition of free phosphoric acid, concentrating it, mixing it with starch as a neutral substance, drying, and pulverizing. It is then mixed with a dry alkaline carbonate to form a baking powder.

230,874—August 10, 1880. E. N. HORSFORD. *Pulverulent preparation of phosphoric acid.*

The liquor resulting from the action of sulphuric acid upon bone-ash is taken directly from the leach, boiled down and mixed with starch, dried, and pulverized; forming a pulverulent product of free phosphoric acid and monocalcic phosphate direct from the liquid. It is mixed with a dry alkaline carbonate to form a baking powder.

239,394—March 29, 1881. H. S. MAXIM. *Process of and apparatus for manufacturing phosphoric anhydride.*

Phosphoric anhydride is produced by bringing together a jet of vapor of phosphorous and a blast of air of sufficient volume to oxidize the phosphorous to its highest equivalency.

258,423—May 23, 1882. W. H. HUGHES AND P. O'RIELLY. *Process of preparing phosphoric acid from bones.*

Liquid acid phosphates are treated with chlorate of potassa and the compound subjected to a high degree of heat to eradicate organic impurities. The process as a whole involves washing, calcining, leaching with sulphuric acid, filtering, treating with hot air or steam and then with chlorate of potassa and heat, and dissolving in water, with successive filtrations at different stages.

306,664—October 14, 1884. S. G. THOMAS AND T. TWYNAM. *Process of obtaining phosphoric acid from metallurgical slags.*

The slag is dissolved in dilute hydrochloric acid, a lime salt added in just sufficient quantity to precipitate the iron as ferric phosphate, and the solution of free phosphoric acid separated.

312,904—February 24, 1885. C. SCHEIBLER. *Process of treating phosphatic slag.*

The fluid slag is allowed to cool very slowly, whereby a concentration of the phosphoric acid takes place on the one part and of the iron and manganese on the other, so as to permit of their being separately removed.

393,428—November 27, 1888. W. B. GILES AND A. SHEARER. *Manufacture of phosphoric acid.*

Phosphoric acid is separated from impurities by distilling impure phosphoric acid at a high temperature—say a red heat—in the presence of a current of air, steam, or hydrochloric acid, and condensing the distillate in a partial vacuum.

459,575—September 15, 1891. C. GLASER. *Process of making phosphoric acid.*

Sulphuric acid is first diluted with phosphoric acid (instead of water), and then successive charges of phosphatic material are treated with sulphuric acid diluted with phosphoric acid of increasing degrees, using the phosphoric acid derived from each charge as a diluent to the sulphuric acid used in treating the succeeding charge.

527,670—October 16, 1894. G. DESCAMPS. *Phosphoric acid with an absorbent.*

Phosphoric acid in a dry form is provided by charging a vegetable cellulose, as sawdust or cane bagasse, with phosphoric acid and drying, the operation being repeated to increase the percentage of phosphoric acid in the absorbing material.

540,124—May 28, 1895. J. VAN RUYMBEKE. *Process of making phosphoric acid.*

A mixture of natural phosphate and clay is submitted to the action of heat in the presence of a reducing agent, as by fusing with coke, and the phosphorus vapors, produced and carried off with the products of combustion, are subjected to the action of air in sufficient quantity to oxidize the vapors into phosphorus pentoxide, which is collected in water, and concentrated to the desired density.

OTHER INORGANIC ACIDS.

76,678—April 14, 1868. D. P. WEBSTER. *Improvement in bottles for holding hydrofluoric acid.*

They are made of wood, papier-maché, or like material, coated inside with asphalt and outside with a compound of india rubber and gum shellac. A bottle may be made of two sections fitted together.

137,072—March 25, 1873. F. GUTZKOW. *Improvement in the manufacture of boracic acid.*

Boracic acid is separated from borate of lime by distillation with superheated steam.

160,761—March 16, 1875. F. FORMHALS. *Improvement in processes of obtaining boracic acid from borate of lime.*

Sulphurous acid is passed through borate of lime while the latter is in a state of suspension in water.

274,660—March 27, 1883. W. B. ROBERTSON, JR. *Process of and apparatus for obtaining boracic acid from borates.*

Nitrous and sulphurous vapors are formed and introduced, together with air, into a borate solution, or borate in suspension in water, forming boracic acid.

289,836—December 11, 1883. J. B. HOBSON. *Process of and apparatus for obtaining boracic acid from native borate of lime.*

Borate of lime is boiled with water and sulphuric acid gradually added, not, however, in excess. The solution is allowed to settle and the liquor is drawn off, filtered, cooled, and the boracic acid crystallized out and pressed to remove the remaining mother liquor and expel its impurities.

650,187—May 22, 1900. C. C. MOORE. *Process of making boracic acid and chlorates.*

Powdered crude borate is suspended in water, or the mother liquor of a previous operation—say three pounds to the gallon—chlorine is passed therethrough with agitation, and the boracic acid precipitated by refrigerating to 15° to 20° C.

322,011—July 14, 1885. W. A. ROWELL. *Manufacture of chromic acid.*

Chromic acid is produced by first producing in a solution of a chromate a precipitate of chromate of strontium, then completing the precipitation of the chromate solution by means of barium; afterwards decomposing the chromate of barium with excess of sulphuric acid and finally applying the same acid to decompose the chromate of strontium.

630,612—August 8, 1899. M. LE BLANC AND H. REISENEGGER. *Process of producing chromic acid by electrolysis.*

See Group X, Electro-chemistry.

394,387—December 11, 1888. E. W. PARNELL AND J. SIMPSON. *Obtaining hydrogen sulphide.*

Ammonium sulphide is first treated with dilute carbonic acid and the evolved gases permitted to escape; then the ammonium sulphide is given a second treatment with carbonic acid, yielding pure hydrogen sulphide.

403,249—May 14, 1889. A. M. AND J. F. CHANCE. *Obtaining hydrogen sulphide from alkali waste.*

Gases containing carbonic acid are passed through alkali waste and the resultant gases, containing hydrogen sulphide, are then passed through fresh alkali waste so that the hydrogen sulphide unites therewith. The waste so enriched is then treated with gases containing carbonic acid, yielding a gas rich in hydrogen sulphide, which is collected.

461,665—October 20, 1891. T. W. CAPPON. *Process of producing hydrofluosilicic acid.*

Hydrofluosilicic acid is produced by passing fluoride of silicon into an aqueous solution containing free hydrofluoric acid—from 10 per cent to 20 per cent or more—during the presence of which free acid the silica is dissolved.

465,607—December 22, 1891. M. W. BEYLIKGY. *Manufacture of hydrofluosilicic acid.*

Hydrofluosilicic acid is produced by heating a mixture of sulphate of iron and an equivalent proportion of finely powdered fluorspar to incipient redness in a closed vessel, passing steam over it to produce fluohydric acid charged with vapor of water, and finally passing the said acid condensed with water through silica.

626,511—June 6, 1899. E. TEISLER. *Process of obtaining silicic and hydrofluosilicic acids.*

An aqueous solution of fluorine compounds, resulting from the purification of graphite, is heated to evolve a mixture of steam and gasiform fluosilicate, and the mixture is then cooled so as to cause the fluosilicate to decompose into silicic acid and hydrofluosilicic acid, and the two compounds are separated.

489,633—January 10, 1893. F. GRUESSNER. *Process of recovering metastannic acid.*

Metastannic acid combined with arsenic is recovered by dissolving the compound in concentrated hot sulphuric acid, then adding an oxidizing agent, as nitric acid, and then diluting until free metastannic acid is precipitated.

529,100—November 13, 1894. I. A. F. BANG AND M. C. A. RUFFIN. *Manufacture of anhydrous stannic acid.*

A solution of an alkaline bicarbonate is added to a solution of an alkaline stannate to precipitate metastannic acid, which precipitate is mixed with sulphuric acid, dried and calcined at a red-white heat.

575,240—January 12, 1897. A. K. HUNTINGTON. *Process of making hydrocyanic acid.*

A mixture of acetylene and nitric oxide is ignited and rapidly burned in a closed chamber—as in a gas engine. The products, hydrogen and hydrocyanic-acid gases, are passed through solutions of substances which combine with hydrocyanic acid—as soda or potash—producing cyanides. The carbonic oxide and hydrogen may be used for combustion.

101,011—March 22, 1870. M. HATSCHEK. *Improved apparatus for producing sulphurous acid.*

A solution of sulphurous acid is produced by spraying water through the ascending fumes of sulphur.

123,713—February 13, 1872. P. MARCELIN. *Improvement in the manufacture of sulphurous acid.*

Pure sulphurous acid is produced by the decomposition of sulphate of iron with sulphur in a retort at a bright cherry-red heat.

268,530—December 5, 1882. R. P. PICTET. *Production and dehydration of sulphurous oxide and apparatus therefor.*

Sulphurous acid gas is passed through a refrigerator in which pure anhydrous sulphurous acid is undergoing vaporization, whereby at the low temperature (at least −10° C.) the hydrate of the sulphurous acid crystallizes out.

308,289—November 18, 1884. T. TERRELL. *Making ferric oxide and sulphurous acid from ferric sulphate.*

The ferric sulphate is decomposed by heat; free sulphur (about 10 per cent) being mixed therewith to assist the decomposition.

311,595—February 3, 1885. I. S. McDOUGALL. *Production of sulphurous acid.*

In the production of sulphurous acid air is forced under pressure into a closed vessel containing ignited sulphur or sulphur-bearing material, the vessel being water jacketed or cooled to maintain a temperature below that of volatilization of sulphur; the sulphurous gases are conducted from said retort into and below the surface of an absorbing liquid.

363,457—May 24, 1887. H. B. FORD. *Apparatus for and process of the manufacture of sulphurous oxide.*

In the manufacture of sulphurous oxide in liquid form all moisture is removed from the air before it is supplied to the sulphur furnace.

378,673—February 28, 1888. C. E. GETCHELL. *Apparatus for making sulphurous acid.*

A combining chamber has thin sinuous or zigzag passages for the acid fumes, with water inlet at the upper part, thus affording an intimate contact with one another.

197,574—November 27, 1877. C. R. STUNTZ. *Improvement in compositions for producing sulphureted hydrogen.*

A powder consisting of an intimate mixture of coal tar and sulphur, the latter being equivalent to or in excess of the hydrogen of the coal tar. If the gas is prepared in fragile vessels, the powder is diluted with sand to make the coke friable.

224,426—February 10, 1880. W. E. A. HARTMANN. *Manufacture of hydrogen sulphide.*

Hydrogen sulphide is produced by bringing together at a red heat, in a converter, sulphurous acid (or the vapor of sulphur or of sulphuric acid), carbon (coke), and steam.

ACETIC ACID.

93,817—August 17, 1869. L. D. GALE AND I. M. GATTMAN. *Improvement in the manufacture of sugar of lead and acetic acid.*

Lead is corroded by vapors of vinegar mixed with atmospheric air, the vinegar concentrated by means of chloride of sodium and the sugar-of-lead solution bleached with sulphureted hydrogen. Acetic acid, free from pyroligneous odor and color, is obtained by the distillation of acetate of lime with sulphuric acid.

121,586—December 5, 1871. J. F. CAVARLY. *Improvement in purifying acetic acid.*

Acetic acid is deodorized and purified by mixing therewith a small quantity of any of the alcohols included in the formula $C_{2n}H_{2}\,({}_{2n}+1)\,O_{2}$.

118,788—September 12, 1871. C. J. T. BURCEY. *Improvement in the manufacture of acetic acid.*

Acetate of lime and concentrated sulphuric acid are introduced into a boiler while under direct agitation, and the vapors condensed.

209,978—November 19, 1878. A. PIRZ. *Improvement in the manufacture of acetic acid.*

A solution of permanganate of potash is added to impure acetic acid and the product distilled to remove impurities (1 pound of permanganate to 100 pounds of acid).

209,979—November 19, 1878. A. PIRZ. *Improvement in the manufacture of acetic acid.*

Acetic acid is extracted from acetate of lime by leaching with sulphuric acid in gradually weakened solutions, using the weak acetic acid as a diluent for the sulphuric acid.

401,992—April 23, 1889. I. A. F. BANG AND M. C. A. RUFFIN. *Process of purifying acetic acid.*

Crude acetic acid in the liquid state is purified from pyroligneous matter by bringing into intimate contact with a carbon compound, such as a hydrocarbon of the benzene series, whereby the impurities are dissolved, and the acid then separated from the purifying agent. Air is first blown through the crude acid to oxidize the tarry matters.

414,277—November 5, 1889. I. A. F. BANG AND M. C. A. RUFFIN. *Process of purifying acetic acid.*

In the purification of crude acetic acid a small quantity of an oxidizing agent, such as binoxide of manganese, is introduced as well as a heavy hydrocarbon, the former to oxidize the impurities insoluble in hydrocarbons and not affected by the air. The acid is heated to ebullition and the vapors caused to pass through the hydrocarbon purifying agent to the air, and the condensed particles to fall back through the purifying agent.

431,243—July 1, 1890. F. C. ALKIER. *Obtaining acetic acid and methyl alcohol.*

Wood-pulp lyes are concentrated by repeated use; the concentrated solution neutralized by an alkali; the methyl alcohol recovered by distillation; the residuary liquor evaporated to dryness; and the acetate distilled with an acid to obtain the acetic acid.

432,926—July 22, 1890. I. A. F. BANG AND M. C. A. RUFFIN. *Process of making acetic acid.*

In the manufacture of acetic acid a hot solution of acetate of lime is acted upon by hot sulphuric acid and the aqueous acetic acid drawn off from the crystalline product. A concentrated solution of acetic acid is formed by dissolving the acetate of lime in a weak solution of acetic acid and decomposing the resulting solution while hot by means of hot sulphuric acid.

485,461—November 1, 1892. F. P. DEWEY. *Process of obtaining alumina and acetic acid.*

A solution of acetate of alumina, which may be formed from sulphate of alumina and acetate of lime, is subjected to destructive distillation; the acetic-acid vapor is collected in a condenser, and the precipitated alumina recovered.

595,787—December 21, 1897. A. SCHMIDT. *Purification of crude acetic acid.*

Acetic acid is filtered in a finely divided state through coal or coke, pure oxygen gas being forced up through the coal in an opposite direction.

634,271—October 3, 1899. H. PLATER-SYBERG. *Process of extracting acetic acid from alkaline acetates.*

See Group X, Electro-chemistry.

LACTIC ACID.

243,827—July 5, 1881. C. E. AVERY. *Manufacture of lactates.*

Lactic acid and lactates are produced by the fermentation of a sugar of vegetable origin with a lactic ferment in the presence of nitrogenous matters, chiefly of vegetable origin, and of a substance suitable to gradually neutralize the acid as formed.

290,252—December 18, 1883. G. A. MARSH. *Manufacture of lactates and lactic acid.*

In the manufacture of lactic acid and the lactates by the fermentation of dextrine or like gums with an active lactic ferment and an acid neutralizing substance, agitation is prevented during fermentation to avoid butyric and other destructive fermentations.

290,253—December 18, 1883. G. A. MARSH. *Manufacture of lactates for the production of lactic acid.*

Lactic acid and the lactates are produced by the fermentation of any amylaceous substance, as corn meal, in its original form, in water, with an active lactic ferment charged with an acid neutralizing substance, as carbonate of lime.

290 34—December 18, 1883. C. O. THOMPSON. *Manufacture of lactic acid and lactates.*

Neutral calcium-lactate crystals are obtained by digesting amylaceous matter, converting a portion into glucose, and adding to the glucose liquor, still mixed with the nitrogenous matters and residues, pure white glucose, fermenting with lactic ferment and neutralizing the acid as it forms with carbonate of lime. Acid crystals are obtained from the neutral crystals by digesting same in hot water, filtering, treating with sulphuric acid, again filtering, concentrating, and crystallizing.

321,925—July 7, 1885. C. N. WAITE. *Process of distilling lactic acid.*

It is distilled and purified by the aid of free steam; the steam takes up the pure lactic acid and is then condensed.

330,815—November 17, 1885. C. E. AVERY. *Manufacture of lactates.*

A lactic ferment is purified and preserved by adding it to a medium specially favorable to its growth and less favorable to the growth of other ferments. A pure reagent is prepared by successive impregnations of a series of culture baths with lactic ferment, the impregnation of each solution from the preceding one being effected at the point of full height of fermentation, as evidenced by the evolution of carbonic acid gas at its first maximum. A culture bath is formed by adding 1,000 parts of starch sugar, dextrine, glucose, or milk sugar to 6,000 parts of water, then 500 parts of carbonate of lime, and finally 100 parts of vegetable nitrogenous matter, the mixture being kept at a heat of 35° to 45° C.

365,655—June 28, 1887. C. N. WAITE. *Manufacture of lactic acid.*

In the lactic fermentation of a fermentable sugar with lactic ferment and a neutralizer, glue is added to supply soluble nitrogenous matter.

368,032—August 9, 1887. C. N. WAITE. *Process of lactic fermentation.*

A pure lactate of lime is produced by the fermentation of sugar, glucose, or pure starch with a minute quantity of nitrogen in the form of ammonia, and a minute quantity of phosphoric acid, and lactic ferment in a closed vessel in the absence of air.

455,078—June 30, 1891. C. N. WAITE. *Process of manufacturing lactic acid.*

Crude salts, such as zinc lactate, are dissolved in boiling water, an excess of milk of lime is added to the solution, the precipitate removed by filtration and sulphuric acid added to the filtrate, which is then again filtered to remove the sulphate of lime.

584,707—June 15, 1897. P. ROOSEN. *Process of making lactic acid.*

Carbohydrates are heated with milk of lime in a closed vessel at not less than 130° C., by which the carbohydrates are hydrolyzed to lactic acid.

TARTARIC ACID.

199,039—January 8, 1878. F. DIETRICH. *Improvement in the manufacture of tartaric acid.*

Argols and residues of wine making are exposed in a dry state to a temperature of 140° to 170° C., to facilitate the purifying of the tartaric acid salts.

221,297—November 4, 1879. H. GOLDENBERG. *Improvement in the manufacture of tartaric acid.*

In the manufacture of tartaric acid, potassium hydrate is recovered by mixing neutralized tartrate of potassium, 226 parts, and water 8 times as much, with quick lime, 112 parts, slacked in 16 times the quantity of water, and pouring into the mixture while stirring a solution of tartrate of potassium.

455,768—July 14, 1891. R. W. SCHEDLER. *Manufacture of tartaric acid.*

Sulphuric acid, from 5 to 15 per cent, is added to solutions of tartaric acid concentrated to the point of crystallization to increase the quantity of crystallized tartaric acid. The mother liquor is used to treat tartrate of lime.

CITRIC ACID.

515,033—February 20, 1894. C. WEHMER. *Process of making citric acid.*

A sugar solution of from 10 to 20 per cent, acidulated with from 2 to 5 per cent of citric acid, is exposed to the air until a fungous growth forms thereon, when the spores of fungi are cultivated in a sterilized sugar solution, and the pure culture thus obtained is introduced into other sugar solutions and allowed to stand eight to fourteen days until citric acid is formed. The acid is converted into a lime salt with carbonate of lime from which citric acid is prepared.

SALICYLIC ACID.

150,867—May 12, 1874. H. KOLBE. *Improvement in the processes of preparing salicylic and other acids.*

Salicylic acid, as well as the isomeric and homologous acids, is produced by the action of carbonic acid on carbolic acid, or cressolic acids, or on a mixture of them, in presence of alkalies or alkaline earths.

166,863—August 17, 1875. W. E. GRAF. *Improvement in processes of producing salicylic acid.*

Salicylic acid is produced by conducting carbonic acid from a generator into a closed, heated still, containing carbolic acid and alkali. (Apparatus No. 166,862.)

196,254—October 16, 1877. E. SCHERING. *Improvement in purifying salicylic acid by dialysis.*

Salicylic acid is purified by filtering it through animal membrane.

334,290—January 12, 1886. R. SCHMITT. *Manufacture of salicylic acid.*

Salicylic acid and its homologues are produced by subjecting the phenolates of the alkalies and earthy alkalies to the action of dry carbonic acid under pressure at low temperatures, to produce phenyl carbonic alkaline and earthy alkaline salts, and then converting these salts into salicylates and their homologues by heating in hermetically closed vessels at from 120° to 140° C.

355,875—January 11, 1887. T. KEMPF. *Manufacture of salicylic acid and substitutes thereof.*

Salicylic acid, or the substitutes and homologues thereof, is produced in one operation by subjecting the phenolates of the alkalis and earthy alkalis, and the substituted phenolates of said alkalis and earthy alkalis, to the action of carbonic acid under pressure at from 120° to 145° C.

416,318—December 3, 1889. H. BAUM. *Dithiosalicylic acid.*

A new product, having the general formula $C_{14}H_{10}S_2O_6$, and which melts as a resin. It is formed by heating protochloride of sulphur (or the bromide or iodide) with salicylic acid.

529,182—November 13, 1894. S. MARASSE. *Process of making salicylic acid.*

A dry mixture of phenol and potassium carbonate in excess is treated at a gradually increasing temperature with carbonic-acid gas under pressure until the reaction is completed and potassium salicylate is obtained. Salicylic acid is then produced from the potassium salicylate in the well-known way.

611,014—September 20, 1898. L. LIMPACH. *Process of making salicylo-acetic acid.*

Monochloracetates are caused to act on salts of salicylamid, and the product is saponified.

644,077—February 27, 1900. F. HOFFMANN. *Acetyl salicylic acid.*

A new product, soluble in benzene, alcohol, and glacial acetic acid, M. P. 135° C., is obtained by heating salicylic acid with acetic anhydride.

TANNIC ACID.

231,489—August 24, 1880. J. HOLTZ. *Obtaining tannic acid.*

Tannin or tannic acid is produced in acicular form by passing the inspissated tannin extract through a fine sieve and breaking up the dried threads.

263,797—September 5, 1882. A. MITSCHERLICH. *Manufacture of tannic acid.*

Wood is first subjected to the action of steam under pressure, and then to the action of an aqueous solution of bisulphite of lime at a temperature above the boiling point; and the tannic acid solution and a solution of bisulphite of lime are simultaneously produced by exposing small pieces of carbonate of lime to the joint action of a spray of water from above and the fumes of the aforesaid solution from below.

OTHER ORGANIC ACIDS.

276,888—May 1, 1883. C. RUDOLPH. *Manufacture of cinnamic acid.*

Benzylideacetone is heated with bromine dissolved in soda lye and diluted sulphuric acid added when the bromoform generated has separated from the aqueous solution. The cinnamic acid is purified by recrystallization with alcohol or water.

284,862—September 11, 1883. M. H. LACKERSTEEN. *Process of treating fats and oils.*

See Group X, Electro-chemistry.

353,566—November 30, 1886. M. H. LACKERSTEEN. *Process of manufacturing soap and glycerine.*

See Group X, Electro-chemistry.

407,906—July 30, 1889. B. R. SEIFERT. *Process of making paraoxybenzoic acid.*

In the manufacture of this acid the heating of potassium phenate and dry carbonic acid is done in a closed vessel under a superatmospheric pressure to 180° C. or more.

470,920—March 15, 1892. B. R. SEIFERT. *Process of making oxymethoxybenzoic acids.*

Guaiacol acid and eugetinic acid are produced by evaporating an aqueous solution of guaiacol or eugenol and an alkali or earthy alkali, and saturating the dry salt with carbon dioxide under pressure and heating to over 100° C.

488,290—December 20, 1892. B. R. SEIFERT. *Process of making oxyuvitic acid.*

Alkaline or earthy alkaline salts of cresol are subjected to the action of carbonic acid at a temperature of from 160° to 220° C. The product is dissolved in water and alpha oxyuvitic acid is precipitated by means of hydrochloric acid. It has a M. P. of 290° C. It may be purified from any cresotinic acid by partial precipitation of the solution of a salt of the acid.

511,450—December 26, 1893. A. A. NOYES AND A. A. CLEMENT. *Process for the manufacture of paraamidophenol sulphonic acid.*

See Group X, Electro-chemistry.

547,611—October 8, 1895. L. LEDERER. *Process of making aromatic oxycarbon acids.*

The homologous phenoxacetic acids are melted with caustic alkalis; as ortho-cresoxacetic acid one part and caustic soda two parts, and heated to 270° C. with the addition of a little water. The aqueous solution of the melt is decomposed by dilute sulphuric acid.

555,711—March 3, 1896. B. R. SEIFERT. *Citricphenetidin acid and process of obtaining it.*

New products, having the form of white crystalline powders, of acid reaction, soluble in water, in alcohol, and in soda solutions, are produced by heating para-amido-phenetol with citric acid or its derivatives; treating the product with hot water or with solutions of soda or caustic soda, and of a mineral acid successively, and crystallizing.

557,410—March 31, 1896. W. MAJERT. *Pyrocatechin mono-acetic acid and process of making same.*

A new compound, M. P. 131° C., is produced by subjecting one molecule of pyrocatechin to the action of one molecule of chloracetic acid in the presence of an alkali or alkali carbonate.

563,076—June 30, 1896. B. R. SEIFERT. *Paraphenetidin succinic acid and process of making same.*

New products, derived from the dicarbon acids of the fatty series and paraphenetidin, soluble in water, M. P. 163° to 195° C., are produced by heating paraphenetidin with one of the dicarbon acids of the fatty series, boiling the product with soda solution and adding a mineral acid, and purifying by crystallization.

598,790—February 8, 1898. A. KREFTING. *Process of treating seaweed (tang acid).*

The lime is extracted by means of dilute sulphuric acid before the seaweed is otherwise chemically treated, the liquid filtered, and the nonnitrogenous and pure tang acid precipitated.

644,331—February 27, 1900. E. SAPPER. *Process of making phthalic acid.*

A substance whose formula contains that of the naphthalene nucleus is heated with sulphuric acid in the presence of mercuric sulphate.

335,962—February 9, 1886. E. SCHAAL. *Converting petroleum and similar hydrocarbons into acids.*

Petroleum and other hydrocarbons of the series $C_nH_{2n}+2$ are converted into organic acids by subjecting them in the presence of alkaline substances—caustic alkalis, alkaline earths or their carbonates—to the action of an oxidizing agent, separating out the alkaline salts produced and decomposing them with a mineral acid, and finally separating the organic acids into liquid acids and solid acids by distillation.

GROUP II.—SODAS.

CAUSTIC SODA.

16,111—November 25, 1856. C. BICKELL. *Process of treating feldspar for manure.*

Potash or soda is obtained either in the caustic or carbonated state.

See Group VIII, Fertilizers, Processes.

22,888—February 8, 1859. H. PEMBERTON. *Improvement in the process of manufacturing caustic soda and other caustic alkalis.*

The solution of caustic soda or other caustic alkalies is separated from the carbonate of lime or other precipitate by filtration through fire brick or other porous substance capable of resisting the caustic action of the alkaline liquors.

152,845—July 7, 1874. C. AND J. JURON AND A. AND L. IMBERT. *Improvement in the production of caustic alkalis from carbonates.*

Superheated steam is passed through the mass of alkaline carbonates to be converted.

169,800—November 9, 1875. H. GASKELL, Jr. *Improvement in processes of manufacturing caustic soda.*

A heated revolving furnace is first charged with salt cake, or with cake and coal slack, and when the salt cake has become fluxed or softened the chalk or lime is added and the balance of the slack.

201,028—March 5, 1878. C. LÖWIG. *Improvement in manufacture of caustic alkalis and preparations of alumina.*

Carbonate of soda or potassa is heated to a red heat with so much alumina, or alumina ore, or oxide of iron, as to present one equivalent of alkali to one equivalent of alumina. By subsequent lixiviation aluminate of soda is obtained free of carbonate of alkali. The product is decomposed by the addition of a paste of hydrate of lime, of hydrate of strontia, or of hydrate of magnesia, forming the aluminates of said earths as precipitates, the caustic alkali remaining in solution. Gelatinous hydrate of alumina is produced by the formation of chloride of aluminium from the aluminates of the earths prepared according to this process, and the decomposition of the same by means of the earths, or their carbonic-acid salts, or the aluminates.

203,761—May 14, 1878. E. W. PARNELL. *Improvement in the manufacture of caustic alkalis.*

Carbonates of soda and potassa of a greater specific gravity than 1,200° are heated with caustic lime in a closed vessel under pressure.

241,383—May 10, 1881. G. T. LEWIS. *Perfumed caustic soda.*

An essential oil is added to granulated or pulverized caustic soda while in a dry state.

254,918—March 14, 1882. E. CAREY, H. GASKELL, Jr., AND F. HURTER. *Purification of alkaline solutions.*

Alumina in solution is added to alkaline solutions containing an excess of silica to precipitate the same.

258,850—May 30, 1882. E. CAREY, H. GASKELL, Jr., AND F. HURTER. *Purification of alkaline solutions obtained in the manufacture of soda.*

The sulphur compounds are oxidized with the aid of manganese oxide or sodium nitrate, and the liquor is then heated to at least 176° C. to cause the double decomposition of the oxidized sulphur compounds and the cyanogen compounds. Ammonia is recovered.

272,127—February 13, 1883. C. B. DUDLEY. *Method of making soda-lime.*

Sal soda is mixed with caustic lime—without extraneous heat—in such proportions that the water of crystallization will be taken up by the caustic lime.

274,619—March 27, 1883. C. LÖWIG. *Process of manufacturing caustic alkalis.*

A mixture of carbonate of soda—or of potash—and oxide of iron is furnaced, and subsequently lixiviated.

362,677—May 10, 1887. E. SOLVAY. *Manufacture of caustic soda.*

Sodium bicarbonate obtained by the ammonia-soda process is mixed directly with oxide of iron, heated in a closed apparatus and then transferred to another furnace and heated to the temperature necessary to drive out the remaining carbonic acid so as to obtain caustic soda.

402,226—April 30, 1889. J. A. BRADBURN. *Process of manufacturing caustic soda.*

Sodium chloride, or potassium chloride, is treated with nitric acid and peroxide of manganese in a still. The spent liquor is treated with caustic soda or potash, the precipitated manganese oxidized and removed, and the nitrate solution evaporated, mixed with ferric oxide, furnaced, and the mass then lixiviated.

442,334; 442,396; 442,594—December 9, 1890. I. L. ROBERTS. *Electrolytic apparatus.*

See Group X, Electro-chemistry.

450,103—April 7, 1891. E. A. LE SUEUR. *Electrolytic apparatus.*

See Group X, Electro-chemistry.

454,136—June 16, 1891. A. KAYSER. *Manufacture of caustic alkali, etc.*

A mixture of an alkaline chloride with a clay containing silica—in the proportions of 1¼ pounds of silica to 1 pound of alumina—is heated to a white heat in a converter by the direct action of highly heated gas containing steam; then melted with an alkali, leached, and the residue ground to release the alkali. The gaseous products from one converter, combined with additional highly heated gases, are applied to a second mixture of the chloride with clay.

458,563—September 1, 1891. F. ELLERSHAUSEN. *Process of making caustic alkali.*

In the manufacture of caustic soda and potash from solutions of their respective sulphides, the solutions are filtered through granulated ferrate of sodium or potassium.

459,688—September 15, 1891. G. H. GRAY. *Process of making soda with strontium salts.*

Sodium, or potassium, hydrate is produced by treatment of sodium sulphate with strontium hydrate, followed by treatment of the strontium sulphate thus produced with magnesium carbonate and sodium, or potassium, salts, thus producing strontium carbonate to be afterwards converted into strontium hydrate.

462,366—November 3, 1891. J. SIMPSON. *Process of making caustic soda.*

Calcic phosphate is treated with hydrochloric acid, sulphate of soda is added, the liquor is drawn off and concentrated, and the concentrated mass is subjected to a red heat, fused, and the fused mass dissolved. The phosphate of soda and sodium chloride contained in the solution are separated, the former treated with caustic lime, and the resulting phosphate of lime and caustic soda separated.

481,407—August 23, 1892. F. M. LYTE. *Production of caustic alkalis and chlorine.*

See Group X, Electro-chemistry.

484,990—October 25, 1892. H. BLACKMAN. *Electrolytic process and apparatus.*

See Group X, Electro-chemistry.

491,700—February 14, 1893. E. B. CUTTEN. *Method of electrolytically producing soda and chlorine.*

See Group X, Electro-chemistry.

498,769—June 6, 1893. T. CRANEY. *Method of electrolyzing salts.*

See Group X, Electro-chemistry.

501,121—July 11, 1893. C. N. WAITE. *Art of manufacturing chlorine or caustic alkali by electrolysis.*

See Group X, Electro-chemistry.

501,783—July 18, 1893. E. HERMITE AND A. DUBOSC. *Method of and apparatus for electrolyzing solutions.*

See Group X, Electro-chemistry.

504,703—September 12, 1893. A. BREUER. *Electrolytic diaphragm.*

See Group X, Electro-chemistry.

508,804—November 14, 1893. H. S. BLACKMORE. *Process of and apparatus for dissociating salts of alkalis by electrolysis.*

See Group X, Electro-chemistry.

510,979—December 19, 1893. G. LUNGE AND C. H. M. LYTE. *Process of making basic lead salts and caustic alkali.*

Crude pig lead is oxidized and the oxide dissolved in nitric acid; the lead nitrate decomposed by soda carbonate and caustic soda to form basic lead carbonate and pure sodic nitrate. Nitric acid, for use over again, and ferrite of soda is then formed by double decomposition of the sodic nitrate with ferric oxide, and the ferrite of soda is decomposed into ferric oxide and caustic soda. Silver, if any, is precipitated from the lead nitrate with finely divided lead.

514,125—February 6, 1894. F. M. LYTE AND G. LUNGE. *Process of making caustic alkali and lead chloride.*

An alkaline nitrate is first formed by the double decomposition of nitrate of lead and an alkaline chloride, and the alkaline chloride is then decomposed, while in admixture with ferric oxide in sufficient proportion to maintain the porosity of the mass, by the action of heated air and steam at a temperature sufficient to convert the whole of the base of the alkaline nitrate into a ferrite of the alkali with the evolution of nitrous fumes, which are converted into nitric acid.

518,065—April 10, 1894. C. HOEPFNER. *Electrolytic apparatus.*

See Group X, Electro-chemistry.

518,135—April 10, 1894. H. Y. CASTNER. *Electrolytic apparatus.*

See Group X, Electro-chemistry.

518,710—April 24, 1894. H. CARMICHAEL. *Method of and apparatus for electrochemical decomposition.*

See Group X, Electro-chemistry.

522,614—July 10, 1894. I. L. ROBERTS. *Electrolytic diaphragm.*

See Group X, Electro-chemistry.

522,616—July 10, 1894. I. L. ROBERTS. *Method of electrolytic decomposition of salts.*

See Group X, Electro-chemistry.

523,026—July 17, 1894. C. N. WAITE. *Diaphragm for electrolytic cells.*

See Group X, Electro-chemistry.

528,322—October 30, 1894. H. Y. CASTNER. *Process of and apparatus for electrolytic decomposition of alkaline salts.*

See Group X, Electro-chemistry.

531,235—December 18, 1894. C. T. J. VAUTIN. *Process of and apparatus for the production of caustic alkali.*

See Group X, Electro-chemistry.

534,033—February 12, 1895. T. CRANEY. *Apparatus for manufacturing caustic soda.*

See Group X, Electro-chemistry.

541,146—June 18, 1895. H. BLACKMAN. *Electrolytic process and apparatus.*

See Group X, Electro-chemistry.

541,597—June 25, 1895. J. D. DARLING. *Method of and apparatus for manufacturing sulphuric acid and by-products.*

See Group X, Electro-chemistry.

546,328—September 17, 1895. C. HOEPFNER. *Anode for electrolytic apparatus.*

See Group X, Electro-chemistry.

556,038—March 10, 1896. M. H. WILSON. *Electrolytic apparatus.*

See Group X, Electro-chemistry.

568,231—September 22, 1896. H. BLACKMAN. *Electrolytic anode and apparatus.*

See Group X, Electro-chemistry.

572,472—December 1, 1896. H. Y. CASTNER. *Anode for electrolytic processes.*

See Group X, Electro-chemistry.

578,457—March 9, 1897. C. KELLNER. *Process of and apparatus for simultaneously producing ammonia, sodium hydroxide, and chlorine.*

See Group X, Electro-chemistry.

583,330—May 25, 1897. E. A. LE SUEUR. *Process of electrolysis.*

See Group X, Electro-chemistry.

585,387—June 29, 1897. C. KELLNER. *Electrolytic diaphragm.*

See Group X, Electro-chemistry.

586,236—July 13, 1897. L. P. HULIN. *Process of electrolytic decomposition of solutions.*

See Group X, Electro-chemistry.

586,729—July 20, 1897. C. KELLNER. *Method of and apparatus for effecting electrolysis.*

See Group X, Electro-chemistry.

587,830—August 10, 1897. L. P. HULIN. *Process of and apparatus for manufacturing metallic peroxids and caustic alkalis.*

See Group X, Electro-chemistry.

588,276—August 17, 1897. C. KELLNER. *Electrolytic process and apparatus therefor.*

See Group X, Electro-chemistry.

590,548—September 21, 1897. C. KELLNER. *Process of producing hydrates or other salts of alkaline metals.*

See Group X, Electro-chemistry.

590,826—September 28, 1897. J. D. DARLING. *Porous diaphragm for electrolytic apparatus.*

See Group X, Electro-chemistry.

591,730—October 12, 1897. W. BEIN. *Process of and apparatus for electrolyzing.*

See Group X, Electro-chemistry.

592,802—November 2, 1897. N. MARCHAL. *Electric diaphragm.*

See Group X, Electro-chemistry.

606,981—July 5, 1898. W. S. ROMME. *Process of and apparatus for decomposing solid substances.*

See Group X, Electro-chemistry.

609,745—August 23, 1898. W. G. LUXTON. *Diaphragm for electrolytic purposes.*

See Group X, Electro-chemistry.

612,009—October 11, 1898. G. B. BALDO. *Process of and apparatus for electrolyzing sea water.*

See Group X, Electro-chemistry.

623,693—April 25, 1899. C. E. ACKER. *Process of and apparatus for making caustic alkalis.*

A fused alloy, containing an alkali metal, is submitted to the direct action of steam from below the surface, by means of a converter having an inverted bell with steam inlet, whereby the steam is decomposed and hydrogen gas and an alkaline hydrate are formed, the hydrate being immediately removed as formed.

623,918—April 25, 1899. W. LANG, C. PISTOR, AND M. OTTO. *Process of purifying caustic alkalis.*

The diffusiveness of a solution of the lyes, mixed with other solutions of a similar diffusiveness, is increased by increasing the degree of concentration, and the lyes are then separated from the mixture by diffusion into water through a diaphragm.

631,468—August 22, 1899. C. KELLNER. *Method of and apparatus for producing alkali salts.*

See Group X, Electro-chemistry.

636,234—November 7, 1899. E. BAKER. *Process of and apparatus for electrolytic decomposition of saline solutions.*

See Group X, Electro-chemistry.

637,410—November 21, 1899. G. H. POND. *Process of and apparatus for dissociating substances by electrolysis.*

See Group X, Electro-chemistry.

641,276—January 16, 1900. J. D. DARLING. *Porous diaphragm for cells employing fused electrolytes.*

See Group X, Electro-chemistry.

649,565—May 15, 1900. C. E. ACKER. *Process of manufacturing alkali and halogen gas.*

See Group X, Electro-chemistry.

652,611—June 26, 1900. J. HARGREAVES. *Combined diaphragm and electrode.*

See Group X, Electro-chemistry.

652,761—July 3, 1900. J. B. ENTZ. *Electrolytic production of caustic soda, etc.*

See Group X, Electro-chemistry.

SODIUM CARBONATES.

1,191—June 24, 1839. H. G. DYER AND J. HEMMING. *Improvement in the manufacture of carbonate of soda.*

Carbonate or bicarbonate of ammonia is used in converting common salt into a carbonate of soda, with recovery of the ammonia for use in subsequent operations.

9,346—October 19, 1852. H. PEMBERTON. *Improvement in making soda-ash and carbonates of soda.*

A mixture of sulphate of soda and carbonaceous matter is melted, without the addition of lime or other matter. An aqueous solution of the product is treated with carbonic acid and evaporated to dryness and again treated in the dry state by carbonic acid to form bicarbonate of soda.

39,213—July 14, 1863. L. CHANDOR. *Improvement in the manufacture of alkaline carbonates.*

Potassium and sodium sulphurets in solution are transformed into carbonates by the action of cream of lime and a current of carbonic acid. By the reaction of solutions of sulphuret of barium and sulphate of soda, sulphuret of sodium is obtained and sulphate of baryta. To free the sulphohydric acid from carbonic acid it is passed through a solution of sulphuret of barium, producing carbonate of baryta.

49,597—August 22, 1865. T. MACFARLANE. *Improved process of preparing chlorine, bleaching powder, carbonate of soda, and other products.*

Chlorine is produced by heating a mixture of calcined green vitriol, common salt, and peroxide of iron in a current of air, and the residue used for the manufacture of carbonate of soda and soda ash. A mixture of burnt lime and slag is used for the furnace hearths. In the manufacture of carbonate of soda and soda ash the deep green alkaline solution is decolorized by the application of heat and the passage of the flame and carbonic acid produced by combustion over the solution, the gases being absorbed. The artificial sulphuret of iron is converted into the sulphate by the action of the air and moisture, the sulphate being washed out with hot water and the solution concentrated.

55,600—June 19, 1866. H. M. BAKER. *Improvement in the manufacture of carbonate of soda, etc.*

Bicarbonate of magnesia, produced by charging carbonate of magnesia with carbonic acid under heat and pressure, is mixed with one equivalent proportion of sodium chloride, giving bicarbonate of soda and magnesium chloride. The latter is decomposed by heat, yielding muriatic acid, which is distilled out, and magnesia, which latter is bicarbonated and again used.

64,385—April 30, 1867. A. P. VON PÖHRNHOFF. *Improved process in the manufacture of bicarbonate of soda.*

Hydrate of soda is treated with carbonic gas and steam.

90,140—May 18, 1869. I. WALZ AND J. M. PENDLETON. *Improvement in the manufacture of carbonate of soda and other chemicals.*

A mixture of carbonate of lime and sodium nitrate in chemical proportions is heated in a retort with admission of steam to regenerate nitric acid. The product is available for caustic soda solutions.

116,664—July 4, 1871. W. H. BALMAIN. *Improvement in the manufacture of bicarbonate of soda.*

Bicarbonate of soda, being insoluble in a saturated solution of salt or of sulphate of soda, is washed and purified by allowing water to filter through it.

130,174—August 6, 1872. J. YOUNG. *Improvement in processes and apparatus for the manufacture of carbonate of soda.*

Bicarbonate of soda mixed with compounds of ammonia is boiled to reduce to carbonate of ammonia by driving off a portion of the carbonic acid and the residual compounds of ammonia, which are recovered.

136,463—March 4, 1873. E. SOLVAY. *Improvement in processes and apparatus for the manufacture of carbonate of soda.*

Carbonic acid gas is forced into the bottom of a high column of a solution of salt and ammonia, the liquor being fed into the column midway of its height. The ammonia is regenerated with magnesia or basic magnesium chloride, the residue being boiled down with steam and the chlorine condensed.

143,755—October 21, 1873. H. DE GROUSILLIERS. *Improvement in the manufacture of alkaline carbonates.*

They are produced from their haloid salts by treating same with carbonate of ammonia dissolved in strong alcohol or wood spirit.

195,142—September 11, 1877. J. MACTEAR. *Improvement in manufacture of granulated crystalline carbonate of soda.*

The "vat," or "red," or similar liquor is first carbonated and then concentrated, and cooled under agitation. The residuary liquor is boiled down to dryness and the salts decomposed in a furnace, as practiced with fresh soda-sulphate.

198,293—December 18, 1877. F. GUTZKOW. *Improvement in the manufacture of soda from its sulphate.*

Sulphate of lime is dissolved in water with the aid of sulphurous acid and sulphate of soda added, and the precipitated sulphate of lime removed. The solution of bisulphite of soda is then heated and converted into a neutral sulphite solution and treated with quicklime to form caustic soda and sulphite of lime. The caustic soda is exposed to the action of carbonic acid to convert it into a carbonate.

202,356—April 16, 1878. G. T. LEWIS AND W. J. MENZIES. *Improvement in manufacture of bicarbonate of soda.*

Bicarbonate of soda is produced by passing carbonic-acid gas through a mixture of sal soda and carbonate of soda by the ammonia process.

222,152—December 2, 1879. C. V. PETRAEUS. *Improvement in processes for manufacturing alumina and carbonate of soda.*

Hydrated alumina and carbonate of soda are manufactured from cryolite and bauxite, by roasting together crushed cryolite and caustic lime, adding crushed bauxite, and boiling the mixture in water and treating the solution with carbonic-acid gas.

222,153—December 2, 1879. C. V. PETRAEUS. *Improvement in processes for manufacturing alumina and carbonate of soda.*

A roasted mixture of cryolite and caustic lime is treated with water, the solution separated from the sediment, the liquor boiled with bauxite, and the liquor last formed separated from the sediment and treated with carbonic-acid gas, producing hydrated alumina precipitate and carbonate of soda in solution.

222,154—December 2, 1879. C. V. PETRAEUS. *Improvement in processes for manufacturing alumina and carbonate of soda.*

A mixture of bauxite and cryolite is boiled with milk of lime, the solution separated, and the clear liquor treated with carbonic-acid gas to form a precipitate of alumina and solution of carbonate of soda.

224,240—February 3, 1880. A. STEARNS. *Manufacture of carbonates and bicarbonates.*

The substance to be charged with gas is molded into perforated blocks and then exposed to the gas.

227,032—April 27, 1880. W. J. MENZIES. *Manufacture of bicarbonate of soda.*

Soda ash of commerce is dissolved in water; any free soda is neutralized with carbonic acid or bicarbonate of soda; chloride of lime is added to oxidize any sulphur compounds, and the solution is finally treated with carbonic acid.

227,561—May 11, 1880. W. J. MENZIES. *Manufacture of bicarbonate of soda.*

Bicarbonate of soda is purified of ammonia and organic coloring matter by passing a current of carbonic acid over or through dry bicarbonate of soda while under heat and pressure.

229,090—June 22, 1880. H. BURGESS. *Concentrating alkaline solutions.*

The liquid trickles downward through a tower in the presence of hot air or products of combustion which are induced to take the same downward course.

243,991—July 5, 1881. E. SOLVAY. *Manufacture of soda.*

About 50 per cent of soda, already decomposed or calcined, is mixed with bicarbonate of soda previous to introduction of same into the decomposing apparatus, to prevent incrustation.

251,962—January 3, 1882. E. SOLVAY. *Manufacture of soda.*

Waters obtained from the distillation of ammonia in the manufacture of ammonia soda are heated in a vessel which is heated to a higher temperature in its upper than in its lower portion, the salt being precipitated in the cooler portion and driven into a nonheated portion of the apparatus and separated out. The concentrated solution of calcium chloride is decanted from the remaining water and from the salt.

254,919—March 14, 1882. E. CAREY, H. GASKELL, Jr., AND F. HURTER. *Purification of alkaline solutions.*

The solutions are submitted to the action of sulphur or sulphur compounds added to or produced in the alkaline solution, and of carbonic acid, the solution thus treated being then subjected to an elevated temperature to separate contained iron.

263,821—September 5, 1882. E. SOLVAY. *Manufacture of soda.*

Bicarbonate of soda is calcined under violent agitation so as to maintain it as a cloud of dust and secure contact of every particle with the heated walls.

263,981—September 5, 1882. E. SOLVAY. *Manufacture of soda by the ammonia process.*

A continuous supply of both brine and ammonia is fed to the saturating vessel, from which the overflow is conducted to a vessel in which precipitation of the sludge takes place before carbonating and during the continuous flow of the ammoniacal brine.

264,044—September 5, 1882. J. McCRODDEN. *Soda block.*

A block of soda has its surface grooved or furrowed to give a large surface for the action of heat and impregnating gases.

265,367—October 3, 1882. B. T. BABBITT. *Manufacture of bicarbonate of soda.*

Soda ash is blown against an abutment by a blast of carbonic-acid gas induced by a jet of superheated steam.

265,368—October 3, 1882. B. T. BABBITT. *Manufacture of bicarbonate of soda.*

Soda ash is treated with carbonic-acid gas under a super-atmospheric pressure.

270,668—January 16, 1883. E. N. HORSFORD AND C. A. CATLIN. *Preparing alkaline bicarbonates.*

Alkaline bicarbonates are moistened with solutions of salts of magnesium or with solutions of other salts which by double decomposition with the bicarbonates will form a superficial inert or less active carbonate—as by moistening with a solution of sulphate of magnesium—and then dried.

271,366—January 30, 1883. E. H. RUSSELL. *Process of purifying soda ash.*

Sodium carbonate is purified of sodium sulphide by dissolving in water containing hyposulphite of soda or potash and adding sulphate of copper.

276,020—April 17, 1883. H. GASKELL, Jr., AND F. HURTER. *Manufacture of bicarbonate of soda.*

Anhydrous carbonate of soda is subjected to the action of aqueous vapor and carbonic-acid gas, the aqueous vapor being so proportioned as to produce a dry bicarbonate.

276,990—May 1, 1883. E. CAREY, H. GASKELL, Jr., AND F. HURTER. *Manufacture of bicarbonate of soda.*

Salts, obtained by the evaporation of solutions of carbonate of soda, are mechanically agitated and treated with carbonic-acid gas, the excess being removed, and moisture removed or added as required.

283,508—August 21, 1883. E. W. PARNELL. *Manufacture of alkalis.*

Crude alkaline solutions obtained by the Le Blanc process are purified of sulphurets by adding zinc or zinc oxide dissolved in a caustic alkali solution.

287,551—October 30, 1883. C. KNAB. *Process of making sodium carbonate.*

A mixture of chloride of lead and caustic soda or potash is produced by the decomposition of chloride of sodium or potassium by the oxide of lead in water, and the caustic alkali is then dissolved out with alcohol, the alcoholic solution treated with carbonic acid, and the lead recovered in the moist way by precipitating with white cast-iron and subsequent oxidation.

298,256—May 6, 1884. J. TOWNSEND. *Process of obtaining soda.*

A mixture of kainit and silica, or silica and alumina, is heated to from 540° to 815° C., then air or steam is passed through or over it, whereby chlorine or hydrochloric acid is evolved. The sulphates in the residue are then mixed with carbonaceous material, heated and reduced to sulphides, and the latter treated with carbonic acid to form carbonates of soda and potash.

308,512—November 25, 1884. L. MOND AND G. JÁRMAY. *Manufacture of sodium bicarbonate.*

The crude soda is dissolved under pressure in water heated to near the decomposing point of sodium bicarbonate at that pressure; the insoluble matters separated; the solution cooled below 65° C.; the pressure removed; the solution cooled by passing through pans; and the pure sodium bicarbonate separated. The mother liquor is used for dissolving fresh crude salt.

320,256—June 16, 1885. A. KAYSER. *Process of making sodium carbonate.*

Sodium sulphate is heated to a low red heat below the smelting point of the sulphate and a current of carbonic-acid gas and carbon monoxide—one equivalent of each—is passed through the heated sulphate, forming carbonate of soda and sulphurous acid. The sulphurous-acid gas is employed for the conversion of sodium chloride into sodium sulphate.

326,423—September 15, 1885. H. GASKELL, Jr. *Process of purifying ammonia soda.*

Bicarbonate of soda contaminated with ammonia is heated in an atmosphere of carbonic acid, to volatilize the ammonia without decomposing the bicarbonate, the gases withdrawn, and the ammonia condensed.

343,673—June 15, 1886. E. W. PARNELL AND J. SIMPSON. *Ammonia-soda process.*

The ammonium chloride obtained in the ammonia-alkali process is mixed with the alkali waste of the Le Blanc process, and the sulphide of ammonium so produced is employed for admixture with the sodium-chloride solution in the ammonia-alkali process, the hydrogen sulphide produced being collected and utilized.

357,824—February 15, 1887. J. HAWLICZEK. *Manufacture of bicarbonate of soda.*

A solution of a chloride or sulphate of sodium or other alkali metal is mixed with a crude carbonate or sulphide of sodium solution, and then treated with carbonic-acid gas in two stages, the impurities deposited in the first stage being separated, and bicarbonate of soda deposited in the second stage.

361,355—April 19, 1887. H. FRASCH. *Manufacture of soda by the ammonia process.*

The ammoniacal solution is passed through a succession of vessels, and treated with mixed live steam and exhaust steam. The ammoniacal vapors of the successive distillations are taken off separately. A large body of brine is maintained in the absorbing apparatus, and the ammonia is brought in contact with a part only of the same. The salt strength of the ammoniated brine is restored by passage through a vessel in which a body of salt is suspended near the upper part.

361,622—April 19, 1887. H. FRASCH. *Process of and apparatus for the manufacture of soda by ammonia.*

Limekiln gases are washed with a solution of soda, potash, or ammonia, or a carbonate thereof—such as the decomposed ammonium-chloride solution from which sodium carbonate has been separated—to remove sooty matters without absorption of carbonic acid, and then forced directly into the ammoniated brine. The brine is given a preliminary carbonation, then cooled, and then again carbonated to precipitate sodium bicarbonate. Ammoniated brine and an ammonium-chloride solution are introduced into the precipitating apparatus, so that in the early stages the formation of sodium bicarbonate in a liquid containing a considerable proportion of ammonium chloride is insured. Clogging of openings is prevented by artificially heating the walls of the openings.

363,952—May 31, 1887. H. FRASCH. *Process of and apparatus for making sodium carbonate by ammonia.*

The brine is treated with magnesium carbonate to precipitate calcium, then with sodium carbonate to precipitate the magnesium, and afterwards with ammonia and carbonic acid. The brine, under a continuous flow, is beaten into a spray in one or more tubes containing an atmosphere of ammonia. After saturation with ammonia the brine flows or percolates through a mass of solid salt to regenerate the solution. The brine is super-ammoniated, and its strength then reduced by addition of other brine. Revolving brackets carry compressed carbonic acid from above a body of ammoniated brine down into it and there discharge it. Ammoniated brine is treated with the gases obtained from burning lime with hydrocarbon oil or similar clear fluid fuel. A continuous filter employs a moving filter cloth.

364,732—June 7, 1887. E. SOLVAY. *Process of and apparatus for making sodium bicarbonate.*

Crude bicarbonate is decomposed by heat, the carbonic-acid gas evolved is cooled and lixiviated, the soda solution decanted and cooled, and then treated with the purified gas and the resulting carbonate filtered and dried.

376,306—January 10, 1888. A. KAYSER. *Process of making alkaline silicates and carbonates.*

Chloride of sodium (or potassium) is mixed with clay, and the mixture heated in a converter directly by passing highly-heated gases containing steam through the converter, converting the chloride into oxide and generating muriatic-acid gas. The converted material is smelted with an alkali and the sodium, or potassium, combinations extracted by lixiviation.

382,551—May 8, 1888. E. W. PARNELL AND J. SIMPSON. *Making sodium carbonates by sulphides of the alkaline earths.*

A mixture of ground sulphate of lime or baryta and carbonaceous matter is roasted in a nonoxidizing atmosphere; the sulphuret produced is mixed with chloride of ammonium and heated, and the sulphuret of ammonium evolved, together with carbonic-acid gas, is conducted into a solution of sodium chloride.

384,884—June 19, 1888. M. R. WOOD. *Manufacture of bicarbonate of soda.*

Crude bicarbonate mixed with water to a cream-like consistency is heated to 88° to 99° C. while subjected to pressure by forcing air into and through it to expel the excess of ammoniacal impurities. Carbonic acid is afterwards forced through it to replace any carbonic acid that may have been driven off by the air.

387,613—August 7, 1888. L. F. J. WRINKLE. *Process of treating native soda.*

A saturated solution of the crude soda in hot water is cleared by settling, strained while hot, partially cooled and crystallized, and run off into other vessels and further cooled and crystallized.

399,175—March 5, 1889. J. I. WATTS AND W. A. RICHARDS. *Salt of sodium.*

A new product, a salt, "sesquicarbonate of soda," containing one equivalent of bicarbonate of soda, one equivalent of monocarbonate of soda, and two equivalents of water, in chemical combination ($NaHCO_3Na_2CO_32H_2O$), produced by process No. 399.176.

399,176—March 5, 1889. J. I. WATTS AND W. A. RICHARDS. *Process of making a sodium salt.*

Sodium sesquicarbonate is produced by crystallizing at above 35° C. an aqueous solution containing not less than 3 equivalents of soda (Na_2O) to 4 equivalents of carbonic acid (CO_2).

401,699—April 16, 1889. F. H. GOSSAGE. *Process of making soda.*

In the manufacture of sulphide of sodium or potassium, to prevent destruction of the furnace lining, 8 parts by weight of sodium chloride is added to the mixture for every 20 parts of the sulphate.

415,644—November 19, 1889. G. KERNER AND J. MARX. *Process of electrolyzing salts of the alkalis.*

See Group X, Electro-chemistry.

430,734—June 24, 1890. F. W. A. FRERICHS. *Process of making alkaline carbonates and acetone.*

The acetate of an alkaline earth, as acetate of lime, is treated with the sulphate of the desired alkali to make an acetate of the same, which is then subjected to distillation, together with the anhydride of acetic acid.

439,330—October 28, 1890. L. A. STAUB. *Process of and apparatus for decomposing bicarbonate of soda.*

The bicarbonate is mixed with water at about 60° C. and treated with steam and ammonia in a closed chamber; carbonic acid is drawn off at the top and the monocarbonate, as a semiliquid mud, at the bottom.

446,267—February 10, 1891. B. PEITZSCH. *Process of treating Stassfurt salts.*

Potassic raw salts are treated with sulphuric acid, the sulphates thus obtained mixed with milk of lime, the gypsum thus formed and the magnesia being separated by filtering from the resulting solution of the alkaline sulphate, and the latter mixed with sulphide of barium and converted into a solution of sulphide of alkali and treated in a concentrated condition with carbonic acid. Separation of the bicarbonates of potassium and sodium is effected by their different degrees of solubility in water, and potash is obtained from its bicarbonate by roasting, and soda by calcination.

462,567—November 3, 1891. F. M. LYTE. *Process of making alkaline carbonate and chlorine.*

See Group X, Electro-chemistry.

492,929—March 7, 1893. K. J. SUNDSTROM. *Manufacture of soda.*

Bicarbonate mud is first treated with a solvent of the ammonia combinations, such as concentrated salt brine, and then water in fine spray is passed through the mud to remove the sodium chloride.

516,075—March 6, 1894. H. R. BROWNE. *Process of making soda crystals.*

Bicarbonate of soda obtained by the ammonia-soda process is heated until it is converted into a mixture of monocarbonate and bicarbonate of soda and the ammonia has been driven off; and the mixture thus obtained is then dissolved in caustic-soda liquor obtained by the electrolysis of brine, and the monocarbonate of soda crystallized out.

552,895—January 14, 1896. T. CRANEY. *Process of and apparatus for making carbonates of soda.*

See Group X, Electro-chemistry.

552,955—January 14, 1896. T. CRANEY. *Process of and apparatus for manufacture of sodium bicarbonate.*

See Group X, Electro-chemistry.

560,518—May 19, 1896. J. MEYRUEIS. *Treatment of sodium chloride.*

See Group X, Electro-chemistry.

579,317—March 23, 1897. E. J. CONSTAM AND A. VON HANSEN. *Process of manufacturing percarbonates.*

See Group X, Electro-chemistry.

636,448—November 7, 1899. W. D. PATTEN. *Process of making cakes of bicarbonate of soda.*

Moist carbonate of soda is formed into small cakes, and then treated with carbonic-acid gas, converting them into bicarbonate of soda and making them rigid.

BORATES.

449,064—March 24, 1891. N. M. BELL. *Art of manufacturing borax.*

Borate of lime is boiled with a carbonate of soda solution under pressure with constant agitation or circulation, and then run into settlers and crystallizers. In the manufacture, the material is sorted into coarse and fine, and the coarse particles are first charged into the solution of the full strength required for the full charge of borates, and the finer particles added during the boiling.

476,592—June 7, 1892. J. ASCOUGH. *Process of making borax.*

The component parts—crystal sodium carbonate 71 pounds and boracic acid 62 pounds—are placed in a suitable vessel with a small quantity of water, in the shape of steam, and subjected to heat to drive off the superfluous moisture, then agitated in other vessels during process of cooling.

RECOVERY PROCESSES.

33,953—December 17, 1861. H. LOWE. *Improvement in processes of recovering soda used in the manufacture of paper stock.*

The spent solution of caustic soda is charged with carbonic-acid gas to precipitate the organic matter.

46,244—February 7, 1865. M. L. KEEN AND H. BURGESS (*Reissue: 7,486—January 30, 1877*). *Improvement in processes and apparatus for evaporating and calcining alkaline solutions.*

The solution is evaporated to dryness and calcined, being continuously subjected to flame and hot gases, whereby the vegetable matter is consumed.

53,839—April 10, 1866. T. F. LEHMANN. *Improved method of recovering waste alkali used in the manufacture of paper.*

The unspent caustic alkali of alkaline solutions is converted into a carbonate by carbonic-acid gas.

54,093—April 24, 1866. H. M. BAKER. *Improved process for recovering waste alkali.*

The waste liquor is evaporated to dryness and the residue subjected to destructive distillation.

83,733—November 3, 1868. C. D. J. SEITZ. *Improvement in recovering waste alkalies from paper stock and other fibers.*

The waste liquor is evaporated down to from one-half to one-fourth; soda is added (caustic soda or soda ash) and the hot solution run over quicklime, which disposes of the remaining water; and the mixture furnaced.

101,003—March 22, 1870. W. GOODAIRE AND G. STEAD. *Improvement in restoring waste alkali used in oil refineries.*

Spent alkali liquor is evaporated to a paste, and then calcined to consume the oleaginous portions, leaving black ash, which is leached, and the hot filtrated liquid treated with hydrated lime.

132,452—October 22, 1872. C. M. TESSIÉ DU MOTAY. *Improvement in recovering waste alkalis used in treating paper pulp.*

The hot liquor is treated with carbonic-acid gas and sulphuret of sodium, or a bicarbonate, after which it is boiled and then recaustified and the precipitated matter removed.

156,483—November 3, 1874. D. HANNA. *Improvement in processes for restoring and purifying caustic alkali.*

The spent liquor is agitated, filtered, heated to boiling with agitation, and then treated with quicklime, with or without ammonia.

157,919—December 22, 1874. A. S. LYMAN. *Improvement in restoring spent alkalis.*

Spent alkali is exposed to air currents for evaporation by means of revolving disks. The gases from the incinerating furnace pass through a filter stack that is kept moistened with dilute alkali.

181,405—August 22, 1876. S. BROWN. *Improvement in the process of saving caustic alkali in the manufacture of paper pulp.*

Straw is boiled in a weak solution of lime, crushed and reduced in a rag-engine to "half-stuff," and then subjected under steam pressure to the action of caustic alkali.

191,759—June 12, 1877. W. W. HARDING. *Improvement in restoring and recovering alkaline wastes.*

To recover alkali from the waste liquor used in disintegrating paper stock, it is first reduced to a dry, porous, or flocculent substance, by exposing the liquid in thin layers to the action of heated cylinders or plates and removing the dried material by scrapers or brushes as fast as formed, and then incinerating the porous mass in the hearth of a reverberatory furnace.

194,141—August 14, 1877. H. H. FURBISH. *Improvement in processes for recovering alkalis used for the reduction of wood to paper pulp.*

The spent lees are washed from the cooked mass in water heated by steam from the digester, evaporated, the ash recovered in a recovery furnace and boiled and rendered caustic by lime, and the same evaporated and reduced to proper strength.

229,264—June 29, 1880. C. C. MARKLE AND J. JORDAN. *Recovering soda from spent liquors after treating vegetable fiber.*

In incinerating the residue of the waste liquor, air-slaked lime is added to and burned with the residue to render the lime again caustic.

366,956—July 19, 1887. P. HOGAN. *Process of and apparatus for recovering alkali.*

Dry peat is saturated with spent liquor from the manufacture of wood pulp and other materials and heated in a slowly revolving cylinder, the vapor being conveyed off and forced into a convoluted condensing flue by a fan blower.

391,459—October 23, 1888. J. W. DIXON. *Process of concentrating liquids.*

The liquor is heated *in vacuo* by interior heating coils while passing through a cylinder, a vapor space being preserved above the liquor with constant exhaust of the vapors, and also continuous withdrawal of the liquor by suction.

403,869—May 21, 1889. V. G. BLOEDE. *Recovering spent alkali.*

Spent alkaline lyes are first saturated with phosphoric acid to precipitate the fatty and coloring matters; then decanted or filtered, any residuary color being destroyed with chlorine; and the clarified liquor is then treated with lime, barium, or like compound capable of forming an insoluble combination with the phosphoric acid and liberating the soda or potash in an available form.

403,870—May 21, 1889. V. G. BLOEDE. *Recovering alkali.*

Spent alkaline lyes are saturated with sulphurous acid, effecting a separation of the impurities, and the sulphites or bisulphites of the alkali are then converted into hydrates or carbonates by the action of caustic or carbonate of lime, barium or equivalent compounds.

405,754—June 25, 1889. S. WOLF. *Recovering soda.*

In the sulphate cellulose process there is added to the brown lye of the process acid sulphate of soda which has previously been treated with the lime mud of the said process, transforming the latter into gypsum, a well-known manure, the unwashed alkalis being recovered out of the calcareous mud.

418,265—December 31, 1889. E. N. ATWOOD. *Process of recovering soda.*

Spent soda liquor of wood-pulp mills is atomized and burnt as fuel under pressure. The products of combustion pass through water to catch floating particles of alkali.

418,274—December 31, 1889. F. A. CLOUDMAN. *Process of recovering soda.*

Chemicals, such as soda of spent soda liquors, are recovered by spraying liquor containing the chemical by means of steam and oil into a combustion chamber and burning the mixture as fuel.

424,756—April 1, 1890. H. BLACKMAN. *Process of recovering soda.*

The liquor is atomized by a gaseous blast, subsequently superheated, and the mixture is then injected into a furnace.

478,981—July 19, 1892. H. BLACKMAN. *Apparatus for and process of recovering alkali.*

The concentrated liquor is introduced in a bath on the calcining hearth and subjected to the heat of gases of combustion, the material being moved from said bath along the calcining hearth until its combustible constituents are calcined out, and the material is finally fused and allowed to flow off.

480,109—August 2, 1892. G. LUNGE AND J. DEWAR. *Process of recovering sulphur, carbonate of soda, and iron oxide.*

The residue obtained by decomposing sodium sulphide with a ferrite is acted on, in a moist condition, with a suitable mixture of carbonic acid and oxygen.

558,970—April 28, 1896. O. LUGO AND H. T. JACKSON. *Method of electrolytic treatment of soap-lyes.*

See Group X—Electro-chemistry.

620,751—March 7, 1899. L. J. DORENFELDT. *Process of utilizing sulphite lyes.*

The concentrated waste liquors of sulphite wood pulp mills are utilized as fuel by heating to liquidize, filtering under pressure, and then spraying into the combustion chamber.

620,755—March 7, 1899. V. DREWSEN AND L. J. DORENFELDT. *Process of utilizing sulphite lyes.*

The waste liquor is neutralized with sodium carbonate; evaporated with addition of calcium carbonate; the residuum burned; the sodium carbonate in the product leached out, and the insoluble calcium sulphide treated with carbonic acid, producing calcium carbonate and hydrogen sulphide, which latter is converted into sulphurous acid or sulphur.

PACKING PROCESSES.

15,957—October 21, 1856. G. THOMPSON. (*Reissue: 654—February 1, 1859; 2,569—April 16, 1867; 5,886—May 26, 1874.*) *Improvement in the manufacture of caustic alkali.*

A block of caustic alkali is inclosed in resin, beeswax, or other similar saponifiable material.

18,214—September 15, 1857. G. THOMPSON. *Improvement in boxes for preserving alkalis.*

A metallic box has the top and bottom united to the cylinder side with an infusible cement made of fire clay moistened with linseed oil.

52,465—February 6, 1866. T. C. TAYLOR. *Improvement in putting up caustic alkali.*

Metal cylinders are stood on end in sand, nearly filled with molten alkali, the top sealed with cement, then reversed and the bottom sealed with cement.

52,466—February 6, 1866. T. C. TAYLOR. *Improvement in putting up and preserving caustic potassa and soda.*

To prevent melting the solder a small quantity of alkali is poured into a case and allowed to partially cool, and the case is then filled by installments.

52,910—February 27, 1866. T. C. TAYLOR. *Improved method of putting up caustic alkali.*

Blocks of alkali are packed in a case, and oil, grease, or like material poured in to fill the interstices.

86,319—January 26, 1869. J. REAKIRT. *Improvement in putting up caustic alkalis.*

They are packed in glazed stone jars having a shoulder to receive a disk, the whole sealed with cement.

89,704—May 4, 1869. T. C. TAYLOR. *Improved mode of putting up caustic soda for the manufacture of soap.*

Caustic alkali is comminuted, then mixed with oil or grease and packed in barrels or vessels. It can be cut out as required for use.

110,189—December 20, 1870. W. H. BALMAIN. *Improvement in packing caustic alkalis.*

They are granulated or pulverized and packed in cases without the admixture of other materials. When in powdered form a corrosive liquid is not formed, but the moisture is absorbed until a protective coating of carbonate forms on each particle.

123,544—February 6, 1872. J. H. SEIBERT. *Improvement in packages for caustic alkalis, acids, and salts.*

They are made of a plastic compound, as plaster of paris, with one-tenth flour or marble dust, cast in a protecting wrapper. The heads are cast on to combine and form a solid casing.

124,859—March 19, 1872. J. H. SEIBERT. *Improvement in packages for alkalis, acids, etc.*

The package is formed by casting a plastic substance, as a mixture of glycerine, wax, and paper pulp between an inside and an outside protecting wrapper.

128,176—June 18, 1872. J. H. SEIBERT. *Improvement in packages for putting up caustic alkalis, acids, etc.*

It is cast of a plastic composition and coated with a resinous or protective coating. The alkali is congealed to conform to the package and then placed therein.

137,137—March 25, 1873. G. W. HUMPHREY. *Improvement in incasing caustic alkali.*

It is put up in india-rubber envelopes or coverings.

139,955—June 17, 1873. H. B. HALL. *Improvement in packages for caustic soda or alkali.*

The alkali is packed in a spun or stamped metal cup with a cover of resin poured in in a liquid state.

150,508—May 5, 1874. B. T. BABBITT. *Improvement in caustic-alkali packages.*

A block of caustic alkali hermetically sealed and protected from atmospheric influence by a coating or envelope of turpentine.

150,509—May 5, 1874. B. T. BABBITT. *Improvement in the processes for coating caustic alkalis.*

Balls or blocks of caustic alkali are submerged in melted turpentine in a vessel in which a vacuum is produced.

158,094—December 22, 1874. A. K. LEE. *Improvement in putting up caustic alkalis.*

Paper and wood as a carrier for caustic alkalis, etc., is first coated with a cement formed of white lead ground in oil, sulphur, and black oxide of manganese; then with a composition of asphaltum, paraffin, black oxide of manganese, and soapstone; the asphaltum, paraffin, and black oxide of manganese being reduced to a fluid by a product obtained from crude turpentine distilled at not exceeding 225° and from which the pyroligneous-acid water has been separated while the turpentine is in vapor.

164,405—June 15, 1875. T. C. TAYLOR. *Improvement in compositions for coating blocks of caustic alkali.*

It consists of a mixture of a fine earth and oil.

184,925—November 28, 1876. T. C. TAYLOR. *Improvement in methods of packing caustic alkali.*

It is inclosed in a solid molded form in a can, with a surrounding envelope of any mineral powder which will absorb the lye.

193,330—July 24, 1877. H. B. HALL AND E. HINE. *Improvement in processes and apparatus for putting up caustic alkali.*

Dry granulated caustic alkali is compressed into air-tight packages.

206,891—August 13, 1878. A. MENDLESON. *Improvement in compositions for coating alkali balls.*

It consists of Burgundy pitch 16 parts, plaster of paris 2 to 4 parts, and oil one-half part.

229,161—June 22, 1880. A. MENDLESON. *Coated caustic-alkali ball.*

A coated alkali ball has a sealing-boss formed of the coating over the spruespot.

238,064—February 22, 1881. M. M. SMITH. *Manufacture of alkali balls.*

A series of alkali balls is cast on a common wire and coated.

243,939—July 5, 1881. W. J. MENZIES. (*Reissue: May 9, 1882, No. 10,108 for the process; No. 10,109 for the product.*) *Grinding and sieving caustic alkali.*

Caustic alkali is ground and sieved while hot or in a temperature sufficiently high to prevent deliquesence.

256,095—April 4, 1882. B. T. BABBITT. *Method of putting up caustic alkali.*

The molten alkali is run into cans with soldered heads, which are set in water or otherwise cooled during the process of filling.

260,272—June 27, 1882. B. T. BABBITT. *Method of putting up caustic alkali.*

Cans formed of a cylindrical body and a head with an outwardly turned flange inserted into the body are filled with the molten alkali, and the heads are then inserted while the alkali is still molten, and pressed down upon the alkali, and finally, after the alkali has hardened, soldered to the can.

261,228—July 18, 1882. C. HEMJE AND T. C. BRECHT. *Process of and apparatus for compressing plastic and other materials.*

Compressed cakes of plastic or other material, as bicarbonate of soda, have a cemented crust or film of the same material formed thereon, as by subjecting them to a bath of steam. The steam may be impregnated with gum arabic.

270,997—January 23, 1883. T. C. TAYLOR. *Packing caustic alkali.*

Pulverized alkali is mixed with resinous or fatty matter—about 20 per cent—and compressed into balls or blocks, and finally given a suitable coating to prevent deliquescence.

270,998—January 23, 1883. T. C. TAYLOR. *Packing caustic alkali.*

A fatty or resinous matter is added to caustic alkali during the process of grinding or preparation to prevent the giving off of caustic dust.

275,498—April 10, 1883. E. KIRK. *Treatment of caustic soda.*

A new composition, consisting of a mixture of powdered caustic soda and powdered sand.

282,633—August 7, 1883. T. S. HARRISON. *Process of producing a perfumed soap alkali.*

A package of soap-making alkali contains a soluble or fusible capsule of perfume.

286,132—October 2, 1883. F. P. HARNED. *Process of grinding caustic soda.*

One or 2 per cent of carbonate of soda or soda ash is added to caustic alkali, and it is then ground and bolted without deliquescence.

287,128—October 23, 1883. C. HEMJE. *Method of compressing pulverized material.*

In the formation of compressed cakes of pulverized material, as of bicarbonate of soda, the molds are subjected to a jet of steam prior to filling, which condenses on the sides of the mold, and the cakes formed have a glazed exterior shell composed of the same material as the body of the cake.

318,044—May 19, 1885. C. SEMPER. *Process of grinding caustic soda.*

Ground salt cake or dried sulphate of soda—say 4 per cent—is added to caustic soda, and the mixture ground and bolted.

338,924—March 30, 1886. J. W. CARSON AND F. P. HARNED. *Manufacture of blocks of bicarbonate of soda.*

It is compressed into blocks immediately on removing it from the carbonating chambers or the washing tables, and before drying or grinding.

624,972—May 16, 1899. H. PRECHT. *Process of packing caustic alkalies.*

The caustic alkali is cast in blocks and packed in casks, with an alkaline carbonate packed in between the caustic-alkali blocks and the walls of the cask.

GROUP III.—POTASH.

POTASHES, CARBONATES.

228—June 10, 1837. G. CLEMENT. *Improvement in the process of leaching ashes.*

In setting up the leach a small quantity of hot unslaked lime and hot ashes is placed in the middle of the ashes.

1,697—July 18, 1840. J. OSBORN. *Improvement in the mode of extracting the alkali from ashes in the manufacture of potash.*

A little alum with lime and salt is added to the leaching solution.

3,783—September 7, 1844. E. CHAMBERLIN. *Improvement in the manufacture of saleratus.*

The volatile products of the combustion of anthracite coal, purified only of dust in connection with steam, are employed for the conversion of pearlash.

124,964—March 26, 1872. M. B. MANWARING AND R. DE WITT BIRCH. *Improvement in the manufacture of potash and phosphate of lime.*

Potash is extracted from the ashes of cotton-seed hulls by boiling in water and adding lime.

130,613—August 20, 1872. W. WENTWORTH AND G. W. CLEAVELAND. *Improvement in the manufacture of pearlashes.*

Ground bark, preferably spent tan bark, is mixed with the lye, the liquor evaporated, and the residuum incinerated.

216,483—June 10, 1879. J. AND R. H. WOODRUM. *Improvement in separating potash from ashes.*

Water at boiling heat is percolated through the ashes heated to a red heat.

252,653—January 24, 1882. C. R. ENGEL. *Manufacture of carbonate of potassium.*

A double carbonate of magnesium and potassium is first formed by treating a mixture of carbonate of magnesium, or free magnesia, and an aqueous solution of a potassium salt with carbonic-acid gas. Carbonate of potassium is then separated out of the double carbonate by boiling or heating in a dry state.

376,366—January 10, 1888. F. BRÜNJES. *Process of obtaining potassium carbonate.*

A mixture of potassium chloride and ammonia-magnesium carbonate is dissolved in water and the precipitate which forms is removed and digested in water to separate the potassium chloride which goes into solution, the other carbonates being less soluble.

484,921—October 25, 1892. P. RÖMER. *Process of making potassium carbonate.*

A mixture of equal molecules of potassium sulphate and potassium bichromate in aqueous solution is converted by means of calcium hydrate or barium or strontium hydrate into potassium chromate, the solution saturated with carbonic acid, the precipitated potassium bichromate separated from the potassium bicarbonate produced, the potassium bichromate remaining in solution is separated, and lastly a potassium carbonate containing chromium is obtained from the lye by further evaporation.

GROUP IV.—ALUMS.

AMMONIA ALUM.

308,623—December 2, 1884. W. J. MENZIES. *Manufacture of burnt alum.*

Concentrated solutions of sulphate of ammonia and sulphate of alumina are mixed in the proportion of 1 part of the former to 4 parts of the latter and evaporated to dryness.

POTASH ALUM.

328,477—October 20, 1885. H. C. FREIST. *Manufacture of crystal alum.*

Crystal alum free from iron is produced by treating a solution of sulphate of alumina containing iron with chlorate of potash or like oxidizing agent to convert the ferrous oxide into ferric oxide, and adding, either before or after the impurities have been removed, sulphate of potash, sulphate of ammonia, or sulphate of soda, and crystallizing the alum.

521,712—June 19, 1894. J. HEIBLING. *Process of making potash alum and alumina.*

A mixture of clay, sulphate of potash, and sulphate of ammonia (in the proportion of the alumina of the clay and sulphate of potash each 1 part, sulphate of ammonia 3 parts) molded into bricks is heated to from 275° to 300° C., until the ammonia is driven off, when it is dissolved, the iron eliminated, and the ammonia previously removed is added, whereby the alumnia is precipitated and the sulphate of ammonia and sulphate of potash are regenerated.

SODA ALUM.

267,610—November 14, 1882. P. & F. M. SPENCE. *Manufacture of alum.*

In the manufacture of soda alum, cold saturated solutions are mixed with stronger solutions—as of sp. gr. 1.55—of a higher temperature, to prevent solidification with crystallization, or, if solidified, to change into the crystalline form.

420,488—February 4, 1890. E. AUGÉ. *Process of making soda alum.*

A solution of sodium sulphate combined with a solution of aluminum sulphate is condensed by evaporating in vacuo at a temperature not exceeding 60° C., cooled and crystallized.

435,139—August 26, 1890. E. AUGÉ. *Process of crystallizing soda alum.*

A solution of sulphate of alumina and sulphate of soda is concentrated to between 1.32 and 1.42 sp. gr., cooled to a pasty form, and then exposed in layers upon inclined surfaces at a temperature of 15° to 20° C. till the mother liquors are separated.

454,189—June 16, 1891. F. M. & D. D. SPENCE AND A. ESILMAN. *Process of making soda alum.*

Sufficient sulphate of soda is dissolved in a boiling concentrated solution of sulphate of alumina, or alumino-ferric sulphate, of a sp. gr. not exceeding 1.8, to form with the sulphate of alumina soda alum; the impurities settled in a closed vessel; the solution evaporated to a sp. gr. of from 1.425 to 1.450, then agitated and cooled until a magma is formed, which is stirred and turned over from time to time until it is converted into crystals of soda alum and mother liquor.

456,294—July 21, 1891. F. M. & D. D. SPENCE. *Manufacture of soda alum.*

To a boiling concentrated solution of soda alum, prepared from sulphate of alumina and sulphate of soda, or from alumino-ferric and sulphate of soda, of a sp. gr. of 1.450, there is added a small quantity of a cold saturated solution of soda alum sufficient to yield on cooling of the mixture a magma not too stiff to be freely stirred and turned over until transformed into crystals of soda alum and mother liquor.

497,570—May 16, 1893. T. S. HARRISON AND C. SEMPER. *Aluminous compound.*

A compound of sulphate of alumina and double sulphate of alumina and soda; a hard, dry compound, readily ground, but highly soluble; the product of process No. 497,571.

497,571—May 16, 1893. T. S. HARRISON AND C. SEMPER. *Process of making aluminous compounds.*

An aluminous solution is hardened by adding powdered sulphate of soda, say 20 per cent, to the concentrated aluminous solution ready to run off.

CONCENTRATED ALUM.

1,945—January 23, 1841. ·M. J. FUNCKE. *Improvement in the manner or process of manufacturing sulphate of alumina.*

The clay is prepared by desiccation, reduced to a powder, and treated with sulphuric acid, dried, then treated with water to dissolve the salt, settled, and any free acid neutralized with lime water. The clear liquor is drawn off and the iron precipitated with prussiate of potash, the exact quantity required being ascertained by a test sample.

60,780—January 1, 1867. H. PEMBERTON. *Improvement in the manufacture of sulphate of alumina, alum, and other aluminous compounds.*

In place of sulphuric acid, the acid solution obtained from the tarry acid residuum resulting from the refining of petroleum, etc. (impure sulphuric acid), is used.

191,160 ·May 22, 1877. C. LENNIG. *Improvement in processes of manufacturing aluminic sulphate and alum.*

The alumina in clay or kaolin is dissolved by sulphuric acid under pressure in a closed vessel.

196,043—October 9, 1877. G. P. ROCKWELL. *Improvement in manufacture of alum.*

Aluminic sulphate and alum are manufactured by the decomposition of the mineral indianaite, a practically pure silicate of alumina, by means of sulphuric acid, and the elimination of the separated silica. For alum the equivalent of alkali is added prior to crystallization.

208,615—October 1, 1878. F. LAUR. (*Reissue: 8,882—September 2, 1879; 9,340—August 10, 1880.*) *Improvement in manufacture of sulphate of alumina.*

In the process of manufacturing sulphates of alumina a neutral solution is made and then pieces of zinc ore introduced to convert the iron into a colorless compound of iron prior to concentration.

221,787—November 18, 1879. A. A. CROLL. *Improvement in the manufacture of sulphate of alumina.*

The saturating vessel is jacketed to prevent the escape of heat and maintain the fluidity of the mass, and the charge is drawn off successively from different levels, producing batches of different grades.

230,106—July 20, 1880. W., T., & J. CHADWICK AND J. W. KYNASTON. *Process of making and purifying sulphate of alumina or alum.*

In the manufacture of alumina, alum cake, or alum, the iron is precipitated out of the solution by treating with arsenious acid and neutralizing with carbonate of lime. The remaining arsenic is then precipitated by hydrogen sulphide.

237,816—February 15, 1881. W., T., & J. CHADWICK AND J. W. KYNASTON. *Purifying sulphate of alumina.*

Iron is removed from the aluminous solution by the addition of ferrocyanide of calcium, and the arsenic then precipitated by a soluble sulphide, as hydrogen sulphide, by this means carrying down the suspended ferrocyanide. A small quantity of sulphate of copper or sulphate of zinc is used when arsenic is not employed to remove the suspended ferrocyanide.

239,089—March 22, 1881. J. H. EASTWICK. *Manufacture of sulphate of alumina.*

Halloysite (Indianaite) is ground and bolted—roasting being dispensed with—mixed with sulphuric acid, and then treated with hydrate of alumina, producing spontaneous ebullition and decomposition of the halloysite.

243,949—July 5, 1881. B. E. R. NEWLANDS. *Manufacture of sulphate of alumina.*

Sulphate of alumina is purified of sulphuric acid and iron by evaporating a solution of impure salt to the point of crystallization on cooling, or by adding sufficient water to the salt to obtain the impurities in solution and leave the sulphate pure, and then separating the mother liquor containing the impurities by pressure or centrifugal action.

245,750—August 16, 1881. C. SEMPER. *Manufacture of sulphate of alumina.*

A solution of ferruginous sulphate of alumina is treated in a finely divided state or in spray with sulphurous acid or hydrogen sulphide to decolorize it.

257,567—May 9, 1882. C. FAHLBERG AND C. SEMPER. *Method of removing iron from ferruginous saline solutions.*

The ferruginous solution is treated with plumbic dioxide either by adding same to the solution or by converting a neutral monobasic or polybasic salt of lead, or an oxide of lead into plumbic dioxide in said solution. Ferrous oxides are first converted into ferric oxides.

257,568—May 9, 1882. C. FAHLBERG AND C. SEMPER. *Recovery of plumbic dioxide from ferruginous solutions.*

The waste plumbic dioxide and ferric plumbate is treated with nitric acid, or other acid or acid salt, to recover the iron.

264,773—September 19, 1882. C. SEMPER. *Removing iron from ferruginous solutions.*

The solution is treated with manganese dioxide or manganic sesquioxide. Ferrous oxide when present should first be converted into ferric oxide and the solution should be basic or neutral. The spent manganic dioxide is revived by treatment with dilute sulphuric acid.

264,774—September 19, 1882. C. SEMPER. *Process of removing iron and manganese from certain solutions.*

Iron and manganese are both removed by a single operation from ferruginous solutions (of such salts as are not decomposed in the operation of the process) containing manganous salts by treatment with a permanganate and heat.

266,451—October 24, 1882. R. A. FISHER. *Sizing for paper makers.*

An aluminous compound containing sodium or zinc, a new product of a viscid or creamy consistency is produced by neutralizing a portion of the acid of an acid solution of aluminum sulphate by means of sodic or zincic oxide or zinc, evaporating the solution to about 37° Baumé, and then cooling under agitation.

266,452—October 24, 1882. R. A. FISHER. *Sizing for paper makers' use.*

Sulphate of alumina of a viscous or creamy consistency, a new product, is made by cooling under agitation a solution of sulphate of alumina evaporated to about 37° Baumé when boiling.

280,088—June 26, 1883. C. SEMPER. *Manufacture of sulphate of alumina.*

A neutral porous alumina sulphate containing magnesia sulphate is produced by treating a hot solution of alumina sulphate of such degree of concentration that it will harden when cold, with carbonate or bicarbonate of magnesia.

280,089—June 26, 1883. C. SEMPER. *Manufacture of sulphate of alumina.*

A neutral or basic alumino-magnesian compound is formed by treating a hot acid solution of sulphate of alumina with magnesic carbonate, bicarbonate, or oxide.

280,090—June 26, 1883. C. SEMPER. *Manufacture of sulphate of alumina.*

Porous alumina sulphate containing zinc is produced by adding zinc sulphite to a hot solution of alumina sulphate from which silica has been removed, and which is of such degree of concentration as to harden when cold.

321,092—June 30, 1885. R. A. FISHER. *Neutral sizing material for paper makers' use.*

A solution of sulphate of alumina free from iron is made neutral or slightly basic with oxide of zinc, or other suitable neutralizing material; insoluble matter, if any, is removed; the clear solution concentrated to about 65° Baumé; bicarbonate of soda added to the hot viscid mass to produce a porous or vesicular structure, and the mass cooled and broken into lumps.

321,093—June 30, 1885. R. A. FISHER. *Neutral sizing material for paper makers' use.*

For the production of a white sizing material from ferruginous aluminous sulphate a solution of sulphate of alumina containing iron is prepared, the ferric sulphate reduced to ferrous sulphate, and the solution made neutral, etc., as per No. 321,092.

321,094—June 30, 1885. R. A. FISHER. *Manufacture of an aluminous sizing material for paper makers' use.*

For the production from any ferruginous sulphate of alumina solution of a porous sizing material free from iron, nearly all of the iron is first converted into insoluble prussian blue by means of a slight excess of yellow prussiate of potash, the incidently formed soluble prussian blue removed and the excess of yellow prussiate of potash by means of oxide of zinc; when the solution of sulphate of ammonia is freed from prussian blue and other insoluble matter by subsidence, filtration, or otherwise, and concentrated to about 65° Baumé, etc., as in No. 321,092.

321,095—June 30, 1885. R. A. FISHER. *Manufacture of a sizing material for paper makers' use.*

For the manufacture of a porous sulphate of alumina containing magnesia, but free from iron and excess of alumina and acid, artificial hydrate of alumina free from iron is dissolved in sulphuric acid and water; then magnesia or carbonate of magnesia is added to the hot fluid, which is then cooled until it begins to thicken, when bicarbonate of soda is added to produce a porous or vesicular structure.

321,096—June 30, 1885. R. A. FISHER. *Sizing material to be used in the manufacture of paper.*

For the manufacture of a sizing material containing both zinc and iron, but free from an objectionable buff color, hot sulphuric acid is mixed into any ferruginous alum clay, water being added from time to time to prevent overflow; the liquor is then drawn off, settled, decanted, and treated with zinc and bicarbonate of soda.

321,097—June 30, 1885. R. A. FISHER. *Manufacture of sizing for paper makers' use.*

For the manufacture of a porous sizing material free from iron direct from ferruginous aluminous mineral, hot sulphuric acid is mixed with finely ground ferruginous alum clay; all or nearly all of the iron is removed by means of a plumbic oxide, manganese dioxide or sesquioxide, or potassium permanganate or other precipitate of iron from aluminous solutions, and the solution is cleared and concentrated and bicarbonate of soda added.

321,098—June 30, 1885. R. A. FISHER. *Manufacture of sizing material for paper makers' use.*

In the production of a porous sizing material direct from ferruginous aluminous minerals, hot sulphuric acid is mixed with ferruginous alum clay, the ferric oxide reduced to ferrous oxide by the addition of zinc, and the clear liquor decanted, concentrated, and treated with bicarbonate of soda.

333,680—January 5, 1886. C. SEMPER. *Manufacture of sizing compounds for paper makers' use.*

Plumbic oxide, or other substance which will precipitate iron, is added to a neutral ferruginous solution of sulphate of alumina, which is then filtered, and either before or after treatment with plumbic oxide, oxide of zinc is added to make the solution sufficiently basic not to act upon ultramarine blue. Bicarbonate of soda is finally added to make the product porous.

345,604—July 13, 1886. C. SEMPER. *Process of making porous alum.*

A ferruginous solution of sulphate of alumina is treated with plumbic dioxide or other precipitant of iron from aluminous solutions, the insoluble matter is removed, and bicarbonate of soda is added to the solution in a sufficiently cool and concentrated condition, and the vesicular mass is crushed or broken into lumps.

345,605—July 13, 1886. C. SEMPER. *Process of making porous alum.*

A ferruginous solution of sulphate of alumina is treated with zinc to reduce ferric oxide to ferrous oxide, the insoluble impurities removed, and the clear liquor in a sufficiently cool and concentrated condition treated with bicarbonate of soda, and finally the mass is crushed into lumps.

351,210—October 19, 1886. C. SEMPER. *Sizing material for paper makers' use.*

A solution of sulphate of alumina free from iron is treated with oxide of zinc, either before or after the removal of any insoluble matter, and then, when sufficiently concentrated and cooled, bicarbonate of soda is added.

351,211—October 19, 1886. C. SEMPER. *Sizing material for paper makers' use.*

A solution of sulphate of alumina containing iron is treated with a reducing agent to convert ferric sulphate into ferrous sulphate, and it is then treated with oxide of zinc to render it neutral or basic; any insoluble matter is removed, and, when sufficiently concentrated and cooled, bicarbonate of soda is added.

503,901—August 22, 1893. W. E. CASE. *Process of making aluminum compounds.*

An insoluble aluminum compound, free from iron, is obtained by treating an aqueous solution of crude aluminum sulphate with nitric and sulphuric acids, adding calcium fluoride, then adding a solution of an alkali carbonate, as sodium carbonate, to precipitate iron, and mechanically separating the liquid from the solid products of the reaction. The solution is then treated with a further quantity of the alkali carbonate to precipitate the aluminum compound.

520,416—May 29, 1894. J. ENEQUIST. *Process of making porous sulphate of alumina.*

A hot concentrated solution of sulphate of alumina is run off and solidified on a zinc or aluminum surface, whereby the hydrogen given off makes the material porous.

ALUM CAKE.

209,488—October 29, 1878. G. T. LEWIS. *Improvement in manufacture of alum cake and sulphate of alumina.*

The aluminous materials are ground and mixed with sulphuric acid in one operation, and the mixture afterwards heated from 82° to 126° C.

217,460—July 15, 1879. T. S. HARRISON. *Improvement in manufacture of aluminous cake.*

Fibrous aluminous cake, a new article of manufacture, has fibrous silicate of magnesia, or fibrous sulphate of lime or equivalent material, substituted for the silica of alum cake.

220,720—October 21, 1879. F. LAUR. *Improvement in the manufacture of aluminous cake.*

Zinc is introduced into an acidulated ferruginous solution of sulphate of alumina to neutralize the free acid and convert the iron into a colorless iron compound prior to concentration.

225,300—March 9, 1880. C. V. PETRAEUS. *Manufacture of aluminous cake.*

White aluminous cake is made from ferruginous aluminous sulphate by treating the aluminous sulphate in solution with alkaline sulphides, sulphides of alkaline earths, or metallic sulphides, such as finely ground zinc blende or galena.

225,301—March 9, 1880. C. V. PETRAEUS. *Manufacture of aluminous cake.*

The peroxide of iron in ferruginous aluminous sulphate is reduced to the protoxide and decolorized by the addition of powdered or spongy lead, and then boiling or agitating the solution.

233,916—November 2, 1880. G. F. BIHN AND R. HEERLEIN. *Manufacture of aluminous cake.*

Aluminous sulphate in a semifluid condition is treated with sulphites, bisulphites or hyposulphites of the alkalis, alkaline earths, or the metallic bases to decolorize the iron and produce a white cake.

234,704—November 23, 1880. G. F. BIHN. *Manufacture of white aluminous cake.*

A pulverized mixture of halloysite and bauxite is treated with sulphuric acid and the mass decolorized as in No. 233,916.

238,613—March 8, 1881. C. SEMPER. *Manufacture of aluminous cake.*

A ferruginous aluminous sulphate is treated with oxalic acid, or oxalates of the alkalis, of the alkaline earths, or of the metallic bases to produce a colorless aluminous cake containing the iron salts.

240,597—April 26, 1881. G. T. LEWIS AND C. V. PETRAEUS. *Manufacture of aluminous cake.*

The last traces of prussian blue are removed from an aluminous-cake solution, to which yellow prussiate of potash has been previously added, by treating the liquor with metallic zinc, oxide of zinc, or zinc ore.

243,635—June 28, 1881. C. SEMPER. *Manufacture of aluminous cake.*

Ferruginous aluminous sulphate is decolorized by treating it in a semifused condition with zinc or zinc dust.

253,377—February 7, 1882. T. S. HARRISON. *Manufacture of aluminous cake.*

A blue aluminous cake containing ferrocyanide of iron is produced by precipitating the iron as prussiate of iron in a ferruginous aluminous sulphate solution and then concentrating the solution without removing the prussiate of iron.

271,371—January 30, 1883. C. SEMPER. *Manufacture of aluminous cake.*

The aluminous sulphate in a semifused condition is treated with sulphites, bisulphites, or hyposulphites of the alkalis, alkaline earths, or the metallic bases.

342,599—May 25, 1886. F. P. HARNED. *Process of making neutral aluminous compounds.*

In the manufacture of sulphate of alumina pulverized caustic soda or aluminate of soda is mechanically mixed with the product during the grinding to neutralize the free acid, the quantity required for the neutralization being ascertained by a test of the aluminous cake.

344,140—June 22, 1886. C. SEMPER. *Process of making a sulphate of alumina compound.*

A basic compound containing basic sulphate of alumina and sulphate of magnesia and water is produced by treating a neutral or slightly basic solution of sulphate of alumina with the oxide, carbonate, or bicarbonate of magnesia.

443,685—December 30, 1890. H. W. SHEPARD. *Process of making alum cake.*

Sufficient sulphuric acid is added to bauxite or other aluminous material to form basic sulphate of alumina, when an alkaline or alkaline earthy sulphide, as impure calcium sulphide, is added to the hot pasty mass and mixed therewith in quantity sufficient to reduce the soluble iron to the ferrous state. The mass is then diluted with water and the dissolved sulphate separated from the insoluble impurities and concentrated.

526,205—September 18, 1894. J. V. SKOGLUND. *Aluminous cake and process of making same.*

An aluminous cake free from ferric iron and consisting of sulphate of alumina, ferrous iron, an excess of a stannous compound, and a stannic compound, is produced by reducing the greater portion of the iron in a ferruginous sulphate of alumina solution by means of a weaker reducing agent, such as sulphurous acid or a sulphite, and then finishing the reduction with any stannous compound as stannic oxide.

OTHER ALUMS.

222,152—December 2, 1879. C. V. PETRAEUS. *Improvement in processes for manufacturing alumina and carbonate of soda.*

See Group II, Sodium Compounds.

223,442—January 13, 1880. R. A. FISHER. *Preparing a sizing material used by paper makers.*

A neutral compound consisting essentially of sulphate of alumina and zinc is made by treating a solution of sulphate of alumina with oxide of zinc.

223,449—January 13, 1880. R. A. FISHER. *Manufacture of a white compound for paper makers' use.*

A solution of sulphate of alumina, obtained from aluminous earths containing iron, is treated with a reducing agent to convert ferric into ferrous salts, and then with oxide of zinc to neutralize the free acid.

228,867—June 15, 1880. W., T. & J. CHADWICK AND J. W. KYNASTON. *Process for the purification of alumina, bauxite, etc.*

The iron in aluminous materials, such as bauxite or clay, is converted into a soluble oxalate by treating with a solution of oxalic acid, and the oxalate is then removed by filtration and decantation.

269,957—January 2, 1883. C. V. PETRAEUS. *Manufacture of porus zinciferous alum.*

Porus zinciferous alum is produced by adding carbonate of zinc to molten sulphate of alumina.

282,878—August 7, 1883. F. GARDAIR AND T. GLADYSZ. *Manufacture of anhydrous alumina.*

Crystals of chlorhydrate of aluminum are prepared by the reaction of chlorhydric acid upon a solution of aluminum sulphate, and then decomposed by heat.

301,174—July 1, 1884. A. E. SPENCER. *Desiccating alum.*

It is melted and dried in a revolving cylinder by heat externally applied, the alum flowing evenly over the interior surface of the cylinder.

312,894—February 24, 1885. C. V. PETRAEUS. *Manufacture of alumina by paper-mill sludge.*

A product free from iron is produced from ferruginous aluminous material by mixing same with the spent soda-liquor from wood-pulp manufacture, evaporating down, and burning.

GROUP V.—COAL-TAR PRODUCTS. See Group XVIII.

GROUP VI.—CYANOGEN COMPOUNDS.

CYANIDES.

269,309—December 19, 1882. L. MOND. *Manufacture of cyanogen compounds and ammonia.*

In the manufacture of barium cyanide and ammonia, briquettes are formed of an intimate mixture of carbon, carbonate or oxide of barium, and a refractory basic absorbent—such as magnesia—and heated in a reducing flame before exposure to nitrogen, or the mixture is heated in mass, cooled, and broken up. The nitrogenous gases are passed through the hot barium salts, thereby cooling them, and then through fresh layers of barium salts and carbon at the temperature required to form cyanogen compounds.

277,851—May 15, 1883. A. T. SCHUESSLER. *Process of treating spent lime from gas works for cyanides.*

The soluble substances are extracted by leaching; the liquor treated with carbonic-acid gas and the hydrogen sulphide utilized; while the residuum of the first process is decomposed by the addition of commercial salt of sulphate of potash, the precipitate removed, and the liquor evaporated to form salt for the manufacture of ferrocyanides.

484,579—October 18, 1892. G. T. BEILBY. *Process of making cyanides.*

Ammonia is passed through a liquid-fused mixture of anhydrous alkali, cyanide, and carbon. The gases may be led through secondary retorts containing alkalized charcoal at a suitable temperature for the formation of cyanide.

507,753—October 31, 1893. D. J. PLAYFAIR. *Process of making cyanides.*

A sulphocyanate (sulphocyanide or thiocyanate) is heated to from 800° to 1,000° F. with a metal fusible at the said temperature, of the class comprising lead and zinc, producing a sulphide insoluble in the cyanide. The cyanide is separated by settling or lixiviation.

509,957—December 5, 1893. W. SIEPERMANN. *Process of and apparatus for making cyanides.*

Ammonia is passed into a mixture of alkaline carbonates and powdered charcoal, heated to a dark-red heat, and the heat is subsequently raised to a bright red. Cyanide of potassium is separated from its aqueous solution by gradually increasing the percentage of carbonate of potash or caustic potash.

526,592—September 25, 1894. C. T. J. VAUTIN. *Process of making cyanides of alkaline metals.*

In the manufacture of cyanides of the alkaline metals from ferrocyanides by the substitution of an alkaline metal for the iron, instead of potassium or sodium an alloy of the alkaline metal with lead is used, and the resulting fused cyanide is separated from the residue of iron and lead.

539,279—May 14, 1895. W. McD. MACKEY. *Process of making potassium cyanide.*

A carbonaceous and potassium mixture is treated in a vertical furnace having two sets of tuyères at different levels and an intermediate outlet for the cyanide vapors.

541,066—June 18, 1895. H. Y. CASTNER. *Process of making cyanides.*

Previously or separately made alkaline metal is treated with nascent nitrogen and carbon.

543,643—July 30, 1895. H. Y. CASTNER. *Process of and apparatus for making alkali cyanides.*

A molten alkali metal, as sodium, at a temperature of 300° to 400° C., is introduced into an atmosphere of anhydrous ammonia in the proportions of 23 pounds of alkali metal for each 17 pounds of ammonia gas. The amid produced is withdrawn and passed through carbon heated to redness.

546,528—September 17, 1895. C. HOEPFNER. *Anode for electrolytic apparatus.*

See Group X, Electro-chemistry.

548,058—October 15, 1895. B. HUNT. *Process of recovering cyanides.*

A solution of zinc sulphate containing some free sulphuric acid is added to spent cyanide liquor, the supernatant liquor is drawn off, more than sufficient sulphuric acid is added to the precipitate to decompose the zinc cyanide, the mixture is distilled, and the distillate washed and passed through two caustic alkali solutions, the first containing sufficient alkali to combine with a part only of the hydrocyanic acid, and the other an excess of alkali for absorbing the remainder.

567,551—September 8, 1896. J. RASCHEN. *Process of making cyanides.*

A sulphocyanide, as of sodium or calcium, mixed with water, is heated in the presence of an oxidizing agent, as nitric acid, and the evolved gases passed through a solution of caustic alkali or alkaline earth, whereby the hydrocyanic acid is absorbed. The unabsorbed nitric-oxide gas is reconverted into nitric acid with air and steam.

567,552—September 8, 1896. J. RASCHEN. *Process of making cyanides.*

Referring to No. 567,551, the evolved oxidized gases are passed through a heated-water scrubber, where the nitrous fumes are retained, then into cold water or a water tower, by which the hydrocyanic acid is absorbed for subsequent obtainment of cyanide, then through or in contact with lime water to obtain cyanide, the escaping nitric oxide being reconverted into nitric acid.

569,104—October 6, 1896. J. A. KENDALL. *Process of and apparatus for making cyanides.*

The heating vessel, which may be made of nickel or sheet cobalt, with a platinum discharge flue, is inclosed in an outer vessel with hydrogen gas circulating through the intervening space.

569,325—October 13, 1896. P. DANCKWARDT. *Process of and apparatus for producing cyanides.*

See Group X, Electro-chemistry.

576,264—February 2, 1897. J. D. GILMOUR. *Process of making cyanides.*

A mixture of carbonaceous material and an alkali at a high temperature is treated with atmospheric nitrogen, forming a cyanide, which is lixiviated, and carbon dioxide and nitrogen, obtained from combustion of carbon in atmospheric air, is passed through the solution while at a high temperature, forming hydrocyanic acid and a carbonate of the base of the cyanide. The said acid and carbonate are separated, and the carbonate dried and mixed with carbonaceous material in a fresh operation, and the nitrogen, freed from the said carbon dioxide, is passed therethrough while maintained at a high temperature.

577,837—March 2, 1897. H. Y. CASTNER. *Process of making cyanide.*

Molten alkali metal is percolated through carbon heated to redness in the presence of a current of free nitrogen. The molten alkali metal enters the retort and the cyanide is conducted out through trapped pipes.

579,639—March 30, 1897. H. W. CROWTHER, E. C. ROSSITER, G. S. ALBRIGHT, AND J. J. HOOD. *Process of and apparatus for making cyanides.*

In the manufacture of ferrocyanides the iron is cleaned by treating it with an alkaline or alkaline-earth sulphide. It is then mixed with a sulphocyanide and the mixture dried in the presence of an inert gas, as limekiln gases, to prevent oxidation.

579,988—April 6, 1897. C. KELLNER. *Process of producing metallic cyanides.*

See Group X, Electro-chemistry.

590,217—September 21, 1897. A. FRANK AND N. CARO. *Process of making cyanides.*

Carbides of a suitable metal—as a metal of the alkalis—are heated to a red heat and subjected to the action of nitrogen saturated with steam. A caustic alkali or an alkali carbonate may be mixed with the carbide.

591,575—October 12, 1897. J. R. MOÏSE. *Process of making cyanides.*

Boride of nitrogen is produced by calcining a mixture of biborate of sodium 100 pounds, and hydrochoride of ammonium 150 pounds, lixiviating with boiling water acidified with hydrochloric acid, and filtering. A mixture of the boride of nitrogen thus obtained with carbonate of potassium and carbon is heated to a dark red, forming cyanides and borates, which are separated by crystallization. Ferrocyanide is produced direct by adding iron filings to the mixture.

591,730—October 12, 1897. W. BAIN. *Process of and apparatus for electrolyzing.*

See Group X, Electro-chemistry.

596,641—January 4, 1898. H. R. VIDAL. *Process of making cyanides.*

Cyanogen compounds are produced by heating phospham (PN_2H) with a carbonate, *e. g.*, phospham, 6 parts, potassium carbonate, 19 parts. The addition of coal carbon produces a cyanide instead of a cyanate, and iron a ferrocyanide. Sulphocyanides are obtained in the presence of sulphur, and gaseous cyanogen by heating a mixture of phospham and dry natural potassium oxalate.

605,694—June 14, 1898. H. S. BLACKMORE. *Process of making cyanides.*

Metallic sulphides, as potassium sulphide, are converted into cyanides, sulphocyanides and ferrocyanides by introducing a metallic carbide, as granular iron carbide, into the molten sulphide and passing nitrogen gas therethrough.

607,507—July 19, 1898. P. DANCKWARDT. *Process of and apparatus for making ferrocyanides.*

A mixture of an alkali sulphocyanide, as that of sodium, with lime, charcoal, and a carbide or carbides, preferably calcium carbide and iron carbide, is heated, leached with water, and the ferrocyanide separated.

607,881—July 26, 1898. H. REICHARDT AND J. BUEB. *Process of making cyanides from molasses lyes.*

Cyanide of ammonium is produced direct from molasses or molasses lyes by distilling with exclusion of air and maintaining the gases at about 1,100° C. until cyanide of ammonium is formed, by passing them through highly heated fire-brick flues. The cyanogen is separated as ferrocyanide by leading the gases through an iron-salt solution.

623,709—April 25, 1899. A. FRANK AND N. CARO. *Process of making cyanides.*

A carbide, as an alkaline metal carbide, is mixed with an oxide of a metal only, and heated in the presence of nitrogen, free or bound. It is heated to a temperature below the melting point of the cyanide until absorption of nitrogen ceases, and then the temperature is raised to the melting point.

625,964—May 30, 1899. J. BUEB. *Process of extracting cyanogen from coal gas.*

The gas, before going to the ammonia scrubbers, is passed through a concentrated solution of a metallic salt—as chloride or sulphate of iron—thereby precipitating all of the cyanogen and part of the ammonia, and leaving the greater part of the ammonia with the gas.

641,571—January 16, 1900. W. WITTER. *Process of producing solution of cyanogen halide.*

A solution of cyanogen halide—such as chloride or bromide—is produced by electrolyzing, without a diaphragm and with inert electrodes, a solution containing an alkali cyanide, an alkali halide, such as chloride or bromide, and the salt of a metal—as magnesium—which forms an insoluble hydroxide.

642,782—February 6, 1900. J. BUEB. *Process of making hydrocyanic acid.*

Gases resulting from the destructive distillation of organic matters, cooled and freed of ammonia, are subjected to contact with alcohol, as in an alcohol tower, and the alcoholic solution of hydrocyanic acid is subjected to fractional distillation. The hydrocyanic-acid gas is separated from the alcohol by reaction with alcoholic caustic alkali.

651.346—June 12.1900. A. DZIUK. *Process of making cyanides.*

Cyanides and ferrocyanides of the alkaline earth metals, including magnesium, are produced by subjecting carbides of the said metals in the nascent state to the action of a superheated current of pure nitrogen, as by passing heated nitrogen over the carbide while in a fluid state in an electric furnace.

FERROCYANIDES.

441—October 28, 1837. H. STEPHENS. (*Reissue: 3—April 21, 1838.*) *Improved manufacture of coloring matter.*

Prussiate of potash or soda is produced by passing the gases evolved from the distillation of animal matters, or other matters that yield nitrogen and hydrocarbons, direct into a mass of alkali in a state of fusion, and then into a solution of alkali contained in separate vessels. Prussian blue of commerce is digested in strong acid to render it more soluble in oxalic acid, and then dissolved in oxalic acid as a final process.

5,419—January 25, 1848. M. KALBFLEISCH. *Improved mode of treating animal matters previous to calcination for the manufacture of prussiates of potash or soda.*

Animal matter of any kind is dissolved in caustic potash or soda and dried before calcining.

222,547—December 9, 1879. J. TCHERNIAC AND U. GUNZBURG. *Improvement in processes of and apparatus for making ferrocyanides.*

Carbon disulphide and an ammoniacal solution are mixed under heat, and the resultant sulphocyanide of ammonium is mixed with lime under heat; a soluble carbonate or sulphate, as of potassium, is added to the solution; and finally the resultant sulphocyanide is mixed with lime, carbon, and iron, and heated to a red heat.

245,661—August 16, 1881. T. RICHTERS. *Manufacture of potassium ferrocyanide.*

Nitrogenous material is moistened with a solution of carbonate of potassium, dried without combustion while in contact with carbonic acid, then heated in a retort to drive off the volatile ingredients, and the residuum lixiviated with iron; the prussiate of potash being then separated from the liquor, which can be used for moistening fresh material.

259,802—June 20, 1882. H. BOWER AND W. L. ROWLAND. *Process of obtaining ferrocyanides from gas liquor.*

The ammoniacal liquor is treated with iron or a ferric salt, and then with lime (and the ammonia distilled off), and the ferrocyanides are extracted from the sediment by the addition of an alkaline salt, such as potassium or sodium carbonate.

259,908—June 20, 1882. C. C. PARSONS AND E. F. CRUSE. *Process of obtaining cyanides.*

Iron in the form of a salt or in the insoluble form of hydrate, carbonate, oxide, or sulphide, or of metallic iron, is added to ammoniacal gas liquor in the absence of acid and without neutralizing the ammonia, and before the ammonia is removed, to convert the cyanides of ammonium into ferrocyanides of ammonia. Lime is then added, the ammonia distilled off, and the ferrocyanides of calcium converted into prussian blue by the addition of acid and a salt of iron.

291,163—January 1, 1884. C. DE VIGNE. *Manufacture of ferrocyanides.*

Coal gas containing cyanogen or hydrocyanic acid is cooled and deprived of tarry products and then passed through a mixture of iron and an alkaline salt, as iron filings and crystallized carbonate of soda, the mixture being subsequently washed and the solution evaporated to obtain the ferrocyanide.

303,437—August 12, 1884. H. KUNHEIM AND H. ZIMMERMANN. *Process of making ferrocyanides.*

Ferrocyanide of calcium potassium is produced by precipitating ferrocyanide of calcium from its solution by means of chloride of potassium. Spent materials used in gas purification may be used.

312,248—February 17, 1885. H. BOWER. *Manufacture of ferrocyanide of potassium.*

A mixture of nitrogenous animal matters, potassium carbonate, and iron is heated and the resultant cake or melt treated with water and carbon dioxide.

362,236—May 3, 1887. J. VAN RUYMBEKE. *Obtaining cyanide and ferrocyanide from tank water.*

A solution of alkali, as soda or potash, holding finely divided baryta in suspension, is added to tank water which has been prepared from animal substances by the action of steam at a high heat and under pressure, and the resulting solution evaporated to about 20 per cent of the moisture, when the residue is subjected to destructive distillation at red heat and the ammonia generated is forced to pass downward through the porous mixture of red-hot alkali, carbon, and cyanides already formed.

465,600—December 22, 1891. W. L. ROWLAND. *Process of recovering cyanides from coal gas.*

A soluble salt of iron is added to the water used for extracting the ammonia from the gas passing through the scrubbers, in proportion to remove cyanides, but insufficient to remove sulphides, thus forming soluble ferrocyanide of ammonia along with the ammonia compounds. The ammonia is boiled off and the residue treated with lime to give ferrocyanide of calcium, which is treated with an alkaline chloride or sulphate, and the resulting double salt decomposed with an alkaline carbonate to form an alkaline ferrocyanide.

556,130—March 10, 1896. H. BOWER. *Process of making prussiates.*

Prussiate of potash or soda is produced from sulphocyanide of iron by forming cyanide of potassium, adding to this the sulphocyanide during fusion, and then cooling, lixiviating, and crystallizing.

560,965—May 26, 1896. H. BOWER. *Process of recovering cyanogen compounds from gas liquors.*

An acidified solution of a copper salt is added to gas liquor containing soluble ferrocyanide and sulphocyanide and freed of ammonia, to form insoluble ferrocyanide and sulphocyanide of copper, and metallic iron is then added to decompose the precipitate and form a solution of sulphocyanide of iron. If the last step is conducted with heat and pressure, there is produced sulphide of copper and ferrocyanide of iron.

624,383—May 2, 1899. W. SCHRÖDER. *Process of making yellow prussiate of potash.*

The gaseous products of the destructive distillation of coal are passed through an aqueous solution of protochloride of iron, and the solution is then distilled with milk of lime to precipitate calcium ferrocyanide. The excess of lime in the residual solution is first precipitated; then ferric chloride is added to precipitate the remaining calcium ferrocyanide, and the entire precipitate is treated with a solution of potassium carbonate to precipitate calcium carbonate and ferric hydrate when the solution is concentrated to crystallize out the yellow prussiate of potash.

OTHER CYANIDES.

570,480—November 3, 1896. J. J. HOOD AND A. C. SALAMON. *Manufacture of cyanogen compounds.*

Carbon bisulphide, ammonia, and a fixed base or bases, as peroxide of manganese and lime, are heated together in such proportions that the products of the reactions of the carbon bisulphide and ammonia combine with the fixed base or bases, forming sulphocyanide and sulphide of the base or bases, the whole of the ammonia being utilized in the production of sulphocyanic acid.

578,908—March 16, 1897. G. J. ATKINS. *Chlorocyanid salts and process of making same.*

A new series of compounds, chlorocyanide salts, efficient agents for leaching ores, consist of an alkali and a compound of cyanogen fused together, at as low a temperature as possible, with one or more bases; as, for example, potassium ferrocyanide 1 part and sodium chloride 2 parts.

GROUP VII.—WOOD DISTILLATION.

38,071—March 31, 1863. M. A. LE BRUN-VIRLOY. *Improvement in drying and carbonizing wood, peat, and other fuel.*

First, the material is introduced at one side or end of a furnace and withdrawn from the other side or end in a state suitable for use as fuel; second, the doors or openings are hermetically closed; third, regulated taps, valves, and registers control the admission and exit of air, gas, and other volatile products; fourth, a portion of the volatile products is collected and removed after the whole or part of its caloric has been utilized; fifth, the material and débris of little value and the combustible gases are utilized; and, sixth, the material to be treated is subjected first to a low temperature and then to a gradually increasing temperature.

49,247—August 8, 1865. A. H. EMERY. *Improvement in the manufacture of pyroligneous acid.*

In the distillation of wood in the manufacture of pyroligneous acid, steam is admitted in large quantities, while the heat is not raised sufficiently to char the wood until the wood is thoroughly dried and a large portion of the spirits of turpentine and resin taken out, when the heat is raised to commence rapid charring, the steam being nearly or quite shut off.

62,097—February 12, 1867. P. H. VANDER WEYDE. *Improvement in the manufacture of white lead.*

For use in the manufacture of white lead, acetic acid is produced from the distillation of wood, and at the end of the operation the remaining charcoal is transformed into carbonic acid by blowing air into the bottom of the still. The precipitate is treated with a hot alkaline solution of quicklime, or its equivalent, and the filters washed out with lime water.

93,817—August 17, 1869. L. D. GALE AND I. M. CATTMAN. *Improvement in the manufacture of sugar of lead and acetic acid.*

See Group I, Acetic Acid.

118,787—September 12, 1871. C. J. T. BURCEY. *Improvement in the manufacture of acetate of lime.*

Superheated vapors of pyroligneous acid and dry slaked lime are agitated together. The empyreumatic vapors are condensed, the gaseous products of condensation being utilized for combustion in the furnace.

131,312—September 10, 1872. J. D. STANLEY. *Improvement in processes and apparatus for producing oils, etc.*

Vapor from the distillation of pine wood is passed into condensing water, the uncondensed vapor passes off as an inflammable gas, the floating oil is separated, and the condensing water and acids flow off as waste.

184,898—November 28, 1876. H. M. PIERCE. *Apparatus and process for treating wood for charcoal and other purposes.*

To make concentrated pyroligneous acid the hot volatile products are exhausted from a charcoal kiln and compressed until the acid vapors are liquefied, the temperature being maintained at such height that the diluting water will be separated and permitted to escape in a vaporized condition.

185,141—December 5, 1876. E. R. SQUIBB. *Manufacture of acetic acid.*

Wood in a retort is subjected to the action of heat in an oven, whereby, the temperature being even and controllable, an acid practically free from tar is obtained.

300,384—June 17, 1884. J. A. MATHIEU. *Distillation of wood.*

The vapors resulting from the carbonization of the upper portion of a mass of material in a retort are partially condensed by passing the vapors downward through the uncarbonised portion of the material.

353,998—December 7, 1886. T. W. WHEELER. *Process of and apparatus for distilling wood.*

Wood is first subjected to distillation with steam under low pressure and temperature, thereby softening the wood and driving off the turpentine vapors, which are passed into a bath of limewater, warmed and agitated by a current of steam; when the wood is softened the steam valve and turpentine-vapor valve are closed, the oil valve opened, and the temperature raised to nearly 400° F., thereby quickly running off the creosote oil and pyroligneous acid, which are separated until they run off of the same gravity, when the tar valve is opened and the temperature gradually lowered until the tar and gas are run off.

385,777—July.10, 1388. G. RUMPF. *Manufacture of acetone.*

See Group XVIII, Ketones.

388,529—August 28, 1888. F. S. CLARK. *Process of obtaining creosote, etc.*

The process consists in mingling a caustic-soda solution containing creosote or analogous phenoloid bodies with pyroligneous acid, thereby occasioning a reaction between the mingled bodies, and depositing creosote, and forming acetate of soda by the union of the soda solution and the acetic acid of the pyroligneous-acid solution.

393,079—November 20, 1888. G. RUMPF. *Manufacture of acetone.*

See Group XVIII, Ketones.

407,442—July 23, 1889. E. MEYER. *Process of obtaining methyl alcohol from woodpulp lyes.*

See Group XVIII, Alcohols.

490,497—January 24, 1893. F. H. & R. H. PICKLES. *Process of purifying pyrolignites.*

Pyrolignites in a liquid state are purified of tarry matters by treatment with the carbonaceous residue obtained in the manufacture of prussiate of potash, or alkaline carbonaceous matter prepared by carbonizing animal matter with carbonates or hydrates of the alkalis.

504,264—August 29, 1893. F. J. BERGMANN. *Method of distilling wood waste.*

The method of manufacturing wood vinegar from wood waste, such as sawdust or chips, consists in converting the same into blocks by pressure up to about three hundred atmospheres, expressing water contained in the wood, then carbonizing the blocks in retorts, and precipitating the gases generated.

535,552—March 12, 1895. O. PORSCH. *Process of making acetone.*

See Group XVIII, Ketones.

577,802—February 16, 1897. A. HESSE. *Terpene alcohol.*

See Group XVIII, Alcohols.

622,194—March 28, 1899. F. W. J. F. SCHMIDT. *Method of preparing wood for dry distillation.*

The wood is cut crosswise of the grain into thin laminæ, and then distilled.

648,389—May 1, 1900. H. O. CHUTE. *Process of making acetone.*

See Group XVIII, Ketones.

RESINS AND TURPENTINE.

4,412—March 14, 1846. N. U. CHAFEE. *Improvement in the manufacture of rosin and spirits of turpentine.*

In the manufacture of white resin and white spirits of turpentine from the gum of pines, steam is conducted in and mixed with the gum in a still and then passed through a metal heater.

5,004—March 15, 1847. N. L. MARTIN. *Improvement in refining turpentine.*

Spirits of turpentine are refined by the use of alkali and water, using a strong solution of potashes and water, not less than 12 pounds to the gallon, and 1 gill of alkali to a gallon of spirits of turpentine.

7,528—July 30, 1850. C. J. MEINICKE. *Improvement in distilling spirits of turpentine.*

Crude turpentine is mixed with grease and soda solution and heated, forming a soap, a solution of common salt is added and the spirits of turpentine distilled, leaving the resin saponified ready for soap making.

8,488—November 4, 1851. L. S. ROBBINS. *Improvement in tanners' oil from rosin.*

The product obtained by distilling a mixture of oil, which has been distilled from resin at about 600° F., and slacked lime, say about 5 per cent, with the addition of steam, followed by a second distillation with caustic lime, and further treatment of the product with steam.

8,489—November 4, 1851. L. S. ROBBINS. *Improvement in lubricating oil from rosin.*

The product obtained by distilling a mixture of oil, which has been distilled from resin at about 550° F., and slacked lime, say about 5 per cent, with the addition of steam, followed by a second distillation with caustic lime, and further treatment of the product with steam.

8,490—November 4, 1851. L. S. ROBBINS. *Improvement in distilling acid and naphtha from rosin.*

Resin is melted and heated up to 325° F., or thereabouts, and maintained between 300° F. and 325° F. until the acid and water are driven off, when steam is injected and the temperature maintained at 325° F. to throw off the naphtha.

8,491—November 4, 1851. L. S. ROBBINS. *Improvement in paint oil from rosin.*

The product obtained by the double redistillation with steam of oil which has been distilled from resin at about 650° F. and further treatment of the product with steam.

9,680—April 19, 1853. S. L. DANA. *Improvement in purifying rosin oil.*

Resin oil is deodorized by combining the fluid formed by the first distillation of resin or resin oil with slacked lime or other alkaline, earthy or equivalent metallic base, and distilling the compound.

9,752—May 24, 1853. M. PAGE. *Improvement in processes of distilling rosin oil.*

Steam is introduced into the head of the goose-neck so that the vaporized oils will pass through and be commingled therewith.

10,849—May 2, 1854. H. HALVORSON. *Improvement in processes for distilling rosin oil.*

Clay is mixed with resin—5 parts of clay to 1 part of rosin—and the mixture distilled; no pitch residuum being left in the retort.

27,624—March 27, 1860. D. FEHRMAN. *Improvement in the manufacture of resin.*

Resin is purified by treatment and distillation in a vacuum pan with a small quantity of water and steam at low temperature, rising from 150° F. to 180° F.

27,646—March 27, 1860. H. NAPIER. *Improvement in the manufacture of resin.*

The crude turpentine is heated in a still until it attains a temperature rather exceeding that of steam at a pressure of 10 pounds, then steam at said pressure is caused to permeate and pass through the mass without condensation, until all the oil of turpentine has passed over, when the heat is raised to 550° to 600° F. with the continued blowing of steam through the mass at the same pressure.

28,663—June 12, 1860. S. FRAZER. *Improvement in distillation of oils from resin.*

Crude resin is distilled and certain specified quantities of product are successively drawn off from the receiver of the condenser, the temperature of the product being successively raised from 74° F. for the first drawing to 132° F. for the fourth drawing, and then lowered to 106° F. for the fifth drawing.

44,314—September 20, 1864. D. HULL. *Improvement in extracting rosin and other substances from pine wood.*

Resin is produced direct from pine wood by heating same with heated air or superheated steam, the outgoing blast being conveyed to a condenser, where the spirits of turpentine is collected.

44,435—September 27, 1864. G. R. H. LEFFLER. *Improvement in distilling turpentine from wood.*

Turpentine is distilled direct from wood saturated or thoroughly moistened with steam or water.

46,092—January 31, 1865. A. H. EMERY. *Improvement in obtaining spirits of turpentine, oil, resin, and other products from pine wood.*

A current of ordinary steam is passed over and through the wood into a condenser, the retort being externally heated enough to prevent condensation of steam, the pressure in the boiler being sufficient to give the requisite heat. When the spirits of turpentine have passed over, the temperature is increased for the remaining products.

48,406—June 27, 1865. D. HULL. *Improvement in extracting turpentine and other products from resinous woods.*

Pine or other resinous wood is distilled under less than atmospheric pressure.

49,248—August 8, 1865. A. H. EMERY. *Improvement in the manufacture of pitch.*

Pitch is made from pine wood by one distillation, by heating the bottom of the retort to the requisite degree.

49,249—August 8, 1865. A. H. EMERY. *Improvement in the manufacture of turpentine, etc.*

Wood is distilled under more than atmospheric pressure, say, up to 2 or 3 atmospheres, without the application of steam or superheated steam, to secure an increased production of oil of turpentine and resin before destructive distillation begins.

50,132—September 26, 1865. J. JOHNSON. *Improvement in the manufacture of spirits of turpentine.*

Water, steam, air or gases, and solvents are caused to circulate among the wood in suitable receptacles at a temperature sufficiently low to secure the extractive terebinthinates and resins free from empyreumatic odors. The wood is placed over a stratum of water which condenses the volatile products of the wood and fixes the resin. Two boilers are successively used to economize the heat and save waste of terebinthine products. Suitable soluble salts are added to raise the boiling point and increase the temperature for extraction. Wood is compressed after steaming to eliminate oleo-resins.

54,081—April 17, 1866. J. A. PASTORELLI. *Improved method of extracting turpentine from wood.*

In the distillation of resinous woods for the extraction of essence of turpentine, etc., the wood is placed in a boiler over a fire together with water to form steam to prevent the burning of turpentine formed.

89,493—April 27, 1869. J. MERRILL. *Improvement in the manufacture of rosin oil.*

Resin oil is deodorized by gradually raising the temperature and distilling off the odorous naphthaly oil until the oil coming over reaches from 18° to 14° Baumé's hydrometer, when the distillation is stopped, the remaining oil being virtually free from odor.

100,958—March 15, 1870. J. TREAT. *Improvement in the manufacture of rosin oil.*

Resin oil is refined and bleached by adding from 2 to 4 ounces of caustic soda per gallon of oil and a small quantity of gum benzoin, and distilling. Steam is introduced into the worm to commingle with the vapor before condensation.

130,598—August 20, 1872. J. D. STANLEY. *Improvement in distilling and purifying turpentine from wood.*

The vapor from the distillation of pine wood is introduced into a receiver containing the vapor generated from water or other liquid impregnated or saturated with lime, which vapors combine and condense.

139,402—May 27, 1873. A. K. LEE. *Improvement in bleaching resins.*

Resin is reduced to a powder or small lumps and bleached by the direct action of steam and heat while the mass is under agitation.

145,151—December 2, 1873. S. L. COLE. *Improvement in the production of turpentine from sawdust.*

Spirits of turpentine is produced from sawdust by destructive distillation by the application of fire direct to a retort containing the same.

179,960—July 18, 1876. A. ROCK. *Improvement in production and treatment of resin.*

In the distillation of scrap turpentine and the production of resin therefrom the condensable vapors are eliminated while under treatment in a retort during distinct and separate meltings, or exposures to a melting heat, followed in each instance by an exposure to a cooler temperature, and the vapors are condensed, whereby colopholic acid is prevented from being unduly developed in the resin; the vapors are eliminated by means of currents of air sweeping over the turpentine or resin while successively melted and cooled.

180,467—August 1, 1876. L. J. DUROUX. *Improvement in purifying spirits of turpentine.*

Powdered alum, or alum water, is mixed with spirits of turpentine—2 to 3 per cent of powdered alum or a solution of 5 to 10 per cent of alum in water equal to the turpentine—and agitated, and the mixture allowed to settle, when the purified spirit is drawn off.

194,701—August 28, 1877. A. MARTIN. *Improvement in the manufacture of brewer's pitch.*

Brewer's pitch is made direct from crude turpentine, using oil of resin instead of tallow or other oils, by first melting the turpentine and drawing off a portion, reducing the remainder by extracting spirits and acids before adding the oil of resin and ocher, and, when drawing off the mass through a strainer, adding thereto a portion of turpentine first drawn off.

200,168—February 12, 1878. D. M. BUIE. (*Reissue: 10,338—June 5, 1883.*) *Process of manufacturing oils from organic substances.*

See Group XVI, Essential Oils.

242,015—May 24, 1881. J. A. McCREARY. *Process of and apparatus for distilling turpentine.*

The crude material is diluted with a suitable menstrum, as spirits of turpentine; an alkali added, the excess of the latter precipitated, filtered, and then distilled; and pending the process of distillation the uncondensed products are conducted from the worm to the still and forced through the liquid contents of the latter.

276,981—May 1, 1883. L. PRADON. *Method of and apparatus for the manufacture of oil from resinous wood.*

Pine oil, a mobile transparent liquid, $C_{10}H_{16}$, produced by distilling resinous wood at a temperature of about 400° C. It is mixed with petroleum or coal oil to form an illuminating oil.

277,505—May 15, 1883. H. M. PIERCE. *Process of and apparatus for the recovery of turpentine and other wood products, and for the manufacture of charcoal.*

The vapors from wood distillation are subjected to the action of a spray of water, whereby the oils and resinous matters are separated, and the supernatant oily matter is then drawn off.

277,506—May 15, 1883. H. M. PIERCE. *Process of and apparatus for the manufacture of turpentine.*

Wood is subjected in a closed chamber to the action of heated gases and steam, and the gases and vapors withdrawn and condensed.

284,367—September 4, 1883. L. BELLINGRATH. *Process of manufacturing rosin and spirits of turpentine.*

Crude turpentine is melted and heated by steam heat to a temperature sufficient to volatilize the spirit which is driven off and condensed, the resin being passed through sieves and retained heated and in a liquid state by steam heat until all the water and vaporizable impurities are dispelled.

324,878—August 25, 1885. D. J. OGILVY. *Rosin oil.*

As a new article of manufacture, resin oil of commerce treated with and containing an alkaline salt of sodium or potassium sufficient to wholly or partially neutralize the resinous acids, say from 1½ to 2½ per cent of commercial caustic soda.

386,138—July 17, 1888. E. KOCH. *Process of distilling pine wood for the production of crude dry turpentine and pine tar.*

The pine oil is extracted by dry distillation; the distillate treated with milk of lime and agitation; the mixture settled; the oil and lye or other impurities combined therewith separated; the oil agitated with dilute sulphuric acid to remove the last traces of alkali; and the oil finally distilled.

390,451—October 2, 1888. F. S. CLARK. *Pine-oil product.*

An oily body, light in color, sp. gr. heavier than water, not distilling over below 500° F., not volatile at ordinary temperatures, not flashing when heated under 350° F., and becoming solid between zero and 32° F., is produced by the fractional distillation and treatment of pine oil. (Process No. 390,454.)

390,452—October 2, 1888. F. S. CLARK. *Pine-oil product.*

An oily body, sp. gr. at 68° F. of 0.856, completely volatilizing if soaked in paper, boiling at 326° F., produced from the distillation and treatment of pine oil. (Process No. 390,454.)

390,454—October 2, 1888. F. S. CLARK. *Process of refining pine oil.*

The process consists in fractionally distilling pine oil and separating the fractions at or about 540° F., and in separately treating said fractions by two or more fractional distillations and treatments with caustic soda and one or more treatments with sulphuric acid. (Products Nos. 390,451 and 390,452.)

393,942—December 4, 1888. J. B. UNDERWOOD. *Process of distilling turpentine.*

A refined petroleum is mixed with crude turpentine and the mixture distilled, thereby obtaining an increased yield of spirit, and toughening the resin left as a residuum.

395,731—January 8, 1889. E. A. BEHRENS. *Bleaching and refining resins and other substances.*

Resins are first dissolved in a volatile substance, having a low boiling point, such as naphtha, the solution mixed with an alkali to separate the impurities, the alkali and impurities removed, the solution mixed with a suitable bleaching agent and the latter removed, and finally the resin separated by evaporation of the solvent and the latter recovered. The movements of the solutions are controlled by the compression and exhaustion of the air.

495,543—April 18, 1893. G. COL. *Process of treating crude resins and their residues.*

The heated crude products are stirred, then run into settling tanks and settled, and the upper liquid portion decanted and distilled until the volatile matters have passed into a condenser.

508,608—November 14, 1893. R. L. ETHERIDGE. *Manufacture of rosin.*

Bluing (indigo) is mixed with turpentine and distilled to produce a high-grade resin, and eradicate the coloring matter imparted by mixing the "virgin" and the "yearling" dips.

568,258—September 22, 1896. V. J. KUESS. *Process of and apparatus for distilling fatty substances,*

See Group X, Electro-chemistry.

631,749—August 22, 1899. A. MULLER-JACOBS. *Manufacture of substances from rosin oils.*

The invention consists in the products resulting from and in the process of producing from resin oil an oil useful as a lubricant and gums or resinous substances useful as substitutes for shellac, by treating the resin oil with sulphuric acid, converting the resulting sulpho-acids into water-soluble alkali salts, removing the oil, and treating the remaining liquid with acid or with soluble salt or salts of an alkaline earth or metal forming corresponding precipitates, and washing and drying the matter precipitated.

656,252—August 21, 1900. F. G. KLEINSTEUBER. *Compound for dissolving resins.*

See Group XV, Other Plastics.

GROUP VIII.—FERTILIZERS.

PRODUCTS.

6,234—March 27, 1849. P. S. AND W. H. CHAPPELL. *Improvement in artificial manures.*

The residuum from the manufacture of alum and the residuum from the manufacture of epsom salts are mixed with sulphate of lime, the residuum from the manufacture of prussiate of potash, bisulphate of soda, common salt, and a composition resulting from the treatment of bones with gas liquor and sulphuric acid.

7,053—January 29, 1850. R. HARE. *Preparation of animal and other manure.*

Animal material or nitrogenous vegetable matter is treated with mineral acids to produce a concentrated manure; wood tar, coal tar, or their equivalents are also added.

17,392—May 26, 1857. L. S. ROBBINS. *Improvement in fertilizing compounds.*

Green sand, containing little or no carbonate of lime, is mixed with superphosphate of lime in the proportion of 2 parts of the former to 1 of the latter, and ground.

22,544—January 11, 1859. D. BRUCE. *Improvement in artificial manure.*

Animal matter, decomposed to a pulpy mass by standing in closed vessels at a temperature of 32° to 50° C., is disinfected by mixing therewith charred bituminous shale or a roasted mixture of carbonaceous matter and clay, and then dried.

24,988—August 9, 1859. E. BLANCHARD. *Improvement in composts.*

A mixture of lime, sodium chloride, wood ashes, charcoal, wheat bran, chimney soot, and gypsum.

26,184—November 22, 1859. L. HARPER. *Improvement in fertilizers.*

Peat, muck, or lignite are mixed with sulphate of lime, soda, potash, and magnesia, and, if desired, with green-sand marl, as a base for fertilizer compositions; phosphate and biphosphate of lime is added to the base, and the mixture impregnated with ammonia, as by admixture of pulpy nitrogenous matter.

26,196—November 22, 1859. J. J. MAPES. *Improvement in fertilizers.*

One hundred parts by weight of apatite or calcined bones or phosphate of lime is saturated with sulphuric acid, and after the superphosphate of lime is formed there is then added 36 parts of Peruvian guano and 20 parts of sulphate of ammonia.

26,507—December 20, 1859. J. J. MAPES. *Improvement in fertilizers.*

The fertilizer product of No. 26,196 is mixed and ground with equal quantities by weight of dried blood.

26,985—January 31, 1860. L. HARPER. *Improvement in fertilizers.*

Green-sand marl, after atmospheric disintegration, is spread in a layer, covered with a layer of fish or offal, and the latter covered with marl impregnated with sulphate or nitrate of soda or potash. After decomposition is advanced, marl mixed with bone dust dissolved in an excess of sulphuric acid is added, and sulphate of lime is sprinkled from time to time until decomposition is completed and no more ammonia is evolved; the mass being repeatedly turned toward the end, and finally dried.

27,072—February 7, 1860. A. ROLLAND. *Improvement in fertilizers.*

A mixture of alum, 7 parts; sulphate of iron, 29 parts; sulphate of soda, 36 parts; sulphate of lime, 25 parts; sulphuric acid, 3 parts; all by weight, to be used direct as a fertilizer, or a solution of the same is sprinkled on manure.

28,516—May 29, 1860. L. STEPHENS. *Improvement in fertilizers.*

A mixture of decomposed animal matter, 1,200 pounds; animal charcoal, 150 to 200 pounds; sombrero guano, 200 pounds; Peruvian guano, 175 pounds; ammonium sulphate, 25 pounds; common salt, 100 pounds; and solution of bone in muriatic acid, 50 gallons.

33,706—November 12, 1861. J. B. HYDE. *Improvement in manufacture of manure from fish.*

Dried peat, marl, clay, or plaster is mixed with fish pulp or pumice and the mixture ground, whereby effectual pulverizing is secured.

34,039—December 24, 1861. ST. J. O'DORIS. *Improvement in fertilizers.*

A mixture of coal ashes, 75 parts; animal manure, 15 parts; animal matter, 5 parts; and vegetable matter, 5 parts—all in bulk.

34,825—April 1, 1862. J. M. GALLACHER. *Improved fertilizing composition.*

A mixture of liquid animal matter, obtained by condensing the gases and vapors from the charring or burning of bones, with animal charcoal and sulphuric acid.

39,519—August 11, 1863. G. F. WILSON. *Improved fertilizer or manure.*

Bone sulphate of lime, the residue from the treatment of bone coal with sulphuric acid for the production of phosphate of lime, is mixed with the ammoniacal and other bodies condensed in the distillation of the bones.

41,331—January 19, 1864. E. VON NORDHAUSEN. *Improved artificial manure.*

The residuum of petroleum, known as "still bottoms," is crushed and mixed with slacked lime and a sulphate of lime produced, to which is added urine, producing a sulphate or ammonia, and the mass dried.

43,639—July 26, 1864. W. H. H. GLOVER. *Improved fertilizer.*

Muck is dried and mixed with the refuse water, gurry, etc., from the manufacture of fish oil.

46,847—March 14, 1865. W. D. HALL. *Improved manure.*

Lobster refuse is desiccated and pulverized.

46,957—March 21, 1865. J. B. TRIBBLE. *Improved composition for preventing disease in vegetables.*

A mixture of wood ashes, 3 pecks; slacked lime, 2 pecks; sulphur, 1 peck; and sodium chloride, 1 peck (per acre of land; a preventive of potato rot).

49,943—September 12, 1865. J. D. WHELPLEY. *Improved fertilizer.*

A mixture of finely pulverized feldspar, feldspathic granite, and other potash-bearing rock, with gypsum and bone or phosphate of lime.

50,940—November 14, 1865. O. LUGO. *Improved fertilizer.*

Leather treated with sulphuric or other acids, boiled, ground, and afterwards treated with urate of ammonia.

52,844—February 27, 1866. J. GOULD. *Improved fertilizer.*

Mixtures of gas lime, lime, salt, and animal and vegetable or vegeto-animal matter are fermented, whereby the carbolic acid and carbo-hydrogens of the gas lime are intimately combined with the lime.

55,871—June 26, 1866. J. AND A. HURSH. *Improved fertilizer.*

Ocher, either in a raw or burnt state, is used as a fertilizer.

61,870—February 5, 1867. F. C. RENNER. *Improved fertilizer.*

A mixture of rich earth, 1,600 pounds; saltpeter, 100 pounds; sulphate of ammonia, 200 pounds; and flour of raw bone, 100 pounds; the mixture being allowed to "sweat" in a heap.

64,602—May 7, 1867. W. VERMILYA. *Improved composition for invigorating fruit and forest trees.*

A mixture of sulphate of copper, 3 pounds; sulphur, 1 pound; saltpeter, 1 ounce; and iron filings, half a pound. A hole is bored near the root of the tree, and after inserting some of the mixture the hole is plugged.

66,357—July 2, 1867. P. G. KENNY. *Improved manure.*

Sulphate of iron is mixed with manure, and dissolved by urine passed through the mass. Aluminous earth may be spread on the pile above a sprinkling of iron sulphate.

66,650—July 9, 1867. J. A. THOMPSON. *Improved composition of matter for disinfecting and preparing fertilizers.*

Charcoal charged with sulphurous acid or other disinfecting or other gas is mixed with ground gypsum, as a disinfectant and deodorizer. It is mixed with animal and vegetable substances to form a fertilizer with or without the addition of common salt, wood ashes, bone dust, or other material.

67,335—July 30, 1867. J. K. MOORE. *Improved fertilizer.*

Powdered clam or oyster shells (not burnt) treated with acid.

67,450—August 6, 1867. H. E. POND. *Improved artificial fertilizer.*

Meadow muck is partially dried, then treated with sulphuric acid; lime is then added and mixed therewith, then a solution of potash, salt, and nitrate of soda, and finally superphosphate of lime, and the mass dried.

70,608—November 5, 1867. H. E. POND. *Improved fertilizer.*

Meadow muck is partially dried, then treated with sulphuric acid; sulphate of lime or gypsum is then mixed therewith, then a solution of nitrate of potash, salt, and nitrate of soda, and finally superphosphate or biphosphate of lime.

71,724—December 3, 1867. L. S. FALES. *Improved fertilizing compound.*

A mixture of sea sand, sulphate of ammonia, charcoal, bones, and dried blood.

71,725—December 5, 1867. L. S. FALES. *Improved fertilizer.*

A mixture of night soil treated with waste acid from petroleum refineries, charcoal—preferably that made from peat—sulphate of ammonia, pulverized bones, dried blood, and saltpeter.

72,026—December 10, 1867. W. C. GRIMES. *Improved fertilizer.*

Eight bushels of ground bone and 80 pounds of sulphate of ammonia are dissolved in 180 pounds of oil of vitriol, and 40 gallons of urine and 10 bushels of rich earth added, and the mixture dried.

74,799—February 25, 1868. J. COMMINS. *Improved mode of treating mineral phosphates for the manufacture of fertilizers.*

Phosphatic minerals or earths are heated to a red or white heat and saturated with a solution of sodium chloride while hot, to convert the insoluble phosphates into soluble mineral.

76,991—April 21, 1868. W. G. BUSEY. *Improved fertilizer.*

Six hundred pounds of Peruvian guano and 100 pounds of sodium chloride are mixed together and then mixed with 1,300 pounds of soluble superphosphate of lime, formed by treating carbonized bone with sulphuric acid.

77,667—May 5, 1868. A. SMITH. *Improvement in fertilizers.*

Cracklings reduced to powder are combined with phosphates.

77,840—May 12, 1868. J. S. RAMSBURG. *Improved fertilizer.*

One hundred pounds of calcined bone is mixed with 25 pounds of sulphate of ammonia and 3 gallons of hot water or barnyard liquor, and 25 pounds of sulphuric acid added to form an ammoniated superphosphate of lime, which while hot is mixed with 60 pounds of sulphate of soda, 125 pounds of sulphate of lime, and 150 pounds of slacked ashes or muck.

77,860—May 12, 1868. J. ALTHOUSE. *Improved fertilizer.*

Seven hundred pounds of air-slacked lime is mixed with 180 pounds of ground bone and 100 pounds of wood ashes, covered with a layer of ground plaster and wet with 320 pounds of urine, and allowed to stand for eight to twelve weeks, when it is mixed with 400 pounds of wheat bran and 300 pounds of hen dung.

79,160—June 23, 1868. D. A. TER HOEVEN. (*Reissue: 4052 and 4053—June 28, 1870.*) *Improvement in fertilizers.*

A fertilizer composed of horns, hoofs, or like animal matter; produced by steaming, drying, and crushing or grinding.

86,574—February 2, 1869. O. A. MOSES. *Improved prepared phosphate.*

South Carolina phosphates and marls are ground under water and separated according to their specific gravity and dried, thereby producing, as the finer material, nearly pure fertilizing phosphates.

88,443—March 30, 1869. S. A. BURKHOLDER and G. W. WILSON. *Improvement in fertilizers.*

A mixture of bone dust, 600 pounds; oil of vitriol, 200 pounds; sulphate, 100 pounds; sodium nitrate, 10 pounds; sodium chloride, 50 pounds; ground plaster or sulphate of lime, 300 pounds; wood ashes, 80 pounds; and 7 bushels of earth or sand.

88,466—March 30, 1869. L. S. FALES. *Improved fertilizer.*

A mixture of bones, leather scrap, and blood in sulphuric acid and water is subjected to the steam and ammoniacal vapors from a mixture of sulphate of ammonia, gas liquor, and slacked lime, the solid portion of the product drained and mixed with dry peat.

90,057—May 11, 1869. D. STEWART. *Improved phosphate fertilizing compound.*

Manures are produced from soluble silicates and phosphates by composting them with caustic alkalis, as by forming alternate layers of insoluble phosphates previously moistened with a saturated solution of crude potash and quicklime, and allowing the successive layers to slack as strata after strata is added. After cutting down and mixing, a handful of ground gypsum is added to each shovel of the compost.

91,667—June 22, 1869. F. C. RENNER. *Improved fertilizer.*

One thousand and fifty pounds of rich earth is mixed with 100 pounds of sulphate of ammonia and 50 pounds of saltpeter, and then incorporated with 300 pounds of bone dust, 100 pounds of salt cake, 200 pounds of Peruvian guano, and 200 pounds of plaster.

92,077—June 29, 1869. E. N. McKIMM AND H. W. BENDER. *Improved fertilizing compound.*

A mixture of earth, 1,000 pounds; sulphate of ammonia, 100 pounds; sodium chloride, 100 pounds; pearlash and sulphate of soda, each 25 pounds; together with ground bone, 400 pounds; Peruvian guano, 150 pounds; and ground plaster, 150 pounds.

92,810—July 20, 1869. R. FISH. *Improved fertilizer.*

A mixture of night soil, marl, peatashes, charcoal, copperas, salt, tobacco, gypsum, tincture of almonds, tincture of coffee, and coffee grounds.

97,169—November 23, 1869. B. R. CROASDALE. *Improved bags for guano, phosphates, and other fertilizers.*

They are coated inside with tar, pitch, or gum, and then inside and outside with a thin coat of crude petroleum or other oil.

97,939—December 14, 1869. O. LUGO. (*Reissue: 3,840—February 15, 1870.*) *Improved fertilizer or guano.*

An antiseptic fertilizer from fish or other animal matter, prepared by passing hot air downward through the material until about 90 per cent of the water is extracted, and then introducing, by means of a current of air, hydrocarbon and phenol (carbonic acid) vapors, followed by a blast of hot air to expel the remaining portion of water and hydrocarbon. The oils and fatty matters in solution with the hydrocarbon and surplus phenol are condensed.

99,255—January 25, 1870. I. W. SPEYER. *Improvement in fertilizers.*

The minerals obtained from the mines of Stassfurt, Prussia, chiefly sulphates and muriates of potash and magnesia, are pulverized, dissolved in boiling water, and crystallized out by cooling, for use as a manuring compound.

99,294—February 1, 1870. J. COMMINS. *Improvement in fertilizers.*

A mixture of 1 part, by measure, of gas-liquor and 3 parts of blood, is coagulated with one five-hundredth part of sulphuric acid, dried, and reduced to a powder.

99,452—February 1, 1870. O. LUGO. *Improvement in fertilizers or fish-guano.*

Fish are dried (without scorching or roasting) before decomposition sets in, so as to secure a highly nitrogenized product, pulverized and mixed with phosphates, etc.

99,978—February 15, 1870. A. VAN HAAGEN AND W. ADAMSON. *Improved fertilizer from glue residuum.*

Glue residuum is boiled in an alkaline solution, common salt added the soap product removed, and charcoal or plaster of paris or other fertilizing absorbent mixed with the mass.

100,163—February 22, 1870. O. LUGO. *Improvement in the manufacture of fertilizers from animal substances.*

An antiseptic fertilizer, prepared from animal matter by treating it with carbolic acid or phenol, in solution with suitable hydrocarbons or preferably in a state of vapors, with or without a current of hot air or gases.

100,629—March 8, 1870. H. A. HOGEL. *Improvement in treating blood for the preparation of fertilizers, and for other purposes.*

Coagulated blood, prepared by the action of steam, drained and pressed.

100,729—March 15, 1870. J. COMMINS. *Improvement in fertilizers.*

A fertilizer formed of gas-liquor, blood, and sulphuric acid, with dry ground phosphate of lime, mixed and evaporated to dryness.

101,131—March 22, 1870. H. A. HOGEL. *Improvement in fertilizers.*

The fat of dead animals is extracted with steam, and the flesh is subjected to heavy pressure, dried, and pulverized.

102,438—April 26, 1870. W. I. SAPP. *Improvement in the manufacture of fertilizers.*

A fertilizer made from silicated phosphates, produced by treating phosphatic guano or like material with soluble silicic acid or water glass, to render the phosphates soluble.

102,648—May 3, 1870. E. P. BAUGH. *Improvement in drying guano.*

Rock phosphate, or other material, is banked over grated flues for hot gases, so that they can penetrate the mass.

106,313—August 16, 1870. G. BOURGADE. *Improvement in compound for fertilizer.*

A mixture of blood and lime, formed by mixing slacked lime with the blood, adding water and heating at a low heat and subjecting the coagulated mass to pressure to expel the albumen.

106,626—August 23, 1870. T. SIM. *Improvement in the manufacture of fertilizers.*

Cottonseed residuum, or other matter, divested of oil by chemical means (as by bisulphide of carbon), is mixed with phosphate of lime.

107,878—October 4, 1870. J. COMMINS. *Improvement in the manufacture of fertilizers.*

Black salt-marsh grass (*Spartina glabia*), is chopped, macerated, and reduced to a pulpy mass, for use with phosphates or animal matter; it contains a large amount of nitrogen, 10 per cent of potash, and 8 per cent of soda.

108,369—October 18, 1870. J. M. LOEWENSTEIN. *Improvement in fertilizing compounds.*

Night soil is mixed with double the quantity of pulverized unslaked lime, subjected to pressure to express superfluous liquid, and is then treated with dilute sulphuric acid.

111,357—January 31, 1871. J. M. LOWENSTEIN. *Improvement in fertilizing compounds.*

A composition formed of night soil, sulphuric acid, bones or bone dust, and unslacked lime.

112,653—March 14, 1871. T. TAYLOR. *Improvement in fertilizers.*

A mixture of night soil with peat, clay, soluble silicates, a persalt of iron, and tincture of quassia.

114,133—April 25, 1871. W. B. HAMILTON. *Improvement in fertilizing compounds.*

A mixture of night soil, cotton-seed meal, salt, gypsum, and bone phosphate.

114,798—May 16, 1871. L. C. GIFFORD. *Improvement in compounds for preserving fruit trees.*

A mixture of 2 parts of calomel and 1 part of carbonate of soda, by weight, mixed dry.

118,987—September 12, 1871. U. S. TREAT. *Improvement in fertilizers from seaweed.*

Seaweed is reduced to a pulp by the action of steam under pressure and mixed in a mill with finely powdered quicklime.

119,994—October 17, 1871. D. W. PRESCOTT. *Improvement in the manufacture of soluble phosphates for fertilizers.*

A mixture of 1,600 pounds of bone dust and 300 pounds of soda ash is moistened thoroughly with water and allowed to remain in a heap for two weeks and then dried.

124,254—March 5, 1872. B. R. CROASDALE. *Improvement in bags for phosphates, etc.*

It is made of a textile fabric, as burlap, coated with roofing paper, which may be saturated with an acid-proof or waterproof substance.

124,413—March 5, 1872. J. R. WESTOVER. *Improvement in compounds for fruit trees, etc.*

A mixture of kerosene oil, 1 quart; fish oil, 1 pint; flour of sulphur, one-half pound; pulverized saltpeter, one-fourth pound, and 1 pint of water, as an insect destroyer and fertilizing compound.

125,927—April 23, 1872. J. R. BLACK. *Improvement in fertilizers.*

A mixture of stable manure and muck in equal parts is formed; and also a mixture of saltpeter 50 pounds, common salt 3 barrels, lime 3 barrels, and ashes 5 barrels; and a compost formed of alternate layers of the two mixtures, the latter mixture being one-fourth of the former.

125,939—April 23, 1872. J. M. DEERING. *Improvement in fertilizing compounds.*

Fish or lobster chum is mixed with material charged with carbolic acid, as tar water, ammoniacal water, or spent lime, spread and covered with dry earth, peat, or brick dust, then with air-slacked lime, then wet seaweed, then ground gypsum, and then dry earth or peat. The layers may be repeated, and the pile is allowed to slowly decompose.

126,418—May 7, 1872. T. SEWELL. *Improvement in compositions for deodorizing and preparing fertilizers.*

Ground peat charcoal is saturated with equal parts of carbolic acid and perchloride of manganese, and used in combination with clay, earth, or soil.

128,578—July 2, 1872. W. S. AMIES. *Improvement in artificial manures.*

Carbon and sulphate of iron are mixed in the proportions of from 1 to 5 parts of carbon to 1 part of sulphate of iron.

132,543—October 29, 1872. C. F. SMITH. *Improvement in compositions for renovating and invigorating apple trees.*

A mixture of pulverized blue vitriol, 4 parts; white chalk, 1 part, and iron scales, 1 part, all in bulk; applied by boring a hole to the center of the tree near the roots and filling it with the mixture.

138,458—April 29, 1873. J. WHITEHILL. *Improvement in fertilizers.*

For agricultural purposes caustic lime is ground to the state of sand.

143,213—September 23, 1873. J. B. WILSON. *Improvement in fertilizing soils.*

Pulverized anthracite coal, either with or without manure ingredients, is used as a fertilizer; it maintaining the soil in a moist condition.

143,310—September 30, 1873. J. J. STORER. *Improvement in fertilizers from offal.*

A fertilizer consisting of offal, tank-stuff, blood, etc., treated with burning gases directly in contact so as to impregnate the mass with soot and free carbon, and give a dark brown or almost black color to the product.

147,035—February 3, 1874. R. BIRDSALL. *Improvement in fertilizing compounds to be used to protect trees, etc.*

A mixture of 8 bushels of topsoil, 1 bushel of gas lime, 4 quarts of common salt, 2 quarts spirits of turpentine, 2 pounds of saltpeter, and 2 quarts of crude coal oil, with sufficient water to work into a homogeneous mass; afterwards dried.

149,243—March 31, 1874. C. PERRY. *Improvement in fertilizers.*

Malt, or grain, with the germinating principle destroyed, is used as a fertilizer or as an ingredient for a fertilizer and plant food.

149,244—March 31, 1874. G. J. POPPLEIN. (*Reissue: 7,296—September 5, 1876.*) *Improvement in fertilizers.*

A fertilizer containing tripoli, or consisting of tripoli and phosphate of lime, pulverized and intimately mixed.

149,472—April 7, 1874. J. H. GREEN. *Improvement in waterproofing compounds for guano bags, bales, etc.*

A composition for waterproofing bagging consists of rubber cement, linseed oil, benzine, zinc or white lead, magnesia, umber, flour bran or sawdust, litharge, and sulphur.

152,725—July 7, 1874. R. A. CHESEBROUGH. *Improvement in antiseptic fertilizers.*

A mixture of boneblack and hydrocarbon oil, say in the proportions of 70 per cent and 30 per cent. It should be mixed with an equal amount of earth.

152,921—July 14, 1874. S. D. SHEPARD. *Improvement in fertilizing compounds.*

A composition of peat, 120 pounds; fish oil, 15 gallons; and fish liver, from which the oil has been removed, 30 gallons.

153,477—July 28, 1874. B. R. CROASDALE. *Improvement in bags for phosphates, guano, etc.*

Bags of a textile fabric are saturated with hydrate of lime, dried, and then immersed in oil or oil and paraffine.

154,017—August 11, 1874. B. G. CARTER. *Improvement in fertilizing compounds.*

A mixture of Peruvian guano, 500 pounds; archilla guano, 300 pounds; dissolved bone, 200 pounds; wood ashes, 300 pounds; soda, 50 pounds; and ground plaster, 650 pounds.

155,341—September 22, 1874. G. E. E. SPARHAWK AND M. A. BALLARD. *Improvement in fertilizers.*

A mixture of 2¼ bushels each of air-slacked lime, wood ashes, hen guano, and soil; 1 bushel of salt, 200 pounds of gypsum, and 10 pounds of bone dust.

160,191—February 23, 1875. C. H. HOFFMANN. *Improvement in fertilizing compounds.*

A fertilizing liquid for germinating seeds, etc., produced by boiling a mixture of 3 gallons of liquid manure, 3 ounces of salt, and 2 ounces of saltpeter; dissolving therein three-quarters of a pound of unslacked lime; straining, and then adding one-half ounce each of crude petroleum and sulphur balsam.

171,857—January 4, 1876. ST. J. RAVENEL. *Improvement in fertilizers.*

Pulverized iron pyrites is mixed with ground phosphatic material.

173,621—February 15, 1876. A. G. GRIFFITH. *Improvement in fertilizers.*

One hundred pounds of horse manure is mixed with 80 to 100 pounds of sulphuric acid, and then 100 pounds each of bone dust and of archilla, curacoa or Mexican guano are mixed therewith.

174,568—March 7, 1876. G. J. POPPLEIN. (*Reissue: 8,187—April 16, 1878.*) *Improvement in fertilizers.*

An intimate mixture of tripoli or infusorial earth and potash or soda.

175,846—April 11, 1876. J. B. WILSON. *Improvement in composts.*

A pile is formed of layers of mud, muck or marl, manure or guano, and salt, with a dilute solution of sulphuric acid poured thereover, then a layer of lime, and a covering of sand or earth; the mass standing for thirty days or so, when it is thoroughly decomposed.

178,194—May 30, 1876. A. W. ROWLAND. *Improvement in fertilizers.*

A compound of wood ashes, cottonseed, earth, manure, sulphates of magnesia of soda, and of ammonia, sodium chloride, sodium nitrate, dissolved bone, and ground plaster.

191,476—May 29, 1877. H. SELIGMAN. *Improvement in deodorizing, disinfecting, and fertilizing compounds.*

A compound of mineral potash salt, as carnaillit, 70 parts; gypsum or other calcareous substance, 25 parts; and sulphuric acid, 5 parts.

193,890—August 7, 1877. C. F. PANKNIN. *Improvement in fertilizers.*

A fertilizing compound consisting of a comminuted mixture of 95 parts of phosphate of lime and 5 parts of sulphur.

203,674—May 14, 1878. B. J. TIMBY. *Improvement in compositions for protecting trees.*

A compound of 20 pounds of sulphur, 2 pounds of soot, and 900 balm-of-Gilead buds.

206,077—July 16, 1878. T. J. BOYKIN AND J. W. CARMER. *Improvement in fertilizers.*

A compound consisting of a mixture of dissolved bone, 3 bushels; ground plaster, 3 bushels; sodium nitrate and sodium sulphate, each 40 pounds; and ammonium sulphate, 33 pounds; to be incorporated with a suitable base. as dry peat or muck.

208,224—September 24, 1878. A. F. CROWELL. *Improvement in fertilizers.*

A fertilizer consisting of the waste nitrogenous and gelatinous fluid obtained in the process of extracting oil from fish, combined with the soluble portions of a superphosphate, the solution being concentrated or evaporated to dryness.

208,540—October 1, 1878. C. RICHARDSON. *Improvement in fertilizers.*

A fertilizer composed of hair or bristles in the form of fine powder, produced by treating them with live steam at, say, 90 pounds pressure, drying, and grinding.

209,980—November 19, 1878. A. PIRZ. *Improvement in fertilizers.*

A fertilizer composed of bone and artificial sulphate of lime (a waste product from the manufacture of acetic acid) in equal parts. The constituents are mixed with water and allowed to lie until the mass has become solid.

211,238—January 7, 1879. J. INGMANSON. *Improvement in fertilizers.*

A fertilizer composed of ground bone. 90 pounds; caustic lime, 10 pounds; mixed together with 5 pounds of oil of vitriol diluted with 5 gallons of water.

216,290—June 10, 1879. E. OSGOOD. *Improvement in compounds for preventing the destruction or rotting of bags, etc.*

A compound of beeswax and tallow, to which tar may be added, is applied to fertilizer bags.

232,756—September 28, 1880. H. M. POLLARD. *Fertilizer.*

A mixture of night soil and calcined plaster, in equal quantities, with umber in the proportion of 1 in 200 by weight, and sulphuric acid 1 in 25.

233,875—November 2, 1880. J. C. PERKINS. *Mixed phosphatic manure.*

A mixture of sulphuric acid, water, animal charcoal, bones, marl, coprolite, sugar scum, night soil, fish or fish refuse, hard-wood charcoal, castor pomace, hydrochloric acid, sulphate of lime, ashes from calcined leather, tobacco ashes, sodium nitrate, and ammonium sulphate.

234,782—November 23, 1880. B. JOHNSON AND W. P. GIDDINGS. *Fertilizer.*

A mixture of ground and unburned oyster shells, 100 pounds; common potash, 2 pounds; and carbonate of soda, 1 pound.

240,025—April 12, 1881. W. H. HUBBELL. *Fertilizer.*

A mixture of guano, 200 pounds; bone dust, 400 pounds; plaster, 800 pounds; and German potash, 200 pounds.

242,193—May 31, 1881. W. FIELDS. *Fertilizer.*

A composition of limestone, 500 pounds; feldspar, 1,000 pounds; oyster shells, 300 pounds, all unburned and ground fine; cast-iron scrapings and moldings from foundry, 200 pounds; water, 9 gallons; sulphuric acid, 2 gallons; and nitric acid, 1 pint.

246,121—August 23, 1881. L. GRAF. *Artificial manure.*

Produced by mixing an alkaline solution of leather scrap with lime or lime salts—such as sulphate or carbonate of lime—and with phosphate of lime, and then treating the mixture with sulphuric acid.

246,242—August 23, 1881. B. TERNE. *Treatment of tank waters of slaughterhouses, etc.*

Concentrated tank water is combined with sulphuric acid and used as a solvent for phosphatic substances in the manufacture of manures.

250,706—December 13, 1881. H. S. BRADLEY. *Compost.*

A mixture of 1,000 pounds each of stable manure and of swamp muck, 1 bushel of slacked lime, 8 pounds each of sulphate of ammonia and of sulphuric acid, and 1 pound of alum.

251,364—December 27, 1881. E. J. HOUSER. *Fertilizing compound.*

A mixture of cottonseed meal, 4 parts; dissolved bone, 3 parts; and German potash salts, 3 parts; by weight.

251,628—December 27, 1881. G. B. OAKES. *Manufacture of fish guano.*

A pulverized fertilizer composed of boiled fish refuse with 5 per cent of sulphuric acid, pulverized charcoal, finely ground gypsum or mineral phosphates, and salt to prevent fermentation.

253,971—February 21, 1882. I. BROWN. *Fertilizer.*

As a manure or an ingredient therefor, a solid mixture of sulphuric acid and gypsum, or peat or equivalent medium, denominated a "supersulphate."

253,991—February 21, 1882. I. ELSASSER. *Fertilizer.*

A mixture of bat guano, cottonseed meal, bone dust, and the shell known as *Gnathadon cuneata*, pulverized.

258,524—May 23, 1882. R. R. ZELL. *Fertilizer bag.*

A bag made acid proof by treatment with an aqueous solution formed of rosin soap, 100 parts by weight; alum, 5 parts; asbestos, 4 parts; and gelatine, 1 part.

263,907—September 5, 1882. W. H. HORNER AND F. HYDE. *Bag for holding phosphates, etc.*

Fertilizer bags are made acid proof by treatment with a composition of rosin, paraffine, or mineral oil, and soap or saponified grease.

268,314—November 28, 1882. W. D. STYRON. *Fertilizer compound.*

A compound known as the "Norfolk Fertilizer and Insecticide" is a mixture of sulphur, 25 pounds; saltpeter, 40 pounds; salt, 200 pounds; kainit, 200 pounds; bone phosphate, 40 pounds; and lime, 1,495 pounds.

269,704—December 26, 1882. D. E. PAYNTER. *Fertilizing compound.*

A compound of calcined gypsum, water, and mineral coal dust is burned, the ashes mixed with acidulated urine, and dried.

277,023—May 8, 1883. J. GOULD. *Fertilizer.*

A mixture of salicylic acid, gas lime from gas works using oyster-shell lime, animal matter (night soil or blood), vegetable matter (sumac, seaweed, or leaves), with salt, alum, and carbolic acid.

278,383—May 29, 1883. J. R. YOUNG, JR. *Fertilizer.*

A mixture of night soil, bone phosphate of lime, and sulphuric acid is evaporated to dryness after the resulting chemical action is complete.

278,384—May 29, 1883. J. R. YOUNG, JR. *Fertilizer.*

A mixture of night soil, 1,000 pounds; dry fish scrap, 400 pounds; and sulphuric acid, 175 pounds; dried.

278,480—May 29, 1883. J. R. YOUNG, JR. *Fertilizer.*

A mixture of night soil, 100 gallons; phosphatic guano, 400 pounds; and sulphuric acid, 75 pounds; evaporated to dryness after chemical action is complete.

281,840—July 24, 1883. W. J. COURTS. *Fertilizer.*

A mixture of dissolved raw bone, sulphates of aluminum, of ammonium, of iron, of magnesium, and of potash, sodium nitrate, kainit, and humus or rich dirt, in certain specified proportions.

283,508—August 14, 1883. T. WELLS. *Fertilizer.*

A mixture of carbonate of ammonia, 8 pounds; carbonate of soda, 12 pounds; salt, 50 pounds; wood ashes, 3 bushels; and stable manure, 20 bushels.

285,555—September 25, 1883. J. B. BECK. *Fertilizer.*

A mixture of bitter salt, limestone, plaster, sodium sulphate, ammonium sulphate, and potash.

290,633—December 18, 1883. A. EDWARDS. *Fertilizer for tobacco crops.*

A comminuted mixture of fresh horse manure, 1 ton, blood, 100 pounds or more; and potash, 100 pounds.

290,829—December 25, 1883. W. R. WILKINSON. *Fertilizer.*

A mixture of bone ash, 50 per cent; gypsum, 10 per cent; sulphate of iron, 5 per cent; sulphate of potash, 22½ per cent; and dried blood, 12½ per cent.

292,470—January 29, 1884. D. R. CASTLEMAN. *Fertilizer.*

A mixture of pulverized tobacco stems and prepared phosphate, in equal proportions.

298,939—May 20, 1884. B. C. BRIGGS. *Fertilizer.*

A mixture of 1 barrel each of bone meal and plaster; 2 barrels each of ashes, hen manure or guano, muck, and urine, and 1 bushel of salt.

307,718—November 4, 1884. L. HAAS. *Fertilizer.*

A mixture of furnace slag and sulphate of ammonia composed of liquid ammonia and sulphuric acid, to which is added limestone or oyster shells and ground bone, sodium nitrate, sodium chloride, sodium sulphate, and potash, with plaster.

308,397—November 25, 1884. J. R. YOUNG, Jr. *Fertilizer.*

A mixture of night soil, phosphate of lime, sulphuric acid, nitrogen compound (as ammonia), and potash.

317,010—May 5, 1885. W. S. PIERCE. *Phosphate fertilizer.*

A fertilizer is made from the insoluble phosphates of alumina, iron, lime, and other bases, by drying and pulverizing the raw material, mixing with it a certain quantity of sulphate of ammonia—sufficient to prevent the fertilizer from absorbing moisture—treating the mixture with strong sulphuric acid, and drying.

318,371—May 19, 1885. L. HAAS. *Fertilizer.*

A compound of furnace slag, oyster shells, charcoal, tan-bark waste, tobacco stems, broom-corn seed meal; sodium nitrate, sulphate, and chloride; diluted sulphuric acid or ammonia, plaster, ashes, phosphatic iron ores, phosphatic rock, ground slag, and kainit.

327,256—September 29, 1885. L. HAAS. *Fertilizer.*

A fertilizer and insect preventive, consisting of furnace slag, 70 per cent; salt, 10 per cent; ashes, 10 per cent; charcoal, 10 per cent; and water, with 5 per cent of acid.

330,075—November 10, 1885. A. E. WEMPLE. *Fertilizer.*

A mixture of bone flour, 50 per cent; sulphate of ammonia, 15 per cent; sodium nitrate, 15 per cent; potassium chloride, 5 per cent; magnesium sulphate, 5 per cent; and nitrogenous matter, as dried blood, 10 per cent.

341,968—May 18, 1886. J. VAN RUYMBEKE. *Fertilizer.*

A nonviscid and nondeliquescent fertilizer, consisting of concentrated and partially decomposed tank wastes, containing carbolic acid and other phenols without the addition or artificial mixture of said phenols; the product of No. 342,238.

345,507—July 13, 1886. W. W. HICKS. *Treatment of humus and muck.*

A mixture of calcined humus and muck, which has been changed and sweetened by the heat and gases of the said calcining.

346,024—July 20, 1886. H. H. COLQUITT. *Fertilizer.*

A mixture of the raw kernels of cottonseed with phosphoric rock or phosphate of lime.

349,289—September 14, 1886. P. VINSON. *Combined fertilizer and insecticide.*

A mixture of cattle dung, horse dung, sheep dung, fowl dung, blue vitriol, saltpeter, slacked lime, leached ashes, cayenne pepper, black pepper, ginger, mustard seed, and garlic.

353,210—November 23, 1886. D. W. DUDLEY. *Fertilizer.*

Equal quantities of bone meal and wood ashes are mixed and saturated with water and allowed to stand for about three weeks, then lime is slacked in brine and added to the mixture, and gypsum and salt in equal quantities are added to the mass.

367,732—August 2, 1887. J. VAN RUYMBEKE. *Fertilizer.*

Nitrogenous fertilizing material, consisting of the undecomposed coagulated albuminoids of concentrated tank waters freed from undue deliquescence and viscidity produced by rendering the gelatinous substances insoluble, as by the addition of sulphate of iron.

371,630—October 18, 1887. P. B. ROSE. *Tank-waste fertilizer.*

A fertilizer in a dry form consisting of tank waste incorporated with cellulose or lignine vegetable material, or paunch material taken from slaughtered animals.

372,087—October 25, 1887. J. REESE. *Phosphatic fertilizer.*

A fertilizer composed essentially of pulverized calcareous phosphatic basic slag; pulverized to an impalpable powder.

377,084—January 31, 1888. G. H. MURRAY. *Fertilizing composition.*

A compound of one-half pulverized tan bark, one-quarter distillery slop or animal excrement, and one-quarter common salt, slacked lime, and potash.

378,688—February 28, 1888. P. C. JENSEN. *Fertilizer.*

Tankage or tank-water residue is dried at a low temperature, broken up and mixed with unslacked lime, and the mixture thoroughly pulverized.

382,604—May 8, 1888. S. L. GOODALE. *Fertilizer.*

Crude mineral containing hydrated aluminic and ferric phosphates is pulverized and mixed with carbonaceous matter wet with sulphuric acid, and the mixture heated to a degree sufficient to expel the constituent water contained in the hydrated phosphate.

396,274—January 15, 1889. H. ENDEMANN. *Fertilizer.*

A fertilizer produced from tobacco, and having certain specified characteristics; product of process No. 404,348.

397,056—January 29, 1889. P. HOGAN. *Fertilizer.*

Composed of dissolved lignine from vegetable substances, and alkaline salts from the digesters in the manufacture of chemical fiber or similar works, in combination with peat, clay, lime, earth, or other absorbent matter.

407,240—July 16, 1889. N. B. POWTER. *Phosphatic fertilizer.*

A dry granular compound composed of phosphatic rock or earth containing over 10 per cent of alumina or iron, 1,000 pounds; sulphuric acid (60°), 500 pounds; and tank water containing about 20 per cent of animal matter, 750 pounds.

407,241—July 16, 1889. N. B. POWTER. *Phosphatic fertilizer.*

A dry fertilizing composition composed of Cayman Islands phosphatic rock, 800 pounds; 600 pounds of animal matter combined with not more than the same amount of water; 550 pounds of sulphuric acid (60°), and 50 pounds of carbonate of lime.

408,491—August 6, 1889. J. A. LIGHTHALL. *Fertilizer.*

Tobacco stems reduced to dry, granular charcoal.

415,246—November 19, 1889. J. J. HANSELMAN. *Liquid manure.*

It consists of water, sulphurous acid, soap, salt, lime, isinglass, spirits of ammonia, and the soluble parts of cow dung and guano.

432,091—July 15, 1890. J. D. SIMMONS. *Phosphatic fertilizer.*

A mixture of wood ashes, 6 parts; phosphate of lime, 9 parts; muriate of potash, 2 parts; pulverized sulphur, 2 parts; and sodium nitrate, 1 part; all by weight.

434,243—August 12, 1890. L. J. CARLILE AND G. B. RUMPH. *Combined fertilizer and insecticide.*

A composition of refuse tobacco, bran, cottonseed meal, paris green, powdered hellebore, arsenious oxide, and India berries (cocculus indicus).

438,859—October 21, 1890. J. PATTERSON. *Fertilizer.*

A mixture of caustic lime—unslacked when introduced—gypsum, rotten rock, common bog, sulphate of iron, salt, and water.

446,088—February 10, 1891. J. VAN RUYMBEKE. *Nitrogenous fertilizer.*

A fertilizing material consisting of "stick" and a soluble salt of iron or alumina made basic by the addition of lime thereto.

448,387—March 17, 1891. J. VAN RUYMBEKE. *Nitrogenous fertilizer.*

A dry pulverulent and practically nondeliquescent material consisting of a mixture of liquid stick, 1 ton, and ground, dried animal matter, 600 to 800 pounds, subjected to a heat not exceeding 380° F.

450,253—April 14, 1891. J. REESE. *Ammoniated phosphate.*

A fertilizer composed essentially of pulverized, calcareous, phosphatic, basic slag and salts of ammonia, such as sulphate of ammonia.

450,254—April 14, 1891. J. REESE. *Phosphatic fertilizer.*

A fertilizer composed essentially of pulverized, calcareous, phosphatic, basic slag and potassic material such as kainit, sulphate of potash, or muriate of potash.

450,255—April 14, 1891. J. REESE. *Phosphatic fertilizer.*

A mixture of pulverized, calcareous, phosphatic, basic slag, potash, and ammonia (such as the sulphate).

450,531—April 14, 1891. J. REESE. *Phosphatic fertilizer.*

A mixture of muriate of potash and pulverized, calcareous, phosphatic, basic slag.

453,749—June 9, 1891. J. VAN RUYMBEKE. *Phosphatic fertilizer.*

A fertilizer consisting of a metaphosphate prepared by submitting acidified rock to the action of a high degree of heat (No. 446,087), and stick loaded with about 15 per cent of carbonate of lime, mixed and allowed to stand until granulated.

453,750—June 9, 1891. J. VAN RUYMBEKE. *Phosphatic fertilizer.*

A mixture of iron or alumina acid phosphates and stick, subjected to the action of heat at or above 212° F. until it assumes a black color, when it will granulate.

462,476—November 3, 1891. C. W. DOUGHTY. *Fertilizer.*

A compound of ground and unburnt but dried carbonate of lime and human feces in equal proportions, and dried but unburnt gypsum in the proportion of 10 per cent of the carbonate of lime.

484,631—October 18, 1892. J. J. DUNNE. *Nitrogenous fertilizer and process of making the same.*

A fertilizing material, consisting of a bulky, flocculent, pulverulent, impalpable precipitate composed of coagulated nitrogenous albuminoids of tank waters combined with phosphatic material insoluble in water, but soluble in citrate of ammonia; produced by heating tank waters with phosphates and an acid, then treating with a neutralizing agent, separating the precipitated matter, and drying.

484,679—October 18, 1892. J. D. SIMMONS. *Fertilizing composition.*

A mixture of sulphuret of iron, 2 parts; sulphate of potash, 2 parts; wood ashes, 6 parts; and phosphate of lime, 10 parts, all by weight.

508,220—November 7, 1893. C. J. GREENSTREET. *Nitrogenous fertilizer and process of making same.*

A soluble salt of manganese—as black oxide of manganese—with or without the addition of basic ferric sulphate, is mixed with "stick" and evaporated to dryness.

517,486—April 3, 1894. S. B. SCHENCK. *Fertilizer.*

A fertilizer produced by boiling skins or their products or other like nitrogenous materials in sulphuric acid, to produce a jelly-like mass, and adding night soil, boneblack, and ground tobacco.

517,661—April 3, 1894. N. B. POWTER. *Phosphatic fertilizer.*

A dry, odorless fertilizing compound, consisting of substantially pure phosphate of alumina containing insoluble phosphoric acid mixed with slaughterhouse or other refuse, without the addition of acid; the product of No. 517,662.

522,561—July 3, 1894. E. GULICK. *Mineral fertilizer.*

A mixture of aluminous shale, 80 per cent, and wood charcoal, 20 per cent.

525,242—August 28, 1894. J. VAN RUYMBEKE. *Coagulant.*

A coagulant, formed by adding a boiling solution of an alkaline bichromate to a mixture of copperas and sulphuric acid.

536,283—March 26, 1895. J. W. HICKMAN. *Fertilizer.*

Composed of muriate of potash, black hellebore, sodium nitrate, paris green, superphosphate of lime, hydrocyanic acid, and ground bone.

537,822—April 23, 1895. C. J. GREENSTREET. *Fertilizer and process of making same.*

A nitrogenous fertilizer composed of solids of tank water combined with a soluble silicate, produced by adding an agent capable of neutralizing the silicate and retaining free ammonia (such as sulphuric acid), then adding a soluble silicate of an alkali and expelling the surplus water, and drying.

539,747—May 21, 1895. J. M. McCANDLESS AND J. F. ALLISON. *Fertilizer compound.*

A mixture of an acid phosphate, 1,200 pounds; dried blood, 100 pounds; cottonseed meal, 250 pounds; muriate of potash, 50 pounds; and ground graphitic schist, 400 pounds.

550,545—November 26, 1895. C. H. THOMPSON. *Fertilizing material and process of making same.*

Peat moss, or like fibrous or spongy material, is boiled in a weak solution of phosphoric acid together with a fertilizing composition—as soot, bone meal, and gypsum—and then strained and partially fermented.

576,848—February 9, 1897. P. HUFF. *Fertilizer.*

A composition, for protecting and fertilizing corn, of coal tar, brimstone, soft soap, saltpeter, lime, and plaster.

589,197—August 31, 1897. J. E. STEAD. *Phosphate and method of making same.*

A silico-phosphate, readily soluble in solvents existing in the soil, of the formula: $(CaO)_4\,P_2\,O_5 + CaO.\,SiO_2 = Ca_5\,P_2\,SiO_{12}$; capable of isolation in characteristic crystals in the form of a double salt; produced by melting normally insoluble phosphates with silicious and calcareous matter in proportion to yield compounds containing the ratio of 310 of tribasic phosphate of lime to between 58 and 116 of monosilicate of lime.

599,056—February 15, 1898. V. DOANE. *Insecticide.*

A composition of kainite, potassium nitrate, and white arsenic, the kainite being in excess; for destroying cranberry insects.

601,089—March 22, 1898. J. G. WIBORGH. *Phosphate and method of making same.*

A tetra-calcium-sodium (or potassium) phosphate, readily soluble in citrate of ammonia; produced by heating apatite to a red or yellow heat with matter containing sodium (or potassium) in proportion to yield a compound containing the ratio of about 426 of phosphoric acid to 560 of oxide of calcium, and from about 124 to 188 of oxide of sodium (or potassium).

619,633—February 14, 1899. C. H. THOMPSON. *Fertilizer and method of making same.*

A fermented fertilized material (which will serve as a substitute for earth), produced by dissolving phosphoric acid, potassium carbonate, and sodium nitrate in water; adding thereto a mixture of soot, gypsum, and bone meal with water; boiling therein a spongy or fibrous material as peat moss; straining; adding yeast and sugar or saccharine matter, and fermenting the product.

635,622—October 24, 1899. W. WARING AND J. E. BRECKENRIDGE. *Acid-proof bag for fertilizers.*

The bags are treated with an acetate, preferably acetate of lime.

639,805—December 26, 1899. J. H. BREWER. *Fertilizing compound.*

A solution of water, saltpeter, sal soda, bluestone, nitrate of ammonia, and potash, is sprinkled on stable manure, and then wood ashes, salt, lime, phosphate, cottonseed meats, and kainit is mixed therewith.

649,941—May 22, 1900. H. MEHNER. *Artificial fertilizer.*

A fertilizer containing as an essential ingredient silicon nitrides, which form ammonia with the acid reagents in the soil.

PROCESSES.

3,139—June 24, 1843. C. BAER AND J. GOULIART. *Improvement in making manure.*

Vegetable matter is formed into heaps, without previous immersion in lye (as according to the Jauffret method), and subsequently the lye is poured onto it.

12,480—March 6, 1855. R. C. DEMOLON AND G. A. C. THURNEYSSEN. *Improvement in treating fish for manure and oil.*

It is reduced to a dry powder, by steaming, expressing the oil, grating, desiccating, and pulverizing.

16,111—November 25, 1856. C. BICKELL. *Process of treating feldspar for a manure.*

Feldspar, either potash or soda feldspar, is decomposed by heating it with lime and phosphate of lime, to obtain potash or soda, either in the caustic or carbonated state, or for the purpose of obtaining a fertilizer.

16,882—March 24, 1857. L. REID. *Improvement in processes for preparing fertilizers.*

The liquid matter obtained from the treatment of animal matter with high pressure steam, after separation of the fat and pulpy matter, is treated with sulphuric acid, and neutralized with bone dust; then the solid matter properly ground is mixed therewith together with pulverized bones and dried clay, and the mass dried and ground.

17,237—May 5, 1857. C. STEARNS. *Improved process of preparing green-sand marl as a fertilizer of lands.*

The sand is washed with agitation to separate useless earthy matters, then disintegrated, with or without the admixture of animal matter, and then ammonia is added, in the form of ammonia sulphate or otherwise.

25,772—October 11, 1859. D. STEWART. *Improved method of preparing bones for fertilizing purposes.*

Bones are stratified in a heap along with animal, vegetable, and mineral matter, to effect decomposition, the order of stratification being old plaster; stable manure, etc.; bones, blood, etc.; stable manure, etc.; old plaster.

26,548—December 20, 1859. W. D. HALL. *Improvement in fertilizers.*

Fish is boiled in fresh water, drained, sprinkled with from 1 to 3 per cent of sulphuric acid, mixed, and dried.

35,417—May 27, 1862. L. HARPER. *Improvement in fertilizers.*

Phosphatic guano, which is deficient in soluble matter, is spread in moistened layers together with layers of nitrogenous matter and layers of sulphate of lime, sprinkled with sulphuric acid, and exposed to the sun, with turnings of the material.

38,040—March 31, 1863. L. D. GALE. *Improvement in treating phosphatic guanos.*

Animal matter is treated with acid, or its equivalent, to separate the nitrogenous matter from the oil; and a concentrated manure is formed by mixing animal matter so treated with pulverized gypsum and then with guano.

41,428—February 2, 1864. L. HARPER. *Improvement in restoring phosphatic guano.*

A portion of the phosphatic guano is nitrogenized by saturating it with animal broth or juice or urine, and dried; another portion is treated with sulphuric acid; and nitrogenous animal matter is treated with alkaline salts, sulphate of iron, and magnesium chloride; the three masses are then mixed in a heap and subjected to fermenting and heating for a month.

41,663—February 16, 1864. A. A. HAYES. *Improvement in restoring deammoniated guano.*

Common salt is mixed with the phosphate or guano and oil of vitriol diluted with water, animal secretion, or ammonia water. After the moist mixture begins to stiffen it is placed in a heap and mixed with animal matter sufficient to supply the required amount of ammonia and allowed to ferment until putrefaction ceases.

42,006—March 22, 1864. G. A. LIEBIG. *Improvement in treating and preparing Navassa guano.*

The larger particles, available for fertilizers, are separated out, and the finer material containing peroxide of iron, organic and indefined material, is used for paint and other uses.

43,466—July 12, 1864. W. ADAMSON. *Improved process of treating hair.*

Hair of hogs and other animals is dried and deodorized by subjecting it to the direct action of the products of combustion of coal or other fuel.

45,961—January 17, 1865. G. A. LIEBIG AND E. K. COOPER. *Improved process for manufacturing fertilizing phosphates.*

Navassa guano or other substances containing phosphate of iron or of alumina are made available for agricultural purposes by, first, treating with caustic lime or carbonate or sulphate of lime, giving a phosphate of lime convertible into superphosphate with sulphuric acid; second, treating with caustic or carbonate or sulphate of soda or potash; third, treating with silicic acid.

46,318—February 14, 1865. W. ADAMSON. (*Reissues; 2,114—November 28, 1865; Div. A 8,741* (*process*)*; Div. B 8,742* (*product*)*, June 10, 1879.*) *Improved method of treating offal.*

Animal offal is drained and dried by subjecting it to the direct action of the products of combustion, in a chamber, at one operation.

46,700—March 7, 1865. R. B. POTTS. *Improved process for treating Navassa guano.*

Superphosphate of lime is made from Navassa guano or all guano containing more than 6 per cent of iron and alumina, by sprinkling it with the requisite quantity of sulphuric acid while the mass is continually agitated.

47,610—May 9, 1865. E. P. BAUGH. *Improved mode of manufacturing superphosphate of lime.*

Bones and other offal or guano are fed into a closed or nearly closed tank, along with a stream of sulphuric acid, and therein thoroughly mixed; the product being continuously discharged from the bottom.

47,611—May 9, 1865. E. P. BAUGH. *Improved method of treating manure.*

Sewage, guano, etc., is dried by passing the products of combustion from a furnace through the material; the same being fed by traveling aprons across the current of hot gases.

47,941—May 30, 1865. R. B. FITTS. *Improved process for treating and compounding marl.*

Marl is treated with night soil in combination with sulphuric acid, and to the product there is added salt cake, gas lime, and animal charcoal.

49,831—September 5, 1865. G. A. LIEBIG. *Improvement in the manufacture of superphosphates.*

Sulphurous acid, or muriatic acid, or sodium chloride is used as a substitute for sulphuric acid in the production of a superphosphate from Navassa guano or other phosphatic compound.

49,891—September 12, 1865. F. KLETT. *Improvement in the manufacture of fertilizers.*

A mixture of feldspar, carbonate or hydrate of lime, fluoride of calcium, and phosphate of lime or iron is calcined at a red heat for about five hours, using 2 parts of the carbonate or hydrate of lime and 1 part of the phosphate of lime or iron for every 1 part of the feldspar and 2 parts of fluoride of calcium for every 1 part of alkali contained in the mineral.

52,863—February 27, 1866. A. AND E. LISTER. *Improvement in deodorizing offal*

Hot air and gases are forced into closed offal-drying chambers, and at the same time the gases, vapors, and exhalations are withdrawn therefrom and passed into the furnace.

54,635—May 8, 1866. J. WISTER. *Improved mode of grinding bones for manure, etc.*

Hard plaster is mixed with bones in grinding to facilitate the process and prevent gumming of the mill.

59,978—November 27, 1866. A. DE FIGANIÈRE. *Improvement in the manufacture of super-phosphates of lime.*

The powdered guano is brought into contact with a surface wet with sulphuric acid, as the surface of a revolving cylinder.

60,948—January 1, 1867. A. SMITH. *Improved fertilizer.*

Boiled animal matter is subjected to pressure, as in a hydraulic press, to preserve the fleshy matter from decomposition.

62,760—March 12, 1867. G. A. LEINAU. *Improvement in preparing fertilizers.*

Sod is banked up with quicklime, and after standing for some time blood, urine, domestic guano, and land plaster are successively applied or spread on the bank, and then spent charcoal is worked into the mass.

70,671—November 5, 1867. W. DE ZENG. *Improvement in the preparation of fertilizers.*

Finely pulverized slags of reducing and smelting furnaces are used in combination with acids and alkalis, as the waste acids of dyeworks, and also with urine, farm-house manure and other ammoniacal compounds.

71,689—December 3, 1867. J. W. BITNER. *Improvement in fertilizers.*

Manure is damp-rotted, then dried and pulverized.

75,325—March 10, 1868. G. F. WILSON. *Improvement in the manufacture of phosphatic fertilizers.*

A mixture of bones, bone ash or bone coal, and hot viscid niter or salt cake is treated in a revolving cylinder with hot water and steam under pressure.

75,326—March 10, 1868. G. F. WILSON. *Improvement in the preparation of bones for the manufacture of phosphoric acid and phosphates.*

To remove the cyanides, sulphides, and other organic compounds from bones which have been distilled according to No. 75,329. The bone-black material is heated in a muffle furnace and the material turned over from time to time until it assumes a uniform gray tint.

75,327—March 10, 1868. G. F. WILSON. *Improvement in the manufacture of phosphates for agricultural purposes.*

Bones are treated with water and oil of vitriol in a vat having a steam heating coil until the whole mass is reduced nearly or quite to dryness.

78,061—May 19, 1868. J. COMMINS. *Improved mode of treating mineral phosphates for the manufacture of fertilizers.*

Mineral or earthy or natural phosphates are heated and plunged into gas liquor, combined with sulphuric acid or other acid or salt. The phosphates may be first treated with a solution of sodium chloride.

78,730—June 9, 1868. L. S. FALES. *Improvement in the manufacture of fertilizers.*

Bones, blood, and highly nitrogenous material are treated with the waste acid from oil refineries and the vapors from waste ammoniacal water of gas works, and the mass reduced to a pasty consistency and cooled to a powder. This is mixed with blood digested with sulphuric acid and peat.

79,180—June 23, 1868. D. A. TER HOEVEN. (*Reissue: 4,052 and 4,053—June 28, 1870*). *Improvement in the manufacture of fertilizers.*

Horns, hoofs, or other animal matter of an equivalent character are steamed, dried, and crushed or ground.

88,223—March 23, 1869. A. SMITH. *Improved fertilizer.*

Refuse leather is steamed at about 75 pounds pressure for four to eight hours, dried and pulverized without the use of chemical agents. It may then be mixed with a phosphate.

90,328—May 18, 1869. G. F. WILSON. *Improved process of treating offal-gelatine and scrap for the manufacture of fertilizers.*

Offal-gelatine and scrap is treated with acid phosphate of lime concentrated and dried, and mixed with bone sulphate of lime, dried peat, gypsum, clay, etc.

90,367—May 25, 1869. W. LALOR. *Improved fertilizer.*

The refuse acid of petroleum-oil refineries is used instead of sulphuric acid in the conversion of bone into superphosphates.

92,744—July 20, 1869. J. G. NICKERSON. *Improved fertilizer from seaweed.*

Seaweed is cut into small pieces, dried, mixed with any of the fertilizing ingredients, and ground.

99,924—February 15, 1870. O. LUGO. *Improvement in the manufacture of fertilizers and in extracting oils and fats.*

Fish, offal, blood, and other animal matter is treated with sulphurous acid or with nitrous fumes and sulphurous acid, separate or in connection with hot air, steam, or gases of combustion.

100,457—March 1, 1870. C. U. SHEPARD, JR. *Improvement in preparing ammoniated sulphuric acid for the manufacture of fertilizers.*

Phosphatic material is treated with ammoniated sulphuric acid for the production of an ammoniated superphosphate, said acid being produced by treating ammoniacal water with lime or other liberating material, or by the liberation of ammonia from boneblack or other ammoniacal matter, and the absorption of the vapor by sulphuric acid in such proportions as to leave a part of the sulphuric acid uncombined.

102,689—May 3, 1870. O. LUGO. *Improvement in the manufacture of fertilizers and oil from fish.*

Fish is boiled, steamed, or cooked in acid or acid-salt solution to retain and bind the nitrogenous substances.

104,327—June 14, 1870. O. LUGO. *Improvement in manufacture of fertilizers from fish, etc.*

Fish liquor is treated with sulphuric acid, acid sulphates, hydrochloric acid, or pyroligneous acid, and may then be concentrated, either to dryness, forming a highly nitrogenized product, or partially concentrated and mixed with fish scrap or pomace previous to desiccation.

105,283—July 12, 1870. E. WHITLEY. *Improvement in the manufacture of fertilizers.*

Vegetable matter is burned under a covering of earth, so that the latter is impregnated with the gaseous products of combustion, and the earth and ashes are then mixed.

105,319—July 12, 1870. A. DUVALL. *Improvement in treating vitriolized phosphates.*

Pulverized crude phosphate mixed with sulphuric acid, in a semiliquid state, is run into a large bin, the heat generated in the mass keeping it in a state of ebullition and thoroughly mixing it. It also effects the evaporation of the water. The side of the bin is afterwards removed and the mass broken up.

108,909—November 1, 1870. C. P. HOUGHTON. *Improvement in the manufacture of fertilizers.*

Pulverized crude marl is treated with a solution of soda-ash, niter, and salt to correct its caustic qualities, and may be mixed with bones and Peruvian guano.

111,734—February 14, 1871. L. S. FALES. *Improvement in treating blood for the manufacture of fertilizers.*

Blood is treated with lime, soda, or potash, and acids and afterwards subjected to heat and agitation to evaporate its water.

111,851—February 14, 1871. W. B. JOHNS. *Improvement in treating bones, horns, hoofs, etc., for manufacture of fertilizers.*

They are desiccated and rendered friable by treating with steam in contact therewith, at the commencement of the operation, and then subjected to heat evolved from steam not in contact; in one continuous operation and in one vessel or apparatus.

111,910—February 21, 1871. J. J. CRAVEN. *Improvement in treating blood for the manufacture of fertilizers and ammoniacal salts.*

Dried salt cake—either the bisulphate or binitrate of soda—is mixed with blood and submitted to heat sufficient to dissolve the salt.

113,416—April 4, 1871. D. FORBES AND A. P. PRICE. *Improvement in the treatment of sewage and the manufacture of fertilizers.*

Natural phosphates of alumina are treated with the sulphuric acid or hydrochloric acid, or mixtures of the same, either with or without a base such as lime, and sewage is then treated with the product.

114,693—May 9, 1871. G. T. LEWIS. *Improvement in grinding phosphate substances.*

Mineral phosphates are ground with water, instead of grinding dry, to reduce them to extremely fine powder.

119,000—September 19, 1871. W. ADAMSON AND C. F. A. SIMONIN. (*Reissue: Div. A, 5610; Div. B, 5611; Div. C, 5612—October 21, 1873.*) *Improvement in treating offal, flesh, entrails, etc., for preservation of manure, etc.*

Animal oils and fats are extracted by means of hydrocarbon vapors in a closed vessel; the residue, deprived of its fatty constituents and retaining the ammonia, constitutes a fertilizer.

122,273—December 26, 1871. W. H. McNEILL. *Improvement in deodorizing the gases from lard boiling, etc.*

The vapors are subjected to the action of a disinfectant previous to passing to the condenser.

122,773—January 16, 1872. J. A. MANNING. *Improvement in processes for manufacturing fertilizers.*

The contents of vaults and cess pits is treated with 5 per cent of sulphuric acid, and then evaporated in tanks. Products of combustion passing over or in contact with the material are then forced, with the vapors, into a condenser; the carbureted hydrogen passing to a purifier and thence to a gas holder; the weak solution of ammonia treated for the manufacture of sulphate of ammonia; and the dry product for a fertilizer.

123,744—February 13, 1872. B. TANNER. *Improvement in the manufacture of superphosphates of lime.*

Slowly soluble superphosphate of lime; produced by heating a mixture of sulphate of lime and phosphate of soda or of potash, with or without water; or by treating lime or sulphate of lime with any of the forms of phosphate of soda or of potash; or with phosphoric acid and sodium or potassium chloride, or equivalent agents. Soda or potash in a caustic condition, or in combination with an acid, are produced as by-products.

124,041—February 27, 1872. J. E. DOTCH. *Improvement in deodorizing and fertilizing materials.*

Pulverized clay, argillaceous earth, and clay marl is treated with sulphomuriatic acid and then mixed with night soil, etc. Clay thus treated may be mixed with coal ashes, coke, or gas-house silt, as a disinfecting substitute for dry earth.

124,901—March 26, 1872. J. M. LOEWENSTEIN. *Improvement in deodorizing and fertilizing compounds.*

Dilute sulphuric acid is neutralized with caustic or carbonate of lime, and then equal quantities of peat, charcoal, sand, carbolic acid, clay, common salt, and river sediment are added; the composition to be used in a dry state to deodorize night soil.

124,964—March 26, 1872. M. B. MANWARING AND R. DE WITT BIRCH. *Improvement in the manufacture of potash and phosphate of lime.*

See Group III, Potash.

125,017—March 26, 1872. S. BROWN. *Improvement in preparing fertilizing materials from earth, etc.*

A fertilizer composed of burnt earth and wood ashes, prepared by charging and burning a kiln with alternate layers of wood and earth.

125,074—March 26, 1872. H. H. PARISH. *Improvement in treating sewage for fertilizers, etc.*

A mixture of retorted charcoal (the product of pyroligneous-acid works), 1 part, and slacked lime, 2 parts, is mixed with sewage to deodorize and convert into manure.

125,112—March 26, 1872. M. J. STEIN. *Improvement in rendering animal matters and drying and pulverizing the same.*

A fertilizer derived from the treatment of animal matters in a confined condition, the material not coming in contact with the air at any stage of the process.

125,343—April 2, 1872. A. SMITH. *Improvement in apparatus for pulverizing animal matters for fertilizers.*

Animal matter is desiccated and pulverized by triturating the same in a hot chamber in a revolving cylinder, mixed with hard substances, as pieces of iron or stones.

125,613—April 9, 1872. N. A. PRATT. *Improvement in treating phosphates of lime for the manufacture of fertilizers.*

Crude phosphates treated with sulphuric acid are at once subjected to hydraulic or other pressure to extract the soluble phosphates. The liquor, and a thin smooth paste of lime, are heated to about 180° F. and one poured into the other in such proportions as to neutralize, and boiled and stirred until the phosphate of lime is precipitated, when it is compressed into cakes.

126,904—May 21, 1872. N. A. PRATT AND G. T. LEWIS. *Improvement in the treatment of phosphates for the manufacture of fertilizers, etc.*

Crude phosphate is ground with acid and water, and the product pressed in bags, to obtain the phosphoric extract, which extract is then ground with lime, magnesia, or other base, or their salts to produce an artificial phosphate.

127,670—June 4, 1872. M. J. STEIN. *Improvment in drying and deodorizing animal matters, oils, etc.*

The vapors and gases are exhausted from the heating chamber or vessel as fast as generated.

128,454—July 2, 1872. H. C. BABCOCK. *Improvement in baling manures.*

It is formed and pressed into bales, either with or without embedded handles.

129,517—July 16, 1872. E. P. AND D. BAUGH. *Improvement in the treatment of horns, hoofs, and other organic matter.*

Exhaust steam is passed through a mass of horns, hoofs, bones, or other organic offal preparatory to grinding (steam, under pressure, having a tendency to force in the glutinous constituents and obstruct the trituration).

128,752—July 9, 1872. N. A. PRATT AND G. T. LEWIS. *Improvement in treating phosphatic rock, etc.*

The phosphatic extract of No. 126,904 is evaporated to dryness, alone or mixed with salts of soda, potash, magnesia, or ammonia; or such mixtures are calcined to produce compound phosphates of lime and of the alkalis. It may be mixed with other fertilizing components.

130,616—August 20, 1872. H. C. BABCOCK. *Improvement in preparing manure for transportation, storage, or market.*

The straw is eliminated and the residuum is compressed into a bale, and may be covered with a coating of clay, cement, or the like.

131,131—September 3, 1872. J. J. STORER. (*Reissue: 5,703—December 23, 1873.*) *Improvement in processes and apparatus for deodorizing and destroying the gases from offal-treating establishments.*

The gases are deodorized by passing them through an independently heated furnace, flue, or other heat-radiating chamber; also by contact with burning coke, charcoal, or coal, or a blast of fine pulverized fuel.

132,498—October 22, 1872. J. J. STORER. *Improvement in treating offal so as to produce fertilizers and destroy offensive gases and vapors.*

Animal refuse is treated in a reverberatory furnace, the steam being drawn off through hot-wall flues and passed through burning fuel, or into the fireplace or stack.

133,404—November 26, 1872. L. W. BOYNTON. *Improvement in preparing manures for transportation.*

Peat is mixed with manure and compressed to concentrate and exclude the atmosphere, and may then receive a waterproofing coat of soft clay.

135,383—January 28, 1873. J. J. STORER. *Improvement in treating offal and manufacturing fertilizers.*

Offal and blood are dried in a cylinder by passing the flame of pulverized fuel and other products of combustion through the cylinder directly over or in contact with the material.

135,995—February 18, 1873. J. McDOUGALL. *Improvement in fertilizers.*

Ammonia gases or vapors arising from the destructive distillation of carbonaceous or ammoniacal substances or from gas liquor are caused to be absorbed by an acid phosphate of lime, the latter being made porous, if need be, by an admixture of sawdust or porous material. Sulphuric acid may be added to the product to render the phosphate again soluble.

136,036—February 18, 1873. W. D. CRAVEN. *Improvement in preparing blood for fertilizers.*

Blood is injected or introduced directly upon the heated walls of a vessel or chamber, whereby immediate dehydration is produced.

137,969—April 15, 1873. E. C. C. STANFORD. *Improvement in deodorizing animal matters for fertilizers, etc.*

Solid or liquid matter, as excreta, is deodorized by subjecting the same to the action of granulated charcoal (preferably seaweed charcoal), alone or mixed with earthy matter; the charcoal being recovered and revivified.

138,250—April 29, 1873. F. HILLÉ. *Improvement in the treatment of sewage.*

Sewage is treated with lime, chloride of zinc, and the chloride of magnesium, and the solid and liquid constituents separated by deposition and filtration. The precipitate is mixed with the spent filtering materials (charcoal) and dried for fertilizer.

140,391—July 1, 1873. J. TURNER. (*Reissue: 5845—April 21, 1874.*) *Improvement in treating offal and manufacturing gas.*

The gases are separated from the moisture and carbureted.

140,559—July 1, 1873. B. TANNER. *Improvement in the manufacture of superphosphate of lime.*

A chemical examination is made of a calcic phosphate solution, and if the phosphoric acid and lime or calcium are present in the proportion of 71 parts of phosphoric acid for 28 parts of lime or 20 parts of calcium, it is evaporated to dryness and the heat maintained until the final decomposition is complete. If the lime or calcium is in excess the solution is treated with sulphuric or oxalic acid in a specified manner, or phosphoric acid is added to balance the lime; if phosphoric acid is in excess, lime in proper proportion is added.

141,848—August 19, 1873. A. F. ANDREWS. *Improvement in fertilizers.*

Tank stuff or animal matter is mixed with about one-third the quantity of unslacked lime, either with or without the addition of sodium chloride or calcium chloride, and subjected to agitation in a mixer, which is externally heated, and reduced to a dry condition.

141,853—August 19, 1873. C. C. COLE. *Improvement in drying and disintegrating animal matters.*

Blood and animal matter is mixed with from 5 to 10 per cent of dry quicklime and partially dried, and then from 2 to 5 per cent of sulphuric acid is added and the drying finished.

144,877—November 25, 1873. H. STEVENS. *Improvement in the manufacture of fertilizers.*

After the rendition of fatty matter from animal matter, the remaining liquor is evaporated to a sirup, and then mixed with the solid animal matter and plaster of paris, forming a friable mass.

146,285—January 6, 1874. B. F. SHAW. *Improvement in treating waste liquors of slaughterhouses to produce fertilizers.*

The washings, scrubbings, and waste liquors are defecated by cooling to a point at which blood will not coagulate, adding a quantity of blood and thoroughly mixing and boiling for a few minutes, with or without the prior addition of charcoal or the addition of chemical reagents.

149,038—March 31, 1874. A. HERBERT. *Improvement in methods of analyzing soils.*

Ten experimental plats of homogeneous land are planted in like manner, using a fertilizer formed from nine ingredients of plant food, one plat with the complete manure, and each of the others with the complete manure less one of the ingredients, whereby the fertilizer required in that soil for perfect plant growth is ascertained.

151,905—June 9, 1864. G. E. NOYES. *Improvement in the manufacture of fertilizers from night soil.*

Night soil is mixed with hydraulic cement or calcined plaster, and sprinkled with sulphuric acid, to form solid bricks or lumps.

152,389—June 23, 1874. H. A. P. LISSAGARAY. *Improvement in fertilizers.*

Blood is converted into an imputrescible fertilizer by treatment with an alkaline sulphite or its equivalent, and then adding sulphuric acid in constant and regulated quantities. The apparatus is also claimed.

154,092—August 11, 1874. H. Y. D. SCOTT. *Improvement in the manufacture of fertilizers from sewage.*

Process of deodorizing excreta and urinous liquors by separating the solids from the liquids by the use of charcoal, dried earth, sawdust, or like material, and then extracting the phosphoric acid and nitrogen from the liquids by lime or hydrated phosphate of magnesia.

154,093—August 11, 1874. H. Y. D. SCOTT. *Improvement in treating sewage.*

Quicklime is added to sewage water, in any of the modes usually practiced, and the precipitate calcined to obtain useful and marketable products.

155,517—September 29, 1874. E. H. HUCH. *Improvement in treating blood.*

Blood is treated with pulverized unslacked lime, and the gelatinous mass dried. It may be mixed with boneblack and used as a manure, or with flour or other farinaceous substance as an article of food.

158,772—January 19, 1875. B. ACKERMAN. *Improvement in the preparation of fertilizers.*

Excrementary matter and straw or litter is baled in rectangular form, the lines of band compression, when the bales are corded up, forming ventilating grooves.

161,827—April 6, 1875. S. SEITZ. *Improvement in fertilizers.*

Oyster shells, as a base fertilizer, are scorched and dried, so as to render them friable, without decomposing the nitrogenous matter connected with them, and then ground.

163,099—May 11, 1875. T. MYERSON. *Improvement in processes of treating blood for the manufacture of manures.*

Blood is treated with a salt of alumina—as the sulphate or double sulphate of alumina and ammonia—to retain the ammonia.

165,172—July 6, 1875. C. H. NORTH. *Improvement in fertilizers.*

The soup obtained from rendering offal, after the water is nearly all evaporated, is treated to a heat of about 300° F. for about four hours, forming a brittle and soluble fertilizer product without deliquescence.

165,345—July 6, 1875. O. LUGO. *Improvement in fertilizers.*

Coagulated, granular, pulverulent blood combined with antiseptics, is prepared by breaking it up with agitation, coagulating with heat, and removing the free water by centrifugal action. The antiseptic is preferably added after the disintegration of the clots (though it may be incorporated before) or to the finished product.

172,590—January 25, 1876. L. STOCKBRIDGE. *Improvement in processes of manufacturing fertilizers.*

Salts containing nitrogen, potash, and phosphoric acid are compounded—and these elements with lime and magnesia for cotton and tobacco—in the proportions in which they are taken up by the crop, as shown by an analysis of the plants, and in amounts requisite to produce any desired amount of crop within certain limits.

183,242—October 10, 1876. R. R. ZELL. *Improvement in processes and apparatus for manufacturing fertilizers from night soil.*

The night soil is separated into watery and semifluid bodies, and the ammonia vapor distilled from the watery constituent and incorporated with the semifluid mass or base of the fertilizing compound after the treatment of the latter with sulphuric acid, for the purpose of fixing the ammonia.

186,204—January 16, 1877. S. L. GOODALE. *Improvement in processes of treating fish scrap.*

Fish or fish scrap is washed subsequent to its being cooked (preferably after cooking, draining, and once pressing), and before it is finally pressed; whereby gelatine is removed, the yield of oil increased, and the subsequent drying of the scrap facilitated.

196,881—November 6, 1877. P. G. L. G. DESIGNOLLE. *Improvement in treatment of mineral phosphates.*

Poor mineral phosphates are enriched, carbonate of lime eliminated, and also tribasic phosphate of lime transformed into monobasic phosphate in solution by the use of sulphurous acid, either in closed or open vessels. The monobasic phosphate of lime so obtained is concentrated to 45° to 50° Baumé and mixed with sufficient plaster of paris to absorb excess of water and solidify the mass.

206,158—July 16, 1878. H. WIESINGER AND L. RISSMÜLLER. *Improvement in treating rags for obtaining paper stock and fertilizers.*

Woolen and half-woolen rags, hair, etc., are subjected to the action of hot limewater to disintegrate the animal fiber, and then dried. The nitrogenous powder is then separated from the unchanged cellulose, for use in the manufacture of fertilizers.

209,445—October 29, 1878. E. P. BAUGH. *Improvement in the treatment of offal for fertilizers.*

The residuum of fat-rendering tanks is agitated and exposed to heat during agitation, after leaving the main rendering tank and before it is subjected to pressure.

216,816—June 24, 1879. W. ADAMSON. *Improvement in methods of treating bones for glue stock.*

Bones are first subjected to the action of hydrocarbons, liquid or vapor, to extract fat and oily matter, and then to the usual acid treatment.

221,232—November 4, 1879. J. M. HIRSH. *Improvement in processes and apparatus for deodorizing and disinfecting.*

The noxious gases are converted into salts by contact with a liquid composed of metallic salts in solution mixed with a solution of organic salts—as the nitrates of iron and the salts of the phenyl, xylol, cresyl, etc., series. The apparatus is claimed.

228,387—June 1, 1880. W. PLUMER. *Process and apparatus for the manufacture of fertilizers.*

Night soil is heated to desiccate it and expel its noxious vapors; antiseptic vapor, as carbolic acid, is mingled with the desiccated material, and the free ammonia is fixed as crude sulphate of ammonia and mixed with the disinfected desiccated material to complete the fertilizer.

228,955—June 15, 1880. B. TERNE. *Treatment of sewerage.*

A solution for disinfecting and precipitating tank and sewage waters, consisting of water containing superphosphate of lime and tannic or gallic acid.

229,955—July 13, 1880. J. H. CHAMBERS. *Manufacture of an improved fertilizer from stable manure.*

Stable manure is rotted by subjecting it to a moderate heat in a closed chamber with moistening at intervals. The chamber is provided with a steam coil and a steam inlet pipe.

236,763—January 18, 1881. F. J. BOLTON AND J. A. WANKLYN. *Process of manufacturing artificial manures.*

Urine is evaporated at about 212° F., with a small proportion of charcoal, soot, burned bones, or other charred absorbent material, and the solid constituents obtained in a condition suitable for manure.

238,133—February 22, 1881. G. T. LEWIS. *Manufacture of fertilizers.*

Pulverized bone phosphate or other insoluble phosphates are mixed with coarsely powdered pyrites, and exposed to the action of atmospheric oxygen and moisture for several months.

238,240—March 1, 1881. J. M. & J. LIPPINCOTT. *Fertilizer.*

Slag or scoria from blast furnaces for the manufacture of pig iron from iron ores—preferably the nonvitreous or gray slag—is pulverized and used as a base in the manufacture of fertilizers.

241,465—May 10, 1881. R. WERDERMANN. *Manufacture of fertilizers from blood*

A rich nitrogenous product is produced by adding lime to fresh blood, agitating the mixture, precipitating the lime by settling, and finally drying the coagulated blood.

241,868—May 24, 1881. G. A. LIEBIG. *Treating phosphates for fertilizers.*

A calcined mineral phosphate, produced by mixing phosphates or phosphorites with coal or charcoal and subjecting it to a great heat, the phosphoric acid formed, though insoluble in water, being available for plant food.

242,777—June 14, 1881. A. J. HUET. *Treatment of animal and vegetable substances for the manufacture of fertilizers, etc.*

A solution of magma of lava resulting from treating lava with acid, alunite calcined with chloride of potassium, and lime mixed with oxidized oil of tar, to preserve and disinfect and destroy germs.

247,579—September 27, 1881. W. PLUMER. *Process of and apparatus for manufacturing and desiccating animal and vegetable substances.*

The material is subdivided and passed through heated retorts into receptacles, the gases and vapors generated being carried off by a blast of air through a pipe connected with the retorts, but without actual contact with the material treated, the material being cooled and aerated by another blast of air after leaving the retorts.

252,029—January 10, 1882. J. F. GIBBONS AND G. A. LIEBIG. *Treating phosphates for fertilizers.*

A phosphatic fertilizing compound consisting of superphosphates combined with acid salts of alkalis and lime; produced by mixing crude ferruginous or aluminous phosphates with salts of soda, potash, or magnesia, and carbonaceous matter, burning or calcining, and then mixing the product with an acid.

258,737—May 30, 1882. C. L. FLEISCHMANN. *Treatment of prairie soil to obtain useful products therefrom.*

Rich prairie soils are exposed to the heat of combustion and sublimation, and the products treated by purification and lixiviation to extract the alkaline, carbonaceous, and nitrogenous matter.

259,140—June 6, 1882. F. L. HARRIS. *Manufacture of fertilizing material.*

Two or more charges of bone, horns, or hoofs are successively boiled in the same water in a closed vessel under pressure, removed and dried, then a suitable quantity of the material thus treated is soaked in the liquor to absorb the gelatine contained therein, and it is finally dried and pulverized.

259,202—June 6, 1882. F. PETRI. *Method of and means for treating sewage.*

The solid substances are eliminated; the liquid passed through an absorbent filtering and antiseptic material, then again filtered, then acidulated or a chloride is mixed therewith; the acid or chloride is then eliminated or neutralized, and finally the neutralizing agent is eliminated by filtration.

260,165—June 27, 1882. H. COLLET. *Treatment of excreta for the production of fertilizing substances.*

Solid and liquid constituents of excreta are separated and the solid ingredients collected as a scum by the application of "nitriolic powder;" the latter formed by treating sulphate of iron with nitric acid and sulphuric acid, and the sulphate of sesquioxide of iron thus formed is mixed with clay or argillaceous earth.

261,038—July 11, 1882. A. F. POULLAIN-DUMESNIL. *Special fertilizer for plants.*

A fibrous absorbent material, such as moss, is wetted with an adhesive fluid (as milk) impregnated with a fertilizing substance in the state of an impalpable powder (as the phosphates and nitrogenous substances), and then dried.

263,322—August 29, 1882. A. F. CROWELL. *Manufacture of fertilizers.*

Fish and superphosphate—say in the proportion of 6 of the former to 1 of the latter by weight—are cooked together, and then subjected to pressure; the oil being separated and the gelatinous, nitrogenous, and phosphatic liquid used as a fertilizing material.

269,487—December 19, 1882. B. TERNE. *Utilizing tank waters of slaughterhouses.*

Tank waters are concentrated, mixed with animal charcoal, and dried.

276,143—April 17, 1883. J. J. KNIGHT. *Preparation and production of mineral phosphates.*

Mineral phosphates containing alumina and oxides of iron are subjected to the action of strong sulphuric acid of 1.70 specific gravity, equal to 140° Twaddle, or upward, in excess; by means of which the sulphates of alumina and iron produced are rendered insoluble, while the phosphoric acid is rendered soluble, and can be separated out.

279,445—June 12, 1883. C. SCHEIBLER. *Obtaining phosphatic fertilizers from basic iron slag.*

Slags obtained in the dephosphorization of iron are powdered, roasted by an oxidizing flame, treated with muriatic acid, the quantity being sufficient only for dissolving caustic lime and magnesia, together with the silicates and the phosphates thereof, while its dilution is such as is attained by adding at least 9 parts of water to 1 part of the acid of commerce of 21° Baumé, and the phosphate of lime or magnesia finally precipitated by adding to the liquor, separated from the residue, caustic lime or magnesia (or the carbonates may be used).

280,320—June 26, 1883. C. J. F. R. DE JANNEL MENARD AND H. J. E. HENNEBUTTE. *Manufacture of fertilizers.*

Sewage is agitated or mixed with chloride or sulphate of zinc and subsequently with a salt of alumina (preferably impure sulphate), filtered, and the residue dried.

281,635—July 17, 1883. A. H. KOEFOED AND T. B. STILLMAN. *Method of treating phosphates of iron and alumina.*

Insoluble phosphates are powdered and mixed with powdered dolomite or limestone, the mixture calcined, then pulverized and treated with a mineral acid.

283,426—August 21, 1883. E. A. SCRIBNER. *Process of manufacturing artificial fertilizers.*

A small percentage of sulphur is mixed with phosphates of iron and alumina and the mixture roasted.

283,427—August 21, 1883. E. A. SCRIBNER. *Process of manufacturing artificial fertilizers.*

Mineral phosphates are ground and roasted, and the vapor of sulphur or sulphurous anhydride is forced through the mineral while roasting.

284,674—September 11, 1883. G. ROCOUR. *Process of treating phosphatic slags for manure, etc.*

The phosphate of iron in phosphatic slag is reduced by roasting into a phosphide, and the latter is then converted into a soluble alkaline phosphate by oxidation with a sulphate of sodium or potassium, carbon, and sulphur or iron pyrites.

285,187—September 18, 1883. T. G. WALKER. *Offal drier.*

The offal is forced by a current of steam, and in the presence of a current of air, through a heated coil; the process being continuous.

301,248—July 1, 1884. G. A. LIEBIG AND J. F. GIBBONS. *Treating phosphates of alumina and iron.*

Mineral phosphates containing iron or alumina are treated with dilute acid of a strength between 32° and 47°, according to the amount of water contained in the phosphorite.

301,406—July 1, 1884. S. G. THOMAS. *Manufacture of alkaline phosphates.*

Phosphate of soda or potash is obtained by treating their chlorides in a basic Siemens furnace or Bessemer converter in the presence of oxygen and superheated steam, or other hydrogen-supplying substance, with molten phosphoric iron and atmospheric oxygen or oxide of iron.

301,407—July 1, 1884. S. G. THOMAS. *Manufacture of alkaline phosphates.*

Soluble alkaline phosphates are manufactured from phosphoric nonsilicious molten pig iron in a basic-lined Siemens furnace or Bessemer converter, by pouring the molten metal upon alkaline carbonate (covered with an iron casing or plate, or with limestone or oxide of iron to prevent too rapid volatilization of the carbonate before the acid has decomposed it), turning on the blast, and with the blast introducing a further quantity of the carbonate, the alkali rising through the bath, and combining with the nascent phosphoric and silicic acids and forming a slag of phosphate and silicate of soda and potash; running off the slag; lixiviating it; and evaporating or precipitating with milk of lime.

302,266—July 22, 1884. G. A. LIEBIG AND J. F. GIBBONS. *Treating phosphates for fertilizers.*

Mineral phosphates containing iron or alumina are treated with dilute acid of 32° to 47°, and then salts of ammonia or potash. Preferably the sulphates are added, producing a fertilizer consisting of soluble and available phosphate of iron, soluble and available phosphate of alumina, and alum.

303,571—August 12, 1884. F. L. HARRIS. *Manufacture of fertilizing materials.*

Phosphates, mineral and phosphatic guanos, marine and oyster shells, lime-bearing and other substances are placed in a closed vessel with enriched liquor from animal substances, and heated to 250° to 320° F., or higher, after which the material is dried and broken up.

305,249—September 16, 1884. T. B. STILLMAN AND A. H. KOEFOED. *Method of treating phosphates for fertilizers.*

Insoluble phosphates are broken into pieces (not powdered as in No. 281,635), and mixed with dolomite or limestone, also broken into pieces, roasted, pulverized, and treated with a mineral acid.

318,826—May 26, 1885. W. G. STRYPE. *Process of preparing dried blood.*

A solution of sulphate of alumina or alum is added to blood—say 1 part in 50—and the blood finally dried.

324,103—August 11, 1885. C. GIBSON. *Process of making a fertilizer from tank waters.*

Acid sulphate of an alkali, aluminous cake, or sulphate of alumina is added to the tank waters (say in quantity equal to one-fourth of the contained solids), the excess of water evaporated, and a carbonate, oxide, or hydrate of an alkali or alkaline earth added to the residue (say 10 per cent of the original contained solids), and the mass cooled and ground.

342,238—May 18, 1886. J. VAN RUYMBEKE. *Process of making a fertilizer from tank wastes.*

The wastes are evaporated to about 20 per cent of moisture and then distilled at about 460° F., producing a nonviscid and nondeliquescent product. (No. 341,963.)

342,417—May 25, 1886. E. A. BECKER. *Process of making a fertilizer from tank waste.*

Wet or pressed tankage is mixed with sulphuric acid in quantities proportioned to the contained phosphates; then tank water or tank liquor is added, and the mixture dried.

345,625—July 13, 1886. J. J. DUNNE. *Process of making phosphates.*

Fertilizers are made from phosphates, natural or manufactured, containing insoluble phosphate by mixing therewith alkalis or alkaline salts, sulphate of soda, and sulphate of potash, in the proportion of from about one-half to an equal part of alkaline salt to the quantity of phosphate, and furnacing the mixture at a high temperature in conjunction with carbon.

353,825—December 7, 1886. C. SCHEIBLER. *Manufacture of phosphates from slags.*

Process No. 279,445 is modified by using acids which are less diluted than with 9 parts of water to 1 of acid, the slag being first roasted in an oxidizing flame and pulverized, thereby dissolving the main portion of the silica and alkaline-earth phosphates and a part of the oxides of iron and manganese, and then fractionally precipitating the elements of the solution with successive quantities of milk of lime or magnesia, whereby there are separately obtained the phosphates of iron and manganese, and then the alkaline-earth phosphates, with or without the silica; the phosphorus is separated from the iron and manganese by oxidation, dissolved and precipitated, whereby there is obtained an additional amount of alkaline-earth phosphates and an amount of metallic oxides.

354,983—December 28, 1886. J. T. JULLIEN. *Manufacture of fertilizers.*

A combined fertilizer and antiphylloxeric formed by dissolving sulphur in liquid sewage and adding sulphide of carbon.

361,656—April 19, 1887. T. TWYNAM. *Process of producing soluble alkaline phosphates.*

The fused alkaline slag produced in a basic furnace or converter receives such additional quantity of an alkaline salt, as carbonate of soda, as will form, with the alkali already present, at least three equivalents of base for each equivalent of phosphoric acid, or trisodic or tripotassic phosphate. Soluble alkaline phosphates are produced by adding to phosphoric pig iron (during its conversion into iron or steel in a basic or neutral lined converter or furnace) trisodic or tripotassic phosphate.

387,104—July 31, 1888. D. E. PAYNTER. *Process of drying offal and garbage.*

The mass is subjected to the action of heated air and the vapors passed through sulphate of lime before escaping, forming carbonate of lime and sulphate of ammonia, and destroying offensive odors.

395,532—January 1, 1889. W. J. WILLIAMS. *Phosphatic fertilizer.*

Nitrogenous matter, as wool waste, hair, blood, tankage, etc., is treated with sulphuric acid, and at the same time calcined phosphate of alumina or iron, or a mixture of the two, is mixed with water, and the two mixtures are then thoroughly incorporated, and the mass dried at a heat not exceeding 180° F.

404,348—May 28, 1889. H. ENDEMANN. *Process of making fertilizers.*

Tobacco is moistened, crushed, subjected to the action of mineral acid, washed with water, and the extract added to basic material, such as ground bones. (Product No. 396,274.)

409,230—August 20, 1889. C. C. PECK. *Process of making fertilizers.*

Tank water is evaporated to a semiliquid condition, mixed with infusorial earth, and dried.

413,232—October 22, 1889. T. R. HOUSEMAN AND C. B. M. SPROWLES. *Process of desiccation.*

Garbage, brewer's grain, etc., is desiccated by subjecting to pressure and at the same time heating it by a dry heat throughout its mass.

423,320—March 11, 1890. E. R. HODGKINS. *Process of making phosphatic fertilizers.*

Finely pulverized phosphatic material and calcic oxide are combined, as by spreading them in alternate layers, the calcic oxide slacked by the addition of water, and the ingredients mixed.

434,977—August 26, 1890. C. CLIFFORD. *Process of preparing fertilizers.*

Refuse leather is dampened and placed in a heap to undergo a natural sweating; when the sweating subsides the heap is opened and turned over to expose to the air, again closed up and again sweated, the operation being repeated as long as fermentation lasts; the resulting product is then ground.

438,646—October 21, 1890. P. B. ROSE. *Manufacture of fertilizers.*

An insoluble compound of iron, as ferrous or ferric oxide, is added to "stick" or other albuminoid, either with or without an alkaline earth or its salt, or an alkali or a salt of the same, and the mass evaporated to dryness. A soluble iron salt may be added, and then precipitated by an alkaline earth or an alkali, or their salts.

439,880—November 4, 1890. J. A. LIGHTHALL. *Process of making bags acid-proof.*

Sufficient dry pulverulent acid-proof material is introduced into fertilizer bags to cover the interior surface, and they are then passed between rollers.

442,490—December 9, 1890. C. G. MOOR. *Process of making fertilizer from sewage sludge.*

Sewage sludge, obtained by the use of sulphate of magnesia as a precipitant, is compressed; fed in successive charges to a furnace having a forced draft; a part of the sludge removed from time to time when carbonized (for use with precipitating agent and filter bed); the remainder calcined; the ash removed from time to time; and finally mixed with sulphate of ammonia to form a manure.

443,559—December 30, 1890. H. T. YARYAN. *Process of making fertilizer from tank water.*

Tank water is evaporated to about 25° Baumé and then passed through a dialyser, by which such salts as produce deliquescence (the potash and other alkaline salts) are removed, and the material is then evaporated to a dry product.

445,055—January 20, 1891. R. GIEBERMANN. *Process of separating gluten from slaughterhouse washings.*

The temperature of the washings is gradually raised to about 200° F.; an alumina compound is then introduced to precipitate the gluten, and the washings are passed through a filter.

445,255—January 27, 1891. W. B. SEAL. *Process of making fertilizers.*

Raw phosphatic material is subjected to the action of sulphuric acid, and then powdered coal is added while the chemical changes are taking place, with or without the subsequent addition of nitrogenous material.

446,087—February 10, 1891. J. VAN RUYMBEKE. *Phosphate and process of making the same.*

An iron and alumina metaphosphate mixed with an iron and alumina sulphate; produced by treating an iron and alumina acid phosphate with sulphuric acid and then heating it at a temperature of from 400° to 800° F., until the acid phophate contained therein is converted into metaphosphate, usually indicated by the product assuming a gray color.

446,998—February 24, 1891. J. VAN RUYMBEKE. *Making phosphatic fertilizers.*

Iron and alumina phosphate is pulverized, mixed with muriate of potash or preferably low-grade sulphate of potash, treated with sulphuric acid, and then subjected to heat until the contained acid phosphate is converted into metaphosphate.

453,300—June 2, 1891. C. GLASER. *Process of separating alumina from phosphates.*

Phosphate of alumina is dissolved out of phosphatic material by a hot solution of a carbonate of an alkali, as sodium carbonate; the phosphate of alumina separated as a precipitate from the solution on cooling; and the solution again used as a solvent for repeating the operation.

458,744—September 1, 1891. E. WATSON. *Manufacture of fertilizers.*

Tank water, or stick, is converted into a practically dry nondeliquescent fertilizer by adding thereto a portion of other animal matter practically nondeliquescent, and an alkali, and drying the product.

461,164—October 13, 1891. J. VAN RUYMBEKE. *Process of making fertilizer from stick.*

"Stick," a substance produced by concentrating tank water, is first treated with sulphates in any usual way, as with basic persulphate of iron, to cure the vicidity and deliquescence of the substance, then dissolved in sulphuric acid, and then there is mixed therewith tribasic phosphate of lime and the mass allowed to lie until apparently dry.

471,306—March 22, 1892. J. VAN RUYMBEKE. *Process of making nitrogenous fertilizers.*

A solution of soluble salt of iron or alumina is formed with slacked lime added in about the proportions of 10 per cent, in weight, of dry slacked lime, and boiled, and the solution is then mixed with stick, preferably hot (in proportions determined by the condition of the stick) and the product dried.

474,419—May 10, 1892. T. M. SMITH. *Process of making fertilizers*

Animal substances are placed within a suitable vessel with a definite amount of water (sufficient only to reduce the material to a soft and pasty mass while hot), the vessel closed and subjected to heat until the texture of the material has been destroyed; though soft while hot it becomes brittle and pulverable when cold without further desiccation.

489,010—January 3, 1893. O. T. JOSLIN. *Process of making fertilizer from tank water.*

The water is evaporated to a sirupy condition, heated to 140° to 200° F., when a small percentage of sulphuric acid is added, and then from 5 to 20 per cent of sulphate of magnesium may be added and an absorbent of the supernatant liquid, and the product dried by subjecting it to a temperature of 300° to 400° F. while in motion, for fifteen minutes to an hour.

494,939—April 4, 1893. L. RISSMÜLLER AND H. VOLLBRECHT. *Manufacture of superphosphates from kettle residue.*

The kettle residue of glue factories is mixed with warm sulphuric acid of 50° Baumé, heated at about 200° F., and allowed to stand until the nitrogenous substances have entered into solution with the acid, the gypsum has been precipitated, and the fat risen to the surface, when the solution is separated and powdered phosphate is added thereto in sufficient quantity to take up all the sulphuric acid present, thus rendering soluble the phosphoric acid of the added phosphate and yielding a comparatively dry fertilizer product.

494,940—April 4, 1893. L. RISSMÜLLER AND H. VOLLBRECHT. *Manufacture of superphosphates.*

The process of No. 494,939 is applied to offal, bones, and other animal matter, the fat and fat acids being skimmed off and separately collected as fast as they rise to the surface.

495,042—April 11, 1893. O. T. JOSLIN. *Process of making fertilizer from tank water.*

Tank water is first decomposed by the addition of sulphuric acid, then 5 to 13 per cent of a concentrated solution formed by dissolving waste fuller's earth in sulphuric acid is added, and the product is then dried at a temperature of from 300° to 350° F.

495,043—April 11, 1893. O. T. JOSLIN. *Process of making fertilizer from tank water.*

From 5 to 10 per cent of an acid phosphate of calcium is added to tank waters; then from 5 to 13 per cent of a concentrated solution formed by dissolving waste fuller's earth in sulphuric acid; then an absorbent, as pressed, cooked blood, may be added, and the product dried.

496,687—May 2, 1893. P. C. HOFFMANN. *Process of treating phosphates.*

Florida inland phosphates are pulverized, mixed with a theoretical amount of sulphuric acid, and heat is supplied to the ingredients, independent of the heat of chemical reaction, sufficient to retain the mass (until the free phosphoric acid has had its effect upon the insoluble phosphoric acid) at a temperature above the normal temperature occasioned by the chemical reaction of the mixture, which is ordinarily about 50° C., and yet not exceeding the temperature at which pyro-phosphates are formed, or about 200° C.

500,100—June 20, 1893. M. A. GOLOSEIEFF. *Fertilizer.*

The gelatine refuse from tallow manufactories is evaporated to the consistency of 27° to 28° Baumé; unslacked lime is then combined therewith in the proportion of 500 pounds of lime to 1,000 pounds of the partially evaporated broth; the mass is then allowed to expand and dry, and is reduced to a powdered state.

501,037—July 4, 1893. H. B. ARNOLD. *Process of disposing of city garbage.*

The material is cooked in a closed vessel from 4 to 8 hours, with condensation of the vapors that pass off; the solid matter or tankage is separated from the water or grease; and the tankage pressed and dried in a closed drier with condensation of the vapors.

506,363—October 10, 1893. N. DOWLING. *Process of and apparatus for treating garbage.*

The solid and liquid matter is disinfected in transit; the solid separated from the liquid, squeezed, pulped, compressed, and dried; conveyed to a furnace and incinerated; the separated liquid matter being continuously agitated and disinfected. The apparatus is claimed.

514,042—February 6, 1894. J. J. SELDNER. *Process of converting hair into fertilizers.*

Hair or other substance is heated with a weak solution of mineral acid in a closed vessel to a temperature that will produce a pressure and disintegrate the hair; sufficient pulverized alkaline matter is then added to neutralize the free acid; and the mass is dried.

514,043—February 6, 1894. J. J. SELDNER. *Process of making fertilizers.*

A mixture of hair or like material and an acid phosphate is subjected to heat in a closed vessel until the material becomes disintegrated and dissolved.

515,708—February 27, 1894. J. GREGORY. *Process of making phosphatic fertilizers.*

Boneblack, which has been previously used as a filtering material for oil, either by itself or mixed with bones or offal, is mixed with sulphuric acid, and the mixture boiled to cause the greasy substance to rise and filter through the boneblack, the residue being separated from the greasy material for fertilizer.

517,662—April 3, 1894. N. B. POWTER. *Process of making fertilizers.*

From 5 to 50 per cent of substantially pure phosphate of alumina containing insoluble phosphoric acid is mixed with slaughterhouse refuse and similar waste, in quantity sufficient to take up all soluble and volatile ingredients.

524,813—August 21, 1894. C. WEIGELT. *Process of making fertilizers.*

Fish and meat refuse is comminuted and mixed with potassium salts (as potassium chloride or potassium sulphate) and allowed to stand, say from three to five days, until a lye is formed, which is then drawn off; the fatty matter contained in the remaining mass is extracted; and the material dried and ground.

527,810—October 23, 1894. E. RECORDS. *Process of making fertilizers.*

The solid parts of tankage are disintegrated, without pulverizing, by the admixture of powdered marl. A mixture of pulverized calcareous marl and blood, tankage, or offal is dried, and then more blood, tankage, or offal is added to the mixture and again dried. The ultimate addition of sulphuric acid converts the ammonia into a stable compound.

530,126—December 4, 1894. N. B. POWTER. *Process of utilizing garbage and similar waste products.*

Garbage is reduced to a condition of sludge by steaming or boiling in the presence of sulphuric acid; the grease is removed, a proper amount of insoluble alumina phosphate is added; and the mass subjected to simultaneous stirring and evaporation in vacuum until it is converted into a dry, granular mass.

535,076—March 5, 1895. A. R. C. PIEPER. *Process of making citrate soluble phosphates.*

Pulverized phosphate of iron or alumina is mixed with a hot pulp, obtained by slacking caustic lime in a soda or potash lye in such proportions that there will be about two equivalents of oxide of lime for each equivalent of phosphoric acid in the compound. The burnt lime is slacked in from 5 to 10 per cent of an alkali lye. A nitrate, as saltpeter, is preferably added to the final product.

535,204—March 5, 1895. H. M. HOWE AND J. E. STEAD. *Process of making tetrabasic phosphates.*

In the dephosphorization of iron, phosphoric acid is rendered soluble by adding phosphates to the slag thereby produced, with or without the addition of a base, such as an alkaline earth, oxide of iron, oxide of manganese, or alumina, or their equivalent. The product, when finely ground, may be utilized direct as a fertilizer.

542,080—July 2, 1895. D. T. DAY. *Process of making phosphates soluble in dilute citric acid.*

A mixture of phosphate rock containing a suitable percentage of silica, or added silica, and a calcareous base is heated to a temperature at which carbonate of lime gives up its carbonic acid, and the temperature maintained well below partial fusion to secure a maximum of citric-acid-soluble phosphate. A potassium salt, such as sulphate or muriate, may be added, whereby the temperature can be reduced to between 535° and 650° C.

546,716—September 24, 1895. W. A. SHEPARD. *Method of and apparatus for preparing fertilizers.*

Superheated steam is passed through excrement in an air-tight chamber; the ammoniacal and other gases condensed in water; and the dehydrated and cooked solid matter mixed with lime.

548,342—October 22, 1895. J. WODISKA. *Process of treating garbage.*

The liquid is expressed, the garbage heated to further expel moisture, and it is then subjected to destructive distillation in a retort.

550,024—November 19, 1895. E. MEYER. *Process of disintegrating Thomas slag.*

The disintegration of Thomas slag is facilitated by introducing, while in a fluid state, a small quantity of an alkaline disintegrating agent, such as alkaline carbonate, or alkaline silicate, either with or without a reducing powder, such as coke powder or a metallic sulphide.

578,512—March 9, 1897. H. A. HOGEL. *Process of and apparatus for making fertilizers.*

Garbage is digested with hot water and steam under pressure and reduced to a sludge; filtered by forced filtration while well heated; hot water is forced through the mass; the grease is separated from the rest of the filtered liquids; and the solid matter dried, mixed with phosphatic fertilizing ingredients and converted into a finely powdered condition.

580,224—April 6, 1897. W. S. RICHARDSON. *Method of making fertilizers.*

Hair, fleshings, or similar refuse of skin dressers is converted into a fertilizing component by dry distillation, by subjection to a dry heat in a closed oven at a temperature to make available the nitrogenous matter thereof and the fixing of the same, as ammoniates, in the resulting product, say from 150° to 160° C.; the by-products being driven off and condensed, and the residual product reduced to a comminuted state.

588,266—August 17, 1897. G. DE CHALMOT. *Treatment of phosphates.*

See Group X, Electro-chemistry.

596,008—December 21, 1897. L. RISSMÜLLER. *Process of treating garbage.*

Garbage is boiled with acid in a digester and reduced to a sludge; the evolved gases are led to a furnace, heated and mixed with producer gas by passing therethrough and utilized as fuel; the digested waste is subjected to centrifugal action to remove the grease; and the residue is dried.

602,363—April 12, 1898. W. E. ROWLANDS. *Process of making fertilizers.*

Waste leather is fermented, mixed with crude phosphate, and the mass agitated with the addition of sufficient sulphuric acid to decompose the phosphate.

603,668—May 10, 1898. J. B. TAYLOR AND H. V. WALKER. *Process of and apparatus for recovering ammonia and waste products from garbage.*

The garbage is divided into sections for successive treatment; one section dried and burned in a thick layer, the products led off, the ammonia separated from the combustible gases, and the latter burned in the presence of the next successive section, for drying the same; the cycle being repeated with further sections successively.

609,797—August 30, 1898. H. DUDEN. *Process of making fertilizers.*

Concentrated tank water is mixed with albuminous substance, as concentrated blood serum and the like, and the mixture (acidified if necessary) simultaneously subjected to the action of steam and electricity—say a current of 75 to 120 volts—whereby it is vigorously oxidized. It is finally dried and ground.

611,580—September 27, 1898. L. RISSMÜLLER. *Process of treating garbage and fertilizers obtained therefrom.*

A grease-freed fertilizer, having available ammonia, is produced by boiling garbage and converting it into a uniform fluid mass and then separating the ingredients by centrifugal action, according to their respective specific gravities.

619,056—February 7, 1899. B. TERNE. *Process of making fertilizers from garbage.*

The pressed and dried solid matter obtained from garbage is subjected to destructive distillation, and the phosphated charcoal obtained is mixed with concentrated tank liquors, expressed from the garbage, and the mixture dried.

620,443—February 28, 1899. W. L. GOLDSMITH. *Process of making fertilizers.*

Phosphate rock and lignite or bituminous coal are crushed and pulverized together, whereby they are intimately mixed, and the powder is then treated with sulphuric acid.

622,401—April 4, 1899. F. M. SPENCE. *Process of treating sewage for obtaining fertilizers.*

A mixture of aluminic sulphate and ferric sulphate is added to sewage and sufficient sulphuric acid to complete the neutralization of the alkalinity of the sewage; the precipitated putrescible and fatty matters are separated from the liquid, pressed, dried, and treated with a solvent to dissolve out the fat or fatty acid; the solid fertilizing portion separated; and the fat or fatty acid separated from the solvent.

631,181—August 15, 1899. G. SCHÜLER. *Process of making superphosphates.*

To produce a double superphosphate, a lye of mineral superphosphate of a specific gravity of at least 1.21 is formed, thereby precipitating gypsum, the precipitate separated from the remaining product, which is a mixture of monocalcium phosphate and phosphoric acid, comminuted phosphate added to the said product, and the mixture heated to about 110° C.

634,423—October 3, 1899. D. CAMERON, F. J. COMMIN, AND A. J. MARTIN. *Process of and apparatus for treating sewage.*

Sewage is subjected under exclusion of air, of light, and of agitation to the action of anaerobic bacteria until the whole mass of solid contained organic matter becomes liquefied, and the liquid effluent is then subjected to air and light.

646,559—April 3, 1900. L. RISSMULLER. *Process of making fertilizers from refuse liquids.*

Nitrogenous substances are extracted from nitrogenous refuse liquids (in a heated condition) by adding sulphite residue of the cellulose industry—the water from the sulphite liquor may be more or less evaporated—then filtering and drying the resulting product.

646,716—April 3, 1900. B. TERNE. *Process of making fertilizers.*

In the manufacture of fertilizers from animal excreta, the urine is collected, the liquid is separated from the solid excrements by pressure, mixed with the collected urine, and allowed to putrefy, when it is distilled to obtain the contained ammonia in the form of its salts, which are then mixed with the solid matter.

GROUP IX.—BLEACHING MATERIALS.

CHLORINE.

49,597—August 22, 1865. T. MACFARLANE. *Process of preparing chlorine, bleaching powder, carbonate of soda, and other products.*

See Group II, Carbonate of Soda.

85,370—December 29, 1868. H. DEACON. *Improvement in the manufacture of chlorine.*

For the continuous production of chlorine a current of hydrochloric-acid gas and atmospheric air, heated preferably from 200° to 450° C., is passed over heated material impregnated or mixed with oxides of copper and manganese, or the like.

118,211—August 22, 1871. H. DEACON. *Improvement in apparatus for producing chlorine.*

It is cleansed of dust or deposit of foreign matter by means of powerful blasts of air, reversible at pleasure.

134,190—December 24, 1872. L. E. AUBERTIN. *Improvement in producing chlorine.*

A mixture of air and gaseous or liquid hydrochloric acid is passed over sesquioxide of chrome, heated by preference to about 315° C.

141,333—July 29, 1873. H. DEACON. *Improvement in the manufacture of chlorine.*

In Deacon's process for the manufacture of chlorine, there is employed a mixture of an inactive but accelerating substance such as sulphate of soda, with an active substance such as sulphate of copper.

165,801—July 20, 1875. H. DEACON. *Improvement in the manufacture of chlorine.*

In the manufacture of chlorine by the Deacon process, the impure hydrochloric-acid gas is submitted to the action of aqueous hydrochloric acid, or of chlorides such as sodium chloride, at an elevated temperature, to absorb the sulphuric acid contained in the gas.

165,802—July 20, 1875. H. DEACON. *Improvement in the manufacture of chlorine.*

In the manufacture of chlorine, substances consisting mainly or essentially of sesquioxide of iron are employed as the porous material. Salts or compounds of magnesia are used in conjunction with salts or compounds of copper or other active chemical agents, and the same may be natural magnesian minerals or products impregnated with salts of copper, etc.

316,196—April 21, 1885. E. SOLVAY. *Manufacture of chlorine.*

In the manufacture of chlorine, a composition is used consisting of calcium chloride, silica, alumina, and the residuum remaining after treatment of the composition in a previous operation, the latter being infusible at the temperatures required to produce reaction.

348,348—August 31, 1886. G. RUMPF. *Process of producing chlorine.*

Sal-ammoniac vapors are passed over an oxide of manganese at a temperature below the red-hot state. Atmospheric air is then passed over the resulting chloride of manganese producing free chlorine and regenerating the manganese oxide.

357,659—February 15, 1887. D. G. FITZ-GERALD. *Obtaining chlorine by electrolysis.*

See Group X, Electro-chemistry.

389,781—September 18, 1888. W. WEBSTER, JR. *Process of electrolyzing sewage and sea water.*

See Group X, Electro-chemistry.

390,895—October 9, 1888. A. R. PECHINEY. *Manufacture of chlorine.*

In the manufacture of chlorine and hydrochloric acid by heating magnesium or manganese chlorides in the presence of oxygen or steam with exclusion of products of combustion, the chlorine-yielding material is charged into chambers which have been previously internally heated by hot gases, a series of regenerators being used.

391,159—October 16, 1888. J. A. JUST. *Process of making chlorine.*

Nitric acid, hydrochloric acid, and manganese dioxide are heated in a generator—the nitric acid and manganese dioxide being in equivalent excess of the hydrochloric acid—until all of the chlorine gas is evolved. The residual manganous nitrate liquor is then decomposed by heat, forming manganous dioxide and nitrous vapors, which latter are recovered as nitric acid.

416,038—November 26, 1889. L. MOND AND G. ESCHELLMANN. *Process of obtaining chlorine.*

An intimate mixture of magnesia and a chloride of a fixed alkali is briquetted and treated at from 400° to 600° C. with the vapor of hydrochloric acid or of chloride of ammonium, and then with hot dry air or oxygen.

420,837—February 4, 1890. E. SOLVAY. *Process of making chlorine.*

Chlorides are decomposed in the dry state by charging a mixture of a chloride and calcined silicious clay into the shaft of a decomposing apparatus, introducing gas or combustible dust midway of the shaft and producing combustion therein, and then introducing an air current into the bottom of the shaft.

423,868—March 18, 1890. C. HORNBOSTEL. *Production of chlorine gas.*

A continuous current of air is forced into and through the chlorine-generating materials in the generating vessel, and conducted, charged with the gas, to the point of application.

427,467—May 6, 1890. R. DORMER. *Obtaining chlorine.*

An aqueous mixture of sulphuric acid, hydrochloric acid, and manganese dioxide is formed and the chlorine evolved is collected. The aqueous residue is neutralized, and calcium chloride added in excess, thereby throwing down calcium sulphate, which is separated, and the remaining solution of manganese chloride and calcium chloride treated with lime to form manganese dioxide.

462,567—November 3, 1891. F. M. LYTE. *Process of making alkaline carbonate and chlorine.*

See Group X, Electro-chemistry.

463,767—November 24, 1891. P. DE WILDE AND A. REYCHLER. *Process of making chlorine.*

In the manufacture of chlorine by the alternate passage of hydrochloric-acid gas and heated air through a body of material which disengages chlorine at a red heat, a mixture of sulphate of magnesium and manganite of magnesia is used, formed by calcining equivalent quantities of sulphate of magnesium, chloride of magnesium, and chloride of manganese, all three being hydrated.

495,462—April 11, 1893. J. A. JUST. *Process of making chlorine.*

Hydrochloric acid with a slight excess of double the equivalent of manganese dioxide is decomposed by heat and nitric acid added to decompose the resulting manganous chloride and the residual manganese dioxide. The residual manganous nitrate liquor is then neutralized with manganese protoxide, hydroxide or carbonate, settled, evaporated, calcined, and the gases condensed.

503,429—August 15, 1893. F. M. & C. H. M. LYTE. *Process of producing chlorine and purifying lead.*

See Group X, Electro-chemistry.

510,276—December 5, 1893. F. M. LYTE. *Process of electrilytically decomposing fused metallic chlorides.*

See Group X, Electro-chemistry.

518,445—April 17, 1894. W. DONALD. *Process of making chlorin.*

Dry and cool hydrochloric acid gas is subjected to a mixture of strong nitric and sulphuric acids at a low temperature—about 0° C.—and the resulting chlorine and nitrogen-oxide gases are subjected to dilute nitric acid, and finally to strong sulphuric acid.

518,446—April 17, 1894. W. DONALD. *Process of making chlorin.*

As a modification of the process of No. 518,445, additional hydrochloric-acid gas or hydrochloric-acid gas and air is introduced into the body of resulting chlorine and nitrogen-oxide gases prior to subjecting them to the action of dilute nitric acid.

521,629—June 19, 1894. P. J. WORSLEY, W. WINDUS, AND B. BRACEY. *Process of and apparatus for absorbing chlorin gas.*

Chlorine gas is dehydrated, whereby it can be handled by pumps and pipes, and then the dry product is pumped into vessels containing the absorbing liquid.

529,130—November 13, 1894. L. MOND. *Process of obtaining chlorin.*

Ammonium chloride is vaporized in a retort lined with antimony and containing fused chloride of zinc—preferably by introducing it in small quantities and dropping it into the molten zinc chloride—and the vapors passed through a mass of balls or fragments formed of magnesia, clay, lime, and potassium chloride heated to 350° C. by the prior passage of hot inert gases therethrough, until the balls have absorbed their charge of chlorine, the ammonia given off being collected. A current of inert gas of 500° to 550° C. is then passed through the balls and the ammonia and afterwards the hydrochloric acid given off are collected. Hot dry air of 800° to 1,000° C. is then passed through, liberating the chlorine previously absorbed. The temperature of the balls is then lowered with a current of cold air or inert gas to 350° C. and the cycle is recommenced. Air which is only weakly charged with chlorine, near the end of the process, is passed through another body of chloridized salts to save the diluted chlorine and enrich a subsequent operation.

537,508—April 16, 1895. H. W. WALLIS. *Process of making chlorin.*

Chlorine is manufactured from aqueous acids by decomposing aqua regia in the presence of sulphuric acid and passing the gaseous products through sulphuric acid.

570,624—November 3, 1896. W. DONALD. *Process of making chlorin.*

A mixture of an alkaline chloride and manganic oxide—as the peroxide—with nitric acid and water is heated to produce chlorine, and the residual product evaporated and roasted; the evolved oxides of nitrogen being oxidized and converted into nitric acid, while the residue is dissolved in water, the manganese peroxidized by the blowing in of air, and the caustic alkali separated.

618,575—January 31, 1899. F. M. LYTE. *Method of and apparatus for producing chlorin, zinc, or other metals from mixed ores.*

See Group X, Electro-chemistry.

623,447—April 18, 1899. A. VOGT AND A. R. SCOTT. *Process of obtaining chlorin.*

To produce chlorine, hydrochloric acid, sulphuric acid and nitric acid flow in substantially horizontal and continuous streams in the same direction, in contact with each other, subject to suitable heat.

HYPOCHLORITES, MATERIALS.

147,476—February 17, 1874. M. L. BUSH. *Improvement in putting up chloride of lime.*

Chloride of lime is packed in a wrapper of impervious noncorrosive fabric, as paper saturated with an oleaginous or resinous solution.

210,273—November 26, 1878. T. SIMON, COMTE DE DIENHEIM-BROCHOCKI. *Improvement in the manufacture of bleaching liquids.*

Chlorozone, an oxygenated and chlorous decolorizing agent, having for a base a soluble alkali or alkaline earth, is formed by saturating an alkaline solution by a current of hypochlorous-acid gas, produced by the decomposition in the cold of hypochlorites or of chlorates by an acid and a current of air.

212,890—March 4, 1879. T. DE DIENHEIM-BROCHOCKI. *Improvement in bleaching compounds.*

A solid bleaching compound produced by saturating a solution of sodium protoxide with chlorine gas, and adding to the hypochlorite thus produced 20 to 40 per cent of desiccated carbonate of soda.

271,906—February 6, 1883. A. L. NOLF. *Process of and apparatus for obtaining chlorine and sodium.*

See Group X, Electro-chemistry.

309,970—December 30, 1884. A. McKAY. *Bleaching solution.*

It consists of a solution of chloride of lime to which has been added a mixture of fuller's earth and decoction of Iceland or Irish moss.

325,684—September 8, 1885. G. LUNGE. *Application of chloride of lime to bleaching purposes.*

The action of chloride of lime is increased and hastened by the use of acetic or formic acid added to or used in conjunction with the chloride of lime.

415,644—November 19, 1889. G. KERNER AND J. MARX. *Process of electrolyzing salts of the alkalies.*

See Group X, Electro-chemistry.

417,287—December 17, 1889. E. SOLVAY. *Process of making bleaching powder.*

A mixture of chlorine and carbon dioxide is passed through a dilute solution of chloride of lime with the separation of the carbonic acid; then the liquid chloride of lime is decomposed by the chlorhydric acid produced, and finally solid chloride is formed by means of the rich chlorine gas obtained.

442,334; 442,396; 442,594—December 9, 1890. I. L. ROBERTS. *Electrolytic apparatus.*

See Group X, Electro-chemistry.

450,103—April 7, 1891. E. A. LE SUEUR. *Electrolytic apparatus.*

See Group X, Electro-chemistry.

480,554—August 9, 1892. W. B. BRITTINGHAM. *Bleaching compound.*

A bleaching compound consisting of the tungstate of an alkali, as tungstate of soda, combined with a hypochlorite.

481,407—August 23, 1892. F. M. LYTE. *Production of caustic alkalies and chlorine.*

See Group X, Electro-chemistry.

484,990—October 25, 1892. H. BLACKMAN. *Electrolytic process and apparatus.*

See Group X, Electro-chemistry.

491,700—February 14, 1893. E. B. CUTTEN. *Method of electrolytically producing soda and chlorine.*

See Group X, Electro-chemistry.

501,121—July 11, 1893. C. N. WAITE. *Art of manufacturing chlorine or caustic alkali by electrolysis.*

See Group X, Electro-chemistry.

523,263—July 17, 1894. G. A. CANNOT. *Process of manufacturing hypochlorous acid.*

See Group X, Electro-chemistry.

541,146—June 18, 1895. H. BLACKMAN. *Electrolytic process and apparatus.*

See Group X, Electro-chemistry.

541,598—June 25, 1895. J. D. DARLING. *Process of utilizing niter-cake or other acid sulfates.*

See Group X, Electro-chemistry.

546,328—September 17, 1895. C. HOEPFNER. *Anode for electrolytic apparatus.*

See Group X, Electro-chemistry.

556,038—March 10, 1896. M. H. WILSON. *Electrolytic apparatus.*

See Group X, Electro-chemistry.

558,240—April 14, 1896. C. N. WAITE. *Method of utilizing saline solutions.*

See Group X, Electro-chemistry.

558,241—April 14, 1896. C. N. WAITE. *Method of utilizing saline solutions.*

See Group X, Electro-chemistry.

559,454—May 5, 1896. C. KELLNER. *Process of and means for producing bleaching agents.*

See Group X, Electro-chemistry.

560,518—May 19, 1896. J. MEYRUEIS. *Treatment of sodium chlorid.*

See Group X, Electro-chemistry.

565,953—August 18, 1896. E. ANDREOLI. *Apparatus for indirect electrolysis.*

See Group X, Electro-chemistry.

568,229—September 22, 1896. H. BLACKMAN. *Electrode.*

See Group X, Electro-chemistry.

568,230—September 22, 1896. H. BLACKMAN. *Electrode for electrolytic decomposition.*

See Group X, Electro-chemistry.

568,231—September 22, 1896. H. BLACKMAN. *Electrolytic anode and apparatus.*

See Group X, Electro-chemistry.

572,472—December 1, 1896. H. Y. CASTNER. *Anode for electrolytic processes.*

See Group X, Electro-chemistry.

578,457—March 9, 1897. C. KELLNER. *Process of and apparatus for simultaneously producing ammonia, sodium hydroxid, and chlorine.*

See Group X, Electro-chemistry.

583,330—May 25, 1897. E. A. LE SUEUR. *Process of electrolysis.*

See Group X, Electro-chemistry.

583,513—June 1, 1897. W. SPILKER. *Electrolysis of watery salt solutions.*

See Group X, Electro-chemistry.

586,236—July 13, 1897. L. P. HULIN. *Process of electrolytic decomposition of solutions.*

See Group X, Electro-chemistry.

591,730—October 12, 1897. W. BEIN. *Process of and apparatus for electrolyzing.*

See Group X, Electro chemistry.

606,981—July 5, 1898. W. S. ROMME. *Process of and apparatus for decomposing solid substances.*

See Group X, Electro-chemistry.

609,745—August 23, 1898. W. G. LUXTON. *Diaphragm for electrolytic purposes.*

See Group X, Electro-chemistry.

621,908—March 28, 1899. H. H. DOW. *Porous diaphragm for electrolytic cells and method of producing same.*

See Group X, Electro-chemistry.

637,410—November 21, 1899. G. H. POND. *Process of and apparatus for dissociating substances by electrolysis.*

See Group X, Electro-chemistry.

652,611—June 26, 1900. J. HARGREAVES. *Combined diaphragm and electrode.*

See Group X, Electro-chemistry.

HYPOCHLORITES, PROCESSES.

63,056—March 19, 1867. T. GRAY. *Improvement in the manufacture of bleaching powder.*

In the manufacture of bleaching powder, free acid is neutralized or eliminated by passing the chlorine gas through a solution of caustic soda or by mixing the alkali with the lime.

81,709—September 1, 1868. A. P. VIOL AND C. P. DUFLO. *Improvement in bleaching and dyeing feathers.*

Black, gray, brown, or otherwise tawny-colored feathers are first bleached (either by the action of chlorine in the gaseous form or in solution, or by means of chlorine salts, or by the action of sulphurous acid in a gaseous form or in solution, or by sulphites, or by chromates, bichromates, or oxygen salts and acids, or, in some cases by alkalis, separately, or in succession or even simultaneously) and then dyed.

100,071—February 22, 1870. E. T. RICE. *Improved process of bleaching and cleaning vegetable fibers.*

The fibers or fabric are first steeped in a weak acid solution, and then steeped, washed, or scrubbed in a weak alkaline solution or ordinary soapsuds at above 100° and below 212° F. It is then treated with chlorine or other bleaching agent, followed by an acid solution, and washing in a weak alkaline solution.

118,210—August 22, 1871. H. DEACON. *Improvement in the manufacture of bleaching powders.*

The sections of the apparatus or shelves are arranged in series, each becoming the first of the series in rotation, the freshly filled lime section being always at the gas exit end of the series, so that the strongest chlorine gas acts first on lime that has absorbed the most chlorine, and the most diluted chlorine passes over the freshest lime.

121,595—December 5, 1871. H. DEACON. *Improvement in the manufacture of bleaching powders, sulphates, etc.*

The apparatus has a series of oppositely inclined shelves with narrow interspaces and a controlled discharge at the bottom; the chemical gas passing upward and acting on the solid material during its passage downward, over and along the inclined shelves.

126,550—May 7, 1872. F. M. IRONMONGER. *Improvement in bleaching peanuts.*

They are washed in a weak aqueous solution of sal soda, and then treated with a dilute aqueous solution of chloride of lime and sulphuric acid; then washed and dried.

139,239—May 27, 1873. H. DEACON. *Improvement in the manufacture of bleaching liquors.*

Carbonate of lime—such as lumps of limestone or of chalk, or that obtained by causticizing solutions of the carbonates of soda and of potash by means of lime—is used to replace, wholly or in part, the caustic lime usually employed in the manufacture of bleaching liquors. Carbonates of lime are used to absorb chlorine when the same is mixed with carbonic-acid gas, or is otherwise diluted.

145,816—December 23, 1873. J. B. RICKARDS. *Improvement in bleaching damaged cotton.*

Vegetable fibers are first treated in a bath of permanganate of potassium and chloride of lime, and then in a bath of carbonate of potassium and chloride of lime, with or without the addition of glycerine in either bath.

154,292—August 18, 1874. J. L. SNEED AND J. S. MOUNT. *Improvement in bleaching hemp.*

It is soaked first in hot water and then in a solution of chloride of lime, after which it is dried and hackled.

184,577—November 21, 1876. J. BÈNÉ. (*Reissue: 7,850—August 21, 1877.*) *Improvement in refining and bleaching hair.*

Hair is refined and bleached by treatment in a bath composed of acids and chlorate of potash; the color is then fixed or set by treatment in a bath of warm water, muriate of tin, bisulphite of soda, and muriatic acid; and finally the hair is washed in water and ammonia to cleanse and remove all impurities, producing hair of fine texture from coarse hair.

196,258—October 16, 1877. E. SOLVAY. *Improvement in manufacture of hypochlorites of lime and magnesia from the silicates and aluminates.*

The compound silicate resulting from the manufacture of chlorine or hydrochloric acid is treated with chlorine gas. The hypochlorite formed is separated from the silicate and aluminate by lixiviation.

263,365—August 29, 1882. C. TOPPAN. *Bleaching fabrics.*

Cotton or linen fabrics are boiled in a solution of water and "sinapetroline" No. 2 (patent No. 186,640—January 23, 1877), then treated with a solution of chloride of lime and water, aired, and finally washed in a solution of hot water and "sinapetroline" No. 2.

280,094—June 26, 1883. F. SUTER. *Process of producing open-work fabrics.*

Vegetable fibers are embroidered on a ground of animal fiber, and the latter is then dissolved in a solution of chloride of lime.

280,141—June 26, 1883. L. A. DELABOVE. *Bleaching threads and fabrics.*

Fibers or fabrics of flax or hemp are first treated with a solution of calcium hypochlorite, and afterwards with a solution of aluminum sulphate saturated with aluminum hydrate.

293,376—February 12, 1884. J. B. THOMPSON. *Process of and apparatus for bleaching.*

Vegetable fibers and fabrics are boiled in a solution of cyanide of potassium or sodium, then subjected to alternate baths of a solution of chloride of lime and of carbonic-acid gas in a closed vessel, and lastly passed through a solution of triethylrosaline and oxalic acid, with suitable washings.

294,619—March 4, 1884. E. HERMITE. *Bleaching of paper pulp or other fibrous or textile materials or fabrics.*

See Group X, Electro-chemistry.

297,319—April 22, 1884. J. C. VANLOHE. *Bleaching raw cotton.*

The cotton in a compressed state, as in a bale, is subjected to the action of bleaching liquids, then rinsed, then torn apart or loosened and dried.

303,065—August 5, 1884. J. A. SOUTHMAYD. *Process of bleaching vegetable tissues.*

The material is first treated with permanganate of potash to destroy the coloring matter; then treated with oxalic acid, sulphite of sodium, and chlorine, to neutralize and bleach; and finally washed to remove the chlorine and discharging agents. As a preparatory step the material may be boiled with potash under pressure.

333,875—January 5, 1886. W. MATHER. *Process of bleaching.*

Cotton yarns and fabrics are first treated with a boiling solution of caustic soda, then steamed in a closed vessel with occasional introductions of the soda liquor while subject to the steaming, and then washed—the steps may be repeated—and then subjected to the action of chlorine liquor, washed, and finally scoured.

339,493—April 6, 1886. E. SOLVAY. *Manufacture of bleaching powder.*

The chlorine gas is drawn or forced in a downward direction through the lime and the porous or pulverulent beds.

382,159—May 1, 1888. E. HERMITE. *Process of bleaching.*

See Group X, Electro-chemistry.

389,898—September 25, 1888. R. M. PERRINE. *Process of bleaching wax.*

The combined vapor of bleaching solution of steam and gases, resulting from decomposed chloride of lime, is passed through the melted wax in divided jets, and finally pure steam is passed through the body of wax to cleanse and remove the bleaching solution.

396,551—January 22, 1889. F. E. BROWN. *Process of bleaching cotton.*

Cotton fabric, spread out wide, is passed through a boiling solution of caustic soda, then passed over perforated steam pipes and subjected to the action of steam, cooled by passing into a cold solution of caustic soda, boiled in a solution of soda-ash and washed, subjected to the action of chlorine liquor, steamed, scoured, and finally washed.

415,608—November 19, 1889. I. Q. BRIN. *Process of bleaching.*

The material is treated with a chlorous bleaching solution, and free oxygen is introduced into the mass, during the action, in regulated quantities.

432,401—July 15, 1890. A. & B. GRATZ. (*Reissue: 11,205—December 1, 1891.*) *Process of making jute bagging.*

A solution of sodium chloride is applied to fabric made from jute butts and it is then stored away in mass while damp, to allow the bleaching action to take place.

471,454—March 22, 1892. A. E. WOOLF. (*Reissue: 11,244—June 7, 1892.*) *Process of and apparatus for bleaching by electrolysis.*

See Group X, Electro-chemistry.

481,414—August 23, 1892. J. A. MYRICK. *Process of bleaching.*

Cotton-chain warp or like fiber is subjected to the action of a solution of chloride of lime, then to hot water, then to a solution of sulphurous acid, and finally rinsed.

499,184—June 6, 1893. C. J. DELESCLUSE. *Process of bleaching cotton.*

Cotton is bleached in a bath consisting of a chloride solution to which has been added a viscous acid solution composed, say, of 20 parts of water, by weight, and 1 part of a mixture of grape sugar, 90 per cent, and sulphuric acid, 10 per cent.

541,147—June 18, 1895. H. BLACKMAN. *Process of and apparatus for bleaching.*

See Group X, Electro-chemistry.

560,411—May 19, 1896. C. KELLNER. *Process of and apparatus for bleaching vegetable fibers.*

See Group X, Electro-chemistry.

565,706—August 11, 1896. B. S. SUMMERS AND C. O. BORING. *Electrolytic separation of vegetable fibers.*

See Group X, Electro-chemistry.

569,680—October 20, 1896. B. S. AND L. L. SUMMERS. *Electrolytic process of bleaching and refining.*

See Group X, Electro-chemistry.

588,084—August 10, 1897. G. H. POND. *Process of and apparatus for electro-chemical treatment of straw or other fibrous materials.*

See Group X, Electro-chemistry.

588,085—August 10, 1897. G. H. POND. *Method of and apparatus for electro-chemical treatment of fibrous material.*

See Group X, Electro-chemistry.

610,265—September 6, 1898. V. C. DRIFFIELD, A. CAREY, AND F. W. WRIGHT. *Process of and apparatus for making bleaching powder.*

The gas issuing from one compartment is dried to remove the vapor of water evolved in that or preceding compartments, and also cooled before it enters a succeeding compartment.

616,139—December 20, 1898. G. H. POND. *Method of electrolytically treating straw or other fibrous material.*

See Group X, Electro-chemistry.

616,988—January 3, 1899. B. S. SUMMERS. *Method of refining vegetable fiber.*

See Group X, Electro-chemistry.

655,239—August 7, 1900. T. JESPERSEN. *Process of bleaching by electrolytic chlorin water.*

See Group X, Electro-chemistry.

SULPHUR DIOXIDE.

121,564—December 5, 1871. J. WATTEAU. *Improvement in bleaching wool.*

Wool is bleached by means of a suitable bleaching gas forced through the wool by the atmospheric pressure produced by an exhausting or condensing fan or centrifugal machine.

125,469—April 9, 1872. P. MARCELIN. *Improvement in bleaching and disinfecting*

A sulphurous-acid solution is used as a bleaching and disinfecting agent.

129,819—July 23, 1872. E. C. HASERICK. *Improvement in bleaching wools, yarns, etc.*

Wool and woolen fabrics are bleached by treating in a water bath of a compound of sulphurous acid and an alkali or a sulphite, then rinsing, and then treating in an acid bath to decompose the sulphite and set the sulphurous acid free.

147,887—February 24, 1874. J. B. FRÈZON. *Improvement in treating mixed fabrics previous to dyeing.*

Woolen and silk fabric containing vegetable matter or impurities is exposed to a heated acid bath containing a mordant, to simultaneously destroy the vegetable matter and prepare the fabric for dyeing or bleaching.

187,882—February 27, 1877. W. MAYNARD. *Improvement in processes of softening, decolorizing, and cleansing animal and vegetable fiber.*

The fiber is subjected to the action of hydrated sulphurous acid and a solution of an alkali mixed in neutralizing proportions.

311,595—February 3, 1885. I. S. McDOUGALL. *Production of sulphurous acid.*

Air is forced under pressure into a retort containing ignited sulphur-bearing material and in which a low temperature is maintained by a cooling jacket, the sulphurous gases being conducted off and passed into and below the surface of an absorbing liquid in a vessel or series of vessels before it escapes.

HYDROGEN DIOXIDE AND OZONE.

87,155—February 23, 1869. W. ELMER. *Climozonator.*

An ozonized atmosphere for dwellings is produced by means of a thermoelectric battery operated by the differences in temperature of the warmed and cool air currents.

107,071—September 6, 1870. O. LOEW. *Improvement in process of obtaining ozone or ozonized air.*

Atmospheric air is passed transversely through a flame, preferably that of a Bunsen burner, and the ozone collected.

109,601—November 29, 1870. C. F. DUNDERDALE. *Improvement in apparatus for the manufacture of ozone.*

Atmospheric air or oxygen is passed through finely divided streams or currents of electricity to convert the oxygen into ozone.

118,976—September 12, 1871. P. A. ROYCE. *Improvement in generating ozone.*

It is produced from phosphorous acted on by water and air, under hydraulic and atmospheric pressure.

128,227—June 25, 1872. T. A. HOFFMANN. *Improvement in the generation of ozone, and in treating liquids with the same.*

Atmospheric air is forced into a mixture of potassium permanganate or hypermanganate and sulphuric acid, producing ozone, and then through a washer. It is applied to fermenting and fermented saccharine liquids and the production thereof.

185,040—December 5, 1876. H. MILSOM. (*Reissue: 9,976—December 20, 1881.*) *Ozone machine.*

The process consists in the generation, purification, and emission of ozone by the slow oxidation of phosphorous in a chamber having porous earthenware walls, whereby the separation and retention of the acid fumes and the egress of ozone are effected.

261,270—July 18, 1882. J. STEIN. *Process of bleaching hair.*

Hair is bleached by first saturating it in a mixture of a solution of peroxide of hydrogen and ammonia with a solution of peroxide of hydrogen and cream of tartar, and then passing it through a solution of blue aniline and alcohol. A composition of peroxide of hydrogen and cream of tartar is claimed, the latter substance preserving the softness of the hair and preventing it from becoming stiff and breaking.

273,569—March 6, 1883. C. MARCHAND. *Manufacture of hydrogen peroxide.*

In the manufacture of hydrogen peroxide, the acid solution is given a continuous movement of rotation in vertical as well as in horizontal planes in a cooled vessel, while adding the binoxide.

302,800—July 29, 1884. M. TRAUBE. *Manufacture of hydrogen dioxide.*

Hydrogen dioxide is produced by bringing a flame of carbonic oxide or other gas in contact with water; as, for example, by spraying water through the flame.

361,923—April 26, 1887. A. & L. Q. BRIN. *Ozone apparatus.*

Oxygen or air is passed between layers or masses of granular conducting material connected, respectively, with the poles of an electric generator.

392,742—November 13, 1888. J. E. P. MEYER. *Composition for developing ozonized oxygen.*

A mixture of barium permanganate, 25 parts, with the acid salts of sulphuric acid, as anhydrous sodium bisulphate, 16 parts, in powdered form, generates ozonized oxygen when mixed with water.

420,394—January 28, 1890. C. F. W. STELZER. *Process of making ozone water.*

A small quantity of hydrochloric acid or hydrochloric acid with a chloride is added to ozone water to make it retain all of its properties.

440,792—November 18, 1890. W. ERWIN. *Process of making hydrogen peroxide.*

A powdered metallic oxide (protoxide or peroxide), as of lead, chromium, or manganese, is suspended in water maintained in gentle agitation or circulation, and under generated gas pressure or of air forced in, and decomposed by such an acid, as hydrofluoric acid, as is ordinarily used in making hydrogen peroxide. An intermediate substance, as fluorspar, may be added, which upon treatment by an acid, as sulphuric acid, will liberate the acid required for the decomposition of the oxide.

450,404—April 14, 1891. J. C. DITTRICH. *Preparing ozone water.*

A small quantity of a phosphite or hypophosphite is added to ozone water, before or after charging, to cause it to retain its properties.

509,163—November 21, 1893. N. HELMER. *Process of liberating ozone.*

For the purpose of quickly liberating ozone from peroxide of hydrogen, the latter is added to a solution of an alkali, such as refined carbonate of potash.

511,330—December 26, 1893. E. FAHRIG. *Process of and apparatus for manufacturing ozone gas.*

See Group X, Electro-chemistry.

513,825—January 30, 1894. C. R. POULSEN. *Process of and apparatus for making ozone.*

Ozone is produced by the action of oxygen, or the oxygen of the air, upon phosphorous moistened with a diluted solution of sulphuric acid and permanganate of potash.

527,326—October 9, 1894. J. T. DONOVAN AND H. L. GARDNER. *Process of producing ozone.*

See Group X, Electro-chemistry.

563,288—July 7, 1896. W. LOBACH. *Electrical production of chemical reactions.*

See Group X, Electro-chemistry.

577,523—February 23, 1897. G. J. ANDERSSON AND J. C. DITTRICH. *Process of manufacturing ozone and by-products.*

See Group X, Electro-chemistry.

596,936—January 4, 1898. F. K. IRVING. *Process of producing ozone.*

See Group X, Electro-chemistry.

632,096—August 29, 1899. G. T. BRUCKMANN. *Composition of matter.*
Hydrogen peroxide is charged with carbonic acid to preserve it.

OTHER METALLIC DIOXIDES.

109,025—November 8, 1870. J. LAMBERT, Jr. *Improvement in removing dyes made from analine, etc., from portions of fabrics.*

Aniline dyed fabrics are decolorized, according to design, by the application of powdered metals or soluble cyanides.

223,463—January 13, 1880. P. T. AUSTEN. *Method of preparing an aqueous bleaching solution of soda or potassa.*

A bleaching solution of silicate of sodium or potassium, barium peroxide, and the hydrate of sodium, potassium, or ammonium.

231,106—August 10, 1880. C. M. SARTWELL. *Preparing moss for upholstery.*

It is treated with a solution of protoxide of calcium, to remove the bark or exterior coating.

277,054—May 8, 1883. I. OHNSTEIN. *Art of treating jute, butts, and animal hair.*

The jute is torn into fine fibers, then the animal hair is macerated in a solution of lime and washed in boiling water, then the several materials are steeped in a solution of potash and dyestuff, dried, mixed, and moistened with castor oil and alcohol, and batted.

482,477—September 13, 1892. C. J. E. DE HAEN. *Process of bleaching.*

The goods are treated in a bath of peroxide of sodium and magnesium salts, such as magnesium chloride—a salt containing an oxide capable of being precipitated by sodium.

486,188—November 15, 1892. H. Y. CASTNER. *Bleaching compound.*

A bleaching compound composed of sodium peroxide and one or more neutral salts of the alkaline-earth metals.

650,023—May 22, 1900. H. OPPERMANN. *Process of making magnesium superoxid.*

See Group XIX, Oxides.

650,518—May 29, 1900. C. SAVIGNY. *Process of making dioxid of barium.*

See Group XIX, Oxides.

METALLIC PERMANGANATES.

266,660—October 31, 1882. P. THOMAS. *Bleaching fiber.*

The material is first boiled with caustic soda, then treated in a bath of potassium permanganate, and lastly in a solution of borax in hydrated sulphurous acid.

475,551—May 24, 1892. C. GIRARD. *Process of ungumming and decorticating textile material.*

Textile plants are treated with a basic salt of a polyatomic acid, as manganate of potash, to dissolve the gummy substance of the plant; then the fiber is washed; and then passed into a bath of sulphurous acid to remove the gum and oxides, and washed.

534,450—February 19, 1895. J. CLAPHAM, J. PICARD, C. VILLEDIEU, AND W. W. L. LISHMAN. *Process of bleaching.*

Fibers are treated in a bath containing a sulphonated or soluble oil, such as olein oil; then in a bath containing a manganate or permanganate salt; then in a bath of acidulated water; then in a bath having a bleaching action; then washed; and to make the fiber easy to work up it may be further treated in a bath containing olein or soluble soap as an emulsion.

OTHER BLEACHING AGENTS, MATERIALS.

11,786—October 10, 1854. E. N. HORSFORD. *Improved mode of removing chlorine from substances and fabrics.*

"Antichloride of lime," a neutral sulphite of lime, CaO,SO_2, is employed as a neutralizing agent for chlorine.

110,800—January 3, 1871. G. W. SYLVESTER. *Improvement in apparatus and processes of cleaning cotton waste.*

Cotton or woolen waste is cleaned by washing with a hydrocarbon, such as kerosene or paraffine oil. The recovered heavy oil is purified from waste by macerating or filtering with boneblack.

118,668—September 5, 1871. W. ADAMSON. *Improvement in apparatus and processes for treating animal and vegetable fibers.*

Animal and vegetable fibers and fiber-bearing vegetable substances are treated with hydrocarbon or hydrocarbon vapor, or both, under heat and determined pressure, to cleanse and extract oily, fatty, and resinous matters. The solvent is caused to circulate through the material.

119,187—September 19, 1871. C. F. A. SIMONIN. *Improvement in processes for treating textile fabrics with hydrocarbons.*

Textile fabrics are subjected to hydrocarbon vapors to prepare for bleaching or dyeing, or to cleanse and renovate.

203,723—May 14, 1878. W. E. GEER. *Improvement in processes for the manufacture of oakum.*

New fiber of flax, hemp, or the like is saturated in a solution of tar, sal soda, or similar alkali, and water, and the fiber afterwards cleansed of soda by treatment in a dilute aqueous solution of muriatic or similar acid.

225,154—March 2, 1880. J. W. W. MARTIN. *Process and material for fulling and scouring.*

The material or article is dampened and then a soap compound in a powdered form is applied by sifting or sprinkling.

244,674—July 19, 1881. J. J. SACHS. *Preparing and bleaching jute.*

Vegetable fiber, after cutting into lengths and bleaching, is treated in a solution of caustic soda or potash (or other liquid to cause the fiber to contract or curl), then neutralized, and the liquid expressed.

278,409—May 29, 1883. J. G., E. P., & D. W. DAVIS. *Washing compound.*

A detergent composed of water, 1 gallon; white rock potash, 1 pound; borax, one-quarter of a pound; kerosene oil, 4 ounces; and benzine, one-half ounce.

338,806—March 30, 1886. C. TOPPAN. *Process of scouring wool.*

Wool is immersed in a warm solution of expressed oil of mustard seed, petroleum products (paraffine oil and vacuum oil) and alkali.

350,218—October 5, 1886. C. TOPPAN. *Bleaching compound.*

A bleaching compound consisting of expressed oil of mustard seed, paraffine, caustic soda, tallow soap, sulphate of soda, and water.

354,223—December 14, 1886. H. R. RANDALL. *Treatment of silk fiber.*

Silk fiber, raw silk, and cocoons, before removal of the gum, are subjected to the action of an aqueous solution of acetic acid (one ounce of acid to a gallon of water) at a temperature below the boiling point; a small proportion of sulphuric acid may be added.

361,700—April 26, 1887. F. M. IRONMONGER. *Process of bleaching edible nuts.*

They are subjected to a bath of a solution of protochloride of tin ("tin salt" or "tin crystals") dissolved in muriatic acid and diluted 10 parts of water to 1 of salt.

381,444—April 17, 1888. C. TOPPAN. *Scouring composition for fibers and fabrics.*

It consists of benzine, mustard-seed oil, and an alkali, as caustic soda.

386,202—July 17, 1888. F. M. IRONMONGER. *Bleaching edible nuts.*

They are subjected to a bath of a mixture of tartaric and oxalic acids, and then dried.

576,860—February 9, 1897. G. A. LANAUX. *Process of bleaching rice.*

A compound for cleaning and bleaching rice, consisting of ultramarine blueing, soapstone, and petrol oil, is applied to the rice grains, and they are then brushed and polished.

OTHER BLEACHING AGENTS, PROCESSES.

13,928—December 11, 1855. W. M. WELLING. *Improvement in the method of bleaching ivory plates..*

The plates are sustained on their edges, in a suitable case, and placed in a north and south position for exposure to the sun.

15,983—October 28, 1856. J. PHYFE. *Process of bleaching ivory.*

Ivory is exposed to the rays of the sun on a glass table with a reflector below it.

16,100—November 18, 1856. J. A. ROTH. *Mode or process of bleaching vegetable fibers.*

Atmospheric air is forced into the bleaching liquor, thereby creating a rapid action of the bleaching agents.

18,204—September 15, 1857. J. A. JILLSON AND H. WHINFIELD. *Method of treating various materials or substances in a permanent vacuum for washing, bleaching, and analagous purposes.*

The operations are performed in a vacuum either with or without heat.

41,826—March 8, 1864. G. W. BILLINGS. (*Reissue: 1,761—September 13, 1864*) *Improvement in cleaning and separating the fibers of flax, hemp, etc.*

The vegetable fiber is subjected to a retting or fermenting operation after the stalk or other woody portions have been removed in whole or part; the fiber is washed in alternate directions for its cleansing while contained in a closed vessel.

85,875—January 12, 1869. D. K. TUTTLE. *Improvement in bleaching ivory, bone, etc.*

Ivory and bone are bleached by exposure to light in a bath of spirits of turpentine or other liquid.

190,995—May 22, 1877. H. T. YARYAN. *Improvement in processes for bleaching beeswax.*

It is dissolved in a solvent, such as any of the volatile products of petroleum, and exposed to sunlight in glass vessels or in shallow vessels under glass.

194,799—September 4, 1877. H. T. YARYAN. *Improvement in processes of bleaching beeswax.*

Any material which will act as a body, such as cotton cloth, is passed through melted wax, and saturated or coated with a thin layer, which is then exposed to the action of sunlight until the color of the wax is discharged, when the bleached wax is removed, either by heat and pressure, or by dissolving in a volatile solvent, and then the solvent is removed by heat.

202,078—April 2, 1878. A. VIOL AND C. P. DUFLOT. *Improvement in processes for bleaching feathers.*

They are immersed in a resinous bath, such as turpentine, of regulated temperature (89° to 90° F.), and at the same time exposed to both light and air.

281,780—July 24, 1883. J. MILLER. *Method of and apparatus for bleaching ivory.*

Ivory is placed in a hermetically-closed, glass-covered vessel and exposed to the action of the rays of the sun, at a low temperature.

303,342—August 12, 1884. C. TOPPAN. *Process of separating and subdividing vegetable fiber.*

The resinous and glutinous substances are dissolved and removed by boiling vegetable fibers in a solution of "sinapetroline" No. 2 (a product of expressed mustard-seed oil, petroleum products, and alkali: Patent No. 186,640, January 23, 1877).

304,088—August 26, 1884. J. A. ENGELER. *Process of bleaching cotton fabrics.*

Cotton fabrics are exposed to vapors of chloroform under pressure, and then dechlorinized by exposure to a mixture of hydrogen, carbonic acid, and sulphuric ether.

307,801—November 11, 1884. A. L. RICE. *Mode of separating embroideries.*

The goods are ruled on the separating line with a disintegrating acid, whereby the fabric on the line is partially destroyed, and further chemical effect is then arrested.

335,958—February 9, 1886. H. R. RANDALL. *Process of separating the fiber of cocoons.*

Cocoons are subjected to the action of a solution of hydrochloric acid (an ounce of acid to a gallon of water), at about 150° F., to prepare them for separation of the fibers.

354,222—December 14, 1886. H. R. RANDALL. *Treatment of tussah-silk cocoons.*

"Wild tussah cocoons" or other silk fiber, or vegetable fiber also, are washed, then sprinkled with a saponifiable oil, then subjected to the action of a heated solution of sodium stannate (or aluminate, plumbate, silicate, or borate of sodium or potassium, or an alkaline solution of zinc oxide), then washed and dried.

387,579—August 7, 1888. N. CONLON. *Treating crude animal hair.*

The hair is washed; cooked in a solution of water, quicklime, sal soda, and sulphuric acid; rubbed, teased, and washed to complete the cleansing; again cooked in a solution of water, sulphuric acid, and black oxide of manganese to further deodorize and render moth proof, thereby preparing it for dyeing, curling, and drying in one continuous process.

389,944—September 25, 1888. J. SMITH AND P. W. NICOLLE. *Process of bleaching fiber.*

Vegetable material is treated in a bath containing one or more alkaline sulphates, as sulphate of potash, and the solution is then removed, to effect the separation of the gums, resin, and coloring matter from the fibers.

396,325—January 15, 1889. A. & L. Q. BRIN. *Method of bleaching fibrous substances.*

See Group X, Electro-chemistry.

412,080—October 1, 1889. E. J. FISCHER. *Process of cleaning animal-hair.*

To remove the oily matter from the tubular cavities, hair or wool is given a long-continued soaking in clear water until it becomes soft, then soaked in a saponifiable solution to extract said oily matter, washed in clear water, and dried.

442,297—December 9, 1890. F. G. WISELOGEL. *Process of bleaching hair.*

It is first thoroughly washed in cold water, then treated in a bath of hot water to which has been added a small quantity of lime. It is then dried by forcing a strong current of dry, sulphureted air through it.

489,919—January 17, 1893. B. BEYER. *Process of treating raw silk.*

Silk waste or fabric thereof is subjected to the successive action of oil soap, cold water, and salt steam baths and drying, oft repeated, and then to the action of running water. The manufactured fabric is washed in a bath containing permanganate of potash.

496,072—April 25, 1893. H. THIES AND E. HERZIG. *Process of bleaching.*

The material is immersed in a solution containing hydrofluoric acid, then washed in a bath containing an alkaline earth compound, the air adhering to the material is removed, and it is then treated with boiling caustic alkaline lye, which is kept concentrated by a constant discharge of steam.

575,645—January 19, 1897. E. HERMITE. *Apparatus for purifying or disinfecting.*

See Group X, Electro-chemistry.

635,248—October 17, 1899. H. HADFIELD. *Process of bleaching.*

Fabrics are continuously bleached and washed by passing them through a hot wash, then through a chemicking bath, then subjecting them to the simultaneous action of acetic acid and steam, and then washing.

642,387—January 30, 1900. T. TEMPIED AND G. DUMARTIN. *Process of preparing peat for surgical use.*

Natural peat is macerated for several days, then beaten and washed in pure water to cleanse thoroughly, then treated with an ammoniacal bath to restore its color, and sterilized.

GROUP X.—CHEMICAL SUBSTANCES PRODUCED BY THE AID OF ELECTRICITY.

INORGANIC PRODUCTS.

211,070—December 17, 1878. E. WESTON, *Improvement in manufacture of metallic nickel.*

A malleable ductile electro-deposit of nickel; obtained by the addition of borate of nickel (or other compounds of boron) to a nickel-depositing solution.

589,161—August 31, 1897. F. CHAPLET. *Hard body for rifling chromated steel.*

A new hard compound—a carbo titanide of silicium—is produced by the reduction of an intimate mixture of titanic acid, silicic acid, and carbon in an electric furnace. It is capable of scratching chrome steel and cutting and shaping hard stones.

589,415—September 7, 1897. G. DE CHALMOT. *Silicon alloy.*

An alloy of silicon with a metallic silicide, a new product, is produced by smelting material containing a metal—such as a metallic oxide—and silicon (silica) with carbonaceous matter in an electric furnace with a direct current, until the carbonaceous matter is eliminated. At the end of the operation the cathode is covered with the product. Crystalline silicon is produced by treating said alloy with a solvent of the silicide.

602,975—April 26, 1898. G. DE CHALMOT. *Silicid of iron.*

New ferrosilicides, containing appproximately 25 per cent of silica or upward, and consisting either of Si_2Fe_3 or a mixture of Si_2Fe_3 and Si_2Fe. The lower grade silicides are molten in a common furnace, readily cast, making exact castings—they take a fine polish and do not tarnish in the air—from white (as silver) to gray in color.

656,353—August 21, 1900. C. B. JACOBS. *Alkaline-earth silicid.*

A new chemical compound: the silicide of an alkaline-earth metal, viz, calcium, barium, or strontium silicide, of the formula $R\,Si_2$, wherein R represents the alkaline-earth metal. They are white or bluish-white substances of metallic appearance, having a crystalline fracture, oxidizing slowly in the air to silicon oxide and an alkaline earth-metal oxide, and decomposing with water evolving large volumes of hydrogen, together with silica and the alkaline earth-metal hydrate. They are produced by the reduction of an intimately mixed charge of an alkaline earth, silica, and carbon in an electric furnace, as, for example, lime 60 parts, sand 130 parts, and coke 70 parts.

ORGANIC PRODUCTS—CARBIDES.

492,767—February 28, 1893. E. G. ACHESON. (*Reissue: 11,473—February 26, 1895.*) *Production of artificial crystalline carbonaceous materials.*

A new product: silicide of carbon, Si C (carborundum), characterized by great hardness, refractability, and infusibility; produced by subjecting materials containing carbon and silica, free or combined, to the action of an electric current. The current is passed through a conducting heating core embedded in the charge.

541,138—June 18, 1895. T. L. WILLSON. *Product existing in form of crystalline calcium carbide.*

A new product: crystalline calcium carbide existing as masses of aggregated crystals; produced by the reduction of intimately commingled coke and lime in an electric furnace.

555,796—March 3, 1896. C. WHITEHEAD. *Compound of magnesium, calcium, and carbid.*

A new compound: the double carbide of magnesium and calcium; produced by the treatment of intimately commingled carbon and the double oxide of calcium and magnesium in an electric furnace. Calcined dolomite supplies the double oxide.

615,816—December 13, 1898. J. A. DEUTHER. *Process of treating calcium carbids.*

Metallic carbide is crushed and mixed with an inert binding material, such as resin, and formed into tablets, which represent, by decomposition, a definite amount of gas.

637,681—November 21, 1899. T. G. TURNER. *Carbid cartridge.*

A package, for use in making gas, consisting of a hollow body of fragile material filled with calcium carbide, hermetically sealed.

648,348—April 24, 1900. C. E. YVONNEAU. *Method of treating carbid of calcium.*

Calcium carbide is saturated with oil and then crushed for formation into tablets, cartridges, etc., while so protected from decomposition.

648,349—April 24, 1900. C. E. YVONNEAU. *Process of preparing calcium carbid.*

Calcium carbide is crushed and heated and about 80 parts introduced into a heated mixture of 16 parts of glucose and 4 parts of an oily substance, and molded into shape; it may then be coated with a protective medium impervious to moisture and which will dissolve slowly in water.

648,350—April 24, 1900. C. E. YVONNEAU. *Prepared calcium carbid.*

A gas-producing body formed of calcium carbide crushed in oil, combined with an agglomerating mixture, molded and provided with a protecting coating (No. 648,349).

650,235—May 22, 1900. F. A. J. FITZGERALD. *Carborundum article.*

A dense coherent recrystallized body of carborundum, the product of the process of No. 650,234.

650,747—May 29, 1900. J. BILBIE AND H. DRIVET. *Process of treating carbid of calcium.*

Broken or granulated calcium carbide is treated with an essential oil, such as citronella, mirbane, or eucalyptus, to kill the natural odor of the carbide, then coated with petroleum, and again treated with an essential oil.

656,238—August 21, 1900. C. H. WORSNOP. *Composition of matter for making gas.*

Calcium carbide is immersed in a hot liquid mixture of paraffine wax, grease, (as cocoa butter), and sugar.

659,447—October 9, 1900. M. P. E. LÉTANG. *Preparation of carbid of calcium.*

Calcium carbide is given a protective coating of glucose, or its equivalent, capable of dissolving or liquifying the lime when produced from the decomposition of the carbide; an inert powder, such as carbonate of lime, is also combined therewith and petroleum, and small particles of, or powdered, carbide are formed into a mass.

For the production of acetylene, see Group XVII, Hydrocarbons.

OTHER ORGANIC PRODUCTS.

618,167—January 24, 1899. A. CLASSEN. *Sodium salt of iodin compound.*

A new product: the sodium salt of an iodine compound containing the iodine in the benzene nuclei of phenolphthalein; a nearly odorless and tasteless dark-blue amorphous powder; soluble in water, glycerine, and alcohol. It is produced by the electrolysis of an aqueous solution of phenolphthalein and sodium hydrate with potassium iodide.

618,168—January 24, 1899. A. CLASSEN. *Iodin derivatives of phenols and bismuth salts thereof.*

New products: as a bismuth salt of an iodine compound containing the iodine in the benzene nuclei of phenolphthalein, a nearly odorless and tasteless reddish-brown powder, insoluble in water and acids, and with difficulty soluble in alcohol. They are produced by reacting with agents containing iodine on an alkaline solution of phenolphthalein, with the aid of electrolysis.

PROCESSES.

7,821—December 10, 1850. G. MATHIOT. *Process of preventing the adhesion of the deposit to the recipient in the electrotype process.*

The plate is exposed to the action of a halogen element or compound, as iodine, bromine, or chlorine, and then further exposed to the action of a strong light for several hours before introducing it into the electrotyping apparatus.

59,910—November 20, 1866. A. T. HAY. *Improvement in preventing incrustation of sugar or other boilers.*

The formation of scale or incrustation in evaporating pans or kettles is prevented by passing around the pan an electric current.

87,193—February 23, 1869. C. C. PARSONS. *Improvement in purifying pyroligneous or acetic acid.*

The vapors from the still are passed through carbonaceous or purifying material. The terminals of a galvanic battery are connected respectively with the condensing worm and the water of the condensing tub.

98,110—December 21, 1869. S. RUST, Jr. *Improvement in electro-plating with brass and other alloys.*

The depositing bath is formed by dissolving the brass or other alloy directly by the electro-process in a solution of potassium cyanide and sulphuret of carbon. The process of electroplating with brass or other alloy is claimed, and articles coated by the process.

113,331—April 4, 1871. R. O'NEIL. *Improvement in ornamenting the surface of metals by electro-depositions from solutions.*

The surface of the metal is painted with a salt or a solution of a salt of the metal to be deposited by means of a pencil in connection with a galvanic battery, the metal operated upon being in connection with the other pole of the battery.

116,579—July 4, 1871. M. G. FARMER. *Improvement in nickel plating.*

The double sulphate of nickel and ammonia is formed by the electrolysis of a solution of sulphate of ammonia, using a nickel anode.

116,658—July 4, 1871. I. ADAMS, Jr. *Improvement in nickel-plating.*

Heat is applied to the solution of sulphate of ammonia—about 150° F.—in forming the double sulphate of nickel and ammonia by the electrolytic process.

130,362—August 13, 1872. E. E. DE LOBSTEIN. *Improvement in plating and coating metals.*

The article to be coated is subjected to a weak cold solution of the required coating metal and to the action of a galvanic battery and is subsequently subjected to the heat required to melt the coating.

179,658—July 11, 1876. N. S. KEITH. *Improvement in apparatus for removing tin from scraps, etc., by electricity.*

Scrap tin plate, separated and extended on an endless chain conveyor, is progressively treated in a heated electrolyzing bath.

229,542—July 6, 1880. J. L. MARTIN. *Process and apparatus for aging liquors.*

Liquors are subjected to the combined action of a current of electricity and a catalytic agent acting upon the liquor through the medium of a porous diaphragm or cell.

256,330—April 11, 1882. E. D. KENDALL. *Process of treating certain derivatives of coal-tar colors.*

Nitro-benzene, or a mixture of nitro-benzene and nitro-toluene (e.g., nitrobenzene or the mixture 1 part, sulphuric acid 2 parts, and water 30 parts), is electrolyzed in the negative compartment of a cell, with acidulated water in the positive compartment, producing the corresponding amido compounds (analine or toluidine). The negative electrode should be gently agitated. The color-yielding products are obtained, at the same time, by placing analine or toluidine in contact with the electrode in the acidulated water of the positive compartment.

264,928—September 26, 1882. H. R. CASSEL. *Process of and apparatus for separating metals.*

The cathode of an electrolytic cell is provided with a protective covering of a dense, porous, nonconductive material—such as leather, parchment, or canvas—which admits the passage of the current and prevents deposition upon the cathode.

271,906—February 6, 1883. A. L. NOLF. *Process of and apparatus for obtaining chlorine and sodium.*

A concentrated solution of sodium chloride is electrolyzed in a closed tank in the presence of mercury, which covers the bottom and constitutes the negative electrode.

272,187—February 13, 1883. C. E. BALL. *Electric gas generator.*

Hydrocarbons or other olefiant liquids are sprayed or injected into or upon an electric arc, whereby the liquid is not only volatilized but converted into a fixed gas.

277,977—May 22, 1883. E. BAUER. *Process of and composition for the manufacture of substitutes for leather, horn, tortoise shell, etc.*

See Group XV, Rubber and Rubber Substitutes.

282,964—August 14, 1883. J. L. DELAPLAINE, J. G. HENDRICKSON, AND F. J. CLAMER. *Removing tin from tin scrap by electricity.*

Scrap metal is placed directly in an electric circuit, in an insulated chamber, and the coating metal melted by the heat generated within the mass, by incandescence.

284,862—September 11, 1883. M. H. LACKERSTEEN. *Process of treating fats and oils.*

Fat acids and glycerine are produced by passing a current of electricity through an emulsion of the fat, or oil and water.

286,208—October 9, 1883. L. LÉTRANGE. *Process of and apparatus for reducing zinc ores.*

Sulphuret and carbonate ores of zinc are simultaneously roasted in the same or communicating chambers and converted into soluble sulphates, which are leached and the solution electrolyzed. Zinc is deposited on metal cathode plates, and sulphuric acid is led off as fast as formed.

291,463—January 1, 1884. C. E. BALL AND C. S. BRADFORD, Jr. *Electric gas generator.*

A mixed or combined hydrocarbon-hydrogen gas is produced by generating hydrocarbon gas according to No. 272,187, and in like manner generating hydrogen gas in another electric generator, and mingling the gases.

292,119—January 15, 1884. J. K. KESSLER. *Process of making white lead.*

An acetate of an alkali is electrolyzed, using lead for both anode and cathode, with the formation of acetate of an oxide of lead at the positive pole and a caustic solution of the alkali at the negative pole, the products formed being kept separated in the cell and subsequently mixed; whereby hydrated oxide of lead is precipitated and the original solution of the acetate regenerated. Carbonic acid gas is introduced into the solution with the precipitate in suspension, converting the precipitate into white lead.

292,753—January 29, 1884. J. K. KESSLER. *Process of making sponge lead.*

A solution of the acetate of an alkali is used as the electrolyte, with lead electrodes, the lead of the electrodes being replenished as it is consumed. The sponge like mass of lead deposited upon the surface of the cathode is from time to time removed for conversion into white lead and red lead.

294,051—February 26, 1884. J. K. KESSLER. *Process of making copper salts by the aid of electricity.*

Basic acetate of copper is produced by first electrolyzing a solution of chloride of sodium or potassium, using a copper anode, keeping the products separate, and then mixing them, whereby hydrated suboxide of copper is precipitated; and, second, mixing the hydrated suboxide of copper, washed and dried, with neutral acetate of copper (in the proportions of 79:198), moistening the mixture with water, and exposing it to the air.

294,619—March 4, 1884. E. HERMITE. *Bleaching of paper pulp or other fibrous or textile materials or fabrics.*

Chlorides of soda or potash are decomposed by an electric current under conditions producing an alkali and a metalic chloride, as chloride of lead (lead cathodes being used). The metallic chloride, diluted or acidified, is then electrolytically decomposed, in the presence of the materials to be bleached (fabrics or paper pulp), and the metal recovered. A rag engine with suitable electrodes is used.

296,357—April 8, 1884. A. J. ROGERS. *Process of and apparatus for reducing metals by electrolysis.*

Fused sodium chloride or potassium chloride is fed into a separate electrolytic cell and electrolyzed, and the chlorine and vapor of sodium, or potassium, led off into separate receptacles, that for the latter containing coal oil; the passage which conducts the sodium, or potassium, vapor into the receptacle being supplied with hydrogen or other suitable gas to prevent contact of oxygen with the vapor.

319,795—June 9, 1885. E. H. & A. H. COWLES. *Process of smelting ores by the electric current.*

Ores or metalliferous compounds are subjected to the action of heat generated by passing an electric current through a granular body of conductive but resistant material forming a continuous part of the circuit, and mixed or otherwise in contact with the material to be treated.

322,940—July 28, 1885. T. KEMPF. *Manufacture of iodoform, bromoform, and chloroform.*

They are produced by the electrolysis of a solution of the corresponding halogen combinations of the alkalis and alkaline earths in the presence of alcohol, aldehyde, or acetone, with the application of heat, and in the case of iodoform, with the introduction of carbonic acid.

323,514—August 4, 1885. W. MAJERT. *Manufacture of methylene-blue by electrolysis.*

Methylene-blue and other homologous colors containing sulphur are produced from paramido derivatives of primary, secondary, and tertiary amines (e. g., paramido-dimethylaniline), and from the hydrazo compounds of the latter, by electrolysis in an acidulated solution and in the presence of such sulphurous substances (e. g., hydrogen sulphide) as, under the action of the electric current, separate out sulphur on the positive pole.

324,658—August 18, 1885. E. H. & A. H. COWLES. *Electric process of smelting ore for the production of alloys, bronzes, and metallic compounds.*

Pieces of base metal, or ore thereof, are mixed with the charge of process No. 319,795, to produce an alloy of the metals present.

324,659—August 18, 1885. E. H. & A. H. COWLES AND C. F. MABERY. *Process of electric smelting for obtaining aluminium.*

A mixture of aluminium compound, carbon, and an alloying metal is reduced in an electric furnace, and then the alloyed metals are separated by amalgamation or lixiviation.

326,657—September 22, 1885. T. KEMPF. *Process of manufacturing permanganates.*

Permanganic-acid salts are obtained, and free metallic hydroxides, by electrolytically treating the solutions of the manganic-acid salts; using a double cell with a diaphragm, the negative electrode being suspended in water and the positive electrode in the solution of the manganic-acid salt.

335,499—February 2, 1886. C. S. BRADLEY AND F. B. CROCKER. *Process of heating and reducing ores by electricity.*

An electric current is passed through the conducting walls of a retort, the same being in contact with a mixture of conducting material and material to be heated, so that electric heat is generated both in the walls of the retort and in the mixture.

339,727—April 13, 1886. E. C. ATKINS. *Art of manufacturing soap.*

A current of electricity passed through the ingredients in the mixing vat hastens the chemical reactions and the soap formation.

353,566—November 30, 1886. M. H. LACKERSTEEN. *Process of manufacturing soap and glycerine.*

An emulsion of a saturated saline solution—such as sodium chloride—and the melted fats and oils is electrolyzed in a two-compartment diaphragm tank.

356,640—January 25, 1887. A. S. HICKLEY. *Process of manufacturing amalgams by electrolysis.*

A metal-producing solution—as sodium chloride—is continuously circulated in a current between an anode of carbon and a cathode of mercury, thereby depositing the reduced metal upon the mercury and forming an amalgam.

357,659—February 15, 1887. D. G. FITZ-GERALD. *Obtaining chlorine by electrolysis.*

An anode of peroxide of lead in the form of dense, highly conductive layers, plates, or masses is employed in conjunction with a suitable cathode and an electrolyte capable of evolving chlorine.

382,159—May 1, 1888. E. HERMITE. *Process of bleaching.*

An electrolyzed solution of chloride of magnesium is used. The bleaching is continuous without regeneration of solution so long as the electric current acts on the solution in presence of coloring matter.

389,781—September 18, 1888. W. WEBSTER, JR. *Process of electrolyzing sewage and sea water.*

For producing ammonia, chlorine, or other products from sewage, sea water, and other liquids, two bodies of one and the same liquid are subjected to the electrolytic action of positive and negative electrodes in the compartments of a porous diaphragmed cell; one of the bodies being repeatedly renewed while the other is retained and the electrolytic action thereon continued.

393,578—November 27, 1888. L. PAGET. *Production of zinc chloride, etc.*

Zinc chloride is produced as a by product in a voltaic combination in which electro-motive force is set up. A gas, as chlorine, is first generated by the union of sulphuric acid and bleaching powder; sulphate of lime being produced as a by-product. The gas is injected into an electrolyte composed of water holding calcium carbonate in suspension; said electrolyte compound being in contact with the electrodes of the voltaic combination (zinc or iron and lead), whereby zinc chloride (or iron chloride) is produced.

396,325—January 15, 1889. A. & L. Q. BRIN. *Method of bleaching fibrous substances.*

Fibrous material for use in paper making is treated with a mixture of oxygen and chlorine gases (e. g., 90 per cent oxygen and 10 per cent chlorine) which has been subjected to the action of an electric current.

398,101—February 19, 1889. W. WEBSTER, JR. *Process of purifying sewage by electricity.*

Sewage and other impure water is passed in contact with electrically excited positive and negative electrodes of iron, resulting in the formation of a flocculent precipitate of ferrous hydrated oxide, which effects the precipitation of the solid matter and the purification of the impurities held in solution.

414,935—November 12, 1889. T. D. BOTTOME. *Manufacture of white lead.*

Lead anodes are electrolytically dissolved in an alkaline aqueous solution saturated with free carbon dioxide.

415,644—November 19, 1889. G. KERNER AND J. MARX. *Process of electrolyzing salts of the alkalis.*

In the electrolysis of the alkalis, or alkaline and other earths, chemical action is carried on concurrent with electric action, to remove the product resulting from electrolysis before or on reaching the limit at which electrolytic action is arrested, the undecomposed portion of the salt in the solution being further treated. This is effected by passing into the cell a chemical agent to precipitate the portion ot the product formed, or by circulating the electrolyte through an outer precipitating chamber, an enriching cistern, and back into the electrolytic cell.

417,943—December 24, 1889. J. B. READMAN. *Process of obtaining phosphorus.*

Materials containing phosphorus are reduced by heat generated within a furnace chamber and directly applied to the material, as in an electric furnace, without introducing oxidizing, reducing, or other gases.

422,500—March 4, 1890. H. Y. CASTNER. *Process of purifying aluminium chloride.*

The anhydrous double chloride compounds of aluminium containing iron are purified and the iron removed by electrolyzing the compounds in a fused condition and in motion.

427,744—May 13, 1890. T. F. COLIN. *Process of obtaining chlorine compounds from natural gas.*

The chlorides of marsh gas (chlormethane, dichlormethane, and chloroform) are formed by the mutual combustion of chlorine and natural gas or methane, mixed in suitable proportions within a chamber or retort. The gases are ignited and the reaction maintained by an electric spark of proper tension, the chamber being maintained at a proper temperature. The hydrogen chloride is absorbed from the resultant gas and the methyl chlorides liquefied.

428,552—May 20, 1890. E. A. COLBY. *Process of melting, refining, and casting metals.*

The mass of the substance in a retaining vessel is melted by inductively establishing electric currents in the substance or the receptacle.

430,453—June 17, 1890. T. L. WILLSON. *Process of melting or reducing metals by electricity.*

Metals or ores are fused in an electric arc formed between an upper electrode and the metal or ore beneath, and a reducing gas is injected into the crater to protect the incandescent surface of the electrode.

442,661—December 16, 1890. T. D. BOTTOME. *Process of desilverizing lead by electrolysis.*

Argentiferous lead anodes are used in the electrolysis of a solution of ammonium salts (for example, ammonium nitrate and ammoniate carbonate, each one-fourth pound in 1 gallon of water) saturated with free carbon dioxide, whereby lead carbonate precipitates and silver deposits upon the cathodes.

448,541—March 17, 1891. T. PARKER AND A. E. ROBINSON. *Process of making iodine by electrolysis.*

An acid solution of an iodide, such as iodide of sodium or potassium, is electrolyzed in contact with the positive electrode, and an alkaline solution (caustic) in contact with the negative electrode, the two solutions being separated by a porous diaphragm. The iodine is then drained off and washed.

452,030—May 12, 1891. H. Y. CASTNER. *Process of manufacturing sodium and potassium.*

Caustic alkali is maintained at a temperature of not more than 20° C. above its melting point and electrolyzed. A gauze or screen is interposed between the electrodes and a superposed vessel or dome for collecting the separated metal.

459,236—September 8, 1891. C. G. COLLINS. *Process of purifying brine.*

Brine is subjected to a current of electricity having an electro-motive force not exceeding 2½ volts to decompose the impurities, but below the intensity necessary to decompose the sodium chloride, whereby the impurities are rendered insoluble by decomposition. Simultaneously the impurities are removed by filtration.

459,946—September 22, 1891. D. V. KYTE. *Manufacture of white lead.*

Lead anodes are electrolytically dissolved in an acid electrolyte to form oxygen-bearing salts, the silver, if any, is removed from the electrolytic solution by electro-deposition, the remaining solution is rendered neutral, or nearly so, and it is then treated with carbon dioxide.

460,277—September 29, 1891. J. B. GARDNER. *Method of obtaining fluids for primary batteries.*

The method of recovering elements employed with galvanic batteries comprises the following steps: Treating a salt—as chromate of lead or other chromate—with an acid so as to separate it into two parts, one of which contains the depolarizing element, using the depolarizing element thus obtained alone or in combination with an acid or acid salt in a battery fluid; treating the spent depolarizing fluid so as to recover the metal employed or the oxide of that metal; and combining the remainder of the spent depolarizing fluid with the unused part of the salt obtained in the first step to recover the original salt employed.

462,567—November 3, 1891. F. M. LYTE. *Process of making alkaline carbonate and chlorine.*

Sodic or potassic carbonate and chlorine are continuously produced by heating sodic or potassic nitrate with calcic carbonate(in the proportions of two to two and one-fourth), lixiviating out the sodic carbonate and converting the nitrous fumes evolved into aqueous nitric acid, dissolving plumbic oxide in the nitric acid, precipitating plumbic chloride by means of sodic or potassic chloride, fusing the plumbic chloride, and decomposing it electrically to form chlorine and lead for use over again.

462,694—November 10, 1891. A. FOELSING. *Process of purifying tannin solutions by electrolysis.*

Ooze is clarified and decolored by electrolyzing a tannic solution mixed with oxalic acid and sodium chlorides.

464,097—December 1, 1891. L. GRABAU. *Process of obtaining metallic sodium.*

Sodium chloride is combined with another chloride of the metals of the alkalis—as potassium chloride—and with a chloride or chlorides of the metals of the alkaline earths—as strontium chloride—in the proportion of one molecule of the latter to three molecules of the chlorides of the metals of the alkalis, forming a trisalt combination the melting point of which is lower than that of sodium chloride. The trisalt is melted and the sodium separated by electrolysis. Potassium may be eliminated therefrom by oxidizing fusion.

466,460—January 5, 1892. T. A. EDISON. *Art of electrolytic decomposition.*

Substances not readily decomposable at low temperatures—such as chloride of aluminum—are decomposed by subjecting them to the action of an electric current at a high temperature and under pressure. They are confined in a suitable vessel, heated sufficiently to vaporize material in the vessel and produce pressure and raise the temperature above the boiling point, and then electrolyzed.

466,720—January 5, 1892. S. C. C. CURRIE. *Process of obtaining insoluble chlorides by electrolysis.*

The metal—as, for example, silver, lead, or mercury—to be converted into a chloride is made the anode in an electrolytic cell containing a neutral metallic chloride solution, such as chloride of zinc, and electrolytically converted into an insoluble chloride.

470,181—March 8, 1892. C. G. COLLINS. *Purification of brine.*

As an improvement on the process of No. 459,236, oxygen is independently supplied to the brine whereby ozone is formed without decomposing the chloride of sodium. The nascent oxygen generated in the brine combines with the dissolved oxygen, producing a maximum amount of ozone.

471,454—March 22, 1892. A. E. WOOLF. (*Reissue: 11,244—June 7, 1892.*) *Process of and apparatus for bleaching by electrolysis.*

Sea water, or a like saline solution, is electrolyzed in the vat containing the material to be bleached, atmospheric air being forced in between the electrodes, thereby generating ozone and chlorine as the bleaching agents.

472,230—April 5, 1892. J. H. SCHARLING. *Process of decorating glass.*

Metal is applied to articles having nonconducting surfaces by repeatedly pouring a solution of metallic salts over the article until it is completely covered, slowly turning it or moving it during the process, and finally subjecting it to the action of an electroplating bath.

477,735—June 28, 1892. J. BLAIR. *Process of making white pigments.*

A charge of sulphuric acid, an alkaline nitrate and water, with metallic lead, forming the anode of an electric circuit, is heated by injected steam, and the lead corroded. The reduced lead, sulphate, and nitrate, is then washed in a solution of an alkaline hydrate. The process without the electrolytic action is also claimed.

478,048—June 28, 1892. C. G. COLLINS. *Process of purifying water.*

The process of No. 470,181 is applied to water purification. Free oxygen is independently supplied to water while it is under the decomposing action of an electric current.

479,781—August 2, 1892. C. W. BRUNSON. *Process of purifying liquid.*

Liquids, including spirituous liquors, and those of an oily nature, are purified by the application or electrolysis at a temperature approximating to its freezing point. The impurities rise to the surface and are removed by skimming or otherwise.

480,492—August 9, 1892. E. B. CUTTEN. *Method of electrolytically producing potassium chlorate.*

Magnesium chloride (e. g., 15 to 20 per cent solution) is eloctrolyzed in the presence of potassium chloride and slacked lime, the electrolyte being agitated during electrolysis.

For the production of magnesia and potassium chlorate, a solution of magnesium chloride is electrolyzed in the cathode compartment, and potassium chloride, magnesium chloride, and slacked lime in the anode compartment of a cell having a porous partition, whereby potassium chlorate is produced at the anode and magnesia at the cathode.

480,493—August 9, 1892. E. B. CUTTEN. *Method of electrolytically producing potassium chlorate.*

Magnesium chloride is electrolyzed in the presence of potassium chloride and magnesium oxide; the electrolyte should be agitated pending electrolysis.

481,407—August 23, 1892. F. M. LYTE. *Production of caustic alkalis and chlorine.*

Caustic alkali and chlorine are conjointly and continuously produced by decomposing an alkaline nitrate by heating it with ferric oxide to evolve nitrous fumes, decomposing the residue by boiling with water into caustic alkali and a precipitate of ferric hydrate, converting the nitrous fumes into aqueous nitric acid, dissolving plumbic oxide therein, precipitating plumbic chloride, fusing it, and decomposing it electrolytically into chlorine and lead, and finally converting this (or other) lead into plumbic oxide and the ferric hydrate into ferric oxide for recommencing the cycle.

484,990—October 25, 1892. H. BLACKMAN. *Electrolytic process and apparatus.*

A centrifugal electrolytic cell is employed, whereby the products resolve themselves into distinct layers, and the process becomes continuous, with a constant inflow of brine and discharge of chlorine and caustic soda, or other material and products, as the case may be. Under the centrifugal action the gas products are thrown inwardly, and the caustic soda outwardly, and both separated from the electrolyte and discharged through separate conduits.

486,575—November 22, 1892. T. L. WILLSON. *Process of electrically reducing refractory compounds.*

A pulverized metallic compound—as alumina—is first saturated with a reducing agent in a liquid condition—as coal tar—and the impregnated compound is then reduced by electric heat.

489,632—January 10, 1893. F. GRUESSNER. *Process of regenerating solutions.*

Electrolytic solutions used for refining purposes, and which have become charged with arsenic and like impurities, are regenerated by mixing therewith metastannic acid and boiling until the impurities are precipitated.

491,394—February 7, 1893. T. L. WILLSON. *Process of electrically reducing aluminum and forming alloys thereof.*

Refractory metallic oxides, as alumina, are subjected, in the presence of comminuted carbon as a reducing agent, to the heat of an electric arc passing between a molten metallic bath and a carbon electrode above. A bath of base metal produces an alloy, and the comminuted carbon protects the electrode from oxidation.

491,700—February 14, 1893. E. B. CUTTEN. *Method of electrolytically producing soda and chlorine.*

The electrolysis of a saline solution takes place in a cell having a closed anode compartment with means for exhausting the atmosphere, whereby the chlorine is withdrawn from the body of the solution, and access of the same to the freed sodium is prevented, and substantially all of the soda gravitates to the bottom.

491,701—February 14, 1893. E. B. CUTTEN. *Method of electrolytically producing potassium chlorate.*

A solution of magnesium chloride, to which potassium chloride is added, is electrolyzed by means of a slowly alternating current, the potassium chlorate being constantly removed and potassium chloride added.

492,003—February 21, 1893. H. GALL AND A. DEVILLARDY DE MONTLAUR. *Manufacture of chlorates of the alkaline metals and metals of the alkaline earths.*

An aqueous solution of the chloride corresponding to the required chlorate is electrolyzed in a cell having a porous partition and a heating coil, and the contents of the negative compartment is continuously conveyed into the positive compartment where the chlorate is formed.

492,377—February 21, 1893. T. L. WILLSON. *Electric reduction of refractory metallic compounds.*

Refractory compounds are commingled with subdivided carbon in sufficient proportion to prevent the formation of a bath of the fused compound, and reduced by an electric arc maintained close above the material, whereby fluctuations in the resistance of the arc due to the ebullition of a bath are avoided.

493,023—March 7, 1893. W. T. GIBBS AND S. P. FRANCHOT. *Process of obtaining chlorates of the alkalis or of the alkaline earth metals by electrolysis.*

A solution of chloride of potassium is electrolyzed in a cell having a cathode composed of an oxide (copper oxide) which readily yields up its oxygen in the presence of nascent hydrogen, until about one-half of the potassium chloride is converted into potassium chlorate, when the solution is drawn off, cooled, and the potassium chlorate allowed to crystallize. The cathode is removed, washed, dried, reoxydized at a dull red heat, and replaced. The liquor is regenerated and returned to the cell and the process repeated.

496,109—April 25, 1893. A. B. BROWNE. *Process of manufacturing white lead.*

A body of metallic lead constitutes the anode in an electrolytic solution of a nitrate of an alkaline base—as nitrate of soda—whereby a lead is precipitated. The solution and product is drawn off, the lead hydrate settled, the solution drawn off therefrom, and the lead hydrate dried in the air or an atmosphere containing carbonic acid gas.

498,769—June 6, 1893. T. CRANEY. *Method of electrolyzing salts.*

In an apparatus for the manufacture of sodic hydrate, a series of covered electrolytic diaphragm cells is arranged on descending levels with inlet and outlet connections between the successive chambers of the series. Fresh solution is supplied to the anode compartment in quantity to maintain the solution in concentration; a limited amount of the solution is supplied to the cathode chamber, and the supply is regulated to produce a discharge of the product in a uniform state of concentration.

501,121—July 11, 1893. C. N. WAITE. *Art of manufacturing chlorine or caustic alkali by electrolysis.*

Prior to electrolyzing a saline solution, the brine, or so much thereof as is to be used on the anode side of the cell, is treated with an alkaline chloride—as barium chloride—to convert all trace of sulphuric acid into an insoluble precipitate.

501,578—July 18, 1893. H. PFANNE. *Method of manufacturing varnish, and apparatus therefor.*

Purified linseed oil is thoroughly mixed and agitated with sulphuric acid and water and subjected to the passage of an electric current for two or three hours; the oxygen produced in the nascent state converts the oil into varnish.

501,732—July 18, 1893. H. ROESKE. *Method of and apparatus for purifying water.*

The water is filtered through a stratum or body of comminuted iron which is simultaneously agitated and subjected to the action of an electric current.

501,783—July 18, 1893. E. HERMITE AND A. DUBOSC. *Method of and apparatus for electrolyzing solutions.*

In the electrolysis of an alkaline solution a thin sheet of mercury flowing over inclined electrodes forms an amalgam of the metal of the base; which amalgam, received in a trough, is separated from the saline solution by a layer of liquid—as sulphuret of carbon—lighter than the amalgam and heavier than the saline solution. The mercury separates from the amalgam by gravity, and the latter discharges into a water tank and gives up its sodium, or base, to form the caustic soda or like product.

502,431—August 1, 1893. H. H. EAMES. *Process of desulphurizing metallic ores.*

Impurities and foreign substances, as sulphur and phosphorous, are eliminated from metallic ores or obtained from minerals by subjecting the ore, in a closed vessel, to the action of heat (sufficient to liquify sulphur but insufficient to fuse the ore) and an electric current.

503,429—August 15, 1893. F. M. & C. H. M. LYTE. *Process of producing chlorine and purifying lead.*

A soluble chloride—calcic chloride or magnesic chloride—is decomposed with lead nitrate, forming lead chloride and a nitrate; then, on the one hand, the lead chloride in a fused state is electrolytically decomposed to produce chlorine and lead; and, on the other hand, the nitrate is decomposed to obtain nitric acid, which is used over again for the production of more nitrate of lead by oxidizing lead (freed from zinc), and dissolving the lead oxide in the nitric acid, precipitating any silver from the nitrate of lead solution to form pure nitrate of lead with which to continue the cycle of operations.

505,846—October 3, 1893. P. DEP. RICKETTS. *Process of separating metallic nickel.*

Nickel is separated from other metals, salts of metals, and impurities combined therewith in nickeliferous bodies by purifying and concentrating when necessary, forming the purified mass into plates or shapes, immersing the plates in sulphuric acid, adding thereto sulphates of alkaline bases or other similar reagents in such quantities as not to interfere with the said reaction; thereby forming a bath of such composition as to dissolve the copper and nickel and retain the former in solution, and form with the latter insoluble salts; then causing an electric current to traverse the bath from the nickeliferous body as anode to a suitable cathode placed therein, whereby the copper is deposited upon the cathode; and, finally, in separating the precipitated salts and subjecting them to further treatment.

506,248—October 10, 1893. G. OPPERMANN. *Process of and apparatus for purifying water.*

It is successively electrolyzed, agitated, and heated.

508,804—November 14, 1893. H. S. BLACKMORE. *Process of and apparatus for dissociating salts of alkalis by electrolysis.*

The electrolytic cell is composed of three compartments, the end compartments, which are charged with water and contain the electrodes, being connected with the middle compartment by siphons. A uniform and constant level of the bath and of the liquid of the electrode compartments is maintained, and the saturated portions of the liquid of the electrode compartments are from time to time drawn off.

510,276—December 5, 1893. F. M. LYTE. *Process of electrolytically decomposing fused metallic chlorides.*

In an apparatus for the electrolysis of fused metallic chlorides, the mouth of a bell chamber is sealed against the escape of chlorine by dipping into a bath of molten metal corresponding to the base of the chloride treated, and resulting, in part, from the decomposition of the chloride.

510,884—December 12, 1893. H. S. BLACKMORE. *Process of and apparatus for dissociating soluble salts by electrolysis.*

The process consists in providing a bath of the electrolyte and two independent bodies of liquid, establishing a dialytic communication between the bath and each of the independent bodies of liquid, maintaining the latter at a higher level than the level of the bath, and passing a current of electricity through the independent bodies of liquid and through the bath. The solutions of the ions from the independent bodies of liquid are withdrawn while the current is maintained.

511,330—December 26, 1893. E. FAHRIG. *Process of and apparatus for manufacturing ozone gas.*

Oxygen is absorbed from the air by a suitable absorbent, as manganate of soda and lime in a heated retort, and is then liberated by steam, the temperature of the composition being raised from 1,500° to 1,800° F. The steam is then eliminated from the gas by cooling and condensing, and the oxygen is dried and passed through an ozonizing apparatus.

511,450—December 26, 1893. A. A. NOYES AND A. A. CLEMENT. *Process for the manufacture of para-amido-phenol-sulphonic acid.*

A strong sulphuric-acid solution of nitro-benzol is electrolyzed; the product is diluted and filtered; the solid washed and treated with caustic soda, or other alkali, which dissolves out the para-amido-phenol-sulphonic acid as a sodium salt, the sulphonic acid being precipitated by neutralizing with hydrochloric acid.

512,276—February 6, 1894. P. DEP. RICKETTS. *Process of electrolytic separation of nickel from copper.*

A division of No. 505,846: the nickeliferous body in this case being first dissolved in any suitable acid, and then, if necessary, concentrated in solution, the acid reaction being maintained, and the separation effected by the subsequent addition of the desired reagents in connection with the electric current.

515,763—March 6, 1894. C. VON GRABOWSKI. *Process of and apparatus for purifying sulfate lyes.*

Sulphate lyes or liquors containing free sulphuric acid, and, in addition to metallic sulphates, containing also arsenic and antimony, are purified by evaporating to a s. g. of 52° Baumé and allowing the sulphates to crystalize out. The liquor is then electrolyzed with a current of high strength using lead or copper electrodes, and the arsenic and antimony are deposited.

517,001—March 20, 1894. J. D. DARLING. *Mode of producing nitric acid and metals from nitrates.*

Nitrate of soda or potash is electrolyzed in a state of fusion in a closed vessel, the nitrogen peroxide being led off and converted into nitric acid, and the metallic base being drawn off as formed. By preference the temperature is limited to an extent to prevent the breaking down of the nitrate and the liberation of oxygen. Some of the oxygen may be driven off by preheating at a high temperature.

518,710—April 24, 1894. H. CARMICHAEL. *Method of and apparatus for electrochemical decomposition.*

The process, applicable to the electrolysis of any available solution as well as sodium chloride, consists in maintaining within the electrolytic cell a zone of undecomposed solution of sodium chloride interposed between the sodium hydrate and chlorine at their respective electrodes, by supplying to such zone fresh quantities of sodium chloride solution so as to displace the sodium hydrate toward its appropriate electrode, and by withdrawing from the cell the sodium hydrate thus displaced; the supply of sodium chloride solution and the withdrawal of sodium hydrate being made to proceed at such a rate as to maintain the zone of undecomposed sodium chloride between the ions substantially constant in volume.

519,400—May 8, 1894. H. BLUMENBERG, JR. *Electrolysis.*

An electrolyte containing a haloid salt—bromide or chloride—is electrolyzed, and the liberated gas is transferred from the positive to the negative electrode, forming a chlorate or bromate. The liquid electrolyte is then drawn off, settled, and the liquor resaturated and returned to the cell.

522,616—July 10, 1894. I. L. ROBERTS. *Method of electrolytic decomposition of salts.*

The salt crystals are continuously fed into the anode compartment, instead of into the cathode, and maintained in contact with the anode and up to the level of the solution, whereby no impoverishment of the solution in any part can occur.

523,263—July 17, 1894. G. A. CANNOT. *Process of manufacturing hypochlorous acid.*

Oxygen and chlorine gases are thoroughly dried and mixed and electric sparks are passed through the mixture to convert the gases into chlorine monoxide. The gases are cooled while subjected to the electric sparks during their passage through an ozonizing tube, and the resultant gaseous products are conveyed into a suitable solvent.

526,147—September 18, 1894. T. A. EDISON. *Art of plating one material with another.*

The body to be plated is supported in an exhausted chamber together with an electrode (or electrodes) of the material to be deposited, and the material is electrically vaporized in the chamber, the body being moved to bring different portions of it successively into proximity to the electrode. An alloy deposit is formed by means of electrodes of different conducting material and maintaining an arc between them. Metallic foil is made by depositing on a suitable body and subsequently stripping off the deposited metal.

527,326—October 9, 1894. J. T. DONOVAN AND H. L. GARDNER. *Process of producing ozone.*

Ozone is produced by the electrolysis of a solution of a permanganate of a solid metallic base, such as potassium permanganate, in water.

528,322—October 30, 1894. H. Y. CASTNER. *Process of and apparatus for electrolytic decomposition of alkaline salts.*

A moving body of mercury, or other liquid metal or alloy, occupies the bottom, and communicating passage, of the compartments of a decomposing cell, separating the solutions therein, and the electric current passes from the electrode and liquid of one compartment into and through the mercury to the liquid and electrode of the other compartment; whereby, while the alkaline metal is being deposited and amalgamated with the mercury in one compartment, a like amount of the alkaline metal is being set free in the other compartment, reducing the counter electromotive force.

531,235—December 18, 1894. C. T. J. VAUTIN. *Process of and apparatus for the production of caustic alkali.*

A fused salt of sodium, or potassium, in an open hearth or a closed chamber, is electrolyzed upon a molten bath of lead, which constitutes the cathode, and with which the sodium alloys. In a second heated chamber connected with the molten cathode by an open conduit, the sodium of the alloy, the same being a part of the cathode *in situ*, is subjected to steam and converted into a caustic alkali which is drawn off. The feed is continuous and the chlorine is collected.

535,802—March 12, 1895. O. LUGO. *Process of purifying water.*

It is electrolyzed, using aluminum anodes (which form insoluble aluminum oxyhydrate), and the water flows in a continuous course through the tank containing the electrodes. The coagulated matter is then removed by filtration or otherwise.

536,848—April 2, 1895. H. BLUMENBERG, JR. *Electrolysis.*

An electrolyte containing a haloid salt—bromide or chloride—is electrolyzed in a cell having a closed positive compartment, and the gas generated, under its own pressure, passes therefrom to a holder. The base product is conveyed to a tank, the gas from the holder passed into said tank, and the product—bromates or chlorates—therein formed.

537,179—April 9, 1895. H. BLUMENBERG, JR. *Electrolysis.*

An electrolyte containing a haloid salt—bromide or chloride—is electrolyzed in a cell having a closed positive compartment, and the gas generated, under its own pressure, passes therefrom to a holder. Additional fluid pressure is then applied to said gas; the base product is conveyed to a tank, the gas passed into the tank, and the product—bromates or chlorates—therein formed.

537,403—April 9, 1895. G. D. BURTON. *Art of extracting grease from wool.*

The greasy, fibrous substance is immersed in an electrolyzed solution, as of bichromate of potash, the current causing a dielectric polarization and movement of the fibrous substance; the electrodes may be of lead. For 30 gallons of solution of a gravity of 1.05 an electric current of 220 volts and 65 amperes may be used, the current to be reduced to 20 amperes as soon as the temperature of the bath rises to about 155° F.

538,998—May 7, 1895. A. B. BROWNE AND E. D. CHAPLIN. *Process of manufacturing chromate of lead.*

Chrome hydrate, precipitated from a solution of chrome alum, is mixed with an excess of caustic alkali and redissolved, and the resulting solution is mixed with a solution of chloride of sodium, and the joint solution electrolyzed to decompose the alkaline solution and produce a mixture of bichromate and chromate of potash. The combined chromates are then mixed with a solution of a soluble salt of lead (as the nitrate, acetate, or chloride) to precipitate lead chromate, which is filtered, washed, refiltered, and dried.

541,137—June 18, 1895. T. L. WILLSON. (*Reissue: 11,511—Oct. 22, 1895.*) *Calcium-carbide process.*

Pulverulent and thoroughly commingled carbon and lime is fed into the interspace between two electric poles by means of an alternating current of electricity (the action not occurring to the same extent when a direct current is used) and is converted into calcium carbide by the electric arc formed between said poles.

541,146—June 18, 1895. H. BLACKMAN. *Electrolytic process and apparatus.*

The electrolyte is cooled, to prevent excessive heating, by continually drawing it off from the cell, passing it through a cooler, and returning it to the cell, at the same time maintaining it cool in the cell by cooling pipes.

541,147—June 18, 1895. H. BLACKMAN. *Process of and apparatus for bleaching.*

The hypochlorite electrolyte of an electrolyzed bleaching solution of a chloride of an alkali or alkaline earth is heated and employed for bleaching at an elevated temperature, then drawn off, cooled, and again electrolyzed at a low temperature, to again generate the hypochlorite and reconstitute it as a bleaching agent.

541,335—June 18, 1895. C. SALZBERGER. *Process of and apparatus for disinfecting and purifying water.*

The water is mixed with lime paste, then charged with carbon dioxide to form bicarbonate of lime, and then electrolyzed to set free carbonate of lime and carbon dioxide.

541,465—June 25, 1895. C. T. J. VAUTIN. *Electrolytical process and apparatus.*

Alloys of lead, tin, and alkaline metals are produced by supplying lead and (or) tin intermittently to an electrolytic furnace together with a fused alkaline salt superposed thereon, discharging intermittently alloys of lead and tin with volatile metals when formed electrolytically, treating said alloys by distillation while still molten, condensing the pure distilled volatile metals, and returning the nonvolatile metal to the reducing furnace.

541,597—June 25, 1895. J. D. DARLING. *Method of and apparatus for manufacturing sulfuric acid and by-products.*

A fused nitrate, as nitrate of soda, is electrolytically decomposed in a closed cell, and the disengaged gases directly conducted to a Glover tower for use in the sulphuric-acid chambers. The basic residuum—mainly sodium monoxide if nitrate of sodium has been used—is drawn off after each run.

541,598—June 25, 1895. J. D. DARLING. *Process of utilizing niter cake or other acid sulfates.*

A solution of acid sulphates—niter cake—is electrolyzed in the negative compartment of a double cell having a porous diaphragm, the positive compartment being charged with a base-supplying electrolyte—as a saturated solution of sodium chloride—whereby the base is transferred to the sulphate by electrolytic travel, producing a neutral sulphate. The chlorine gas is collected.

542,057—July 2, 1895. L. P. HULIN. *Electrolytic process and apparatus.*

An alloy of an alkali metal or an alkaline earth metal with a heavy metal (or metals) is formed by employing as an electrolyte the fused salts of the metal of one ingredient of the proposed alloy and an anode consisting of a carbon member and a metal member (or members) composed of the other ingredient (or ingredients) of the proposed alloy. The distribution of the positive current through the anodes governs the composition of the alloy. With metals difficult to obtain in the metallic state an anode formed of an intimate mixture of an oxide of the metal and carbon can be used. For metals fusible at the temperature of the electrolysis a dish-shaped anode-metal container is employed.

551,461—December 17, 1895. W. C. CLARKE. *Art of producing carbide of calcium.*

In an electric furnace having horizontal electrodes embedded in a mass of pulverized and intimately commingled lime and carbon of such extent that a material portion will remain undecomposed, the current is started and the electrodes are gradually separated, as the material between them is reduced, so as to produce between the electrodes a body of calcium carbide surrounded by an undecomposed mass of the mixture.

552,890—January 14, 1896. W. C. CLARKE. *Manufacture of carbide of calcium.*

The furnace wall is built up as the formation of carbide progresses—fresh charges of material being added from time to time—the lower end of the upper electrode being at all times kept near the upper edge of the furnace wall.

552,895—January 14, 1896. T. CRANEY. *Process of and apparatus for making carbonates of soda.*

In the electrolysis of a sodium chloride solution, the cathode solution, continuously circulating through a series of electrolytic cells, is passed through an outer vessel in circuit, where the warm solution is charged with carbonic-acid gas, then into a cooler to precipitate the increment of carbonate, and then back into the cathode compartments.

552,955—January 14, 1896. T. CRANEY. *Process of and apparatus for manufacture of sodium bicarbonate.*

In the electrolysis of a sodium-chloride solution the cathode solution, continuously circulating through a series of electrolytic cells, is passed in circuit through an outer vessel, where it is treated with carbonic-acid gas, and the bicarbonate of soda precipitate deposited. The aqueous solution of bicarbonate of soda is then returned to the cathode compartments and reconverted into monocarbonate by the additional supply of caustic soda.

552,960—January 14, 1896. C. HOEPFNER. *Process of producing cuprous oxides.*

Cupriferous material is leached with a cupric-chloride solution containing calcium chloride, whereby a solution containing cuprous chloride is obtained. The cuprous chloride in a portion of the solution is converted into cupric chloride by means of an acid—as sulphurous acid in the presence of oxygen—and employed for leaching a fresh batch of crude material, and the other portion of the solution is freed from metals other than copper by a suitable precipitant, and the cuprous chloride therein is converted into cuprous oxide by a suitable reagent, as caustic lime.

553,593—January 28, 1896. M. OTTO AND A. VERLEY. *Manufacture of vanillin.*

A solution of iso-eugenate of soda is electrolyzed, converting it into vanillate of soda, and the solution is then treated with an acid—oxalic acid or sulphuric acid—to set free the vanillin.

554,718—February 18, 1896. R. McKENZIE. *Process of producing lakes or coloring compounds by electrolysis.*

A solution or mixture of the fundamental bases of coloring matters—such as chromic acid, alizarine or cochineal—in a suitable liquid, is electrolyzed, using an anode of oxidizable metal, or alloys of metals, according to the color desired. The lakes or pigments are then separated from the menstrum, dried and powdered.

555,232—February 25, 1896. A. B. BROWNE AND E. D. CHAPLIN. *Process of manufacturing white lead by electrolysis.*

A solution of sodium nitrate is flowed through the anode compartments of a plurality of electrolytic cells having lead anodes, whereby a quantity of lead nitrate forms in each of the cells and is held in solution, thus making a mixture of sodium nitrate and lead nitrate. A portion of said mixed nitrates is mixed with sufficient sodium hydrate (from the cathode compartments) in a separate vessel to precipitate lead hydrate, which is filtered, carbonated, and washed. A portion of the mixed nitrates of soda and lead is mixed with fresh sodium nitrate and returned into the electrolyte to maintain a uniform electrical resistance.

557,057—March 24, 1896. E. N. DICKERSON. *Process of and apparatus for producing metallic compounds by electricity.*

A finely divided mixture of calcic oxide and carbon is fed into an electric furnace and the carbon monoxide produced is utilized to preheat the charge, by burning the same with added air. The furnace comprises an interior chamber through which the charge is fed, a surrounding heating chamber, and a furnace chamber and electrodes at the foot of the said interior chamber, with a connecting feed flue.

557,324—March 31, 1896. G. D. BURTON. *Art of electric dyeing.*

The fibrous substance to be dyed is immersed in the dye liquor, and an electric current of forty or more volts and of sufficient volume to warm it is passed through the liquor where the substance is intermingled, whereby the fibers are forced apart and exposed to the action of the dye liquor.

557,325—March 31, 1896. G. D. BURTON. *Art of and apparatus for electrodyeing.*

To prevent contamination of the dye liquor by dissolved metals and injury to the color, carbon electrodes are used in the process of No. 557,324.

558,240—April 14, 1896. C. N. WAITE. *Method of utilizing saline solutions.*

A saline solution is electrolyzed, producing chlorine and hydrate; the hydrate solution is digested with wood fiber, the fiber separated from the liquor, the latter evaporated, and the residuum roasted, producing black ash, which is dissolved and enough quicklime added to causticise the carbonate of soda. This solution is then used in the cathode compartment of an electrolytic cell, and the operation repeated.

558,241—April 14, 1896. C, N. WAITE. *Method of utilizing saline solutions.*

In the practice of the process of No. 558,240, the black ash is lixiviated with a limited amount of water to remove a portion of the carbonate, and the residuum is then dissolved and treated with quicklime, etc., according to the said process.

558,717—April 21, 1896. H. L. BREVOORT. *Process of electrically treating fabrics for waterproofing or other purposes.*

The fabric, moistened with water, is placed between and in contact with an anode of an oxidizable metal and a suitable cathode, and a current of electricity passed through the moistened fabric, oxidizing the anode and depositing the oxide on or in the fabric.

558,718—April 21, 1896. H. L. BREVOORT. *Art of fixing dyes in fabrics.*

The natural dye in a suitable solvent is applied to the fabric, the fabric pressed between an anode of an oxidizable metal and a suitable cathode, and a current of electricity passed therethrough, oxidizing the anode and combining the oxide with the natural dye to form a lake.

558,970—April 28, 1896. O. LUGO AND H. T. JACKSON. *Method of electrolytic treatment of soap lyes.*

Caustic alkali is extracted and recovered from crude glycerine and spent soap lyes or saponification liquors by electrolyzing the liquor in a porous partition cell, using an anode of zinc in contact with the liquor, and a cathode of metal not attacked by caustic alkali. The precipitates formed are filtered, and the filtrate distilled or condensed.

559,454—May 5, 1896. C. KELLNER. *Process of and means for producing bleaching agents.*

The chlorine liberated at the anode, and the alkaline hydrate formed at the cathode, of an electrolytic cell, in the electrolysis of an alkaline chloride solution, are combined as a bleaching agent, in a separate vessel, by spraying the alkaline hydrate down through an ascending column of the chlorine gas.

560,291—May 19, 1896. E. G. ACHESON. *Electrical furnace.*

Silicide of carbon is produced by interposing between the electrodes of an electric circuit a core of granulated refractory material of comparatively low resistance (coke), forming a conducting path for the electric current, and surrounding this core with the mass to be treated—comprising silicious and carbonaceous material—of relatively high resistance. The mass to be treated, for the production of silicide of carbon, comprises a carbonaceous material, as anthracite coal, 20 parts; a silicious material, as sand, 29 parts; and a fibrous material, as sawdust, 29 parts; with or without a flux, as common salt, 5 parts.

560,411—May 19, 1896. C. KELLNER. *Process of and apparatus for bleaching vegetable fibers.*

The material to be bleached is first subjected to the chlorine solution produced by the electrolysis of an alkali metal chloride, whereby the coloring matter in the material is converted into combinations that are soluble in water, and into combinations that are insoluble in water, and it is then subjected to the action of the alkali solution, which removes the insoluble coloring matter. The solutions are then mixed and returned to the electrolytic cell. The apparatus permits of the alternate flow of the chlorine and alkali solutions through the same bleaching vat and the suspension and movement of the material while under treatment.

560,518—May 19, 1896. J. MEYRUEIS. *Treatment of sodium chlorid.*

For the manufacture of chlorine, white lead, and bicarbonate of soda, an acidulated solution of sodium chloride is electrolyzed in a cell having a porous diaphragm. Chlorine gas is drawn off from the positive compartment. The negative solution is drawn off, litharge is dissolved therein, and white lead precipitated therefrom by carbonic-acid gas. The alkaline liquor remaining is again treated with carbonic acid and bicarbonate of soda obtained on evaporation.

562,402—June 23, 1896. W. R. KING AND F. WYATT. *Process of forming calcium carbid.*

A mound is formed of mixed coke and lime around a vertical core of conducting material—such as a small carbon rod supported between two superposed electrodes—or the core is forced down through the center of the heap. A current is passed until a nugget of calcium carbide is formed in the center of the mound, the upper electrode descending freely as the supporting mixture is fused and reduced. The nugget is removed with tongs, a new core inserted, the material thrown up around it, and the process repeated.

563,288—July 7, 1896. W. LOBACH. *Electrical production of chemical reactions.*

The substance to be acted upon—a nongaseous substance for reaction with oxygen or other gas, as oil to be bleached—is passed between electrodes by sprinkling or scattering, an electric "silent" discharge being produced between the electrodes. Oxygen, or an oxygen product, is also passed between the electrodes to produce oxygen in the nascent state, with which the substance (oil) is thus brought into intimate contact at the moment of formation, and combination takes place.

563,527—July 7, 1896. T. L. WILLSON. *Process of producing calcium compounds.*

Mingled lime and carbonaceous deoxidizing agent, such as coke, is subjected to the heat of an electric arc in an electric furnace, the carbonaceous matter being in excess of that required to combine with the freed oxygen—say 65 per cent of lime and 35 per cent of carbon. The carbon may be supplied by saturating lime with a liquid hydrocarbon and drying it before feeding to the furnace.

563,528—July 7, 1896. T. L. WILLSON. *Process of manufacturing hydrocarbon gas.*

Calcium carbide is produced from a lime and carbon mixture subjected to the heat of an electric arc in an electric furnace, the carbon being in excess of that required to combine with the freed oxygen, and then decomposed with water to generate a hydrocarbon gas (acetylene).

563,553—July 7, 1896. A. B. BROWNE AND E. D. CHAPLIN. *Process of manufacturing white lead.*

A solution, electrolytically separable into a solvent of lead and an alkaline hydrate, is electrolyzed in a cell having two diaphragms and an intermediate compartment between the anode and cathode to separate the electrolyte into a solvent of lead and an alkaline hydrate, and the same are maintained separate on the outer sides of the diaphragms, by preponderance of pressure of the electrolyte in the intermediate compartment, on the inner sides of the diaphragms. Metallic lead is dissolved in the lead solvent in the anode compartment and an oxidizing agent—nitric acid—is continuously added thereto to prevent the formation of insoluble lead salts. The anode and cathode solutions are withdrawn and mixed and hydrate of lead formed and carbonated.

563,554—July 7, 1896. A. B. BROWNE AND E. D. CHAPLIN. *Process of manufacturing oxids of lead.*

Metallic lead, as an anode, is electrically dissolved in an alkaline hydrate formed by the prior electrolytic separation of an alkaline base into an alkaline hydrate and a neutralizing agent, such as nitric acid. The oxide of lead produced is dissolved in the alkaline hydrate to form a plumbate of an alkaline base, and the solution is neutralized by the aforesaid neutralizing agent to precipitate the desired lead oxide. The remaining solution is again used as the alkaline base electrolyte.

563,555—July 7, 1896. A. B. BROWNE. *Manufacture of white lead.*

A solution, electrolytically separable into a solvent of lead and an alkaline hydrate, is introduced between two pervious diaphragms interposed between the anode and cathode of a cell, and electrolyzed, and the liquid withdrawn from between the diaphragms as it becomes alkaline; to which liquid may be added alkaline hydrate withdrawn from the cathode department. Metallic lead is electrolytically dissolved in the lead solvent. The resulting solution is withdrawn and mixed with the withdrawn alkaline liquid, forming a hydrate of lead.

564,940—July 28, 1896. G. H. SELLERS. *Method of purifying water.*

Pieces of iron in direct contact with pieces of another metal (copper, tin, lead) with which the iron can form a galvanic couple, are agitated in water. Air is forced through the water to form a coagulent and precipitate the iron salts and impurities.

565,524—August 4, 1896. H. BLUMENBERG, JR. *Electrolysis.*

A chloride solution is caused to flow through the closed positive compartment of an electrolytic cell (a series of cells, into and from the bottom of each), and a separate electrolyte through the negative compartment in an opposite direction, and to the bottom of a separate tank; the chlorine gas from the positive compartment being also conveyed to the bottom of the same tank, where the chlorate is formed. Retort carbon, for an electrode, is saturated with a hydrocarbon which has been charged with chlorine gas, and then coked.

565,706—August 11, 1896. B. S. SUMMERS AND C. O. BORING. *Electrolytic separation of vegetable fibers.*

The gum or cementing material of vegetable fibers (ramie, etc.) is removed by electrolyzing the fibers in a bath containing a fluoride of the alkaline metals (as sodium fluoride) in the positive compartment of an electrolytic cell.

568,258—September 22, 1896. V. J. KUESS. *Process of and apparatus for distilling fatty substances.*

Fats or resinous substances in liquid condition are distilled by passing therethrough an electric current and simultaneously injecting steam, whereby the steam is decomposed and acts as an electric conductor through the mass.

568,323—September 29, 1896. E. G. ACHESON. *Manufacture of graphite.*

A carbide is subjected to a temperature sufficiently high to drive off and volatilize the noncarbon constituents and separate the combined carbon as graphite. A mixture of carbon and one or more oxides is converted into a carbide in an electric furnace and the heating continued, as above, until graphite is formed.

569,825—October 13, 1896. P. DANCKWARDT. *Process of and apparatus for producing cyanids.*

A molten bath of the chloride of an alkali or alkali-earth metal is formed and electrolyzed while in contact with carbon and nitrogen, which are introduced into the bath, the cyanide formed being continuously removed from the action of the electric current. Coal and ammonia gas may be used to supply the carbon and nitrogen.

569,680—October 20, 1896. B. S. & L. L. SUMMERS. *Electrolytic process of bleaching and refining.*

The material (ramie) is bleached in the positive compartment of an electrolytic cell, in a bath containing a fluoride and a material yielding a hydrate (sodium hydrate) bleaching agent. The fluoride prevents the impairment of the fiber. It may subsequently be electrolyzed in a fluoride bath.

571,084—November 10, 1896. H. ELDRIDGE, D. J. CLARK, AND M. W. WAMBAUGH. *Composition of matter for manufacturing calcium carbide.*

Calcium sodic carbide is produced by subjecting a mixture of quicklime, 72 parts by measure; carbon, 40 parts; soda, 4 parts; and borax, one-eighth part, to the fusing heat of an electric furnace. The water of crystallization of soda and borax is expelled by heat before mixing.

571,531—November 17, 1896. R. LANGHANS. *Process of producing coatings composed of earthy oxids.*

For the formation of incandescent mantles, basic earth salts are prepared by dissolving hydrated oxides of earth metals in solutions of neutral earth salts, to form an electrolyte, and the hydroxides of the earth metals are separated by an electric current of high density, they being deposited on electric-conductive foundations. The deposited hydroxides are dipped in an aqueous solution of an acid capable of converting the hydroxides into salts which are indissoluble in the solution and which are reduced to oxides by heat, and then dried and calcined; or an alkaloid salt is combined with the solution containing basic earth salts, thereby depositing in an intimate union hydroxides of earth metals and the alkaloid upon the foundation, which is dried and calcined to destroy the organic substance and convert the hydroxides into oxides.

571,532—November 17, 1896. R. LANGHANS. *Process of producing coatings composed of earthy oxids.*

Porous coatings of incandescent mantles are formed by electrolyzing a dilute aqueous solution of a metahydroxide of an earth or alkali-earth metal by an electric current of low density, depositing thereby upon an electro-conductive foundation, as the cathode, a coating of hydroxide, and drying and calcining the deposit. An organic base may be added to the solution of a meta-earthy hydroxide, which organic base is deposited along with the earthy hydroxide and is destroyed by the calcining process, leaving a porous coating of earthy oxide.

571,533—November 17, 1896. R. LANGHANS. *Electrolytic process of converting hydroxids of earth and earth-alkali metals into indissoluble organic or inorganic salts, etc.*

The process of electrolytically transforming into salt the hydroxide of earth metal deposited upon electro-conductive foundations consists in placing such coated foundation as an anode in an electrolyte; which consists of an aqueous solution of selenious acid, or its described equivalent, and subjecting the electrolyte to the action of a current of low density. The salt is afterwards reduced to oxide by calcination.

572,512—December 8, 1896. H. ALBERT. *Process of manufacturing phosphates of alkalis.*

An anode bath of phosphoric acid and a cathode bath of one or more of the soluble salts of the alkali metals, separated by a porous diaphragm, are electrolyzed, whereby a mono-, di-, or tri-basic phosphate of the alkali employed is produced at the cathode. The alkaline phosphate may be directly converted into caustic alkali with lime.

572,636—December 8, 1896. J. E. HEWES. *Electric furnace.*

The carbide and associated half-formed product of an electric furnace is discharged into a closed chamber, the dust drawn off by suction, the material screened, and the cleansed carbide removed. The furnace has an inclined hearth: one movable electrode is parallel and close to the hearth, up the slope, and the other electrode—constituting a trapdoor—is stationary at the foot of the hearth, and stands at an angle thereto. Feed is provided for the material and for the movable electrode.

573,290—December 15, 1896. M. PRIDHAM. *Process of purifying and decolorizing saccharine or other liquids.*

As a modification of the process of No. 573,289, the ozone is passed through subsequent to electric action.

575,645—January 19, 1897. E. HERMITE. *Apparatus for purifying or disinfecting.*

A disinfecting solution is made by electrolyzing a solution containing chloride of magnesium, or chloride of magnesium and chloride of sodium (sea water or mother liquor from salt works).

575,788—January 26, 1897. T. L. WILLSON. *Electric smelting.*

Pulverized material to be smelted, as alumina, is fed into the neighborhood of an electric arc of an alternating current of a frequency adapted to set the mass of material into vibration, whereby the arc pulsations draw the material within its influence. A pool of molten material may form the lower electrode and the same may be of a base-alloying metal.

577,329—February 16, 1897. N. SLAWIANOFF. *Electric casting of metals.*

An electric arc is formed between a rod of the casting metal and the mold, or the fused metal in the mold, and the mold filled from the fusing of the metal electrode, the arc being continuously regulated.

577,523—February 23, 1897. G. J. ANDERSSON AND J. C. DITTRICH. *Process of manufacturing ozone and by-products.*

Air is first freed from carbon dioxide and dried, then passed through an ozonizing apparatus, forming ozone and nitrous oxides by the simultaneous oxidizing of the nitrogen, and the nitrous oxides are then separated from the ozone by absorbing them in suitable liquids, as water forming nitric acid, or a solution of caustic alkali forming nitrite or nitrate of the alkali.

577,802—February 23, 1897. G. M. WESTMAN. *Process of and apparatus for treating arsenic ores.*

The ore is melted in a closed electric furnace with a lead bath for the bottom electrode beneath the ore, with which the precious metals alloy, the arsenical vapors being led off and condensed.

578,457—March 9, 1897. C. KELLNER. *Process of and apparatus for simultaneously producing ammonia, sodium hydroxid, and chlorin.*

Sodium chloride—or other alkali metal chloride—is electrolytically decomposed in a closed cell having a mercury cathode in the form of a thin layer in continuous motion in a helical direction toward a central point where it flows off. The chlorine product is drawn off and the alkali metal amalgam passes to a closed decomposing vessel and flows over a conductive surface beneath a hot solution of sodium nitrate (or nitrate of other alkali metal) and an electrode, thereby forming ammonia and sodium hydroxide and developing electrical energy which may be utilized. The mercury then passes through a cooler and is returned to the electrolytic cell.

578,685—March 9, 1897. E. R. WHITNEY. *Process of and apparatus for producing calcium carbid.*

Mechanically compacted columns of fragmentary charcoal are moved longitudinally toward each other, and constitute the electrodes of an arc furnace, into and through which arc a mixture of pulverized lime and charcoal is fed. A number of separate electric arcs proceeding from charcoal electrodes and crossing each other are used.

579,317—March 23, 1897. E. J. CONSTAM AND A. VON HANSEN. *Process of manufacturing percarbonates.*

Percarbonates of the alkali metals and ammonium, as new chemical compounds which are readily soluble in water and possess strong oxidizing properties, are produced by electrolyzing a saturated solution of their carbonates at temperatures below zero centigrade.

580,919—April 20, 1897. A. E. WOOLF. *Method of and apparatus for disinfecting and deodorizing.*

Infected water or sewage (running streams, sources of supply for cities, etc.) is disinfected and deodorized by discharging or injecting thereinto an electrolyzed solution of salt water.

583,131—May 25, 1897. H. G. STIEBEL, JR. *Apparatus for and method of sterilizing liquids.*

The liquid is caused to drop through an atmosphere of ozone produced by a series of disruptive electric discharges, and in the path of such discharges, between the electrodes but out of contact therewith.

583,330—May 25, 1897. E. A. LE SUEUR. *Process of electrolysis.*

In the electrolysis of saline solutions, the solution in the anode compartment is maintained in the chemical condition in which it exists at the commencement by adding hydrochloric acid to combine with the hydrate that leaks or diffuses through the diaphragm.

583,498—June 1, 1897. J. T. MOREHEAD. *Manufacture of carbid of calcium.*

The furnace wall is built up as the formation of carbide progresses, fresh charges of material being added from time to time. (Same as No. 552,890.)

586,236—July 13, 1897. L. P. HULIN. *Process of electrolytic decomposition of solutions.*

The electrolyte is confined between two permeable electrodes, and the ions are filtered therethrough, whereby an immediate separation of the ions from the electrolyte is effected at the point and instant where and when they are generated.

586,729—July 20, 1897. C. KELLNER. *Method of and apparatus for effecting electrolysis.*

In an apparatus for the electrolytic decomposition of salts of metals capable of combining with mercury, a mercury cathode flows uninterruptedly from a higher to a lower level, and flows alternately and repeatedly out of contact with the salt solution and into contact with a decomposing agent for the amalgam.

587,138—July 27, 1897. I. L. ROBERTS. *Process of and apparatus for manufacturing metallic carbids.*

A conducting path of material to be heated to incandescence is established between electrodes within a mixture of pulverized ore or oxide (as calcium oxide) and carbon, and as the heat thereof converts the adjacent portions of the mixture into a conductive body the electrodes are gradually withdrawn and the mixture is gradually moved transversely to the line of the current, whereby successive portions of the mixture are brought into the heating field, and a slab of carbide is formed. The floor of the furnace chamber is a slowly moving horizontal conveyor, and the electrodes, entering at one end of the chamber in the same horizontal plane, are angularly adjustable so that they can take a parallel position.

587,343—August 3, 1897. G. S. STRONG. *Electric furnace.*

The electrodes are formed of a mass of material, including a binder, which is agglomerated, formed, and fed forward to the arc by pressure, and exposed in the guides to a high temperature before actually entering the furnace. One or more or all of the materials used in the smelting operation may constitute the said mass of material; the electrodes constituting the smelting charge.

587,437—August 3, 1897. F. HURTER. *Apparatus for manufacturing chlorate of potash by electrolysis.*

The cathode consists of a metallic vessel having a porous protective lining, essentially of cement.

587,509—August 3, 1897. I. L. ROBERTS. *Process of and apparatus for making metallic carbids.*

A mixture of the metallic compound and carbon is passed beneath a horizontal electric arc and in direct contact therewith in the nonoxidizing atmosphere of a closed chamber. The arc is deflected downward by means of an electro-magnet, and the carbide formed is continuously removed. The material, fed in through a double hopper, is carried by a horizontal endless belt under the arc, and the unchanged material, the carbide being scraped off, is carried back and again fed onto the belt.

587,830—August 10, 1897. L. P. HULIN. *Process of and apparatus for manufacturing metallic peroxids and caustic alkalies.*

The higher peroxides of heavy metals, such as lead, antimony, bismuth, chromium, and manganese, are formed by alloying said metals with an alkali metal or alkali-earth metal (fused by an electric current), and subjecting the alloy to the action of heat—a dull red—and atmospheric air to form the desired peroxide in combination with the anhydrous alkaline oxide formed conjointly therewith; continuously withdrawing the peroxide and alkaline oxide from the presence of the alloy under treatment, and decomposing the salt of the metallic acid thus formed to separate the peroxide.

588,012—August 10, 1897. I. L. ROBERTS. *Process of and apparatus for making metallic carbids.*

The process and apparatus of No. 587,509 is supplemented by a reflecting dome placed above the arc, whereby the reflected heat assists in the formation of the carbide.

588,084—August 10, 1897. G. H. POND. *Process of and apparatus for electro-chemical treatment of straw or other fibrous materials.*

The straw packed in a tank, with an open anode cell at the side thereof, is subjected to the action of a solution of sodium chloride, which is circulated throughout the mass of straw while a current of electricity is passing through the solution. The solution is caused to circulate quickly at the beginning of the operation and then the speed of circulation is decreased.

588,085—August 10, 1897. G. H. POND. *Method of and apparatus for electro-chemical treatment of fibrous material.*

Straw or other fiber is packed in an electrolytic tank having removable partitions and containing a chloride of sodium solution, so as to form anode and cathode compartments on opposite sides of the mass; and, during the electrolytic action, the solution is caused to circulate throughout the straw, first from the cathode side to disintegrate it, and then from the anode side to bleach it.

588,266—August 17, 1897. G. DE CHALMOT. *Treatment of phosphates.*

Natural phosphate rock containing silica, alumina, or iron oxide, is fused in an electric furnace—whereby the proportion of soluble phosphoric acid is increased—and immediately removed from the furnace and brought into contact or mixed with silica, and then dropped into water while hot, which cracks it so that it is easily pulverized; it is then available as a fertilizer.

588,276—August 17, 1897. C. KELLNER. *Electrolytic process and apparatus therefor.*

In the electrolysis of compounds whose electropositive constituent will combine with mercury, the mercury is moved continuously out of and back into the field of action of the electric currents to successive points where the amalgam acts as an anode, and is decomposed successively at such points by a decomposing agent in presence of a cathode; the successive electrodes being connected in series, whereby an independent current of electricity is generated of higher potential than the electrolyzing current.

588,883—August 24, 1897. P. G. SALOM. *Process of making litharge or protoxid of lead from lead ore.*

Pulverized lead ore—galena—is subjected to the action of nascent hydrogen electrolytically developed, as in the cathode compartment of a cell, producing thereby a spongy mass, which is then heated in the open air, first at a temperature below the melting point of lead and afterwards at a higher temperature.

589,523—September 7, 1897. J. BOELSTERLI. *Process of and apparatus for electrolyzing fused salts.*

A fused alkali-metal salt is electrolyzed and the alkali metal liberated exclusively at the surface of the electrolyte. The cathodes, just dipping below the surface of the electrolyte, and the anodes, each provided with an insulated gas-conducting sheath, depend from supporting rods and have means for vertically and horizontally adjusting the cathodes.

589,592—September 7, 1897. S. BLUM. *Composition of matter for manufacturing calcium carbid.*

A mixture of air-slaked lime, 22 parts by measure; carbon, 8 parts; plumbago containing iron, 4 parts; and potash, one-half part; is used for the manufacture of calcium carbide in an electric furnace. The fluxing quality of certain of the ingredients hastens the operation.

589,801—September 7, 1897. H. C. WOLTERECK. *Process of manufacturing white lead.*

A lead anode is dissolved in an alkaline electrolyte consisting of a solution of a salt of an alkali in combination with any acid which will produce a soluble lead salt and of a bicarbonate of an alkali (4 parts of acetate, nitrate, or other salt of soda, potash, or ammonia, and 1 part of bicarbonate), causing the formation of a soluble compound of lead, which is transformed into the hydrated carbonate by the simultaneous generation of free carbonic acid at the anode and by the presence of caustic alkali generated at said cathode, a current of carbonic-acid gas being passed through the electrolyte to regenerate the spent alkaline bicarbonate.

589,967—September 14, 1897. R. F. S. HEATH. *Composition for manufacturing calcium carbids.*

A mixture of quicklime, 9 parts; carbon, 4 parts; and sodium or potassium chloride, one-quarter ounce to the pound of mixture is used for the manufacture of a carbide of calcium in an electric furnace.

590,514—September 21, 1897. A. H. COWLES. *Process of producing metallic carbides.*

Same as No. 551,461.

590,548—September 21, 1897. C. KELLNER. *Process of producing hydrates or other salts of alkaline metals.*

An amalgam is formed by the electrolysis of a solution of a suitable salt with a mercury cathode and simultaneously an equivalent quantity of the alkaline metal of the amalgam is oxidized by making the amalgam the anode of a galvanic cell containing a liquid reagent and a cathode electro-negative to the amalgam and short circuited therewith. The mercury in a narrow compartment forms a partition between the electrolytic and the galvanic cells.

590,673—September 28, 1897. F. H. SODEN. *Process of and apparatus for electrically treating ores.*

Ores are purified, preparatory to smelting, by heating in a closed chamber by contact with unbroken electric resistance conductors embedded in the ore, and by the resistance of the ore to the current shunted therethrough, and by introducing into the ore at the same time, first, super-heated air, and then a purifying gas, such as hydrogen.

591,355—October 5, 1897. H. MOISSAN. *Process of obtaining cast titanium.*

Cast metallic titanium combined with carbon is obtained by subjecting an oxide of salt of titanium in presence of carbon to an electric arc produced by a current of from 1,000 to 2,000 amperes and 60 to 70 volts.

591,730—October 12, 1897. W. BEIN. *Process of and apparatus for electrolyzing.*

The electrolytic cell has a series of vertical partitions which permit the passage of the electrolyte above or below them; horizontally disposed electrodes arranged in different vertical planes; a feed pipe for fresh solution; and outlet pipes for the decomposed layers. The process, resulting from the cell structure, permits of the feeding in of fresh solution and withdrawal of the decomposed anodic and cathodic solutions, and the maintenance, in predetermined positions, of the layers of decomposed products outside of the influence of the current. It is applicable to the electrolysis of brine and the production of acids, as nitric acid by electrolyzing saltpeter, sulphuric acid from sulphates, etc.

594,740—November 30, 1897. H. L. HARTENSTEIN. *Process of and apparatus for carbureting calcium.*

Limestone is calcined, and while still hot carbonaceous material—as pulverized coke—is forced into the mass by the aid of a combustible gas under pressure, the mass being simultaneously subjected to the action of an electric current.

The apparatus comprises a calcining chamber above a removable electric furnace chamber, mounted on a track; mechanism and connections being provided for forcing gas and with it coke dust into the furnace chamber.

596,704—January 4, 1898. H. L. HARTENSTEIN. *Process of and apparatus for utilizing waste products of blast furnaces.*

As a modification of the process of No. 596,749, the gas injected is a reducing gas.

The apparatus comprises a converter having a slag-receiving portion, a mixing portion with tuyers, and an electric-treatment portion having electrodes, by which the several steps of the process are successively performed in the converter.

596,705—January 4, 1898. H. L. HARTENSTEIN. *Process of utilizing waste products of blast furnaces.*

The process of No. 596,749 is applied to solidified slag, which is reduced to a molten state and then treated.

596,749—January 4, 1898. H. L. HARTENSTEIN. *Process of utilizing waste products of blast furnaces.*

Carbonaceous material is diffused through molten slag in suitable proportions—as 1 part coke to 3 parts slag—by blowing it in with gas pressure; the mixture is then agitated to enhance the impregnation, and then subjected to the fusing action of an electric current, producing a carbide of calcium, aluminium, and silicon.

596,936—January 4, 1898. F. K. IRVING. *Process of producing ozone.*

Ozone is produced by the electrolysis of a metallic salt—as sulphate of copper—the base of which is reducible, and thereby serves to dispose of the hydrogen by secondary action during electrolysis; the freed ozone being conveyed into a suitable menstruum, as glycerine and distilled water.

596,999—January 11, 1898. J. E. HEWES. *Process of making calcium carbids.*

A carbide of calcium mixture is fused in an electric furnace with a flux consisting of manganese oxide and calcium carbonate. Carbon and lime may be introduced into a fused bath containing manganese and calcium and oxygen, and a continuous electric current passed therethrough to effect chemical combination.

598,549—February 8, 1898. H. H. WING. *Process of manufacturing graphite.*

Graphite is produced by passing an electric current through powdered carbonaceous material—as coke—in an electric furnace, whereby the heat converts part of the carbon into graphite, and then separating the unconverted carbon from the graphite. The material is continuously fed into the furnace; and the product is continously withdrawn at the bottom, which is water-jacketed to cool the product before discharge.

601,064—March 22, 1898. I. L. ROBERTS. *Process of preserving carbids.*

The interspaces of the carbide in a vessel are filled with dehydrated wheat chaff, and the vessel is then charged with a gas—as acetylene gas—which will not form an explosive mixture with acetylene generated in the vessel, and it is then hermetically sealed.

601,366—March 29, 1898. C. L. WILSON, C. MUMA, J. W. UNGER, H. SCHNECKLOTH, A. P. BROSIUS, AND J. C. KUCHEL. *Method of and apparatus for producing calcium carbid.*

The furnace pot or chamber is to be lined with granulated calcium carbide. Compressed sticks of pulverized lime and carbon, connected together, are fed into the arc of a furnace having the said lining.

602,872—April 26, 1898. J. W. RICHARDS AND C. W. ROEPPER. *Process of producing chemical compounds by electrolysis.*

An alternating current is passed through electrodes of similar composition immersed in an electrolyte, one or more of whose constituents forms alternately at each electrode, by electrolytic attack thereon, a compound partially derived from the consumption of that pole, which is insoluble in either the electrolyte or the products formed at the opposite pole for the time being, as, for example, with electrodes of metallic cadmium, in a 10 per cent solution of sodium hyposulphite, an insoluble sulphide of cadmium is formed, which is disengaged from the metal pole by the mechanical action of the bubbles of hydrogen and falls to the bottom.

602,747—April 19, 1898. C. K. HARDING. *Process of smelting phosphorus.*

A phosphoric oxide substantially free from lime is first made from a phosphatic base, and roasted in the presence of carbon until the combustible impurities have been consumed and substantially 2 parts of the oxygen has been smelted out. The phosphoric oxide remaining is mixed with carbon and subjected to the action of an electric arc developed within the mass of the material, and between a negative electrode and the material, in an atmosphere of hydrogen. A part of the carbon for the reaction is supplied in a fluid form, as gasoline, forced in through a hollow negative electrode.

Phosphatic material, as phosphatic rock, is treated with sulphuric acid to eliminate substantially all of the lime, and then roasted with carbon to eliminate the major part of the sulphur and smelt out a part of the oxygen.

602,873—April 26, 1898. J. W. RICHARDS AND C. W. ROEPPER. *Process of electrolytically manufacturing metallic sulfids.*

The metal or metals whose sulphide is desired—for example, cadmium sulphide—is employed as an anode in the electrolysis of a solution containing a hyposulphite salt—as sodium hyposulphite—the sulphide sought being formed from the anode and precipitated.

602,976—April 26, 1898. G. DE CHALMOT. *Process of producing silicids of iron*

The ferrosilicides of No. 602,975 are produced by subjecting a silicon compound with iron and carbonaceous matter (coke)—the silicon compound being in excess—to the heat of an electric furnace until the carbonaceous matter is eliminated and the silicon is reduced.

605,380—June 7, 1898. H. S. BLACKMORE. *Process of producing aluminum sulfid and reducing same to metallic state.*

Aluminum sulphide is produced by exposing aluminum oxide to the action of thio carbonate-of-alkali bases in a heated state. The electrolysis of a molten bath of sodium and potassium sulphides, using carbon anodes, produces thiocarbonates (sulphocarbonates). Alumina, converted by the bath into aluminum sulphide, is electrolytically decomposed and aluminum deposited.

606,981—July 5, 1898. W. S. ROMME. *Process of and apparatus for decomposing solid substances.*

Solid substances, as the chlorides of sodium and potassium, are electrolytically decomposed by continuously supplying the mass, placed between electrodes, in a solid, granular state, with such quantity of solvent as will be retained by the mass by capillarity without submerging the body.

607,646—July 19, 1898. P. MARINO. *Electrolytic bath.*

The process of electrolytic production of metals consists in adding to a solution of a salt of the metal to be deposited alkali metal salts of the same acid and an alkali-earth-metal salt of another acid in such quantity as to give, by an incomplete double decomposition, an insoluble precipitate and a mixed solution of different soluble salts of the metal to be deposited, and electrolyzing the mixed solution; an organic acid and an acid such as chlorhydric or sulphuric acid, capable of attacking the mineral, is added to the electrolyte, to facilitate the decomposition, and maintain a constant density in the bath; the mineral itself is used as the soluble anode. For example, a solution containing one equivalent of sulphate of magnesium is mixed with a solution containing less than one equivalent of chloride of barium, giving an insoluble precipitate of sulphate of barium in a solution of sulphate and of chloride of magnesium; the liquid forming an electrolyte for depositing magnesium.

607,953—July 26, 1898. H. MEHNER. *Method of producing ammonia.*

A mixture of coal and alkali or an alkaline earth-metal carbonate is heated in an electric furnace while air is caused to pass through the same, and the cyanide vapors produced escape at the zone of the electrodes into a receiver and are therein condensed upon a body of coal. Steam is then admitted to the receiver, decomposing the condensed cyanide into ammonia and alkali carbonate; the ammonia is led off and the alkalinized coal returned to the electric furnace and the operation continued. The receiver is above the furnace, so that the residual mixture of coal and alkali can fall into the furnace on opening a slide door.

609,864—August 30, 1898. M. P. WOOD. *Process of and apparatus for producing calcium carbide.*

The pulverized mineral and carbon with a suitable binder having been formed into cartridges, a number of the cartridges are subjected to the highest heat of a combustion furnace, an electric current being at the same time passed through each of the cartridges successively until it is melted down, when it is replaced with a new one. The cartridges are held in a vertical position and the initial contact and fusion occurs at the top of the cartridge.

612,009—October 11, 1898. G. B. BALDO. *Process of and apparatus for electrolyzing sea water.*

Two bodies of sea water are decomposed, in a three-compartment cell, at the anode and cathode, respectively, in presence of a body of fresh water on the opposite side of the cathode to the sea water, precipitating magnesium and calcium hydrates at the cathode and caustic soda in the fresh-water compartment. Chlorine gas is evolved at the anode, and subsequently the liquid of the anode compartment containing sulphuric acid is vaporized to one-fourth of its bulk, distilled, and the vapor collected as hydrochloric acid.

612,694—October 18, 1898. H. ASCHERMANN. *Process of simultaneously producing carbids and metals or alloys.*

A mixture of carbon with an oxygen compound and a sulphide of metals having different affinities for carbon is electrically heated. If nonvolatile, the uncombined metal sinks to the bottom of the mass; if volatile, its vapors can be collected. For example, a mixture of iron pyrites and lime and carbon treated in an electric furnace gives calcium carbide and metallic iron, with a greatly reduced consumption of current.

614,927—November 29, 1898. G. D. BURTON. *Process of and apparatus for separating metals and by products from ores by electricity.*

Ore, under exclusion of air, is subjected to electric heat below the fusing point of the metals, to drive off the by products as sulphur. A gas containing oxygen is then admitted, causing combustion, and the ore is subjected to the combined heat of combustion and electricity at a temperature above the fusing point of the metals. With ores containing metals of different melting points, the temperature is first raised and maintained by regulation of the current, above the fusing point of one and below that of the other, for melting out the low fusing metal, and the temperature is then raised to melt the remaining metal. The furnace has a hollow perforated electric-conducting shaft and spiral wings admitting air or gas to the charge.

614,929—November 29, 1898. G. D. BURTON. *Process of tanning hides or skins of animals.*

The hides are electrolyzed in a tanning solution; coloring matter is then added to the solution; and it is again electrolyzed.

614,930—November 29, 1898. G. D. BURTON. *Process of and apparatus for separating metals from ores by electricity.*

The ore is simultaneously subjected to pressure and the passage of a heating electric current, the pressure following the diminishing mass of ore. The furnace has perforated electrode plates, one of them movable, to clamp the ore mass between them; and a chamber below receives the molten metal.

616,139—December 20, 1898. G. H. POND. *Method of electrolytically treating straw or other fibrous material.*

Straw or like fibrous material for the manufacture of paper pulp is disintegrated in a heated solution formed by electrolyzing a solution of sodium chloride in the presence of calcium hydrate, allowing it to settle and drawing off the solution. After use, the solution is returned to the electrolyzing tank, reenforced with fresh sodium chloride, and the operation repeated.

616,988—January 3, 1899. B. S. SUMMERS. *Method of refining vegetable fiber.*

The material (ramie) is degummed and refined by subjecting the fibers to the action of a chemical bath containing a hydrate of an alkali metal, and then to the electro-chemical action of a bath containing a hydrate of an alkali metal and a soluble fluoride with a current of electricity passing therethrough.

617,979—January 17, 1899. E. G. ACHESON. *Method of manufacturing graphite articles.*

Articles containing a greater or less percentage of graphite, as brushes for electric motors, crayons, stove polish, crucibles, etc., are produced by forming the articles from a mixture of carbon and a metallic salt having a base capable of being reduced by and combining with carbon, and then subjecting them to a temperature sufficiently high to form and then decompose a carbide, thereby converting the carbon into graphite. The articles to be graphitized are embedded in the heating core of fine carbon of an electric furnace.

618,575—January 31, 1899. F. M. LYTE. *Method of and apparatus for producing chlorine, zinc, or other metals from mixed ores.*

Complex sulphide ores of zinc, usually carrying lead and silver, are ground and calcined at a low red heat to convert the zinc sulphide into zinc sulphate; the latter is extracted by lixiviation and converted into zinc chloride by treating with an alkaline chloride and refrigerating; the zinc chloride is concentrated and rendered anhydrous by heating it in the presence of metallic zinc, assisting the action of the zinc by electrolysis, in order to decompose the water of hydration, subsequently decomposing, first the zinc oxide and then the zinc chloride by electrolysis with a carbon anode and a cathode of fused metallic zinc for the production of chlorine and zinc; the lead and silver are recovered by smelting.

620,683—March 7, 1899. T. A. UEHLING. *Process of and apparatus for reducing and oxidizing salts.*

An electrolytic diaphragm of palladium, or a suitably supported layer or film of palladium, is used. Substances are electrolytically oxidized and reduced by the transferring of hydrogen from one compartment of an electrolytic cell to the other through a diaphragm, like palladium, that is nonporous, electrically conducting, and capable of absorbing and transmitting hydrogen, but not other elements, under the influence of the electric current.

623,691—April 25, 1899. C. E. ACKER. *Process of and apparatus for manufacturing alkali metals.*

The fused salt of an alkali metal is electrolyzed with a molten metal cathode (lead) with which the liberated metal will alloy, and a forced circulation is imparted to the molten metal to conduct the alloy as formed to a separate chamber, where it stratifies and then volatilizes—in an inert atmosphere in said chamber—the alkali metal out of contact with the electrolyte; the volatilized metal is then collected. The same body of inert gas circulating through the chamber assists in carrying off the volatilized metal.

623,692—April 25, 1899. C. E. ACKER. *Process of and apparatus for manufacturing metallic alloys.*

Following the process of No. 623,691, an alloy of the alkali metal with the heavy metal (as lead, tin, zinc, etc.) is made by flowing off the lighter portion from the surface of the metal in the separate chamber after it stratifies, the heavier portion circulating back into the electrolytic compartment.

624,041—May 2, 1899. C. B. JACOBS. *Process of manufacturing soluble barium compounds.*

Barium oxide is produced by heating in an electric furnace a mixture of barium sulphate and sufficient carbon to extract part only of the oxygen of the sulphate—for example, sulphate 20 parts and carbon 1 part—until sulphur dioxide ceases to escape.

625,918—May 30, 1899. E. BAILEY, G. R. COX AND W. T. HEY. *Process of and apparatus for producing white lead.*

An electric arc is formed at the surface of a body of molten lead, and the necessary gases or fumes—commingled steam, carbonic-acid gas, and acetic-acid fumes—are introduced through the upper electrode into the arc, the products conveyed away and the white lead caught.

626,330—June 6, 1899. C. LUCKOW. *Process of producing peroxid of lead.*

Lead anodes are used in an electrolyte containing from 0.3 to 3 per cent of the sodium, potassium, or ammonium salts of sulphuric acid in mixture with the sodium, potassium, or ammonium salts of chloric acid; the mixture should be about 99.5 per cent of the sulphuric-acid salt, and about 0.5 per cent of the chloric-acid salt. The process is continuous, air being blown in to facilitate the reaction and keep the electrolyte in motion.

626,331—June 6, 1899. C. LUCKOW. *Process of producing neutral chromate of lead.*

Neutral chromate of lead is produced by using a lead anode in the electrolysis of an aqueous solution containing from 0.3 to 3 per cent of the sodium, potassium, or ammonium salts of chloric acid in mixture with the sodium, potassium, or ammonium salts of chromic acid. The bath is maintained constant by the addition of water and chromic acid. The mixture should be about 80 per cent of the chloric-acid salt and 20 per cent of the chromic-acid salt.

626,547—June 6, 1899. C. LUCKOW. *Process of producing oxid of copper.*

Oxide of copper is produced by using an anode of copper in the electrolysis of an aqueous solution containing from 0.3 per cent to 3 per cent of the sodium, potassium, or ammonium salts of boric acid in mixture with the sodium, potassium, or ammonium salts of chloric acid. The mixture should be about 95 per cent of the boric-acid salt and 5 per cent of the chloric-acid salt.

626,635—June 6, 1899. G. SCHWAHN. *Process of reducing aluminium from its compounds.*

An aluminium compound is vaporized and the vapor subjected to the action of a hot carbon-gas deoxidizer in the presence of incandescent carbon for an appreciable length of time—not less than fifteen seconds—air being excluded. The mixed vapor and gas, which may contain fluorine as an admixture, may be passed through a carbon mass made incandescent by an electric current.

627,000—June 13, 1899. P. IMHOFF. *Process of making oxyhalogen salts.*

Oxyhalogen salts of the alkali metals are produced by electrolyzing (without a diaphragm) a solution of an alkali-metal chloride in which is suspended a metallic oxide, such as aluminic oxide or boron trioxide, which can act both as a basic and acid radical, thereby forming chlorine and an alkali-metal compound wherein said metallic oxide acts as the acid radical, and causing the chlorine to react upon such compound to form oxyhalogen salts of the alkali metal. The bath is regenerated with the metallic oxide.

627,002—June 13, 1899. C. LUCKOW. *Process of producing white lead by means of electrolysis.*

White lead is produced by using lead anodes in the electrolysis of an aqueous solution containing from 0.3 to 3 per cent of sodium, potassium, or ammonium salts of chloric acid in mixture with the sodium, potassium, or ammonium salts of carbonic acid. The bath is maintained constant by the addition of carbon dioxide and water. The mixture should be about 80 per cent of the chloric-acid salt and 20 per cent of the carbonic-acid salt.

627,063—June 13, 1899. P. IMHOFF. *Manufacture of oxyhalogen salts.*

Oxyhalogen salts of the alkaline chlorides, or other chlorides, are produced by electrolyzing—without a diaphragm—a neutral or alkaline solution of the chloride to which has been added an inorganic oxidizing salt of the oxygen acid—such as potassium chromate in the electrolysis of potassium chloride—thereby effecting a diminution in the reduction brought about by nascent hydrogen and a diminution of the decomposition of water.

627,266—June 20, 1899. C. LUCKOW. *Process of producing acid chromate of lead.*

Acid chromate of lead is produced by using lead anodes in the electrolysis of an aqueous solution containing from 0.3 to 3 per cent of the sodium, potassium, or ammonium salts of chloric acid in mixture with the sodium, potassium, or ammonium salts of chromic acid. The bath is maintained constant by the addition of water and chromic acid. The mixture should be about 80 per cent of one of the salts of chloric acid, and about 20 per cent of one of the salts of chromic acid.

627,267—June 20, 1899. C. LUCKOW. *Process of producing basic phosphate of copper by means of electrolysis.*

Basic phosphate of copper is produced by using copper anodes in the electrolysis of an aqueous solution containing from three-tenths to 3 per cent of the sodium, potassium, or ammonium salts of chloric acid in mixture with the sodium, potassium, or ammonium salts of phosphoric acid. The bath is maintained constant by the addition of water and phosphoric acid and air. The mixture should be about 80 per cent of the salts of chloric acid and 20 per cent of one of the salts of phosphoric acid.

628,806—July 11, 1899. W. S. HORRY. *Method of producing carbid of calcium.*

Electrodes of opposite polarity are arranged in a vertical position and adjacent to each other; the charge fed around the electrodes, and an electric current caused to flow between the electrodes, thereby forming an initial pool of carbide, the charge being kept around the electrodes of such depth as to retain a considerable portion of the heat generated and thereby maintain the pool of carbide in a melted condition until it spreads laterally beyond the field of reduction; the carbide and charge being shifted vertically with respect to the electrodes to bring successive portions of the charge into the field of reduction.

629,394—July 25, 1899. I. L. ROBERTS. *Process of reducing metallic compounds and producing metallic carbids.*

The mixture of the metallic compound and carbon is supported upon an incandescent conductor or conductors, which support the charge and fuse the material, the fused metal or carbides passing the conductor. The conductors form a grate (or an incandescent pan is used for volatile metals), the chamber below being closed in.

630,612—August 8, 1899. M. LE BLANC AND H. REISENEGGER. *Process of producing chromic acid by electrolysis.*

A solution of a chromium-oxide salt in an aqueous solution of the corresponding acid—as chromium sulphate in sulphuric acid—is placed in the anode and cathode compartments of a vessel coated with lead, provided with a diaphragm, and having lead electrodes, and electrolyzed. The chromic acid produced and the residual solution are removed from the anode compartment, and the solution previously in the cathode compartment is transferred to the anode compartment. The residual solution from the anode compartment is recharged with chromium sulphate and replaced in the cathode compartment, and the electrical operation begun again.

630,690—August 8, 1899. H. L. HARTENSTEIN. *Process of manufacturing metallic carbids.*

As a modification of the process of No. 596,749, finely powdered limestone is, along with the carbonsceous matter, diffused through the molten slag.

631,253—August 15, 1899. F. A. GOOCH. *Process of reducing aluminium.*

A bath is formed by fusing together fluorides of aluminium and of an alkaline metal, as sodium; adding to the bath in suitable quantity carbon disulphide together with alumina, and electrolyzing with a current of suitably low voltage.

631,468—August 22, 1899. C. KELLNER. *Method of and apparatus for producing alkali salts.*

A solution of a suitable substance is electrolyzed in a cell having a mercury cathode forming an amalgam, the amalgam being then transferred to a second cell, where it is decomposed by means of a suitable solvent while passing therethrough the electrolyzing current and the secondary current produced by metallically connecting the electrodes of the said second cell.

631,839—August 29, 1899. H. C. WOLTERECK. *Process of manufacturing white lead or other pigments by electrolysis.*

White lead is produced by using lead anodes in the electrolysis of a solution capable of dissolving lead and containing an alkali metal carbonate—as, for example, ammonium nitrate 9 to 12 parts, ammonium bicarbonate 1 part—maintaining the electrolyte at a temperature below 25° C.; continuously withdrawing the mixed electrolyte and precipitate, and removing the white lead therefrom by filtration. The filtrate is regenerated with carbon dioxide and returned to the vat. For metallic pigments or lakes (zinc white, copper greens, etc.), a suitable anode is used and an electrolyte capable of dissolving said anode and containing a reagent suitable to produce the precipitate.

633,272—September 19, 1899. T. PARKER. *Process of manufacturing chlorates by electrolysis.*

An aqueous solution of an alkali-metal chloride is electrolyzed in a cell without a diaphragm, with a current density of about 20 amperes per square foot; the solution being covered with a layer of buoyant nonconducting material, as pumice stone or cork, to scrub the disengaged gases.

634,271—October 3, 1899. H. PLATER-SYBERG. *Process of extracting acetic acid from alkaline acetates.*

For producing the alkaline acetates, wood and mosses, rich in carbohydrates, may be boiled in a highly concentrated alkaline lye, air being injected into the mass, the temperature not going above 130° C. The process consists in first separating the acetic acid from the alkaline acetate by electrolysis cold in a trough provided with a positive electrode of iron or other equivalent metal, and a porous diaphragm, (the anode may be broken cast iron or iron shavings, and the anode compartment is lined with insulating material; the diaphragm being formed of two perforated sheet-iron plates, with the interspace packed with amianthus fiber); then in transforming the ferrous acetate into a ferric acetate by oxidizing with air; next, in acting under the influence of heat upon this ferric acetate with neutral acetate of potash; and finally in decomposing by heat the biacetate thus obtained into acetic acid and neutral acetate of potash, which serves to decompose fresh quantities of ferric acetate.

636,234—November 7, 1899. E. BAKER. *Process of and apparatus for electrolytic decomposition of saline solutions.*

A film of mercury flows continuously from a higher to a lower level beneath a column of the saline solution, in the electrolytic cell, thereby forming an amalgam, which, in its outflow, passes out of the cell and up in a substantially vertical direction until its column counterbalances the fluid head of the saline solution.

637,410—November 21, 1899. G. H. POND. *Process of and apparatus for dissociating substances by electrolysis.*

A soluble salt is packed between two vertical electrodes, and a saturated solution of the same salt is continuously fed by capillary attraction to the inner face of each electrode, and the electric current passed through the electrodes, the descending films of saturated solution, and the packed material.

641,552—January 16, 1900. M. RUTHENBURG. *Process of agglomerating comminuted ores or concentrates.*

Finely comminuted ores or concentrates are partially fused by the passage of an electric current through the mass until the contiguous corners of the particles cohere, producing a coherent body of open porous structure.

642,023—January 23, 1900. G. N. VIS. *Process of purifying brine.*

Brine is purified by passing therethrough an electric current not sufficient to decompose the calcium and magnesium salts present, but sufficient only to produce sodium hydroxide by decomposing part of the sodium chloride, allowing the sodium hydroxide to decompose the calcium and magnesium salts; and then removing the redissolved portion of calcium hydroxide by means of carbonic acid.

642,081—January 30, 1900. G. D. BURTON. *Process of unhairing animal hides or skins.*

They are electrolyzed in an unhairing solution, the current entering the solution and passing out away from the hides, and of sufficient volume to raise the hair and permit circulation through it.

642,390—January 30, 1900. F. P. VAN DENBERGH. *Process of making sulphuric acid.*

Calcium sulphate or gypsum, or other sulphur-bearing material, with or without a flux, is subjected to heat and electrolysis produced by an electric current in an electric furnace and applied directly to the material while in a molten state, and in the presence of an excess of oxygen, thereby forming sulphur oxides which are subsequently hydrated.

644,050—February 27, 1900. H. BECKMANN. *Manufacture of lead peroxid and its application to electrical storage batteries.*

The production of lead peroxide, particularly as a coating for the electrodes of storage batteries, by introducing metallic lead into a solution of sulphurous acid, or of a salt that in conjunction with an acid will generate sulphur dioxid, and adding a suitable acid, and subjecting the lead as a positive electrode to the action of an electric current.

644,510—February 27, 1900. E. F. FROST. *Process of electrical reduction.*

Chemicals or nonconducting ores are reduced by passing them into an electric arc formed between an electrode and an aqueous electrolyte, as acidulated water. For carbide of calcium the aqueous electrolyte floats on a substance that has no chemical affinity for the carbide and is not a solvent of water, as bisulphide of carbon, heavy oils, or coal tar.

644,779—March 6, 1900. J. W. RICHARDS AND C. W. ROEPPER. *Process of manufacturing metallic carbonates by electrolysis.*

An anode of the metal whose carbonate is to be formed—for example lead, in the manufacture of white lead of commerce—is used in the electrolysis of a salt of an organic acid—as acetate of sodium—either with or without an oxidizing reagent—such as sodium sulphite—whereby carbonic acid is generated at the anode, forming therewith a carbonate, while the oxygen evolved from the oxidizing reagent, if used, forms with the anode metal a hydrated oxid, intermingled with the carbonate.

645,284—March 13, 1900. E. G. ACHESON. *Method of electrically treating materials.*

The working faces of a pair of electrodes are arranged within the slope of a pile of material to be treated; fresh material is continuously supplied to the apex of the pile and the treated material delivered from the bottom

645,285—March 13, 1900. E. G. ACHESON. *Method of manufacturing graphite.*

Anthracite coal, or other noncoking coal, is heated to a high temperature by passing electricity through the coal and generating the heat electrically within the same, until it has been progressively converted into graphite. The coal is made the heating core of an electric furnace. The process is applicable to carbonaceous matter, the pieces or particles of which contain inherent impurities capable of forming carbides, but less in amount than enough to convert the whole of the respective pieces into said carbides, and naturally distributed with substantial uniformity in the piece, and which can be heated to a charring temperature without destroying the relative positions of the carbon and such associated impurities.

648,119—April 24, 1900. E. VIELHOMME. *Process of manufacturing rich ferro-chromium.*

Chromite is subjected to the heat of an electric furnace in the presence of a flux and pulverized coke, the temperature being sufficient for the reduction and the volatilization of most of the iron, producing a rich chrome iron.

648,439—May 1, 1900. A. J. ROSSI. *Process of producing alloys of iron and titanium.*

A bath is formed of a molten reducing metal, the heat of the formation of whose oxide is at a given temperature greater than that of titanic acid, as for example aluminum. Iron is added thereto and melted, and titanic acid is supported therein, a temperature being developed in the charge sufficiently high to insure the reaction between the reducing metal and the oxygen of the titanic acid, and the alloying of the titanium with the iron.

648,463—May 1, 1900. R. I. KNAUR, H. W. BUCK, AND C. B. JACOBS. *Process of abstracting silicon from silicious materials.*

Silicious material is heated to incandescence in an electric furnace and water gas is then forced therethrough, the silicon hydrid being led off as a gas. Aluminum silicate so treated leaves as a residue an aluminous product ($Al_2 SiO_5$) of value as an abradent.

649,565—May 15, 1900. C. E. ACKER. *Process of manufacturing caustic alkali and halogen gas.*

A molten salt of an alkali metal is electrolytically decomposed in contact with a molten lead cathode, forming an alloy of lead and the alkali metal, and the molten cathode is caused to circulate in continuous flow past an anode, or series of anodes, out of the furnace compartment and into a second compartment—steam being forced into the molten body below its surface to effect the circulation—and back into the furnace compartment, where it again takes up alkali metal. In the second compartment hydrogen and molten alkali separate from the lead or alloy and are severally removed from circulation. The feed of fresh salt is melted by burning the resulting hydrogen, and heat energy is also conserved by the heat of combination of the alkali metal with the oxygen of injected steam.

650,040—May 22, 1900. E. W. ENGELS. *Fire and acid proof material and process of making same.*

A brick or slab of refractory material is covered with carborundum and then subjected to electric heat sufficient to make an intimate fusion of the coating with the material of the brick.

650,234—May 22, 1900. F. A. J. FITZGERALD. *Process of making carborundum articles.*

Carborundum is compressed in the desired form and then recrystallized by heating in an electric furnace to or about the temperature required for the formation of silicon carbide. An adhesive material, as a glue solution, may be mixed with the carborundum, and if the article is to be an electrical conductor graphite is mixed therewith.

650,536—May 29, 1900. A. HOUGH. *Process of manufacturing substances resembling mannite.*

An aqueous solution of glucose is electrolyzed in the negative compartment of a double cell having a porous partition, in conjunction with water in the positive compartment, and subsequently evaporated down to obtain the solid material, having the formula of $C_6H_{14}O_6$.

651,167—June 5, 1900. J. E. HEWES. *Manufacture of carbid of calcium.*

Horizontal and parallel electrodes, capable of being longitudinally adjusted, are used beneath a mass of the raw material, together with an armature—a block of carbon—to start the current. After the formation of product is started by means of the armature, the latter is removed and the circuit completed through the fused material, the electrodes being longitudinally adjusted as required, and the solidified product withdrawn from beneath the mass and away from the ends of the electrodes.

651,396—June 12, 1900. E. A. G. STREET. *Production of chromium oxid.*

A solution of an alkali metal chromate or bichromate is electrolyzed at a temperature of about 70° C., using a mercury cathode, resulting in the precipitation of the whole of the chromium as hydroxid.

651,718—June 12, 1900. H. LELEUX. *Method of electrically treating ores of nickel, etc.*

For the electric smelting of nickel, cobalt, silver, lead, and copper ores without preliminary roasting or fusion, a furnace is used having electrodes of a metal whose heats of combination with the nonmetallic constituents of the ore containing the metal to be liberated are higher than the heats of the said metal to be liberated. The electrodes are in contact with the ore, and the electric current brings the ore to such a temperature as to cause the suitably chosen metal of one of the electrodes to unite, by exothermic reaction, with the metals that are associated with the particular metal to be liberated. Thus, for the smelting of a nickel ore, the hearth electrode is of cast steel, water cooled below, and faced with nickel. For argentiferous galena or a complex ore of copper, nickel, or analogous metals combined with sulphur, arsenic, or antimony, the electrodes are of iron.

652,761—July 3, 1900. J. B. ENTZ. *Electrolytic production of caustic soda, etc.*

The mercury cathode of an electrolytic cell is subjected to the influence of a magnetic field to cause it to circulate and transfer the amalgam or deposited substance out of the electrolytic cell and into a depositing compartment.

652,846—July 3, 1900. J. HARGREAVES. *Process of purifying and strengthening brine for use in electrolytic cells.*

The weakened brine withdrawn from the electrolytic cell is caused to circulate, by means of a steam jet, upward through a mass of impure salt in a sealed vessel, and then back to the cell.

652,877—July 3, 1900. R. C. BAKER. *Process of obtaining hardening or toughening compounds for alloying with iron or steel.*

The boride of a metal capable of use as a hardening or toughening agent for steel and other metals (ferro-boron, nickel-boron, chromium-boron, or tungsten-boron) is obtained simultaneously with calcium carbide by subjecting a mixture of calcium borate, carbon, and a material containing such metal to heat sufficient to effect the reaction, as in an electric furnace. The boride compound is obtained in a fused mass, and may be run off, with the calcium carbide above it.

653,716—July 17, 1900. J. T. VAN GESTEL. *Process of waterproofing fabrics.*

For the purpose of setting the dye or rendering the fabric waterproof the fabric is impregnated, in a bath, with a soluble metallic salt capable of yielding an insoluble oxide upon electrolysis, and the wet fabric is then placed between nonoxidizable electrodes and an electric current passed therethrough. In fixing a dye, the metallic salts are mingled with the dye in the goods under the influence of the electric current, thereby acting as a mordant, or a fabric already dyed may be treated as for waterproofing.

653,739—July 17, 1900. W. M. JEWELL. *Process of purifying water.*

An insoluble coagulent is continuously formed (ferrous hydrate) by electrolytically decomposing a solution of a suitable salt (sodium chloride), in which is immersed an anode composed of a substance (iron) adapted to combine with one or more of the constituents separated by the electrolytical decomposition, which coagulent as formed is introduced into the water to be purified, and the water filtered.

655,239—August 7, 1900. T. JESPERSEN. *Process of bleaching by electrolytic chlorin water.*

It consists in electrolyzing a dilute solution of hydrochloric acid, using an immersed anode and a surface cathode, bleaching in the same tank with the resulting chlorine water and thereby restoring hydrochloric acid to the solution; and again electrolyzing as before, all being simultaneous and continuous.

656,156—August 14, 1900. W. S. HORRY. *Method of producing carbid of calcium, etc.*

The zone of reduction is formed between the ends of vertically depending electrodes, the charge being maintained around and above the electrodes to a depth sufficient to oppose the upward passage of evolved gases, which escape laterally by the path of least resistance. The product mass is automatically lowered, as formed, to bring successive portions of the charge into the zone of reduction.

656,599—August 21, 1900. R. DOOLITTLE. *Process of manufacturing carbids.*

A mixture of the carbide materials is showered down a closed vertical shaft through a flame formed by gas or oil burners near the top, and then through a zone of increased temperature formed by a number of superimposed electric arcs, the gases being drawn off below the electric furnace.

656,988—August 28, 1900. E. D. KENDALL. *Electrolytically treating scrap tin.*

An aqueous solution of a nitrate of an alkali metal or nitrate of an alkaline earth metal is electrolyzed, using scrap tin plate as the anode, and the nitrate transformed into a nitrite; sodium or other nitrate is added as required, and finally the strong solution is evaporated and the nitrite salt recovered therefrom, which may be used for the preparation of fertilizers. The stannic oxide and any metallic tin is utilized for the production of sodium stannate or otherwise.

See Group XVIII for other methods and processes for the production of such bodies as are also produced electrolytically.

APPARATUS.

102,478—May 10, 1870. I. ADAMS, JR. *Improvement in the electro-deposition of nickel.*

A nickel anode combined with carbon is used to prevent the formation upon the anode of peroxide of nickel.

310,533—January 6, 1885. B. MOEBIUS. *Apparatus for the electrolytical separation and deposition of metals.*

Adjustable brushes or scrapers are provided with means for moving them along the surface of the electrodes, together with other structural details specially applicable to the electrolysis of metals.

312,803—February 24, 1885. C. S. BRADLEY. *Electrical conducting material.*

See Group XV, Rubber and Rubber Substitutes.

312,814—February 24, 1885. H. R. CASSEL. *Apparatus for treating metals by means of electrolysis.*

It includes an anode cell constructed in part of porous material and in part—as the bottom—of nonporous material, for containing material to be subjected to electrolytic action; besides features specially applicable to the electrolysis of metals.

319,945—June 9, 1895. E. H. & A. H. COWLES. *Electric smelting furnace.*

An elongated horizontal chamber has oppositely located electrodes in conductive relation to the charge but otherwise insulated from one another. The lining is of granular nonheat-conducting material of less conductivity than the charge.

335,058—January 26, 1886. A. H. COWLES. *Electric furnace and method of operating the same.*

The electrodes are introduced into the charge in proximity to each other, and caused gradually to recede—to obtain a uniform action of the electric current—until the mass of the charge is contained between them, the same remaining in contact with both electrodes.

335,059—January 26, 1886. E. H. & A. H. COWLES. *Electric furnace for metallurgic operations.*

The lining for an electric furnace consists of finely divided charcoal mixed with finely divided refractory material of low conductivity, as lime.

360,144—March 29, 1887. E. H. & A. H. COWLES. *Electric furnace.*

An incandescent electric furnace has charge-feeding mechanism automatically controlled by the electric resistance of the charge. The feed to and discharge from the zone of fusion is through tubular electrodes.

382,183—May 1, 1888. J. OMHOLT. *Apparatus for producing metals by means of electrolysis.*

A reverberatory furnace has half-retorts supported a short distance above its floor, an electrode in each half-retort, and a tube establishing communication between each half-retort and a chamber below. The bottom edges of the half-retorts being immersed in the molten halogen combinations are thereby sealed, and the light metals collecting on the upper surface of the molten mass pass into the bottom chamber in a fluid state or as a gas and are collected.

391,034—October 16, 1888. H. H. EAMES. *Device for refining metallic ores.*

Retorts have electrodes extending their entire length to electrolyze the charge when heated.

403,752—May 21, 1889. J. C. HOBBS. *Method of operating electric furnaces.*

The charge of an incandescent electric furnace is enveloped or covered with sawdust, the furnace chamber being lined therewith.

410,976—September 10, 1889. G. KERNER AND J. MARX. *Diaphragm for electrolytic apparatus.*

It consists of a liquid inclosed between two or more partitions having perforations of considerable size, too large to act osmotically by themselves. The liquid must not be in the same state as the osmotical and endosmotical liquids, and it is constantly or at intervals renewed.

428,378—May 20, 1890. E. A. COLBY. *Electric furnace for melting metals.*

The material is heated by inductively established electric currents in metal of a refractory mass. (Process No. 428,552.)

428,379—May 20, 1890. E. A. COLBY. *Electric induction device.*

A refractory conducting receptacle constituting a closed secondary circuit is heated by induced currents from a primary circuit. (Process No. 428,552.)

442,203—December 9, 1890. I. L. ROBERTS. *Separating-diaphragm for electrolytic cells.*

A nonporous diaphragm of a relatively high electrolytic resistance; preferably composed of a gelatinous substance, as a gelatinized solution of silicate of soda and water of about 18° Baumé, held by supporting walls.

442,204—December 9, 1890. I. L. ROBERTS. *Diaphragm for electrolytic cells.*

It is formed of asbestos freed from soluble constituents. Asbestos board and asbestos cloth are sewed together within a cloth case, treated with muriatic acid, rolled, kneaded, washed, and pressed.

442,332—December 9, 1890. I. L. ROBERTS. *Electrolytic apparatus.*

A nonporous diaphragm or partition is used, composed wholly or in part of a body capable of acting as an electrolyte; it permitting such decompositions and recombinations to take place as are essential to the electrolytic action. Preferably a cup, plate or sheet of earthenware is soaked in an aqueous solution of alum, then immersed in an alkali solution, such as caustic soda, until the pores are filled with a gelatinous mass.

442,333—December 9, 1890. I. L. ROBERTS. *Apparatus for use in electrolysis.*

Two or more electrolytic partitions of nonporous material (No. 442,332) are employed, forming compartments for the electrodes, with one or more bodies of electrolytic or conducting paste interposed between the partitions.

442,334; 442,396; 442,594—December 9, 1890. I. L. ROBERTS. *Electrolytic apparatus.*

In apparatus for the electrolysis of saline solutions and the manufacture of caustic alkali, encasing jackets for the anodes, or porous partitions, are used formed of anthracite coal or coke in the condition of impalpable powder, which is a barrier to the mechanical transfusion of fluid, but permits of the transference of the acid radical to the anode.

450,103—April 7, 1891. E. A. LE SUEUR. *Electrolytic apparatus.*

A vegetable parchment diaphragm is employed in an electrolytic cell, for saline solutions; placed below the positive electrode whereby it is preserved from contact with the gases formed at said electrode.

455,451—July 7, 1891. E. A. LE SUEUR. *Diaphragm for electrolytic cells.*

The diaphragm, specially adapted for the electrolysis of alkaline chlorides, consists of a layer, sheet, or film of albumen which has been dried and coagulated by heat. It may be combined with a sheet of paper or other supporting material.

464,096—December 1, 1891. L. GRABAU. *Apparatus for obtaining metals of the alkalis from molten chloride.*

A bell-shaped pole-cell is constructed with double walls, with the inclosed chamber open at the top, so that conductivity can take place through the walls thereof.

465,369—December 15, 1891. L. GRABAU. *Production of insulating coatings or linings in electrolytic apparatus.*

A bell-shaped pole-cell having double walls encompasses one of the electrodes of a fused bath, the pole-cell having means for causing a cooling agent to circulate therethrough, whereby the fused mass in contact with the pole-cell is congealed and forms a protective crust thereon.

469,428—February 23, 1892. C. N. WAITE. *Diaphragm for electrical cells.*

The diaphragm, specially adapted for the electrolysis of highly corrosive liquids, consists of a dense and compact layer, sheet, or film of a metallic albuminate. A sheet of albumen is formed, dried so as not to coagulate the albumen, and dipped in a solution of metallic or earthy salt, such as tartrate of antimony, chloride of tin, or sulphate of alumina, forming an insoluble albuminate of the metal.

473,117—April 19, 1892. P. HÉROULT. *Electrode for use in electro-metallurgical processes.*

It consists of a plurality of carbon strips secured together in a single block and a metal combined therewith and extending substantially the entire length of the electrode. The metal is adapted to lower the electrical resistance of the electrode, and it should be the same as one of the normal constituents of the useful products of the desired operation.

473,393—April 19, 1892. P. L. T. HÉROULT. *Electrode.*

It is built up of carbon blocks or slabs fitted together and secured by pins or clamps to a metal plate or plates extending the entire length of the electrode. The metal should be such as can enter into the product.

482,586—September 13, 1892. T. PARKER. *Electric furnace.*

Relates to details of auxiliary electrodes to heat the charge between fixed electrodes and start the furnace.

489,551—January 10, 1893. C. N. WAITE. *Electrical diaphragm.*

It consists of a sheet or layer of asbestos or other acid-resisting fibrous material and bichromatized gelatine. Bichromate of potash dissolved in a glue solution may be mixed with asbestos fiber and a sheet formed thereof, which is dried and exposed to sunlight, or treated in a bath of hyposulphite of soda.

494,585—April 4, 1893. W. MITCHELL. *Means for electrically heating crucibles.*

A crucible has opposite sections of electrically conducting material with an intermediate insulating strip, made, for example, by cutting a plumbago crucible on the line of its axis and interposing a strip of asbestos. It is grasped by a holder which establishes electrical connection with its opposite conducting sides.

494,586—April 4, 1893. W. MITCHELL. *Apparatus for electrically heating crucibles.*

A receptacle for crucibles is formed of conducting end sections of electrically high resistance, an interposed U-shaped insulating strip, and a filling of pulverized conducting material. An inclosed crucible may be attached to and removable with the said strip.

495,600—April 18, 1893. G. O. RENNERFELT. *Electrolytic apparatus.*

A bell-shaped cathode, having an exterior of nonconducting material, is employed with a suction pipe connected with the interior of the cathode, whereby, in the electrolysis of a fused bath, the metal set free at the cathode can be removed by suction.

503,451—August 15, 1893. W. E. CASE. *Apparatus for electrolysis of fused salts.*

A containing vessel for the electrolysis of fused salts has an inner wall of electrically nonconducting material, and an outer surrounding envelope therefor and a bottom both of electrically conducting material, with the envelope and bottom insulated from one another. The lining or inner wall and insulation is formed of fused or solidified salt.

504,282—August 29, 1893. S. SHAW. *Apparatus for melting iron.*

It relates to special details, particularly of feed mechanism for electrodes for a cupola furnace.

504,308—August 29, 1893. S. SHAW. *Apparatus for melting iron or iron ore.*

A cupola furnace has a concave base and electrodes introduced at the lower end of the vertical side walls, said furnace chamber having a central narrowed passage opening into a receiving chamber below, the latter chamber having discharge openings at different elevations, and hinged bottom doors or traps.

504,703—September 12, 1893. A. BREUER. *Electrolytic diaphragm.*

A porous diaphragm capable of resisting the action of caustic bodies, formed of a cement that will set at normal temperatures when combined with a suitable liquid in due proportions, and of a porous substance capable of resisting the reaction of an electrolyte, as comminuted pumice stone, combined with and mixed throughout the body of cement.

507,374—October 24, 1893. F. M. LYTE. *Electrode.*

A hollow carbon electrode, closed at the bottom, has a core of metal or alloy (to reduce the electrical resistance), which is fusible at or below the working temperature of the fused bath.

508,084—November 7, 1893. A. BREUER. *Diaphragm used in electrolytical processes.*

It is formed of a cement adapted to harden or set when combined with water, and of a substance or body soluble or destructible in a liquid which can be removed after the cement has set, leaving the diaphragm porous.

512,602—January 9, 1884. C. L. COFFIN. *Furnace for heating or working metals electrically.*

It relates to details of an electric forge. A pipe coil in the bed or hearth conducts hot air or gas into the arc.

513,270—January 23, 1894. A. F. W. KREINSEN. *Process of and apparatus for melting metals by means of electricity.*

Relates to details of a cap or cover for a crucible, which cover carries a carbon electrode and an electrode of the metal to be melted.

513,602—January 30, 1894. E. THOMSON. *Electric furnace.*

It consists of carbon bars or slabs, in an electric circuit, packed in powdered carbon in a chamber of nonheat-conducting material, with a receptacle for the material to be heated set in the powdered carbon.

513,661—January 30, 1894. C. T. J. VAUTIN. *Electrolytic cell.*

A mercury electrode is supported by a nonconducting reticular mesh or sieve or perforated plate.

518,065—April 10, 1894. C. HOEPFNER. *Electrolytical apparatus.*

The diaphragm is constructed of a nitrated organic substance, which may be strengthened with one or more auxiliary diaphragms. Paper, textiles, or the like may be treated with nitric acid or nitrating gases, or a coating of nitro-cellulose is applied, or paper-pulp or asbestos, etc., may be combined with nitro-cellulose and diaphragms formed thereof.

518,135—April 10, 1894. H. Y. CASTNER. *Electrolytic apparatus.*

In an electrolytic cell or apparatus where a certain portion of the substance circulates between communicating compartments, as mercury and sodium amalgam, for the relinquishment of its sodium in the reduction of a solution of sodium chloride, the cell is periodically rocked to cause the mercury to flow from one compartment to another and back again.

522,614—July 10, 1894. I. L. ROBERTS. *Electrolytic diaphragm.*

It is composed of an insoluble nonconducting pulverized substance mixed with a gelatinizable silicate. A paste formed of powdered anthracite coal and a solution of silicate of soda or potash is molded into the desired shape, temporarily supported, and gelatinized by electrolytic action.

523,026—July 17, 1894. C. N. WAITE. *Diaphragm for electrolytic cells.*

It consists of a film, sheet, or fabric of asbestos or like indestructible material with a layer of sand or like comminuted material overlying it.

523,262—July 17, 1894. G. A. CANNOT. *Apparatus for the manufacture of chlorin monoxid.*

Apparatus for the carrying out of process No. 523,263.

530,019—November 27, 1894. C. L. COFFIN. *Box of furnace for electric heating apparatus.*

Relates to structural details of a furnace box or chamber.

530,479—December 4, 1894. G. A. GOODSON. *Apparatus for casting molten material.*

The metal is kept fluid in transmission through a pipe connecting the casting pot and the mold by an electric current sent through the pipe and its metal contents.

531,143—December 18, 1894. J. W. WOODFOLK AND J. C. WHARTON. *Apparatus for electric heating, smelting, and separating.*

Relates to minor details of a furnace having a circulation of acidified water.

533,596—February 5, 1895. H. A. HOUSE. *Apparatus for refining metals by electrolysis.*

A rotary segmental cathode is partially immersed in the electrolyte, and a scraper removes the film of metal from the cathode above the solution, the segment of the cathode in engagement with the scraper being insulated.

537,009—April 9, 1895. G. D. BURTON AND E. E. ANGELL. *Method of and apparatus for electric metal-heating.*

An electric forge having electrodes adapted to receive and support a connecting bar of iron and heat it by its electric resistance.

538,571—April 30, 1895. H. G. O'NEILL. *Electrically and chemically heated crucible.*

A mixture of diatomaceous earth and carbonaceous material is used as the heating body of an incandescent electric furnace. The receptacle has a resistance wound around it as an auxiliary heater.

544,153—August 6, 1895. W. BORCHERS. *Vessel for electrolytic separation.*

A vessel (constituting the cathode) for the electrolytic treatment of metals—as the formation of lead sodium alloy in the electrolysis of fused chloride of sodium—has numerous superimposed grooves on its interior face and a bottom discharge opening, whereby the material exposed to electrolytic action flows downwardly from one groove to another.

546,328—September 17, 1895. C. HOEPFNER. *Anode for electrolytic apparatus.*

An anode, with a surface of a compound of silicium and another conductive metal in such proportions (*as minimo* 10 per cent silicium) as to be proof against the action of liquids or gases, particularly chlorine. It is made wholly or in part of ferro-silicium. If of carbon, it may be coated or plated with ferro-silicium.

546,361—September 17, 1895. D. TOMMASI. *Apparatus for extracting, separating, and refining metals by electrolysis.*

Polarization is prevented by using a rotating cathode disk composed of a mixture of carbon and oxide of copper, partially immersed in the electrolyte. The disk is formed of removable segmental sections.

548,162—October 15, 1895. J. HARGREAVES AND T. BIRD. *Combined diaphragm and electrode.*

A permeable electrode, as wire gauze or perforated metal, has directly secured thereto a face of fibrous material and an insoluble binding agent, superposed on which there may be a layer of porous stone-like material, such as cement.

551,014—December 10, 1895. J. A. VINCENT. *Electric smelting furnace.*

The material is forced by a positive horizontal feed through a horizontal channel way and between electrodes, forming in part the walls of the channel, into a discharging pit.

552,841—December 31, 1895. J. A. VINCENT AND J. E. HEWES. *Electric smelting furnace.*

It has a removable electrode bottom to the hearth with an adjustable upper electrode and feeding devices for the material.

556,038—March 10, 1896. M. H. WILSON. *Electrolytic apparatus.*

To avoid the rapid destruction of electrodes, as by caustic soda and chlorine in the electrolysis of a saline solution, the electrode is formed of a relatively small stream or column of water which serves as a conducting medium through which the electric current enters or leaves the solution.

556,626—March 17, 1896. A. C. GIRARD AND E. A. G. STREET. *Electric furnace.*

A heating chamber has a longitudinal passage extending through it, a tubular cylinder for containing the material to be heated, with means for feeding the cylinder through said passage, an electrode projecting into the heating chamber, and connections to establish an arc between the electrode and the said cylinder.

558,357—April 14, 1896. M. R. CONLEY. *Electrical furnace.*

A melting pot or vessel made of a carbon composition electrically heated by its resistance has integral arms or opposite sides to which the electrical connections are made.

562,400—June 23, 1896. W. R. KING AND F. WYATT. *Electric furnace.*

An arc furnace with a hollow vertical upper electrode has a feed tube extending down within the said electrode.

562,403—June 23, 1896. W. R. KING AND F. WYATT. *Electric furnace.*

Appliances for carrying out the process of No. 563,402 and handling the carbide nugget.

562,404—June 23, 1896. W. R. KING. *Electric furnace.*

A plurality of upper electrodes, preferably arranged in a ring, each adjustable and all carried by a common adjustable frame, form a plurality of arcs with a common hearth electrode. There is a central feed and a deflector to throw the material into the field of the several arcs.

565,955—August 18, 1896. E. ANDREOLI. *Apparatus for indirect electrolysis.*

For the indirect electrolysis of solutions the cell has three compartments formed by two porous diaphragms; the middle section to contain the solution to be treated (e. g. sodium bisulphite), and also a series of perforated plates, and the end sections positive and negative electrodes and suitable solutions (e. g. caustic potash and sodium chloride, respectively).

567,699—September 15, 1896. J. A. VINCENT. *Electric smelting furnace.*

An upright furnace chamber open at top and bottom has a vertically movable floor, positive down feed for material, and side electrodes with automatic feed. The material is forced down between the electrodes and the smelted product feeds down with the floor.

568,177—September 22, 1896. N. TESLA. *Apparatus for producing ozone.*

Apparatus for the production of ozone by the action of high-tension electrical discharges, involving the combination with a circuit of direct currents, of a controller for making and breaking the same, a motor included in or connected with said circuit so as to increase its self-induction and driving the said controller, a condenser in a circuit around the controller, and a transformer through the primary of which the condenser discharges.

568,229—September 22, 1896. H. BLACKMAN. *Electrode.*

An anode for use in electrolytic decomposition, consisting of a dense impermeable mass of combined electro-conductive iron oxide and a flux, as, for example, the residue from pig-iron furnaces known as "black slag."

568,230—September 22, 1896. H. BLACKMAN. *Electrode for electrolytic decomposition.*

An anode consisting of a casting of ilmenite, with a small proportion of fluxing material.

568,231—September 22, 1896. H. BLACKMAN. *Electrolytic anode and apparatus.*

An anode for electrolytic decomposition, consisting of electro-conductive oxide of iron in a dense impermeable mass, as, for example, magnetite.

569,122—October 6, 1896. A. A. NAVILLE AND P. A. & C. E. GUYE. *Electrical gas-reaction apparatus.*

The apparatus for the treatment of gases comprises a series of independent insulated tubes interposed in line between two electrodes of an electric circuit, with gas conduits communicating with the inside and outside of the several tubular electrodes. It is applicable to the production of nitric acid by means of moist air circulating in an apparatus with the electrodes made of coal, and the production of acetylene gas by means of hydrogen in such an apparatus.

569,521—October 13, 1896. R. G. G. MOLDENKE. *Apparatus for melting metals.*

A regenerative or other crucible furnace has a sloping platform for the charge and an electric arc at the foot of the slope to supplement the heating. An electro-magnet deflects the arc onto the charge.

570,133—October 27, 1896. W. DE C. MAY. *Apparatus for electrolytic deposition.*

The apparatus, for the electrolytic treatment of material in a fine state of subdivision, comprises a series of superimposed pans, the bottom of each extending down into the immediately subjacent one, and each with an overflow for the electrolyte into the next pan of the series. Each pan contains a layer of the material to be treated, and the electrolyte is returned from the bottom to the top pan in continuous flow.

571,655—November 17, 1896. A. C. GIRARD AND E. A. G. STREET. *Electric furnace.*

An electric furnace has a carbon tube or casing for the material, said tube being interposed, as a common electrode, between one or more electrodes to produce arcs outside of the tube. The hearth is below the tube.

572,312—December 1, 1896. E. F. PRICE. *Electric furnace.*

It has an inclined electric hearth with means for adjusting the inclination, and a range of perpendicular adjustable electrodes, with the material fed down around them. Casings around the electrodes—there being intervening feed spaces—have flues for escaping gases.

572,472—December 1, 1896. H. Y. CASTNER. *Anode for electrolytic processes.*

A graphitized carbon electrode; produced by submitting a shaped electrode of gas-retort or like carbon to the intense heat produced by passing an electric current therethrough while it is protected from the air. The disintegration of the carbon in a bath by the combined action of oxygen, chlorine, and water is materially reduced as the carbon approaches the graphitic variety.

573,041—December 15, 1896. M. SCHINDLER. *Electric furnace.*

Relates to details of a cooled holder for a furnace electrode.

575,826—January 26, 1897. J. A. DEUTHER. *Electric furnace.*

The upper suspended electrode of an arc furnace is vibrated, and the material is fed onto the bottom electrode and within the arc path as the upper electrode swings to and fro.

575,829—January 26, 1897. J. JOYCE AND J. A. DEUTHER. *Electric furnace.*

The bottom electrode is laterally displaced, at intervals, to expose part of its surface, but not to break the arc, and the material is automatically fed onto the exposed surface of the electrode.

577,317—February 16, 1897. F. J. PATTEN. *Electric furnace.*

A plurality of incandescent carbon pencils are successively thrown into circuit in rotation—to give a diffusion of heat—by means of a liquid commutator; a rotating switch operates in an acidulated water bath.

577,370—February 16, 1897. F. J. PATTEN. *Electric furnace.*

The material is passed between electrodes, and the arc is reciprocated transverse to the path of material by a magnetic field, the current of the magnetic field or of the electrodes being alternated.

577,493—February 23, 1897. F. J. PATTEN. *Electric furnace.*

The furnace has a central vertical carbon core, and numerous lateral carbon pencils radiating from it, through the charge mixture, to the walls and to independent leads. The current is sent in succession or in groups through the pencils.

578,073—March 2, 1897. H. BLUMENBERG, JR. *Porous diaphragm.*

Asbestos, formed into the desired shape, is treated with acid to remove the metallic salts and toughen it. A binding material is then forced into the pores of the asbestos under high pressure, and it is then baked at a high temperature, which changes it from a fibrous to crystalline state.

579,324—March 23, 1897. W. S. HADAWAY, JR. *Electric furnace.*

Relates to details of a muffle electrically heated by incandescent outer packing, with a hydrocarbon gas injected therethrough, which gas is decomposed, and the hydrogen gas burnt in the outer shell of the muffle.

582,721—May 18, 1897. J. A. DEUTHER. *Electrode.*

Relates to structural details.

582,923—May 18, 1897. A. E. HUNT. *Electrolytic apparatus.*

To protect workmen attending the several pots or vessels connected in series of an electrolytic apparatus, a metal platform is provided for each pot or vessel in electrical connection therewith and maintained at the same electrical potential as the pot.

583,249—May 25, 1897. A. H. COWLES. *Electric furnace and method of operating same.*

The material is heated by internally generated heat, and a gas, or gas and air, is periodically passed therethrough in opposite directions.

583,250—May 25, 1897. A. H. COWLES. *Electric furnace.*

A furnace chamber has gas-pipe connections and valves, and bodies of broken carbon through which the gas passes on entering and leaving the furnace chamber. (See No. 583,249.)

583,513—June 1, 1897. W. SPILKER. *Electrolysis of watery salt solutions.*

A membrane, serving as a foundation, is used in the electrolysis of an alkaline cathode solution from an anode solution consisting of a mixture of the chlorides of the alkali metals and calcium holding the corresponding oxyhydrate—caustic lime—in solution, which causes a solid porous coating to be attached to the foundation membrane on the side of the anode space.

583,618—June 1, 1897. H. ELDRIDGE, G. H. WRIGHT, AND D. J. CLARK. *Vacuum electric-arc furnace.*

The furnace has a cylindrical pot cathode and a hollow cylindrical anode adjustably supported within an arcing distance; also means for sealing the chamber and other details.

583,936—June 8, 1897. E. F. PRICE. *Electric furnace.*

The furnace has an inclined hearth electrode with an adjusting screw for one end, a range of upper electrodes with a surrounding water-cooled hopper, stirrers for loosening the charge below the hopper, and other structural details.

585,040—June 22, 1897. C. G. P. DE LAVAL. *Method of melting iron by means of electricity.*

The melting chamber has a transverse bridge with pole pieces at the bottom of the pockets on each side of the bridge, and outlets for molten metal in the sides above the bottoms of the pockets. The path for the current is through the material over the bridge.

585,387—June 29, 1897. C. KELLNER. *Electrolytical diaphragm.*

It is composed of a slab of soap, which may have a reenforcing backing.

586,686—July 20, 1897. R. F. S. HEATH. *Electric furnace.*

It has a stationary upper electrode offset with respect to the axis of the furnace, and a rotary pot electrode, together with structural details.

586,687—July 20, 1897. R. F. S. HEATH. *Electric furnace.*

Means are provided for rotating vertically and laterally adjustable carbons around the axis of the furnace, the hearth constituting the other electrode.

586,822—July 20, 1897. F. J. PATTEN. *Electric furnace.*

The furnace has electrodes and passages for conveying material through the arcing space between the electrodes, such as a lower carbon-slab electrode and an upper tubular electrode; and means for rotating the arc about the axis of the upper carbon, as, for example, a magnetizable ring surrounding the arcing space with means for creating a rotating magnetic field in said ring.

586,824—July 20, 1897. F. J. PATTEN. *Electric furnace.*

A homogeneous mass of material of low and uniform conductivity is heated by passing an electric current through the mass and establishing around it a rotating magnetic field transverse to the current flow in the mass. The lines of current flow are deflected by the magnetic field and the rotation of the deflected lines of flow widens the body of heated material.

587,182—July 27, 1897. G. DE CHALMOT. *Electric furnace.*

The hearth is given a horizontal reciprocatory movement to facilitate the feeding of granular material into the arc. The carbon holder, of special construction, has separable lining plates to receive the wear of any contact arc and protect the holder.

588,267—August 17, 1897. G. DE CHALMOT. *Electric furnace.*

The furnace discharges its overflow product upon a sand-sprinkled revolving cylinder. The overflow wall, formed of the furnace product, is renewed by increasing the heat and partially fusing it down, then supplying additional material and reducing the heat until sufficient has congealed against the wall to build it up.

588,866—August 24, 1897. J. W. KENEVEL. *Means for manufacturing carbids.*

The furnace employs rotatable electrodes arranged in a horizontal plane (like a pair of rollers) with mechanism for rotating the same, and means for feeding the prepared material between the electrodes.

590,826—September 28, 1897. J. D. DARLING. *Porous diaphragm for electrolytic apparatus.*

It consists of a support having a granular filling of a vitrified oxide or oxides substantially resistant to combination or fluxing by a fused hydroxide under the conditions of electrolysis. Magnesia or other earthy oxides, as those of calcium or barium, may be fused in an electric furnace, crushed, and granulated to pass a twenty-mesh sieve.

592,802—November 2, 1897. N. MARCHAL. *Electric diaphragm.*

It consists of a plate cut from limestone, or is formed of equivalent integral natural alkaline-earth carbonate, as of a paste of pulverized limestone and burned magnesia, compressed.

595,712—December 21, 1897. J. E. HEWES. *Electric furnace.*

The furnace has an upper suspended electrode, a regulator for the same, and means for imparting thereto a longitudinally reciprocating motion whereby the furnace becomes self-stoking and the agitation prevents crystallization of the carbide.

597,476—January 18, 1898. T. L. WILLSON. *Electric furnace.*

A feed flue delivers material against the side of an upright movable carbon pencil. A removable crucible hearth having an outer flange, has a circuit-connecting clamp of special form engaging with said flange.

597,880—January 25, 1898. W. S. HORRY. *Electric furnace.*

A bottomless hopper has inclined electrodes supported on the walls of the hopper, and a rotatable receptacle (a spool-like structure) arranged below said hopper with plates removably applied to the periphery of the receptacle (spool) and forming the outer wall of the hearth.

597,945—January 25, 1898. C. S. BRADLEY. *Electric furnace.*

The furnace is carried by a wheel turning on a horizontal axis, giving a continuous downward movement of the charge relative to the electrode, by a movement of rotation. Removable rim sections form the receptacle for the charge, which is continuously fed in on one side of the periphery, and the product removed on the other.

598,318—February 1, 1898. J. E. HEWES. *Electric furnace.*

The material is laterally fed from a supply chamber into the field of the electrodes by a reciprocating rammer, the latter being controlled by fluctuations in the current.

601,367—March 29, 1898. C. L. WILSON, C. MUMA, J. W. UNGER, H. SCHNECKLOTH, A. P. BROSIUS, and J. C. KUCHEL. *Electric furnace for manufacturing calcium carbid.*

The furnace has a base electrode and an upper vertically movable electrode having a number of longitudinal flues extending therethrough with a like apertured block of insulating material superposed. The charge, in the form of sticks of compressed lime and carbon, is fed into the flues of the upper electrode, the sticks resting on the base electrode.

602,815—April 19, 1898. G. G. CLARK. *Electric furnace.*

Relates to details of construction, including a revoluble pot electrode and a scraper for feeding the material inward toward the arc.

603,058—April 26, 1898. H. ELDRIDGE, D. J. CLARK, and S. BLUM. *Electrical retort.*

Relates to structural details of an apparatus for making hydrogen from water by heat of an arc and electrolytic action.

609,745—August 23, 1898. W. G. LUXTON. *Diaphragm for electrolytic purposes.*

It is made of a composition of cement, sand, and a porous material, such as gypsum, lime, coke, etc., mixed with water and allowed to set; the diaphragm having pores through the substance of the porous material and interstices between the cement and the other constituent particles due to the contraction of the cement in drying or setting.

611,142—September 20, 1898. R. PIGNOTTE, F. LORI, S. REGNOLI, M. BESSO, AND M. PANTALEONI *Electric furnace.*

It relates to the structural details of a furnace involving, with other details, a carbon-bottom electrode having an opening closed with a lever-operated carbon plug, a suspended electrode, feeding mechanism, and a gas-heated chamber for preheating the material.

612,943—October 25, 1898. L. BRESSON. *Electric furnace.*

A crucible having axial openings for electrodes and carrying a feed hopper can be tilted to discharge its load. Inwardly projecting electrodes are coupled by levers which permit of a parallel vertical movement of their extremities and maintenance of the arc as the charge rises in the crucible.

616,906—January 3, 1899. J. A. DEUTHER. *Electric furnace.*

Relates to special details, including a fan to supply the material to the arc and telescopic wall sections.

618,391—January 31, 1899. H. BOVY. *Electric furnace.*

The furnace has an inclined floor formed of a series of carbon block electrodes with intermediate filling of carbon powder. These electrodes are made incandescent by the flow of the current through to upper electrodes and the charge.

621,908—March 28, 1899. H. H. DOW. *Porous diaphragm for electrolytic cells and method of producing same.*

The diaphragm is composed of two layers; that on the cathode side composed of a chemical substance that will consume halogens by chemical action, and the layer on the anode side composed of a different chemical substance that will not be consumed by free halogen and containing a substance with which any soluble alkali diffusing from the cathode side will readily combine chemically (e. g., iron hydrate on the anode side and calcium and magnesium hydrates on the cathode side). Two part diaphragms, in cells for the electrolytic production of chlorine, are formed wholly by the action of electrolysis on the cell contents, by electrolyzing a solution containing sodium, magnesium, and calcium chlorides, and introducing into the neighborhood of the anode a soluble iron salt, whereby the hydrates of iron, calcium, and magnesium are precipitated to form in place a coherent porous diaphragm.

625,252—May 16, 1899. H. ELDRIDGE, D. J. CLARK, AND S. BLUM. *Electric furnace.*

Relates to structural details, including a fume-collecting hood.

628,782—July 11, 1899. J. J. FAULKNER. *Electric furnace.*

It relates to structural details, including a normally stationary electrode and a series of opposing electrodes with specific means for automatically adjusting each of the latter, including spring-actuated plungers. A tilting hearth is mounted beneath the electrodes.

629,008—July 18, 1899. O. FRÖLICH. *Apparatus for distilling metals or similar substances.*

An electric crucible furnace has a tubular electrode and a condensing chamber carried by and above the same. The material surrounds the tubular electrode and condensing chamber which receives the distilled metals, the molten products being tapped off below.

630,283—August 1, 1899. W. BORCHERS. *Method of and apparatus for utilizing waste gases and heat from electric furnaces.*

The furnace, or a series of electric furnaces, are incased in a steam generator, each furnace having a dust filter for the gases generated.

630,966—August 15, 1899. L. K. BÖHM. *Carbid furnace.*

It relates to details of the furnace pot or carbide tank, which has bottom grooves in which fit ribs of a supporting plate, to facilitate the withdrawal of the pot.

636,956—November 14, 1899. F. G. CURTIS. *Process of making battery cups.*

Clay is mixed with a solution of water and hydrate of potassium and an electric current passed through the mixture, reducing the clay from a granular state to a powder paste by reason of the hydrogen being set free. It is then molded into cups and baked.

641,276—January 16, 1900. J. D. DARLING. *Porous diaphragm for cells employing fused electrolytes.*

It consists of a suitable support and a filling of Portland cement and a powdered oxide substantially resistant to combination or fluxing by the fused electrolyte, as ground-burned magnesite.

641,438—January 16, 1900. J. D. DARLING. *Electrolytic apparatus.*

In an electrolytic apparatus using a porous diaphragm with a metallic wall, a small percentage of the current—say 5 per cent—is shunted through the wall of the diaphragm, by connecting it with the positive pole, to prevent destructive electrolytic action.

641,976—January 23, 1900. R. H. LAIRD. *Down-draft electrical furnace.*

A water-jacketed furnace stack has a series of spirally arranged, downwardly inclined electrodes.

643,254—February 13, 1900. A. J. PETERSSON. *Electric furnace.*

The electrodes are at the ends of a flat hearth and covered by the reduced material so that the heat is developed by the resistance of the reduced material, and the unreduced material is reduced solely by contact therewith. The hearth chamber may be movable, and an upper chamber has flues within the charge which receive and burn the generated gases.

647,614—April 17, 1900. M. RUTHENBURG. *Electric furnace.*

A quadrilateral bosh, open at top and bottom, laterally incloses the opposed electrodes; and a crucible directly beneath the bosh has an overflow outlet at its top.

651,916—June 19, 1900. J. ZIMMERMAN AND I. S. PRENNER. *Furnace for producing calcium carbid.*

The charge, supported by a strip (stiff paper) that is projected coincident with the feed of the material, is continuously fed into the horizontal arc of an electric furnace. Compressing and feed mechanism is provided for the mixed lime and carbon and feed for the traveling flexible support.

652,611—June 26, 1900. J. HARGREAVES. *Combined diaphragm and electrode.*

A stratified diaphragm-electrode, dense as to one side and porous as to the other, is formed by covering wire cloth or perforated plate with a thin layer of clay or equivalent material adapted temporarily to perform a retentive function and ultimately to be dissolved or washed away, then applying a coating of Portland cement or like hard or dense material to one face, and covering the latter with asbestos cloth or equivalent soft or porous material.

654,363—July 24, 1900. H. LELEUX. *Electric furnace.*

Relates to details of the attachment of the vertical electrode to its hanger, the electrode being formed of cores of carbon of high conductivity surrounded by agglomerated carbon of lower conductivity.

654,367—July 24, 1900. J. MACTEAR. *Furnace for heating and treating gaseous mixtures.*

The apparatus has a chamber with a removable cover and bottom, and gas inlet and outlet flues, a catalytic substance contained in the chamber, and refractory tubes depending from the cover with electrical resistances within the tubes.

655,779—August 14, 1900. W. S. HORRY. *Control of electric furnaces.*

An electrically controlled motor actuates the movable member of the furnace, as the movable receptacle, and an electro mechanical device under the control of the furnace circuit controls the motor to keep the amperes constant, a switch being provided for controlling the motor by hand and for cutting in and out the said electro-mechanical devices.

655,780—August 14, 1900. W. S. HORRY. *Electric furnace.*

Relates to mechanism for controlling the movable element in response to predetermined variations in the furnace circuit, and keeping the furnace current approximately constant.

656,600—August 21, 1900. R. DOOLITTLE. *Means for manufacturing carbids.*

A smelting furnace for the process of No. 656,599.

656,930—August 28, 1900. W. BORCHERS. *Electric furnace.*

The furnace has an inclined water-jacketed column for the product below the hearth, a supporting roller for the carbide core, and a chisel for breaking up the carbide.

657,736—September 11, 1900. W. S. HORRY. *Electric furnace.*

A carbide furnace having a vertically movable bottom to support the product and charge, and means for clamping and temporarily holding the column of finished product to allow for the removal of the bottom portion thereof and the running up of the furnace bottom; thus permitting a continuous downward feed and delivery.

657,911—September 18, 1900. G. D. BURTON. *Apparatus for separating metals from ores by electricity.*

The reducing chamber has a cylindrical body of electro-conductive resistance material resting on a flat electrode which forms the bottom of the chamber and from which it can be lifted to deliver the charge, the other electrode clamping the chamber under a projecting flange.

658,315—September 18, 1900. A. H. COWLES. *Electric furnace.*

The electric furnace chamber is flanked by two fuel chambers and means is provided for causing a reversing flow of gas through hot-blast stoves, the fuel chambers, and the electric furnace.

GROUP XI.—DYESTUFFS AND EXTRACTS.

NATURAL, INORGANIC.

557,325—March 31, 1896. G. D. BURTON. *Art of and apparatus for electro-dyeing.*

See Group X, Electro-chemistry.

557,324—March 31, 1896. G. D. BURTON. *Art of electric dyeing.*

See Group X, Electro-chemistry.

NATURAL, ORGANIC.

951—September 27, 1838. L. KENT. *Improvement in the mode of extracting color from dyewood.*

The ground wood is leached with steam, the liquor being drawn off into a boiler, the steam therefrom returned into the wood, and the coloring matter dried.

4,192—September 13, 1845. F. PFANNER. *Improvement in preparation of dyestuff from spent madder.*

Dyestuff or carasene is obtained from spent madder by the chemical action of water, sulphuric acid, and an alkali.

50,495—October 17, 1865. G. H. REED. *Improved preparation and manufacture of dyes and colors.*

Liquid dyes from vegetable or mineral coloring matters, so mixed and prepared with concentrated mordants as to endure heat and cold and keep without change, and to dye silk or wool at one application.

74,935—February 25, 1868. A. PARAF. *Improved process of separating coloring matter from madder and other plants.*

The coloring matter is liberated from the ligneous matter by the solution of the cellulose, as by steeping the madder root in aqueous ammonia in the presence of metallic copper, and the separation of the coloring matter from the insoluble compounds formed. The sugary matter is first removed by successive washings.

76,107—March 31, 1868. C. SEIDEL. *Improved vegetable coloring matter.*

An indelible vegetable fluid consisting of the pigment of the cashew nut in a menstrum solvent, as oil of turpentine.

81,992—September 8, 1868. C. E. & M. E. FOX. *Improved dyestuff.*

The extract of manzanita, a red coloring matter, obtained by crushing and boiling the roots.

83,182—October 20, 1868. J. LIGHTFOOT. (*Reissue: 3,647—September 28, 1869.*) *Improvement in printing certain textile fabrics and yarns.*

The indigo preparation is modified, by employing much less tin, whether as oxide or in the state of salt, in the process of dissolving the indigo; and, in connection with such modified preparation, carbonate of potash, alkaline silicates, or the chemical equivalents of them are used in simultaneously fixing indigo blue or green, or both, in juxtaposition with ordinary madder mordants.

86,047—January 19, 1869. T. WEBER. *Improved indigo dye.*

A dyeing compound obtained by dissolving the hydrated oxide of tin and common indigo in caustic lye.

86,939—February 16, 1869. A. PARAF. *Improved process of extracting the coloring matter of madder*

The coloring matter is extracted from madder root by treatment with water at a high temperature—150° C.—and it is then precipitated from the liquid.

93,900—August 17, 1869. A. PARAF. *Improved material for dyeing and printing, obtained from madder*

Tinctorine, the coloring matter of madder root, combined with fatty or resinous matters, and free of pectic acid or its compounds, produced according to No. 86,939.

95,039—September 21, 1869. A. PARAF. *Improved extract of madder for dyeing and printing.*

A compound extract of madder (as tinctorine, No. 93,900), with an alkaline base and a volatile acid, such as the acetate of potash or acetate of lime, which will decompose after printing and permit the alkaline base to develop the color.

97,497—December 7, 1869. J. GEE. *Improved process of dyeing black.*

The fabric is first run through a mixture of extract of logwood and sulphate of copper, and is then treated with the sizing material mixed with bichromate of potash. For fabrics which have to be sized twice, the logwood and sulphate of copper is mixed with sizing.

99,496—February 1, 1870. G. W. TALBOT. *Improvement in dyes for coloring wool.*

A dye for coloring is produced by combining extracts made from domestic barks, woods, or plants with the foreign dyes, such as fustic, madder, nutgalls, logwood, etc., producing a dye having less stringent power than the domestic extracts alone and more permanence than the foreign dyes.

109,489—November 22, 1870. S. BORDEN. *Improvement in the preparation of garancine.*

The coloring matter contained in garancine is eliminated by the combined or separate action of hard soap and chlorate of potash.

110,994—January 17, 1871. A. PARAF. *Improvement in material called "Oleizerine," for dyeing and printing.*

A new compound of the coloring matter of madder with oily matter, prepared by treating garancine with petroleum in which paraffine has been dissolved. A caustic-soda solution is added to cause the coloring matter to separate from the hydrocarbon solvent, and it is precipitated with an acid.

110,995—January 17, 1871. A. PARAF. *Improvement in processes of extracting the coloring matter of madder.*

The coloring matter of madder is extracted by means of a liquid hydrocarbon.

113,918—April 18, 1871. A. PARAF. *Improvement in products from madder.*

"Oil-izarine," produced by treating garancine with a hydrocarbon, such as kerosene, and consisting of a solution of the coloring matter of madder within insoluble matter.

117,620—August 1, 1871. F. GRAUPNER. *Improvement in compounds for dyeing.*

A combination of sulphate of copper, muriatic acid, and zinc. Added to a dye of logwood and catechu, it dyes cotton black.

120,392—October 31, 1871. A. PARAF. *Improvement in compositions of madder for dyeing.*

Alizaride, a compound of the coloring matter of madder with a neutral alkali and with ammonia.

134,694—January 7, 1873. G. MOLT. *Improvement in indigo-blue vats for coloring wool and cotton.*

Indigo is dissolved in a composition formed by mixing a solution composed of lime and soda ash, with a solution composed of muriate-of-tin crystals and soda ash.

134,876—January 14, 1873. L. G. FELLNER. *Improvement in the extract of yucca.*

The yucca root is ground, steeped in water, and pressed, and the solution evaporated to dryness in molds, or melted in forms. Yuccatin cleanses skins, hair, and wool without destroying their softness.

139,056—May 20, 1873. F. A. GATTY. *Improvement in dyeing madder colors.*

Cotton fabrics or yarns are treated with neutral soap or emulsions of fatty acids, or of oils or fats, either saponified or in their natural state, in lieu of dunging.

139,573—June 3, 1873. F. G. GRAUPNER. *Improvement in dyeing fabrics.*

Oxyduloxyd of iron, or anvil dust, is combined with muriatic acid as a base for dye. It is combined with quercitron and logwood to form a black, slate, or drab dye.

167,360—August 31, 1875. J. S. SELLON AND R. PINKNEY. *Improvement in dyeing and printing.*

A dyeing or printing compound, consisting of the salts or compounds of vanadium and animal dyeing or printing materials, such as cochineal.

169,377—November 2, 1875. W. H. SEAMAN. *Improvement in processes for testing the purity of dye in black silk thread or fabrics.*

A fixed quantity of the black silk thread or fabric is treated in a chemical liquid, of which oxalic acid is the base to ascertain the purity of the dye.

175,829—April 11, 1876. W. H. FISH. *Improvement in dyes.*

An indigo-dye aqueous solution, composed of indigo and zinc dust, together with bisulphite of soda and caustic soda.

179,939—July 18, 1876. G. MOLT. *Improvement in blue dyes.*

It is composed of indigo, 1 pound; caustic potash, 2 pounds; and water enough to dissolve; heated to boiling point, with 2½ pounds of oxalere, 5 pounds of liquid ammonia, and 2 pounds of sal ammoniac.

210,280—November 26, 1878. E. & H. WELLS, A. E. RICHARDSON, AND W. J. VAN PATTEN. *Improvement in refining and packing catechu.*

Refined and concentrated catechu, incased in a tight integument, is made by liquefying with water and heat, introducing steam of a high temperature, skimming, straining, and settling, and drawing off, while still liquid, into boxes, preferably of paper.

220,638—October 14, 1879. G. MOLT. *Improvement in compound dyes.*

An indigo dye, consisting of indigo (XX), 50 pounds; caustic soda, 25 pounds; tin crystals, 5 pounds; and a sirup made by boiling hops, madder, bran, and molasses in water.

240,467—April 19, 1881. G. SCHWARZWALD. *Composition for printing textile fabrics.*

It consists of powdered almond shells, water, hydrochloric acid, coloring matter, gelatine, oxidized metal powder, and bichromate of potassa.

272,499—February 20, 1883. H. W. VAUGHAN. *Method of preparing dyestuffs for application to fibrous materials.*

The coloring matter, with or without a mordant, is ground with an oleaginous constituent, as paraffine oil, and a pulverulent material is then incorporated therewith, to enable the mass to be worked in a finely powdered condition.

276,061—April 17, 1883. A. M. MEINCKE. *Dyeing compound.*

It consists of corn meal, highly concentrated cudbear, indigotine, acid magenta, wool orange, and imported cudbear.

282,971—August 14, 1883. C. D. EKMAN. *Method of obtaining coloring matters.*

The raw vegetable material is boiled under pressure in a solution containing sulphurous acid and a base or alkali, as soda.

306,434—October 14, 1884. M. E. SAVIGNY. *Process of making extracts for dyeing, etc.*

Tannic woods or plants colored yellow are crushed and boiled with an oil or fatty body saponified with an alkaline solution or with a soap solution, the clear liquor being drawn off and evaporated.

306,435—October 14, 1884. M. E. SAVIGNY. *Dyeing extract.*

A soap extract from yellow-colored tannin woods or plants of a yellowish-brown color and brittle texture; the product of process No. 306,434.

308,706—December 2, 1884. M. E. SAVIGNY. *Dyeing extract.*

An acid extract produced from so-called "red-colored tannic woods and plants" by disintegration and fermentation or oxidation with acids. A soap extract is secured from the residue, or in conjunction with the fermentation or acid oxidation in one operation.

320,526—June 23, 1885. C. E. AVERY. *Process of preparing logwood extract.*

Logwood liquors, or extracts of the same, after their extraction from the wood and before they are mingled with the necessary mordants, are oxidized by the formation of hæmatein from hæmatoxylin by the action of oxidants, such as solution of bleaching powder, hypochlorous acid, chloric acid, chlorates or nitrates of the alkalis, and alkaline earths.

338,431—March 23, 1886. A. MORAND. *Art of clarifying extracts.*

An alkaline solution of caseine is mingled with the acidulous tannin or like extract in sufficient proportions to neutralize the free acid, and the precipitate separated from the clarified extract.

356,368—January 18, 1887. J. A. MATHIEU. *Manufacture of dyestuffs.*

In the manufacture and purification of lac dyes, the material is treated with turpentine or other solvent; the residuum treated with water and an alkali; neutralized with an acid; the precipitation completed by the addition of acetate of lead; and the precipitate treated with dilute sulphuric acid.

386,933—July 31, 1888. F. E. SCHMÜCKERT. *Process of preparing a solution of indigo for dyeing purposes.*

A woad-bath for dyeing with indigo is prepared by mixing guano salts with water, adding zinc dust and indigo, or other bodies having an affinity for oxygen, and then heating the mixture.

417,492—December 17, 1889. W. W. MACFARLANE. *Process of preparing logwood extracts.*

Logwood extract is treated with free chlorine, as a gas or in solution, to increase its dyeing power.

437,638—September 30, 1890. A. AINSWORTH. *Indigo solution.*

A solution for reducing indigo for dyeing purposes is prepared by saturating a solution of sodium bisulphite with metal filings, separating the liquor, adding sodium sulphide till the formation of precipitate ceases, filtering, and adding caustic soda.

443,026—December 16, 1890. F. C. WEISS. *Dye.*

The material is steeped in dilute anacardin extract, then pressed as hard as possible, then treated to a hot bath of bichromate of potassium, then washed in cold water, and then subjected to the ordinary indigo-dyeing process.

456,773—July 28, 1891. T. B. OSBORNE. *Process of extracting zein.*

The nitrogenous remainder, after the manufacture of cornstarch from Indian corn, is treated with a solvent of zein, as alcohol partially diluted with water. The solution is then evaporated to a sirupy consistency and poured into water.

491,972—February 14, 1893. P. T. AUSTEN. *Coloring matter from logwood and mode of preparing same.*

An alkaline nitrite is added to logwood extract in the presence of water, causing a reaction between the nitrite and the extract, and the product is evaporated to dryness. It is characterized by being a friable solid, soluble in cold and rapidly soluble in hot water.

492,368—February 21, 1893. P. T. AUSTEN. *Solid coloring matter from fustic and process of preparing same.*

An alkaline nitrite is added to fustic extract in the presence of water, causing a reaction between the nitrite and the extract, and the product is evaporated to dryness. It is characterized by being a friable solid, soluble in hot or cold water.

494,237—March 28, 1893. P. T. AUSTEN. *Process of curing logwood chips.*

The chips are moistened by sprinkling with an aqueous solution of nitrite of soda, or potash, or other suitable nitrite, well mixed and dried.

508,592—November 14, 1893. P. T. AUSTEN. *Obtaining friable coloring matter from dyewood extracts.*

A solid friable extract of logwood, produced by adding ammonium carbonate to a slightly warmed logwood solution, say 7 per cent, allowing the reaction to take place, and evaporating to dryness.

509,703—November 28, 1893. A. TAYLOR. *Process of making extracts from the redwood tree.*

The bark and wood of the redwood (*Sequoia sempervirens*) is comminuted, steeped in water and a caustic alkali or a carbonate of an alkali, the alkali neutralized, and the solid matters obtained.

542,403—July 9, 1895. P. T. AUSTEN. *Process of making coloring matter from logwood.*

A small proportion of borax, say 2 per cent, is dissolved in hot dilute logwood extract, which is then cooled sufficiently to cause a precipitation of coloring matter, which is then separated and dried.

558,718—April 21, 1896. H. L. BREVOORT. *Art of fixing dyes in fabrics.*

See Group X, Electro-chemistry.

610,282—September 6, 1898. W. T. SCHEELE. *Process of making coloring extracts.*

Ketones having their boiling point between 80° and 227° C., as ethylmethyl, diethyl, dipropyl, butyl, etc., are used as solvents for the extraction of the coloring principle from vegetable substances.

637,707—November 21, 1899. F. E. BUCHER. *Process of treating logwood extracts.*

Vapors of peroxide of nitrogen, preferably diluted with air, are passed through logwood liquors or extracts containing hæmatoxylin, whereby the hæmatoxylin is converted into hæmatein.

640,061—December 26, 1899. E. S. WILSON. *Dye from cottonseed oil.*

Cottonseed oil is heated with an alkaline solution, the solution separated from the oil and treated to remove the impurities, and then the coloring matter is precipitated from the solution by an acid.

ARTIFICIAL, INORGANIC.

441—October 28, 1837. H. STEPHENS. (*Reissue 3—April 21, 1838.*) *Improved manufacture of coloring matter.*

See Group VI, Ferrocyanides.

2,060—April 24, 1841. J. D. PRINCE. *Improved mode of producing a black color in the operation of dyeing.*

Arsenious acid is used in combination with sulphate of iron, as a mordant.

3,068—May 2, 1843. H. HIBBARD. *Improved mode of preparing and using compounds in dyeing, etc.*

Mordants are used in conjunction with logwood liquor:

No. 1. Sulphate of iron, muriate of soda, and hydrate of lime, 1 pound each.

No. 2. Sulphate of iron, 1 pound; sulphate of copper, muriate of soda, 8 ounces each.

No. 3. Sulphate of iron, sulphate of copper, 1 pound each; nitrate of potash, muriate of ammonia, 8 ounces each.

No. 4. Sulphate of zinc, 2 pounds; muriate of soda, 4 ounces; and sulphate of iron, sufficient to sadden.

No. 5. Sulphate of iron and of aluminium, 1 pound each.

No. 6. Bar or yellow soap, 2 pounds; litharge, 1 pound; and water, 2 quarts, boiled fifteen minutes.

9,890—July 26, 1853. F. G. VETTERCKE. *Compound to produce a liquor for coloring kali blue.*

Four pounds of prussiate of potash in 3 gallons of boiling water is prepared in a receiver, and 5 pounds of manganese and 4 pounds of common salt in a retort, to which is added a mixture of vitriol and water previously prepared, and the retort connected with the receiver and allowed to stand for six hours, when the retort is heated for six hours. The receiver is then disconnected and sealed up ready for use, the contents of the same constituting the "kali compound."

72,817—December 31, 1867. J. H. DILKS. *Improved process of making soluble bluing for use in laundries and bleaching.*

A mixture of ferrocyanide of potassium, 100 pounds, and sulphuric acid, 40 pounds, in water, is added to a solution of 10 pounds of iron in 40 pounds of nitric acid, and boiled until a violent action takes place, then washed free from acid, pressed, and dried.

73,756—January 28, 1868. J. REYNOLDS. *Preparation of dyes.*

Yellow prussiate of potash, dissolved in hot water, is treated with chlorine gas, but not more than will prevent precipitation.

87,270—February 23, 1869. A. LEYKAUF. *Improvement in the manufacture of colors.*

A violet color is produced by heating a compound of manganese with phosphoric acid and ammonia; the addition of iron gives a light blue color.

88,291—March 30, 1869. E. HARRSCH. *Improvement in the manufacture of colors and pigments.*

Colors or dyes are extracted from franklinite ores—their residues or ores containing oxide of zinc, manganese and iron—by treating with dilute sulphuric acid and then precipitating with various reagents.

88,793—April 13, 1869. J. LORY. *Improved hair dye.*

A compound of nitrate of silver, ammonia liquor, and lac-sulphur in distilled water.

95,040—September 21, 1869. A. PARAF. *Improved process of printing colors on textile materials.*

The textile material is printed with the coloring material, then a compound of an alkali and volatile acid is applied—as acetate of lime, potash, or soda—and it is then steamed to liberate the alkali.

110,277—December 20, 1870. A. PARAF. *Improvement in the manufacture of colors and their application to fabrics.*

Colors are applied to fibrous and textile articles by means of coloring matter and a coloring liberating salt of a class possessing certain characteristics, viz.: They are mineral salts; do not contain lime; alkaline or neutral, not acid; do not produce a chemical compound with the coloring matter; the acid of the salt makes an insoluble compound with the base of the mordant; and they liberate the coloring matter from the other vegetable matter.

192,491—June 26, 1877. H. D. DUPEE. *Improvement in mordanting textile fabrics.*

Coloring matters upon textile fabrics are mordanted by means of gelatine combined with chromic acid, and subjected to the action of steam.

202,822—April 23, 1878. R. HOFFMAN. *Improvement in manufacture of ultramarine colors.*

The blue or (so-called) white ultramarine, or mixtures of the same, while heated to 120° to 200° C., is exposed to the action of the vapors of acids derived from the halogen group of elements—as hydrochloric acid—and the soluble salts afterwards washed out. Blue is first converted into violet, and by continuation of the treatment into red ultramarine.

207,093—August 13, 1878. J. ZELTNER. *Improvement in manufacture of red ultramarine.*

Red ultramarine is produced by the action of nitric acid upon violet ultramarine or ultramarine hydrate.

207,836—September 10, 1878. J. ZELTNER. *Improvement in manufacture of violet ultramarine.*

Violet ultramarine, or ultramarine hydrate, is produced by the reaction upon blue or green ultramarine, or mixture thereof, of an oxidizing reagent, as chlorine, and water.

213,189—March 11, 1879. L. GRAF. *Improvement in the manufacture of prussian blue.*

A solution of leather scraps in caustic alkali is evaporated to dryness, mixed with iron filings, the mixture fused, the fused mass washed, and the lye treated with acid and persulphate of iron.

240,467—April 19, 1881. G. SCHWARZWALD. *Composition for printing textile fabrics.*

A composition for imparting a bright silk or satin like appearance to cotton goods, paper, etc., consisting of powdered almond shells, water, hydrochloric acid, coloring matter, gelatine, oxidized metal powder, and bichromate of potassa in specified proportions.

242,080—May 24, 1881. H. W. VAUGHAN. *Dyeing fibrous material.*

A dyestuff and a mordant in conjunction are mechanically incorporated with the fibrous material during the process of manufacture, by the aid of infusorial earth, or other vehicle for the same, and an oleaginous constituent, and the dyestuff and mordant are then chemically combined by heating or steaming the material, or an infusorial earth charged with a mordant is so combined with the material, and it is subsequently immersed in a dye bath to combine chemically with the mordant and make a fast dye.

ARTIFICIAL, ORGANIC.

32,965—July 30, 1861. G. E. C. DELAIRE. *Improvement in aniline colors.*

Blue and violet of aniline are produced by the reaction of aniline red upon pure aniline at a suitable temperature. A mixture of aniline red and pure aniline is boiled for several hours at 165° C. The violet coloring matter is mixed with water and hydrochloric acid and boiled, yielding the violet residue. This is successively boiled with hydrochloric acid and washed in boiling water, producing a blue precipitate.

38,589—May 19, 1863. J. LIGHTFOOT. (*Reissue: 4,746; 4,747—February 6, 1872.*) *Improvement in dyeing and printing textile fabrics and yarns with aniline black.*

The use of a salt or salts of aniline is claimed for producing or developing a black in textile fabrics. To prepare the solution 4 ounces of chlorate of potash is dissolved in a gallon of water; 8 ounces of aniline combined with 8 ounces of hydrochloric acid at 32° Twaddell is added; then 1 pint of acetic acid and 8 ounces of perchloride of copper at 88° Twaddell; and finally 4 ounces of sal ammoniac.

43,066—June 7, 1864. A. W. HOFMANN. *Improvement in preparing coloring matters for dyeing and printing.*

Coloring substances, of a violet-blue, violet, or red-violet tint, are produced by the action of the iodides and bromides of alcohol radicals on rosaniline, heated to 100° C. in a closed vessel under pressure. There may be taken 1 part of rosaniline, 2 parts of iodide of ethyl, and 2 parts of strong methylated spirit or alcohol.

49,958—September 12, 1865. A. S. L. LEONHARDT. *Improved method of preparing aniline colors for dyeing and printing.*

The blue and violet colors of commerce obtained from magenta, and insoluble in water, are rendered in a fine state of subdivision by dissolving them in alcohol or aniline or sulphuric acid and allowing the solutions, under brisk and constant agitation, to drop into cold water, or into cold water containing in solution neutral salts, caustic, or carbonated alkalies; or, when aniline is used, into cold water containing hydrochloric acid; or, when sulphuric acid is used, into cold water containing alkali in amount equivalent to the acid. The solvent is recovered.

50,335—October 10, 1865. C. CLEMM. *Improvement in the manufacture of aniline red.*

Aniline red is produced by the reaction of salts of aniline and its homologues with the arseniates of the alkalis, as by fusing at 210° C. a mixture of arseniate of soda and the sulphate of aniline, equal parts; the latter prepared by mixing sulphuric acid of 66° Baumé and water, equal parts, and stirring in two and one-half parts of aniline. The sulphate of soda of the dry mass is washed out and the residue dissolved in muriatic acid, neutralized and recrystallized.

51,404—December 5, 1865. J. HOLLIDAY. *Improvement in the manufacture of coloring matter.*

Cotton-violet dye of commerce, 1 part, is treated with 6 parts of a very weak alkali and the precipitate washed and dried. The color is purified by dissolving 1 part in 8 parts or more of methyl-alcohol and adding one-half part of acid. This may be repeated several times, rendering the color each time bluer and clearer.

53,241—March 13, 1866. P. CHEVALIER. *Improvement in the manufacture of coloring matters from aniline.*

Coloring matters, red and violet, are produced by transforming commercial aniline into a salt, as arseniate; adding a nitrite; as nitrite of potash, and heating the mixture to the temperature at which the aniline is raised to the boiling point—which should not be exceeded—until it turns blue in the presence of an acid. The mixture at the boiling point is treated with alkalinized water, which dissolves the red and leaves the violet insoluble. The red is precipitated by a neutral salt, as sodium sulphate.

54,957—May 22, 1866. G. H. REED. *Improvement in the manufacture of dyes and colors.*

Coloring matters and their mordants, one having an affinity for woolen and one for silk, and neither neutralizing the other, in quantities each suited to the quantity of the other, are boiled together in water with frequent stirring, and dissolved and concentrated until the liquid has absorbed all it will take up, when the proper quantity of glycerine and alcohol or wood naphtha is added to prevent change.

76,031—March 24, 1868. E. ZINSSMANN. *Improved compound of aniline colors.*

A soluble compound is produced by treating an aniline color (insoluble in water) with glue or equivalent material dissolved in acetic acid, glycerine, or like material.

79,942—July 14, 1868. B. BLOCH. (*Reissue: 3,103—September 1, 1868.*) *Improved aniline dye.*

A gray dye, prepared by mixing and boiling aniline oil with arsenic acid in liquid form and about 75° strength. The mixture is purified by boiling with muriatic acid, filtering, washing, drying, and then dissolving in alcohol with 20 per cent of sulphuric acid, boiling, and filtering.

82,129—September 15, 1868. J. LAMBERT, Jr. *Improved aniline dye.*

Saffranine red is produced by dissolving 1 part of violet-harmaline paste in 2 parts of acetic acid, of 8° Baumé, and 100 parts of water, heating and adding 1 part of binoxide of lead, boiling, and finally neutralizing with plenty of caustic soda. The saffranine-red solution is filtered and boiled with a little carbonate of lime to remove any remaining violet.

95,465—October 5, 1869. C. GRAEBE AND C. LIEBERMANN. (*Reissue: 4,320, 4,321—April 4, 1871.*) *Improved process of preparing alizarine.*

Bibromanthrakinon, or bichloranthrakinon, is first prepared by the action of bromine or chlorine on anthrakinon (oxanthracene), and then converted into alizarine by heating in a solution of caustic potash or soda to 180° to 260° C. until the mass has a deep blue color; then dissolving in water and filtering the violet solution, from which the alizarine is precipitated by an organic or inorganic acid.

96,242—October 26, 1869. C. LAUTH. *Improved coloring material for dyeing and printing.*

Vegetable fibers are mordanted in a concentrated solution of a salt of manganese, and after desiccation the fiber is passed through an alkaline solution to eliminate the oxide of manganese. The oxide is transformed into a sesqui or binoxide, by exposure to the atmosphere, or by passing it through chloride of lime. The fibers are washed and placed in an acid solution of aniline and instantaneously dyed black. Animal fibers are mordanted with manganates and permanganates.

97,597—December 7, 1869. J. BRÖNNER AND H. GUTZKOW. (*Reissue: 4,558—September 19, 1871.*) *Improvement in preparing coloring matters from anthracene.*

The product obtained from anthracene by oxidation (oxanthracene) is nitrated. The product thus obtained is treated with a concentrated solution of caustic alkali up to 220° C., dissolved in water, and the coloring matter—alizarine—precipitated by an acid.

111,654—February 7, 1871. J. LIGHTFOOT. *Improvement in dyeing and printing textile fabrics.*

A black dye or color is produced by printing or staining with a salt of aniline mixed with certain oxidizing agents. Crystallized carbonate of soda or sesqui carbonate of ammonia is added to an aqueous solution of tartaric acid, and a solution of chlorate of potash is mixed therewith, producing chlorate of soda or ammonia and cream of tartar (a by-product). For printing, the filtrate is thickened with gum or starch, heated, and aniline and hydrochloric acid mixed therewith. Just before using the color a suitable copper salt, as sulphate of copper or sulphide of copper paste, is added. For dyeing, in lieu of the thickening, acetic acid and sugar is added and less of the copper salt.

127,426—June 4, 1872. W. H. PERKIN. *Improvement in the manufacture of coloring matters from anthracene.*

Chlorinated or brominated anthracene, 1 part, is treated with sulphuric acid, 5 parts, and the product oxidized by means of any suitable oxidizing agent, as manganese binoxide. The solution is further treated with caustic alkali.

134,076—December 17, 1872. F. LAMY, Jr. *Improvement in dyeing fabrics with naphthylamine colors.*

Naphthylamine is dissolved in a mixture of nitric or hydrochloric acid and acetic acid, and treated with chloric and chromic acid. After printing the color is fixed by passing into a bath of bichromate of potash with acid, and a puce-garnet shade is developed by passing into chlorine or into ammonia; a violet shade is obtained by passing into a bath of nitrate of iron and *aqua regia*, instead of ammonia or chlorine; and a reddish violet by substituting chloride of iron and a salt of copper.

153,536—July 28, 1874. H. CARO, C. GRAEBE, AND C. LIEBERMANN. *Improvement in the preparation of coloring matters from anthracene.*

Sulphuric acid is substituted for bromine or chlorine in the process of No. 95,465.

154,153—August 18, 1874. C. RUMPFF, F. BAYER, F. WESKOTT, AND A. SILLER. *Improvement in treating anthracene and the manufacture of dyes.*

Anthracene, 1 part, is mixed with from 1 to 5 parts of powdered peroxide of manganese and heated in a retort to 200° C., whereby anthrakinon is produced by a dry and direct process.

182,234—September 12, 1876. R. SIMPSON, A. BROOKE, AND T. ROYLE. *Improvement in preparation of alizarine, etc., made from anthracene.*

Alizarine and other analogous coloring matter made from anthracene is produced in the form of a dry powder by mixing the coloring matter with a paste of hydrate of lime and water, drying, and passing through a sieve.

186,032—January 9, 1877. H. CARO. *Improvement in obtaining coloring matters suitable for dyeing and printing.*

Alizarine-orange is obtained by treating dry, powdered alizarine with nitrous fumes or by dissolving it in a solvent, such as concentrated sulphuric acid, and treating the solution with nitrous, hyponitric, or nitric acids. A coloring matter possessing the properties of purpurine is produced by subsequently heating the alizarine-orange solution to about 150° C., until the evolution of gas ceases.

186,485—January 23, 1877. L. LEIGH. *Improvement in preparing aniline dyes.*

A block or cake composed of soap, gelatine, and an aniline dye, the whole soluble in water.

188,061—March 6, 1877. F. De LALNDE. *Improvement in process of obtaining artificial purpurine from alizarine.*

A mixture of alizarine, 10 parts, antimonic acid, 5 to 10 parts, and sulphuric acid, 66° Baumé, 80 to 100 parts, is heated to from 392° to 428° F., with constant stirring, until with dilute caustic soda it produces a currant-red color, when water is added, twenty to thirty times the volume of the mass, and it is boiled, cooled, and filtered.

188,217—March 6, 1877. J. WOLFF AND R. BETLEY. *Improvement in processes of making dyes from naphthaline.*

Dyes from naphthaline and its derivatives, in which one atom of hydrogen therein is substituted by one molecule of benzole, its homologues or their derivatives, are produced by submitting the same to an oxidizing process, and the products to a second oxidizing process, and finally to the action of an alkali.

189,538—April 10, 1877. J. WOLFF AND R. BETLEY. *Improvement in production of coloring matters from aniline.*

A dye, or series of dyes, of blue shades is produced from aniline, toluidine, or mixtures of the same, either with or without xylidine, together with nitro-benzole or nitro-toluol, or mixtures of the same, in conjunction with metallic salts, as protochloride of tin. Coloring matters are produced from aniline in conjunction with nitro-benzole by the employment of hydrochloric acid or other suitable hydrogen acids. If coloring matters are produced from arsenic acid, or other metallic oxygen acids, such arsenic acid is employed in such proportions as to saturate one-half to two-thirds of the aniline.

193,158—July 17, 1877. W. J. S. GRAWITZ. *Improvement in dyeing yarns and fabrics in aniline-black.*

The process consists in the slow concurrent progressive reaction on the fiber of aniline salts and metallic oxidizing salts or acids without exposure to the air, and with a subsequent peroxidation by means of chloric or chromic acid. A complex base, containing both an aniline and a metal, and which redissolves in acids, is obtained by precipitating certain metallic salts by means of aniline oil; or, a bath is formed containing the elements of a double salt of aniline and of a metal, as perchloride of iron and hydrochlorate of aniline; or, a bath is formed containing the elements of an aniline salt combined with the metal. All have the property of enabling the aniline to gradually oxidize with the greatest facility, producing black or shades bordering on black.

203,140—April 30, 1878. L. GRAF. *Improvement in dyestuffs or coloring matter.*

A brown dye or coloring matter prepared from leather scraps, as, for example, by digesting same with caustic soda or potash in a closed boiler under pressure, and precipitating the liquid leather with dilute acid.

204,796—June 11, 1878. H. CARO. *Improvement in the production of dyestuffs from methyl-aniline.*

"Methylene-blue:" produced from tertiary monamines, particularly from dimethyl-aniline; by, first, producing nitroso-dimethyl-aniline, by treating a cold solution of dimethyl-aniline in concentrated muriatic acid and water with pure nitrite of soda; second, reduction to amido-dimethyl-aniline, with the aid of hydrogen sulphide; third, treatment with an oxidizing agent, as perchloride of iron. The blue coloring matter is separated by saturating with sodium chloride, and adding an aqueous solution of zinc chloride. It is soluble in water and forms insoluble blue compounds with metallic tannates.

204,797—June 11, 1878. H. CARO. *Improvement in methyl-aniline violet colors.*

Coloring matter produced by converting methyl violet (comprising methyl purples, Paris violets, and Hoffman's violets) into its sulpho-acid compound (which is capable of being employed in the presence of acid or acid mordants), by drying at 110° C., and treating at that temperature, little by little, with fuming sulphuric acid under constant agitation, until a sample supersaturated with an alkali gives a clear yellowish solution without a percipitate. The thick fluid mass is dissolved in water and treated with milk of lime, filtered, and treated with a solution of soda forming a salt of soda which is evaporated to dryness. For commercial purposes, on account of deliquescence, the salt is transformed into an acid sodium salt.

204,798—June 11, 1878. H. CARO. *Improvement in ethyl-rosaniline dyestuffs.*

A dyestuff or coloring matter yielding purple or violet shades is produced by the reaction of ethyl iodide on the sulpho-acid of rosanline or fuchsine; as by heating a mixture of the soda-salt of the sulpho-acid of the fuchsine, water, alcohol, soda lye, and ethyl iodide. The iodine is recovered as subiodide of copper.

204,799—June 11, 1878. H. CARO. (*Reissue: 9,144—April 6, 1880.*) *Dye stuff or coloring matter.*

Sulpho-acid of beta-oxyazo-naphthaline, a red coloring matter: obtained from the reaction of the diazo compound of the sulpho-acid of naphthylamine and beta-naphthol: is prepared by converting naphthylamine into its diazo compound and causing equal molecules of the same and of naphthol or naphthylic alcohol to react, in an alkaline solution. Beta-oxyazo-naphthaline, so obtained, is then converted into its sulpho-acids, as by heating with fuming sulphuric acid, the excess of sulphuric acid being removed.

210,054—November 19, 1878. F. Z. ROUSSIN. *Improvement in coloring matters obtained by the reaction of the diazoic derivative of sulphanilic acid upon the amines, the amides, and the phenols.*

Coloring matters, orange, red, and yellow: produced by the reaction of the diazo derivatives of sulphanilic acid upon the amides, amines, and phenols. The azo derivative of sulphanilic acid is produced by adding dilute sulphuric acid to a mixture of an alkaline sulphanilate and an alkaline nitrite, while briskly agitating.

210,233—November 26, 1878. H. BAUM. (*Reissue: 9,986; 9,987—December 27, 1881.*) *Coloring matter or dye stuff.*

Red-scarlet coloring matter (9.986) is produced by the action of the sodium salt of bisulpho-beta-naphtholic acid, insoluble in alcohol, on the diazo derivative of xylidine.

Yellowish-red scarlet coloring matter (9.987) is produced by the action of the sodium salt of bisulpho-beta-naphtholic acid, soluble in alcohol, on the diazo derivative of xylidine.

The two isomeric bisulpho-beta-naphtholic acids are produced by mixing beta-naphthol, 1 part, with sulphuric acid of 1.848 s. g., 8 parts, and heating for twelve hours at 100° to 110° C., and the acids separated by digesting the soda salts thereof with alcohol.

211,180—January 7, 1879. A. F. POIRRIER, A. ROSENSTIEHL, AND Z. ROUSSIN. *Improvement in colors from crude naphthylamine.*

A series of coloring matters, as an intense red (adapted to replace "orseille"), is produced by the action of the sulpho-conjugated diazo derivatives of phtalamine upon the phenols and amines. By the action of heat, particularly with the concurrence of water and an alkali or an alkaline salt, new and different coloring matters are obtained.

211,525—January 21, 1879. Z. ROUSSIN AND A. F. POIRRIER. *Improvement in colors derived from nitraniline.*

New coloring matters are produced by the reaction of the diazo derivatives of nitraniline upon the amines, amides, and phenols.

211,671—January 28, 1879. Z. ROUSSIN AND A. F. POIRRIER. *Improvement in colors derived from toluidine and xylidine.*

New coloring matters are produced by the reaction of the diazo derivatives of the toluidines and xylidines upon the amines, the amides, and the phenols.

213,563—March 25, 1879. J. P. GRIESS. *Improvement in coloring matters.*

"Anisol-crimson:" produced by the action of the diazo-anisol upon an alkaline solution of disulpho-acid of beta-naphthol. A hydrochlorate of anisidine is prepared from anisidine—the amido compound of anisol—by treatment with nitrous acid combined with an alkaline solution of disulpho-acid of beta-naphthol.

213,564—March 25, 1879. J. P. GRIESS. *Improvement in coloring matters.*

A red coloring matter produced by the action of the diazo-anisol upon an alkaline solution of the monosulpho-acid of beta-naphthol (using the mono in lieu of the disulpho-acid of No. 213,563).

221,114—October 28, 1879. J. H. STEBBINS, Jr. *Improvement in colors from diazo-benzole nitrate and pyrogallol.*

"Pyrogallidine:" produced by the reaction of diazo-benzole nitrate on an alkaline solution of pyrogallol. Silk is dyed a yellow brown, and wool, with a tannic-acid mordant, the same.

221,115—October 28, 1879. J. H. STEBBINS, Jr. *Improvement in colors from picric acid.*

"Picridine:" produced by the reaction of an aqueous solution of diazo-benzole nitrate and picric acid dissolved in alcohol. Silk is dyed an orange yellow without mordants; wool a light yellow when mordanted with tannic acid.

221,116—October 28, 1879. J. H. STEBBINS, Jr. *Improvement in coloring matters obtained from diamido-naphthaline and diazo-naphthaline nitrate.*

"Naphthaline-brown:" produced by the reaction of diamido-naphthaline on diazo-naphthaline nitrate. Silk unmordanted is dyed a brown; mordanted with acetic acid a deeper brown; with iron chloride an almost black color; and with tin chloride a fine purple.

221,117—October 28, 1879. J. H. STEBBINS, Jr. *Improvement in coloring matters obtained from cresol.*

"Cresolidine:" produced by the reaction of an aqueous solution of diazo-benzole nitrate on an alkaline solution of cresol. Wool is dyed yellow, with or without mordants; silk, mordanted with muriate of tin, dyes orange.

221,118—October 28, 1879. J. H. STEBBINS, Jr. *Improvement in coloring matters obtained from salicylic acid.*

"Salicylidine:" produced by the reaction of an aqueous solution of diazo-benzole nitrate on salicylic acid dissolved in alcohol. Silk, unmordanted, is dyed an orange red; mordanted with muriate of tin, it is dyed red; wool is dyed a salmon color with a tannic-acid mordant.

221,119—October 28, 1879. J. H. STEBBINS, Jr. *Improvement in coloring matters obtained from naphthylamine and diazo-benzole nitrate.*

"Naphthylamidine:" produced by the reaction of an alcoholic solution of naphthylamine and an aqueous solution of diazo-benzole nitrate, with the addition of strong hydrochloric acid and gentle heat. In glacial acetic acid it dyes silk a dark brown, cotton a crimson, and wool a fine red.

221,120—October 28, 1879. J. H. STEBBINS, Jr. *Improvement in coloring matters derived from toluol.*

"Toluol-orange:" produced by the action of an aqueous 1-per-cent solution of diazo-benzole nitrate on a 10-per-cent solution of toluylendiamine in strong alcohol. It dyes animal fiber with or without mordants, and for dyeing cotton it forms insoluble compounds with some metallic salts, as oleate of lead or aluminate of zinc.

222,257—December 2, 1879. O. G. DOEBNER. *Improvement in green coloring matters.*

"Malachite-green:" produced by the reaction of benzo-trichloride, 2 parts, on dimethyl-aniline, 3 parts, in the presence of metallic chlorides, such as zinc chloride, 1½ parts.

224,927—February 24, 1880. F. KÖHLER. *Dyestuff or coloring matter.*

A bluish-red coloring matter produced by the action of the sulpho-acid of diazo-azo benzole upon an alkaline solution of a bisulpho-acid of beta-naphthol.

224,928—February 24, 1880. F. KÖHLER. *Dyestuff or coloring matter.*

A red coloring matter produced by the action of the sulpho-acid of diazo-azo benzole upon an alkaline solution of beta-naphthol.

225,108—March 2, 1880. H. CARO. *Coloring matter obtained from alpha-naphthol.*

The sulpho-acid of dinitro-alpha-naphthol: produced by the action of nitric acid upon certain alpha-naphthol-sulpho acids. Alpha-naphthol is dissolved in and heated with sulphuric acid until the mono-sulpho-acids produced in the first stage of the process are changed into those sulpho-acids which may be acted upon by nitric acid without losing their sulpho groups entirely, and then treated with nitric acid. The yellow coloring matter dyes and prints with other dyestuffs of similar acid properties.

225,908—March 23, 1880. Z. ROUSSIN. *Artificial coloring matter.*

Coloring matters, varying from yellow to red, produced by causing the diazo derivative of naphthionic acid to react upon the amines, the amides, and the phenols. They consist of the sulpho-acids or sulpho-salts of oxy-diazo pairs of aromatic radicals, one being the naphthyl derived from naphthionic acid, and the other from the amine, amide, or phenol employed.

227,470—May 11, 1880. A. BAEYER. *Manufacture of artificial indigo.*

"Artificial indigo:" produced by the action of an alkali and a deoxidizing agent, as glucose, upon ortho-nitro-phenyl-propiolic acid, its homologues and substituted compounds.

228,300—June 1, 1880. A. BAEYER. *Manufacture of artificial indigo-blue.*

It is developed in or upon fiber by impregnating yarn, fiber, or cloth with a mixture of ortho-nitro-phenyl-propiolic acid, an alkali, and a deoxidizing agent, as glucose, and then submitting the material to heat.

233,458—Oct. 19, 1880. A. BAEYER. *Manufacture of artificial indigo.*

The dibrominated compound of ortho-nitro-cinnamic acid: produced by the action of bromine on ortho-nitro-cinnamic acid, at an ordinary or an elevated temperature. It is used in the manufacture of artificial indigo.

233,459—Oct. 19, 1880. A. BAEYER, *Process for producing artificial indigo.*

Ortho-nitro-phenyl-oxyacrylic acid: produced by exposing ortho-nitro-cinnamic acid to the action of hypochlorous or hyprobromous acid, and then treating the product with alcoholic potash. It is used in the manufacture of artificial indigo.

233,460—October 19, 1880. A. BAEYER. *Process for the production of artificial indigo.*

Ortho-nitro-phenyl-propiolic acid: produced by treating the dibrominated compound of ortho-nitro-cinnamic acid with alcoholic potash and heat. It is used for the manufacture of artificial indigo.

233,465—October 19, 1880. H. BAUM. *Red coloring matter.*

Produced by subjecting the diazo compound derived from amidoazo-benzole to the action of disulpho-beta-naphtholic acid (using the one that is practically insoluble in alcohol).

235,193—December 7, 1880. A. BAEYER. *Manufacture of artificial indigo.*

A dyestuff or coloring matter produced by the action of a reducing or deoxidizing agent, such as ferrous sulphate, upon a new derivative of ortho-nitro phenyl propiolic acid, resulting from treating the said acid with sulphuric acid in the cold. It is in a great part soluble in aniline at ordinary temperature, and also in an aqueous solution of sulphuric acid.

235,188—December 14, 1880. A. BAEYER. *Manufacture of dyestuff or coloring matter.*

A new product, of a dull-blue crystalline appearance: produced by repeated treatment of the artificial indigo of No 235,193, with a cold and aqueous solution of sulphurous acid followed by a mineral acid.

240,359—April 19, 1881. A. BAEYER AND H. CARO. *Manufacture of artificial indigo.*

A dyestuff, distinguished by the presence of free sulphur, produced by the deoxidizing action of an alkaline xanthate upon an alkaline compound of ortho-nitro-phenyl-propiolic acid.

240,360—April 19, 1881. A. BAEYER AND H. CARO. *Dyeing fabrics with artificial indigo blue.*

Blue dyes are developed in or upon textile fiber, etc., by impregnating the same with a solution of a mixture of ortho-nitro-phenyl-propiolic acid and alkali and a deoxidizing sulphur compound belonging to the class of sulphocarbonates, such as xanthates of soda, and then submitting the material to a drying or aging process.

240,361—April 19, 1881. A. BAEYER. *Manufacture of artificial indigo.*

A blue dyestuff or coloring matter obtained from the artificial indigo of No. 235,193, by repeated treatment of the same with a cold and aqueous solution of sulphurous acid, and subsequent precipitation with sodium chloride.

240,941—May 3, 1881. A. BAEYER. *Manufacture of artificial indigo.*

A blue dyestuff or coloring matter produced by exposing isatine-chloride to the action of glacial acetic acid and zinc dust, or other reducing agents.

240,942—May 3, 1881. A. BAEYER AND A. EMMERLING. *Manufacture of artificial indigo.*

A blue dyestuff or coloring matter produced by the action of a mixture of phosphorus-trichloride and acetyl-chloride with yellow phosphorus on isatine, at from 70° to 80° C.

241,738—May 17, 1881. Z. H. SKRAUP. *Manufacture of artificial chinoline.*

See Group XVIII, Fine Chemicals.

242,707—June 7, 1881. J. H. STEBBINS, Jr. *Azo color.*

A dyestuff or coloring matter produced by the reaction of monosulpho-acid of beta-naphthol on a mixture of diazo-benzole and diazo-naphthaline hydrochlorates. It dyes silk or wool in an acid bath a light scarlet similar to cochineal.

242,855—June 14, 1881. N. C. ARMAND AND J. E. BERTON. *Dyeing fabrics with aniline colors.*

Aniline colors are rendered soluble in benzines and essences, by combining them with a solvent or intermediary agent, such as a composition of oil or fat, an acid (as acetic acid), ether, and alkalis.

244,757—July 26, 1881. E. LABHARDT. *Coloring matter from tetranitro-naphthol.*

"Heliochrysine," a sodium salt of tetranitro-naphthol: produced by the energetic nitrification of monobromnaphthaline; a yellow coloring matter, prominent by its brilliancy and fastness, and easy application on silk and wool.

246,221—August 23, 1881. J. SCHUNCKE. *Azo color.*

"Archil red:" produced by the action of the diazo compound of amidoazo-xylole upon an alkaline solution of beta-naphthol bisulpho-acid. It dyes wool, silk, and cotton with garnet shades similar to archil.

246,272—August 23, 1881. H. BAUM. *Azo coloring matter.*

A red coloring matter or dyestuff produced by the reaction of beta-naphthol monosulphonate of sodium and the diazo compound of amidoazo-benzole sulphonate of sodium. It is freely soluble in water and in dilute mineral acids. It dyes a fiery red on cotton mordanted with alum and in a continuous bath.

246,327—August 30, 1881. C. A. MARTIUS. *Methyl-blue color.*

A blue coloring matter produced by the reduction of methyl-orange, III, $C_{14}H_{14}N_3SO_3Na$, by the action of an excess of sulphohydrate of ammonia at from 105° to 110° C., followed by oxidation by the action of perchloride of iron. It dyes silk and wool without a mordant; vegetable fiber with a mordant.

248,153—October 11, 1881. O. FISCHER. *Process of preparing leuco base of aniline blue.*

Process consists in dissolving para-nitrobenzaldehyde in alcohol and muriatic acid, adding zinc powder and distilling off the alcohol, mixing the product with diphenylamine and methyl-diphenylamine and zinc chloride, and heating to 120° to 140° C., and finally separating the leuco base.

248,154—October 11, 1881. O. FISCHER. *Process of preparing coloring matter.*

The leuco base of rosaniline is produced by substituting chlorhydrate of aniline (or a mixture of aniline with toluidine) for diphenylamine and methyl-diphenylamine in the process of No. 248,153.

248,246—October 11, 1881. O. N. WITT. *Coloring matter.*

A violet dye, a substitute for madder violet, produced by the action of nitrosodimethylaniline on meta-phenylendiamine. It gives dark-violet shades on cotton, wool, and silk.

249,136—November 1, 1881. O. N. WITT. *Production of coloring matter.*

A dark-red dye formed by the action of nitroso-dimethylaniline on meta-toluylenediamine.

249,926—November 22, 1881. J. H. H. O. GÜRKE. *Coloring matter.*

A bluish scarlet dyestuff or coloring matter produced by the action of the disulpho-beta-naphtholic sodium salt insoluble in alcohol on the diazo derivative of para-amido-cinnamic acid methylic ether.

250,035—November 22, 1881. A. BAEYER. *Manufacture of artificial indigo.*

Indogenic acid is produced by first producing indogenic ether by treating an ether compound of ortho-nitro-phenylpropiolic acid with a reducing agent, such as ammonium sulphydrate, followed by the action of muriatic acid and a cold and dilute solution of caustic soda, and then converting the indogenic ether into indogenic acid by treatment with caustic alkalis and subsequently with muriatic acid. It is converted into artificial indigo blue by oxidation.

250,036—November 22, 1881. A. BAEYER. *Manufacture of artificial indigo.*

"Indogen" is produced by the action of heat upon indogenic acid (No. 250,035), either in a dry state or in a solvent. It is rapidly converted into artificial indigo by the access of air.

250,038—November 22, 1881. H. BAUM. *Manufacture of crimson coloring matter.*

A crimson coloring matter produced by the action of disulpho beta naphtholic sodium salt insoluble in alcohol, on the diazo derivative of amido para-cresol methylic ether.

250,201—November 29, 1881. H. CARO. *Sulphonated compound of rosaniline.*

Trisulpho acid of rosaniline, a red coloring matter: produced by the action of anhydrous sulphuric acid on fuchsine, at from 120° to 170° C., with constant agitation. It dyes wool in a boiling dye bath with mineral acids or acid mordants.

250,247—November 29, 1881. J. HOLLIDAY. *Manufacture of rosaniline colors.*

The sulpho-conjugated compound of rosaniline, capable of being used with acids or acid mordants, is produced by the action of fuming sulphuric acid on rosaniline, or its salts, preferably on anhydrous chloride of rosaniline.

251,162—December 20, 1881. H. BAUM. *Dyestuff or coloring matter.*

A yellow-orange coloring matter produced by the reaction of the disulpho-beta-naphtholic sodium salt, soluble in alcohol, upon the diazo derivative of aniline.

251,163—December 20, 1881. H. BAUM. *Dyestuff or coloring matter.*

A deep red scarlet dyestuff or coloring matter produced by the reaction of the disulpho-beta-naphtholic sodium salt, insoluble in alcohol, on the diazo compound derived from the amido-ethylxylol.

251,164—December 20, 1881. H. BAUM. *Dyestuff or coloring matter.*

A claret-red dyestuff or coloring matter, produced by the reaction of a mixture of the two isomeric disulpho-beta-naphtholic sodium salts upon the diazo derivative of naphthylamine.

251,499—December 27, 1881. A. BAEYER. *Manufacture of artificial indigo.*

Ortho-nitro-acetenyl benzene, used in the manufacture of an artificial indigo, is produced by the distillation of ortho-nitro-phenylpropiolic acid with steam.

251,500—December 27, 1881. A. BAEYER. *Manufacture of artificial indigo.*

Düsatogen, a red crystalline solid, is produced by mixing ortho-dinitro-acetenylphenyl with concentrated sulphuric acid and treating with fuming sulphuric acid, and precipitating by means of alcohol or water. It is converted into an artificial indigo blue by the action of reducing or deoxidizing agents.

251,501—December 27, 1881. A. BAEYER. *Manufacture of soluble derivatives of indigo blue.*

An alkaline salt of indigo-white sulphonic acid, convertable into indigo blue upon treatment with acid and oxidizing agents, is produced by the action upon indigo of alkaline pyrosulphates and reducing agents, such as ferrous sulphates and alkalies.

251,671—December 27, 1881. A. BAEYER. *Preparation of new material for the manufacture of artificial indigo.*

Ortho-dinitro-diacetenylphenyl, a yellow crystalline solid, m. p. 212° C., is produced by forming a copper compound of ortho-nitro-acetenyl benzene by treating an alcoholic solution of the latter with an ammoniacal solution of cuprous chloride, then treating same with prussiate of potash and caustic potash, washing and drying the precipitate, digesting with chloroform, and distilling off the solvent. It dissolves in concentrated sulphuric acid upon the addition of fuming sulphuric acid, with an intensely red color and with the production of düsatogen.

253,202—January 10, 1882. O. FISCHER. *Rosaniline-red coloring matter.*

A rosaniline red obtained from paranitrobenzaldehyde and a salt of commercial aniline oil. Nitroleuco bases are first formed from the said materials in the presence of dehydrating agents, and the rosaniline red is produced either direct from the bases or after transformation into leucoaniline.

252,203—January 10, 1882. O. FISCHER. *Preparation of rosaniline-blue coloring matter.*

A blue coloring matter produced by first forming nitroleuco bases from para-nitro benzaldehyde and diphenylamine in the presence of dehydrating agents, and then forming the aniline blue direct therefrom or after transforming them into amidoleuco bases.

252,273—June 10, 1882. J. H. STEBBINS, Jr. *Purple dyestuff or coloring matter.*

A dark-violet coloring matter produced by the action of an acid solution of the soda salt of beta-naphthol-monosulpho acid upon nitroso-dimethyl-aniline hydrochlorate, at from 110° to 121° C. It dyes wool mordanted with an iron or alum mordant a dark purple color.

252,274—January 10, 1882. J. H. STEBBINS, Jr. *Manufacture of blue coloring matter.*

A coloring matter or dyestuff produced by the action of an alkaline solution of the soda salt of alpha-naphthol-monosulpho acid on para-amido dimethyl-aniline hydrochlorate. It dyes wool with a chrome mordant an indigo color; with an alum mordant and tannin added to the dye bath it dyes wool a dark blue-green.

252,317—January 17, 1882. T. HOLLIDAY. *Producing azo colors upon vegetable fiber.*

Process consists in subjecting the fiber to the action of oil followed by an alkali, to oxidize the oil on the fiber; subsequently to the action of a naphthol or phenolic body, and then the azo color is produced upon the fiber by treating with a diazo compound, whereby the color is fastened upon the fiber in conjunction with the oil.

252,782—January 24, 1882. A. LIEBMANN. *Manufacture of the higher homologues of phenol, naphthol, and resorcin.*

See Group XVIII, Fine Chemicals.

253,443—February 7, 1882. J. H. STEBBINS, Jr. *Coloring matter or dyestuff.*

A blue dyestuff produced by the action of chloride of lime upon an alkaline mixture of dimethyl-para-phenylendiamine hydrochloride and orthocresol. It dyes wool with alum or chrome mordants at about 150° F. a prussian blue.

253,444—February 7, 1882. J. H. STEBBINS, Jr. *Coloring matter or dyestuff.*

A blue dyestuff produced by the action of dimethyl-para-phenylendiamine hydrochloride upon an alkaline solution of orthocresol in presence of an oxidizing agent; the coloring matter is developed with acetic acid. It dyes wool with alum or chrome mordants at about 150° F. an indigo extract blue color.

253,445—February 7, 1882. J. H. STEBBINS, Jr. *Coloring matter or dyestuff.*

A blue dyestuff produced by the action of para-amido-dimethyl-aniline hydrochloride upon an alkaline solution of phenol in the presence of chloride of lime. It dyes wool mordanted with alum or chrome mordants at about 180° F. a deep indigo blue.

253,598—February 14, 1882. F. GRAESSLER. *Manufacture of yellow coloring matters.*

The sulpho-acid of amidoazo-benzole; obtained by producing the amidoazo-benzole and then transforming it into the sulpho-acid compound thereof; or by transforming a sulpho-acid compound of aniline—a sulphanilic acid—into the amidoazo-benzole sulpho-acid; or by commencing with a sulpho-acid compound of aniline and transforming this into the corresponding amidoazo-sulpho acid. They afford fast coloring matters.

253,721—February 14, 1882. H. KOECHLIN. *Manufacture of colors or dyestuffs.*

Violet coloring matters produced by the action of nitroso derivatives of the tertiary amines on tannin, or on principles analogous to tannin, as by heating a solution of nitroso-dimethyl-aniline and gallic acid.

254,064—February 21, 1882. J. H. STEBBINS, Jr. *Dyestuff or coloring matter.*

A blue dyestuff produced by the action of diethyl-para-phenylendiamine chloride upon an alkaline solution of the soda salt of alphanaphthol monosulpho-acid in presence of an oxidizing agent. Wool is dyed at 150° F. in a neutral bath without mordants or acids; also with alum or chrome mordants.

254,065—February 21, 1882. J. H. STEBBINS, Jr. *Dyestuff or coloring matter.*

A blue dyestuff produced by the action of diethyl-para-phenylendiamine chloride upon an alkaline solution of alpha-naphthol in the presence of an oxidizing agent. The color on wool is developed by an oxidizing agent, as bichromate of potash, into a bright indigo blue.

254,098—February 21, 1882. W. PICKHARDT. *Manufacture of chinoline.*

See Group XVIII, Fine Chemicals.

254,550—March 7, 1882. T. & R. HOLLIDAY. *Process of dyeing colors or textile fabrics.*

Azo colors are produced direct in or upon cotton or other textile fibers by impregnating the same with a solution of naphthol or naphthols and with a solution of a diazo-azo compound.

255,349—March 21, 1882. J. H. STEBBINS, Jr. *Dyeing blue colors upon textile fabrics.*

A blue color is developed within or upon textile fiber, etc., by the reaction in or upon the fiber of nitroso-diethyl-aniline chloride and the soda salt of alpha-naphthol in the presence of an oxidizing agent.

255,350—March 21, 1882. J. H. STEBBINS, Jr. *Manufacture of blue coloring matter.*

A blue dyestuff produced by the action of diethyl-para-phenylendiamine chloride upon an alkaline solution of phenol in the presence of an oxidizing agent. It dyes wool with or without alum or chrome mordants at 150° F. a deep blue.

256,330—April 11, 1882. E. D. KENDALL. *Process of treating certain derivatives of coal-tar colors.*

See Group X, Electro-chemistry.

256,375—April 11, 1882. C. RUMPFF. *Dyestuff or coloring matter.*

The product resulting from the reaction of diazo-azo-toluol-monosulphonic acid with the sodium salt of the alpha-monosulphonic acid of beta-naphthol.

256,376—April 11, 1882. C. RUMPFF. *Manufacture of dyestuff or coloring matter.*

The product resulting from the reaction of diazo-alpha-naphthaline-monosulphonic acid with a solution of the sodium salt of the alpha-monosulphonic acid of beta-naphthol.

256,377—April 11, 1882. C. RUMPFF. *Manufacture of dyestuff or coloring matter.*

Product resulting from the reaction of diazo-beta-naphthaline-monosulphonic acid with the sodium salt of the alpha-monosulphonic acid of beta-naphthol.

256,378—April 11, 1882. C. RUMPFF. *Manufacture of dyestuff or coloring matter.*

Product resulting from the reaction of diazoazo-xylol-monosulphonic acid with the sodium salt of the alpha-monosulphonic acid of beta-naphthol.

256,379—April 11, 1882. C. RUMPFF. *Manufacture of dyestuff or coloring matter.*

A yellow dyestuff resulting from the reaction of the nitro-alpha-monosulphonic acid with carbonate of potash.

256,380—April 11, 1882. C. RUMPFF. *Manufacture of dyestuff or coloring matter.*

A scarlet dyestuff resulting from the reaction of diazoazo-benzole with alpha-monosulphonic acid of beta-naphthol.

256,381—April 11, 1882. C. RUMPFF. *Manufacture of a new coloring-producing acid.*

The alpha-monosulphonic acid of beta-naphthol is produced by treating beta-naphthol, 100 kilograms, with commercial sulphuric acid (66 per cent), 200 kilograms, the temperature not exceeding 50° to 60° C. Also the soda salt of the same, a new product. It gives coloring matters, with diazo compounds, fast against soap and light.

256,400—April 11, 1882. J. H. STEBBINS, Jr. *Production of naphthyl-sulphate soda salt.*

The soda salt of naphthyl-sulphate: produced by treating beta-naphthol with sulphuric acid at not to exceed 20° C. It is separated out by the action of hot alcohol.

256,401—April 11, 1882. J. H. STEBBINS, Jr. *Dyestuff or coloring matter.*

The dyestuff or coloring matter produced by the action of diazoazo-benzole-monosulpho-acid upon the soda salt of naphthyl-sulphate. It dyes wool, in a bath acidulated with sulphuric acid, a pure scarlet red.

256,596—April 18, 1882. P. REID AND J. EASTWOOD. *Ink for dyeing purposes.*

It is composed essentially of pyroxyline, a coloring agent, camphor, and a suitable menstruum, such as alcohol, wood-naphtha, etc.

256,599—April 18, 1882. C. H. RUDOLPH. *Production of coloring matter.*

A yellow coloring matter obtained from a mixture of acetanilide and hydrochlorate of aniline by heating the same with chloride of zinc or other dehydrating agent. The methylated, ethylated, etc., derivatives are obtained by the action of chloride, bromide, or iodide of methyl, ethyl, etc., on the same or on the base contained therein.

257,242—May 2, 1882. C. RUMPFF. *Manufacture of brown dyestuff.*

A brown coloring matter formed by the reaction of nitrous acid upon the salts of the alpha-naphthylamine-sulphonic acid in neutral or very slightly acid solution. Distinguished by immense dyeing power.

257,243—May 2, 1882. C. RUMPFF. *Manufacture of brown dyestuff.*

A brown coloring matter formed by the reaction of nitrous acid upon the salts of the beta-naphthylamine-sulphonic acid in neutral or very slightly acid solution. Distinguished by immense dyeing power.

257,498—May 9, 1882. H. KOECHLIN. *Manufacture of coloring matter.*

The leuco bases and leuco products or reduction products of the bodies obtained by the action of nitroso derivatives upon tannin, or on principles analogous to tannin, the same being obtained by the reaction of said bodies, or directly as by the heating of a solution of gallate of soda and chlorhydrate of nitro-sodi-methylaniline.

257,717—May 9, 1882. E. JACOBSEN. *Manufacture of red coloring matter.*

The process of manufacturing a red or violet coloring matter consists in heating a mixture of equal parts of chinoline or pyridine and benzotrichloride, and subsequently treating with water and an alkali. It dyes cotton mordanted with tannin. It shows an intense yellow fluorescence visible on wool and silk.

257,812—May 9, 1882. A. BAEYER AND V. B. DREWSEN. *Preparation of material for manufacture of artificial indigo.*

The process of producing ortho-nitro-cinnamylformic acid consists in treating ortho-nitro-benzoldehyde with pyroracemic (pyruvic) acid in the presence of hydrochloric acid.

257,813—May 9, 1882. A. BAEYER AND V. B. DREWSEN. *Preparation of material used in the manufacture of artificial indigo.*

Ortho-nitro-cinnamylformic acid—product of No. 257,812—a yellowish-white crystalline solid, characterized by the facility with which its alkaline solutions containing an excess of the base are decomposed with production of artificial indigo.

257,814—May 9, 1882. A. BAEYER AND V. B. DREWSEN. *Manufacture of artificial indigo.*

The process consists in treating ortho-nitro-benzaldehyde with acetone in the presence of a diluted solution of an alkali, such as caustic soda.

257,815—May 9, 1882. A. BAEYER AND V. B. DREWSEN. *Artificial indigo.*

The product of No. 257,814: distinguished from vegetable and from the artificial indigo of No. 227,470 by its pure blue color and absence of any coloring matter soluble in alcohol with a red or purple color.

258,530—May 23, 1882. H. BRUNCK. *Manufacture of anthracene blue.*

"Anthracene blue:" produced from alizarine orange—No. 186,032—by heating same with glycerine and sulphuric acid at not to exceed 110° C., and subsequently treating the product with bisulphite of soda. It is not decomposed in aqueous solution by acetic or tartaric acid, or the lime, magnesian, or chromic salts of these organic acids.

258,531—May 23, 1882. H. BRUNCK. *The production of blue colors upon textile fabrics.*

The fiber or fabric is impregnated with an aqueous solution of the anthracene blue—No. 258,530—and then exposed to heat of from 70° to 100° C. The material may first be impregnated with a solution of acetic acid or tartaric acid, or of the lime, magnesian, or chromic salts of said acids.

259,260—June 6, 1882. A. BAEYER. *Process of manufacture of indigo blue.*

An ether compound of ortho-nitro-phenylpropiolic acid is first produced, such as its ethylic ether; then the same is converted into indogenic ether, which is converted into indogenic acid by treatment with caustic alkalis, followed by muriatic acid, and the product finally exposed to an oxidizing action.

259,261—June 6, 1882. A. BAEYER. *Process of manufacture of indigo blue.*

Process the same as No. 259,260, except the indogenic acid is transformed into indogen by the action of heat, and the indogen is then exposed to an oxidizing action.

259,629—June 13, 1882. A. BAEYER. *Manufacture of artificial indigo.*

Produced by starting from toluene, successively through benzyl chloride, benzyl cyanide, phenylacetic acid, oxindol, nitroso-oxindol, amido-oxindol, artificial isatine, and isatine-chloride to artificial indigo. It contains "indirubin," and colors alcohol purple on boiling; on combustion it leaves an ash containing zinc.

260,242—June 27, 1882. C. RUMPFF. *Manufacture of coloring matter from naphthylamine.*

A brown dyestuff or coloring matter produced by the action of diazoazo-benzol-sulphonate of soda upon naphthylamine in an acid solution. It dyes wool and silk a dark reddish brown in an acidulated bath, fast to soap and light.

261,175—July 18, 1882. C. RUMPFF. *Manufacture of coloring matter from naphthylamine.*

A brown dyestuff or coloring matter produced by the action of diazo-naphthalene-sulphonate of soda upon naphthylamine in an acid solution. It dyes silk and wool in an acidulated bath.

261,518—July 18, 1882. H. KOECHLIN AND O. N. WITT. *Manufacture of blue and violet coloring matters.*

Produced by the reaction upon a phenol of a nitroso amine or phenol or a chloroquinonimide in the presence of a reducing agent, or a paramido body in the presence of an oxidant.

261,600—July 25, 1882. J. H. H. O. GÜRKE. *Production of soluble alizarine-blue color.*

A dark yellow coloring matter produced by the reaction of sulphite of ammonia upon commercial "alizarine blue" ($C_{17}H_9NO_4$) at from 30° to 40° C.

261,766—July 25, 1882. C. RUMPFF. *Manufacture of brown dyestuff.*

Produced by adding to a solution of amidoazoxylolsulphonate of soda, first, muriatic acid, then a solution of sodium nitrite, and then naphthylamine in acid solution. It dyes wool and silk a dark reddish brown in an acidulated bath.

261,767—July 25, 1882. C. RUMPFF. *Manufacture of brown dyestuff.*

Produced by adding to a solution of amidoazotoluolsulphonate of soda, first, muriatic acid, then a solution of sodium nitrite, and then an acid solution of naphthylamine. It dyes wool and silk a dark reddish brown in an acidulated bath.

262,620—August 15, 1882. C. RUMPFF. *Manufacture of dyestuff.*

A brown dyestuff or coloring matter produced by combining diazoazobenzolsulphonic acid with a solution of naphthylaminsulphonate of soda. It dyes wool and silk a dark reddish brown in an acidulated bath.

262,680—August 15, 1882. F. MANN. *Manufacture of rosaniline color.*

A red dyestuff or coloring matter produced by treating rosaniline or a suitable salt thereof with carbyl sulphate or ethionic acid. For practical purposes an acid alkali salt of the dyestuff is prepared.

262,695—August 15, 1882. C. RUDOLPH. *Manufacture of artificial indigo.*

Produced from benzaldehyde by first converting the same into monobenzylidenacetone, then converting the latter into its orthonitro substitution derivative, separating this orthonitro product from isomers by crystallization, filtration, and distillation, and finally digesting in a weak alkaline lye.

263,341—August 29, 1882. H. KEOCHLIN AND O. N. WITT. *Manufacture of blue coloring matters called "indophenols."*

Soluble indophenols: produced by the reaction between nitrous derivatives of amines or chloroquinonimides, as nitroso dimethylaniline, and phenols, as alpha naphthol, by heating, without the presence of alkali or a reducing agent. The indophenol is obtained in the shape of leuco compound, and rendered soluble in alkaline lyes by excess of the phenol, and in water by the addition of alkali. Insoluble indophenols may be treated with phenols or their alkaline derivatives, in the formation of the former or when already formed.

263,420—August 29, 1882. R. MELDOLA. *Manufacture of blue coloring matters.*

Produced by the reduction of the diazo colors formed from the various amidonaphthaline-sulphonic acids in conjunction with dimethylaniline and other tertiary monamines by means of a sulphide, with or without the addition of zinc dust, the products being oxidized by means of ferric chloride or other suitable oxidant. It dyes wool and silk from a neutral or ammoniacal bath, and cotton with or without a mordant, according to the shades required.

263,964—September 5, 1882. H. ROSE. *Manufacture of dyestuff from alizarine-blue.*

Produced by mixing an alkaline salt of alizarine blue, as the natrium salt in paste, with an alkaline bisulphite and a mordant, whereby the salt of the alizarine blue dissolves quite easily.

263,965—September 5, 1882. H. ROSE. *Manufacture of alizarine-blue color.*

A brownish-red coloring compound produced by first combining alizarine blue, $C_{14}H_9NO_4$, with alkalis, and then treating the alkaline salt thus obtained with the bisulphites of the alkalis.

266,912—October 31, 1882. J. H. STEBBINS, JR. *Coloring matter or dyestuff.*

A green dyestuff produced by the action of benzoyl chloride upon methyldiphenylamine in the presence of zinc chloride, at about 100° C.

268,113—November 28, 1882. C. MARTIUS. (*Reissue: 10,353—July 10, 1883.*) *Process of producing a basic coloring matter from xylidine.*

Process of producing crystallized cumidine, a base for the manufacture of azo colors: consists in treating hydrochlorate of xylidine with methyl alcohol in a digester to 280° C., converting the crude hydrochlorate of cumidine into a nitrate, separating the nitrate from the mother liquors, washing it, and subsequently converting it into the base and subjecting it to fractional distillation between 225° and 245° C. and crystallization.

268,505—December 5, 1882. C. F. L. LIMPACH. *Manufacture of coloring matter.*

A bluish-red coloring matter produced by the action of the sulphonic acid of amidoazo-benzole upon an alkaline solution of betanaphthol trisulphonic acid.

268,506—December 5, 1882. C. F. L. LIMPACH. *Manufacture of coloring matter.*

A red coloring matter produced by the reaction, with sodium salt, of the betanaphthol trisulphonic acid upon the diazo compound derived from alphanaphthylamine sulphonic acid.

268,507—December 5, 1882. C. F. L. LIMPACH. *Manufacture of coloring matter.*

A bluish-red coloring matter produced by the action of the diazo compound of the amidoazo-benzole upon an alkaline solution of betanaphthol trisulphonic acid.

268,543—December 5, 1882. C. RUDOLPH. *Production of methylquinoline.*

Produced by treating ortho-nitro-benzylidenacetone with reducing agents, as tin chloride and muriatic acid, and purifying by distillation in a current of steam. It boils at 240° C. and is used for the production of azo coloring matters.

269,359—December 19, 1882. O. WALLACH. *Manufacture of coloring matter.*

A brown coloring matter produced by combining diazotized aniline and resorcin, dissolving the product in caustic soda, and then combining again with diazo-sulphanilic acid. It dyes wool and silk in reddish-brown shades.

270,311—January 9, 1883. E. HEPP. *Manufacture of blue dyestuff or coloring matter.*

Produced from nitroso derivatives of tertiary aromatic monamines such as dimethylaniline, by dissolving same in concentrated sulphuric acid and then subjecting to the action of a reducing agent, as a metallic sulphide.

271,656—February 6, 1883. T. HOLLIDAY. *Production of azo colors on cotton fabrics.*

They are produced direct by the action of a neutralized bath (e. g., neutralized by carbonate of lime) of the diazo compounds upon fiber previously treated with the naphthols or phenols.

274,081—March 13, 1883. H. BRUNCK. *Manufacture of anthracene-blue.*

In the manufacture of anthracene blue, No. 258,580, the time is shortened by the use of a solvent. Alizarine blue is exposed to the action of a solution of bisulphite of soda or other alkali, an alkaline earth, or a metal, such as zinc, chromium, or iron, in the presence of a suitable solvent, such as alcohol, acetic acid, or acetic ether.

275,774—April 10, 1883. H. KOECHLIN AND O. N. WITT. *Treatment of indophenols.*

"Leuco-indophenol" is produced from indophenol by the reaction of alkaline or acid reducing agents upon the latter. The indophenol is ground to a paste and maintained alkaline or acid during the reaction, according to the reducing agent used.

276,796—May 1, 1883. O. FISCHER. *Preparation of oxyhydro-methyl chinoline.*

See Group XVIII, Fine Chemicals.

276,888—May 1, 1883. C. RUDOLPH. *Manufacture of cinnamic acid.*

See Group I, Acids, Other Organic.

276,889—May 1, 1883. C. RUDOLPH. *Material for the manufacture of metamethyl indigo.*

Ortho-nitro-meta-methyl-benzaldehyde is produced by dissolving toluylaldehyde in concentrated sulphuric acid, thereafter slowly adding a cold mixture of nitric and concentrated sulphuric acids, pouring into ice water to separate the nitroaldehyde in the form of an oil, which is consecutively washed in water and a dilute carbonate of soda solution.

276,890—May 1, 1883. C. RUDOLPH. *Manufacture of metamethyl indigo.*

Produced by dissolving ortho-nitro-meta-methyl-benzaldehyde in a double quantity of acetone or ethylaldehyde, and adding a sodium lye. As contrasted with natural indigo the methyl indigo is easily soluble in alcohol.

277,182—May 8, 1883. J. WOLFF. *Production of coloring matters from diazoamido compounds.*

A scarlet coloring matter produced by the reaction of a solution of diazoxylolamido-benzol sulphonate of ammonia with a solution of sodium betanaphthol disulphonate.

277,864—May 15, 1883. H. ENDEMANN. *Production of sulpho-acid compound of betanaphthol.*

A new compound produced by treating betanaphthol with fuming sulphuric acid at 115° to 125° C. for two hours, when the temperature is reduced to 100° to 110° C. and more fuming sulphuric acid is added from time to time. It is used in the manufacture of coloring matters.

278,926—June 5, 1883. E. FISCHER. *Production of paranitrobenzylidene chloride.*

Process consists of treating paranitrotoluol with a current of chlorine gas at a high temperature, rising from 130° to 160° C., and washing the resulting mass successively with water, a solution of sodium carbonate, and finally with water, and crystallizing from alcohol. It is used in the manufacture of coloring matters.

280,317—June 26, 1883. L. LIMPACH. *Manufacture of coloring matter.*

A betanaphthol trisulpho acid compound which produces brilliant colors when treated with diazo compounds, produced by reacting upon betanaphthol with sulphuric anhydride (or single oleum) at 160° C. for five to ten minutes, and neutralizing the acid solution, when the reaction is complete, with caustic soda or a salt thereof, so as to form a salt of the said trisulpho acid.

282,835—August 7, 1883. A. BERNTHSEN. *Manufacture of materials suitable for dyestuffs.*

Thiodiphenylamine, a yellowish-white crystalline solid, is produced by heating a mixture of diphenylamine and sulphur at from 250° to 300° C.

282,836—August 7, 1883. A. BERNTHSEN. *Manufacture of coloring matter.*

A purple dyestuff or coloring matter obtained from thiodiphenylamine (No. 282,835) by converting the same into a nitro compound, then acting thereon with reducing agents, as tin and hydrochloric acid, and oxidizing the product. It dyes cotton previously mordanted with tannin, and becomes fixed on the fiber without the aid of a mordant.

283,265—August 14, 1883. N. McCALLUM. *Composition to be used as a paint or dye.*

"Echurine," a yellow dye, consists of nitric acid, picric acid, and flavine, boiled and evaporated to dryness.

283,766—August 28, 1883. E. FISCHER. *Manufacture of the nitro-leuco base of rosaniline.*

Produced by the reaction of para-nitro-benzylidene chloride dissolved in a medium, such as ligroine, benzine, or alcohol, on aniline, at the temperature of a water bath, followed by distillation of the solvent, extraction of the residue with water, and precipitation of the base by an alkali. It varies in color from yellow to red and melts under boiling water to a wax-like mass.

285,335—September 18, 1883. J. WOLFF. *Manufacture of cardinal-red coloring matter.*

Produced by the reaction of a solution of diazo-naphthalene-amido-benzole sulphonate of ammonia and a cold solution of one equivalent of betanaphthol disulphonate of sodium in 10 to 12 parts of its own weight of water. It is distinguished by containing besides the diazo compound of naphthalene, the amido-benzole sulphonate compound with the beta-naphthol sulphonate.

286,526—October 9, 1883. A. BERNTHSEN. *Sulphureted derivative of diphenylamine as a basis for the production of coloring matters.*

Thiodiphenylamine produced by heating diphenylamine with sulphur at from 250° to 300° C. The product is purified by distillation.

286,527—October 9, 1883. A. BERNTHSEN. *Process of obtaining coloring matter or dyestuff from thiodiphenylamine.*

Thiodiphenylamine is treated with nitric acid, the nitro compound obtained is reduced, and the resulting colorless compound oxidized. It is a purple coloring matter, dyeing cotton which has been mordanted with tannin, and it becomes fixed on animal fiber without the aid of a mordant.

289,543—December 4, 1883. I. LEVINSTEIN. *Manufacture of yellow coloring matter.*

Coloring matter produced by the action of nitric acid upon the mono and disulpho acids of nitroso-alpha-naphthol, or a mixture of the same.

289,613—December 4, 1883. O. BREDT. *Manufacture of red coloring matter.*

Produced by diazotizing naphthylamine sulphonic acid, and then treating it with naphthol. The alpha form of naphthylamine sulphonic acid yields bluish-red and the beta form, yellowish-red shades.

290,585—December 18, 1883. E. JACOBSEN. *Production of yellow coloring matter.*

Produced by heating chinaldine with phthalic anhydride and zinc chloride to from 190° to 210° C. The melt is boiled out with muriatic acid. As obtained, it is soluble only in spirit. It is made soluble in water by heating with sulphuric acid, monochlorhydrine, or fuming sulphuric acid.

290,856—December 25, 1883. H. CARO AND A. KERN. *Manufacture of dyestuff.*

The process for manufacturing crystallized methyl-violet by the reaction of oxychloride of carbon (phosgene) upon a mixture of dimethylaniline and anhydrous chloride of aluminium and then separating the coloring matter.

290,891—December 25, 1883. A. KERN. *Manufacture of dyestuff or coloring matter.*

Crystallized methyl-violet, the product of process No. 290,892. It is marked by its uniformity of composition. It dyes textile fiber a bluish-purple shade similar to "methyl-violet 5B."

290,892—December 25, 1883. A. KERN. *Manufacture of purple dyestuff.*

Process consists in converting dimethyl-aniline into tetra-methyl-diamido-benzophenone; treating the same with reducing or hydrogenizing agents; combining tetra-methyl-diamido-benzhydroll, the hydrogenized product, with dimethyl-aniline; submitting the new product to an oxidizing process; and finally crystallizing the dyestuff from its solution in suitable solvents.

290,893—December 25, 1883. A. KERN. *Manufacture of dyestuff or coloring matter.*

"Ethyl-purple 6B:" produced by converting diethylaniline into tetraethyl-diamido-benzophenone, treating the same with reducing or hydrogenizing agents, combining the hydrogenized product with diethylaniline, and then oxidizing, and separating out the dyestuff or coloring matter.

295,825—March 25, 1884. Z. H. SKRAUP. *Manufacture of parachinisol.*

See Group XVIII, Fine Chemicals, Nitro-substitution compounds.

297,413—April 22, 1884. A. KERN. *Manufacture of ethyl-blue coloring matter.*

"Victoria blue BB:" produced by the condensation of alpha-phenyl-naphthylamine with tetra-ethyl-diamido-benzophenone, in the presence of phosphorus oxychloride.

297,414—April 22, 1884. A. KERN. *Methyl-blue coloring matter.*

"Victoria blue B:" produced by the condensation of alpha-phenyl-naphthylamine with tetra-methyl-diamido-benzophenone, in the presence of phosphorus oxychloride.

297,415—April 22, 1884. A. KERN. *Methyl-blue coloring matter.*

"Benzyl-violet B:" produced by the condensation of tetra-methyl-diamido-benzophenone with dibenzyl-aniline, in the presence of phosphorus oxychloride.

297,416—April 22, 1884. A. KERN. *Ethyl-blue coloring matter.*

"Benzyl-violet BB:" produced by the condensation of tetra-ethyl-diamido-benzophenone with dibenzyl-aniline, in the presence of phosphorus oxychloride.

297,844—April 29, 1884. A. F. POIRRIER AND D. A. ROSENSTIEHL. *Sulpho-conjugated violets of Paris.*

A new product having the free acid neutralized, readily soluble, and with the coloring matter unaltered; produced by treating the crude coloring matter with potash, soda, ammonia, zinc, magnesia, or other suitable base, to transform the excess of acid into soluble sulphate.

297,852—April 29, 1884. Z. ROUSSIN AND D. A. ROSENSTIEHL. *Manufacture of yellow and orange coloring matters.*

Azo coloring matters, varying from yellow to orange and even red, having the radical of carbonic acid substituted for that of sulphuric acid, are produced by substituting the amido-carboxylated acids, such as amidobenzoic acid, for the corresponding sulpho acids in the manufacture, in the state of free acid. They are insoluble in water, but their alkaline salts are sufficiently soluble.

298,998—May 20, 1884. P. MONNET. *Obtaining brown dyes from the aromatic diamines.*

Process consists in saturating the material in a bath composed of chlorhydrate of paraphenylene diamine, or paratoluylene diamine, sulphuric acid and water, then wringing, and then treating the material to an oxidizing bath to develop the color.

300,874—June 24, 1884. F. KRÜGER, G. TOBIAS, AND E. KEGEL. *Production of coloring matters from dinitro-phenol.*

Dinitro-phenol-sulpho acid and its salts are produced by nitrating phenol-sulpho acid, or mono-nitro-phenol-sulpho acid, or their salts. The commercial product is the dinitro-phenol-sulphonate of potash, a red product, ground, mixed with spirit of ammonia, and evaporated to dryness.

301,802—July 8, 1884. H. CARO AND A. KERN. *Manufacture of yellow coloring matter.*

"Auramine:" produced by fusing a mixture of tetra-methyl-diamido-benzophenone, ammonia hydrochlorate, and zinc chloride, and washing out and crystallizing the product. When dissolved in alcohol and treated first with sodium amalgam, and then with acetic acid and heat, it is decomposed into tetra-methyl-diamido-benzhydrol and ammonia.

302,170—July 15, 1884. J. H. STEBBINS, JR. *Manufacture of brown coloring matter.*

"Phenanthrol brown:" produced by the action of diazoazobenzole-parasulpho-acid upon beta-phenanthrol in alkaline solution. When treated with reducing agents, as tin and hydrochloric acid, it splits up into beta-amido-phenanthrene, aniline, and sulphanilic acid.

302,790—July 29, 1884. A. SPIEGEL. *Azo coloring matter.*

Produced from ortho-amido-dichlorphenol by diazotizing and then combining with a molecular quantity of beta-naphthol, producing the azo coloring matter dichlorphenol-azo-beta-naphthol, which is then treated with spirits of wine along with a concentrated solution of the bisulphite of an alkali and heat. It is distinguished by solubility in water with a yellow color, and when an alkali is added to the solution, or when boiled with a nitrite, the bisulphite compound is decomposed and a bluish-violet paste is precipitated.

302,791—July 29, 1884. A. SPIEGEL. *Fastening azo colors on yarn or textile fabrics.*

Azo colors are developed in or upon textile fiber, etc., by impregnating the fiber with the bisulphite compounds of azo coloring matters formed from diazo compounds, combined with aromatic hydroxylated bodies or phenols, together with salts of alumina, iron, or chromium, and then exposing to heat, preferably steam, or to an alkaline agent, or a hot solution of a nitrite.

303,335—August 12, 1884. A. SPIEGEL. *Azo coloring matter.*

The bisulphite compound of dichlorphenol-azo-ethyl-beta-naphthol (soluble in water): produced by treating the scarlet azo coloring matter dichlorphenol-azo-ethyl-beta-naphthol (insoluble in water) with a concentrated solution of the bisulphite of an alkali along with spirits of wine.

306,546—October 14, 1884. A. SPIEGEL. *Manufacture of bisulphite compounds of azo coloring matters.*

Azo coloring matters soluble in spirit—i. e., not sulphonic acids—are converted into compounds soluble in water by combining such azo coloring matters, in the presence of a solvent, with the bisulphite of an alkali.

306,969—October 21, 1884. A. SPIEGEL. *Preparation of pheneto-sulpho-diazo-beta-naphthol with bisulphite compound.*

A coloring matter soluble in water is produced from phenetol-sulphon-diazo-beta-naphthol—insoluble in water—by treating same with a concentrated solution of the bisulphite of an alkali, along with spirits of wine.

307,401—October 28, 1884. C. LOWE. *Coloring matter derived from aurin.*

Process of manufacturing "roso-phenoline," a basic red coloring matter, consists in heating aurin with a mixture of ammonia and an organic acid either in aqueous, ethylic, phenylic, or other alcoholic solution, at from 212° to 400° F.

308,748—December 2, 1884. H. CARO AND A. KERN. *Manufacture of purple-blue coloring matter.*

"Victoria blue 4 R:" produced by the condensation of tetramethyl-diamido-benzophenone with methyl-phenyl-alpha-naphthylamine, in the presence of phosphorus oxychloride.

308,912—December 9, 1884. F. MACHENHAUER. *Manufacture of rosaniline derivatives.*

Yellow coloring matters produced from "azuline," of commerce—a blue coloring matter—and the sulphonic acids thereof, by treating the same with nitric or nitrous acids or their salts.

309,882—December 30, 1884. Z. ROUSSIN AND D. A. ROSENSTIEHL. *Manufacture of bromated azo coloring matters.*

Yellow and orange brominized azo coloring matters are produced by introducing bromine directly into the coloring matter after the latter has been formed. They are more readily fixed on vegetable fiber than substances not bromated.

310,128—December 30, 1884. E. ERLENMEYER. *Production of rosaniline coloring matters.*

Process of manufacturing coloring matters of the rosaniline series of different composition by the oxidation of various combinations or mixtures of methylated amines or anilines or rosanilines with primary, secondary, or tertiary aromatic amines in such a way that the methyls of the former compounds are applied under the influence of oxidizing media—a methan carbon—in order to combine therewith always three aromatic molecules of the latter compounds.

310,155—December 30, 1884. L. VIGNON. *Sulpho-alpha-naphthol coloring compound.*

Produced by the reaction of a sodium sulpho-alpha-naphthol rendered slightly alkaline by sodium carbonate or ammonia hydrate upon diazo-benzole.

313,118—March 3, 1885. J. H. STEBBINS, JR. *Red coloring matter.*

Benzole-azo-sulphonate of soda-azo-diethylaniline: produced by treating a solution of amidoazo-benzole-sulphonate of soda with sodium nitrite, and then adding the diazo compound to a solution of diethylaniline in methyl alcohol. It is split by reducing agents into para-phenylendiamine, sulphanillic acid, and para-amido-diethylaniline. It dyes a brownish red.

314,938—March 31, 1885. M. HOFFMANN. *Coloring matter from beta-naphthol.*

A red coloring matter, producing on wool and silk a blue shade: produced by mixing the diazo compound of the difficultly soluble alpha-naphthylamine sulphonic acid with an alkaline solution of beta-naphthol gamma disulphonic acid.

314,939—March 31, 1885. M. HOFFMANN. *Red coloring matter from gamma disulphonic acid of beta-naphthol.*

Produced by the action of the diazo compound of amidoazobenzole upon an alkaline solution of gamma disulphonic acid of beta-naphthol. It dyes wool, silk, and mordanted cotton a brilliant scarlet.

315,932—April 14, 1885. R. GNEHM. *Production of chlorinated derivatives of benzaldehyde.*

Benzaldehyde is treated with iodine and pentachloride of antimony under heat, and the chlorinated substitution products of benzaldehyde are then separated by known methods. They are employed in the manufacture of coloring matters.

316,036—April 21, 1885. O. HOFFMANN. *Coloring matter derived from naphthol.*

Naphthol-green: produced from the reaction of nitroso-naphtho-sulphonic acids or their salts upon iron or its salts, or by the reaction of nitrous acid upon naphthol-sulphonic acids treated with iron or its salts.

316,471—April 28, 1885. C. LOWE: *Manufacture of derivatives of aurin.*

"Roso-phenoline," the product of process No. 307,401.

318,484—May 26, 1885. C. LOWE. *Manufacture of the derivatives of aurin.*

Roso-phenoline sulphonic acid, a conjugated acid red coloring matter: produced by heating aurin at a low temperature with sulphuric acid and heating the product, after removing excess of acid, with ammonia in aqueous, ethylic, phenylic, or other alcoholic solution. It combines with alkali to form solid or pasty salts, insoluble in benzole but soluble in alcohol or water.

319,646—June 9, 1885. L. VIGNON. *Process of obtaining coloring matter from amidoazo-benzole and homologues.*

A solution of chlorhydrate of amidoazo-benzole, hydrochloric acid and water, is heated to from 140° to 176° F., and a solution of sodium sulphide is then added until the reduction is complete, when the liquid is filtered and oxidized.

322,368—July 14, 1885. R. GNEHM. *Production of chlorophthalic acid.*

Tetrachlorophthalic acid (or its anhydride): produced by the action of chlorine upon a mixture of anhydrous phthalic acid and antimony pentachloride, heated to about 200° C.

322,940—July 28, 1885. T. KEMPF. *Manufacture of iodoform bromoform, and chloroform.*

See Group X, Electro-chemistry.

323,514—August 4, 1885. W. MAJERT. *Manufacture of methylene-blue by electrolysis.*

See Group X, Electro-chemistry.

324,615—August 18, 1885. L. VIGNON. *Manufacture of coloring matter from alpha-naphthol and dinitro-naphthol.*

The process of producing a yellow coloring matter consists in treating alpha-naphthol with sulphuric acid at 66° Baumé; cooling and diluting with ice; adding nitric acid at 40° Baumé; maintaining the temperature under 30° C.; then heating to near 40° C.; cooling to 12° or 15° C.; and finally filtering, redissolving the precipitate, and precipitating with carbonate of potash in solution.

324,630—August 18, 1885. H. ZIEGLER. *Coloring matter from phenylhydrazine.*

A yellow dyestuff or coloring matter produced by the action of bioxytartaric acid (carboxytartronic acid) upon the sulpho-acid of phenylhydrazine. It is soluble in water; almost insoluble in strong alcohol and glacial acetic acid.

325,827—September 8, 1885. F. FISCHER. *Manufacture of violet dyestuffs.*

Process consists in treating diethyl-aniline by perchlormethyl-mercaptan.

325,828—September 8, 1885. F. FISCHER. *Violet methyl dyestuff.*

Product of process No. 325,827.

327,265—October 6, 1885. A. KERN AND C. L. MÜLLER. *Production of blue dyestuffs.*

Trimethyl triphenyl rosaniline is produced by the reaction of oxychloride of carbon (phosgene) upon methyl diphenylamine, followed by digestion of the warm mass with zinc chloride and carbon oxychloride, separation of the base from residual matters, and purification.

329,125—October 27, 1885. A. T. BÖHME. *Process of making coloring matter.*

Consists in boiling glucosides derived from quercitrin, horse-chestnut, Brazilian wood, or the like, in water mixed with nitric or hydrochloric acid to precipitate the resin, removing the braziline, or the like, treating with potassium permanganate, filtering, lixiviating the precipitate, and treating with acid, cooling and neutralizing.

329,632—November 3, 1885. C. DUISBERG. *Coloring matter obtained from tetrazo-ditolyl.*

Produced by the action of tetrazo-ditolyl upon the alpha-naphthylamine sulpho-acids. It dyes unmordanted cotton alizarine-red.

329,633—November 3, 1885. C. DUISBERG. *Coloring matter obtained from tetrazo-ditolyl.*

Produced by the action of tetrazo-ditolyl upon the beta-naphthylamine sulpho-acids. It is isomeric to No. 329,632, dyeing an alizarine red, although a little yellower.

329,634—November 3, 1885. E. ELSAESSER. *Red dyestuff or coloring matter.*

Obtained by the reaction of the diazo derivative of the monosulpho acid of beta-naphthylamine, and the monosulpho-acids of alpha-naphthol derived from naphthionic acid and sulpho-naphthyladamic acid.

329,636—November 3, 1885. F. FISCHER. *Production of new violet dyestuffs.*

Process consists in treating dimethyl-aniline with perchlor-methylmercaptan, which is the product of the reaction of chlorine upon carbon bisulphide. Its muriate forms bronze-like needle crystals.

329,637—November 3, 1885. F. FISCHER. *Violet coloring matter.*

Product of process No. 329,636.

329,638—November 3, 1885. E. FRANK. *Yellow coloring matter.*

Product of process No. 329,639. Unmordanted cotton is dyed a sulphur yellow in a boiling soap bath.

329,639, November 3, 1885. E. FRANK. *Production of new yellow coloring matter.*

Process consists in azotizing benzidine sulphate by means of sodium nitrite, forming tetrazo-diphenyl, and treating it with oxibenzoic acids—salicylic acid—and finally separating and purifying the product.

330,275—November 10, 1885. M. E. WALDSTEIN AND A. MÜLLER. *Composition of matter to be used in dyeing.*

A composition containing a sulpho compound of the fatty acids, such as sulphoricinoleic acid or sulpholeic acid, aniline or its homologues, and a neutralizing alkali.

331,059—November 24, 1885. M. HOFFMANN. *Manufacture of beta-naphthol sulphonic acid.*

The gamma disulphonic acid of beta-naphthol is produced by first sulphonating the alpha-monosulphonic acid of beta-naphthol or beta-naphtol itself, and finally purifying the acid. Coloring matters are formed by combination with aromatic diazo compounds.

331,964—December 8, 1885. H. HASSENCAMP. *Manufacture of benzylated methyl violet.*

The product of No. 331,965, a benzylated methyl violet which has been sulphonated and oxidated. It is principally used for dyeing wool when sulphuric acid is used as a mordant.

331,965—December 8, 1885. H. HASSENCAMP. *Manufacture of benzylated acid violet.*

Process consists in reducing the methyl violet of commerce to its leuco base, benzylating the leuco base, transforming into its leuco-sulpho acid, and finally obtaining the sulpho-acid of the dyestuff by oxidation.

332,350—December 15, 1885. E. OSTERMEYER AND M. DITTMAR. *Producing chloriodine double combinations from pyridine and chinoline bases.*

The process of producing double combinations of chloriodine with pyridine, chinoline, tetrahydrochinoline or chinoline methylate, from which coloring matters may be obtained: consists in treating these bases with chloroid-hydrochloric acid.

332,728—December 15, 1885. M. HOFFMANN. *Dyestuff made from diazo-naphthaline.*

Produced by the reaction of diazo-naphthaline with the gamma-disulphonic acid of beta-naphthol in alkaline solution. It dyes wool, silk, and other materials a bluish-red shade, and is characterized by its great tendency to crystallize.

332,829—December 22, 1885. H. PRINZ. *Manufacture of beta-naphthylamine sulpho-acid.*

The beta-naphthylamine sulpho-acid obtained by treating the beta-naphthol monosulpho-acid described by Schäfer with ammonia at from 180° to 200° C., by which a reaction exchange of the hydroxyl group with the amido group takes place. It is difficultly soluble in water and forms almost insoluble salts of highly crystallizing properties.

332,830—December 22, 1885. H. PRINZ. *Red coloring matter from beta naphthylamine sulpho-acid.*

Produced by combining beta-naphthol disulpho acid with the diazo combinations of beta-naphthylamine sulpho-acid (No. 332,829). It dissolves in concentrated sulphuric acid with a cherry-red color, and when treated with tin and muriatic acid, it forms beta-naphthylamine sulpho-acid and the disulpho-acids of amido beta-naphthol.

333,034—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Manufacture of color producing acids.*

A new naphtholdisulphonic acid, produced by converting into the diazo compound the naphthylamine sulphonic acid whose sodium salt is not easily soluble in water, and then treating the diazo compound with sulphuric acid. When treated with nitric acid it forms a yellow dyestuff, and it forms dyestuffs with diazo compounds.

333,035—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Coloring matter derived from alpha naphthol disulphonic acid.*

Produced by the reaction of diazo-xylol with the soda salt of alpha-naphthol-disulphonic acid (No. 333,034).

333,036—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Nitro-naphtholsulphonic acid.*

A yellow dyestuff, naphtholmononitromonosulphonic acid: produced by the reaction of a nitro compound of alphanaphtholdisulphonic acid (No. 333,034) with carbonate of potash.

333,037—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Manufacture of dyestuff from naphthol.*

Produced by the reaction of diazoazobenzol with a solution of the sodium salt of alphanaphthol disulphonic acid (No. 333,034).

333,038—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Manufacture of dyestuff from naphthol.*

Produced by the reaction of diazotoluol with a solution of the sodium salt of alphanaphtholdisulphonic acid (No. 333,034).

333,039—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Coloring matter derived from diazobenzol and alphanaphtholdisulphonic acid.*

Produced by the reaction of diazobenzol with a solution of the sodium salt of alpha-naphthol-disulphonic acid (No. 333,034).

333,040—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Alpha-naphtholsulphonic acid.*

Produced by converting into the diazo compound the naphthylaminesulphonic acid whose sodium salt is easily soluble in water, and treating the same in boiling water with a small quantity of sulphuric acid. It produces, with diazobenzol, a bright scarlet dye.

333,041—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Coloring matter derived from diazobenzol and alphanaphthol.*

A bright scarlet dye: produced from the reaction of diazobenzol with a solution of the sodium salt of the new naphthol-monosulphonic acid (No. 333,040).

333,042—December 22, 1885. H. VOLLBRECHT AND C. MENSCHING. *Coloring matter derived from alphanaphthol and diazotoluol.*

Produced by the reaction of diazotoluol-sulphonic acid with the sodium salt of the new naphtholmonosulphonic acid (No. 333,040). It dyes scarlet with a bluish shade.

333,649—January 5, 1886. C. LOWE. *Manufacture of derivatives of aurin.*

The process of manufacturing "rosophenolinesulphonic acid," a conjugated acid red coloring matter, consists in heating aurin, 1 part, with sulphuric acid, 5 parts at from 38° to 100° C., separating the excess of sulphuric acid, and heating the product with an aqueous or alcoholic solution of ammonia.

333,861—January 5, 1886. A. KERN. *Manufacture of soluble methyl-blue from rosaniline.*

"Methyl-blue 8:" produced by the sulphonization of trimethyl triphenyl rosaniline, which results from the action of carbon oxychloride (phosgene) upon methyl diphenylamine.

334,140—January 12, 1886. J. A. VAN WINKLE. *Compound for softening and dyeing broom corn.*

It consists of water, alum, saltpeter, cider vinegar, and diamond dye (green).

334,257—January 12, 1886. C. A. MARTIUS. *Manufacture of archil-red azo colors.*

Process consists in the combination of beta-naphthylamine—monosulpho acid (No. 332,829), with para-diazonitro—benzole.

341,991—May 18, 1886. F. BENDER. *Production of yellow azo coloring matter.*

Produced by the action of diazotized metanitroaniline or its sulpho-acids upon phenylene diamine. It is hardly soluble in cold water, somewhat more so in hot water, but soluble in alcohol, sulphuric and nitric acid.

342,207—May 18, 1886. A. MÜLLER-JACOBS. *Coloring compound.*

A coloring composition, insoluble in water or alcohol and soluble in benzine and similar solvents, formed by compounding the resinate of a metal or alkaline earth and coloring matter or dye soluble in water or alcohol. The resinate is formed by dissolving and mixing at boiling heat colophony or other resins with caustic alkali, and saturating same with sulphate of zinc, aluminum, or other salt of a metal or alkaline earth, and washing out the precipitate, which has the property of uniting with any coloring matter soluble in water or alcohol.

342,432—May 25, 1886. C. DUISBERG. *Blue coloring matter from nitrophenetol.*

Produced by azotizing the diamido-diphenol-diethylester (ether) (diphenetidin) obtained from nitro-phenol-aethylester (ether) (nitrophenetol) by alkaline reduction, and the transformation of the formed hydrazo-diphenol-diaethylester (ether) by means of acids with sodium nitrite, forming the tetrazo-diphenol-diaethylester (ether) and heating it in an organic acid solution with beta naphthylamine-monosulpho acid.

343,793—June 15, 1886. O. BIELSCHOWSKI. *Dyeing cotton fiber.*

Cotton or other textile fibers or fabrics are dyed by steeping in a solution of alpha-naphthylamine, and then slowly adding to said solution an oxidizing aqueous solution of potassium bichromate and sulphuric acid to develop the color on the fiber. Printing is done first with a paste of alpha-naphthylamine, and then with a mucilaginous solution of potassium bichromate.

344,075—June 22, 1886. F. BENDER. *Production of yellow coloring matter.*

Produced by combining diazotized nitro-amido-benzoic acid with metaphenylen-diamine, converting the same into a sodium salt and crystallizing.

344,971—July 6, 1886. C. A. MARTIUS. *Producing mixed azo colors.*

Process consists in combining one molecule of a salt of tetrazo-diphenyl or tetrazo-ditolyl with one molecule of an aromatic amido compound, and combining the product with one molecule of a different aromatic amido compound, or of a phenol compound.

345,901—July 20, 1886. M. HOFFMAN AND A. WEINBERG (*Reissue: 11,598—April 27, 1897*). *Naphthol-black color compound.*

Produced by diazotizing sodium naphthylamine disulphonate, then treating with alpha-naphthylamine chlorhydrate, and converting the product into the diazo-azo compound, which latter is allowed to act upon an alkaline solution of sodium beta-naphthol-alpha-disulphonate (salt R). It produces on the fiber in an acidulated bath dark-blue shades.

346,022—July 20, 1886. H. BULL AND C. L. MÜLLER. *Sulphonated purple dyestuff from benzyldiphenylamine.*

Produced by the sulphonization of the basic derivative resulting from the condensation of tetramethyldiamidobenzophenone with benzyldiphenylamine.

348,483—August 31, 1886. H. VON PERGER. *Production of phenyl-methyl oxy quincine.*

See Group XXIII, Fine Chemicals, Esters.

348,613—September 7, 1886. R. BOHN. *Manufacture of yellow coloring-matter or dyestuff from gallic acid.*

"Galloflavine," produced by the oxidizing action of atmospheric air, or oxygen, upon alkaline solutions of gallic acid, at not exceeding 10° C. It combines with metallic oxides, forming yellow lakes or pigment colors from a greenish to an orange yellow.

348,816—September 7, 1886. H. M. BAKER. *Resorcin blue compound.*

Produced by making a solution of resorcin in a solution of caustic ammonia, adding cuprous ammonio-carbonate or other ammoniacal copper salt, agitating the mixture by a copper plate dipping or moving therein, immersing metallic zinc to precipitate the copper, treating with dilute sulphuric acid, boiling, and filtering. It combines with bases to form lakes, and has the formula $C_{18}H_{12}N_2O_6$.

350,229—October 5, 1886. F. BENDER. *Yellow coloring matter.*

Produced by treating the soda salt of a paranitro toluol sulpho acid with caustic soda lye, reducing the red product of condensation into a hardly soluble amido-sulpho acid, diazotizing the latter, and combining the diazo product with a mixture of phenol and its carbon acids, or only with the one or the other component of said mixture in an alkaline solution. It is fixed on unmordanted cotton with a brilliant yellow shade.

350,230—October 5, 1886. F. BENDER. *Red coloring matter.*

Produced by treating the soda salt of paranitrotoluol mono-sulpho acid by caustic soda lye, reducing the red product of condensation into a hardly soluble amido-sulpho acid, diazotizing the latter, and combining the diazo product with a mixture of hydrochloric salt of beta-naphthylamine and a sodium salt of beta-naphthylamine sulpho acid, or only with the one or the other component of said mixture. It is fixable on cotton without a mordant, giving a purple-like color.

350,468—October 5, 1886. R. SCHMITT AND C. KOLBE. *Manufacture of naptholcarbonic alkaline salts.*

See Group XVIII, Fine Chemicals, Esters.

351,056—October 19, 1886. F. KRÜGER. *Production of betanaphthol-disulpho acids.*

Process consists in introducing betanaphthol, 1 part, into concentrated sulphuric acid, 4 parts, heated to 125° to 135° C., with temperature maintained at 125° to 145° C. during four to five hours, when the thus obtained betanaphthol-disulpho acid is separated by treating its acid or neutral soda or lime salts in aqueous solution with common salt.

352,361—November 9, 1886. C. SCHRAUBE. *Production of acetine-blue colors.*

Produced by mixing induline with or dissolving it in acetine.

353,264—November 23, 1886. C. L. MÜLLER. *Manufacture of sulphonated purple dyestuffs from basic rosaniline.*

Produced from the basic rosaniline derivative resulting from the condensation of tetraethyl-diamido-benzophenone with methyl-diphenylamine, by sulphonization of the same.

353,265—November 23, 1886. C. L. MÜLLER. *Manufacture of sulphonated purple dyestuffs from basic rosaniline.*

Produced from the basic rosaniline derivative resulting from the condensation of tetraethyl-diamido-benzophenone with benzyl-diphenyl-amine, by sulphonization of the same.

353,266—November 23, 1886. C. L. MÜLLER. *Manufacture of sulphonated purple dyestuffs from basic rosaniline.*

Produced from the basic rosaniline derivative resulting from the condensation of diethyl-amido-benzoic acid with methyl-diphenyl-amine, by sulphonization of the same.

354,714—December 21, 1886. C. LOHMANN. *Process of dyeing wool azodiphenylblue.*

Wool and other animal fibrous materials are boiled in an aqueous solution of azodiphenyl blue, extract of logwood, blue vitriol, green vitriol, an alkali bisulphate, and oxalic acid.

354,746—December 21, 1886. L. SCHAD. *Production of coloring matter.*

A bluish black coloring matter produced by the combination of the disulpho-acid of diazo-azo-benzol with para-tolyl-beta-naphthylamine.

355,935—January 11, 1887. T. HOLLIDAY. *Naphthol-dyed fabric.*

The product of process No. 355,933, being the combination of cotton or other fiber with oxide or soap of lead and alpha or beta naphthol, or coloring matter formed with them.

356,672—January 25, 1887. H. VOLLBRECHT AND C. MENSCHING. *Red coloring matter from alpha diazo beta-naphthylamine sulphonic acid.*

"Brilliant red:" produced from the reaction of beta-naphthol with alpha diazonaphthylaline monosulphonic acid.

357,273—February 8, 1887. C. DUISBERG. *Blue coloring matter from tetrazodiphenyl.*

Produced by the action of tetrazo-diphenol-dimethylester (ether) upon the alpha naphthol alpha monosulpho acid. It dyes cotton not mordanted in a boiling bath containing alkali, and develops with phosphate of soda or carbonate of potash into a deep blue, fast to mineral acids.

357,274—February 8, 1887. C. DUISBERG. *Red coloring matter for dyeing by the action of tetrazo dyes with beta-naphthylamine sulpho acid.*

Produced by azotizing the diamido-diphenol-dimethylester (ether) (dianisidin) obtained by alkaline reduction of the nitro-phenol-methylester (ether) (nitroanisol) and transforming the formed hydrazo-diphenol-dimethylester (ether) (hydrazoanisol) by means of acids, with sodium nitrite, forming the tetrazo-diphenol-dimethylester (ether) and heating it in an organic acid solution with beta-naphthylamine-monosulpho acid. The aqueous solution dyes dark blue by the action of strong acids. It dyes unmordanted cotton a bluish red in an alkaline bath containing phosphate of soda or carbonate of potash.

358,865—March 8, 1887. C. A. MARTIUS. *Production of mixed azo coloring matter.*

Mixed azo colors are formed by combining the intermediate product formed first by one molecule of tetrazodiphenyl, or tetrazoditolyl, or tetrazodixylyl and one molecule of an amine, amido-sulpho-acid, amido-carbo-acid, phenol, phenol-sulpho-acid, or phenol-carbo-acid. The reaction of salts of tetrazodiphenyl or tetrazoditolyl upon amines, phenols, sulpho-acids, or carbo-acids at first causes one molecule of the tetrazo compound to combine with one molecule of the amine, phenol, sulpho-acid or carbo-acid. The first product containing still one free diazo group is able to be combined again with the same or another amine, phenol, sulpho-acid or carbo-acid, forming a new azo color.

359,576—March 15, 1887. A. RÖMER. *Manufacture of red coloring matter.*

Produced by first converting alpha-naphthalene-diamine (a reduction compound of alpha-dinitro-naphthalene, fusing at 216° C.) into its tetrazo compound, and afterwards combining one molecule of the tetrazo compound with two molecules of naphthionic acid. It dyes unmordanted vegetable fiber a full and bright red.

360,553—April 5, 1887. F. BENDER. *Production of disulpho-acid of diamidostilbene.*

Produced by treating the soda salt of para-nitro-toluol-sulpho acid with caustic lye, and reducing the red product of condensation with zinc dust in alkaline solution or with protochloride of tin in an acid solution. It is a yellowish powder, hardly soluble in water or spirit, but dissolves easily in alkaline fluids.

360,792—April 5, 1887. F. BENDER AND G. SCHULTZ. *Obtaining diazo colors by means of diamido-stilbene and amido-fluorene.*

The process for producing azo colors, which dye cotton direct from a soap bath, by combining one molecule of the tetrazo compounds of stilbene or fluorene (obtained from diamido-stilbene or diamido-fluorene) with two equal or different molecules of an amine or a phenol, or of a sulphonic or carbonic acid of an amine or a phenol.

361,404—April 19, 1887. P. FRIEDLAENDER. *Combination of tetrazodiphenyl chloride with resorcin.*

The red azo dyestuff produced by subjecting an alkaline solution of resorcin to the action of tetrazo-diphenyl-chloride or tetrazo-ditolyl-chloride. It is fixable without mordants.

362,560—May 10, 1887. A. WEINBERG AND H. SEIBERT. *Production of a new napthylamine-monosulphonic acid.*

A color-producing acid which is a derivative of the new naphthol-monosulphonic acid, obtained by heating sodium alpha-naphthalene-disulphonate with caustic soda to about 200° C. until dioxynaphthalene is formed, when it is treated with an ammonium salt.

362,592—May 10, 1887. E. ULLRICH. *Trimethylethylthionin-blue coloring matter.*

Produced by joint oxidation of para-amido-dimethyl-aniline and ethylmethyl-aniline in presence of a hyposulphite. It is fixed on fiber by tannin and emetic tartar.

362,813—May 10, 1887. F. BAYER. *Yellow-red dyestuff from tetrazo-diphenyl.*

A yellowish-red coloring matter produced by the action of the tetrazo compound of benzidine upon beta-naphthylamine deltamonosulphonic acid. It dyes unmordanted cotton in an alkaline bath, and is distinguished by being easily soluble in hot water.

362,835—May 10, 1887. T. HOLLIDAY. *Process of dyeing.*

Wool or other animal fiber is dyed by impregnating it with metallic mordants and then immersing in a bath containing one or more nitroso compounds of naphthols. The product is also claimed.

363,502—May 24, 1887. F. BAYER. *Manufacture of dyestuffs and coloring matter.*

A bluish-red coloring matter produced by the action of the tetrazo compound of toluidine on beta-naphthylamine deltamonosulphonic acid. It dyes cotton a bluish red in a boiling alkaline or soap bath; color not altered by acetic acid.

364,320—June 7, 1887. E. ULLRICH. *Nitrosophenyl-blue dyestuff.*

Prepared by the action of paranitroso-phenyltolylamine upon phenols or oxycarbonic acids. The paranitroso-phenyltolylamine is prepared from phenyltolyl-nitrosoamine by treatment with alcoholic hydrochloric acid. It is fixed on the fiber by chrome or iron mordants under addition of acetate of lime. It dyes a greenish-blue shade.

365,409—June 28, 1887. J. ROHNER. *Production of new coloring matter.*

Brown, reddish-brown, and brownish-violet coloring matters: produced by the action of metaphenylenediamine and metatoluylenediamine upon amidoazobenzole or amidoazo-toluol, or amidoazo-xylol, or amidoazo-anisol. They dye directly unmordanted cotton.

365,666—June 28, 1887. P. BÖTTIGER. *Manufacture of new red dyestuffs or coloring matters.*

Process consists in combining the salts of tetrazodiphenyl with alpha or beta-naphthylamines, and then treating the thus-formed dyestuffs with concentrated sulphuric acid, anhydrous sulphuric acid, or mono chlorhydrine, whereby the mono or disulpho acids of said dyestuffs, or the salts of said acids, are obtained.

365,667—June 28, 1887. P. BÖTTIGER. *Combination of the salts of tetrazodiphenyl and the naphthylamines.*

A red dyestuff or coloring matter which results from the sulphonated combination of the salts of tetrazo-diphenyl and the naphthylamines.

366,078—July 5, 1887. C. DUISBERG. *Manufacture of dyestuffs or coloring matters.*

A blue azo coloring matter produced by the action of tetrazo-ditolyl upon the monosulpho-acid of the alpha-naphthol which is obtained by sulphonizing alpha-naphthol, or by the decomposition of the alpha-diazo-naphthylamine sulpho-acid (diazotized naphthionic acid) by boiling.

366,356—July 12, 1887. E. ULLRICH. *Blue coloring matter formed by the action of paranitroso-diphenylamines on phenols or oxycarbonic acids.*

A blue coloring matter or dyestuff produced by the action of paranitroso-diphenylamine on phenols or oxycarbonic acid. In dyeing and in printing it is fixed on the fiber by chrome or iron mordants, with the addition of acetate of lime.

366,357—July 12, 1887. E. ULLRICH. *Blue coloring matter formed from paranitroso-methyldiphenylamine on phenols or oxycarbonic acids.*

A blue coloring matter or dyestuff prepared by the action of paranitroso-methyldiphenylamine on phenols or oxycarbonic acid. In dyeing and in printing it is fixed on fiber by chrome or iron mordants, with the addition of acetate of lime.

366,639—July 12, 1887. E. ULLRICH. *Production of dimethyldiethylthionin-blue.*

Produced by joint oxidation of paramido-dimethylaniline and diethylaniline in presence of a hyposulphite, or of paramido-diethylaniline and dimethylaniline in presence of hyposulphite. The coloring matter is fixed on the fiber by means of tannin and emetic tartar.

366,640—July 12, 1887. E. ULLRICH. *Production of diethylmethylthionin blue.*

Produced by joint oxidation of paramido-diethylaniline and monomethylaniline in presence of a hyposulphite.

368,054—August 9, 1887. R. BOHN. *Manufacture of soluble naphthazarin.*

"Soluble naphthazarin" (dioxynaphthaquinone): produced by digesting a mixture of naphthazarin in a solution of sodium bisulphite in a closed vessel at from 50° to 70° C. for about eight days. It is soluble in water and characterized by extreme stability in the presence of acids.

368,716—August 23, 1887. E. GREPPIN. *Process for the production of blue coloring matter.*

Blue coloring matters of unsymmetrical structure, produced by the oxidation of a mixture of paramido-dimethylaniline or the derivatives of diethylaniline, dimethylaniline, dimethyl-orthotoluidine, methylethyl-orthotoluidine, and paraphenylendiamine or paratoluylendiamine (paradiamidotoluol) in the presence of hydrogen sulphide in acid solution.

369,764—September 13, 1887. J. ANNAHEIM. *Manufacture of blue coloring matter.*

Products for the manufacture of coloring matters are produced by treating a mixture of bioxynaphthalene and aniline, or one of the homologues of the latter, with a condensing agent, and freeing the product of condensation. Coloring matters are obtained by treating such products of condensation directly with nitroso combinations of the tertiary aromatic amines, or by reducing the nitroso combinations and oxidizing the resulting diamine and the product of condensation.

374,259—December 6, 1887. A. LIEBMANN. *Monosulpho-acid of alpha-naphthol.*

Produced by mixing alpha-naphthol, 1 part, with 4 parts of concentrated sulphuric acid, 170° to 185° C., and heating for about an hour at 180° C. The mixture of sulpho-acids is converted into their barium salts, treated with gaseous hydrochloric acid, and the barium salt crystallized out. The new sulpho-acid does not, on nitration, lose its sulpho group; but yields, with nitric acid, dinitro-sulpho-alpha-naphthol. It forms dyestuffs with diazo compounds.

375,848—January 3, 1888. A. WEINBERG AND H. SEIBERT. *Manufacture of dyestuffs.*

A coloring matter produced by the action of tetrazo-ditolyl upon the naphthylamine sulphonic acid of No. 362,560. It dyes unmordanted cotton a bluish red similar to saffranine.

375,930—January 3, 1888. P. FRIEDLAENDER AND B. PRIEBS. *Production of orange azo dyestuffs.*

Produced by adding a solution of metatoluylenediamine sulpho-acid to a solution of tetrazo-ditolylchloride prepared from tolidine sulphate, and afterwards adding a solution of salicylic acid. It has a striking affinity for raw cotton fiber, dyeing without a mordant.

376,392—January 10, 1888. A. MYLINS. *Production of a new red azo color.*

Process consists in mixing nitro-aniline with water acidulated with sulphuric acid; diazotizing by adding sodium nitrate; mixing therewith, with agitation, alpha naphthylamine disulphonate of sodium; filtering, and saturating with sodium carbonate, and drying.

377,349—January 31, 1888. M. CERESOLE. *Production of new red coloring matter.*

Tetramethyl-rhodamine: produced by the condensation of one molecule of phthalic anhydride or its halogen substitution products, with two molecules of dimethyl-meta-amidophenol or of its alkyl derivatives; dyes in pure tints from pink to crimson.

377,350—January 31, 1888. M. CERESOLE. *Production of new red coloring matter.*

Tetraethyl-rhodamine: produced by the condensation of one molecule of phthalic anhydride, or of its halogen substitution products, with two molecules of diethyl-meta-amidophenol, or of its alkyl derivatives. It dyes in pure tints from pink to crimson.

379,150—March 6, 1888. R. BOHN. *Dyeing animal textile fabrics with naphthazarin.*

Chrome lakes of naphthazarin are produced within or upon textile fibers by exposing said fibers to the action of chromium mordants and naphthazarin in dyeing. The shades vary from a black to a delicate gray or slate color.

380,067—March 27, 1888. A. WEINBERG. *Production of new diamido compounds and of azo colors produced therefrom.*

Process consists in combining the ethers of the tetrazo-oxy-diphenyl and of the tetrazo-oxy-phenyl-tolyl with two equal or different molecules of an amine or of a phenol, or of a sulphonic or carbonic acid of an amine or of a phenol.

380,098—March 27, 1888. T. DIEHL. *Coloring matter from the sulpho-acids of ethyl or diphenylamine combined with tetrazo-diphenyl or tetrazoditolyl.*

Substantive cotton coloring matters, produced by the action of one molecule of tetrazo salt upon two molecules of the sulpho-acids of monoethylaniline or diphenylamine. They may be subsequently combined with phenols, salicylic acids, phenol-sulpho-acids, the sulpho-acids of alpha and beta naphthol, or of alpha and beta naphthylamine.

380,402—April 3, 1888. L. PAUL. *Production of disulpho and dicarbo acids of the diamidoazo-benzidines.*

It consists in the processes for producing mono and diamidoazo-benzidines, transformation of them into tetrazo compounds, and their combination with amines and phenols, or the sulpho-acids of these bodies, and in the colors produced therefrom. Coloring matters are produced by the combination of (a) tetrazo-diphenyl, tetrazo-ditolyl, tetrazo-dixylyl; (b) tetrazo-diphenyl-dicarbon acid and its ethers; (c) tetrazo compounds of the ethers of diamido-diphenol; (d) tetrazo-fluorene, tetrazo-stilbene, or the sulpho-acids of these bodies, with two molecules of aniline, toluidine, xylidine, and cumidine, or their sulpho acids.

380,403—April 3, 1888. L. PAUL. *Production of disulpho and dicarbo acids of the diamidoazo-benzidines.*

It consists in tetrazotizing benzidine, tolidine and diamido-dixylyl, and the combination of the thus obtained tetrazo compounds with one or two molecules of meta or para amido benzol sulpho-acid, or ortho, meta, or para amido-benzoic acid, or the sulpho-acids of ortho or para toluidine or xylidine in alcoholic solution, and the products thereof.

380,927—April 10, 1888. A. F. POIRRIER AND D. A. ROSENSTIEHL. *Production of azo colors.*

Produced by reducing in an alkaline medium nitro-aromatic amines, particularly metanitraniline, the isomeric nitro toluidines fusible at 107° C. and 78° C., and nitro xylidine fusible at 123° C. and combining the polyazo derivatives of these reduction products with the phenols, the oxyphenols, the naphthols, the oxynaphthols, the primary, secondary, and tertiary amines, the diamines, and also the alkyl, sulpho, and carboxyl derivatives of all these bodies.

380,928—April 10, 1888. A. F. POIRRIER AND Z. ROUSSIN. *Production of diazoic coloring matters.*

Produced by the reaction of the nitrodiazo benzols, toluols, xylols, etc., with the isomers and homologues of alpha-naphthylamine sulpho, especially the naphthionic acid of Witt.

381,045—April 10, 1888. O. N. WITT. *Manufacture of purple-black azo dyestuff.*

Produced by transforming assymmetrical binitro-aniline (m. p. 180° C.) into its diazo derivative, and treating same with sodium beta-naphthylamine monosulphate (Brönner's modification) and sodic acetate.

381,046—April 10, 1888. O. N. WITT. *Purple azo dyestuff.*

Produced by transforming assymmetrical binitro-aniline (m. p. 180° C.) into its diazo derivative, and treating same with sodium beta-naphthylamine disulphonate, such as may be obtained by heating beta-naphthol disulphonate acid (R) with caustic ammonia under pressure, and sodic acetate.

381,132—April 17, 1888. E. HASSENKAMP. *Production of blue-red azo dyestuff by the action of tetrazo-ditolyl salts on beta-naphthylamine monosulpho acid.*

Produced by the action of tetrazo-ditolyl salts of the alkylated derivatives of beta-naphthylamine monosulpho-acid. It dyes unmordanted cotton bluish red, fast to diluted acids.

381,471—April 17, 1888. E. HASSENKAMP. *Process of producing blue-red coloring matter.*

It consists in combining salts of the tetrazo compound of paradiamines or their sulphonic or carbonic acids with the alky-naphthylamine sulphonic acids.

382,832—May 15, 1888. C. RUDOLPH. *Production of yellow coloring matter.*

"Benzoflavine:" produced from benzaldehyde and toluylen or phenyl-diamine by first condensing benzaldehyde with the said diamines, heating the tetra-amines thus formed with bodies capable of separating ammonia, and then oxidizing the products (the hydro-phenylacridines).

384,315—July 12, 1888. M. HERZBERG. *Manufacture of dyestuffs.*

Brown dyestuffs are produced by combining the salts of diazo compounds of aniline, toluidine, xylidine, cumidine, and the nitro-derivatives of the same, amidoazo-benzol, amidoazo-toluol, amidoazo-xylol, alpha and beta naphthylamine, or their sulpho and carbo acids, and tetrazo compounds of benzidine, benzidine-sulpho, toluidine, diamido-stilbene, or their sulpho or carbo acids, with Bismarck brown (triamidoazo-benzol or triamidoazo-toluol). Insoluble colors are rendered soluble by sulphonation.

384,316—June 12, 1888. M. HERZBERG. *Manufacture of dyestuffs.*

A brown coloring matter, produced by the action of diazo compound of naphthylamine sulpho-acid on Bismarck brown (triamidoazo-benzol or triamidoazo-toluol).

384,342—June 12, 1888. R. G. WILLIAMS. *New coloring matter obtained by the action of tetrazo-diamido benzole on phenols.*

Produced by the action of tetrazo-diamido benzole (hydrochlorate) or its homologues on resorcin, the phenols, benzoic, the oxybenzoic acids, and alpha-naphthol, or their substitution products, on aniline and its homologues, beta-naphthol and the naphthylamines, or their substitution products, and on the sulpho-acids of the above amines, amides, and phenols, or their substitution products.

384,480—June 12, 1888. E. ULLRICH. *Production of blue coloring matter.*

Process of producing methylene-blue by subjecting a solution containing paramido-dimethylaniline, hydrochlorate of dimethylaniline, and sodium hyposulphite to the action of an oxidizing agent, as bichromate, with heat.

386,192—July 17, 1888. S. FOREL. *Obtaining oxyazoic coloring matter from tetrazo diphenyl and ditolyl.*

Produced by the action of tetrazo-ditolyl on phenol, or of tetrazo-diphenyl and tetrazo-ditolyl on phenol and orthocresylol in alkaline solution. It yields a bright yellow on vegetable fiber in an alkali or soap bath.

386,709—July 24, 1888. W. KELBE. *Production of coloring substances by the reaction of aromatic hydrazin sulphonic acids on retenchinon.*

A red coloring matter, characterized by great fastness: produced by the condensation of an aromatic hydrazin sulphonic acid with retenchinon.

387,097—July 31, 1888. P. MONNET. *Dyeing colors by the simultaneous oxidation of diamines and monamines.*

Colors or tints—as blacks, more or less brown or blue—are produced directly upon the materials by the oxidation of a mixture of a salt of a simple diamine—as the chlorohydrate of paraphenylene-diamine—and the salt of a simple monamine, as the chlorohydrate of aniline.

388,185—August 21, 1888. C. DUISBERG. *Blue azo coloring matter.*

Produced by the action of tetrazo-diphenol-diethyl ether upon the alpha-naphthyl alpha-monosulpho acid, which is obtained by sulphonizing alpha-naphthol or by the decomposition of the alpha-diazonaphthylamine sulpho-acid by boiling. It dyes unmordanted cotton in a boiling alkaline bath a fast deep blue, more red than the homologous product of No. 357,273.

389,127—September 4, 1888. H. WOLFF. *Production of new azo colors.*

Produced by diazotizing nitrodiamidotriphenyl-methane or its sulpho-conjugations, and combining with an aromatic amido or diamido compound, phenols, or their sulpho-conjugations.

390,842—October 9, 1888. B. F. CRESSON. *Dyeing aniline black.*

An aniline-black coloring solution is formed by dissolving and mixing in water, chlorate of potash, sal ammoniac, sulphate of copper, nitrate of iron and tragacanth gum, and forming another liquor of aniline oil, muriatic acid, tartaric acid and water, and then mixing the liquors.

392,723—November 13, 1888. E. ELSAESSER. *Blue coloring matter obtained from paraphenylen-diamine, etc.*

Derived from paraphenylene-diamine and hydrochlorate of amidoazo-benzole or its equivalents (hydrochlorate of phenyl-amidoazo-benzole, amidoazo-benzole-monosulpho-acid, or phenyl-amidoazo-benzol-monosulpho acid). It is soluble in cold and hot water.

394,425—December 11, 1888. R. G. WILLIAMS. *Action of salts of tetrazo-ditolyl or diphenyl on dihydroxides of toluene or their sulpho-acids.*

Red coloring matters, dyeing unmordanted cotton in an alkaline bath: formed by the action of a salt of tetrazo-diphenyl or tetrazo-ditolyl, or the sulpho-acids of a salt of tetrazo-diphenyl or tetrazo-ditolyl on the dihydroxides of tolueue, or the sulpho-acids of the same.

394,841—December 18, 1888. C. DUISBERG. *Manufacturing of coloring matters.*

A yellow coloring matter produced by the action of tetrazo compound of benzidine, tolidine or diamidodiphenolether upon cresol carbonic acid.

395,080—December 25, 1888. C. RUDOLPH. *Coloring matter.*

An amidobenzoflavine dyestuff produced from amidoditolylphenylmethan, by transforming the nitrotetraamidoditolylphenylmethan into pentaamidoditolylphenylmethan, then into hydrotriamidodimethylphenylacridine, and finally into the amidobenzoflavine. Cotton mordanted with tannic acid is dyed a greenish yellow.

395,115—December 25, 1888. F. BENDER. *Production of coloring matter.*

A fast yellow coloring matter obtained from paranitrotoluol-sulpho-acid by treating the unstable yellow dyestuff of No. 350,229 with chlorinating, brominating, nitrating, or alkylating agents. When treated with soda-lye it is not changed in color to red.

395,300—December 25, 1888. A. WEINBERG. *Blue coloring matter from nitroso derivatives upon phenylene-diamines.*

A class of blue coloring matters produced by the action of paranitroso derivatives of secondary and tertiary amines upon diphenylmetaphenylendiamine, ditolylmetaphenylendiamine, or dixylylmetaphenylendiamine.

395,474—January 1, 1889. F. BAYER. *Manufacture of dyestuffs or coloring matters.*

Process of producing red azo colors consists in combining betanaphthylaminedeltasulpho acid with the group of tetrazo compounds of paradiamines, such as tetrazodiphenyl, tetrazoditolyl, tetrazodiphenylether, tetrazostilben, or their sulphonic acids.

395,634—January 1, 1889. C. RUDOLPH AND B. PRIEBS. *Orange azo dyestuff.*

Produced from tolidin by diazotation and subsequent heating with cresotin acid and toluylendiaminesulpho-acid. It easily dissolves in hot water, and the solution in concentrated sulphuric acid is violet red.

396,293—July 15, 1889. C. RUDOLPH. *Tetrazo dyestuff.*

Blue-black tetrazo dyestuff produced from the sulpho-acids of the amido cresols by their combination with naphthylamine, the diazotation of the compound thus formed, and its combination with naphtholdisulpho acid.

396,294—January 15, 1889. C. RUDOLPH AND B. PRIEBS. *Yellow coloring matter.*

Produced by the action of tetrazodiphenyl or ditolyl chloride upon one molecule of beta cresotinic acid and the subsequent treatment of the intermediate body with salicylate of soda.

396,417—January 22, 1889. S. M. NEVILLE. *Dye.*

A coloring composition, insoluble in water and alcohol and soluble in benzine, turpentine, and similar solvents: consisting, essentially, of common soap dissolved in water, coloring matter—as aniline colors such as will dissolve in liquid soap—and sulphate of zinc.

396,527—January 22, 1889. F. BENDER. *Production of coloring matter.*

Produced by the action of caustic alkalis upon paranitrotoluol sulpho acid in presence of water, alcohol, or glycerine with an oxidable substance, of mineral or organic nature. It dyes unmordanted cotton in fast shades, depending upon the nature of the oxidable agent employed.

396,574—January 22, 1889. A. KERN. *Formation of purple coloring matter.*

A purple coloring matter, $C_{16}H_{14}N_2O_5HCl$, obtained from the methylic ether of gallic acid and hydrochloric nitroso-dimethylaniline.

396,692—January 22, 1889. G. GRÜN. *Printing of induline dyestuffs.*

Process consists in mixing the induline paste with the formylethers of glycerine (obtained by heating oxalic acid with glycerine to 110° C. until the development of carbonic acid begins).

398,990—March 5, 1889, J. WALTER. *Process of making a yellow dye.*

Sulphuric acid is added to an aqueous solution of sodium salt of thioparatoluidine sulphonic acid, the precipitate cooled with ice, a solution of sodium nitrate gradually added, the diazo solution poured into an alkaline solution of salicylic acid containing enough caustic soda to saturate the acids, and the mixture boiled and the color precipitated with salt.

401,024—April 9, 1889. E. FRANK. *Yellow dye.*

Produced by the action of tetrazo-ditolyl upon salicylic acid. It dyes cotton a more reddish yellow than the homologous product (No. 329,638) of benzidine.

401,483—April 16, 1889. T. DIEHL. *Crimson dye.*

Process consists in first combining one molecule of beta-phenylnaphthylamine monosulpho acid with one molecule of a tetrazo salt. The obtained product is afterwards subjected to the action of phenols, amines, or other sulpho or carbon acids. Unmordanted cotton is dyed direct.

401,633—April 16, 1889. R. BOHN. *Alizarine-blue green.*

Produced by the successive action of sulphuric anhydride and of alkalis or mineral acids upon alizarine blue.

401,634—April 16, 1889. R. BOHN. *Carbazol-yellow.*

Produced by the combination of one molecule of tetrazo-carbazol with two molecules of salicylic acid. It dyes cotton without mordants, and dyes animal fiber in a neutral or acidified bath.

401,635—April 16, 1889. R. BOHN. *Alizarine-green sulpho-acid.*

Produced by the action of moderately-strong fuming sulphuric acid at 130° to 135° C. upon alizarine green. It corresponds in chemical constitution and behavior to a true and staple sulphonated derivative of alizarine green. It dyes chrome-mordanted wool green shades.

402,436—April 30, 1889. R. GNEHM. *Red carbon color.*

Obtained from succinic acid and diethylmetaamidophenol. It dyes wool, silk, and mordanted cotton a brilliant red with yellow fluorescence.

402,980—May 7, 1889. J. SCHMID. *Azo dye.*

Azo bodies produced by the combination of alphadiazonaphthaline with metaamidophenol or its dialkylized derivatives. They possess the same properties as the azo bodies obtained from metaamidophenol.

404,097—May 28, 1889. A. LIEBMANN. *Production of yellow coloring matter.*

Produced by treating a diazo compound of primuline (polychromineate) with an alkaline solution of beta-naphthol, producing an insoluble compound, which is rendered soluble by treating with bisulphite of soda.

404,193—May 28, 1889. J. HAHN. *Process of dissolving aniline colors.*

Aniline is directly united with vegetable oil by dissolving aniline in hot water, adding part of the solution to oil, boiling the mixture, adding the remainder to the boiling oil, and stirring the mixture until the water has evaporated.

404,309—May 28, 1889. J. SCHMID. *Blue azo dye.*

Obtained by subjecting the dialkylized azonaphthalene-metaamido-phenol to the action of a reducing agent and subsequent treatment with an oxidizing agent.

404,331—May 28, 1889. R. GREVILLE-WILLIAMS. *Compound orcine dye.*

Produced by combining one molecule of tetrazo-diphenyl or tetrazo-ditolyl or their sulpho-acids with first one molecule of naphthylamine, or its known sulpho-acids; and then combining this intermediate product with one molecule of orcine or sulpho-acids of the same. The colors are faster against light than No. 394,425.

405,938—June 25, 1889. M. ANDRESSEN. *Naphthol-disulphonic acid.*

A new alpha-naphthol-disulphonic acid obtained by first forming naphthalene-disulphonic acid by treating naphthalene with sulphuric acid and monochlehydrin, or with fuming sulphuric acid, then treating with nitric acid, reducing the alpha-nitro-naphthalene-disulphonic acid to alpha-amido-naphthalene-disulphonic acid, and separating and converting into the corresponding alpha-naphthol-disulphonic acid. It acts upon the diazo compounds of diphenyl, ditolyl, stilbene, etc.

406,669—July 9, 1889. T. SANDMEYER. *Red color.*

Red to violet colors produced by boiling ortho-toluidine with caustic soda and gradually adding nitro-benzene, reducing with zinc powder, treating with concentrated muriatic acid, boiling, diluting, and filtering, when Glauber's salt is added to precipitate the sulphate, and the paste is mixed with muriatic acid, cooled and diazotized, and the product is treated with a solution of soda and naphthionate of sodium, heated, and the color precipitated.

406,670—July 9, 1889. T. SANDMEYER. *Yellow color.*

Produced by boiling ortho-toluidine with caustic soda and gradually adding nitro-benzene, reducing with powdered zinc, treating with muriatic acid, boiling, diluting, and filtering, when Glauber's salt is added, the product is diazotized, poured into a solution of caustic soda, soda, and salicylic acid, heated, and the color precipitated. It dyes unmordanted cotton.

406,952—July 16, 1889. W. PFITZINGER. *Thioparatoluidine.*

A new thioparatoluidine: produced by melting paratoluidine and sulphur to 180° to 220° C. and then to 250° C., and purifying the product. It is infusible at 220° C., nearly insoluble in boiling alcohol and concentrated hydrocholoric acid, and combines with fuming sulphuric acid to form a new sulphonic acid, the soda salt of which dyes unmordanted cotton yellow in an alkaline bath.

407,906—July 30, 1889. B. R. SEIFERT. *Process of making paraoxybenzoic acid.*

See Group I, Acids, Other Organic.

409,384—August 20, 1889. C. S. BEDFORD. *Compound dye.*

A coloring matter consisting of the active principle of fustic dyewood with a diazo compound, produced by treating an aqueous extract of fustic dyewood with a slightly acid solution of a salt of diazo-benzene, diazo-toluene, diazo-xylene or diazo-naphthalene, adding the requisite quantity of alkali, and separating the coloring matter.

409,822—August 27, 1889. J. BRACEWELL. *Aniline black.*

Formed of ferrocyanide of soda, chlorate of potash, and aniline salts prepared so as to be free of hydrochloric acid; that is to say, with the ferrocyanide in amount sufficient to take up the aniline and the chlorate in quantity not less than 35 per cent of that of the aniline, and thereby prevent the formation of chlorate of aniline in injurious quantity in the color.

410,057—August 27, 1889. R. GREVILLE-WILLIAMS. *Process of making orcine dye.*

It consists in combining one molecule of any alkalized orcine—as the mono, di, or tri methyl, ethyl, amyl, or acetyl orcines—or one molecule of a sulpho-acid of an alkalized orcine with the intermediate product formed by combining one molecule of tetrazo-diphenyl, or one molecule of any of the other tetrazo compounds of dixylyl, stilbene, fluorine of naphthalene or their sulpho acids, with one molecule of one of the sulpho-acids of naphthylamine. They dye unmordanted cotton in an alkaline or soap bath.

410,058—August 27, 1889. R. GREVILLE-WILLIAMS. *Process of making orcine dyes.*

It consists in combining one molecule of a compound formed by combining orcine with sodium chloride, with the intermediate product formed by combining one molecule of a tetrazo compound of diphenyl, ditolyl, dixylyl, stilbene, fluorene, or naphthalene or their sulpho acids, with one molecule of one of the sulpho-acids of naphthylamine.

410,295—September 3, 1889. R. SCHMITT. *Process of making beta-naphthol carbon acid.*

Beta-naphthol carbon acid of a m. p. 216° C. is produced by the reaction of carbonic acid upon the alkaline salts of the beta-naphthol under pressure and at 200° to 250° C.

410,733—September 10, 1889. R. GEIGY. *Process of making a violet dye.*

Twenty kilos of gallamide is heated with 30 kilos of the chlorhydrate of nitroso-dimethylaniline in a solution of acetic acid.

410,739—September 10, 1889. T. SANDMEYER. *Process of making aurin derivatives.*

Salicylic acid, 2 parts, dissolved in concentrated sulphuric acid, 15 parts, and methyl alcohol, 4 parts, is heated to 70° C., after which 1½ parts of sodium nitrate is added, and then poured into water by which the product is precipitated. It is then washed, saturated with an alkali, and dried. It dissolves in caustic soda with brown, and in ammonia with red color. Oxides of metals form lakes; chromine lake of a red violet tint

411,149—September 17, 1889. D. E. HUGUENIN. *Blue dye.*

A compound dye consisting of indigo and indophenol.

412,148—October 1, 1889. R. GREVILLE-WILLIAMS. *Process of making dyes.*

It consists in combining one molecule of a tetrazo compound (tetrazo diphenyl and its homologues, tetrazo naphthalene, tetrazo-stilbene, tetrazo-fluorene, tetrazo-diphenol ether, tetrazo azo benzole and its homologues, tetrazo oxydiphenyl, and the alkylized compounds or the sulpho or carbo acids of the same) with two molecules of an alkylized acid of the orchilla lichens or halogen or sulpho compounds of the same. They dye unmordanted cotton in an alkaline or soap bath.

412,149—October 1, 1889. R. GREVILLE-WILLIAMS. *Process of making dyes.*

Mixed coloring matters produced by first combining one molecule of a tetrazo compound (No. 412,148) with one molecule of one of the amines or phenols (the sulpho-acids of the naphthylamines, the naphthols, monoethylaniline, diphenylamine, salicylic acid) and then combining this intermediate product with one molecule of an alkylized acid of the orchilla lichen or halogen or sulpho compound of the same

412,550—October 8, 1889. A. WEINBERG. *Azo coloring matter.*

Produced by the action of diazo derivatives of compounds obtained from naphthylamine and diazo-sulphonic acids upon alpha or beta naphthylamine. It gives dark-blue shades in an acidulated bath, and differs from naphthol-black—No. 45,901—by the presence of the amide group, and by its greater intensity and resistance to washing and milling.

412,613—October 8, 1889. A. HERRMANN. (*Reissue: 11,077—May 20, 1890.*) *Coloring matter.*

A blue-green coloring matter, the sulphonic acid of metaoxytetralkyldiamidotriphenyl carbinol, produced by dissolving meta-amido-tetralkyldiamidotriphenyl methane in a mineral acid, diazotizing by a nitrous acid or a nitrite, decomposing by boiling with water, precipitating with soda or sulphate, and boiling the resulting oxy leuco base with water until it becomes neutral, sulphonating by heating with concentrated or fuming sulphonic acid, and oxidizing with peroxide of lead or similar agent. It is characterized by great resistance to the action of alkalis.

412,614—October 8, 1889. A. HERRMANN. (*Reissue: 11,078—May 20, 1890.*) *Coloring matter.*

A blue green coloring matter, the sulphonic acid of meta-amidotetralkyldiamidotriphenyl carbinol, produced by dissolving meta-amidotetralkyldiamidotriphenyl methane in fuming sulphuric acid, heating until a sample gives a clear solution with cold ammonia, converting the product into the calcium or sodium salt, oxidizing the leuco sulphonic compound thus obtained with peroxide of lead or manganese and dilute sulphuric acid, filtering and evaporating to dryness.

412,615—October 8, 1889. A. HERRMANN. *Coloring matter.*

A fast green-blue coloring matter obtained from the etherized compounds of metaoxytetralkyldiamidotriphenyl methane or metamethyoxy or metaethyoxy tetralkyldiamidotriphenyl carbinol.

412,978—October 15, 1889. J. ROSENHEK. *Production of yellow dyestuffs.*

"Thioflavine T," obtained by introducing alcohol radicals into the primary thionated bases from paratoluidine and xylidine, and which as chlorhydrate is soluble in water, alcohol, and diluted acid. It dyes mordanted cotton a bright yellow.

412,979—October 15, 1889. J. ROSENHEK. *Production of yellow coloring matter.*

Obtained by sulphonating thio bases from paratoluidine and xylidine.

413,048—October 15, 1889. R. GNEHM AND J. SCHMID. *Violet coloring matter.*

Monophenylmeta-amidophenolphthaleine, produced by melting two molecules of metaoxydiphenylamine with one molecule of phthalic-acid anhydride in the presence of a condensing agent, as zinc chloride, at 160° to 170° C.

413,049—October 15, 1889. R. GNEHM AND J. SCHMID. *Blue coloring matter.*

Phenylmeta-amidophenoldichlorphthaleine, produced by the reaction of dichlorophthalic acid on metaoxydiphenylamine in the presence of a condensing agent, as zinc chloride, at 170° to 200° C.

413,050—October 15, 1889. R. GNEHM AND J. SCHMID. *Gray coloring matter.*

Phenylmeta-amidophenoltetrachlorphthaleine, a dark green powder, produced by the reaction of tetrachlorophthalic acid on metaoxydiphenylamine in the presence of a condensing agent, as zinc chloride, at 180° to 210° C.

413,562—October 22, 1889. A. SARAUW. *Production of azo coloring matter.*

The process consists in reacting with a salt of the nitroso derivatives of the tertiary amines, more especially nitroso-dimethyl-aniline, upon a bioxynaphthaline whose boiling point is above 186° C., in the presence of heat and a suitable solvent. The coloring matter ranges from violet-blue to blue.

413,724—October 29, 1889. H. D. KENDALL. *Brown dye.*

A fast-brown coloring matter produced by treating dinitroso-resorcin (Alsace green) or its homologues with a hydrosulphite.

415,088—November 12, 1889. R. BOHN. *Trioxybenzophenone.*

Produced by the condensation of equal molecules of pyrogallol and benzoic acid. It combines with metallic mordants; gives fast yellow shades with alumina, and brown shades with iron and chrome mordants. M. p. 137° to 138° C.

415,257—November 19, 1889. M. ULRICH. *Process of making dioxynaphthalene monosulpho-acid.*

The process consists in melting the beta-naphthol alpha disulpho acid (the so-called "R" salt) or the beta-naphthol beta or gamma disulpho acid (the so-called "G" acid) with caustic alkali at above 200° C.

415,258—November 19, 1889. M. ULRICH. *Azo-blue color.*

Produced by the action of tetrazo-diphenol ether upon the dioxynaphthalene monosulpho acid gained by melting beta-naphthol beta or gamma disulpho acid with caustic alkali.

415,559—November 19, 1889. E. ELSAESSER. *Process of making paratoluidine sulpho-acid.*

The process of producing yellow dyestuffs from paratoluidine consists in extracting the soluble parts of crude dithioparatoluidine with alcohol, filtering and converting the residuum into a sulpho-acid by agitating it with fuming sulphuric acid containing sulphuric anhydride.

416,055—November 26, 1889. G. DÄNLIKER AND H. A. BERNTHSEN. *Manufacture of toluidine blue.*

Produced by converting dimethylaniline into nitroso, then into paramidodimethylaniline, submitting this diamine, in mixture with sodium hyposulphite, to an oxidizing agent to transform it into paramido-dimethylanilinethiosulphonic acid, then producing by addition of orthotoluidine and an oxidizing agent a green indamine ($C_{15}H_{17}N_3S_2O_3$) and finally converting this into toluidine blue by heating it with zinc chloride in the presence of an oxidizing agent. It is a redder tint than methylene blue.

416,145—November 26, 1889. R. GREVILLE-WILLIAMS. (*Reissue: 11,178—July 21, 1891.*) *Process of making azo dyes.*

Produced by combining one molecule of a tetrazo compound (tetrazo-diphenyl and its homologues, tetrazo-naphthalene, tetrazo-stilbene, tetrazo-fluorine, tetrazo-diphenolether, tetrazo-benzole and its homologues tetrazo-oxy-diphenyl as well as the alkylized compounds, or the carbo or sulpho acids of the same) with one molecule of naphthalene-azo-naphthylamine or its sulpho compounds, and afterwards acting on the intermediate body thus formed with one molecule of one of the naphthylamines or sulpho-acids of the same. The process may be reversed.

417,207—December 10, 1889. R. GREVILLE-WILLIAMS. (*Reissue: 11,179—July 21, 1891.*) *Process of making azo dyes.*

Red substantive azo coloring matters produced by combining one molecule of a tetrazo body (No. 416,145) with one molecule of an amine (the amines and phenols are, first, aniline and its homologues, the naphthylamines, diphenylamine and its homologues; second, the alkylized products of these amines; third, sulpho-acids of one and two; fourth, carbolic acid and its homologues; fifth, resorcin and its homologues; and sixth, sulpho-acids of four and five), then combining a molecule of an azotized amine with the thus produced intermediate product, and afterwards reacting on the resulting secondary intermediate with one molecule of one of the amines or phenols.

417,294—December 17, 1889. M. ULRICH. *Azo dye.*

Produced by the action of tetrazo-diphenol ether upon the dioxynaphthalene monosulpho-acid obtained by melting "alpha-naphthol alpha-disulpho-acid S" with caustic alkali. It dyes unmordanted cotton in a boiling soap bath a clear greenish blue.

417,295—December 17, 1889. M. ULRICH. *Azo dye.*

Produced by the action of tetrazo-diphenyl salts from benzidine upon the dioxynaphthalene monosulpho-acid obtained by melting "alpha-naphthol alpha-disulpho acid S" with caustic alkali. It dyes unmordanted cotton in a soap bath a fast reddish blue.

417,296—December 17, 1889. M. ULRICH. *Azo dye.*

Produced by the action of orthotetrazoditolyl salts upon the dioxynapthalene mono-sulpho-acid obtained by melting "alpha-naphthol alpha-disulpho-acid S" with caustic alkali. It dyes unmordanted cotton in an alkaline bath a fast, clear blue.

418,153—December 31, 1889. F. BAYER. *Process of fixing azo dyes.*

Goods of animal or vegetable fibers which have been dyed or printed in the usual way with the substantive cotton coloring matters, are boiled with a solution of a metallic salt, and the metals fixed by the coloring matters in the form of a fixed lac.

418,657—December 31, 1889. G. SCHULTZ. *Production of orange and red dyestuffs.*

The process consists in heating certain amido compounds, such as cumidine or xylidine, with sulphur, treating the sulphide as formed with sulphuric acid, converting the sulphonic so formed into the corresponding diazo compound, and combining it with a phenol, naphthol, orcin, resorcin, amido compound, or naphthylamine, or their carbonic or sulphonic acids.

418,916—January 7, 1890. B. HOMOLKA. *Blue dye.*

A blue-violet coloring matter formed from aniline, hydrochlorides of aniline, and amido-azo-benzole, of the formula $C_{24}H_{18}N_4$, and capable of forming stable acetate. The hydrochloride, $C_{24}H_{18}N_4HCl$, is easily soluble in hot water.

420,164—January 28, 1890. J. MOHLER. *Blue dye.*

Produced from the hydrochloride of nitroso-dimethylaniline and the crystallized condensation product from tannin with aniline. It is rendered soluble in water by treatment with bisulphite of soda and alcohol.

420,311—January 28, 1890. A. F. POIRRIER. *Nitroso dye.*

Brown to gray coloring matters: produced by heating in a suitable medium, as water, a salt of a nitroso derivative of secondary or tertiary amines, as nitroso-dimethylaniline hydrochlorate, and precipitating the coloring matter by a mineral salt.

420,372—January 28, 1890. O. N. WITT. *Blue dye.*

Produced by the combination of beta-naphthylamine beta-naphthionic acid (Broenner's) with one molecule of beta-naphthohydroquinone; distinguished by producing colored lakes with metallic mordants similar to alizarine and allied coloring matters.

420,373—January 28, 1890. O. N. WITT. *Ammonium salt of beta-naphthohydroquinone-beta-sulphonic acid.*

Produced by submitting amido-beta-naphthol-beta-sulphionic acid to the successive action of oxidizing and reducing agents.

420,374—January 28, 1890. O. N. WITT. *Dark-blue dye.*

Produced by the combination of one molecule of Dahl's alphanaphthylamine-disulphonic acid with one molecule of beta-naphthohydroquinone-beta-sulphonic acid. It dyes wool dark blue with a chrome mordant and bluish-purple shades with alumina mordants.

421,049—February 11, 1890. E. D. KENDALL. *Sulphonating rosaniline.*

Process consists in mingling dry bisulphate of soda, or of potash and rosaniline, and heating the same dry until the desired degree of sulphonation is obtained. Any sulphate wholly or in part composed of a higher sulphate than bisulphate is included.

421,640—February 18, 1890. A. WEINBERG. *Blue azo dye.*

Process consists in first combining diazo compounds with the oxyethers of alpha-naphthylamine or their sulpho-acids, forming the sulpho-acids of compounds of the general formula $R_1-N=NC_{10}H_5OR\cdot NH_2$ (where R_1NH_2 stands for the aromatic amido compound, R for the alkyl group), and afterwards diazotizing these basic compounds and reacting with the diazo-azo derivatives upon amines or phenols.

422,018—February 25, 1890. A. HERRMANN. (*Reissue: 11,116—October 14, 1890.*) *Blue-green dye.*

Metaoxytetralkyldiamidotriphenylmethan of unsymmetric constitution is derived from metaoxytetralkyldiamidotriphenylmethan, two different tertiary aromatic bases being condensed with metanitrobenzaldehyde. It is converted into the sulphonic acid by treatment with fuming sulphuric acid and the acid oxidated to coloring matter.

423,341—March 11, 1890. A. F. POIRRIER. *Green dye.*

Produced by condensing with tetramethyldiamidobenzhydrol, in a hydrochloric or sulphuric medium, paratoluidine, alpha-metaxylidine, pseudocumidine, amidotrimethylbenzol, or mesidine, and subjecting the leuco bases thus formed to oxidation, or oxidation in conjunction with the formation of hydroxyl, methyl, ethyl, benzyl, and sulpho-conjugated benzyl derivatives of said leuco compounds.

423,550—March 18, 1890. C. DUISBERG. *Process of making blue dyes.*

The tetrazo compound of benzidine disulphono-disulpho-acid is combined with alpha or beta naphthylamine, or their alkyl derivatives. It dyes cotton in an unmordanted bath and wool in a neutral bath.

423,569—March 18, 1890. P. OTT. *Azo dye.*

Process consists in obtaining substantive dyestuffs from intermediate products not dyestuffs by combining the tetrazo compounds of diamidoditoluylene oxide with one molecule of an amine, or a phenol or their sulpho or carbo or sulpho-carbo acids, and combining the product of the reaction with another molecule of an amine, or a phenol or their sulpho or carbo or sulpho-carbo acids.

424,019—March 25, 1890. R. NIETZKI. *Brown carbon dye.*

A yellowish-brown coloring matter of the formula $CnH_2n{-}8(NO_2)N_2CnH_2n{-}9$ (OH)(COOH), produced by condensing a nitrodiazo body with an ortho-oxycarbonic acid; characterized by great fastness on chrome and nickel mordants.

425,504—April 15, 1890. R. GNEHM. *Red dye.*

Produced by the action of succinic acid upon dimethyl-meta-amidophenol, heated together with chloride of zinc up to 190° C., the temperature not to exceed 210°. It dyes a brilliant red with yellow fluorescence on wool, silk, and mordanted cotton.

425,525—April 25, 1890. J. SCHMID. *Orthonitroparadiamido-diphenyl.*

Produced by nitrating a sulphuric acid solution of benzidine sulphate and separating the nitro product. It is available for the production of a series of new coloring matters.

425,885—April 15, 1890. M. KAHN. *Process of making azo dyes.*

Process of producing violet to blue-black azo dyes for wool consists in combining the diazo compounds of the sulpho-acids of aniline or its specified equivalents with alpha-naphthylamine, again diazotizing the amidoazo compounds thus obtained and combining therewith phenyl alpha-naphthylamine or a homologue thereof.

426,345—April 22, 1890. A. WEINBERG. *Red dye.*

Produced by combining benzidine with beta-naphthol gamma disulpho-acid (No. 331,059), the reaction taking place only between one equivalent of the tetrazo compound and one equivalent of the sulpho acid. It dyes unmordanted cotton a fiery red and wool and silk in an acidulated bath bright scarlet shades.

427,564—May 13, 1890. R. GNEHM AND J. SCHMID. *Carbonic-acid compound of meta-amidophenol.*

Obtained by treating meta-amidophenol in presence of alkalis or alkaline earths with carbonic acid at a high temperature; and used for the production of coloring matters.

427,565—May 13, 1890. R. GNEHM AND J. SCHMID. *Carbonic-acid compound of dimethyl meta-amidophenol.*

Obtained by treating dimethyl meta-amidophenolate of soda with compressed dry carbonic anhydride at 120° to 140° C. It crystallizes in colorless needles, m. p. 145° C., under decomposition, and is used for the production of coloring matters.

428,530—May 20, 1890. C. SCHRAUBE. *Rosinduline monosulpho-acid.*

A red crystaline powder, $C_{22}H_{16}N_3SO_3H$, obtained by sulphonation of rosinduline. It is purified by suspending in water, neutralizing with cold dilute caustic alkali, boiling and adding additional caustic alkali, and converting the precipitate by a mineral acid into the pure monosulpho acid.

428,629—May 27, 1890. W. PFITZINGER. *Substantive yellow dye.*

Process consists in combining the diazo compounds of the thio derivatives, or the sulpho-acids of the thio derivatives, of paratoluidine, metaxylidine, and pseudo cumidine with the thio derivatives of paratoluidine, metaxylidine, and pseudo cumidine, or their sulpho-acids.

429,350—June 3, 1890. G. KOERNER. *Red dye.*

Produced by the combination of two molecules of napthionic acid with one molecule of the tetrazo derivative obtained by the action of nitrous acid on orthometa-toluidine. It dyes unmordanted cotton a bright red.

430,533—June 17, 1890. C. L. MÜLLER. *Process of preparing disazo dyes.*

Certain amidoazo compounds are coupled by twos by means of intermediaries, such as phosgene, and thio phosgene, or carbon bisulphide, in the presence of alkalis and alcohol; the said amidoazo bodies being paramido-benzene-azo bodies of the formula $NH_2.C_6H_4{:}N{:}N.R$, in which the second element (the residue of which is denoted by R) is a phenol, phenol-carboxylic acid, or phenol-sulphonic acid, or an amido-sulphonic acid of the aromatic series, capable of combining with diazo compounds and forming azo bodies.

430,534—June 17, 1890. C. L. MÜLLER. *Red to brown dye.*

A pink to orange-brown substantive dyestuff, a diazo derivative of symmetrical diamido-diphenyl-urea. obtained by coupling together two molecules of paramido-benzene azo-naphthionic acid by the aid of one molecule of phosgene.

430,535—June 17, 1890. C. L. MÜLLER. *Yellow dye.*

A yellow substantive dyestuff, a diazo derivative of symmetrical diamido-diphenylurea, obtained by coupling together two molecules of paramido-benzene salicylic acid by the aid of phosgene.

430,975—June 24, 1890. C. SCHRAUBE. *Red dye.*

Disulpho-acid of rosinduline, of the formula $C_{22}H_{17}N_3(SO_3H)_2$, produced by the action of fuming sulphuric acid or similar body, as monochlorhydrine sulphuric acid, on rosinduline, or upon its monosulpho acid. It dyes animal fiber in an acid bath a crimson tint.

431,297—July 1, 1890. J. WALTER. *Azo color.*

The process consists in adding sodium nitrite to a heated aqueous solution of aniline and muriatic acid, pouring the resulting solution into an alkaline solution of salicylic acid, precipitating with acid, and filtering, dissolving the dried product in sulphuric acid, and then slowly adding a mixture of nitric acid and sulphuric acid, pouring into water, and filtering; producing yellow to brown colors.

431,404—July 1, 1890. C. SCHRAUBE. *Rosinduline sulpho-acid.*

Produced by increasing the action of fuming sulphuric acid, or similar body, upon the disulpho-acid of rosinduline, No. 430,975, or upon the mono-sulpho acid, or on rosinduline itself. It dyes animal fiber in the acid bath a bright red color.

431,541—July 1, 1890. T. REISSIG. *Blue dye.*

Produced by the condensation of alpha-naphthylamine with the mononitroso compound of diethyl-meta-amidophone.

432,989—July 29, 1890. C. DUISBERG. *Blue dye.*

Produced by the action of the tetrazo compound of the benzidine sulphone disulpho-acid—which is manufactured by the sulphuration of benzidine sulphate with fuming sulphuric acid—upon phenyl-beta-naphthylamine. It dyes unmordanted cotton in an alkaline bath, and wool and silk in a neutral bath, indigo blue.

434,493—August 19, 1890. A. WEINBERG. *Blue dye.*

A disulphonated tertiary dibenzyl derivative of thionine, produced from the methyl and ethyl benzyl-paraphenylene-diamine-sulphonic acids. It dyes animal fiber in an acid bath a greenish blue.

437,989—October 7, 1890. A. HERRMANN. *Greenish-blue dye.*

The sulphonic acid of methylated and ethylated meta-amidotetralkyldiamidotriphenyl carbinol, easily soluble in water. The methylated and ethylated leuco bases corresponding to the sulphonated color are obtained by treatment of meta-amidotetralkyldiamidotriphenyl methane with methyl or ethyl halogens.

438,053—October 7, 1890. H. BOEDEKER. *Violet dye.*

Produced by the action of sulphuric acid upon ortho or para ditolyl-meta-amido-phenolphthaloine (ditolylrhodamine), which is obtained by the action of fluoresceine-chloride upon ortho or para toluidine.

438,438—October 14, 1890. R. LAUCH AND C. KREKELER. *Manufacture of dye-stuffs.*

Produced by the combination of the diazo compound of amidosalicylic acid with alpha-naphthylamine, again diazotizing the amidoazo compound obtained and recombining the diazo compound obtained with alpha-naphthol-sulpho-acid. It prints cotton violet and dyes wool blue black in a neutral or weak acid bath, dyeing a blue black with chromium mordants.

440,281—November 11, 1890. C. RIS. *Yellow dye.*

Produced by treating the diazo compound of polychromine (sulpho-acid of thioparatoluidine, also called "primuline") with ammonia. It dyes cotton without a mordant and can be diazotized.

440,288—November 11, 1890. J. WALTER. *Brown dye.*

Produced by combination of metadiamines with two diazo compounds, of which one is diazotized polychromine (the sulpho-acid of thioparatoluidine), and the other, one of the diazo compounds of naphthylamine or amidoazobenzole or amidoazo-toluol sulpho-acid.

440,359—November 11, 1890. C. A. MAYER. *Blue dye.*

Derived from nitroso-dimethylaniline and gallonaphthylamide. Violet coloring matters are produced by the action of nitroso derivatives of the tertiary amines on the products of condensation of tannin or catechine with the primary amines. Further products are obtained by reduction with alkaline bisulphites.

440,536—November 11, 1890. R. BOHN. *Blue dye.*

Produced by the action of nitroso derivatives of tertiary aromatic bases on a symmetrical dihydroxybenzoic acid C_6H_3COOOH. OH. OH. (1.3.5) which is obtained by melting metadisulpho-benzoic acid with an excess of caustic potash. Its alcoholic solution is most characteristic, being reddish-violet and marked by a striking reddish fluorescence.

440,639—November 18, 1890. R. LAUCH AND M. KAHN. *Blue-black azo dye.*

Violet to blue-black dyestuffs produced by combining a tetrazo compound (those of benzidene, toluidine, diamido-diphenol ether, diamido-stilbene, naphthylene-diamine, their sulphones and their sulphonic acids, with the exception of benzidine and toluidine disulphonic acids) with one or two molecules of alpha-naphthylamine (except the benzidine and toluidine disulphonic acids, which combine with two molecules of alpha-naphthylamine), diazotizing the resulting mono and diamido tetrazo compounds, and combining the new tetrazo compounds with naphthols (dioxynaphthalines) and their sulphonic acids.

440,953—November 18, 1890. W. MAJERT. *Blue dye.*

A new dioxynaphthaline, m. p. between 248° and 252° C., prepared by melting alpha-naphthyldisulpho-acid or alpha-naphthaline alpha-sulpho-acid with caustic soda or potash, dissolving the molten mass in water, and separating the dioxynaphthaline by means of acid. Mono or bisulpho acids of dioxynaphthaline are obtained by treating the same with concentrated sulphuric acid, fuming sulphuric acid, or sulphuric chlorhydrin. A blue coloring matter is obtained by treating a tetrazo compound, as tetrazo-diphenyl chloride, in the presence of sodium carbonate with the said dioxy-naphthaline, or its mono or bisulpho acids.

441,945—December 2, 1890. C. DREYFUS. *Red dye.*

Produced by combining diazotized dehydro-thio-paratoluidine sulphonic acid with beta-naphthol and then converting the combination into an ammonia salt.

442,369—December 9, 1890. L. GANS. *Blue-black dye.*

Produced by the action of amidonaphtholmonosulphonic acid upon tetrazo-diphenyl or homologous compounds.

442,680—December 16, 1890. M. HOFFMANN AND A. WEINBERG. *Blue dye.*

Produced by the action of the secondary bases of the series of fat bodies, as dimethylamine, diethylamine, upon the coloring matters belonging to the class of the oxazines (dimethyle or diethyle amidonaphtophenoxazine chloride) forming new bases which are oxidized into greenish-blue coloring matters.

443,402—December 23, 1890. M. V. NENCKI. *Gallacetophenone.*

See Group XVIII, Fine Chemicals, Ketones.

443,408—December 23, 1890. C. SCHRAUBE. *Yellow-red dye.*

Produced by treating rosinduline sulpho acid (No. 431,104) with dilute sulphuric acid at from 175° to 180° C. The acid is diluted so as to boil at the desired temperature.

444,229—January 6, 1891. R. M. DONOVAN. *Compound for coloring broom corn.*

Consists of green aniline, burnt alum, water, and sulphuric acid.

444,538—January 13, 1891. J. MOHLER AND C. A. MAYER. *Blue dye.*

Produced by sulpho-conjugating the new products resulting from the action of the primary aromatic amines, at from 100° to 200° C., on the dyes obtained by the action of the nitroso derivatives of the tertiary aromatic amines on the condensation products of aniline and its homologues.

444,679—January 13, 1891. M. ULRICH. *Dioxynaphthaline-mono-sulphonic acid.*

The dioxynaphthaline-mono sulphonic acid S, obtained by melting alphanaphthol alpha disulphonic acid S (No. 383,031) with caustic alkali. The acid or its salts gives, with diazobenzene an azo dyestuff similar in shade to acid magenta, and with ortho tetrazo ditolyl or tetrazo-diphenyl ethers, direct dyeing coloring matters of bright blue shades.

445,684—February 3, 1891. F. BENDER. *Pink dye.*

Produced by treating dimethyl or diethyl meta-amido-phenol with formaldehyde in order to produce tetramethyl or tetraethyl diamidodioxydiphenylmethane, treating the latter with dehydrating agents to produce tetramethyl or tetraethyl diamidodiphenylmethane oxide, and oxidizing the latter.

446,009—February 10, 1891. W. PFITZINGER. *Yellow dye.*

Produced by treating the diazo compound of thioparatoluidine sulpho-acid with the sulpho-acid of the same thio derivative of the paratoluidine.

446,892—February 24, 1891. R. E. SCHMIDT. *Alizarine derivative.*

"Alizarine cyanine" (pentaoxyanthraquinone) is produced by oxidizing alizarine bordeaux (tetraoxyanthraquinone) in sulphuric acid solution with oxidizing agents, such as manganese or arsenic acid, boiling, filtering, and washing, dissolving the precipitate in hot diluted alkali, filtering and precipitating with acid.

446,893—February 24, 1891. R. E. SCHMIDT. *Alizarine derivative.*

"Alazarine bordeaux" (tetraoxyanthraquinone), is produced by oxidizing alizarine with large quantities of fuming sulphuric acid of a high precentage of anhydride at a low temperature. It crystallizes from glacial acetic acid or nitro-benzole in garnet-red needles which do not melt at 280° C.; composition $C_{14}H_8O_6$.

447,189—February 24, 1891. P. JULIUS. *Red dye.*

A substantive red dyestuff, the sodium salt of diamido-diphenylene ketoxime diazo-naphthionic acid, produced from a new ketoxime base resulting from the action of hydroxylamine or hydroxylamine sulpho-acids upon the diamidodiphenylene ketone.

447,302—March 3, 1891. C. DUISBERG. *Violet dye.*

A direct-dyeing coloring matter derived from the action of one molecule of tertrazodiphenyldialkyl ether, first, on one molecule of alpha-naphthylamine mono-sulpho acid, and then, on one molecule of alpha-naphthol monosulpho acid.

447,303—March 3, 1891. C. DUISBERG. *Orange dye.*

A substantive reddish-orange coloring matter of the formula $C_{29}H_{19}N_5SO_6Na_2$, produced by combining one molecule of tetrazo-diphenyl with one molecule of salicylic acid, and combining the intermediate product with one molecule of naphthylamine monosulpho-acid.

449,520—March 31, 1891. M. CERESOLE. *Benzo-rhodamine.*

A red dyestuff resulting from the condensation of one molecule of benzotrichloride with two molecules of alkylized meta-amidophenol. It dyes in general similarly to the tetramethyl and ethyl rhodamines.

449,551—March 31, 1891. E. MENTHA. *Dihydroxynaphthalene.*

"2.3-dihydroxynaphthalene," m. p. 160° to 161° C., yielding an intensely blue coloration with ferric chloride solution, may be produced by melting dihydroxynapthalene monosulpho acid R with twice its weight of a caustic alkali at 300° to 320° C., or by treating the said monosulpho acid with a dilute mineral acid. It is readily soluble in hot water, alcohol, ether, and fusel oil, slightly soluble in cold water, benzene, and petroleum ether.

449,629—March 31, 1891. J. SCHMID. *Black dye.*

Derived from monoalkylized derivatives of beta-naphthylamine and a diazo compound of the formula $C_{10}H_5(SO_3Na)_2(\alpha)-N=N-C_{10}H_6N=NCl\ (\alpha)$. It dyes wool and silk a brilliant black which in light shades presents a bluish gray.

450,037—April 7, 1891. H. REISENEGGER. *Black dye.*

A quinoline compound, soluble in soda lye with violet-red color, produced from amidoflavopurpurine or amidoanthrapurpurine by treatment with glycerine, sulphuric acid, and an oxydizing agent.

451,502—May 5, 1891. J. MOHLER AND C. A. MAYER. *Blue dye.*

A sulpho acid derived from tannin, aniline, and nitroso-dimethylaniline: produced by combining the coloring matter of No. 420,164 with ordinary sulphuric acid (containing 90 to 95 per cent of monohydrated acid, but no anhydrous sulphuric acid) at 80° C. It combines with alkalis, forming salts readily soluble in warm or cold water.

452,197—May 12, 1891. J. SCHMID. *Orange-yellow dye.*

Produced by combining a diazo compound of salicylic acid, or its homologues, with resorcin. The tints obtained on chrome mordants are orange yellow, on iron mordants brown.

452,210—May 12, 1891. R. BOHN. *Process of dyeing with gallacetophenone.*

Gallacetophenone imparts fast colors to animal and vegetable fiber when combined with metallic oxides or mordants within or upon the fibrous material.

453,477—June 2, 1891. A. HERRMANN. *Blue-green dye.*

The sulphonic acid of meta-chlortetralkyldiamidotriphenylcarbinol, produced by converting metadiazotetralkyldiamidotriphenylmethanchloride into the corresponding metachlor leuco base by treatment with copper or cuprous chloride, sulphonation of the chlor leuco base, and oxidation of the leuco-sulphonic acid thus obtained by means of peroxide of lead.

454,535—June 23, 1891. A. COBENZL. *Gray dye.*

Produced by the action of nitroso-diethylaniline hydrochlorate upon the betanaphtholsulphonic acid of Schäffer. Suited for printing and dyeing woolen fabrics in blue-gray shades.

454,645—June 23, 1891. L. GANS. *Amido naphthol-monosulphonic acid.*

Gamma amido naphthol monosulphonic acid, produced by subjecting the beta-naphthylamine gamma disulphonic acid to the action of a caustic alkali at 210° C. Azo coloring matters are produced by combining the diazo derivatives of aromatic monamines or diamines with the amido-naphthol-monosulphonic acid.

454,840—June 30, 1891. O. BORGMANN. *Orange dye.*

Produced by alkalizing the orange yellow dyestuffs obtained by the combination of a tetrazodiphenyl or tetrazoditolyl with beta-naphthylamine disulpho-acid R and phenol, by treating the same with a halogen alkyl. It withstands the action of alkalis.

455,442—July 7, 1891. J. SCHMID. *Betadelta-amidonaphthol.*

Obtained by melting the sodium salt of beta-naphthylamine-delta-monosulpho acid with caustic alkalis at from 200° to 280° C. It is soluble in water, more so in benzene, easily soluble in ether and alcohol, m. p. 200° C.; used for the production of coloring matters.

455,952—July 14, 1891. C. RIS. *Brown dyestuff.*

Produced by condensation of paranitro-toluol sulpho-acid with paraphenylendiamine or paratoluylendiamine in a solution of caustic alkalis; soluble in water and alcohol.

456,081—July 14, 1891. M. CERESOLE. *Red dyestuff.*

A dye base, symmetrical diethyl-rhodamine: produced by the condensation of one molecule of phthalic anhydride with two molecules of monoethylmeta-amidophenol.

456,627—July 28, 1891. C. A. MARTIUS. *Process of making azo dyes.*

An alpha-naphthol disulphonic acid is, first, formed by treating naphthalene disulphonic acid with nitric acid, reducing the alpha-nitro naphthalene disulphonic acids so formed to alpha-amido naphthalene disulphonic acid and converting it into the corresponding compound alpha-naphthol disulphonic acid; and, second, the disulphonic acid so formed is added to a diazo derivative of an amido compound, such as xylidine, cumidine, alpha-naphthylamine, etc. It forms red, brown, violet, or bluish-violet coloring matters.

456,628—July 28, 1891. C. A. MARTIUS. *Process of making azo dyes.*

An alpha-naphthol disulphonic acid, formed as in No. 456,627, is added to a solution of a tetrazo derivative of an amido compound, such as diamido-stilbene, benzidine, etc., in proportions to form a compound of one molecule of the tetrazo compound combined with one of the alpha-naphthol disulphonic acid; then to this compound there is added a portion of naphthol or naphthol-sulphonic acid, and finally the dyestuff is precipitated from the solution. It forms violet or bluish-violet coloring matters.

456,897—July 28, 1891. C. A. MARTIUS. *Azo dye.*

Process consists in adding to the alpha-naphthol disulphonic acid formed as per No. 456,627, a tetrazo derivative of diphenitidine in proportions to form a compound of one molecule of tetrazo-diphenitidine with one of the alpha-naphthol disulphonic acid, then adding to this compound another portion of the alpha-naphthol disulphonic acid, and finally precipitating the dyestuff. There are formed red, brown, violet, blue, and bluish-black coloring matters.

458,281, August 25, 1891. B. HOMOLKA. *Induline dye.*

A blue coloring matter of the induline series, a zinc chloride double salt, produced by heating a mixture of soluble indulines together with paraphenylenediamine and hydrochlorate of paraphenyldiamine to 150° to 180° C., and after filtering precipitating with common salt and zinc chloride.

458,283—August 25, 1891. H. KUŽEL. (*Reissue: 11,231—April 5, 1892.*) *Azo dye.*

A brown powder adapted for dyeing wool in greatly differing shades, ranging from bluish red to deep black, depending upon the use of acids and metallic mordants, derived from a new dioxynaphthalene disulphonic acid (the subject of a companion application) and diazo bodies.

458,284—August 25, 1891. H. KUŽEL. *Azo dye.*

Produced by the action of diazo bodies upon naphthol trisulphonic acid-monamide (which is formed by adding a solution of caustic ammonia to the naphthosulphon disulphonic acid obtained from napthalene trisulphonic acid, prepared by sulphonation of napthalene, by nitration and reduction, by treatment of the novel naphthylamine trisulphonic acid with nitrous acid, and subsequent boiling with acidulated water). It dyes wool a pronounced bluish-red shade.

458,285—August 25, 1891. H. KUŽEL. *Amido-naphthol monosulphonic acid.*

Produced by melting the salts of beta-naphthylamine disulphonic acid with caustic alkalis. A crystalline powder of difficult solubility in water and alcohol. Combined with diazo or tetrazo compounds it furnishes, in alkaline or acetic solution, azo coloring matters.

458,286—August 25, 1891. H. KUŽEL. *Amido-oxynaphthaline disulphonic acid.*

Produced by heating alpha-naphthylamine trisulphonic acid with caustic alkalis, and crystallizing in long pearly needles. It is easily converted by nitrous acid into a diazo compound of light yellow color, and combines with diazo and tetrazo compounds, in alkaline or acetic solutions, to form azo coloring matters.

462,414—November 3, 1891. C. RUDOLPH. *Brown dye.*

A brown basic dyestuff derived from paradiazoacetanilid chloride, metaphenylene-diamine, and concentrated muriatic acid; easily soluble in water; especially suited for dyeing jute and leather.

462,415—November 3, 1891. C. RUDOLPH. *Blue-black azo dye.*

Produced by combining tetrazo diphenyl or ditolyl chloride with one molecule of amido-oxy-alpha-naphthalene disulpho-acid and with one molecule of alpha or beta naphthalene. It is soluble in water with a red-violet color and dissolves in concentrated sulphuric acid with a blue color.

462,824—November 10, 1891. G. SCHULTZ. *Blue azo dye.*

Blue direct-dyeing dyestuffs, produced by combining one molecule of a tetrazo salt, toluidine, or anisidine, with one molecule of alpha-naphthylamine, again diazotizing the compound, and combining the product with two molecules of an alpha-naphthol disulpho acid.

463,898—November 24, 1891. A. HERRMANN. *Blue dye.*

Produced by oxidizing the sulphonic acids of metaoxy, meta-amido, or alkylized meta amido tetralkyl-diamidotriphenyl carbinols with salts of iron or chromic acid.

464,135—December 1, 1891. M. HOFFMANN. *Blue dye.*

Produced by mixing solutions of amidonaphthol-disulpho-acid H (formed by heating diamido-naphthalene-alpha-disulpho-acid with diluted mineral acids) and of the tetrazo derivatives of paradiamines and sufficient alkali to keep the solution alkaline. Its blue aqueous solution is not changed by addition of carbonate of soda, and it dyes unmordanted cotton.

464,538—December 8, 1891. A. WEINBERG. *Violet dye.*

Tetralkyl disulphobenzyldiamidotriphenylcarbinol: produced by mixing solutions of the substituted diamidodiphenylmethanes with solutions of aromatic monamines and oxidizing substances, to give simultaneous oxidation.

464,566—December 8, 1891. M. HOFFMANN. *Violet dye.*

"Naphthalene-violet:" produced by the action of tetrazonaphthalene beta-disulphonic acid upon alpha-naphthylamine having the constitution $C_{10}H_4(SO_3Na)_2 = [N = N - C_{10}H_6NH_2(a)]_2$. It is transformed by nitrous acid into a tetrazo compound which reacts upon phenols or amines, forming fast colors.

464,775—December 8, 1891. R. LAUCH AND C. KREKELER. *Blue-green azo dye.*

Produced by combining one molecular proportion of the diazo compound of amidonaphthalene azo-salicylic acid with one molecular proportion of dihydroxynaphthalene monosulphonic acid in the presence of sodium acetate.

465,116—December 15, 1891. C. RUDOLPH. *Brown azo dye.*

Produced by first combining diazotized toluylenediamine sulpho-acid 1:2:4:6 ($CH_3 : NH_2 : SO_3H : NH_2$) and two molecules of metaphenylenediamine, and then treating this intermediate compound with diazotized alpha or beta naphthylamine sulpho-acid.

466,202—December 29, 1891. M. ULRICH. *Black azo dye.*

Produced by combining the diazo compound of sulphanilic acid with alpha-naphthylamine, further diazotizing the amidoazo product thus obtained, and causing the diazo derivative to act upon the sodium salt of the dihydroxynaphthalene monosulphonic acid S of No. 444,679. It dyes unmordanted wool fast bluish black to black, and forms lakes with chromium salts.

466,826—January 12, 1892. E. HEPP. *Blue-red dye.*

Trisulpho-acid of "phenyl-rosinduline," $C_{28}H_{16}N_3(SO_3H)_3$, obtained by treating phenyl-rosinduline with fuming sulphuric acid.

466,841—January 12, 1892. M. ULRICH. *Red azo dye.*

Produced by combining molecular proportions of toluidine sulpho-acid after diazotation, and of the dihydroxynaphthalene monosulphonic acid of No. 444,679. It dyes wool in acid baths bluish-red shades.

466,852—January 12, 1892. E. HEPP. *Disulpho-acid of phenyl-rosinduline.*

Beta-disulpho-acid of phenyl-rosinduline, $C_{28}H_{17}N_3(SO_3N_2)$, obtained by treating phenyl-rosinduline with concentrated sulphuric acid at 170° C. Its potassium and sodium salts dye wool red-bluish shades.

467,162—January 19, 1892. C. DUISBERG. *Tetrazo dye.*

Produced by combining with one molecular proportion of dianisidine after its diazotation one molecular proportion of beta-naphthol disulpho-acid R, and then one molecular proportion of alpha-naphthol alpha-monosulpho acid (Neville-Winther). It dyes unmordanted cotton in greenish-blue shades.

468,049—February 2, 1892. C. RUDOLPH. *Azo dye.*

Produced by treating tetrazodiphenyl or ditolyl with one molecule of amidooxyalphanaphthalenedisulpho acid and with one molecule of metaoxydiphenylamine or metaoxytolylphenylamine. It dyes unmordanted cotton blackish violet.

468,142—February 2, 1892. M. ULRICH. *Blue-red azo dye.*

Produced by acting with the diazo compound of paramido-benzol-sulphonic acid on the dihydrooxynaphthalene-mono-sulpho-acid of No. 444,679. It dyes unmordanted wool in sulphuric acid baths clear red shades; wool mordanted with chromium salts, dull violet.

468,539—February 9, 1892. O. BORGMANN. *Red dye.*

Produced by combining a diazo compound of tolidine with betanaphthylamine disulpho acid R, adding to the resulting intermediate body naphthionate of soda, allowing the mixture to stand until the reaction is complete, neutralizing with an alkali, and salting out the dyestuff.

469,329—February 23, 1892. A. WEINBERG. *Blue dye.*

Produced by forming the hydrochlorate of paranitrosomonomethyltoluidine, from the nitrosomine of monomethyl (or ethyl) orthotoluidine, then reducing with zinc dust, neutralizing, adding sodium thiosulphate and potassium bichromate, treating with monomethylorthotoluidine hydrochlorate, and oxidizing.

471,638—March 29, 1892. B. HOMOLKA. *Process of making rosaniline dyes.*

Diamidodiphenylmethan bodies are treated with oxidizing agents in the presence of hydrochlorates of aromatic amines.

471,659—March 29, 1892. E. VONGERICHTEN. *Process of making diamidodiphenylmethan bases.*

Hydrochlorates of aromatic amines are caused to act upon the anhydroformaldehyde compounds of aromatic amines.

472,121—April 5, 1892. M. HOFFMANN. (*Reissue: 11,267—September 6, 1892.*) *Manufacture of yellow dyes.*

A derivative of the diamido beta-naphthalene disulpho-acid, which is prepared by double nitration and reduction of the naphthalene beta-disulpho-acid, F No. 464,566, and obtained from the said diamido acid by combining its tetrazo derivative with phenol or cresol, and treating the product with alkylated halogens.

473,453—April 26, 1892. M. EPTING. *Red dye.*

Produced by sulphonization of triamido-triortho-tolyl carbinol, in the form of its sodium salt; a green mass having metallic luster, of easy solubility in water, but insoluble in absolute alcohol.

473,467—April 26, 1892. H. KUZEL. *Process of making naphthosulfondisulphonic acid.*

Produced by nitrating a specified naphthalintrisulphonic acid (German patent No. 38,281), reducing the nitro compound, converting the naphthylaminetrisulphonic acid thus formed into the diazo compound, and boiling with acidulated water until the development of nitrogen ceases. The neutral disodium salt crystallizes in colorless needles.

475,616—May 24, 1892. R. SENGER. *Induline dye.*

Trioleate of induline, an intensely black liquid of the consistency of castor oil at ordinary temperature: produced by mixing one molecule of induline with three molecules of oleic acid (or stearic or palmitic acid) and heating to 100° to 120° C. It is insoluble in water, but easily soluble in alcohol and in benzene.

476,335—June 7, 1892. M. ULRICH. (*Reissue: 11,308—February 21, 1893.*) *Violet azo dye.*

Produced by combining the diazo compound of paramido-phenol with the sodium salt of dihydroxynaphthalene monosulpho-acid S of No. 444,679; soluble in water. It dyes wool in acid baths a clear violet.

476,336—June 7, 1892. M. ULRICH. *Black azo dye.*

A coloring matter, dyeing unmordanted wool a greenish-black: produced by combining diazotized beta-naphthylamine monosulpho-acid with alpha-naphthylamine, diazotizing the formed amido-naphthalene azonaphthalene sulpho-acid, and coupling the obtained diazo compound with the sodium salt of the dihydroxynaphthalene monosulpho-acid S.

476,337—June 7, 1892. M. ULRICH AND R. LAUCH. *Blue dye.*

A direct-dyeing coloring matter: produced by combining molecular proportions of tetrazo-diphenol-dimethylether and alpha-naphthylamine, diazotizing and combining the resulting tetrazochloride with two molecular proportions of the sodium salt of the dihydroxynaphthalene monosulpho acid S.

476,371—June 7, 1892. C. DUISBERG. *Tetrazo blue dye.*

A direct-dyeing tetrazo dyestuff: produced by combining one molecular proportion of the tetrazo compound of dianisidine with one molecular proportion of beta-naphtholdisulpho acid R and then with one molecular proportion of alphanaphtholalphamonosulpho acid (Cleve's).

476,393—June 7, 1892. R. LAUCH. *Dyestuff.*

A coloring matter, dyeing unmordanted cotton in neutral or alkaline baths a greenish-black or dark-gray: produced by combining molecular proportions of tetrazo-diphenyl, salicylic acid, and alphanaphthylamine, sulphonating the product, diazotizing, and then further combining with one molecular proportion of the sodium salt of alpha-naphthol-alpha-monosulphonic acid.

476,413—June 7, 1892. F. RUNKEL. *Triphenylmethane dye.*

Produced by combining, in the presence of concentrated sulphuric acid, equimolecular proportions of tetramethyldiamidobenzhydrol and alpha-hydroxynaphthionic acid, removing the uncombined alpha-hydroxynaphthionic acid, and then further oxidizing the resulting leuco compound; yielding shades of pure blue.

476,418—June 7, 1892. R. E. SCHMIDT. *Alizarine derivative.*

A coloring matter, dyeing wool mordanted with chromium salts in greenish-blue shades: produced by oxidizing the alizarine bordeaux of No. 446,893 with manganese in concentrated sulphuric-acid solution, at not exceeding 25° C., and combining the resulting diquinone with salicylic acid, likewise in sulphuric-acid solution.

476,419—June 7, 1892. R. E. SCHMIDT. *Alizarine dye.*

An alizarine dye, dyeing wool mordanted with alumina salts clear and pure blue shades, with chromium salts greenish-blue shades: produced by the action of ammonia upon the anthraquinone formed by oxidizing alizarine bordeaux in sulphuric-acid solution with manganese at low temperatures.

476,420—June 7, 1892. R. E. SCHMIDT. *Alizarine derivative.*

An alizarine dyestuff containing nitrogen, dyeing wool mordanted with chromium salts similar to alizarine blue: produced by treating alizarine bordeaux with ammonia and precipitating the color with acids.

476,491—June 7, 1892. R. E. SCHMIDT. *Alizarine dye.*

An alizarine dye, giving a clear bluish green on wool mordanted with chromium salts: produced by oxidizing alizarine bordeaux in sulphuric-acid solution with manganese, treating the resulting anthraquinone with salicylic acid, and then with ammonia.

478,005—June 28, 1892. R. GNEHM AND J. SCHMID. *Violet dye.*

A greenish glittering crystalline powder of an intense metallic luster, dyeing mordanted wool and cotton violet to blue shades: produced by treating a mixture of tetra alkylized diamido-benzo-phenone, sulphuric acid, and pyrogallol with a condensing agent, diluting with water, neutralizing with soda-salt, dissolving in dilute acetic acid, and precipitating with common salt.

479,515—July 26, 1892. R. LAUCH. *Olive dye.*

A grayish-black powder, dyeing unmordanted cotton olive in alkaline-soap baths: produced by reacting with one molecule of tetrazo-diphenyl upon one molecule of salicylic acid and one molecule of alpha-napthylamine, treating said product with fuming sulphuric acid, diazotizing, combining the so-formed diazo compound with one molecular proportion of the sodium salt of dihydroxynaphthalene monosulpho acid, and treating the dyestuff thus obtained with fuming sulphuric acid.

480,326—August 9, 1892. M. HOFFMANN. *Disazo dye.*

Produced by introducing one molecule of amido-naphtholdisulpho acid H into the solution of one molecule of a diazo body in presence of a mineral acid; making the solution alkaline; adding a second molecule of a diazo body; and separating the dyestuff with common salt. It dyes animal fiber an intense and fast greenish blue black.

481,591—August 30, 1892. H. N. F. SCHAEFFER. *Process of dyeing with alizarin.*

The cloth or fiber is first treated with a soluble modification of alizarine, consisting of a soluble salt of boracic acid and alizarine, and then with a mordant.

481,934—September 6, 1892. C. DUISBERG. *Red dye and process of making the same.*

A substantive tetrazo dyestuff produced by combining one molecular proportion of the tetrazo compound of dianisidine with molecular proportions of alpha-naphthylamine alpha-monosulphonic acid (naphthionic acid).

482,106—September 6, 1892. M. ULRICH AND J. BAMMANN. *Azo coloring matter.*

A blue direct-dyeing coloring matter: produced by combining one molecular proportion of tetrazo-diphenyl chloride with one molecular proportion of alpha-naphthylamine; diazotizing the product, and combining the thus obtained hexazo compound with two molecular proportions of the sodium salt of a specified 1.8 amido-naphthol beta-disulpho-acid.

483,368—September 27, 1892. D. A. ROSENSTIEHL. *Process of making azo colors.*

A nitramine is coupled with a phenol amine, or the specified derivative thereof, and the product subjected to the action of a reducing agent in an alkaline medium.

484,521—October 18, 1892. H. KUZEL. *Yellow dyestuff.*

Produced by the action of diazotized diamido sulphones upon oxycarbonic acids.

484,697—October 18, 1892. R. BOHN. *Blue dye.*

Produced by combining tetraalkyldiamido-benzophenone with dihydroxynaphthalene by the aid of a condensing agent such as phosphorusoxychloride. It dyes animal or vegetable fiber, with a metallic mordant, greenish to violet shades of blue.

488,430—December 20, 1892. R. GNEHM AND J. SCHMID. *Basic yellow dye.*

Produced by treatment of a new base—dimethyl diamido-diortho tolylmethane simultaneously with sulphur and ammonia. It dyes cotton mordanted with tannin and tartar emetic yellow shades of a slightly greenish tinge.

489,623—January 10, 1893. F. BENDER AND M. KÄMMERER. *Yellow-red dye.*

Bluish red dyestuffs obtained from dialkylmetaamidophenols (such as the rhodamines of dialkylmeta amidophenol, etc.) or their corresponding leuco compounds are transformed into coloring matters of a more yellowish red tint by treating same with an oxidizing agent such as potassium permanganate.

490,408—January 24, 1893. A. HERRMANN. *Indigo-blue dye.*

An oxidation product of the sulphonic acids of meta substituted tetralkyldiamido-triphenylcarbinols, produced by oxidizing the sulphonic acids of meta-oxy, meta-amido-, or alkylized meta amidotetralkyldiamido-triphenyl carbinols with salts of iron or chromic acid.

491,378—February 7, 1893. J. SCHMID AND J. MOHLER. *Violet-blue induline dye.*

Produced by melting a mixture of para-phenylene-diamine, hydrochlorate of para-phenylene-diamine, and alpha-nitro-naphthylamine at from 160° to 190° C., dissolving the melt in dilute muriatic acid, and precipitating with common salt.

491,410—February 7, 1893. T. DIEHL. *Blue-black azo dye.*

Derived from the tetrazo compound of para-amido-benzene-azoamido-alpha naphthalene and gamma amido naphtholmonosulpho-acid, beta naphthol-alpha monosulpho-acid, or naphthionic acid.

491,422—February 7, 1893. R. GNEHM AND J. SCHMID. *Brown dye.*

A soluble dyestuff obtained by converting the insoluble product of meta or para diazo-benzoic acid with Bismarck brown, with the aid of potash or soda.

493,241—March 14, 1893. H. BOEDEKER. *Pink dye.*

The alkali salt of a sulphonic acid, of the formula $C_{38}H_{33}O_3N_2SO_2$ alk′, derived from fluorescein chloride and mesidine.

493,313—March 14, 1893. B. R. SEIFERT. *Dye from alpha oxyuvitic acid.*

Process consists in combining alpha oxyuvitic acid with diazo compounds by the same manipulations as are used in the manufacture of the ortho and para azo coloring matters.

493,562—March 14, 1893. J. SCHMID AND R. PAGANINI. *Monosulpho-dioxynaphthoic acid.*

Produced by heating the sodium salt of di-sulpho-beta-oxynaphthoic acid with caustic alkalis at from 200° to 260° C. and precipitating the dissolved melt with hydrochloric acid or sulphuric acid.

493,563—March 14, 1893. J. SCHMID. *Blackish-blue azo dye.*

Produced by combining one molecular proportion of diazotized dianisidin with one molecular proportion of the sodium salt of mono-sulpho-dioxy-naphthoic acid, combining the intermediate product with an alkaline solution of one molecular proportion of (1.4) alpha naphthol-alpha-sulphonic acid of Nevile & Winther, and precipitating with common salt.

493,564—March 14, 1893. J. SCHMID. *Gray-black tetrazo dye.*

Produced by combining one molecular proportion of tetrazo-diphenyl or ditolyl with two molecular proportions of the sodium salt of mono-sulpho-dioxy-naphthoic acid. It dyes cotton direct from gray to violet-black shades by the aid of sulphate of soda or common salt and soap.

493,583—March 14, 1893. R. GNEHM AND J. SCHMID. *Red dye.*

Produced by combining molecular proportions of diazotized mono-nitro-benzidine, salicylic acid, and alpha-naphthol-alpha-mono-sulpho acid (Nevile & Winther), and precipitating with common salt. Dark red shades are obtained on wool mordanted with chromium salts.

494,838—April 4, 1893. F. BENDER. *Blue dye.*

A greenish blue coloring matter produced by the reaction of dimethyl-meta-amido-cresol (prepared by diazotizing metaamidodimethyl orthotoluidine and decomposing the diazo-compound with water) with salts of paranitroso derivatives of aromatic amines.

496,139—April 25, 1893. R. E. SCHMIDT AND P. TUST. *Alizarin dye.*

Produced by oxidizing beta nitroanthrapurpurine in sulphuric acid solution with manganese dioxide, and boiling the intermediate product with water, acids, sulphites, or bisulphites. It dyes wool mordanted with alumina salts dull violet, mordanted with chromium salts, greenish-blue shades.

496,592—May 2, 1893. J. BAMMANN AND M. ULRICH. *Tetrazo dye.*

Produced by combining one molecular proportion of tetrazomono-ethoxydiphenyl chloride with two molecular proportions of the 1.8-amidonaphthol-beta-disulpho acid or its salts in alkaline solution. It dyes unmordanted cotton in alkaline soap bath greenish-blue, fast to alkalis.

497,032—May 9, 1893. C. RUDOLPH. *Orange azo dye.*

Produced by the reaction of diazotized toluylendiamin-sulpho acid with beta-naphthylamine. It dyes cotton directly.

497,114—May 9, 1893. J. BRACK. *Blue dye.*

Produced by heating an amine of the fatty series with a gallo-cyanine; colors varying from violet to greenish blue on chrome mordanted fiber.

498,303—May 30, 1893. E. VON PORTHEIM. *Glycine dye.*

Produced by combining one molecule of a tetrazo compound of a diamine with one molecule of naphthylglycine, and combining the product with one molecule of a suitable body, as an amine; direct dyeing; generally soluble in water, and not readily affected by alkalis.

498,304—May 30, 1893. P. OTT. *Greenish-blue dye.*

Produced by combining in equal molecular proportions diazotized aniline and Clève's alphanaphthylamine beta monosulpho acid, diazotizing the formed benzene azo alpha naphthylamine beta monosulpho acid, and coupling the diazo compound with paratolyl-alpha-naphthylamine monosulpho acid obtained from alpha naphthylamine monosulpho acid (1:8) and paratoluidine.

498,305—May 30, 1893. P. OTT. *Disazo dye.*

Produced by combining equal molecular proportions of diazotized aniline and Cleve's alphanaphthylamine beta monosulpho acid beta or delta, rediazotizing the amidoazo product, and coupling the resulting diazo compound with one molecular proportion of phenylalphanaphthylamine alpha monosulpho acid, obtainable from alpha naphthylamine monosulpho acid (1:8) and aniline. It dyes wool, with or without mordants, blue shades with a reddish hue.

498,571—May 30, 1893. H. HASSENCAMP. *Triphenylmethane dye.*

Produced by combining equi-molecular proportions of tetra methyldiamido-benzhydrol and dibenzylanilin disulpho acid, or salts thereof, and then oxidizing the resulting leuco compound. It dyes wool in a sulphuric-acid bath, easily fixed on fiber, a violet color similar to methyl-violet 5 B.

498,758—June 6, 1893. J. BAMMANN AND M. ULRICH. *Blue substantive dye.*

Produced by combining one molecular proportion of tetrazo ortho ditolyl salt with one molecular proportion of 1:8-amidonaphthol beta disulpho acid, or an alkaline salt thereof, and with one molecular proportion of dihydroxynaphthalene.

498,873—June 6, 1893. J. BAMMANN AND M. ULRICH. *Blue tetrazo dye.*

Produced by combining equi-molecular proportions of a tetrazo orthoditolyl salt with 1:8 amidonaphthol beta disulpho acid and alpha-naphthol alpha mono-sulpho acid; dyeing unmordanted cotton.

498,874—June 6, 1893. J. BAMMANN AND M. ULRICH. *Blue tetrazo dye.*

Produced by combining one molecular proportion of the tetrazo chloride of orthodiphenol ether with two molecular proportions of the 1:8-amidonaphthol-beta-disulpho-acid or its salts in alkaline solution; dyeing unmordanted cotton in alkaline soap bath greenish-blue shades, fast to alkalis.

498,882—June 6, 1893. M. HOFFMANN. *Naphthylene-diamine disulpho-acid.*

1.5-diamidonaphthalene-3.7-disulphonic acid, a light yellow insoluble tetrazo compound: produced by treating the naphthalene-beta-disulpho acid with nitric acid, and acting on the dinitro compound with reducing agents. It combines with phenols or amines, forming azo coloring matters.

498,982—June 6, 1893. C. KREKELER AND P. KRAIS. *Red dye.*

Produced by combining equal molecular proportions of alpha-naphthol-alpha-monosulpho acid ($OH:SO_3H=1.5$), or its alkaline salts, and diazotized amidobenzoic acid.

499,198—June 13, 1893. J. BAMMANN AND M. ULRICH. *Blue tetrazo dye.*

Produced by combining equi-molecular proportions of a tetrazodidiphenyl salt with 1.8-amidonaphthol beta disulpho acid and alphanaphthol alphamonosulpho acid, by preference in alkaline solution.

499,216—June 13, 1893. C. DUISBERG. *Blue tetrazo dye.*

Produced by combining one molecular proportion of a tetrazo salt of benzidine sulphone disulpho acid with two molecular proportions of monoethylbetanaphthylamine; dyeing unmordanted cotton, wool, or silk reddish blue.

499,243—June 13, 1893. E. MEYER. *Blue dye.*

Produced by acting with equal molecular proportions of tetra-alkyldiamido-benzhydrol on the products (new blue R) derived from nitrosodialkylanilines and beta naphthol; dyeing blue shades on cotton prepared with tannic acid or the like.

499,927—June 20, 1893. P. MONNET. *Anisolin, and process of making it.*

A coloring matter, or dye, having an alcoholic radical substituted for the metal of a rhodamin salt: produced by heating under pressure and above 100° C., a mixture of an alcoholic haloid salt, a rhodamin salt, and an alcohol—as ethyl alcohol, a potassium rhodamin salt, and a simple or compound alcoholic chloride—then diluting, distilling, adding hydrochloric acid, and precipitating with sea salt. It has a strong affinity for fiber, and dyes unmordanted cotton.

500,761—July 4, 1893. A. G. GREEN AND T. A. LAWSON. *Red azo dye.*

Para-azoxy-ortho-toluidin is prepared by treating a boiling solution of para-nitro-ortho-toluidin with a cold solution of sodium stannite. Substantive azo coloring matters of various shades of yellow, orange, and red are produced by converting para-azoxy-ortho-toluidin into its tetrazo compound, and combining the same with a phenol or amine, or their sulphonic or carboxylic acids, such as the para-sulphonic acid of alpha-naphthol, corresponding to Piria's naphthoic acid.

500,762—July 4, 1893. A. G. GEORGE AND T. A. LAWSON. *Red azo dye.*

Produced by treating azoxytoluidin of m. p. 168° C. with nitrous acid, combining the tetrazo compound thus obtained with one molecule of alpha-naphthol-para-sulphonic acid and one molecule of beta-naphthol-disulphonic acid R, and precipitating the coloring matter.

500,917—July 4, 1893. I. LIFSCHÜTZ. *Violet-red dye.*

Produced by treating ortho-nitro-anthraquinone with concentrated sulphuric acid and heating to about 200° C., and subsequently treating with a caustic potash solution. It shows a characteristic absorption spectrum.

501,069—July 11, 1893. H. HASSENCAMP. *Violet dye.*

A triphenylmethane dyestuff produced by combining equi-molecular proportions of tetramethyldiamidobenzhydrol and ethylbenzylanilin disulpho acid, or a salt thereof, oxidizing the resulting leuco compound, and converting it into the sodium salt. It dyes wool in an acid bath violet with a bluish tinge, fast to lime and ammonia.

501,104—July 11, 1893. F. RUNKEL. *Triphenylmethane dye.*

Produced by combining equi-molecular proportions of tetramethyldiamidobenzhydrol and benzoic acid in the presence of concentrated sulphuric acid, and oxidizing the resulting leuco compound. It gives green shades, fast against fulling.

501,118—July 11, 1893. M. ULRICH AND R. LAUCH. *Blue-black tetrazo dye.*

Produced by combining one molecular proportion of tetrazo-ortho-ditolyl salt with one molecular proportion of alphanaphthylamine, further diazotizing the product, and coupling the tetrazo compound thus obtained with two molecular proportions of 1.8-dihydroxynaphthalene alphamonosulpho acid or an alkaline salt thereof. It dyes unmordanted cotton in a neutral or alkaline soap bath from greenish-blue to bluish-black shades.

501,160—July 11, 1893. W. PFITZINGER. *Process of dyeing black.*

It consists, first, in dyeing cotton by a coloring matter such as is obtained by combining one molecule of tetrazo diphenyl, or analogous compounds thereof, with two molecules of amido naphthol monosulpho acid G; second, in diazotizing on the fiber; and, third, combining the resulting diazo compound with phenol.

501,235—July 11, 1893. B. R. SEIFERT. *Creosote compound.*

See Group XXIII, Fine Chemicals, Alcohols, and Phenols.

501,434—July 11, 1893. C. MÜLLER. *Violet dye.*

A sulphonated derivative of ortho-alkyl-oxy-para-rosaniline: produced by exposing the alkyl-ethers of meta-hydroxy-phenyl-para-tolylamine, meta-hydroxy-phenyl-ortho-tolylamine, or meta-hydroxy-phenyl-meta-xylyamine to the action of a condensing agent, such as phosphorus oxychloride or phosgene, in the presence of a diluent, such as toluene, and then sulphonating the basic coloring matter.

501,500—July 18, 1893. L. GANS AND M. HOFFMANN. *Black dye.*

Bluish-black coloring matters derived from tetrazo compounds of paradiamines, such as benzidine or analogous bodies, one molecule of gamma-amidonaphthol-sulpho acid, and one molecule of amidonaphtholdisulpho acid H. They produce blue to black shades on unmordanted cotton; can be diazotized, and secondary derivatives produced in substance or on the fiber.

502,368—August 1, 1893. R. LAUCH AND C. KREKELER. *Black azo dye.*

A greenish-black powder with metallic luster: produced by combining one molecular proportion of the diazo-compound of amidosalicylic acid with one molecular proportion of 1:8-dihydroxy-naphthalene. It dyes wool mordanted with chromium salts deep black, and produces the same shade on cotton when printed with chrome mordants.

502,369—August 1, 1893. R. LAUCH AND C. KREKELER. *Reddish-blue azo dye.*

A greenish-black powder with metallic luster: produced by combining equal molecular proportions of beta naptholcarbonic acid (m. p. 216° C.) and the diazo compound of amidosalicylic acid. It produces reddish-blue shades, fast against soap when printed with chromium mordants.

502,603—August 1, 1893. R. BOHN. *Green-blue alizarin dye.*

A dark-colored powder, soluble in alcohol, practically insoluble in ether and benzene, slightly soluble in cold water. Derived by the successive treatment of di-nitro-anthra-quinone, first with fuming and afterwards with concentrated sulphuric acid. It yields pure green-blue shades with chrome mordanted sheep's wool fiber.

502,765—August 8, 1893. R. E. SCHMIDT. *Blue alizarin dye.*

A dark-colored paste produced by treating the hexaoxyanthraquinone (alizarinhexacyanin of No. 506,265) with ammonia preferably in the presence of oxygen or atmospheric air. It produces on wool mordanted with alumina salts blue shades, and on wool mordanted with chromium salts greenish-blue shades.

502,912—August 8, 1893. A. F. POIRRIER AND D. A. ROSENSTIEHL. *Black azo dye.*

A secondary diazo of alkalized meta-diamine, produced by combining the diazo derivatives of the mono and disulphonic acids of aniline, of toluidins, of xylidins, and of isomeric naphthylamine, with naphthylamine, again diazotizing the compound obtained, and combining it with an alkalized secondary or tertiary meta-diamine (such as meta-phenylenediamine). It is but slightly soluble in water, characterized by great coloring power and dyeing wool in deep colors.

503,066—August 8, 1893. H. THOMS. *Salicylate of para-tolyldimethylpyrazolon.*

See Group XVIII, Fine Chemicals, Ketones.

503,148—August 15, 1893. R. LAUCH. *Substantive brown dye.*

A grayish-black powder, soluble in ammonia with brown color, produced by combining one molecular proportion of tetrazodiphenylchloride with one molecular proportion of salycilic acid and with one molecular proportion of alphanaphthylamine, sulphonating the tetrazo compound obtained and coupling one molecular proportion of the diazo derivative of this sulpho product with one molecular proportion of alphanaphthylamine. It dyes unmordanted cotton in neutral or alkaline baths.

503,295—August 15, 1893. R. E. SCHMIDT. *Hexaoxyanthraquinone, and process of making it.*

A new hexaoxyanthraquinone, which crystallizes out of nitro-benzene or glacial acetic acid in dark needles of metallic luster: produced by oxidizing with a body containing SO_3, alizarin, quinizarin, anthrachrysone or symmetrical dihydroxybenzoic acid, alizarin bordeaux, purpurin, purpuroxanthin or purpuro bordeaux, which latter product results when purpurin or purpuroxanthan is treated with fuming sulphuric acid. It dyes wool mordanted with alumina, violet, and mordanted with chromium salts, blue shades.

503,305—August 15, 1893. F. BENDER. *Orange dye.*

A basic orange coloring matter derived from acridin, which dissolves in water or spirit, and may be produced by eliminating ammonia from certain tetramido derivatives, which can be manufactured by condensing aldehydes (such as formaldehyde or benzaldehyde) with aromatic substituted metadiamins (such as meta-amidodimethylanilin).

506,265—October 10, 1893. R. E. SCHMIDT. *Alizarinhexacyanin.*

An alizarin dyestuff moderately soluble in alcohol and glacial acetic acid and crystallizing therefrom in dark brilliant crystals, produced by oxidizing alizarin pentacyanin or alizarin bordeaux. It produces violet shades with aluminum mordants and blue shades with chrome mordants.

506,284—October 10, 1893. M. ULRICH AND J. BAMMANN. *Blue coloring matter, and process of making same.*

A coloring matter giving on unmordanted cotton from blue to greenish-blue shades (fast to the action of alkali and acid), produced by the reaction of one molecular proportion of the tetrazo compound of tolidin or dianisidin with two molecular proportions of 1:8-amidonaphthol-alpha-mono-sulpho acid $(NH_2:SO_3H:OH=1:4:8)$ in an alkaline solution. It is further diazotizable when fixed on the fiber.

506,918—October 17, 1893. R. KOTHE, F. REINGRUBER, AND H. HASSENCAMP. *Blue coloring matter.*

Blue triphenyl-methane dyestuffs, dark powders with bronze luster, produced by combining equi-molecular proportions of tetramethyl (or ethyl) diamidobenzhydrol and alpha naphthylamin sulpho acid $(NH_2:SO_3H=1:2)$, sulphonating the resulting leuco compound and oxidizing the thus obtained new leuco sulpho acid (or its salts).

509,623—November 28, 1893. R. LAUCH. *Brown dye.*

A dark brown paste, produced by combining one molecular proportion of a diazotized amido hydroxy carbonic acid of the aromatic series with one molecular proportion of resorcinol or orcinol, and acting on the intermediate body thus obtained with nitrous acid. It dyes unmordanted wool brown, and produces brown shades on fibers mordanted with metallic mordants, either in dyeing or printing.

509,635—November 28, 1893. M. ULRICH AND J. BAMMANN. *Brown dye.*

A brown substantive coloring matter, which can be diazotized when fixed on the fiber, produced by the action of one molecular proportion of tetrazodiphenyl salt upon one molecular proportion of the amido-naphthol-disulpho acid $(NH_2:SO_3H:SO_3H:=1:3:6:8)$, or an alkaline salt thereof, and one molecular proportion of the so-called Bismarck brown (which results from the action of nitrous acid on meta phenylene diamine).

509,929—December 5, 1893. M. MOELLER. *Blue azo dye.*

Blue azo dyes derived from 1:8–amidonaphtholmonosulphonic acid and tetrazoditolyl or tetrazodiphenolether, and which may be prepared by melting with alkali the alphanaphthylaminedisulpho acid mentioned in No. 333,934.

511,532—December 26, 1893. R. KOTHE, M. ULRICH, AND O. DRESSEL. *Blue dye.*

Bluish-black powder: produced by acting with one molecular proportion of a tetrazo compound of the paradiamines on two molecular proportions of the sodium salt of amidonaphtholdisulpho acid $(NH_2: SO_3H: SO_3H: OH=1:2:4:8)$ in an alkaline solution. It produces on unmordanted cotton greenish-blue shades, fast against alkalies.

511,653—December 26, 1893. G. SCHULTZ. *Blue dye.*

Blue basic dyes, produced by the joint oxidation of alkalized derivations of para-phenylenediamin containing one free amido group with di-para-tolylmetaphenylenediamin in a suitable solvent by means of chromates; a violet-black powder easily soluble in water or alcohol, insoluble in ether.

511,708—December 26, 1893. M. MOELLER. *Production of amido naphthol disulphonic acid.*

A new amido-naphthol-disulphonic acid (a disulphonic acid of 1:8-amido naphthol), soluble in water, yielding no diazo compound when treated with nitrite, turning dark green on the addition of ferric-chloride; produced by converting the alphanaphthylaminedisulphonic acid (of German patent No. 40,571) by further sulphonation into alphanaphthylaminetrisulphonic acid, and melting the salts of the latter with caustic alkalis in an open or closed vessel.

511,898—January 2, 1894. H. KUŽEL. *Naphthol trisulfonic-acid monamid.*

The salts of naphtholtrisulphonic-acid monamid, which are soluble in water and precipitated by alcohol and acids, the latter precipitating moss like. They are produced by treating the naphthosulphton-disulphonic acid (described in German patent No. 56,058) with ammonia.

511,901—January 2, 1894. H. LAUBMANN. *Tetranitro-anthrachrysone.*

A yellow powder produced by submitting anthrachrysone to the action of nitric acid; easily soluble in the usual solvents except benzene, ligrone, and chloroform; from its pure glacial acid solution precipitated by chloroform in the form of small crystals, which decompose with detonation at 280° to 300° C.; forming with potassium, sodium, and ammonium, salts insoluble in alcohol, detonating on being heated.

512,116—January 2, 1894. R. KIRCHHOFF. *Crimson azo dye.*

A red-brown powder produced by combining paradiazobenzene-sulpho acid with ortho anisidin, further diazotizing the amidoazo compound thus obtained, and combining the rediazotized product with beta naphthol alpha monosulpho acid.

512,167—January 2, 1894. T. DIEHL. *Blue-black dye.*

An amorphous black-brown powder, derived from the diazo compound of para-amido-benzene-azoamido-alphanaphthalin and paraamidonaphtholmonosulphoacid, soluble in water, sparingly soluble in alcohol. The alpha-naphthol-alpha-monosulpho acid or the naphthionic acid may be substituted for the para-amidonaphtholmonosulpho acid.

512,493—January 9, 1894. M. ULRICH AND J. BAMMANN. *Blue dye.*

Blue substantive dyestuffs, easily soluble in water, produced by combining one molecular proportion of a paradiamin, such as dianisidin, with one molecular proportion of the alkaline salt of amidonaphtholdisulpho acid $(NH_2:SO_3H:SO_3H:OH=1:3:6:8)$, and coupling the so-formed intermediate product with one molecular proportion of beta naphthol or alpha naphthol monosulpho acid $(OH:SO_3H=1:5)$.

514,599—February 13, 1894. M. HOFFMANN AND C. F. DAIMLER. *Diazo dark-green dye.*

A dark-green powder, easily soluble in water with a bluish or greenish color, produced by treating one molecule of the amidonaphtholdisulphonic acid H with a solution of one molecule of a diazo body in presence of free acid, making the solution alkaline, and adding one molecule of a tetrazo body; the solution which now contains the intermediate product is mixed with the solution of a phenol, or of an amine, and the dyestuff is precipitated with common salt.

515,100—February 20, 1894. A. WEINBERG. *Basic yellow dye.*

New dyes, as a yellow powder, derived from diazobenzyl-dialkylamin and resorcin. HCL. $(\text{alk.})_2N-CH_2-C_6H_4-N=N-C_6H_3(OH)_2$, are produced by combining diazobenzylalkylamins with phenols or amins.

515,339—February 27, 1894. A. ISRAEL AND K. PATHE. *Gray dye.*

A gray powder, soluble in cold water with difficulty, easily soluble in hot water with a grayish-black color: produced by combining one molecular proportion of diazotized dehydrothiotoluidinsulpho acid with one molecular proportion of alpha naphthylamin, further diazotizing the intermediate product and coupling the diazo product with one molecular proportion of dihydroxynaphthalene monosulpho acid S, or a salt thereof. On unmordanted cotton it produces from bluish-gray to grayish-black shades, the latter fast against alkali and acid.

515,381—February 27, 1894. M. ULRICH, J. BAMMANN, AND M. HERZBERG. *Brown dye.*

A brown substantive coloring matter produced by treating tetrazo-diphenyl chloride with one molecular proportion of amidonaphtholdisulpho acid, $(NH_2:SO_3H:SO_3H.OH\text{-}1:3:6:8)$, adding to the product one molecular proportion of metaphenylene diamine, and acting on the dyestuff thus produced (an intermediate product) with one molecular proportion of diazoalpha-naphthalene chloride. When fixed on cotton fiber it can be diazotized and directly coupled with any dyestuff component.

515,897—March 6, 1894. J. J. BRACK. *Polyazo dye.*

Yellow polyazo coloring matters: produced by combining a molecule of dioxydiphenylmethane with two molecules of diazo-compounds, of which one at least is the intermediate product resulting from the union of a molecule of salicylic acid and a molecule of the tetrazo derivative of a paradiamido base, such, for example, as benzidin, tolidin, and formaldehyde-tolidin.

516,293—March 13, 1894. M. HOFFMANN AND C. KROHN. *Gray azo dye.*

A blackish-gray powder produced by combining tetrazo bodies with two molecules of amidonaphtholdisulphonic acid H, brought together with nitrite in an acid solution, and the diazo compounds thus obtained are introduced into the solutions of phenols or amines in presence of alkalis. It dyes unmordanted cotton a fast gray.

516,380—March 13, 1894. C. RUDOLPH. *Brown azo dye.*

A blackish powder, dying cotton in an alkaline bath in yellow-brown shades, produced by reacting on diazotized toluylendiaminsulpho acid $(CH_3 : NH_2 : SO_3H : NH_2 = 1 : 2 : 4 : 6)$ with meta-phenylendiamine and separating the dye.

516,381—March 13, 1894. C. RUDOLPH. *Azo dye from amidophenolsulfo-acid.*

A greenish-black powder, with a slight metallic luster, dyeing unmordanted cotton in a corinth shade, produced by adding tetrazo ditolylchlorid to an aqueous solution of a sodium salt of amidophenolsulphonic acid and soda, next adding to the intermediate product a solution of resorcin in soda lye to form an intermediate dyestuff, treating said dyestuff with diazonaphthionic acid in an aqueous emulsion, heating the mass, and precipitating the dyestuff with common salt.

516,568—March 13, 1894. J. J. BRACK. *Yellow tetrazo dye.*

Yellow tetrazo coloring matters, as a compound derived from salicylic acid and the condensation product of formaldehyde with a paradiamin and a hydrochlorate of said paradiamin, which in a dry state is brownish powder readily soluble in water, dyeing unmordanted cotton, in an alkaline bath, are produced by first preparing diamido a base by the condensation of formaldehyde with a paradiamin and a hydrochlorate of said paradiamin, diazotizing, and then mixing the tetrazo derivative with a solution of a carboxylic acid in an alkali.

516,577—March 13, 1894. E. SCHLEICHER. *Basic yellow dye.*

A gold-yellow or orange dye, a diamido-phenyl-acridin, carboxylalkylester, soluble in alcohol and in water, giving red yellow stable solutions possessing a strong yellowish-green fluorescence, may be produced by submitting a body—$C_{20}H_{14}N_2O_2$—to esterification, as by heating with an alcohol, in the presence of hydrochloric acid, sulphuric acid, and the like; said body being obtained by suitably treating fluorescein with ammonia.

516,584—March 13, 1894. H. A. BERNTHSEN. *Red dye.*

A dye, dialkyl-rhodamin-alkyl-ester, derived from dialkyl-rhodamin; as a base soluble in benzene, ether, and warm water, and in the commercial form of hydrochloric-acid salt, a bronze-like crystalline powder soluble in water, giving a scarlet-red solution, possessing a greenish-yellow fluorescence. The introduction of the alkyl-group into the symmetrical diakyl-rhodamins can be effected by the action of alcohols, especially methyl or ethyl, in presence of a mineral acid, muriatic or sulphuric.

516,585—March 13, 1894. H. A. BERNTHSEN. *Red rhodamin dye.*

A dye, a dialkyl-homo-rhodamin-alkyl-ester, readily soluble in water, giving red and strongly fluorescent solutions: produced by preparing a mono-alkyl-ortho-toluidin-sulpho-acid by sulphonation of mono-alkyl-ortho-toluidin, and converting this sulpho acid into mono-alkyl-meta-amido-cresol by melting with a caustic alkali, then obtaining therefrom diakyl-homorhodamin by heating with phthalic anhydrid and zinc chloride, and finally alkylating the dialkyl homo-rhodamin by treatment with alcohol and either hydrochloric or sulphuric acid.

516,588—March 13, 1894. M. CERESOLE. *Rhodamin dye.*

Coloring matters, produced by heating tetra-alkylated rhodamin to partially dealkylate the same. The dyestuff obtained by partially dealkylating the tetra-ethyl-rhodamin of the phthalic-acid series, in the form of its hydrocloric-acid salt is a dark-colored crystalline powder with a bronze-like sheen, soluble in water and in alcohol, dyeing more yellowish shades of red than the tetra-ethyl-rhodamin from which it can be obtained.

516,589—March 13, 1894. M. CERESOLE. *Rhodamin dye.*

A dyestuff, partially dealkylated tetra-methyl-rhodamin of the succinic-acid series, in the form of its hydrochloric-acid salt, appearing as a dark-colored crystalline powder soluble in water and in alcohol, but practically insoluble in ether or benzine.

516,604—March 13, 1894. R. KIRCHHOFF. *Black dye.*

A black dyestuff, readily soluble in water, sparingly soluble in alcohol, insoluble in ether: produced by combining one molecular proportion of tetrazoorthoditolyl salt with one molecular proportion of the amido-oxynaphthalendisulphonic acid of No. 458,286, further diazotizing the intermediate product, and coupling the tetrazo compound thus obtained with two molecular proportions of meta toluylendiamin. It dyes unmordanted cotton in a salt or alkaline bath a deep black.

516,752—March 20, 1894. J. J. BRACK. *Diamido base.*

Unsymmetric diamido-bases, suitable for the production of substantitive cotton dyes, as the base derived from formaldehyde, tolidin, and orthoamidophenol, a yellow-brown mass forming salts, the aqueous-acid solutions of which have a pronounced green fluorescence, are produced by the reaction under heat of one molecule of formaldehyde on a mixture of one molecule of a paradiamin and one molecule of the hydrochlorate of an aromatic monoamido-compound.

516,753—March 20, 1894. J. J. BRACK. *Diamido base.*

Diamido-bases, applicable to the manufacture of substantive cotton dyes, as the base derived from formaldehyde, tolodin, and metaphenylendiamin, which, in a dry state, is a light brown powder, are produced by condensing, with the aid of heat, one molecule of formaldehyde with a mixture of one molecule of a paradiamin and one molecule of the chlohydrate of an aromatic diamin.

516,754—March 20, 1894. J. J. BRACK. *Diamido base.*

Diamido-bases, applicable to the manufacture of substantive cotton dyes, are produced by condensing, with the aid of heat, one molecule of formaldehyde with a mixture of one molecule of dianisidin and one molecule of the basic hydrochlorate of an aromatic diamin. The base derived from hydrochlorate of metaphenylendiamin is a brown powder, insoluble in water, soluble in hydrochloric acid, and forms salts readily soluble in water.

516,755—March 20, 1894. J. J. BRACK. *Diamido base.*

A diamido-base, applicable to the manufacture of substantive cotton dyes, is produced by the reaction, under heat, of one molecule of formaldehyde on a mixture of one molecule of dianisidin and one molecule of the chlorhydrate of an aromatic monoamido-compound. The base derived from the hydrochlorate of aniline is a resinous mass, fusing at 75° to 80° C., and forms salts and a tetrazo-derivative soluble in water.

516,756—March 20, 1894. J. J. BRACK. *Red tetrazo dye.*

Tetrazo coloring matters are produced by combining two molecules of a naphthylamin-sulpho acid with one molecule of the tetrazo-derivative of the unsymmetrical diamido-base resulting from the condensation of one molecule of formaldehyde with one molecule of the hydrochlorate of a monoamido compound. The tetrazo coloring matter derived from alpha-naphthionic acid and an unsymmetrical diamido base obtained by the condensation of formaldehyde with tolidin and the hydrochlorate of a monoamido compound, is a red brown powder, readily soluble in water, dyeing unmordanted cotton a red tint.

516,757—March 20, 1894. J. J. BRACK. *Blue tetrazo dye.*

Tetrazo coloring matters are produced by combining two molecules of a naphtholsulpho acid with one molecule of the tetrazo derivative of the unsymmetrical diamido base resulting from the condensation of equivalent quantities of formaldehyde, dianisidin, and the hydrochlorate of a monoamido compound, as of aniline or orthoamidophenol. The tetrazo coloring matter derived from an unsymmetrical diamido-base in a dry state is a brown powder possessing a metallic luster, and dyes unmordanted cotton a blue tint.

516,758—March 20, 1894. J. J. BRACK. *Blue tetrazo dye.*

Tetrazo coloring matters are produced by combining two molecules of alpha-naphthol-alpha-sulpho-acid with one molecule of the tetrazo-derivative of the diamido base resulting from the condensation of equivalent quantities of formaldehyde, tolidin, and the hydrochlorate of an aromatic diamin. The coloring matter derived from alpha naphthol alpha-monosulpho-acid and the diamido-base from the condensation of formaldehyde, tolidin, and the hydrochlorate of metaphenylenediamin is a brown powder with a metallic luster, soluble in water, and dyes unmordanted cotton in an alkaline bath a blue tint.

516,759—March 20, 1894. J. J. BRACK. *Red tetrazo dye.*

Tetrazo coloring matters are produced by combining two molecules of a naphthylamin-sulphonic acid with one molecule of the tetrazo-derivative of the diamido-base resulting from the condensation of equivalent quantities of formaldehyde, a paradiamin and the hydrochlorate of an aromatic diamin. The coloring matter derived from alpha-naphthionic acid and the diamido-base from the condensation of formaldehyde with tolidin and hydrochlorate of metaphenylendiamin is a red powder and dyes unmordanted cotton a red tint.

516,760—March 20, 1894. J. J. BRACK. *Blue tetrazo dye.*

Tetrazo coloring matters are produced by combining two molecules of alpha-naphthol-sulphonic acid with one molecule of the tetrazo-derivative of the diamido-base resulting from the condensation of equivalent quantities of formaldehyde, dianisidin, and the hydrochlorate of an aromatic diamin. The coloring matter derived from alpha-naphthol-alpha-mono-sulpho acid and the diamido base from condensation of formaldehyde with dianisidin and the hydrochlorate of an aromatic diamin is a brown powder, dyeing unmordanted cotton a blue tint.

517,533—April 3, 1894. A. WEINBERG. *Process of dyeing by the aid of paramidodiphenylamin.*

Fast colors are produced on fiber dyed with a diazotizable dyestuff, by treating such dyeings in a first bath with free nitrous acid, and developing the color in a second bath containing paramidodiphenylamin.

518,458—April 17, 1894. K. KREKELER AND P. KRAIS. *Blue dye.*

A blue coloring matter is produced by the reaction of nitrosodiethylaniline hydrochlorate and gallamic acid in the presence of solvents, as alcohol or acetic acid. It is soluble in hot water and dyes wool and cotton, mordanted with chromium salts, from blue to bluish violet.

518,989—May 1, 1894. H. A. FRASCH. *Petroleum sulfo-acid.*

Sulpho acids are obtained by sulphonating the aromatic series of hydrocarbons contained in petroleum or the distillates or residuums thereof; leaching the sulphonated product with cold water; subjecting the remainder to the action of hot water; separating the matter soluble in hot water, adding a base, such as lime, to the hot-water solution; separating the soluble and insoluble sulpho salts thereby obtained; and liberating from the solution of the soluble salt an acid by the addition of a reagent, such as hydrochloric acid. The new sulpho acid is unaffected by concentrated hydrochloric acid, decomposes into sulphur dioxide and a greenish-black oil at a red heat, is of a greenish-black color when solid, capable of dyeing silk and wool, without mordant, a yellowish color, and its alkaline salts dye wool and silk a bright yellow.

518,990—May 1, 1894. H. A. FRASCH. *Petroleum sulfo-acid.*

A sulpho acid, whose calcium salt is insoluble in water, is obtained from petroleum, its derivatives or distillates, by sulphonating the material; removing the free sulphuric acid; separating the soluble and the insoluble and oily matters from the remainder; converting the soluble matter into a soluble and an insoluble salt by, for example, the addition of carbonate of lime; separating the insoluble salt, and rendering it soluble by a suitable reagent, such as carbonate of sodium, caustic soda, or other substance that will displace the base contained in the insoluble salt, and precipitating from such solution the sulpho acid by hydrochloric or equivalent acid. It is of greenish-black color, soluble in water, fluorescent in solution, and dyes wool or silk a brownish color without a mordant.

518,991—May 1, 1894. H. A. FRASCH. *Brown petroleum nitro dye.*

A nitro body, in the form of a reddish-brown powder, is produced by nitration of petroleum, or the residuum of the distillation, or refining thereof, with nitro-sulphuric acid; washing the resulting product with water, heating with water, settling; removing the solution from the sediment and treating it with a base, such as lime, and thereby forming a soluble and an insoluble salt; and precipitating from the soluble salt solution the dyestuff by a reagent, such as sodium chloride. It is soluble in water, glycerine, and acetone, capable of dyeing wool or silk, without a mordant, a reddish brown, and its calcium salt is soluble in water.

518,992—May 1, 1894. H. A. FRASCH. *Petroleum dye.*

A yellow dyestuff, a sulpho body of the petroleum series of hydrocarbons, is produced by subjecting natural mineral oil, the distillates or residuums thereof, to sulphonation; washing the products of sulphonation with water, treating the products soluble in hot water with a base, such as lime; and isolating from the sulpho salts thereby obtained the dyestuff by treatment with an alkali and then with a precipitant, such as sodium chloride. It is soluble in water, glycerine, and acetone, fluorescent in solution, and dyes wool or silk, without a mordant, in acidulated solution, a canary yellow.

519,036—May 1, 1894. H. A. FRASCH. *Brown petroleum dye.*

A brown dyestuff is obtained from petroleum, or the distillates or residuums thereof, by nitrating the material, washing with water, dissolving the nitro products in hot water, decanting the solution from the remainder and treating it with a base, such as lime; separating the insoluble salt formed and rendering it soluble by the addition of an alkali, such as sodium carbonate; dissolving it in water and precipitating the dyestuff from the solution by the addition of a reagent, in whose solution the dyestuff is insoluble, such as sodium chloride.

It is soluble in water, acetone, and glycerine, dyes cotton without a mordant, and its calcium salt is insoluble in water.

519,522—May 8, 1894. J. J. BRACK. *Polyazo yellow dye.*

A polyazo coloring matter is produced by combining one molecule of dioxydiphenylmethane with two molecules of diazo-compounds, one of said compounds constituting the intermediate product resulting from the union of one molecule of sulphanilic acid with one molecule of the tetrazo-derivative of a paradiamin, such for instance as benzidin. It is a brown powder soluble in water, and soluble in sulphuric acid with a reddish-violet coloration, and dyes unmordanted cotton in an alkaline bath yellow.

519,523—May 8, 1894. J. J. BRACK. *Polyazo yellowish dye.*

Polyazo coloring matters, varying from red to orange, are produced by combining one molecule of dioxydiphenylmethane with two molecules of diazo-compounds, of which compounds one at least is the intermediate product resulting from the union of one molecule of naphthionic acid and one molecule of the tetrazo-derivative of a paradiamido base, such as benzidin, tolidin, tolidin-formaldehyde, dianisidin, or dianisidin-formaldehyde. A brown powder is produced from dioxydiphenylmethane, tetrazoditolyl, and naphthionic acid, which dyes unmordanted cotton a yellowish-red color in an alkaline bath, is soluble in water, and in concentrated sulphuric acid with a blue coloration.

519,971—May 15, 1894. J. SCHMID AND J. BACHELUT. *Blue dye.*

A blue acid coloring matter is produced by heating mixtures of equal molecular proportions of dialkylized aniline, alkylized ortho-toluidin, and meta oxybenzaldehyde in presence of condensing agents, then sulphonating, and finally oxidizing the thus obtained new leoco-sulpho acid. It is a dark powder with metallic luster, soluble in water with blue coloration, soluble in alcohol, but insoluble in ether and benzene.

521,095—June 5, 1894. H. A. BERNTHSEN AND P. JULIUS. *Substantive blue dye.*

A coloring matter which can be derived from tetrazo-ditolyl, the 2.4′.2-amidonaphtholsulpho acid and 1.4-naphthol-sulpho acid. It is readily soluble in water, giving red-violet solutions; soluble in sulphuric acid, giving a blue solution and on diazotizing on the fiber, assumes a blue color.

521,096—June 5, 1894. H. A. BERNTHSEN AND P. JULIUS. *Substantive violet dye.*

A dark powder which can be derived from tetrazo-diphenyl and the 2.4′.2′-amidonaphthol-sulpho acid. It is readily soluble in water, giving claret-red solutions; soluble in sulphuric acid, giving a blue solution; and on diazotizing on the fiber, assumes a grayish-green color.

521,985—June 26, 1894. M. MOELLER. *Blue dye.*

A blue dyestuff derived from 1.8-amidonaphtholdisulpho acid (No. 511,708) and the tetrazo compound of ortho-tolidin. It is easily soluble in water, nearly insoluble in alcohol, dissolving with indigo-blue color in strong sulphuric acid.

521,986—June 26, 1894. M. MOELLER. *Blue dye.*

A blue dyestuff derived from 1.8-amidonaphtholdisulpho acid and the tetrazo compound of diamidodiphenol ether. It is easily soluble in water, nearly insoluble in alcohol, and soluble in strong sulphuric acid, with indigo-blue color.

522,042—June 26, 1894. A. BLANCHON AND A. ALLEGRET. *Process of printing indigo.*

Textile fabrics or yarns are printed with a mixture of refined or crude indigo and a solution of a thickening substance in water, then passed through a reducing bath, as of hyposulphite of lime, to reduce the indigo deposited on the fabric or yarn, and the indigo is then reoxidized in the usual manner.

522,897—July 10, 1894. W. HERZBERG AND O. WEBER. *Blue dye.*

Blue coloring matters are obtained by the condensation of orthoquinones or their sulpho acids with alkyl-para-phenylendiamins or their sulpho acids, when heated with sulphur and fuming sulphuric acid; capable of forming with metallic mordants, lakes, which dye with fast blue tints; specially suited for dyeing and printing wool and cotton, previously mordanted with chromium.

523,138—July 17, 1894. R. VIDAL. (*Reissue: 11,659—April 5, 1898. Black dye and process of making same.*

Greenish-black, bluish-black, and black dyestuffs, capable of dyeing without mordants, are produced by heating ortho or para-dioxybenzene, such as quinone, hydroquinone, toluquinone, or paracatechin in the presence of sulphur and of ammonia, or substances which will generate ammonia during the reaction. They are soluble in alkalis and alkaline sulphites.

524,069—August 7, 1894. C. O. MULLER. *Blue tetrazo dye.*

A new dioxy-naphthalene mono-sulpho acid is produced by melting alpha oxy-naphthoic acid ($OH.COOH.SO_3H.SO_3H=1.2.4.7$) with caustic alkali at 230° to 290° C.

Tetrazo coloring matters are produced by the combination of one molecule of the tetrazo derivative of an aromatic para-diamido compound (such as tetrazo-diphenyl and its homologues, tetrazo-oxydiphenyl-alkyl ethers, tetrazo-stilbene, and tetrazo-azobenzene and its homologues) with one molecule of the dioxy-naphthalene mono-sulpho acid ($OH.OH.SO_3H=1.7.4.$); and the subsequent combination of the intermediate product with a sulpho derivative of a naphthol compound, such as the mono-sulpho and disulpho acids of alpha and beta naphthols, of oxy-naphthols, of amido-naphthols, and the sulpho-acids of carboxylic oxy-naphthols.

The coloring matter derived from dianisidin, dioxy-naphthalene mono-sulpho acid, and disulpho acid of beta-naphthalene, dyes unmordanted cotton, in an alkaline bath, a fast greenish blue; and, in a dry state, is a brown powder with a metallic luster, readily soluble in water and concentrated sulphuric acids with a blue coloration.

524,070—August 7, 1894. C. O. MULLER. *Blue tetrazo dye.*

A new dioxy-naphthoic-mono-sulpho acid is produced by fusing alpha-oxy-naphthoic-disulpho acid ($OH.COOH.SO_3H.SO_3H=1.2.4.7$) with caustic alkali at 189° to 200° C.

Coloring matters are produced by substituting this sulpho acid for the dioxy-naphthalene mono-sulpho acid of No. 524,069.

524,220—August 7, 1894. C. SCHRAUBE. *Substantive blue dye.*

A substantive blue dyestuff is produced by combining the tetrazo-compound of diamido-diphenyl-dicarboxylic acid with 1.1′-benzoyl-amido-naphthol-sulpho acid. It is slightly soluble in cold water, more so in hot water, and insoluble in absolute alcohol, ether, and benzene.

524,221—August 7, 1894. C. SCHRAUBE AND E. ROMIG. *Phenylrosindulinsulfo-acid.*

A monosulpho acid of phenyl-rosindulin—isomeric with No. 428,539—is obtained by the reaction of ortho-amido-diphenylamin-para-sulpho acid and beta-hydroxy-naphthoquinone anil. It is almost insoluble in water, yields alkaline salts, soluble in hot and cold water, and is converted by sulphonation into a disulpho acid which is a violet-red dye for animal fiber.

524,222—August 7, 1894. C. SCHRAUBE AND E. ROMIG. *Violet-red dye.*

A disulpho acid of phenyl-rosindulin is produced by heating together ortho-amido-diphenylamine-para-sulpho acid and beta-hydroxy-naphtholquinone-anil with water and alcohol, and subsequently introducing the second sulpho groups into the monosulpho acid obtained by treatment with concentrated sulphuric acid. It is a violet powder, and, in the form of its alkaline salts, is soluble in water, and dyes animal fiber from an acid bath.

524,235—August 7, 1894. O. BALLY. *Blue dye.*

A coloring matter—in the dry form a coppery-lustered powder—produced by heating gallic acid and the dialkyl-anilins (diethyl and dimethyl-anilin) in the presence of a condensing reagent, such as phosphorus oxychloride, and afterwards zinc chloride. It is slightly soluble in cold water, more soluble on boiling; gives a violet solution in alcohol, and a reddish-yellow solutionin concentrated sulphuric acid.

524,251—August 7, 1894. P. JULIUS. *Soluble safranin azo naphthol.*

Saffranin-azo-alpha-naphthol, containing a saffranin proper, and soluble in water, may be prepared from a solution of saffarin proper and alpha or beta naphthol. When dry it is a dark powder with a slight metallic sheen, insoluble in alkalis, soluble in alcohol, and gives in sulphuric acid a blackish yellow-brown solution.

524,252—August 7, 1894. P. JULIUS. *Dimethyl safranin azo naphthol.*

Dimethyl-saffranin-azo-beta naphthol, soluble in water, may be prepared from a solution of dimethyl-saffranin and alpha or beta naphthol. It gives in sulphuric acid a blackish-green solution.

524,253—August 7, 1894. P. JULIUS. *Safarin azo naphthol dye.*

Dimethyl-saffranin-azo-alpha naphthol, soluble in water, may be prepared from dimethyl saffranin and alpha or beta naphthol. It gives in sulphuric acid a blackish-yellow solution.

524,254—August 7, 1894. P. JULIUS. *Safranin azo naphthol lake.*

A soluble saffranin-azo-naphthol body, obtained by treating a saffranin-azo-naphthol with an acid. A coloring-matter lake resembling indigo in color is obtained by combining a soluble saffranin-azo-naphthol body with a tanno-metallic mordant.

524,256—August 7, 1894. R. KNIETSCH. *Blue dye.*

A blue dyestuff, soluble in water and in alcohol, is produced by dissolving phenyl-glycocoll in strongly fuming sulphuric acid, then diluting by adding sulphuric acid containing water, then passing a current of air through the solution, and finally isolating the coloring matter formed.

524,261—August 7, 1894. C. L. MULLER. *Orange disazo dye.*

A diazo dye, which can be derived from meta-phenylene-diamin-disulpho acid and the diazo-compounds from primulin and anilin sulpho acid, occurring as a brown powder, soluble in water, giving an orange-colored solution, and a brilliant red solution in concentrated sulphuric acid.

524,262—August 7, 1894. C. L. MULLER. *Orange dye.*

An orange-yellow dye, produced by first preparing a disulpho acid of meta-phenylene-diamin by treating meta-phenylene-diamin with fuming sulphuric acid (with at least two molecular proportions of free sulphuric anhydride present for one molecular proportion of meta-phenylene-diamin), and then combining this disulpho acid with diazo-primulin. It is a brown powder soluble in water, giving an orange-yellow solution; same in sulphuric acid.

524,323—August 14, 1894. B. HEYMANN. *Blue dye.*

Blue coloring matters, dyeing cotton and wool with the aid of mordants: produced by the action of the nitroso compounds of alkylated benzylanilin sulpho acids on beta naphthoquinone sulpho acid (1:2:4) in the presence of sodium thiosulphate.

524,665—August 14, 1894. C. BULOW. *Black disazo dye.*

Black dyes, the diazo compounds of 1.8 amido-naphthol-monosulpho acid, can be obtained by the combination of two molecular proportions of a diazo compound with one molecular proportion of the aforesaid sulpho acid. They are soluble in hot water, giving blackish-blue solutions, which are changed to a pure blue to violet on the addition of a caustic alkali. The specific black dye obtained from a diazo compound of sulphanilic acid, aniline, and the aforesaid sulpho acid yields a green solution in sulphuric acid.

524,677—August 14, 1894. E. ELSAESSER. *Blue dye.*

A blue coloring matter produced by treating the beta-dinaphthyl-meta-phenylendiamin disulphonic acid in a dilute acetic solution with nitroso-dimethylaniline. It easily dissolves in water and dyes wool and silk in an acid bath.

525,656—September 4, 1894. P. JULIUS. *Azo dye.*

An azo dye which can be derived from meta-dinitro-aniline and dialkyl-meta-sulphanilic acid, occurring as a crystalline powder readily soluble in hot water, giving a scarlet solution, turning red on the addition of hydrochloric acid, and a bluish-red solution in concentrated sulphuric acid.

525,657—September 4, 1894. P. JULIUS. *Azo dye.*

An azo dye which can be derived from para-nitraniline and diakyl-meta-sulphanilic acid, occurring as a crystalline powder, soluble in water and alcohol, and gives a red to reddish-yellow solution in concentrated sulphuric acid.

531,148—December 18, 1894. J. BIERER AND C. DE LA HARPE. *Blue dye.*

Blue coloring matters are produced by oxidizing the product of condensation of the beta-naphthol sulphonic acid of Schaeffer and a gallocyanin dye resulting from the condensation of hydrochlorate of nitrosodialkylaniline, or of hydrochlorate of dialkylamidoazobenzene and gallic acid or its derivatives. It dyes wool mordanted with chrome mordants, in an acid bath, a blue tint, and is soluble in alkalis with a violet-blue coloration.

531,149—December 18, 1894. J. J. BRACK. *Substantive red dye.*

A hexazo-coloring matter produced by combining three molecules of a naphthylaminsulpho-acid with one molecule of the hexazo-derivative of the triamido-base derived from the condensation of formaldehyde with tolidin; formaldehyde is heated with tolidin in the presence of an excess of hydrochloric acid in dilute aqueous solution. It is a brick-red powder which dyes unmordanted cotton red, readily soluble in hot water, slightly soluble in alcohol, and soluble in concentrated sulphuric acid with a blue-violet coloration.

531,973—January 1, 1895. C. SCHRAUBE AND C. SCHMIDT. *Nitrosamin compound.*

The nitrosamins of the primary amins are produced by treating certain diazo compounds such as diazo-nitro aniline, with a caustic alkali. As sodium salts they are soluble in water, with somewhat alkaline reaction and produce no azo-dye in the presence of beta-naphtholate of sodium and alkali, but on treatment with an excess of acid are converted into the corresponding diazo compound which yields coloring matter on combination with beta naphtholate of sodium. Para-nitro-phenyl-nitrosamin occurs as a yellowish paste or powder.

531,974—January 1, 1895. C. SCHRAUBE AND C. SCHMIDT. *Nitrosamin compound.*

A nitrosamin derived from the tetrazo-compound of benzidin, both in the free state and as a salt in the form of a sodium salt occurring as a yellowish powder soluble in water, yielding a brownish violet color when brought on the fiber with sodium beta-naphtholate and subsequently exposed to the air.

531,975—January 1, 1895. C. SCHRAUBE AND C. SCHMIDT. *Nitrosamin compound.*

A nitrosamin derived from the diazo compound of para-dichloraniline, both in the free state and as a salt, as a sodium salt occurring as a yellowish powder; readily soluble in water, and yielding an orange color when brought on the fiber with beta naphtholate and subsequently exposed to the air. On treatment with a molecular proportion of an acid it assumes the free state.

531,976—January 1, 1895. C. SCHRAUBE AND C. SCHMIDT. *Nitrosamin compound.*

A nitrosamin derived from diazo-naphthalene; a yellowish powder and in the form of sodium salt soluble in water; yielding red shades when brought on the fiber together with sodium beta-naphtholate and subsequently exposed to the air.

531,977—January 1, 1895. C. SCHRAUBE AND C. SCHMIDT. *Nitrosamin compound.*

A nitrosamin, which in the form of sodium salt can be derived from tetrazodianisidin; occurring as a yellowish powder; soluble in water; and yielding a blue color when brought together with sodium beta-naphtholate on the fiber and subsequently exposed to the air.

532,125—January 8, 1895. A. WEINBERG. *Blue disazo dye.*

A dark blue or black powder, produced by treating the diazo-derivative of amidonaphtholdisulpho acid H (Pat. No. 464,135) with cuprous chloride, and combining the thus obtained perchlornaphtholdisulpho acid with tetrazo bodies in an alkaline solution. It is readily soluble in water with violet-blue color, insoluble in alcohol, soluble in concentrated sulphuric acid with greenish-blue color, and dyes unmordanted cotton a blue shade in alkaline or neutral baths.

532,479—January 15, 1895. K. PATHE AND O. DRESSEL. *Red dye.*

Red substantive dyestuffs produced by the combination of one molecular proportion of diazotized dehydrothio-para-toluidin base with one molecular proportion of the amidonaphtholdisulpho acid ($NH_2:OH:SO_3H:SO_3H=2:5:7:1$) in an alkaline solution. Red shades are produced on unmordanted cotton, fast to the action of alkali and acid.

532,484—January 15, 1895. A. F. POIRRIER. *Sulfur dye.*

Coloring matters dyeing fiber direct in black or blackish shades are produced by heating with sulphur or sulphur compounds the doubly substituted derivatives of benzene, such as the dihydroxyl derivatives or the diamid derivatives, the first class including the dioxynaphthalenes and the naphthoquinones, and the second class embracing the diamins of the benzene and naphthalene series, and the substances capable of producing them. They are very soluble in water, alkaline solutions and alkaline sulphids, insoluble in acid, and changeable on exposure to air.

532,503—January 15, 1895. R. VIDAL AND A. F. POIRRIER. *Sulfur dye.*

Process of producing coloring matters dyeing nonmordanted fibers: consists in heating with sulphur or a sulphur compound the joint amin and phenol derivatives, or bodies capable of producing them by reduction.

533,303—February 5, 1895. M. HOFFMANN. *Black azo dye.*

New black azo dyestuffs are produced by combining the diazo compound of alpha 1 alpha 2 naphthylenediamin-beta-sulpho acid with a diazotizable amin, diazotizing again, combining with gamma-amidonaphthol-sulpho acid and saponifying.

533,508—February 5, 1895. M. ULRICH AND J. BAMMANN. *Blue dye.*

Blue substantive dyestuffs: produced by combining one molecular proportion of tetrazotized diamins, as benzidin, tolidin, dianisidin, with one molecular proportion of amidonaphtholdisulpho acid ($NH_2:SO_3H:SO_3H:OH=1:3:6:8$) and one molecular proportion of amidonaphtholmonosulpho acid ($NH_2:SO_3H:OH=1:4:8$). A dark powder with metallic luster, easily soluble in water with a blue color, diazotizable, when fixed on the fiber, and giving with developers, especially beta-naphthol, deep black shades.

533,829—February 5, 1895. C. SCHRAUBE. *Red basic dye.*

A red basic coloring matter, beta-alkyl-eurhodin, produced by heating together alpha-naphthylamin hydrochlorate and an azo dye derived from mono-alkyl-para-toluidin, diazo sulphanilic acid, and phenol. It dyes bright scarlet shades on cotton mordanted with tannin and on silk.

534,573—February 19, 1895. R. PAGANINI. *Blue disazo dye.*

A disazo dyestuff produced by exposing an alkaline solution of alpha-oxy-disulpho-naphthoic acid to the action of a tetrazo derivative, such as the tetrazo derivative of toluidin, and subsequently combining the resulting intermediate product with alpha-naphthol-mono-sulphonate of soda. A dark brown powder with a bronze luster, soluble in water with a blue-violet, in concentrated sulphuric acid with a pure blue, and in solution of caustic soda with a carmine-red coloration.

534,809—February 26, 1895. J. BIERER. *Blue dye.*

Sulphonated gallocyanin dyes are produced by heating a dialkylamidoazo benzenesulpho acid, having a sulpho group in the second benzene nucleus—that is, in the benzene nucleus which forms a diamido derivative on the splitting of the amidoazo compound by reduction—with a gallic compound, in a suitable solvent. It is soluble in water, insoluble in alcohol, dissolving in a solution of sodium acetate with blue color, in caustic alkalis with violet-blue color, in ordinary and diluted hydrochloric acid with red color, and in concentrated sulphuric acid with a bluish to violet-red color; dyeing wool and silk directly in an acid bath and presenting great affinity for metallic mordants.

535,036—March 5, 1895. A. WEINBERG. *Brown dye.*

Brown disazo dyestuffs are produced by combining the tetrazo derivatives of paradiamins, such as benzidin, with one molecule of phenyl-gamma-amidonaphtholsulpho acid and one molecule of an oxycarbonic acid, such as salicylic acid. The dyestuff derived from salicylic acid is a dark brown powder, easily soluble in hot water and alcohol, with a brown color, in concentrated sulphuric acid with a violet shade, and it dyes unmordanted cotton dark brown shades in alkaline or neutral baths.

535,037—March 5, 1895. A. WEINBERG. *Bluish-red azo dye.*

A red coloring matter produced by bringing together the alkaline solution of perchlornaphtholdisulpho acid with the diazotized dehydrothio compounds, such as dehydrothioparatoluidin, dehydrothiometaxylidin, or their sulpho acids. A dark brown powder easily soluble in cold water and in hot spirit with red color, in concentrated sulphuric acid with violet color, and dyes unmordanted cotton a bright bluish-red shade.

536,431—March 26, 1895. M. KAHN AND F. RUNKEL. *Black dye.*

A substantive black azo dye, produced by combining one molecular proportion of tetrazotized diamidodiphenylamin sulpho acid, first, with one molecular proportion of amidonaphtholsulpho acid G, in an alkaline solution, rediazotizing the resulting intermediate product, and finally combining the so formed tetrazo compound with two molecular proportions of a meta diamin, such as meta phenylendiamin or meta tolylendiamin, in an acetic acid solution. A brownish black powder easily soluble in water, insoluble in alcohol and strong soda lye, soluble in concentrated sulphuric acid, with a bluish-black color.

536,524—March 26, 1895. W. HERZBERG. *Amidotriazin.*

"Amidotriazins" are formed by the action of aldehydes, of the aromatic or fat series, upon chrysoidins—the coloring matters formed by the action of diazotized amins or tetrazotized paradiamins or their sulpho or carbo acids on the metadiamins—and the sulpho derivatives of those of the said substances which contain no sulpho or carbonyl groups, produced by the action of sulphonating agents on those. A white crystalline powder, more or less soluble in water, insoluble in alcohol, soluble in alkaline liquors, and possessing a strong sweet taste. They may be diazotized and combined with phenols, amins, the sulpho and carbo acids of phenols and amins to form azo coloring matters.

536,626—April 2, 1895. R. HIRSCH. *Blue dye.*

Two basic coloring matters, blue and gray violet, are produced by oxidizing amido-dimethylaniline with chromic acid in the presence of one molecule of hydrochloric acid to one molecule of amido-dimethylaniline; the blue coloring matter being easily soluble, the gray violet less soluble in water, but perfectly soluble in acidulated water. The blue dyes cotton a dark blue when mordanted with tannin, and black when mordanted with iron; the gray violet dyes cotton mordanted with tannin, and will work on unmordanted cotton.

536,878—April 2, 1895. R. KIRCHHOFF. *Black dye.*

A tetrazo dye is produced by reacting with one molecule of tetrazotized para-amidobenzene-azo-amido-para-cresolether upon one molecule of salicylic acid, and combining the intermediate product with one molecule of gamma-amidonaphthol-monosulpho acid in alkaline solution. It is soluble in cold, more readily in hot water, with dark violet color; in concentrated sulphuric acid, with dark blue color, produces on unmordanted cotton black shades, and after fixation on fiber can be rediazotized and combined with amins and phenols.

536,879—April 2, 1895. R. KIRCHHOFF. *Blue-black dye.*

A dye produced by reacting with one molecule of tetrazotized para-amidobenzene-azo-amido-para-cresolether upon one molecule of $alpha_1$-naphthylamine-$beta_4$-monosulpho acid (Clève's beta acid) and combining the intermediate product with one molecule of gamma-amidonaphtholmonosulpho acid in alkaline solution. It is soluble in cold, more readily in hot water, with a violet-blue color; in concentrated sulphuric acid, with a dark indigo-blue color; and produces on unmordanted cotton bluish-black shades, and after fixation on the fiber, can be rediazotized and combined with amins and phenols.

536,880—April 2, 1895. R. KIRCHHOFF. *Blue dye.*

A dye produced by reacting with two molecules of gamma-amido-naphthol-monosulpho acid in weakly acid solution upon one molecule of tetrazotized para-amidobenzene-azo-amido-para-cresolether. It is soluble in cold, more readily in hot water, with violet-blue color; in concentrated sulphuric acid, with blue-black color; and produces on unmordanted cotton, fast blue shades.

537,511—April 16, 1895. A. WEINBERG. *Phenylamidonaphtholsulfo acid.*

A new compound, $C_{10}H_5.SO_3H.OH.NH.-C_6H_5$, colorless small needles, forming dyestuffs with diazo or tetrazo compounds, is produced by heating gamma-amido-naphtholsulpho acids with aromatic amins in presence of means of condensation, such as hydrochlorate of aniline.

537,723—April 16, 1895. J. SCHMID AND K. JEDLICKA. *Orange dye.*

Orange coloring matters, similar to phosphine, produced by exposing a yellow acridin dyestuff to the action of an alcohol in the presence of a mineral acid. According to the degree of alkalization, orange-yellow to red-orange tints are produced, suitable for dyeing leather and cotton mordanted with tannin.

538,183—April 23, 1895. J. SCHMID AND J. MOHLER. *Blue dye.*

A poly-oxythionin coloring matter produced by condensation of 7 oxy 1.2 naphthoquinone 4. monosulpho acid with thiosulphonic acid of para-amido-alkyl benzylanilin-sulphonate of soda; forming a dark violet powder, which dissolves with a blue-violet coloration in concentrated sulphuric acid, hot water, or in a dilute ammonia solution.

538,215—April 23, 1895. T. SANDMEYER. *Blue dye.*

A blue dyestuff, the sodium salt of the symmetrical trisulpho acid of triphenylrosanilin: produced by the condensation of two molecules of monosulpho acid of diphenylamin with one molecule of formaldehyde in acid solution to the disulpho acid of diphenyldiamidodiphenylmethan, and the oxidation of the said derivative in combination with a further molecule of diphenylamin-monosulpho acid. It dissolves in concentrated sulphuric acid, with a reddish-brown shade, in cold water, with a pale blue shade; its trisulpho acid dissolving in concentrated alkali-lye and ammonia with a brown shade.

539,699—May 21, 1895. M. MOELLER. *Blue dye.*

Blue coloring matters are produced by acting with one molecular proportion of a tetrazo compound of a paradiamin on two molecular proportions of the sodium salt of amidonaphtholdisulpho acid ($NH_2:SO_3H:SO_3H:OH=1:2:4:8$) in an alkaline solution. The dyestuff derived from 1.8 amidonaphtholdisulpho acid and the tetrazo compound of benzidin is easily soluble in water, dissolving with indigo-blue color in strong sulphuric acid; and they dye unmordanted cotton, in an alkaline or neutral bath containing common salt or Glauber's salt, a pure blue.

539,738—May 21, 1895. W. HERZBERG AND O. WEBER. *Blue dye.*

Blue dyes are produced by heating with sulphur and fuming sulphuric acid the condensation products obtained from an $alpha_1$-$beta_1$-amidoanaphthol derivative and a para-nitroso derivative of an alkylated amin. The dye, in case alpha$_1$-beta$_1$-amidonaphthol-beta$_3$-monosulpho acid and para-nitroso-dimethylanilin be used, is moderately soluble in cold, more readily in hot water with a violet-blue color, dissolves in concentrated sulphuric acid, with a green color, and yields by reduction a leuco compound readily reoxidizable. They form lakes with metallic mordants which dye fast-blue tints.

540,412—June 4, 1895. M. ULRICH AND J. BAMMANN. *Amidonaphtholdisulpho acid.*

An alpha-amido-alpha-naphthol-beta-disulpho acid is produced by melting with caustic alkalis, most practically at from 180° to 190° C., the alpha-naphthylamine-trisulpho acid, which is derived from the naphthalenetrisulpho acid obtained at first by Gürke and Rudolph by sulphonating naphthalene or its mono or disulpho acid, prepared first by Koch by nitrating the said naphthalenetrisulpho acid and reducing the alpha-nitronaphthalene-trisulpho acid thus formed. It crystallizes in small, thin, white needles, showing in aqueous solution a weak reddish-violet fluorescence; by combining with the salts of diazobenzene or analagous diazo compounds, red colors with a strong bluish tinge result, while the tetrazo dyestuffs obtained produce, in general, blue shades.

540,564—June 4, 1895. L. WACKER. *Blue acid dye.*

An acid coloring matter is produced by first heating together amido-phthalic acid and monochlor-acetic acid, preferably in an alkaline solution; next heating the phenyl-glycocol-dicarboxylic acid so obtained in a caustic alkaline melt and treating the resulting leuco compound with oxidizing agents; and finally sulphonating the resulting carboxylated product by treating with fuming sulphuric acid. It is soluble in water, giving green-blue solutions; yellow, in alkaline solutions, and green in concentrated sulphuric acid. The carboxylated compound (free and in combination) yields a blue solution of the alkali salts, and on reduction yields a leuco compound from which the dye can be regenerated by oxidation.

545,333—August 27, 1895. H. A. BERNTHSEN AND P. JULIUS. *Azo orange dye.*

A dark reddish-brown powder which can be obtained by the combination of the tetrazo compound of benzidin-disulpho acid with a nitro diamin, such as nitro-meta-phenylene-diamin; soluble in water, precipitated from its aqueous solution by soda solution, and yielding a deep orange precipitate from its aqueous solution on the addition of dilute sulphuric acid; in concentrated sulphuric acid giving a yellow-red solution.

545,336—August 27, 1895. R. BOHN. *Black dye.*

Black coloring matter obtained by treating dinitro-naphthalene with sodium sulphide, yielding fast-black shades on vegetable fiber on dyeing from a bath rendered strongly alkaline with soda. The specific coloring matter obtained as above and subsequently treated with hydrochloric acid is almost insoluble in caustic soda and in concentrated sulphuric acid.

545,337—August 27, 1895. R. BOHN. *Black dye.*

Black coloring matter obtained by treating dinitro-naphthalene with sodium sulphide and subsequently with acetic acid; soluble in soda solution giving a violet coloration.

546,604—September 17, 1895. J. THIELE. *Amido-tetrazotic acid and process of making same.*

A new white crystalline product, soluble in water, and precipitated from its solution by copper salts, is produced by treating a solution of diazo-guanidin with sodium acetate, concentrating by evaporation, and crystallizing.

547,173—October 1, 1895. C. A. MAYER AND C. DE LA HARPE. *Leuco compound and process of making it.*

A leuco body, suitable for printing on textures, is produced by the condensation of a phenol, as resorcin, with a gallocyanin dye obtained by the action of hydrochlorate of nitrosodialkylanilin or of hydrochlorate of dialkylamidoazobenzene on gallic acid or its derivatives. The leuco body, produced from resorcin, colors textures a blue tint when printed thereon and oxidized on the fiber.

548,344—October 22, 1895. A. ASHWORTH AND J. BURGER. *Brown dye.*

A coloring matter: produced by adding alpha amido beta naphthol to a solution of tannin in a condensing agent, such as sulphuric acid, and heating the mixture; little soluble in cold water, easier soluble in hot water, soluble in caustic soda with violet color, changing into brown on agitation and with admixture of air; soluble in concentrated sulphuric acid with a crimsom red color; producing on chrome mordants brown shades.

548,345—October 22, 1895. A. ASHWORTH AND J. BURGER. *Brown dye.*

Coloring matters: produced by adding ortho oxy beta nitroso naphthalene to a solution of tannin in a condensing agent, such as sulphuric acid, and heating the mixture; a dark, nearly black powder slightly soluble in cold water, more soluble in boiling water, soluble in cold dilute caustic soda with a brown color, in concentrated sulphuric acid with a deep purplish brown coloration; producing on chrome mordants brown shades.

548,346—October 22, 1895. A. ASHWORTH AND J. BURGER. *Nitrosonaphthol dye and process of making same.*

Nitrosobetanaphthol is treated with bisulphites at a temperature of 40° to 50° C. The dye consists of grayish to white crystals, easily soluble in water, which solution grows darker on standing. It is decomposed on addition of caustic alkalis, producing green shades with iron mordants and brown shades with chrome mordants.

548,416—October 22, 1895. A. ASHWORTH AND J. BURGER. *Brown dye.*

Coloring matters produced by combining diazo compounds with the condensation product of alpha-nitroso-beta-naphthol and sodium bisulphite, consisting of a brownish powder easily soluble in water, soluble in caustic soda, carbonate of soda, and in alcohol with yellowish-brown color, dyeing on unmordanted wool from an acid bath brown shades and dyeing and printing with chrome mordants brown shades.

548,460—October 22, 1895. C. RIS. *Brown dye and process of making same.*

Tetraoxyazobenzene, a brown coloring matter produced by subjecting the diazo compound of para-amido-phenol or its sulpho acids to the action of pyrogallic acid in an alkaline solution; soluble in alkalis with an intensely brown color, and forming with concentrated sulphuric acid an orange-colored solution.

549,036—October 29, 1895. R. VIDAL. *Process of treating sulphur compounds of aromatic series with sulfites.*

Soluble dyestuffs and coloring matters, characterized by solubility in water and in acids, are produced by treating with alkaline sulphites and bisulphites the coloring matters obtained by the action of sulphur upon bodies of the aromatic series, as the substituted amines of the benzene series.

555,359—February 25, 1896. H. A. BERNTHSEN AND P. JULIUS. *Red dye and process of making same.*

A red substantive diazo body produced by converting a benzidin salt into a tetrazo compound and combining one molecular proportion of the same with one molecular proportion of salicylic acid and subsequently with one molecular proportion of 2. 4′.2′ amido-naphthol-sulpho-acid in alkaline solution, boiling and precipitating with common salt; readily soluble in hot and cold water giving red solutions, in sulphuric acid giving a violet-blue solution, and with nitrous acid yielding a gray to black diazo compound capable of uniting with beta-naphthol to yield a dark shade of color.

555,658—March 3, 1896. R. NIETZKI. *Yellow coloring matter.*

A yellow dyestuff produced by combining the monosulphonic acids of beta-diazo-naphthalene with salicylic acid; forming a yellow-brown powder, difficultly soluble in cold water, petroleum, and benzene, readily soluble in hot water; dissolving in concentrated sulphuric acid with a dark orange-red color; and producing pure yellow shades with alum mordant and olive-yellow shades with chromium mordant.

555,904—March 3, 1896. H. LAUBMANN. *Dye from dinitro-anthrachrysone-disulfo acid.*

A green dyestuff produced by treating dinitro-anthrachrysone-disulphonic acid with sodium sulphide in alkaline solution; forming a black crystalline powder, soluble in hot water with red-blue color, in dilute alkali with red-violet color, in concentrated sulphuric acid with blue-red color; difficultly soluble in glacial acetic acid with red color; completly absorbed by wool from an acid bath, the colored stuff giving green tints on treatment with chromium fluoride.

556,164—March 10, 1896. C. RIS AND C. SIMON. *Gray dye and process of making same.*

A gray coloring matter produced by subjecting the alkyl derivative of beta-amido-alpha$_4$-naphthol-beta$_3$-sulpho acid to the action of a tetrazo compound, as tetrazodiphenyl or tetrazoditolyl; soluble in water with a bluish-gray color, in concentrated sulphuric acid with a blue color; and producing on unmordanted cotton bluish-gray to black shades of considerable fastness.

556,298—March 10, 1896. J. BAMMANN AND M. ULRICH. *Blue dye.*

Violet-blue to greenish-blue mixed substantive dyestuffs produced by combining equi-molecular proportions of any of the known tetrazo bodies, as tetrazoditolyl, with 1.8 amidonaphtholdisulpho acid and any of the hydroxy derivatives of naphthalene, as dihydroxynaphthalene; dyeing unmordanted cotton violet-blue to greenish-blue shades which can be rediazotized on the fiber and converted into deeper blue or bluish-black shades by means of developers; they form grayish-black powders soluble in water, insoluble in diluted hydrochloric or sulphuric acid, but dissolve in concentrated sulphuric acid with blue color.

557,002—March 24, 1896. R. REYHER. *Azine dye.*

Red azine dyes produced by condensing salts of nitroso derivatives of secondary aromatic amins with phenylmetatoluylendiamin, forming a brown powder with metallic luster, easily soluble in water and alcohol, with a red color; insoluble in soda lye; soluble in concentrated sulphuric acid, with a green color, and producing on cotton mordanted with tannin brilliant red shades fast to alkali and light.

557,435—March 31, 1896. J. SCHMID. *Blue dye.*

Blue polyazo dyes are obtained by coupling together two molecules of tetrazo bodies derived from benzidine and the analogous bodies—such as tolidin, diamidostilbene, diamidodiphenol ethers, diamidoethoxydiphenyl—with one molecular proportion of 1.8 amidonaphthol, 3.6 disulphonate of soda, or 1.8 dioxynaphthalene, 3.6 disulphonate of soda; forming black powders with a metallic luster, soluble in water with a blue and in concentrated sulphuric acid with a green-blue coloration; dyeing unmordanted cotton blue tints of a pure shade.

557,436—March 31, 1896. J. SCHMID. *Blue dye.*

Dark violet-blue to blue polyazo dyestuffs are produced by the action of 1.4 naphtholmonosulphonate of soda upon the products of No. 557,435; forming black powders of metallic luster, soluble in water with a violet, in concentrated sulphuric with a blue coloration; dyeing unmordanted cotton in a neutral or alkaline bath violet to pure blue shades.

557,437—March 31, 1896. J. SCHMID. *Black trisazo dye.*

Black triazo coloring matters are produced by subjecting the diazo dyes of No. 525,626 to further diazotation and combination with amins and phenols, as by diazotizing and treating the rediazotized compound with a cold solution of metaphenylenediamin; or metatoluylenediamin or metaamidophenol; or resorcin kept alkaline by an excess of carbonate of soda; forming black powders with a metallic luster, soluble in hot water, with a blue-black coloration and dyeing deep black shades on unmordanted cotton.

557,438—March 31, 1896. J. SCHMID. *Blue dye.*

Triazo dyestuffs obtained by the combination of 1.8 amidonaphthol, 3.6 disulphonate of soda with the rediazotized intermediate products resulting by the action of one molecular proportion of a tetrazo compound, such as the tetrazo compound of benzidine upon one molecule of metaamidoparacresol ether; easily soluble in water with a dark-blue coloration, in concentrated sulphuric acid with a green-blue coloration; and producing indigo-blue tints on unmordanted cotton, which may be rediazotized and developed on the fiber to blue black with amins and phenols.

557,439—March 31, 1896. J. SCHMID. *Polyazo black dye.*

A blue-black polyazo dye obtained by the reaction of two molecular proportions of amidonaphtholmonosulpho acid and one molecular proportion of the intermediate product, resulting by the action of two molecular proportions of tetrazo-diphenyl with one molecular proportion of 1.8 amidoöxynaphthalene 3.6 disulpho acid; a black powder with a bronze-like luster, soluble in water with a black violet—in concentrated sulphuric acid with a pure blue coloration; and dyeing unmordanted cotton blue-black shades in an alkaline bath which may be developed on the fiber to a deep black.

557,440—March 31, 1896. J. SCHMID. *Blue-black disazo dye.*

Asymmetrical coloring matters derived from one molecular proportion of naphthalene-diamine-disulpho acid 1.8.3.6, one molecule of paranitrodiazobenzene and one molecule of another diazo body; forming black powders of a bronze luster, easily soluble in water with a dark violet to dark blue coloration, in concentrated sulphuric acid with a dark-green coloration; and producing deep blue-black to black tints of great fastness on wool in an acid bath or on a mordant of a chrome salt.

558,344—April 14, 1896. H. A. BERNTHSEN AND P. JULIUS. *Blue dye.*

A substantive coloring matter, a mixed disazo dye: derived from tetrazo-dianisidin, 1.5.7 amido-naphtholsulpho acid combined in alkaline solution and alphanaphtholsulpho acid (1.4; 1.5), which in the form of sodium salt is soluble in water, and on treatment with nitrous acid on the fiber yields a more violet diazo compound which combines with beta-naphthol and gives deeper and more violet shades than the original blue.

558,612—April 21, 1896. C. RUDOLPH. *Brown azo dye.*

A brown azo dyestuff produced by first combining diazotized metatoluylendiamin sulpho acid with one molecule of beta naphthylamin, one molecule of a metadiamin and afterwards acting upon the thus formed intermediate product with one molecule of diazo naphthionic acid. It dyes unmordanted cotton a yellow brown, and forms a deep dark brown powder soluble in concentrated sulphuric acid to a dirty violet solution, and in water to a yellowish-brown solution.

558,613—April 21, 1896. C. RUDOLPH. *Oxyquinolin azo dye.*

A red-blue tetrazo dyestuff produced by combining dianisidin with the sodium salt of alpha$_1$-alpha$_4$-amidooxynaphthalene beta$_2$-beta$_3$-disulpho-acid and afterwards combining with this intermediate product an alkaline solution of paraoxyquinolin, a greenish-brown powder of a metallic luster, soluble in water to a blue and in strong sulphuric acid to a pure green-blue solution, and dyeing unmordanted cotton reddish blue.

558,614—April 21, 1896. C. RUDOLPH. *Brown azo dye.*

A brown polyazo dyestuff, dyeing unmordanted cotton: produced by first combining two molecules of Bismarck brown sulpho acid with one molecule of diazotized diamido beta-naphthalene disulpho acid and afterwards combining with this intermediate compound two molecules of diazo-naphthionic acid; a black brown powder, dissolving in concentrated sulphuric acid to a violet-brown solution.

559,062—April 28, 1896. R. REYHER. *Azin dye and process of making it.*

Azin dyes produced by condensing salts of nitrosomonoalkylorthotoluidin with paratoluylmetatoluylenediamin and then separating the dye by filtration; forming a brown powder with metallic luster; soluble in water and alcohol with a red color, in concentrated sulphuric acid with a green color, insoluble in soda lye; and dyeing cotton mordanted with tannin brilliant red shades, fast to alkali and light.

559,063—April 28, 1896. R. REYHER. *Azin dye and process of making it.*

Azin dyes produced by condensing salts of nitrosodialkylanilin with paratoluylmetatoluylenediamin and then separating the dye by filtration; forming a greenish black powder with metallic luster, soluble in water with a violet-red color, in alcohol with a bluish-red color, in concentrated sulphuric acid with a green color; insoluble in soda-lye, and dyeing cotton mordanted with tannin violet-red shades, fast to alkali and light.

560,448—May 19, 1896. A. WEINBERG. *Black azo dye.*

Azo dyes of the general formula: Amidonaphtholsulfo-acid I-amidonaphtholsulpho-acid II-metadiamin paradiamin-metadiamin, are produced by treating the intermediate compound of the general constitution paradiaminamidonaphtholsulpho-acid I amidonaphtholsulpho-acid II with nitrous acid and combining the thus produced tetrazo compounds with two molecules of a metadiamin; forming a black powder soluble in hot water and in concentrated sulphuric acid with a bluish-black color; insoluble in alcohol, ether, or benzene, and dyeing unmordanted cotton a deep black, fast to alkalis.

560,449—May 19, 1896. A. WEINBERG. *Black dye.*

Azo dyes produced by treating the intermediate compounds formed from one molecule of a tetrazo body and one molecule of an amidonaphtholsulpho acid with nitrous acid, as by mixing one molecule of diazotized acetparaphenylenediamin with one molecule of an amidonaphtholsulpho acid, heating with caustic alkalis to remove the acetyl group and treating the diamidoazo body with nitrous acid, and combining the thus produced tetrazoazo compound with one molecule of an amidonaphtholsulpho acid and one molecule of a metadiamin; forming a black powder soluble in hot water with bluish-black color, in concentrated sulphuric acid with a dark-blue color, and dyeing unmordanted cotton a deep black.

560,795—May 26, 1896. B. HEYMANN. *Blue dye.*

Blue coloring matters produced by the action of nitrosomethylbenzylanilinsulpho-acid with beta-naphthoquinonesulpho-acid (1:2:6 or 1:2:7) in the presence of sodium thiosulphate, or with the nitrosonaphtholsulpho-acid (1:2:6 or 1:2:7) which furnishes the corresponding beta-naphthoquinonesulpho-acid by reduction and subsequent oxidation in the presence of sodium thiosulphate; a dark powder with metallic luster, soluble in water with a blue color, in concentrated sulphuric acid with a green color, and dyeing wool and cotton mordanted with chromium salts.

560,796—May 26, 1896. M. HOFFMANN. *Blackish-blue azo dye.*

Azo dyestuffs produced by combining the diazo compound of alpha$_1$-alpha$_2$-amidoacetnaphthalid-beta-sulpho acid with a diazotizable amin, diazotizing again, combining with a hydroxylated naphthalenesulpho-acid and saponifying the product; a black powder soluble in water with a dark-blue color, in sulphuric acid with a bluish-black shade, insoluble in alcohol, and dyeing wool and cotton a blackish blue.

560,890—May 26, 1896. E. BROEMME. *Process of producing lakes.*

Dyestuff-lakes are obtained, for example, from acid tar dyes, by the precipitation of soluble dyestuffs by the addition of a soluble strontium salt to a solution of the dyestuff and sodium carbonate or sodium sulphate.

561,276—June 2, 1896. A. F. POIRRIER. *Sulfureted dye.*

"Thiocatechins;" coloring matters which dye unmordanted cotton in tints varying from yellow to brown and red brown, are produced by heating to prescribed temperatures—200° to 300° C.—with sulphur or sulphur compounds, acetylated paradiamins, and acting on the product with sodium sulphite.

561,277—June 2, 1896. A. F. POIRRIER. *Sulfureted dye.*

Yellow, brown, and yellowish-brown coloring matters, dyeing vegetable fibers without mordant, are produced by the action of sulphur upon the substituted aromatic amins or the acetylated aromatic diamins at between 200° and 250° C.

561,615—June 9, 1896. F. RUNKEL. *Red azo dye.*

A red azo coloring-matter produced by combining molecular proportions of the diazotized ethyl paramidobenzoate with the dioxynaphthalene monosulpho-acid $(OH:SO_3H:OH=1.4.8)$ of No. 444,679; forming a brown powder with a green luster, soluble in hot water and alcohol with a red color, in concentrated sulphuric acid with a bluish-black color, and producing on wool clear red shades fast against alkalis.

561,694—June 9, 1896. A. BLANK, A. ISRAEL, AND M. HERZBERG. *Black azo dye and process of making same.*

A substantive black azo dye produced by combining one molecular proportion of tetrazotized dianisidin or tolidin, first, with one molecular proportion of amidonaphthol disulpho-acid $(NH_2\ SO_3H\ SO_3H\ OH=1.3.6.8)$, or an alkaline salt thereof, then, with one molecular proportion of a metadiamin (such as metaphenylenediamin or metatoluylenediamin) and finally coupling the so-formed mixed dyestuff with one molecular proportion of diazotized acetyl paraphenylenediamin; a black powder soluble in water with a violet black color, in concentrated sulphuric acid with a bluish-black color

561,709—June 9, 1896. M. HERZBERG, A. BLANK, AND A. ISRAEL. *Black azo dye.*

Substantive black azo dyes, produced by combining one molecular proportion of tetrazotized paradiamins (as benzidin), first with one molecular proportion of amidonaphthol disulpho-acid $(NH_2\ SO_3H\ SO_3H\ OH=1.3.6.8)$, or an alkaline salt thereof, then with one molecular proportion of a metadiamin such as metaphenylenediamin, and finally coupling the so-formed mixed azo dyestuffs with one molecular proportion of diazotized acetylparaphenylenediamin: black powders soluble in water with a black color, in concentrated sulphuric acid with a bluish-black color.

562,200—June 16, 1896. J. SCHMID AND K. JEDLICKA. *Dark green dye.*

A new dye is produced by heating the unsymmetric diazo coloring matter of No. 557,440 with water in the presence of a suitable condensing agent; dyeing with more blue or more green shades than the original coloring matter.

563,382—July 7, 1896. F. KRECKE AND I. ROSENBERG. *Amidonaphtholdisulpho acid K.*

The 1.8.4.6-amidonaphtholdisulpho acid K, produced by sulphonating 1.5-naphthalenedisulpho acid with fuming sulphuric acid at temperatures not above that of a water bath, transforming the so-produced 1.3.5-naphthalenetrisulpho acid by nitration and reduction into the 1.4.6.8-naphthylamintrisulphonic acid, the diazo derivative of which can not be precipitated from its aqueous solutions by common salt; heating this naphthylamintrisulpho acid with caustic-soda lye, and precipitating it as acid sodium salt from the alkaline liquid thus obtained, by acidulation with muriatic acid. It is readily soluble in water and gives azo colors more reddish in shade than those prepared with the H acid.

563,383—July 7, 1896. F. KRECKE AND I. ROSENBERG. *Azo dye.*

Azo dyestuffs prepared by combining the "K" acid of No. 563,382 with the molecular proportion of a diazo body; with diazo benzene there is formed a crystalline bronzy powder easily soluble in water, and dyeing wool a bright red from an acid bath.

563,384—July 7, 1896. F. KRECKE AND I. ROSENBERG. *Diazo dye.*

Diazo dyestuffs produced by combining one molecule of acid "K" of No. 563,382 with one molecule of a diazo body in acid solution and acting upon the so-formed intermediate azo product with another molecule of a diazo body, a crystalline powder of reddish-bronze color, dying wool a dark greenish blue in an acid bath.

563,385—July 7, 1896. F. KRECKE AND I. ROSENBERG. *Blue tetrazo dye.*

Tetrazo dyestuffs produced by combining one molecule of a tetrazo body with two molecules of acid "K" of No. 563,382 in alkaline solution; a crystalline yellow-bronze powder, dyeing unmordanted cotton a bright violet blue of great depth.

563,386—July 7, 1896. F. KRECKE AND I. ROSENBERG. *Greenish-blue tetrazo dye.*

Tetrazo dyestuffs produced by combining one molecule of acid "K" of No. 563,382 with one molecule of a tetrazo body, and acting on the so-formed intermediate diazo azo body with an aromatic amin or phenol, or sulpho or carbo acid thereof; forming bronzy crystalline powder, dyeing unmordanted cotton a bright greenish blue.

567,413—September 8, 1896. C. RIS. *Brown diazo dye and method of making same.*

A brown coloring matter, obtained by combining the tetrazo compound of benzidin with salicylic acid and with alkylated beta$_1$-alpha$_4$-amido-naphthol-beta$_3$-sulpho-acid; a dark brown powder soluble in water, with a dark brown color, in concentrated sulphuric acid with a violet-blue color, and producing fast and intense brown shade on unmordanted cotton.

567,473—September 8, 1896. W. HERZBERG AND H. HEIMANN. *Red dye of rosindulin series.*

The disoda salt of phenylrosindulin-trisulphonic acid, derived from alphanaphthylamin and orthoamidodiphenylamin-sulphonic acid by joint oxidation, subsequent phenylation and sulphonation by means of fuming sulphuric acid; of the formula $C_{28}H_{16}N_3SO_3H(SO_3Na)_2$; producing on wool clear red shades of a bluish tint.

567,567, September 8, 1896. A. HERRMANN. *Blue coloring matter.*

Fast-blue coloring matter produced by condensing monobenzylanilin or its homologues, including the sulphonic acids, with metaoxybenzaldehyde; sulphonating the metaoxyleuco bases obtained thereby; and then oxidizing the resulting leuco-sulphonic acid with a suitable reagent, such as lead peroxide.

567,615—September 15, 1896. F. RUNKEL. *Blue azo dye.*

The azo coloring matter produced by combining one molecular proportion of the diazo compound of dimethyl-paraphenylenediamin, $NH_2.C_6H_4.N.(CH_3)_2$, with one molecular proportion of the sodium salt of dihydroxynaphthalene sulpho-acid; a dark powder with bronze-like luster, soluble in alcohol and in hot water with a blue color, in concentrated sulphuric acid with a violet color, and dyeing wool in acid bath.

568,344—September 29, 1896. A. GANSWINDT. *Mordanting textile fabrics.*

Cotton or other vegetable textile fibers are mordanted with lactate of zinc and subsequently dyed.

568,549—September 29, 1896. C. RUDOLPH AND E. VOGES. *Yellow dye.*

A yellow tetrazo dyestuff obtained by the combination of diazotized toluylendiamin-sulpho-acid $(CH_3.NH_2.SO_3H.NH_2=1.2.4.6)$ with nitro-meta-phenylenediamin; a light-brown powder dissolving in water to a yellow solution, from which a gelatinous precipitate is obtained by the addition of an acid; dyeing unmordanted cotton a pure yellow from an alkaline soap bath.

569,395—October 13, 1896. E. ULLRICH AND M. VON GALLOIS. *Process of dyeing phenetidin red.*

A bluish-red color is produced by combining on the fiber orthonitroparaphenetidin with beta-naphthol to an azo compound, and fixing the color by turkey-red oil and a metallic compound, as aluminate of soda.

569,404—October 13, 1896. R. BRASCH. *Alizarin dye and method of making same.*

Alizarin coloring matters—alpha-amido-flavo and anthra purpurin—dyeing mordanted wool and cotton scarlet red shades are produced by heating the alizarin of commerce with benzoyl-chloride, nitrating the product at ordinary temperature with nitrosulphuric acid, separating the benzoylized alpha-nitroalizarin by pouring it into water, saponifying by means of soda-lye and reducing to the amido compound by means of reducing agents, such as zinc.

569,405—October 13, 1896. R. BRASCH. *Green alizarin dye and method of making same.*

Green coloring matters are produced from alpha-amido and alpha-nitro compounds of alizarin by mixing with glycerin and sulphuric acid, gradually heating to a temperature of 110° to 120° C., and separating the quinolized product by pouring into water. Easily soluble compounds are obtained by heating the quinoline compounds with concentrated solutions of alkaline-bisulphites, such as sodium bisulphite. The alpha-quinolin compound of alizarin is nearly insoluble in water, difficultly soluble in the ordinary organic solvents, soluble in sulphuric acid, in alkaline-sulphite compounds with a carmine color, and dyes mordanted wool and cotton in green shades.

569,418—October 13, 1896. H. LAUBMANN. *Blue dye and method of making same.*

Blue coloring matter, produced by treating an acid solution of dinitroanthrachrysone-disulphonic acid—No. 569,419—with reducing agents, such as iron, zinc, etc., and subsequently boiling with alkalis; a red crystalline powder dissolving in hot water with a beautiful red, in diluted alkalis with blue, in concentrated sulphuric acid with bluish-red color, taken up by wool in an acid bath, the fibers assuming shades ranging from blue to violet, with metallic mordants.

569,419—October 13, 1896. H. LAUBMANN. *Dinitroanthrachrysone-disulphonic acid and method of making same.*

Anthrachrysone is sulphonized and the product nitrated. The acid is easily soluble in water and alcohol, ether, benzene, chloroform, and glacial acetic acid, decomposing at above 230° C., soluble in alkalis with red color, its sodium salts crystallizing from water in gold-yellow leaflets with formula of $C_{14}H_4O_6(NO_2)_2(SO_3Na)_2H_2O$; available as coloring matter and for the production of other coloring matters.

571,933—November 24, 1896. C. RIS. *Black triazo dye.*

A black triazo coloring matter produced by diazotizing a mixed diazo dyestuff obtained from benzidin, an alkylated beta, alpha$_4$-amidonaphthol-beta$_3$, sulpho acid and a nonalkylated beta$_1$-alpha$_4$-amidonaphthol-beta$_3$-sulpho acid; and combining the diazo compound thus obtained with resorcin; a black powder soluble in water with bluish-black color, in concentrated sulphuric acid with a grayish-blue color, and dyeing unmordanted cotton in gray to deep-black shades.

572,723—December 8, 1896. C. RUDOLPH. *Trisazo dye.*

Triazo dyestuffs obtained by first forming intermediate products by combining the paradiamins, as, for instance, benzidin, with a metaämidoöxysulpho acid of the benzene series which contains the OH group and the NH_2 group in the so-called "meta" position; then combining these intermediate products with metaphenylendiamin or resorcin; and finally causing diazonaphthionic acid to act upon the thus resulting intermediate dyestuffs; a black powder soluble in water with brown to brown-red solutions, in concentrated sulphuric acid with violet to blue solutions, and dying unmordanted cotton from an alkaline bath brown red to corinth.

573,299—December 15, 1896. T. SANDMEYER. *Red dye.*

A red dyestuff produced by condensing benzaldehydeorthosulpho acid with an alkylated metaämido phenol, such as diethylmetaämidophenol, removing one molecule of water from the thus obtained dihydroxylated tetraethyldiamidotriphenylmethanmonosulpho acid, as by treating with concentrated sulphuric acid, and oxidizing the thus-formed derivative of triphenylmethan oxide; a greenish crystalline powder, easily soluble in alcohol and acetic acid with a bluish-red shade showing a yellowish-red fluorescence, in hydrochloric acid and diluted sulphuric acid with a yellowish-red shade turning to bluish red by addition of water, and producing on wool and silk pure red shades fast against alkalis.

575,228—January 12, 1897. M. VON GALLOIS. *Stable diazo compound.*

Stable, soluble, nonexplosive, diazo compounds of paranitranilin and dianisidin in the form of a paste or powder, produced by concentrating or evaporating to dryness solutions of paranitranilin and dianisidin at a low temperature, below 45° C., in presence of an excess of a mineral acid and in presence of an acid mineral salt. The paranitro diazo benzol sulphate is a light-yellow powder.

575,904—January 26, 1897. C. RIS. *Black azo dye.*

Black azo colors produced by combining the tetrazo compound of a paradiamin, such as paradiamidoditolylamin, with beta$_1$-alpha$_4$-amidonaphtholbeta$_3$-sulpho acid and with a metadiamin; a black powder, soluble in water with a bluish-black color, in concentrated sulphuric acid with blue color, dyeing unmordanted cotton, or mixed goods, deep bluish-black shades of great fastness.

576,222—February 2, 1897. C. O. MULLER. *Rhodamin dye.*

Unsymmetrical dimethyldiethyl rhodamin dyestuff: produced by the condensation of one molecule of a dialkylamidoöxybenzoylbenzoic acid derived from one molecule of anhydrous phthalic acid and one molecule of dialkylmetaämidophenol, with one molecule of an alkyl derivative of metaämidophenol; constituting green crystals, dyeing wool, silk, and cotton a fine red, soluble in water, and dissolving in concentrated sulphuric acid and in hydrochloric acid with yellow coloration which turns red on adding water.

576,223—February 2, 1897. C. O. MULLER. *Rhodamin dye.*

Rhodamin dyes, consisting of an alkylester of the unsymmetrical coloring matter of No. 576,222, produced by boiling same with alcohol and hydrochloric acid; a green powder with metallic luster, dyeing cotton, silk, and wool a blue red.

576,511—February 2, 1897. G. STEINIKE AND F. SCHMIDT. *Blue trisazo dye.*

Mixed triazo coloring matters produced by combining one molecule of dioxynaphthalenemonosulphonic acid S, of No. 444,679, with one molecule of a diazo compound and coupling the monoazo coloring matter thus formed with one molecule of a tetrazo compound, and then coupling the resulting intermediate product with a further molecule of a phenol, naphthol, or their carbonic or sulphonic acids; a gray-black powder, dissolving in water with violet-blue color, soluble in sulphuric acid with blue color, and dyeing cotton blue tints.

578,093—March 2, 1897. A. COBENZL. *Blue dye.*

A blue basic dyestuff, obtained by heating diethylsaffranin, obtained from diethylparaphenylenediamin and anilin, with paraphenylenediamin under pressure and in presence of an indifferent solvent.

578,432—March 9, 1897. M. ULRICH AND J. BAMMANN. *Dark-blue azo dye.*

Dark-blue substantive dyestuffs produced by combining one molecular proportion of a tetrazotized diamin with one molecular proportion of amidonaphtholdisulpho acid ($NH_2{:}SO_3H{:}SO_3H{:}OH=2{:}3{:}6{:}8$) and one molecular proportion of amidonaphtholmonosulpho acid ($NH_2{:}SO_3H{:}OH=1{:}4{:}8$), or alkaline salts thereof; a dark powder soluble in water with a bluish-black color; diazotizable when fixed on the fiber.

578,578—March 9, 1897. C. O. MULLER. *Rhodamin dye.*

Rhodamin dyes produced by the condensation of one molecule of the dialkylamidoöxybenzoyl-benzoic acid, obtained by the action of one molecule of anhydrous phthalic acid on one molecule of dialkylmetaämidophenol, with one molecule of a metaämidophenol, as metaämidocresol ($CH_3{:}NH_2{:}OH=1{:}2{:}4$), and the subsequent conversion of the product of condensation into salt by heating it with an acid. The unsymmetrical dimethyl-methyl-rhodamin dye derived from dimethylamidoöxybenzoylbenzoic acid and metaämidocresol dyes with tannin and tartar emetic mordanted cotton vividly red tints.

578,580—March 9, 1897. F. PETERSEN. *Substantive cotton dye.*

Substantive cotton dyestuffs produced by combining one molecule of the tetrazo derivative of the Griess benzidinsulpho acids with two molecules of gammaämidonaphtholsulpho-acid, diazotizing the dyestuff thus obtained, and subsequently combining the diazotized dyestuff with two molecules of aromatic amido compounds, as an aromatic metadiamin; a black powder, dyeing cotton an intense blue black.

579,773—March 30, 1897. C. RUDOLPH. *Red-blue disazo dye.*

Red-blue diazo dyestuffs produced by combining tetrazo-ditolyl, or tetrazodiphenyl, with one molecule of alpha$_1$-alpha$_4$-amidoöxynaphthalene-beta$_2$-beta$_3$-disulpho acid in an alkaline solution, and then combining the intermediate compound thus obtained with one molecule of 2.3-dioxynaphthalene; a dark blackish-brown powder with a feeble metallic luster, dyeing unmordanted cotton pure red blue.

580,186—April 6, 1897. A. HERRMANN. *Blue dye.*

The monosulphonic acid of tetraälkylmonobenzyltriamidodiphenyl-orthotolylcarbinol, a copper-colored powder of metallic luster: produced by condensing tetraälkyldiamidobenzhydrol with monobenzyl-orthotoluidin monosulphonic acid, and then oxidizing the thus-obtained sulphonic acid of tetraälkylbenzyltriamidodiphenyl-orthotolylmethan. It dyes wool and silk an even and fast blue in an acid bath.

580,187—April 6, 1897. A. HERRMANN. *Fast blue dye.*

The monosulphonic acid of pentaälkyltriamidodiphenyl-orthotolylcarbinol, a copper-red powder of metallic luster: produced by condensing tetraalkyldiamidobenzhydrol with monoalkyl-orthotoluidin sulphonic acid, and then oxidizing the thus-obtained sulphonic acid of pentaälkyltriamidodiphenyl-orthotolylmethane. It dyes wool and silk an even and fast blue in an acid bath

580,188—April 6, 1897. A. HERRMANN. *Blue acid dye.*

The disulphonic acid of monobenzyl-tetraälkyltriamidodiphenyl-orthotolylcarbinol, a copper-red powder of metallic luster: produced by condensing tetraälkyldiamidobenzhydrol with monobenzyl-orthotoluidin disulphonic acid, and then oxidizing the thus-obtained sulphonic acid of monobenzyltetraälkyltriamidodiphenyl-orthotolylmethane.

582,853—May 18, 1897. A. FEER. *Stable diazo compound.*

Compounds for dyeing and printing: produced by combining one molecule of a sulpho acid of an aromatic hydrocarbon, as a disulpho-acid of naphthalene, with one molecule of the diazo derivative of an aromatic amido compound, as of paranitranilin. The disulphonaphthalate of paranitrodiazobenzene is a yellow crystallized stable salt which can be preserved in a dry state. Fabrics, etc., are dyed and printed by first padding with an alkaline solution of beta-naphthol and then applying a solution of the salt.

582,958—May 18, 1897. F. SCHMIDT AND O. ERNST. *Trisazo dye.*

A bluish black triazo dyestuff: produced by combining one molecule of diazonaphthalenesulphonic acid with one molecule of dioxynaphthalenemonosulphonic acid 1.8.4, subjecting the monoazo dyestuff thus formed to the action of one molecule of tetrazotized benzidin until an intermediary product is obtained; and lastly, treating this intermediary product with metaphenyldiamin; a grayish-brown powder, soluble in water with a blue-violet color, in concentrated sulphuric acid with a blue color; the direct-dyeing color of 4 per cent on unmordanted cotton being bluish black.

582,959—May 18, 1897, F. SCHMIDT AND O. ERNST. *Trisazo dye.*

The intermediary product of No. 582,958 is treated with naphthylamin (instead of metaphenylendiamin), producing a violet-brown powder of metallic luster, but dyeing bluish black.

583,267—May 25, 1897. J. SCHMID AND H. WEIL. *Blue-green dye.*

Coloring matters are produced from benzaldehyde disulpho acids ($COH{:}SO_3H{:}SO_3H=1{:}2{:}5$ and $1{:}2{:}4$) and nonsulphonated benzylanilin derivatives, by first forming leuco compounds by the condensation of one molecule of benzaldehyde disulpho acid with two molecules of anilin derivatives, one of which at least is one of the following nonsulphonated benzylanilin derivatives: benzylethylanilin, benzylmethylanilin, dibenzylanilin, monobenzylorthotoluidin, or their products of substitution, which contain a methyl, or nitro group, or chlorin in the radical of benzyl; and subsequently treating these leuco compounds by means of oxidizing agents, as peroxids or chromic acid; dyeing animal fiber in an acid bath a blue-green to green-blue tint, fast against alkalis and dilute acids.

583,439—May 25, 1897. W. HERZBERG AND O. HANSMANN. *Black azo dye.*

A dark-brown powder of metallic luster, obtained by rediazotizing the compound produced by the action of diazotized picramic acid on alpha$_1$-naphthylamin-beta$_3$-monosulphonic acid, and by combining the diazo compound thus obtained with beta-naphthol. It produces on wool blackish-violet tints, which by treatment with chromium salts are converted into fast, deep black shades.

583,634—June 1, 1897. J. SCHMID AND K. JEDLICKA. *Black trisazo dye.*

Black triazo dyestuffs: produced by combining one molecule of the tetrazo derivative of a paradiamido base of the series of diphenyl with one molecule of a monoazo coloring matter derived from one molecule of an amidonaphtholdisulphonic acid and one molecule of an aromatic diazoaldehyde, and one molecule of an aromatic amido compound, such, for example, as metatoluylenediamin, metaphenylenediamin, naphthylamins, naphthylamin-sulphonic acids, amidonaphthols, and amidonaphthol-sulphonic acids; a dark powder of a light-bronze luster, soluble in water with violet-black to blue-black coloration and dyeing cotton violet black to green black.

583,635—June 1, 1897. J. SCHMID AND K. JEDLICKA. *Blue trisazo dye.*

Blue triazo dyestuffs: produced by combining one molecule of the tetrazo derivative of a paradiamido base of the series of diphenyl with one molecule of a monoazo coloring matter derived from one molecule of an amidonaphtholdisulphonic acid and one molecule of a diazo-benzoic-acid compound, and one molecule of a naphtholic compound, such as naphthols, amidonaphthols, oxy naphthols, and their sulphonic acids, a powder of bronze luster, soluble in water with a dark blue to green coloration, and dyeing unmordanted cotton dark blue to greenish-blue fast tints.

584,119—June 8, 1897. C. O. MULLER. *Rhodamin dye.*

The alkyl ether of the unsymmetrical dimethyl methylrhodamin derived from dimethylamidooxybenzoyl benzoic acid and metaamidoparacresol, constituting, in the form of its hydrochloric salt, fine green crystals, soluble in water and alcohol with a red tint, in concentrated sulphuric acid with a yellow tint, and dyeing cotton, silk, and wool in red tints.

584,981—June 22, 1897. M. BONIGER. *Blue dye.*

Blue coloring matter, produced by combining one molecule of the tetrazo compound of dianisidin in an alkaline soda solution with one molecule of 1 naphthol 3.6.8 trisulphonic acid and combining the intermediate product thus formed with one molecule of beta naphthol, a bronze powder soluble in water with a pure blue shade, in strong sulphoric acid with a greenish-blue; dyeing unmordanted cotton in a boiling salt or Glauber salt bath.

585,104—June 22, 1897. K. JEDLICKA. *Green triazo dye.*

Green triazo dyestuffs, produced by combining one molecule of the tetrazo derivative of a paradiamido base of the series of diphenyl with one molecule of a monoazo coloring matter derived from one molecule of an amidonaphthol-disulphonic acid and one molecule of a diazobenzoic-acid compound and one molecule of a phenolic compound, as phenol, cresol, resorcin, and cresotinic acid, a bronze powder soluble in water with a green coloration, and dyeing unmordanted cotton in fast dark-green to yellowish green tints.

585,934—July 6, 1897. C. DE LA HARPE. *Blue dye.*

Blue coloring matter: produced from the leuco body obtained by the condensation of resorcin with a gallocyanin dye (No. 547,173) by sulphonating the said body with sulphuric acid, then subjecting an alkaline solution of the sulpho derivative to contact with the air, precipitating the product of oxidation with sufficient acid to neutralize the alkali employed, and finally forming the product of oxidation into an alkaline salt; dyes nonmordanted wool and chromed wool and mordanted vegetable fibers.

587,757—August 10, 1897. I. ROSENBERG AND F. KRECKE. *Naphthylenediamin-sulfo acid, and process of making it.*

A new naphthylenediamin, characterized by containing two amido groups in meta or 1.3 position, producible by heating 1.3.6 naphthol or naphthylamin-disulpho-acid with an excess of ammonia in an autoclave at temperatures of 160° to 190° C., forming easily soluble alkali salts, and combining with diazo and tetrazo compounds to form valuable cotton dyes.

588,180—August 17, 1897. I. ROSENBERG. *Bluish-scarlet dye.*

Azo dyestuffs produced by combining molecular proportions of diazotized monamins with 1.3 naphthylenediamin-sulpho-acids, as diazotized dehydrothio paratoluidin monosulpho acid with 1.3.6-naphthylenediamin-mono-sulpho acid; a brownish-red bronzy powder soluble in hot water, in concentrated sulphuric acid with violet coloration, dyeing unmordanted cotton a bright bluish scarlet.

588,181—August 17, 1897. I. ROSENBERG. *Reddish-violet dye.*

Tetrazo dyestuffs: produced by combining molecular proportions of tetrazotized diamins, employed in the manufacture of tetrazo dyestuffs, with bimolecular proportions of 1.3 naphthylenediamin-sulpho-acids; black bronzy powders, soluble in hot water, dyeing unmordanted cotton bright reddish violet.

588,182—August 17, 1897. I. ROSENBERG. *Mixed substantive dye.*

Produced by combining molecular proportions of any of the tetrazo bodies usually employed for the manufacture of substantive dyestuffs with molecular proportions of an amin or phenol or a sulpho or carbo acid thereof, and reacting with the so-contained intermediate bodies on molecular proportions of a 1.3 naphthylenediamin mono or di sulpho acid (No. 587,757).

588,183—August 17, 1897. I. ROSENBERG. *Brown substantive dye.*

Substantive dyestuffs: produced by combining the rediazotized primary or mixed tetrazo dyestuffs, characterized by containing a 1.3 naphthylenediamin sulpho-acid as component part, with an amin.

588,388—August 17, 1897. V. G. BLOEDE. *Process of dyeing anilin-black.*

The fiber or fabric is impregnated with anilin, its homologues, or analogues, or a salt of these combined with a suitable oxidizer, and then subjected to the fumes or vapors of a mineral acid capable of liberating the oxidizer.

588,597—August 17, 1897. A. COBENZL. *Gray dye.*

A gray dyestuff produced by condensing alkylsaffranin with formaldehyde in a strong mineral-acid solution; a black powder easily soluble in water, difficultly soluble in alcohol, insoluble in ether, benzene, ligroin, etc., and soluble in concentrated sulphuric acid with a green color.

589,766—September 7, 1897. J. VILLE. *Red dye.*

Red coloring matters formed by heating aromatic hydrazins, as phenylhydrazin, with rosolic acid in the presence of alcohol, the vapors evolved being condensed, and the proportions varied in accordance with the depth of color desired.

590,088—September 14, 1897. C. BULOW. *Black disazo dye.*

Black diazo dyes derived from the oxynaphthylamin-sulpho-acid ($NH_2.OH.SO_3H$—1.8.4) by combining one molecular proportion of this acid with two molecular proportions of one and the same diazo compound or one molecular proportion each of two different diazo compounds, as of diazo-benzene-sulphonic acid and diazo compound of alpha-naphthylamin.

591,309—October 5, 1897. J. VILLE. *Red dye.*

Red coloring matters produced by heating a fatty hydrazin with rosolic acid; soluble in alcohol and acetic acid, forming red solutions, and in hydrochloric and sulphuric acid forming yellowish solutions.

591,616—October 12, 1897. M. BÖNIGER. *Trisazo dye.*

Substantive triazo coloring matters produced by combining one molecule of the tetrazo compound of a paradiamin, such as benzidin, with one molecule of paraxylidin, rediazotizing the intermediate products and combining the thus produced tetrazo compounds with two molecules of amidonaphthol-disulphonic acid H; being powders of slaty to purplish-brown color; soluble in water and methylic alcohol; dyeing unmordanted cotton from a bath containing common salt in intense blue shades ranging between indigo and dark-greenish blue; producing when diazotized on the fiber by combination with beta-naphthol a deep black, with metaphenylene-diamin a greenish-black, and with resorcin a dark green.

592,608—October 26, 1897. B. HEYMANN AND R. REYHER. *Red azin dye.*

Azin dyes produced by oxidizing first one molecular proportion of the hydrochlorate of paraamidomonoalkyl orthotoluidin with one molecular proportion of monoalkyl ortho toluidin, and secondly oxidizing the resulting indamin compound with any primary amin of the aromatic series; brown powder, soluble in water with a splendid red color, same in alcohol, in concentrated sulphuric acid with a green color, producing clear fast red shades on mordanted and unmordanted cotton.

593,347—November 9, 1897. F. BENDER. *Violet disazo dye.*

Diazo dyes derived from 2 amido 5 naphthol 7 sulpho-acid—No. 521,095—and forming dark powders of metallic luster, soluble in water with a red to violet color, dying cotton without mordant, yielding red to violet shades, and the solution in concentrated sulphuric acid having a greenish to bluish shade.

593,790—November 16, 1897. M. ULRICH AND J. BAMMANN. *Blue-black diazo dye.*

A wool-dyeing diazo coloring matter produced by combining one molecular proportion of paradiazobenzene-sulpho acid with one molecular proportion of alpha₁ amido alpha₄ naphthol alpha₂ sulpho acid, or salts thereof, in a weakly mineral acid solution and combining the intermediate product thus obtained with one molecular proportion of alpha-diazonaphthalene in alkaline solution.

594,105—November 23, 1897. H. R. VIDAL. *Sulfur dye.*

Coloring matters are produced by reacting with sulphur upon specified derivatives of benzene (resorcin, metaämidophenol, sulphaminol, chrysoidin), the substances being heated together in the presence of an alkaline sulphide; dyeing cotton fibers a black or brown black.

594,106—November 23, 1897. H. R. VIDAL. *Mixed sulphur dye.*

A coloring matter produced by heating paraphenylenediamin and hydroquinone in equal parts in presence of sulphur; constituted in part by a body directly soluble in acids and dyeing animal fibers an intense black, and in part by a body soluble in alkalis and dyeing vegetable fibers dull blue.

594,107—November 23, 1897. H. R. VIDAL. *Thiazin dye.*

Paradioxythiazin is produced by heating with sulphur a mixture of paramidophenol and hydroquinone; paramidoöxythiazin by heating sulphur, paramidophenol, paraphenylenediamin, and hydroquinone.

594,123—November 23, 1897. C. H. RUDOLPH AND J. HERBABNY. *Blue-red tetrazo dye.*

Bluish-red tetrazo dye: produced by combining tetrazo-dichlordiphenyl, derived from diorthochlorbenzidin, with two molecules of beta-naphthylamin-beta-disulpho-acid, the so-called "amido R acid;" dyeing cotton without mordants a fast and brilliant bluish red.

594,996—December 7, 1897. M. KAHN AND F. RUNKEL. *Black azo dye.*

Black azo dye produced by combining equimolecular proportions of tetrazotized paradiamidodiphenylaminsulphonic acid with alphanaphthylaminbeta-sulphonic acid 1.6 or 1.7, coupling the intermediate product thus obtained with one molecular proportion of amidonaphtholsulphonic acid G, rediazotizing the diazo compound thus obtained and finally combining with two molecular proportions of a metadiamin, such as metaphenylenediamin or metatoluylenediamin; a brownish-black powder, soluble in hot water, with a violet-black color, yielding an unmordanted cotton deep bluish-black shades, fast to alkalis, acids, and light.

595,021—December 7, 1897. M. KAHN AND F. RUNKEL. *Black azo dye.*

A substantive black dyestuff produced by combining one molecular proportion of tetrazotized paradiamidodiphenylaminsulphonic acid with two molecular proportions of amidonaphtholmonosulphonic acid G in an alkaline solution, rediazotizing the diazo dyestuff thus obtained and further combining the so-formed tetrazo compound thereof with two molecular proportions of a metadiamin, such as metaphenylenediamin or metatoluylenediamin.

595,349—December 14, 1897. R. E. SCHMIDT. *Anthrarufin dye.*

A blue-alizarin dyestuff, the disulpho-acid of paradiamidoanthrarufin, produced by treating paradinitroanthrarufin-disulpho acid with reducing agents such as stannous chloride and hydrochloric acid; dyeing unmordanted wool in acid baths pure and even blue shades, with chromium mordants greenish-blue shades.

595,350—December 14, 1897. R. E. SCHMIDT. *Blue dye from chrysazin.*

A blue alizarin dyestuff, a disulpho acid of the paradiamidochrysazin: produced by sulphonating chrysazin and then subjecting the thus obtained disulpho acid of chrysazin to agents of nitration, and finally reducing the disulpho acid of dinitrochrysazin to the disulpho acid of diamidochrysazin; a dark-violet powder with a copper-like luster, dyeing wool in acid baths fast blue shades and yielding on chrome-mordanted fibers greenish-blue shades.

596,333—December 28, 1897. C. O. MULLER. *Rhodol dye.*

Dyestuffs of the phthalein series are produced by condensing the dialkylamidoöxybenzoylbenzoic acids with resorcinol, and the dyestuffs thus obtained may be converted into derivatives soluble in water by treating them with an alcohol and an acid. The dyestuff formed by the hydrochloride of an alkyl ether of dimethyl rhodol dyes wool, silk, and tannin-mordanted cotton in yellow-red tints.

596,559—January 4, 1898. A. WEINBERG. *Brown sulpureted dye.*

A brown coloring matter produced by heating one part of dinitrocresol with 4 to 6 parts of an alkali sulphide and 1 to 3 parts, all by weight, of sulphur; soluble in water in presence of sulphides or strong alkalis; dyeing unmordanted cotton brown.

597,983—January 25, 1898. M. H. ISLER. *Black substantive cotton dyestuff.*

Black coloring matter produced by energetically treating the anthraquinone derivatives, such as dinitroanthraquinones, the corresponding amidoanthraquinones, the intermediate reduction compounds, alizarin, anthrapurpurin, flavopurpurin, anthraquinone-monosulpho-acid, anthraquinone alpha and beta disulpho-acids, with alkaline sulphides or polysulphides until a water-soluble product results, free from unchanged initial material; giving greenish to violet-blue solutions.

598,118—February 1, 1898. H. SCHMID. *Process of discharging red.*

Paranitranilin red is discharged by printing thereon a discharging color containing a tin salt and acetin, a new product, having a dissolving action upon the red, and then allowing the discharge to act in the usual manner by steaming.

599,425—February 22, 1898. R. E. SCHMIDT. *Blue black alizarin dye.*

Alizarin dyestuffs produced by first condensing purpurin with a primary amin, as anilin, which process may be carried out under the addition of condensing agents, such as boric acid, and, secondly, treating the intermediate condensation product thus obtained with sulphonating agents, such as concentrated sulphuric acid.

599,426—February 22, 1898. R. E. SCHMIDT. *Green dye derived from anthraquinone.*

Anthraquinone dyestuffs, being monosulpho acids of condensation products obtainable from one molecule of quinizarin and two molecules of certain primary aromatic amins, as paratoluidin: produced by treating the said condensation products with agents of sulphonation, such as sulphuric monohydrate, containing 99.7 per cent H_2SO_4, until a test portion is clearly soluble in a large quantity of water, introducing the reaction mixture into cold water and precipitating the dyestuff; dyeing wool in acid baths fast green shades.

599,427—February 22, 1898. R. E. SCHMIDT. *Green dye derived from quinizarin.*

Anthraquinone dyestuffs, being disulpho acids of the condensation products, as per No. 599,426, are obtained by sulphonating with weakly fuming sulphuric acid, containing 5 per cent of SO_3, in lieu of the sulphuric monohydrate of said prior patent.

599,532—February 22, 1898. C. RIS. *Black trisazo dye.*

A black triazo color produced by combining the tetrazo compound of paraphenylenediaminazobeta$_1$ alpha$_4$ amidonaphthol beta$_3$ sulpho-acid$_1$ first, in acid solution with one molecule of a metadiamin (such as metaphenylenediamin), and then in alkaline solution with one molecule of beta$_1$ alpha$_4$ amidonapthol beta$_3$ sulpho-acid: dyeing unmordanted cotton in deep black shades.

601,033—March 22, 1898. M. BÖNIGER. *Blue-black mixed trisazo dye.*

Mixed triazo coloring matters produced by combining in an alkaline solution one molecule of the simple azo color obtained in acid solution from diazotized beta$_1$ alpha$_4$ amidonaphthol beta$_2$ beta$_3$ disulphonic acid and alphanaphthylamin with one molecule of tetrazo-diphenyl, and further combining this intermediate product with one molecule of an amidonaphtholsulphonic acid.

601,063—March 22, 1898. C. RIS. *Benzidin-orange.*

An orange coloring matter produced by condensing a paradiamin, such as benzidin, with paranitrotoluolsulpho acid in a solution of a caustic alkali; a brownish powder soluble in water with a deep orange color, in concentrated sulphuric acid with a red-violet color.

601,363—March 29, 1898. H. R. VIDAL. *Thiazin dye.*

Coloring matters derived from thiazin compounds: produced by reaction of sulphur on one or more para substitution products of thiazin derivatives, or mixtures for yielding the same, and consequent condensation of the thiazin molecules to tetraphenetrithiazin products, one or more of said thiazin derivatives having amidogen in the para position in one nucleus and one of specified hydrogen-containing groups in the para position in the other nucleus, and the resulting tetraphenetrithiazins having one of the hydrogen-containing groups in the para position in each of the nuclei at the ends of the chain of four nuclei.

601,364—March 29, 1898. H. R. VIDAL. *Process of obtaining dyes from sulfanilic acid.*

An amidophenol is heated with parasulphanilic acid, yielding a blue coloring matter, dyeing cotton directly in an alkaline bath.

601,365—March 29, 1898. H. R. VIDAL. *Black dye.*

Black coloring matters: produced by heating the condensation products of parasulphanilic acid and paraamidophenol in presence of sulphur, the mass being dissolved in a solution of caustic soda and then evaporated; dyeing unmordanted cotton in shades of very deep black.

601,859—April 5, 1898. C. RUDOLPH. *Blue azo dye.*

Blue tetrazo dyestuff: produced by combining tetrazo diphenyl or ditolyl first with one molecule of amidoöxy-alpha-naphthalene-disulpho-acid in an alkaline solution, and then with one molecule of dioxynaphthalene 2.6 dissolved in alkali; a black-violet powder with a metallic luster, soluble in water with a blue-violet and in sulphuric acid with a greenish-blue color.

602,540—April 19, 1898. M. KAHN. *Violet dye.*

Tetrazo dyestuff: produced by combining one molecule of tetrazotized dianisidin with one molecule of 2.3.6 naphtholdisulpho acid, and further coupling the intermediate product thus obtained with one molecule of paraxylidin; a brownish-black powder with a bronze-like luster, soluble in water with a browish-violet color, in concentrated sulphuric acid with a blue color, dyeing unmordanted cotton violet shades.

602,544—April 19, 1898. P. OTT AND T. KROEBER. *Blue azin dye.*

Azin dyestuffs: produced by condensing sulpho acids of symmetrically disubstituted 1.3 naphthylenediamins having the sulpho group in position 8 with certain disubstituted amidoazo-benzene sulpho acids; dissolving in water yielding blue solutions, in concentrated sulphuric acid with a green color; dyeing unmordanted wool in acid baths fast blue shades.

602,637—April 19, 1898. E. KÖNIG. *Bassic red disazo dye.*

Scarlet-red dyestuff obtained from diazotized meta-trimethyl ammonium phenyl-azo-meta-toluidin and beta-naphthol; a brown-red powder, soluble in water with a blue-red color, and dyeing tanned and untanned cotton, as well as half wool, scarlet red in an acid solution.

602,638—April 19, 1898. E. KÖNIG. *Basic yellow disazo dye.*

Yellow dyestuff obtained from diazotized meta-trimethyl ammonium phenylazo-meta-toluidin and 1 phenyl 3 methyl 5 pyrazolon; an orange-yellow powder, soluble in water, alcohol, ether, and benzene; dyeing tanned and untanned cotton, as well as half wool, in an acid bath, yellow.

602,639—April 19, 1898. E. KÖNIG. *Coppery-brown dye.*

Brown dyestuff obtained from diazotized meta-trimethyl ammonium phenylazo-meta-toluidin and chrysoidin; a black-green powder, soluble in water, with a reddish-yellowish-brown color, and dyeing tanned and untanned cotton, as well as half wool, a coppery brown.

602,640—April 19, 1898. E. KÖNIG. *Red-violet basic disazo dye.*

Reddish-violet dyestuff obtained from diazotized meta-trimethyl ammonium phenylazo-meta-amido-para-cresol ether and beta-naphthol; a brown powder soluble in water with a cherry-red color, and dyeing tanned and untanned cotton, as well as half wool, a reddish violet in an acid bath.

602,641—April 19, 1898. E. KÖNIG. (*Reissue: 11,714—January 31, 1899.*) *Basic disazo dye.*

Brown diazo and polyazo dyestuffs: produced by diazotizing the amidoazo dyestuffs from diazotized aromatic amido-ammonium bases and primary alphylamins, and then combining them with phenols, alphylamins, oxy, or amido azo dyestuffs; yielding, when chrysoidin is used, a blackish-brown powder, easily soluble in water with a brown color, in concentrated sulphuric acid with an olive-green color, and dyeing tanned and untanned cotton, as well as half wool, brown in an acid bath.

602,855—April 26, 1898. K. KREKELER AND A. BLANK. *Blue-black trisazo dye*

Triazo dyestuffs: produced by first combining in an alkaline solution one molecule of a tetrazotized paradiamin, such as benzidin, tolidin, dianisidin, with one molecule of amidonaphtholsulpho acid G; secondly, rediazotizing the resulting intermediate product; and, finally, coupling the intermediate product with two molecules of alpha$_1$, alpha$_4$, dioxynaphthalene alpha$_3$, monosulpho acid; dark powders dissolving in water with a blue color, dyeing unmordanted cotton blue shades which change into blackish blue with chromium and copper salts.

602,856—April 26, 1898. K. KREKELER AND A. ISRAEL. *Black trisazo dye.*

Triazo dyestuffs: produced by first combining one molecule of a tetrazotized paradiamin, such as benzidin, tolidin, or dianisidin, with one molecule of a betamonosulpho acid of alpha-naphthylamin, such as 1.6 and 1.7; secondly, diazotizing the resulting intermediate product; and, finally, combining the tetrazo compound thus produced with two molecules of 1.8 dioxynaphthalene, 4 sulpho acid; dyeing unmordanted cotton blue, changing to black when treated with solutions of chromium and copper salts.

602,857—April 26, 1898. K. KREKELER, A. ISRAEL, AND A. BLANK. *Black trisazo dye.*

Triazo dyestuffs: produced by combining one molecule of a tetrazotized paradiamin, such as benzidin, tolidin, or dianisidin, with one molecule of a betamonosulpho acid of alpha-naphthylamin, such as 1.6 and 1.7; secondly, diazotizing the resulting intermediate product; thirdly, coupling the tetrazo compound thus obtained with one molecule of 1.8 dioxynaphthalene, 4 monosulpho acid; and, finally, combining the body thus produced, which contains still one free diazo group, with a metadiamin of the benzene series, such as metaphenylenediamin; dark powders soluble in water with violet-gray to violet-black color and yielding violet-black shades on unmordanted cotton, changing to fast black with solutions of chromium and copper salts.

602,858—April 26, 1898. K. KREKELER AND E. MARTZ. *Brown trisazo dye.*

Triazo dyestuffs: produced by combining the diazo derivatives of certain diazo compounds (such as the combination of one molecule of tetrazodiphenyl with one molecule of salicylic acid and one molecule of Clève's naphthylaminsulpho acid) with one molecule of an orthoöxycarbonic acid of the benzene series; dark powders soluble in water, dyeing unmordanted cotton yellowish brown to brown, becoming fast and more reddish brown on treatment with solutions of chromium and copper salts, and dyeing wool in acid baths similar shades.

603,008—April 26, 1898. M. KAHN. *Violet azo dye.*

Coloring matter: produced by combining in acid solution one molecule of a tetrazodiphenyl salt and two molecules of 1.8 amidonaphthol and 4 monosulpho acid; a black powder of a bronze-like luster soluble in water with a violet color and dyeing unmordanted cotton violet shades which change to fast black when treated with solutions of diazotized paranitranilin and sodium acetate.

603,009—April 26, 1898. M. KAHN AND F. RUNKEL. *Bluish-red dye.*

Tetrazo coloring matter: produced by combining one molecule of the tetrazo derivative of a certain diamidodiphenylaminsulpho acid with two molecules of metaphenylenediamin; dark-brown powder soluble in water yielding a red solution, yielding on unmordanted cotton intense bluish-red shades which change to fast brown on treatment with a solution of diazotized paranitranilin and sodium acetate.

603,013—April 26, 1898. P. OTT AND T. KROEBER. *Blue azin dye.*

Azin dyestuffs: produced by condensing sulpho acids of symmetrically-disubstituted 1.3 naphthylenediamins, such as 8 mono, 6.8 disulpho-acid with the sulpho-acids of paranitroso derivatives of secondary and tertiary aromatic amins; dark powders dissolving in water with a blue color, dyeing unmordanted wool in acid baths bright blue shades.

603,016—April 26, 1898. A. STEINER. *Triphenylmethane-blue dye.*

Violet to blue dyestuffs: produced by first combining the alkylated derivatives of phenyl-beta-naphthylamin with tetraälkylated diamido-benzophenone, next adding phosphorus oxychloride and keeping an elevated temperature, and finally sulphonating the so-obtained compounds; dissolving easily in concentrated sulphuric acid with a red-brown shade, and in water and in ethyl alcohol with a violet shade.

603,090—April 26, 1898. K. KREKELER AND E. MARTZ. *Brown trisazo dye.*

Triazo dyestuffs: produced by combining one molecule of the diazo derivatives outlined in No. 602,858 with one molecule of a metadiamin of the benzene series, such as metaphenylenediamin, metatoluylenediamin or a sulpho-acid thereof; dyeing cotton from reddish-brown to dark-brown shades which, when treated with solutions of chromium and copper salts, become more yellowish brown and fast.

603,093—April 26, 1898. G. STEINIKE AND F. SCHMIDT. *Black disazo wool dye.*

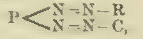
Black diazo dyestuffs: produced by the action of one molecule of a diazotized naphthylaminsulphonic acid and one molecule of a diazotized amin of the benzene or naphthalene series upon one molecule of dioxynaphthalenemonosulphonic acid S of No. 444,679; dark powders of bronze-like luster, soluble in water with a violet color, and dyeing wool in an acid bath.

603,300—May 3, 1898. H. R. VIDAL. *Process of making carboxylated products of triphenylmethane.*

Mono and di carboxylated products are derived from phenolic and amidated compounds of triphenylmethane by heating a mixture of phenol and the compound of triphenylmethane in presence of condensing agents, such as oxalic and sulphuric acid. They constitute light-yellow products in an acid state, and as salts they are a bright scarlet red.

603,645—May 10, 1898. K. KREKELER AND E. MARTZ. *Green trisazo dye.*

Triazo dyestuffs: produced by combining the diazo derivatives of the diazo compounds of the general formula



$$P<\begin{matrix}N=N-R\\N=N-C,\end{matrix}$$

in which P represents a radical of the benzidin series, such as diphenyl, ditolyl, diphenol ether, or the like; R, the radical of an orthoöxycarbonic acid of the benzene series, such as salicylic acid or cresotinic acid; and C, the radical of "Cleve's" alpha-naphthylamin-beta-sulphonic acid (1.6 or 1.7), with one molecule of a mono or di sulpho acid of 1.8 amidonaphthol; forming black powders soluble in water with green color, dyeing unmordanted cotton green shades.

603,646—May 10, 1898. K. KREKELER, E. MARTZ, AND A. ISRAEL. *Gray trisazo dye.*

Triazo dyestuffs: produced by combining the diazo derivatives of the diazo compounds of the general formula $R-N=N-P-N=N-C$ (as per No. 603,645) with one molecule of 1.4 or 1.5 naphtholmonosulpho-acid; forming dark powders dyeing unmordanted cotton greenish-gray shades.

603,647—May 10, 1898. K. KREKELER, E. MARTZ, AND A. ISRAEL. *Green trisazo dye.*

Triazo dyestuffs: produced by combining the diazo derivatives of the diazo compounds of the general formula $R-N=N-P-N=N-C$ (as per No. 603,645) with one molecule of a 1.8 dioxynaphthalene mono or di sulpho acid; forming black powders dyeing unmordanted cotton green shades.

603,648—May 10, 1898. K. KREKELER, E. MARTZ, AND A. ISRAEL. *Brown trisazo dye.*

Triazo dyestuffs: formed by combining the diazo derivatives of the diazo compounds of the general formula $R-N=N-P-N=N-C$ (as per No. 603,645) with one molecule of alpha-naphthylamin, or of a monosulpho acid thereof; dyeing unmordanted cotton dark-brown shades, and wool similar shades in acid baths.

603,659—May 10, 1898. R. E. SCHMIDT. *Dark-green alizarin derivative.*

Alizarin dyestuffs: obtainable by sulphonation of the condensation products from one molecule of alizarin pentacyanin and two molecules of a primary aromatic amin, as paratoluidin; forming dark powders, dyeing unmordanted and chrome-mordanted wool green shades, yielding on chrome-mordanted cotton fast green shades.

603,755—May 10, 1898. R. DEMUTH. *Brown sulphur dye.*

Coloring matter: produced by subjecting cresols and sulphur in a strong alkaline solution to a heat above 200° C.; forming, in the case of its alkaline salts, a black mass, soluble in water, with a greenish-black or blueish-black color, dyeing cotton a fast brown.

605,103—June 7, 1898. M. KAHN AND K. HEIDENREICH. *Black disazo dye and process of making same.*

Diazo dyestuffs: produced by first combining one molecule of the diazo derivative of amidodiphenylaminsulpho-acid, having the formula $C_6H_5.NH.C_6H_4.NH_2$ (1), SO_3H (3), with one molecule of alphanaphthylamin; secondly, diazotizing the resulting amidoazo compound; and finally, coupling the diazoazo compound thus obtained with an alpha-naphthol-alpha-monosulpho-acid, such as 1.4 naphtholsulpho-acid, 1.5 naphtholsulpho-acid; forming dark powders, soluble in water, with a bluish-black color, dyeing wool in acid bath fast black shades.

605,119—June 7, 1898. O. NASTVOGEL. *Diphenylnaphthylmethane dye.*

A diphenylnaphthylmethane dye: produced by first condensing tetraälkyldiamidobenzhydrol with certain alpha-naphthylaminsulpho acids; secondly, diazotizing the resulting leuco compound; thirdly, transforming the diazo group of the body thus obtained into the sulphinic group; and finally, changing the so-produced leuco sulphinic-sulphonic acid into the corresponding dyestuff, sulphonic acid, by means of oxidizing agents; forming a brown powder, dyeing wool in acid bath greenish-blue shades fast to alkalis.

605,568—June 14, 1898. R. E. SCHMIDT. *Anthraquinone dye.*

Paradiamidoanthrarufin-monosulpho acid: produced by sulphonating paradiamidoanthrarufin by means of fuming sulphuric acid with the addition of boric acid; forming a blackish powder dyeing unmordanted wool in acid baths blue shades fast to light, and yielding on chrome mordanted wool fast greenish-blue shades.

605,921—June 21, 1898. R. E. SCHMIDT AND P. TUST. *Blue anthraquinone dye.*

Paradiamidochrysazin-monosulpho acid: produced by sulphonating paradiamidochrysazin by means of fuming sulphuric acid with the addition of boric acid; a blackish powder, dyeing unmordanted wool in acid baths blue shades fast to light, yielding on chrome mordanted wool greenish-blue shades.

606,181—June 28, 1898. J. BAMMANN. *Blue tetrazo dye and process of making same.*

Tetrazo dyestuffs: produced by combining one molecule of a tetrazotized paradiamin with two molecules of 1.8 amidonaphthol 4.6 disulpho-acid; forming dark powders soluble in water with from reddish-blue to blue color, dyeing unmordanted cotton fast violet-blue to blue shades.

606,193—June 28, 1898. R. DEMUTH. *Yellow-brown cotton dye.*

A yellowish-brown cotton dye: produced by subjecting dinitrotoluenesulpho-acid ($CH_3NO_2NO_2SO_3H$ 1:2:4:6), or salts thereof, to the action of an alkaline-sulphid-carrying compound at elevated temperatures, up to 250° C.

606,212—June 28, 1898. B. HEYMANN. *Blue dye and process of making same.*

Dyestuff produced by the reaction of paraämidodimethylanilinthiosulpho acid and nitroso 2.7 oxynaphthoxyacetic acid; dyeing chrome-mordanted wool fast bright-blue shades.

606,264—June 28, 1898. J. BAMMANN. *Dark-blue tetrazo dye and process of making same.*

Tetrazo dyestuffs: produced by combining one molecule of tetrazotized paradiamin, such as benzidin, tolidin, or dianisidin, with one molecule of the 1.8 amidonaphthol, 4.6 disulpho-acid (German patent No. 80,741); and further combining the resulting intermediate product with one molecule of amidonaphtholmonosulpho-acid G; being soluble in water, rediazotizable in solution or on fiber, and dyeing unmordanted cotton from blackish-blue to blue shades.

606,295—June 28, 1898. P. OTT AND T. KROEBER. *Blue azin dye and process of making same.*

Azin dyestuffs: produced by acting with oxidizing agents such as bichromate of sodium on a mixture of equimolecular proportions of paraämidodiphenylaminorthosulpho acid and of a sulpho acid of a symmetrically-disubstituted 1.3 naphthylene diamin; forming a dark powder dyeing wool brilliant-blue fast shades.

606,437—June 28, 1898. F. BENDER. *Amidonaphtholdisulpho acid and process of making same.*

Acid "B," 1.8 amidonaphthol 3.5 disulpho-acid: produced by sulphonating 1.8 amidonaphthol 3 monosulpho acid; soluble in hot water, with difficulty in cold water; the diazo compound being soluble in water with an intensely yellow color; the acid, when boiled with dilute sulphonic acid at 140° C., yielding 1.8 amidonaphthol 3 sulpho-acid, and when heated with dilute caustic-soda lye up to 230° C., yielding 1.8 dioxynaphthaline 3.5 (4.6) disulpho acid, and adapted to form an acid sodium salt.

606,438—June 28, 1898. F. BENDER. *Blue black dye.*

Diazo dyes derived from one molecular proportion of acid "B," No. 606,437, and two molecular proportions of a diazo compound, such as diazo-benzene, soluble in water with a greenish to reddish blue color, and dyeing wool in an acid bath in greenish to bluish-black shades.

606,439—June 28, 1898. F. BENDER. *Green disazo dye.*

A coloring matter, dyeing unmordanted cotton in green shades, prepared by sulphonating 1.8 amidonaphthol 3 monosulpho-acid (acid "B," No. 606,437), benzidin-azo-salicylic acid, or analogous compounds.

607,408—July 12, 1898. E. ELSAESSER. *Blue dye for wool.*

Blue dyestuff for wool: produced by oxidizing a mixture of beta dinaphthylmetaphenylenediamin-disulphonic acid and dimethylparaphenylenediaminthiosulphonic acid in an aqueous solution, and then boiling the oxidized product with soda; a dark-bronze shining powder, readily soluble in water, with difficulty in alcohol.

608,024—July 26, 1898. M. BONIGER. *Brown azo dye.*

Substantive brown polyazo coloring matters: produced by combining, first, one molecule of the azo color beta$_1$ azo alpha$_4$ naphthol beta$_2$ beta$_3$ disulphonic acid metaphenylen or metatoluylen diamin with one molecule of a diazo compound and combining the disazo color thus obtained with one molecule of the intermediate product obtained by combination of one molecule of tetrazodiphenyl or tetrazo-ditolyl with one molecule of salicylic acid; dyeing unmordanted cotton in yellow-brown to blue-brown tints.

606,238—August 2, 1898. K. THUN. *Green alizarin dye.*

Alizarin dyestuffs: produced by sulphonating the condensation products obtainable from one molecule of alizarin bordeaux and two molecules of a primary aromatic amin, as paratoluidin; forming dark powders, dyeing unmordanted and chrome-mordanted wool green shades and yielding on chrome-mordanted cotton green shades fast to light.

608,354—August 2, 1898. H. R. VIDAL. *Process of making violet dyes.*

Violet coloring matters are produced by heating parasulphanilic acid with diamins, one to four, of benzene and naphthalene.

608,355—August 2, 1898. H. R. VIDAL. *Brown-black sulfur dye.*

Coloring matters: produced by heating with sulphur a condensation product of the amidobenzene sulphonic acids with a derivative of phenol or a diamin, such as the condensation product of the parasulphanilic acid and orthoamidophenol; soluble in alkalis, insoluble in acid and directly dyeing unmordanted cotton a brown black.

608,999—August 16, 1898. J. BAMMANN AND M. ULRICH. *Blue-black azo dye.*

A coloring matter: produced by combining equimolecular proportions of a tetrazo-diphenyl salt with 1.8 amido-naphthol-beta-disulpho acid and alphanaphthylamin; soluble in water and alcohol with reddish-violet color, in ammonia with bright, reddish violet, dyeing unmordanted cotton in an alkaline bath violet-black shades, changing to black on treatment with nitrous acid and an alkaline solution of beta-naphthol.

609,327—August 16, 1898. R. BOHN. *Blue-black dye and process of making same.*

A violet-blue to blue-black dyestuff: produced by submitting a dinitronaphthalene to the action of a reducing agent—such as sodium sulphide, grape sugar, sodium stannate, zinc dust, or the like—in alkaline solutions of the sulphites or the bisulphites of the alkalies or the alkaline earths.

609,352—August 16, 1898. P. JULIUS. *Blue dye.*

A blue coloring matter: produced by condensing the nitrosodiethylmetaämidophenol with alpha-naphthylaminmonosulpho acid, yielding fast indigo-like shades.

609,598—August 23, 1898. H. R. VIDAL. *Red dye and process of making same.*

Coloring matters: produced by heating hydrazins with a carboxylated carbinol compound, such as dicarboxylated trioxyphenylcarbinol, forming a vivid red-blue mass, soluble in alkalis, directly dyeing animal and mordanted cotton fibers.

609,599—August 23, 1898. H. R. VIDAL. *Process of obtaining triphenylmethane derivatives.*

Tricarboxylated derivatives of phenolic or aminated compounds of triphenylmethane are produced by heating said compounds in presence of a condensing agent, such as oxalic and sulphuric acid. (See No. 603,300.) They form orange-colored masses, soluble in alkalis and concentrated acids, little soluble in water.

609,997—August 30, 1898. J. SCHMID AND H. REY. *Red-violet phthalein dye.*

In the manufacture of dyestuffs of the phthalein series, equal molecular parts of phthalic anhydrid and metaoxyphenylorthotolylamin are melted until the molten mass thickens, and then the product of condensation is extracted. One molecule of this product is condensed with one molecule of a meta-substituted phenol, such as resorcinol, monoethylmetaämidocresol, dimethylmetaämidophenol, etc., and the monoörthotolylphthalein dye thus obtained converted into a sulpho acid, and then into an alkaline salt. It dyes wool and silk in acid bath in red-violet tints.

609,998—August 30, 1898. J. SCHMID AND H. REY. *Sulfonated monobenzylphthalein dye.*

The alkaline sulphonate of a monobenzylated-phthalein dye is produced by condensing one molecule of the product, resulting from the condensation of equivalent quantities of phthalic anhydrid and of a benzylalkylmetaämidophenol, with one molecule of a meta-substituted phenol; then converting the monobenzylated-phthalein dye into a sulpho acid, and then into an alkaline salt. It dyes textile fibers in fiery-red tints.

610,345—September 6, 1898. B. DEICKE. *Red-acid dye and process of making it.*

Azo dyestuffs: produced by diazotizing amidobenzylamin and its alkyl derivatives, the salts of which are expressed by the general formula $NH_2.C_6H_4.CH_2-NR_3x$ (in which R represents hydrogen or an alkyl and x an acid radical), and combining with a primary aromatic amin, then rediazotizing and combining with an aromatic amin, phenol (pyrazolon), amido or oxyazo dyestuff; soluble in water and alcohol, with a red color, and dyeing half wool red in an acid bath.

610,349—September 6, 1898. O. ERNST. *Violet azo dye and process of making it.*

A monoazo dyestuff: produced by combining diazotized 1.8.4 amidonaphtholmonosulphonic acid with alpha-naphthylamin; a green-black powder of metallic luster, dyeing wool violet in an acid bath and producing by treatment with chromates or chromic acid a fast brown color.

610,367—September 6, 1898. A. PHILIPS. *Basic diazo dye.*

Basic diazo dyestuffs of the general formula, alphyl N_2 alphyl N_2 alphyl, $OHNR_3Cl$., (in which alphyl means an aromatic radical and R an alkyl): produced by diazotizing amidoazo compounds and allowing them to act upon phenol-ammonium bases; the product obtained by diazotizing amidoazo-benzene and treating it with 2.7 naphtholtrimethyl-ammonium being a red powder, dyeing wool and cotton cherry red in an acid bath.

610,541—September 13, 1898. G. KALISCHER. *Black dye and process of making same.*

A black coloring matter produced by heating oxydinitrodiphenylamin with sulphides of alkalis and sulphur in aqueous solution; soluble in water with a blue-black color and dyeing unmordanted cotton directly in an alkaline bath a deep blue-black.

611,111—September 20, 1898. E. ELSAESSER. *Brown dye and process of making it.*

A brown diazo dyestuff: produced by combining the sodium-bisulphite compound of nitroso-beta-naphthol in an acetic-acid solution with a tetrazo compound, such as tetrazo-diphenyl and tetrazo-ditolyl, and then combining the intermediate product thus formed with an alkaline solution of $beta_1$ amido $alpha_4$ naphthol $beta_3$ sulphonic acid; dyeing unmordanted cotton in a neutral or alkaline bath dark brown.

611,112—September 20, 1898. E. ELSAESSER. *Blue-black dye and process of making same.*

A direct-dyeing blue-black cotton dyestuff produced by the action of sodium sulphide upon $alpha_1$ $alpha_4$ dinitronaphthalene $alpha_2$ monosulphonic acid.

611,597—October 4, 1898. J. BAMMANN. *Green-blue tetrazo dye.*

Tetrazo dyestuffs produced by combining one molecule of a tetrazotized paradiamin of the benzidin series (such as benzidin, tolidin, dianisidin) with one molecule of 1.8 amidonaphthol 4.6 disulpho acid and coupling the intermediate product with one molecule of any of the known azo dyestuff components, such as 1.8 amidonaphthol 3.6 disulpho acid, 1.4 naphtholsulpho acid, alphanaphthylamin, or the like; dark powders, soluble in water, rediazotizable in solution or on the fiber, dyeing unmordanted cotton from violet to blue and greenish-blue shades.

611,610—October 4, 1898. R. DEMUTH. *Brown cotton dye.*

A reddish-brown cotton dye produced by subjecting 1 naphthol 4.8 disulpho acid to the action of an alkaline-sulphide carrying compound at temperatures of 260° to 270° C.

611,611—October 4, 1898. R. DEMUTH. *Indigo-blue cotton dye.*

An indigo-blue cotton dye produced by subjecting 1.8 amidonaphthol to the action of an alkaline sulphide and sulphur at 240° C., repeatedly extracting the resulting melt when cold with small quantities of hot water until the blue dye is wholly dissolved out, and finally isolating from the joint filtrates the dye by precipitation with a metallic chloride, such as zinc chloride; dyeing unmordanted cotton in alkaline bath, and in bath containing suitable reducing agents, fast indigo-blue shades.

611,628—October 4, 1898. H. HASSENCAMP. *Violet dye and process of making same.*

A triphenylmethane dyestuff produced by combining in equimolecular proportions tetramethyldiamidobenzhydrol and methylbenzylanilindisulpho acid, oxidizing the resulting leuco compound and converting the oxidation product into an alkaline salt; dyeing unmordanted wool in acid baths fast bluish-violet shades.

611,663—October 4, 1898. M. ULRICH. *Orange dye and process of making same.*

Orange dyestuffs, dyeing unmordanted cotton: produced by combining one molecule of a diazotized paraämidoazo sulpho acid of the benzene series—such as amidoazo-benzene sulpho acid, amidoazo-toluene sulpho acid, or the like—with one molecule of a nitrometadiamin of the benzene series, such as nitrometaphenylenediamin; fast to acids, alkalis, and light.

611,664—October 4, 1898. M. ULRICH. *Blue dye and process of making same.*

Monoazo dyestuffs produced by combining one molecule of a diazotized periamidonaphtholsulpho acid, such as 1.8 amidonaphthol 3.6 disulpho acid, with one molecule of a monosubstituted 1.8 naphthylaminsulpho acid of the general formula $C_{10}H_6$. NHR (1). SO_3H (8), in which R represents an aromatic radicle such as phenyl; dyeing unmordanted wool in acid bath from reddish blue to fast blue shades.

613,113—October 25, 1898. J. J. BRACK. *Rhodol derivative and process of making same.*

Dyestuffs of the phthalein series produced by condensing an alkyl ether of a dialkylrhodol with formic aldehyde; a brilliant greenish powder, dyeing tannin-mordanted cotton a yellowish red, and on printing with potassium ferrocyanide and zinc oxide it yields a lake of the same color, not changed by steaming.

613,578—November 1, 1898. C. DE LA HARPE AND C. VAUCHER. *Blue dye from gallocyanin and process of making same.*

A coloring matter: produced by treating the gallocyanin dye of No. 518,458, with sulphurous acid in a free state or as a sulphite or bisulphite; dyeing and printing bluer tints than the original gallocyanin.

613,638—November 1, 1898. K. ELBEL AND I. ROSENBERG. *Primary disazo blue-black dye.*

A primary diazo coloring matter, dyeing wool a blue black: produced by combining the 1.8.4.6 amidonaphtholdisulpho-acid (K) with one molecule of alpha-diazonaphthalene in presence of free mineral acid and then acting upon the so-formed monoazo color with one molecule of diazo-benzene in an acid combination liquid.

613,639—November 1, 1898. K. ELBEL AND I. ROSENBERG. *Primary disazo blue-black dye.*

A primary diazo coloring matter: produced by combining the 1.8.4.6 amidonaphtholdisulpho-acid (K) with one molecule of paranitrodiazobenzene in presence of free mineral acid and then acting upon the so-formed monoazo color with one molecule of diazo-benzene in an acid combination liquid; dyeing wool from an acid bath blue to deep blue-black shades.

613,640—November 1, 1898. I. ROSENBERG AND K. ELBEL. *Greenish-blue polyazo dye.*

A polyazo dyestuff produced by combining one molecule of alpha-diazonaphthalene with one molecule of 1.8.4.6 amidonaphtholdisulpho-acid (K) in presence of free mineral acid to a monoazo color, acting upon same in presence of free acetic acid with one molecule of tetrazo-diphenyl and uniting the so-formed intermediate product with 2.8.6 amidonaphtholsulpho-acid (G) in presence of alkali; dyeing unmordanted cotton a deep greenish blue.

613,641—November 1, 1898. I. ROSENBERG AND F. KRECKE. *Greenish-blue mixed disazo dye.*

A dyestuff obtained by combining the intermediate product from one molecule of tetrazo-diphenyl and one molecule of 1.8.4.6 amidonaphtholdisulpho acid (K) with one molecule of 2.8.6 amidonaphtholsulpho-acid (G), effected in alkaline solution, characterized by giving with concentrated sulphuric acid a cornflower-colored solution; dyeing unmordanted cotton greenish-blue to greenish-black shades.

613,642—November 1, 1898. I. ROSENBERG. *Deep-blue dye and process of making same.*

A mixed substantive dyestuff produced by combining the tetrazo compound of benzidin first with one molecular proportion of 1.8.4.6 amidonaphtholdisulpho-acid (K), to form an intermediate product which is then put into reaction with one molecular proportion of 1.3[illegible] naphthylenediaminsulpho acid dyeing unmordanted cotton deep-blue indigo-like shade from a weakly alkaline or salt bath.

613,643—November 1, 1898. I. ROSENBERG AND B. HELMERT. *Orange-brown polyazo dye.*

Polyazo dyestuffs produced by combining monoazo colors containing the 1.3.6 naphthalenediaminsulpho acid (No. 587,757), as component part with the intermediate products obtained from one molecule of one of the usually employed paradiamins and one molecule of an oxycarbonic acid; dyeing unmordanted cotton a fast orange-brown shade from an alkaline or salt bath, and dyeing mixed goods from a neutral bath.

613,644—November 1, 1898. I. ROSENBERG AND B. HELMERT. *Reddish-brown polyazo dye.*

A polyazo dyestuff produced according to No. 613,643, using the diazo compound of alpha-naphthylamin; dying unmordanted cotton reddish-brown shades from alkaline or salt baths; dyeing wool same shades from a neutral bath; and especially suited for dyeing mixed goods.

613,645—November 1, 1898. I. ROSENBERG. *Black polyazo dye.*

A polyazo dyestuff produced by reducing in alkaline solution the nitro group of the monoazo color obtained from one molecule of paranitrodiazo-benzene and one molecule of 1.8.4.6 amidonaphtholdisulpho acid (K) in acid solution, combining the reduced product with one molecule of tetrazo-diphenyl to form an intermediate body and acting upon this with one molecule of 1.3.6 naphthalenediaminsulpho acid; a black powder soluble in water with black, in concentrated sulphuric acid with indigo-blue color, dyeing unmordanted cotton black, which can be rediazotized and combined with developers.

613,646—November 1, 1898. I. ROSENBERG AND F. KRECKE. *Substantive disazo dye.*

A mixed substantive diazo dyestuff produced by combining the tetrazo compound of tolidine, first with one molecular proportion of 2.8.6 amidonaphtholsulpho-acid (G) and then reacting on the same with one molecular proportion of 1.3.6 naphthylenediaminsulpho-acid; dyeing unmordanted cotton bluish-violet shades; diazotizable on the fiber, and combining with the usual developers; yielding, for instance, with beta-naphthol indigo-blue shades fast to light and washing.

613,911—November 8, 1898. C. RIS. *Yellow dye and process of making same.*

An orange-yellow powder, dyeing unmordanted cotton, wool, and silk in fast greenish-yellow shades, and produced by condensation of paradinitrodibenzyldisulpho acid with a base of the aniline series in presence of caustic-alkali lye and then further oxidizing the product.

613,920—November 8, 1898. H. GUTZKOW. *Green-blue soluble dye and process of making same.*

Greenish-blue dyestuffs soluble in water, produced by causing the diazo compounds of asymmetric dialkylsaffranin to act upon naphthylamin.

613,926—November 8, 1898. C. HOFFMANN. *Red rhodamin dye and process of making same.*

Rhodamindialkylamids, red dyestuffs, are produced by treating rhodamine with oxychloride of phosphorous and then with dialkylamins.

614,391—November 15, 1898. A. ISRAEL AND R. KOTHE. *Disazo dye and process of making same.*

Diazo dyestuffs: obtainable from acidyl 1.4 naphtylenediamins, Cleve's alphanaphtylaminebetamonosulpho acid and naphtolsulphonic acids; forming dark powders, dyeing unmordanted cotton from reddish blue to grayish-blue shades, which can be further diazotized on fiber and coupled with amins or phenols.

614,538—November 22, 1898. R. DEMUTH. *Indigo-blue dye and process of making it.*

Dyes giving blue shades on unmordanted cotton in alkaline baths, or in baths containing suitable reducing agents: produced by subjecting sulpho-acid compounds of 1.8 amidonaphthol, such as their free acids, or salts thereof, to the action of an alkaline sulphide-carrying compound at elevated temperatures, repeatedly extracting the resulting melt when cold with small quantities of hot water until the blue dye is wholly dissolved out, and finally isolating the dye by precipitation with metallic salts, as zinc chloride.

615,472—December 6, 1898. E. BOURCART. *Green dye and process of making same.*

A green dyestuff produced by treating the sulphonic acids of alkylated metaoxydiamidotriphenylmethane or their homologues at a low temperature with concentrated nitric acid, and then oxidizing the leuco compounds thus obtained; dyeing wool and silk green in an acid bath.

615,485—December 6, 1898. C. HOFFMANN. *Green dye and process of making same.*

Green to blue-green dyestuffs: produced by condensing metaälkyl-oxysulphonic acids with tetraalkyl-paradiamidobenzhydrols, sulphonating with fuming sulphuric acid, and then oxidizing the leucosulphonic acids thus obtained with peroxide of lead.

615,497—December 6, 1898. C. RIS AND C. SIMON. *Black trisazo dye and process of making same.*

A black triazo color produced by combining the tetrazo compound of paraphenylenediaminazo $beta_1$ $alpha_4$ amidonaphthol $beta_3$ sulpho acid first in acid solution with a metadiamin, and then with resorcin; dyeing unmordanted cotton, wool, and silk deep-black shades.

615,791—December 13, 1898. H. BOEDEKER. *Process of making sulfonic acids of asymmetric rhodamins.*

Asymmetric rhodamin dyestuffs are obtained by first substituting in the fluorescein chloride one chlorine atom by the rest of a primary or secondary base of the fat or aromatic series, and then acting on the intermediate product thus obtained with another primary or secondary base of the fat or aromatic series, and transforming the dyestuff thus obtained into the sulphonic acid by treatment with concentrated sulphuric acid. Wool is dyed a bright red in an acid bath.

616,123—December 20, 1898. I. LEVINSTEIN AND C. MENSCHING. *Process of making alphylamidonaphthol sulfonic acids.*

They are produced by heating beta$_1$ alpha$_4$ dioxynaphthalene-beta$_3$ sulphonic acid with aromatic amins in the presence of means of condensation such as the hydrochlorides of the aromatic amins, as anilin and anilin hydrochloride at from 120° to 160° C. Dyestuffs are obtained by treatment with diazo or tetrazo bodies.

616,552—December 27, 1898. C. DE LA HARPE. *Blue dye from gallocyanin and process of making same.*

A leuco body suitable for dyeing and printing on textile fabrics: produced by boiling the product of condensation of resorcinol and a gallocyanin dye, with an aqueous solution of an alkali while out of contact with the air, forming a greenish black powder which colors fibers when applied and oxidized thereon, in redder blue tints than the said product of condensation.

617,430—January 10, 1899. P. JULIUS AND G. E. DARIER. *Phosphin dye and process of making same.*

Phosphins and their alkyl substitution products (substitution in the amido group) are obtained by condensing paraämidobenzaldehyde, or its substitution products, with the alphyl derivatives of the metatoluylenediamin; the dyestuff obtained by condensing dimethyl-paraämidobenzaldehyde with phenylmetatoluylenediamin, dissolving in hot water with a reddish-yellow color, becoming light yellow by the addition of dilute mineral acids.

617,544—January 10, 1899. F. SCHOLL. *Yellow basic disazo dye and process of making same.*

Azo dyestuffs: produced by diazotizing amidoazo dyestuffs obtained from diazotized aromatic amidoammonium bases and primary alphylamins and then acting with the same upon aceto-acetanilid; forming orange yellow powders, dyeing cotton, as well as wool and half-wool, light yellow in an acid bath.

617,627—January 10, 1899. O. BALLY. *Process of making green dyes.*

A green mordant-dyeing coloring matter is produced by melting together brom-fluoresceins and concentrated sulphuric acid and then adding boracic acid.

617,628—January 10, 1899. H. A. BERNTHSEN AND G. J. JAUBERT. *Blue dye and process of making same.*

A blue mordant-dyeing dyestuff is produced by treating an oxynaphthindophenolthiosulphonic substance with a concentrated mineral acid.

617,551—January 10, 1899. L. GIFFORD, ADMINISTRATOR OF K. HEUMANN, DECEASED. *Blue dye and process of making same.*

Dyestuff: produced by melting ethyl-phenyl-glycocol with alkali, and subsequently oxidizing, as by an air blast. It dyes both from the vat and in the form of sulpho acid greenish shades of blue.

617,652—January 10, 1899. L. GIFFORD, ADMINISTRATOR OF K. HEUMANN, DECEASED. *Process of making indigo coloring matters.*

In the manufacture of indigo coloring matters from glycocol derivatives, quicklime is added to the caustic alkaline melt, in which the glycocol derivatives are treated, giving a higher yield of the leuco compound.

617,686—January 10, 1899. M. H. ISLER. *Blue dye and process of making same.*

Blue coloring matters: produced by treating dinitro-anthraquinones with fuming sulphuric acid containing about 30 to 40 per cent SO_3 and boracic acid in presence of sulphur at 120° to 180° C. for two to two and a half hours.

617,703—January 10, 1899. W. HERZBERG AND H. HEIMANN. *Blue safranin dye.*

A blue saffranin dye: prepared from neutral blue by first treating the latter with sulphites and subsequently reacting on the sulpho acid thus formed with dimethylparaphenylenediamin, and forming a dark-brown powder and producing on mordanted cotton blue shades.

617,963—January 17, 1899. H. KIRCHHOFF. *Red dye.*

A dye: produced by combining one molecule of diazotized metaämidoparacresol-ether with one molecule of a salt of naphtholsulphamidosulphonic acid; dyeing wool clear red shades of bluish tint.

617,981—January 17, 1899. O. BALLY. *Anthraquinone derivative and process of making same.*

Coloring matters: produced by condensing the sulphuric acid esters of a polyoxyanthraquinone sulpho acid, which can be obtained by the treatment of a nitro-anthraquinone or reduction product thereof, with fuming sulphuric acid and a reducing agent, such as sulphur, with a phenolic body (including the hydroxycarboxylic and sulphonic acids); dyeing unmordanted wool violet to blue shades which become greenish-blue to blue on treatment with chrome.

618,000—January 17, 1899. O. BALLY. *Yellow dye and process of making same.*

Yellow mordant-dyeing coloring matters: produced by oxidizing an aromatic hydroxycarboxylic acid in sulphuric-acid solution, as by the action of a persulphate.

618,152—January 24, 1899. H. R. VIDAL. *Black sulphur dye.*

Black dyestuffs are produced by causing sulphur to react upon a trisubstituted derivative of benzene, such as diamidophenol.

618,688—January 31, 1899. E. KÖNIG AND F. SCHOLL. *Aromatic amidoammonium and process of making same.*

Aromatic amido-ammonium bases (valuable for the production of azo dyestuffs), of the general formula (aromatic radical) $NH_2N(alkyl)_3x$ in the form of their salts (x representing chlorine or the equivalent radical of an acid), are produced by reducing aromatic nitro-ammonium oases with metals, such as zinc or iron, in an acid or neutral solution.

618,963—February 7, 1899. R. TAGGESELL. *Blue-black azo dye and process of making same.*

Azo dyestuffs: produced by combining one molecule of the diazo derivative of a monosulpho-acid of the benzene series—sulphanilic acid, metanilic acid, or toluidin-monosulpho-acid—with one molecule of alphanaphthylamin, rediazotizing the intermediate product, and combining it with amidonaphtholdisulpho-acid (H) or its equivalent; dyeing wool in an acid bath bluish-black shades of great fastness.

619,114—February 7, 1899. O. BALLY. *Green-black dye and process of making same.*

Coloring matters: produced by heating 1.5-dinitro-naphthalene with sulphuric acid to obtain the well-known naphthazarin intermediate product, and adding to the sulphuric acid solution of this body a phenolic body giving with cold anilin a color within the range of violet to blue.

619,115—February 7, 1899. O. BALLY. *Bluish dye and process of making same.*

A coloring matter obtained by heating 1.5-dinitro-naphthalene with sulphuric acid to obtain the naphthazarin intermediate product, and adding alpha naphthol to the sulphuric-acid solution of this body, giving a bluish-green color in anilin.

619,181—February 7, 1899. M. H. ISLER. *Product from dinitro-naphthalene and process of making same.*

New bodies: produced by submitting 1.8 or 1.5 dinitro-naphthalene to the action of weak fuming sulphuric acid containing not more than 23 per cent SO_3; by treatment with fuming sulphuric acid, or by heating with caustic soda, it yields a brown dyestuff suited for dyeing wool; with dilute caustic soda and a little zinc dust a red color.

619,194—February 7, 1899. I. LEVINSTEIN AND R. HERZ. *Naphthylene diamin-sulphonic acid and process of making same.*

Alpha$_1$ alpha$_2$ naphthylenediamin beta$_1$ sulphonic acid is produced by reducing the azo coloring matters obtained by the combination of diazo bodies, with alpha$_1$ naphthylamin beta$_3$ sulphonic acid. It forms a sodium salt soluble in water and oxydizes in a neutral or an alkaline solution by the oxygen of the air to a yellowish crystalline substance, the aqueous solution of which shows a greenish-yellow fluorescence like that of fluorescein.

619,503—February 14, 1899. C. RIS. *Black trisazo dye and process of making same.*

Black colors: produced by diazotation of the intermediary compounds from one molecule of a paradiamin and one molecule of beta$_1$ alpha$_1$ amidonaphthol beta$_3$ sulpho-acid, and then combination of the formed tetrazo body with one molecule of a derivative of a metadiamin and one molecule of a metadiamin; dyeing unmordanted cotton in deep black shades.

619,518—February 14, 1899. M. ULRICH. *Yellow dye and process of making same.*

Tetrazo dyestuffs: produced by combining one molecule of a tetrazo derivative of diamidodibenzyldisulpho acid with two molecules of a nitrometadiamin of the benzene series, such as nitrometaphenylenediamin; dyeing unmordanted cotton bright fast yellow shades.

619,577—February 14, 1899. P. JULIUS AND A. TKATSCH. *Process of making yellow phosphin dye.*

Alkalated para-amido-benzaldehyde and an alphyl-meta-toluylene-diamin are heated together in alcoholic solution and in the presence of ferric chloride.

619,574—February 14, 1899. M. H. ISLER. *Xanthopurpurin.*

A sulpho-acid of xantho-purpurin obtained by diazotizing and subsequently heating 1.3 diamido-anthra-quinone in fuming sulphuric acid solution; dyeing unmordanted wool dull yellow shades.

619,883—February 21, 1899. L. GIFFORD, ADMINISTRATOR OF KARL HEUMANN, DECEASED. *Dimethyl indigo and process of making it.*

A blue dyestuff of the formula $C_{18}\ H_{18}\ N_4\ O_2$: produced by melting ortho-tolylglycocol with alkali and then oxidizing, as by an air blast; giving greener shades on cotton when dyed from the vat than ordinary indigo, and redder shades on wool than the ordinary indigo sulpho acids when dyed from its soluble sulpho acids.

619,488—February 21, 1899. L. GIFFORD, ADMINISTRATOR OF KARL HEUMANN, DECEASED. *Blue dye and process of making same.*

Coloring matters of the indigo series: produced by heating ethyl-para-tolylglycocol with a caustic alkali, and oxidizing the leuco compound so produced. When sulphonated it is soluble in water and dyes directly.

620,368—February 28, 1899. J. SCHMID. *Blue tetrazo dye and process of making same.*

Blue coloring matters: produced by combining the intermediate product obtained from one molecule of a naphthacetoldisulpho acid and one molecule of the tetrazo derivative of a paradiamin of the series of diphenyl with one molecule of a naphtholic compound, as naphtholsulpho-acids, naphthols, and oxynaphthols; dyeing unmordanted cotton pure reddish to greenish-blue tints.

620,369—February 28, 1899. J. SCHMID. *Blue tetrazo dye and process of making same.*

Blue substantive coloring matters: obtained by first combining molecular proportions of a naphthacetoldisulpho-acid and the tetrazo derivative of a paradiamin of the series of diphenyl, and then combining one molecule of the intermediate product with one molecule of an amidonaphtholsulpho acid.

620,428—February 28, 1899. R. DEMUTH. *Blue cotton dye.*

Blue substantive cotton dyes: produced by subjecting sulpho-acids of 1.8 chloronaphthol to the action of an alkaline sulphide and sulphur at elevated temperatures (to 240° C.), repeatedly extracting the resulting melt when cold with small quantities of hot water, until the blue dye is dissolved out, and finally isolating the dye from the joint filtrates by precipitation with zinc chloride.

620,442—February 28, 1899. L. GIFFORD, ADMINISTRATOR OF K. HEUMANN, DECEASED. *Blue glycocol dye.*

Coloring matters of the indigo series: produced by heating ethyl-ortho-tolylglycocol with caustic alkali, and oxidizing the leuco compound so produced; unsulphonated, the hues are greener on cotton than ordinary indigo; when sulphonated, it is soluble in water and dyes directly.

620,562—March 7, 1899. R. BLANK. *Amido malonic ester and process of making same.*

Amidomalonic acid esters having the formula $A-NH-CH=(CO_2C_2H_5)_2$, where $A-NH_2$ represents an aromatic amin, one H of which is substituted by the malonic acid ester root, are produced by allowing aromatic amins to react upon halogen malonic acid esters. They lend themselves to the formation of indoxylic compounds, readily converted into compounds of the indigo series.

620,574—March 7, 1899. K. ELBER AND J. OPPERMANN. *Black trisazo dye.*

Triazo dyestuffs: produced by diazotizing the intermediate products formed by combination of tetrazotized diamidodiphenylamincarbonic acid with one molecular proportion of an amin suitable for further diazotization as amidonaphtholsulpho acid G, and combining the so-obtained unsymmetrical tetrazo compound with meta-diamins of the benzene series, as meta-toluylendiamin; dyeing dark blue to black shades on unmordanted cotton or mixed goods from neutral or weakly alkaline baths.

621,393—March 21, 1899. H. R. VIDAL. *Triphenylmethane dye and process of making same.*

Violet and blue coloring matters: produced by condensation of tetralyl hydrols with aromatic hydrazins at from 60° to 80° C., the action being prolonged until the leuco base, appearing in the first phase, becomes transformed into coloring matter.

621,652—March 21, 1899. L. GIFFORD, ADMINISTRATOR OF K. HEUMANN, DECEASED. *Blue dye.*

Blue dyestuff, derived from ortho-tolyl-glycocol by heating tolyl-glycocol and caustic alkali at elevated temperatures, up to 340° C.; dyeing wool from a boiling acid bath, yielding redder shades than indigo-carmine.

621,679—March 21, 1899. M. H. ISLER. *Oxyanthraquinone sulfo acid and process of making same.*

Sulpho-acid of oxy-anthra-quinone: produced by diazotizing amido-anthraquinone in fuming sulphuric acid and subsequently heating. The sulpho-acid of anthra-rufin, obtained by diazotizing and subsequently heating 1.5-diamido-anthra-quinone in fuming sulphuric acid solution, dyes unmordanted wool yellow shades, and is an initial material for the production of dyestuffs

622,139—March 28, 1899. L. GIFFORD, ADMINISTRATOR OF K. HEUMANN, DECEASED. *Blue coloring matter and process of manufacturing same.*

Blue dyestuff produced by melting a phenyl-glycocol body with alkali, and subsequently oxidizing, as by a blast of air; in its sulphonated form it is soluble in water.

622,299—April 4, 1899. H. R. VIDAL. *Black dye and process of making same.*

Coloring matters, varying from brown black to deep black, are produced by heating a nitro-cellulose substance, as gun cotton, with sulphur and sodium sulphide; soluble in the raw state in water and capable of directly dyeing cotton without oxidation.

622,961—April 11, 1899. I. LEVINSTEIN AND C. MENSCHING. *Brown tetrazo dye and process of making same.*

Direct cotton dyes are produced by acting with one molecular proportion of a tretrazo compound of a paradiamin on one molecular proportion of an ortho-oxycarbonic acid of the benzene series, combining the intermediate product with one molecular proportion of a rediazotizable primary aromatic monamin of the benzene series (a combination, for example, of tetrazodiphenyl with salicylic acid and aniline), to form a mixed tretrazo coloring matter; rediazotizing this mixed tretrazo coloring matter; and combining the resulting diazo compound with known dyestuff components, as naphthol sulphonic acid gamma.

623,069—April 11, 1899. R. BOHN. *Yellow dye and process of making same.*

A yellow coloring matter produced by treating benzoin with an aromatic oxy-carbonic acid, as gallic acid, in the presence of sulphuric acid; giving a cherry-red to yellowish-red color with caustic soda solution, and with sulphuric acid a red to yellow color with a brown to green fluorescence.

623,219—April 18, 1899. R. E. SCHMIDT. *Chrysazin dye and process of making same.*

An anthraquinone dyestuff, being an acid salt of a disulpho acid of paradihydroxylaminchrysazin, is produced by reducing one molecule of dinitrochrysazin disulpho acid with such quantities of reducing agents as correspond to eight atoms of hydrogen, thereby transforming the nitro groups into hydroxylamin groups; in the form of its acid ammonium salt, soluble in water with a violet color, dyeing wool in acid baths blue shades; and bluish-green on chromium mordants.

623,220—April 18, 1899.. R. E. SCHMIDT. *Anthrarufin dye and process of making same.*

An anthraquinone dyestuff, being an acid salt of paradihydroxylamin anthrarufin, is produced by reducing one molecule of dinitro anthrarufindisulpho acid with such quantities of reducing agents as correspond to eight atoms of hydrogen, for which purpose stannous chloride with muriatic acid may be used; dyeing wool in acid baths reddish-blue shades; bluish-green on chromium mordants.

623,346—April 18, 1899. H. WEIL. *Green wool-dye and process of making same.*

Coloring matters are produced from paranitrobenzaldehyde-orthosulphonic acid by first forming a disulpho-leuco compound of the general formula $C_6H_3(NO_2)-(SO_3Na)-C.H.R.R'$, wherein R designates alkylbenzylaniline and R′ monosulphonated alkylbenzylaniline, and then treating this disulpho-leuco compound with an oxidizing agent. They dye wool in an acid bath a green shade.

623,638—April 25, 1899. K. THUN. *Gray-black anthraquinone dye and process of making same.*

Nitro compounds of the anthraquinone series are produced by mixing a concentrated sulphuric acid solution of sulphonic acids of certain bodies, like purpurin-dianilid, with boric acid, adding nitric acid to this mixture and stirring for an hour at from 10° to 20° C., and then pouring into water and separating the precipitated dyestuff; yielding on chrome-mordanted wool from gray to black fast shades.

624,256—May 2, 1899. K. SCHIRMACHER. *Red-brown monoazo dye and process of making same.*

Monoazo dyestuffs produced by combining diazotized picramic acid with alkylated amidonaphtholsulphonic acids, such as 2:5:7 ethylamidonaphthol, 2:5:7 methylamidonaphtholsulphonic acids; dyeing wool in red-brown shades, which become deep black on subsequent treatment with chromates.

624,877—May 9, 1899. J. SCHMID AND H. REY. *Red Sulfo-acid dye.*

Red sulpho-acid dyes, produced by condensing one molecule of a benzaldehyde compound with two molecules of a monobenzylated metamidophenol, heating the product of condensation with a reagent, as concentrated sulphuric acid, whereby dehydration, sulphonation, and partial oxidation are effected, and finally completing the oxidation with an agent such as ferric chloride at a moderate heat; dyeing wool and silk in fast red tints.

625,174—May 16, 1899. I. LEVINSTEIN AND H. PFEIFFER. *Substantive red tetrazo dye and process of making same.*

Tetrazo coloring matters produced by chlorinating diacetbenzidin melting at 317° C., saponifying the product, tetrazotizing the dichlorbenzidin thus formed, and combining the resulting tetrazodichlorbenzidin with a naphthylamin sulphonic acid; dyeing unmordanted cotton bright-red to bluish-red shades fast to organic acids.

625,268—May 16, 1899. R. KNIETSCH AND P. SEIDEL. *Process of making indigo-red.*

A phenylglycocol body is melted with caustic alkali in the presence of a limited quantity of air, and the isatinic body so obtained is then acted upon with an indoxyl body.

625,536—May 23, 1899. J. J. BRACK. *Rhodol derivative.*

A dyestuff of the phthalein series obtained by condensing the methyl ether of dimethylrhodol with formic aldehyde; a vermilion powder; dyeing tannin-mordanted cotton a yellowish red, and on printing with ferrocyanide of potassium and zinc oxide yielding a lake of same color.

625,637—May 23, 1899. H. A. BERNTHSEN. *Oxynaphtindophenolthiosulfonic acid and process of making same.*

An oxy-naphtindophenol-thio-sulphonic body produced by the oxidation of a mixture of unsymmetrical dialkyl-para-phenylene-diamin-thio-sulphonic acid and 1.2-amido-naphthol-sulpho-acid; especially suited for printing on cotton goods with a chromium mordant.

625,641—May 23, 1899. H. CARO. *Rhodamin dye and process of making same.*

An alkylated rhodamin dye is produced by treating chloral hydrate with alkylated-meta-amido-phenol, without the addition of heat. This condensation product is then acted upon with one molecular proportion of a dialkylated-meta-amido-phenol, the same as used in the production of the product of condensation, by grinding them together and gradually heating from 40° to 70° C. in twelve hours, when the resulting leuco base is oxidized into its blue coloring matter and then converted into its red rhodamin dye.

625,717—May 23, 1899. M. BOEHLER. *Process of dyeing dark blue.*

Dyeings produced with the dyestuffs "immedial blacks" (No. 610,541), and which are derived by heating oxydinitrodiphenylamin with sodium sulphide and sulphur, are treated with hydrogen dioxide, and the shades changed to a dark blue.

626,231—June 6, 1899. B. HEYMANN. *Process of making indigo.*

Diacetyl-indoxyl is saponified with caustic alkaline lyes, the product oxidized, and the indigo separated by filtration.

626,897—June 13, 1899. F. FUCHS AND H. GUSSMANN. *Black sulphur dye and process of making same.*

Black direct-dyeing cotton dyestuffs produced by heating dinitranilin 1. 2. 4 with sulphur and alkaline sulphides at elevated temperatures; dyeing unmordanted cotton even in the cold.

626,913—June 13, 1899. E. KÖNIG. *Brown-yellow azo dye and process of making same.*

Basic azo dyestuffs soluble in water produced by diazotizing aromatic amido-ammonium bases, as amidophenyltrimethylammonium, and treating the resulting compound with substances adapted to unite with diazo bodies to form dyes, as resorcinol; dyeing cotton and leather mordanted with tannin brown-yellow.

626,935—June 13, 1899. F. SCHOLL AND A. HESS. *Disazo dye and process of making same.*

Diazo dyestuffs produced by diazotizing amidobenzylpyridinchloride and combining it first with a primary aromatic amin, as metatoluidin, then further diazotizing and combining it with an azo component, as beta-naphthol; dyeing mordanted cotton or mixed goods with a bluish-red color.

627,679—June 27, 1899. M. BÖNIGER AND J. LAGUTT. *Green trisazo dye and process of making same.*

Green triazo dyestuffs produced by combining in an alkaline solution one molecule of a tetrazotized paradiamin with one molecule of the monoazo dye resulting from the combination in an acid solution of one molecule of diazodichlorbenzene with one molecule 1.8 amidonaphthol 3.6 disulphonic acid, and then coupling the intermediate product thus obtained in an alkaline solution with one molecule of a phenolic compound of the benzene series; dyeing unmordanted cotton green shades.

627,690—June 27, 1899. J. HERBABNY. *Yellow wool-dye and process of making same.*

Yellow dyestuff produced by first forming para-nitro-phenyl-pyrazolone-carboxylic acid by the action of one molecule of para-nitro-phenyl-hydrazin upon one molecule of oxalo-acetic ether, and then combining it with one molecule of diazo-sulphanilic acid; dyeing wool in greenish-yellow tints fast to milling.

627,783—June 27, 1899. K. SCHIRMACHER. *Black azo dye and process of making same.*

Monoazo dyestuff produced by treating diazotized picramic acid with naphtholsulphonic acids containing amido groups, such as 1:8:3:6-amidonaphtholdisulphonic acid "H;" dyeing wool in an acid bath in blue-black shades, which become deep green on treatment with bichromate.

627,896—June 27, 1899. R. BOHN. *Blue dye.*

Blue coloring matter obtained by treating with sulphuric acid the leuco compound of blue naphthazarin, intermediate product, which latter is produced by treating 1.1′-dinitro-naphthalene with sulphuric acid in the presence of a reducing agent, such as zinc or sulphur. This new dye can be applied directly or in the form of its leuco compound.

628,025—July 4, 1899. C. OELSCHLAEGEL. *Blue-black wool-dye and process of making same.*

A diazo dyestuff produced by diazotizing the para-amidophenyl-beta-naphthylaminsulpho acid (derived from para-nitro chlorbenzene-ortho-sulpho acid), combining the diazo compound produced with one molecular proportion of alpha-naphthylamin, rediazotizing the amidoazo compound thus obtained, and combining the diazoazo compound with a naphtholmonosulpho acid.

628,233—July 4, 1899. C. SIMON. *Green trisazo dye and process of making same.*

Green coloring matters produced by combining one molecule of the monoazo color obtained from diazotized orthochloro-paranitranilin and alpha$_1$-alpha$_4$-amidonaphthol-beta$_2$-beta$_3$-disulpho with one molecule of a tetrazo compound, as tetrazodiphenyl, and one molecule of a phenol compound, as salicylic acid; dyeing unmordanted cotton in green shades.

628,243—July 4, 1899. A. HERRMANN. *Green acid dye.*

Green acid dyestuffs of the diphenylnaphthylmethane series; produced by treating the monosulphonic acids of tetralkyldiamidodiphenylnaphthylmethanes with fuming sulphuric acid and oxidizing the leucopolysulphonic acids to dyestuffs; dyeing wool and silk in an acid bath an even green.

628,607—July 11, 1899. B. PRIEBS AND O. KALTWASSER. *Black dye.*

Black dye produced by heating the sodium salt of oxynitrodiphenylaminsulphonic acid with sulphur and alkali sulphides; dyeing unmordanted cotton in alkaline bath fast and intense black shades.

628,608—July 11, 1899. B. PRIEBS AND O. KALTWASSER. *Black dye.*

Black dye produced by heating the sodium salt of dinitroöxydiphenylamincarbonic acid with sulphur and alkali sulphides.

628,609—July 11, 1899. B. PRIEBS AND O. KALTWASSER. *Bluish black dye.*

Bluish black dye produced by heating the sodium salt of oxydinitrodiphenylaminsulphonic acid with sulphur and alkali sulphides.

628,721—July 11, 1899. C. O. MULLER. *Blue-black dye and process of making same.*

Coloring matters produced by coupling the tetrazo derivative of paraphenylenediamin on the one hand with an orthocarboxylised phenol of the benzene series, and on the other hand with the 1.8.4 dioxynaphthalenesulphonic acid; dyeing chromed wool in blue-black tints.

628,814—July 11, 1899. P. JULIUS. *Brown azo dye.*

Brown monoazo dyestuff obtained by the combination of diazo compounds of nitro-amido-phenol-sulpho acids with meta-phenylene-diamin; dyeing wool from an acid bath in deep-brown shades, darkened to deep brown or black-brown on treatment with chromates.

629,221—July 18, 1899. H. R. VIDAL. *Cresol-sulfur dye and process of making same.*

Coloring matters produced by subjecting benzene-azo-cresol, obtained from meta or ortho cresol, to the action of sulphur in the presence of soda; dyeing animal and vegetable fiber direct without oxidation, and imparting to cotton in the dyeing bath a black color from the outset.

629,666—July 25, 1899. C. DE LA HARPE AND C. VAUCHER. *Gallocyanin-leuco derivative and process of making same.*

A leuco-gallocyanin produced by treating a gallocyanin, in a suitable medium, with a reducing agent, as zinc dust; it contains no sulphur, is more ready soluble in water, and gives in printing more intense and bluer tints than the original gallocyanin.

629,748—July 25, 1899. I. LEVINSTEIN AND R. HERZ. *Blue-black diazo color and process of making same.*

A new product, alpha$_1$ alpha$_4$ naphthylenediamin beta$_3$ (beta$_4$) sulphonic acid, readily soluble in soda solution and almost insoluble in water or dilute acid. The new coloring matters are produced by combining Cleve's acid with a suitable diazo body, reducing, and treating with an acetylating agent, diazotizing, and combining with a rediazotizable aromatic amin, rediazotizing, combining with an aromatic color component, and finally saponifying.

630,199—August 1, 1899. C. DREHER. *Lactic-acid dye.*

Basic artificial dyestuffs are dissolved in lactic acid, forming new dyeing substances.

630,224—August 1, 1899. A. HERRMANN. *Green dye and process of making same.*

Green dyestuffs of the diphenylnaphthylmethane series produced by combining tetralkyldiamidobenzhydrols with naphthalenedisulphonic acids in presence of condensing agents to leucodisulphonic acids and then oxidizing the latter into dyestuffs; dyeing wool in an acid bath.

630,952—August 15, 1899. H. R. VIDAL. *Substantive sulfur dye and process of making same.*

A dihydroxylated azo body, such as those resulting from the copulation of one or two molecules of diazo benzene with resorcin, is heated with sulphur in the presence of an alkaline sulphide; dyeing unmordanted cotton in dark shades.

631,089—August 15, 1899. C. O. MULLER. *Red dye and process of making same.*

Coloring matters produced by coupling one molecule of the diazo derivative of para-amido-benzeneazosalicylic acid with one molecule of a sulphonic acid of a naphtholic compound; dyeing chromed wool in red tints.

631,605—August 22, 1899. O. BALLY. *Green dye and process of making same.*

Green coloring matters of the anthracene series produced by heating at a high temperature the halogen derivatives of No. 631,606 with primary aromatic amins.

631,606—August 22, 1899. O. BALLY. *Halogen derivative of anthraquinone and process of making same.*

Halogen derivatives of alphylated diamidoanthraquinones are obtained by treating them with bromine or chlorine in the presence of a solvent; they are soluble in benzene and are converted into green coloring matters on heating with aniline.

631,607—August 22, 1899. O. BALLY. *Dibrom anthraquinone derivative and process of making same.*

A dibrom-1.5-diamido-anthraquinone is produced by treating 1.5-diamido-anthraquinone in a solvent, such as glacial acetic acid, at ordinary temperature with bromine; valuable for the production of coloring matters of the anthracene series.

631,608—August 22, 1899. O. BALLY. *Anthraquinone derivative and process of making same.*

Tri-brom-1.5-diamido-anthraquinone is obtained by energetically treating 1.5-diamido-anthraquinone with bromine, at a high temperature, in a solvent; it is valuable for the production of coloring matters of the anthracene series.

631,610—August 22, 1899. H. A. BERNTHSEN AND P. JULIUS. *Orange dye and process of making same.*

Substantive orange coloring matter obtained by the combination of the tetrazo compound of a diamido base—benzidin or tolidin—with meta-phenylene-diamin-disulpho acid and then with nitro-meta-phenylene-diamin or nitro meta-toluylene-diamin; when treated with nitro-diazo-benzene after dyeing on cotton goods it is slightly changed in color to brown orange.

631,611—August 22, 1899. H. A. BERNTHSEN AND P. JULIUS. *Disazo orange dye and process of making same.*

Orange coloring matter obtained by the combination of a tetrazo compound of benzidin, first, with amido-R acid—that is, beta-naphthylamin-3.3′-disulpho acid—or with amido-F acid—that is, beta-naphthylamin-3.2′-disulpho acid—and then combining the resulting intermediate compound with a nitro-meta-diamin.

631,613—August 22, 1899. R. BOHN. *Black dye and process of making same.*

Black coloring matters produced by reacting with naphthazarin upon an aromatic amin, with or without the use of a condensing agent; dyeing chrome-mordanted wool.

631,614—August 22, 1899. R. BOHN. *Naphthazarin intermediate dye and process of making same.*

A coloring matter produced by subjecting the naphthazarin intermediate product, obtained in the manufacture of naphthazarin by heating 1.5-dinitro-naphthalene with fuming sulphuric acid to the action of a reducing agent. It can be used directly or in the form of its bisulphite compound, dyeing greener than naphthazarin.

632,170—August 29, 1899. R. BOHN. *Blue dye and process of making same.*

Blue coloring matter produced from the coloring matters of No. 609,327 (which are obtained from 1.8-dinitro-naphthalene by the reducing action of an alkaline bisulphite on the one hand and of sodium sulphide, grape-sugar, etc., on the other) by moderately heating the same with sodium sulphide, with or without the addition of sulphur; dyeing cotton a blue shade directly in a cold bath.

632,621—September 5, 1899. O. BALLY. *Brominated dye.*

Coloring matters obtained from tri-brominated-amido-anthraquinone, of No. 631,608, by heating same with an aromatic amin, with or without the addition of a diluent or solvent. The sulphonated compounds are soluble, and dye unmordanted and chrome-mordanted wool blue to green-blue shades.

633,245—September 19, 1899. L. P. MARCHLEWSKI. *Process of making dyes.*

The flocculent precipitate of cotton-seed oil is converted into a dye by oxidizing the same with air in the presence of free alkali.

633,883—September 26, 1899. C. O. MULLER. *Yellow basic dye.*

Yellow basic coloring matter produced from the by-product obtained in heating together phthalic anhydride and a mono-alkylated meta-amido-phenol by submitting said by-product to esterification, as by treatment with sulphuric acid and an alcohol.

633,950—September 26, 1899. R. BOHN. *Green-blue dye and process of making same.*

A coloring matter obtained by oxidizing the naphthazarin intermediate product (obtained in the manufacture of naphthazarin by heating 1.5-dinitro-naphthalene with fuming sulphuric acid). It dyes on chrome-mordants fast shades greener than those obtained from naphthazarin.

634,009—October 3, 1899. I. LEVINSTEIN AND R. HERZ. *Blue-black tetrazo dye and process of making same.*

Deep black tetrazo coloring matters produced from the alpha$_1$ alpha$_4$ naphthylenediamin beta$_1$ sulphonic acid by diazotizing the same, combining the resulting sulphonic acid with beta$_1$ naphthol beta$_2$ beta$_3$ disulphonic acid, rediazotizing the thus-produced bluish-violet amidoazo-coloring matter, and finally combining the resulting diazo compound with aromatic dyestuff components, as beta naphthol; dyeing animal and chrome mordanted fibers dark-blue to blue-black shades.

635,168—October 17, 1899. R. KIRCHHOFF AND E. HAUSSMANN. *Black sulfur dye.*

Black dye obtained by heating equimolecular proportions of dinitroöxydiphenylamin and para-amidophenol with sulphur and alkali sulphides; dyeing unmordanted cotton in an alkaline bath intense and fast black shades.

635,169—October 17, 1899. R. KIRCHHOFF AND E. HAUSSMANN. *Black sulfur dye.*

Black dye produced by heating equimolecular proportions of dinitroöxydiphenylamin and meta-phenylenediamin with sulphur and alkali sulphides; dyeing unmordanted cotton in an alkaline bath intense and fast black shades.

636,065—October 31, 1899. C. RIS. *Stilbene azo dye.*

Coloring matters derived from stilbene by the reaction of two molecules of paranitrotoluenesulpho-acid and one molecule of a para compound containing at least one amido group, with caustic-alkali lye; dyeing unmordanted cotton in gold-yellow to orange shades.

636,066—October 31, 1899. C. Ris. *Black cotton dye.*

Black dyestuff obtained by melting a paraämidophenol compound, such as paraämidophenol paraämidocresol ($CH_3:OH:NH_2=1:2:5$), with acetyl compounds and sulphur at from 200° to 300° C.

637,183—November 14, 1899. H. TERRISSE AND G. DARIER. *Yellow basic dye.*

A new yellow basic coloring matter, obtained from diamido-toluyl-alcohol, beta-naphthylamin, and beta-naphthylamin-hydrochlorate, which is soluble in water and gives a dark-brown-colored diazo compound on treatment with nitrous acid, and which is precipitated from its aqueous solution by common salt, and yields a yellow solution in alcohol possessing a green fluorescence.

638,127—November 28, 1899. G. KOERNER. *Black azo dye.*

Coloring matters derived from amido-naphthol-monosulpho-acid (1.8.4; 1.8.5.) and a tetrazo residue containing one or more basic groups attached to the part of the amido-naphthol-sulpho-acid residue which contains the amido group, and a tetrazo residue containing one or more hydroxyl groups attached to the part of the amido-naphthol-sulpho-acid residue which contains the hydroxyl; characterized by dyeing unmordanted cotton black shades.

638,576—December 5, 1899. C. DE LA HARPE AND C. VAUCHER. *Oxazin dye.*

Coloring matter derived from the oxazin dye resulting from the action of hydrochlorate of nitrosodimethylanilin or of hydrochlorate of dimethylamidoazobenzene upon gallamic acid, by heating the said oxazin dye with sulphurous acid in a free state or as a sulphite or bisulphite in a closed vessel at 90° to 100° C.; dyeing bluer tints than the original oxazin dye.

639,040—December 12, 1899. J. HERBABNY. *Green-blue tetrazo dye.*

A greenish-blue tetrazo substantive dyestuff obtained by the combination of the tetraämido disazo compound derived from a toluylenediaminsulpho-acid and para-nitrodiazobenzene with amidonaphthol-disulpho-acid H.

639,041—December 12, 1899. J. HERBABNY. *Black tetrazo dye.*

A black substantive coloring matter obtained by combining the tetraämido diazo-dyestuff derived from a metadiamin of the benzene series and para-nitro diazo benezene chloride with amidonaphtholsulpho-acid G.

639,042—December 12, 1899. J. HERBABNY. *Claret-red tetrazo dye.*

Direct claret-red coloring matters resulting from the action of a tetrazotized paradiamin, as tetrazoditolyl, upon amido pyrazolone carbonic acid.

639,806—December 26, 1899. W. H. CLAUS, A. RÉE, AND L. MARCHLEWSKI. *Black sulfur dye.*

Dinitroörthohydroxydiphenylamin is heated with sulphur and an alkaline sulphide, producing a black coloring matter dyeing cotton fiber direct.

639,976—December 26, 1899. A. HERRMANN. *Green dye.*

A dyestuff obtained by condensing tetralkyldiamidobenzhydrol with 2.6 naphthalenedisulphonic acid, and oxidizing the resulting leuco compound.

639,977—December 26, 1899. A. HERRMANN. *Green dye.*

A dyestuff obtained by condensing tetralkyldiamidobenzhydrol with 2.7 naphthalenedisulphonic acid, and oxidizing the resulting leuco compound.

640,010—December 26, 1899. C. O. MÜLLER. *Blue-black dye.*

A dyestuff which contains the tetrazo derivative of paraphenylene-diamin, coupled on the one hand with an orthocarboxylized phenol of the benzene series, as salicylic acid, and on the other hand with the 1.8.3.6 dioxynaphthalenedisulphonic acid.

640,559—January 2, 1900. O. HANSMANN. *Brown sulfur dye.*

A brown dye produced by heating with sulphur and sulphides of alkalis the condensation product obtained by the action of paranitrochlorobenzene-ortho-monosulphonic acid upon meta-toluylenediamin; dyeing unmordanted cotton dark-brown shades, which are turned to bronze by treatment with a mixture of copper sulphate and potassium bichromate

640,986—January 9, 1900. O. BALLY. *Green dye.*

Green coloring matter obtained by condensing chlor-substituted diamido-anthraquinone (obtained by treating diamido-anthraquinone with chlorine in the presence of a diluent such as glacial acetic acid) with an aromatic amin and sulphonating the product.

640,989—January 9, 1900. M. BONIGER. *Bluish-red azo dye.*

Azo dyes derived from one molecule of a diazotized aromatic amido compound and one molecule of an 1.8 alphylsulphamidonaphthodisulphonic acid.

641,184—January 9, 1900. H. BOEDEKER. *Rhodamin dye.*

A dyestuff resulting from the simultaneous action of phosphor-oxychloride and monomethylanilin or other aromatic secondary or tertiary base (as monoethylamin, dimethyl- and diethyl-anilin, chinolin, monethyl-orthotoluidin or dibenzylanilin) upon symmetric diethylrhodamin; dyeing cotton a fiery pink.

641,587—January 16, 1900. A. G. GREEN AND A. MEYENBERG. *Process of making black sulfur dye.*

A para-diamin together with a base of the benzene series are jointly oxidized in the presence of thiosulphuric acid in aqueous solution, producing a direct dyeing coloring matter, containing sulphur under the influence of the thiosulphuric acid.

641,588—January 16, 1900. A. G. GREEN. *Black sulfur dye.*

Coloring-matter produced by conjoint oxidation of paraphenylene diamin with an amin of the benzene series containing a free para position to the amido group, such as anilin, orthotoluidin, or paraxylidin, in presence of thiosulphuric acid; dyeing unmordanted cotton a deep black from a bath containing sodium sulphide.

641,589—January 16, 1900. A. G. GREEN AND A. MEYENBERG. *Black sulfur dye.*

Coloring matter produced by conjoint oxidation of paratolylenediamin C_6H_3 (CH_3) $(NH_2)_2$ (1:2:5) with an amin of the benzene series containing a free para position to the amido group, in presence of thiosulphuric acid.

651,953—January 23, 1900. A. G. GREEN AND A. MEYENBERG. *Process of making fast brown dyes.*

A polyamin of the benzene series (containing at least two amido groups in para or ortho position to each other) is oxidized in the presence of thiosulphuric acid in aqueous solution.

641,954—January 23, 1900. A. G. GREEN AND A. MEYENBERG. *Fast brown dye.*

A fast brown coloring matter produced by the oxidation of paratolylenediamin $C_6H_3(CH_3)(NH_2)_2$ (1:2:5) in the presence of thiosulphuric acid in aqueous solution; dyeing unmordanted cotton from an alkaline sulphide bath.

642,256—January 30, 1900. B. PRIEBS AND O. KALTWASSER. *Blue sulfur dye.*

Blue dye produced by treating with hot alcohol the sulphur dyes derived by means of sulphur and alkali sulphides from dinitro-oxydiphenylamin derivatives, then removing the alcohol by filtration and drying the residue; dyeing unmordanted cotton in an alkaline bath intense and fast indigo-blue shades.

642,893—February 6, 1900. H. BOEDEKER AND C. HOFFMANN. *Alkylated rhodamin sulfonic acid.*

The sulphonic acids of alkyl derivatives of the metaamidophenol phthaleins (the tetraalkylated rhodamins excepted) are obtained by treating the metaamidophenolphthaliens with fuming sulphuric acid at a low temperature, so that they are transformed into sulphonic acids and are easily soluble in alkalis and suitable for dyeing purposes. They are completely absorbed by wool in an acid bath and dye with the tint of alkylated metaamidophenolphthaleins with a vivid fluorescence.

643,265—February 13, 1900. C. E. GASSMANN. *Solution of phthalein in phenol.*

For use in printing or dyeing fabrics a phthalein, as a rhodamin and especially a dialkyl rhodamin, is dissolved in a volatile phenol, as cresylic acid.

643,338—February 13, 1900. A. STEINER. *Blue dye from gallocyanin.*

A blue coloring matter obtained by substituting a hydrogen atom in one of the hydroxylic groups of the gallocyanin or its derivatives by an acid radical, especially an alphylsulphon radical XSO_2, where X stands for a benzene, toluene, or xylene group. This esterification can be performed by treating the gallocyanin or its derivatives in alkaline solution with aromatic sulphochlorides.

643,371—February 13, 1900. J. J. BRACK. *Red rhodamin dye.*

Dyestuff obtained by condensing one molecule of formic aldehyde with two molecules of the alkyl ether of the unsymmetrical dimethyl-methylrhodamin of No. 584,119, and which is derived from dimethylamidoöxybenzoylbenzoic acid and metaämidoparacresol (CH_3:NH_2:OH=1:2:4); dyeing tannin-mordanted cotton in fiery-red tints bluer than those obtained from the said ether.

643,451—February 13, 1900. O. BALLY. *Nitroamidoanthraquinone sulfo-acid.*

Coloring matters obtained by treating diamido-anthraquinone sulpho-acids with nitric acid; dyeing chrome-mordanted wool blue-violet to brown-violet shades.

643,502—February 13, 1900. A. H. S. HOLT. *Process of manufacturing indigo-leuco compounds.*

Indigo-leuco compounds produced by melting together a polyhydroxy compound of the fatty series, such as glycerine, with an anthranilic-acid body and an alkali; as, for example, potassium salt of anthranilic acid and potassium glycerate.

643,569—February 13, 1900. F. ULLMANN. *Yellow acridinium dye.*

A dye derived from the acridin series, obtained as a methyl-sulphuric salt by treating an acridin dyestuff as amidotolunaphthacridin, with dimethyl sulphate; dyeing tannin-mordanted cotton orange-yellow shades.

644,233—February 27, 1900. P. JULIUS. *Black disazo dye.*

Disazo coloring matters derived from ortho-nitro-ortho-amido-phenol-sulpho-acid, and which on suitable reduction with ammonium sulphide in ammoniacal solution exhibit a step-by-step reduction, reproducing the nitro-amido-phenol-sulpho-acid.

644,234—February 27, 1900. P. JULIUS. *Black dye.*

A coloring matter derived from ortho-nitro-ortho-amido-phenol-sulpho-acid and having alpha-naphthylamin as both middle and end component.

644,235—February 27, 1900. P. JULIUS. *Black disazo dye.*

Disazo coloring matter derived from ortho-nitro-para-amido-phenol-ortho-sulpho-acid and having Cleve's alpha-naphthylamin-sulpho-acid as middle component, and alpha-naphthol-alpha-sulpho-acid (1.4–1.5) as end component.

644,236—February 27, 1900. P. JULIUS. *Black disazo dye.*

Disazo coloring matter derived from para-nitro-ortho-amido-phenol-ortho-sulpho-acid and having alpha-naphthylamin as middle component, and alpha-naphthol-alpha-sulpho-acid (1.4 or 1.5) as end component.

644,237—February 27, 1900. P. JULIUS. *Black dye.*

Coloring matter derived from ortho-nitro-ortho-amido-phenol-sulpho-acid, alpha-naphthylamin, and beta-naphthol.

644,238—February 27, 1900. P. JULIUS. *Disazo dye from chloramidophenol.*

Disazo coloring matter obtained from para-chloro-ortho-amido-phenol and having Cleve's alpha-naphthylamin-sulpho-acid as middle component, and alpha-naphthylamin as end component.

644,239—February 27, 1900. P. JULIUS. *Black disazo dye.*

Disazo coloring matter obtained from ortho-chlor-ortho-amido-phenol-para-sulpho-acid and having alpha-naphthylamin as middle component, and beta-naphthol-3.6-disulpho-acid (R salt) as end component.

644,240—February 27, 1900. H. A. BERNTHSEN AND P. JULIUS. *Black disazo dye.*

Disazo coloring matter obtained from ortho-amido-para-nitro-phenol, alpha-naphthylamin, and 1.8-dioxynaphthalene-4-sulpho-acid; dyeing wool from an acid bath blue-black shades, turning to green-black on treatment with chromates.

644,291—February 27, 1900. J. HERBABNY. *Black trisazo dye.*

Polyazo coloring matters obtained by the combination of one molecule of a paradiamin first with one molecule of a monoazo coloring matter from 2:8-amido-naphthol-sulphonic acid and toluylene-diamin-sulphonic acid, then with one molecule of an amido-naphthol-sulphonic acid; dyeing cotton without mordants.

644,292—February 27, 1900. J. HERBABNY. *Black polyazo dye.*

Polyazo dyestuffs obtained by the combination of one molecular proportion of a paradiamin with two molecular proportions of a monoazo dye as obtained by combining diazotized 2:8-amido-naphthol-sulphonic acid and toluylene-diamin-sulphonic acid; dyeing cotton without mordants.

644,324—February 27, 1900. P. JULIUS AND W. REESS. *Process of making yellow basic dyes.*

Diamido-toluyl alcohol is treated with beta-naphthol and an oxidizing agent, such as ferric chloride.

644,326—February 27, 1900. R. KNIETSCH AND H. S. A. HOLT. *Process of making indigo products.*

An aromatic glycocoll-carboxy-di-alkyl-ester is heated to above 200° C., and so converted into a piperazine derivative, which intermediate product is then melted with a fixed caustic alkali and lime.

644,333—February 27, 1900. C. SCHRAUBE. *Yellow dye.*

Dyestuffs obtained by the treatment of phenanthrene quinone either with peri-hydroxy-ortho-diamido-naphthalene and subsequent treatment with sulphuric acid or with sulpho-acids of peri-hydroxy-ortho-diamido-naphthalene; dyeing fast yellow shades on wool and silk.

644,334—February 27, 1900. C. SCHRAUBE AND E. SCHLEICHER. *Black trisazo dye.*

Black triazo dye, obtained from oxy-naphthylamin-sulpho acid (NH_2. OH. SO_3H—1.8.4), by combining one molecular proportion of the same with one molecular proportion of diazo-sulphanilic acid in acid solution, and one molecular proportion of diazo-azo-benzene in alkaline solution.

644,462—February 27, 1900. C. RIS. *Disazo dye from stilbene.*

Diazo coloring matters derived from stilbene by diazotizing the product of condensation of two molecules of paranitrotoluene-sulpho acid with one molecule of paraphenylenediamin, and combining the diazo compound with a suitable compound to form an azo dye; dyeing unmordanted cotton orange to brown shades.

644,959—March 6, 1900. J. ABEL. *Green-black dye.*

Coloring matter obtained by treating ortho-hydroxy-dinitro-diphenyl-amin-sulpho-acid with sodium sulphide and sulphur; dyeing unmordanted cotton green-black shades not altered by treatment with chromates and copper salts.

645,738—March 20, 1900. C. RIS. *Black sulfur dye.*

Black coloring matters obtained by melting a paraämidophenol together with an oxyazo compound, as oxyazobenzene, and with sulphur, to which mixture glycerine may be added, at about 200° C. and then dissolving the mass in an alkali and evaporating to dryness; dyeing unmordanted cotton bluish-black shades which are fixed by oxidation into fast deep black.

645,781—March 20, 1900. H. A. BERNTHSEN. *Bluish-red dye and process of making same.*

A coloring matter of the rhodamin series produced by treating the mono-benzylated-di-alkylated rhodamin (obtained by condensation of molecular proportions of dimethyl or diethyl-para-amido-ortho-oxy-benzoyl-benzoic acid with benzyl-meta-amido-phenol) with fuming sulphuric acid; dyeingwool from an acid bath.

646,711—April 3, 1900. O. SOHST. *Black azo dye and process of making same.*

Monoazo-dyestuffs, produced by combining diazotized picramic acid with acetylamidonaphtholsulphonic acids; dyeing wool black and developing to dark olive green on treatment with chrome.

646,794—April 3, 1900. H. A. BERNTHSEN. *Acid rhodamin dye and process of making same.*

An acid dye of the rhodamin series is produced by treating a rhodamin base with fuming sulphuric acid. It dyes animal fiber from a bath suitable for acid dyes, red shades.

646,795—April 3, 1900. R. BOHN. *Naphthazarin sulfo acid and process of making same.*

A sulpho-acid of naphthazarin is produced by treating a sulphonated leuco compound of the naphthazarin intermediate product with hydrochloric acid, in aqueous solution dyeing unmordanted wool from an acid bath brown-red shades, which turn black on treatment with a bichromate.

646,796—April 3, 1900. R. BOHN. *Green dye and process of making same.*

Green coloring matter of the naphthalene series, produced by heating a sulphonated leuco compound of the naphthazarin intermediate product with anilineand aniline hydrochloride and then sulphonating; dyeing unmordanted wool from an acid bath.

646,851—April 3, 1900. R. KNIETSCH, A. H. S. HOLT AND E. OBERREIT. *Process of making aromatic isatin compounds.*

An isatin body of the aromatic series is produced by the direct energetic oxidation (as by a manganic oxidizer) of the corresponding indoxyl compound.

646,873—April 3, 1900. A. F. POIRRIER. *Process of making sulfur dyes.*

Sulphureted coloring matters are produced by treating a simple aromatic substance, as phenol, with sulphur chloride, then heating to a suitable temperature, adding a complex aromatic substance as paraphenylenediamin, increasing the temperature of the mass and maintaining the increased temperature for a suitable period, and finally melting in sodium sulphide and drying.

647,236—April 10, 1900. K. SCHIRMACHER. *Brown dye and process of making same.*

Brown dyestuffs produced by the action of diazotized nitro and sulphonic derivatives of ortho-amidophenol acid—such as 1:2:3:5 and 1:2:5:3 nitroamidophenolsulphonic acids, picramic acid, or amidophenolsulphonic acid—upon metaphenylenediamin or meta-toluylenediamin or their sulphonic acids.

647,260—April 10, 1900. A. HAUSDORFER AND F. REINGRUBER. *Blue diphenylnaphthylmethane dye.*

Diphenylnaphthylmethane dyestuffs produced by first acting with fuming sulphuric acid on basic dyestuffs of the general formula $HO.C.(C_6H_4NR_2)_2.C_{10}H_6NHR'$ (R meaning an alkyl radical such as methyl, ethyl, etc., R′ meaning an alkyl radical such as methyl, ethyl, phenyl, paratolyl, etc.) and secondly isolating the dyestuff sulphonic acids thus produced in the form of their alkaline salts: they dye wool in acid baths blue shades.

647,279—April 10, 1900. T. SANDMEYER. *Process of making isatin.*

Chloralhydrate and aniline are caused to react in the presence of chlorhydrate of hydroxylamin; the thus-obtained isonitrosoethenyldiphenylamidin is condensed by means of concentrated sulphuric acid to alpha-isatinanilid, and the latter is decomposed by diluted mineral acids to anilin and isatin.

647,280—April 10, 1900. T. SANDMEYER. *Process of producing indigo.*

Indigo pure and mixed with indigo-red is produced by forming a solution of alpha-isatin-anilid (No. 647,281), and reducing the same by means of ammonium sulphide.

647,281—April 10, 1900. T. SANDMEYER. *Alpha-isatin anilid.*

Alpha-anilid of isatin is obtained by producing a reaction of basic carbonate of lead upon thiocarbanilid in the presence of an alkalicyanid, treating the thus-obtained hydrocyancarbodiphenylimid with a solution of yellow ammonium sulphide, and then transforming the thioamid by hot sulphuric acid; forming dark needles melting at 126° C.

647,370—April 10, 1900. R. BOHN. *Green dye.*

Green coloring matters obtained by treating the naphthazarin intermediate product with an aromatic amin; readily sulphonated to soluble sulpho acids.

647,293—April 17, 1900. E. HÖLKEN. *Process of mordanting.*

Goods dyed black by sulphur substantive dyes are immersed in a warmed bath containing zinc sulphate, chromate of potash, and chromic acid; then the temperature of the bath is raised to the boiling point, and finally the excess of zinc chloride is washed out; white combinations being formed with the sulphur by the metallic salts which do not discolor the wool.

647,834—April 17, 1900. W. HERZBERG AND O. SCHARFENBERG. *Green-blue dye.*

A green-blue dye of the triphenylmethane series, being a salt of the monosulpho acid, produced by subjecting orthotoluidin to condensation with tetraethyldiamidobenzhydrol in the presence of strong sulphuric acid (instead of diluted acid), diazotizing the leuco base thus produced and transforming the oxyleuco product by sulphonation and oxidation.

647,846—April 17, 1900. R. KIRCHHOFF AND E. HAUSSMANN. *Black sulfur dye.*

A black dye produced by melting with sulphur and sulphides of alkali metals an equimolecular mixture of dinitroöxydiphenylamin and dinitrophenol; directly dyeing unmordanted cotton deep-black shades.

647,847—April 17, 1900. R. KIRCHHOFF AND E. HAUSSMANN. *Black sulfur dye.*

A black dye produced by melting together with sulphur and sulphides of alkali metals an equimolecular mixture of picramic acid and dinitroöxydiphenylamin; dyeing unmordanted cotton from a bath containing common salt deep-black shades.

648,271—April 24, 1900. H. LAUBMANN. *Oxyanthraquinone disulfonic acid and process of making same.*

New pentaoxyanthraquinonedisulphonic acids produced by treating the tetraoxyanthraquinonedisulphonic acids dissolved in strong sulphuric acid, with the calculated quantity of an oxidizing agent for the introduction of a hydroxyl group, dyeing wool, in an acid bath, red, the dye yielding, on subsequent treatment with chromium fluoride, pure-blue tints.

648,331—April 24, 1900. O. BALLY. *Blue anthraquinone dye.*

Coloring matter obtained by treating a halogen derivative of alphylidoanthraquinone (as No. 631,606) with sulphuric acid and boracic acid and subsequently sulphonating, dyeing unmordanted wool blue shades and chrome-mordanted wool green-blue shades.

648,332—April 24, 1900. O. BALLY. *Violet anthraquinone dye.*

Coloring matter obtained by treating halogen derivatives of diamido anthraquinone (Nos. 631,607–8) with boracic acid and sulphuric acid and subsequently sulphonating; giving violet-blue shades on chrome-mordanted wool.

648,597—May 1, 1900. A. F. POIRRIER. *Process of making sulfur dyes.*

Substantive coloring matters produced by the reaction of sulphur and sodium sulphide on a mixture of paramidophenol and alphanaphthol, dyeing cotton clear black in an alkaline bath.

648,623—May 1, 1900. A. ISRAEL AND R. KOTHE. *Blue trisazo dye.*

Trisazo dyestuffs produced by first combining a diazo derivative of monoacidyl-para-phenylendiamin with one molecule of Cleve's alphanaphthylamin-betasulphonic acid (1.6 or 1.7), then rediazotizing, combining the diazo compound thus obtained with a second molecule of one of Cleve's acids, again diazotizing, coupling the diazo product with a naphtholmono or disulphonic acid, and finally treating the resulting trisazo dyestuff with caustic alkalis to split off the acidyl group, dying unmordanted cotton reddish-blue to grayish blue shades, which can be further diazotized on the fiber.

648,753—May 1, 1900. P. JULIUS. *Blue black sulfur dye.*

A blue black coloring matter, directly dyeing unmordanted cotton, obtained from dinitro-di-para-hydroxy-diphenyl-meta-phenylendiamin-di-carboxylic acid by treating same with sulphur and sodium sulphide.

648,754—May 1, 1900. P. JULIUS. *Green-black sulfur dye.*

A green-black coloring matter, dyeing unmordanted cotton, obtained from dinitro-dipara-hydroxy-diphenyl-meta-phenylendiamin-disulpho acid by treating same with sulphur and sodium sulphide.

648,755—May 1, 1900. P. JULIUS. *Black sulfur dye.*

A deep-black dyestuff, dyeing unmordanted cotton, produced from dinitro-di-para-hydroxy-diphenyl-meta-phenylendiamin by treating same with sulphur and sodium sulphide.

649,218—May 8, 1900. C. SCHLEUSSNER. *Process of making black naphthazarin sulfur dye.*

A dyestuff produced from the naphthazarin intermediate product by treating same with sulphides of alkali metals; dyeing cotton directly in blue shades, becoming black when subsequently treated with sulphate of copper.

649,714—May 15, 1900. J. BAMMANN AND W. VORSTER. *Dinaphthylamin sulfo derivative and process of making same.*

A new beta-dioxydinaphthylamin disulphonic acid produced by first dissolving a mixture of beta$_1$-amido-alpha$_3$-naphthol-beta$_4$-monosulphonic acid and water in caustic alkaline lye, heating this solution with a sodium-bisulphite solution, and finally isolating the resulting dinaphthylamin derivative; it is capable of combining with one and also with two molecules of diazo compounds.

649,716—May 15, 1900. H. BOEDEKER. *Sulfonated dichlordiethylrhodamin and process of making same.*

A blue-red dyeing rhodamin dyestuff, obtained from dichlordiethyl-rhodamin by treating same with monoethylamin and anhydrous sulphuric acid.

649,727—May 15, 1900. B. HOMOLKA. *Blue basic dye and process of making same.*

Blue basic saffranin dyestuffs, soluble in water, produced by allowing one molecule of beta-naphthol to act upon two molecules of a diazotized asymmetric dialkyl-saffranin.

649,728—May 15, 1900. B. HOMOLKA. *Blue basic dye and process of making same.*

Blue basic dyestuffs, soluble in water, produced by combining one molecule of beta-naphtol with two molecules of a diazotized saffranin.

650,292—May 22, 1900. J. ABEL AND F. KALKOW. *Brown sulfur dye.*

A brown dyestuff, directly dyeing cotton, produced by treating para-hydroxy-tri-nitro-diphenylamin-meta-sulpho acid with sulphur and sodium sulphide.

650,293—May 22, 1900. J. ABEL AND F. KALKOW. *Black sulfur dye.*

A black coloring matter, with a green cast, directly dyeing cotton, produced by heating with sulphur and an alkaline sulphide certain diphenylamin derivatives, which can be obtained by heating one molecular proportion of para-hydroxy-ortho-para-dinitro-diphenylamin body with one molecular proportion of meta-dinitro-chlorbenzene.

650,326—May 22, 1900. P. JULIUS AND F. REUBOLD. *Brown-black sulfur dye.*

A brown-black coloring matter, directly dyeing unmordanted cotton, obtained from dinitro-ortho-para-dihydroxy-diphenyl-meta-phenylendiamin by treating same with sulphur and sodium sulphide.

650,327—May 22, 1900. P. JULIUS AND F. REUBOLD. *Black sulfur dye.*

A deep-black coloring matter, directly dyeing unmordanted cotton, obtained from dinitro-amido-para-oxy-diphenylamin by treating same with sulphur and sodium sulphide.

650,756—May 29, 1900. M. H. ISLER. *Mordant-dyeing red color and process of making same.*

A mordant-dyeing coloring matter produced from the soluble sulphoacid-like coloring matter which can be obtained from a dinitro-anthraquinone by heating with sulphur, boracic acid, and fuming sulphuric acid, as per No. 617,686, by heating same with concentrated sulphuric acid until it is converted into a comparatively insoluble coloring matter. It dyes alumina-mordanted cotton red shades.

650,757—May 29, 1900. P. JULIUS. *Azo dye for lakes.*

A mono-azo coloring matter obtained by diazotizing 2-naphthyl-amin-1-sulpho acid and combining the diazo compound with beta-naphthol. In the form of its calcium, barium, lead, and alumina salts it is practically insoluble in boiling water.

PROCESSES.

702—April 21, 1838. F. FASSARD. *Improved process of dyeing wool.*

An acid solution of the ferro-cyanide or ferro-sesquicyanide of potassium or sodium is used in conjunction with an acid solution of one of the salts of the black oxide, or of the sesquioxide, or protoxide of iron, which yields a blue precipitate by the interchange of their elements.

703—April 21, 1838. P. MAGENNIS. *Improvement in the art of dyeing.*

The coloring matter and mordants are applied in a concentrated state to the dry cloth or other material to be dyed, which is then immediately passed between rollers, whereby the coloring matter is forced into the material.

746—May 25, 1838. H. HIBBARD. *Improvement in the process of coloring hats, furs, etc.*

A mordant is used of nitric and acetic acids, saturated with copper and tinned iron, and a fixed alkali is added to the dye.

58,591—October 9, 1866. A. C. BRUSH AND G. C. WHITE. *Improvement in dyeing hat bodies.*

The dye or coloring matter is applied to the hat bodies after the sizing has been commenced and before it is completed.

109,341—November 15, 1870. A. PARAF. *Improvement in the manufacture and application of colors for printing and dyeing.*

Colors for printing and dyeing are mixed with soap and so applied.

120,393—October 31, 1871. A. PARAF. *Improvement in dyeing and printing madder colors.*

The madder color is applied to the article in solution with a neutral salt of a fixed alkali and with ammonia; and, second, the coloring matter is precipitated in the article by the mordant adapted to the peculiar color required and the consequent liberation of the ammonia.

147,010—February 3, 1874. A. KELLER. *Improvement in processes of dyeing cotton.*

Cotton is dyed a fast Turkey red, the process involving a series of ten or more steps with a great variety of materials, soda compounds, cows' dung, alum, madder, blood, fish oil, tin salts, etc.

147,887—February 24, 1874. J. B. FREZON. *Improvement in treating mixed fabrics previous to dyeing.*

Woolen and silken fabrics containing vegetable matter or impurities are exposed to a heated acid bath containing a mordant, to simultaneously destroy the vegetable matter and prepare for dyeing or bleaching.

150,427—May 5, 1874. G. MOLT. *Improvement in dyeing with indigo.*

An extract or decoction of hops is added to the indigo solution, to prevent precipitation of the indigo and keep the fabric soft.

163,521—May 18, 1875. J. B. C. H. PETITDIDIER. *Improvement in processes of dyeing silk fabrics.*

The dye solution is in alcohol or similar solvent combined with a fatty and resinous mordant, and the dyed fabric is subsequently passed through a bath of benzine to dissolve the said fatty and resinous mordant.

170,626—November 30, 1875. J. HARLEY. *Improvement in dyeing and printing textile fabrics.*

A fabric is dyed in madder and garancine styles in combination with aniline purples and violets, by first fixing the latter upon the cloth with mordants, and then passing the cloth through the dye bath, whereby it is then dyed up in madder and indigo styles. A fabric having an aniline purple in combination with one or more madder colors is claimed; also the combination of aniline greens and purples upon cloth with mordants suitable for dyeing up in madder colors.

174,891—March 21, 1876. S. BARLOW. *Improvement in processes of manufacturing ornamental textile fabrics.*

A figured fabric is produced by weaving the portions to be stained or printed of vegetable fibers and the portions to be left unstained or unprinted of animal fibers, then printing with aniline-black, suitable for developing in cotton fabrics, and cleansing.

180,628—August 1, 1876. W. PARSONS. *Improvement in processes of ornamenting hosiery and other knit fabrics.*

Hosiery and other knit goods are ornamented by dyeing the ornamentation thereon.

194,392—August 21, 1877. J. WILLIAMS. *Improvement in dyeing and coloring feathers, laces, and other fabrics.*

The material is immersed in a bath consisting of gasoline or naphtha and a mineral pigment ground in oil.

202,910—April 23, 1878. J. WILKINS. *Improvement in treatment of waste from the separation of animal from vegetable fibers.*

The vegetable waste from the separation of animal from vegetable fiber (obtained by treating mixed rags with dilute acid) is converted into dextrine by heating the said material with sulphuric acid, neutralizing with chalk, decanting the solution, decolorizing, if necessary, and evaporating.

223,019—December 30, 1879. H. W. VAUGHAN. *Improvement in methods of coloring fibrous material.*

A dry powder, as infusorial earth, or other suitable vehicle, charged with coloring matter and with an oleaginous constituent, is mechanically incorporated into the fiber in the manufacture of the yarn.

230,753—August 3, 1880. C. P. CULLMANN AND C. A. LORENZ. *Fabrication of onyx from agate.*

One side of the stone is immersed in a bath of dilute nitric acid and iron, and the other side in a bath of potassium carbonate and water; the stones are then dried and burned to fix the color.

235,170—December 7, 1880. G. M. & A. L. RICE. *Art of separating vegetable fibers from animal fibers.*

Chemical disintegrating agents are rendered temporarily inactive during distribution by being absorbed with a suitable comminuted or finely granulated substance, and distributed in a dry or mealy condition through the mixed fibrous material, and the mass is then subjected to heat.

241,661—May 17, 1881. T. & R. HOLLIDAY. *Dyeing colors on cotton or textile fabrics.*

Azo colors are developed in or upon textile fiber, etc., by impregnating the same with a solution of a phenol or phenols, and with a solution of a diazo compound of an aromatic amine or phenol.

242,081—May 24, 1881. H. W. VAUGHAN. *Process of dyeing.*

Dyes of coloring matters in fibrous material which has been superficially colored by impregnation with a dry powder charged with color and an oleaginous constituent (No. 223,019), are fixed by steaming.

253,230—February 7, 1882. A. SANSONE. *Application of coloring matter to fabrics.*

Spotted or stippled effects are produced by scattering upon the mordanted wet fabric a dry insoluble granulous or powdered substance, such as sand, coated or covered with an aniline or other suitable color substance.

262,791—August 15, 1882. M. LANDENBERGER, Jr. *Manufacture of dyed fabrics.*

In the manufacture of mixed cotton and wool fabrics, the cotton is dyed in the yarn with a dye not affected by the dye for the wool, and after weaving, the fabric is dyed with the wool dye.

266,825—October 31, 1882. A. M. JACOBS. *Preparing fabrics for dyeing turkey red.*

Preparatory to dyeing turkey red or alizarine the fabric is treated in a solution of ammonium-aluminum tartrate, whereby the oiling and aluming of the fabric are done in one operation.

272,498—February 20, 1883. H. W. VAUGHAN. *Method of applying dyestuffs to fibrous materials.*

The fiber is sprayed with oleaginous matter, and the coloring matter, combined with a pulverulent vehicle and a mordant, is blown upon the fiber.

283,500—August 21, 1883. J. C. MAGUIRE. *Dyeing and finishing plush fabrics.*

A paste or cementing substance is applied to the nap or face side of the fabric in connection with the dye or color; it is then steamed, and the fabric dried, and finally washed to remove the paste or gum from the nap.

301,344—July 1, 1884. A. N. DUBOIS. *Process of dyeing horse-hair and bristles.*

They are immersed in a boiling bath of water containing salts of lead and salts of soda, boiled for one and a half hours, then washed in cold water, and subsequently in tepid water containing sodium carbonate.

301,475—July 8, 1884. J. BRACEWELL. *Process of printing indigo colors.*

The fabric is saturated with a solution of grape sugar or glucose and dried, and the saccharine crystals over the surface are then broken down, as by passing it through a steam box for a very short time, when the prepared fabric is printed with a mixture of alkali and indigo.

305,057—September 16, 1884. C. ALBERT CONTI DE BARBARAN. *Process of dyeing hair.*

Human hair or the hair or fur of animals is treated first with an ammoniacal solution of nickel and then with pyrogallic acid.

328,465—October 20, 1885. M. CONRAD. *Process of printing textile fabrics.*

Knit or woven fabrics are first printed with a color prepared with laevulinic acid, oil emulsion, acetic acid, and starch, and a solution of dry tannic acid in tragacanth water, and the fabric is afterwards submitted to the action of steam.

331,777—December 8, 1885. A. N. DUBOIS. *Dyeing aniline black.*

The fabric is prepared for dyeing by soaking in a bath of soluble castor oil, then for about three hours in a bath composed of water, aniline oil, hydrochloric acid, nitrate of iron, and bichromate of potash, after which it is finished in a bath of soap.

341,409—May 4, 1886. H. F. DIETZ. *Dyeing hat bodies.*

Hat bodies are dyed while upon the cone or former.

354,223—December 14, 1886. H. R. RANDALL. *Treatment of silk fiber.*

The process consists in treating silk fiber, waste and raw silk and cocoons, before removing the gum, to the action of a solution of acetic acid in water, 1 to 3 ounces in a gallon of water, or a watery solution of acetic acid and sulphuric acid.

355,933—January 11, 1887. T. HOLLIDAY. *Process of napththol dyeing.*

The fiber is passed through a solution of a salt of lead to which an alkali has been added, and then through a soap solution, when the fiber, having on it oxide of lead or lead soap, is impregnated with alpha or beta naphthol, or coloring matter formed with them.

355,934—January 11, 1887. T. HOLLIDAY. *Dyeing textile animal fibers.*

Animal fibers are dyed with the product of oxidation of alpha-naphthol by chromic acid, by acting on the alpha-naphthol with chromic acid in the presence of the fiber.

357,281—February 8, 1887. E. HOLLIDAY AND E. RAU. *Dyeing with basic aniline.*

The material is dyed in a bath composed of the fatty salts of the basic coal-tar colors in a solution of benzine, or other suitable hydrocarbon or like solvent; the surplus color is removed by washing in benzine, and the color is then fixed in a steam box.

362,835—May 10, 1887. T. HOLLIDAY. *Process of dyeing.*

Wool or other animal fiber is impregnated with metallic mordants and immersed in a bath containing one or more nitroso compounds of naphthols.

368,880—August 23, 1887. T. H. DOST. *Dyeing brush stock.*

Vegetable fiber for brushes is dyed in bulk in extract of logwood or other dye producing a black color, then dried, and finally subjected to the fumes of sulphur to fasten the color and also make it lighter.

374,320—December 6, 1887. E. RAU. *Process of dyeing.*

A bath is formed by dissolving the color in water, treating with caustic soda and oleic acid, and then adding oil. The fabric is passed through the dye bath, the surplus color is pressed out, it is dried and steamed, and then washed with hydrocarbons to remove the oil and leave the color only in the fabric.

379,150—March 6, 1888. R. BOHN. *Dyeing animal textile fabrics with naphthazarin.*

Chrome lakes of napthazarin are produced within or upon textile fibers by exposing said fibers to the action of chromium mordants and naphthazarin in dyeing.

385,426—July 3, 1888. J. C. PENNINGTON. *Dyeing.*

Silks, wools, and mixed fabrics are dyed with aniline colors by impregnating them with a solution of the alkaloidal bases of such colors in ether or other equivalent liquids, and afterwards submitting them to the action of steam containing suitable acid to reconstitute the color and to volatilize the residual solvent.

386,247—July 17, 1888. T. HOLLIDAY. *Process of dyeing.*

Cotton or other vegetable fiber is dyed by the formation thereon of the colored products of the combination of the nitroso compounds of alpha or beta naphthol with metallic mordants.

388,703—August 28, 1888. P. P. F. MICHEA. *Treating plants containing indican.*

In the manufacture of indigo ammonia is introduced into the indigo liquor and atmospheric and ozonized air, with agitation to increase the yield.

390,842—October 9, 1888. B. F. CRESSON. *Dyeing aniline-black.*

An aniline-black coloring solution is formed by dissolving and mixing together water, chlorate potash, sal-ammoniac, sulphate of copper, nitrate of iron, and tragacanth gum, then forming another liquor of aniline-oil, muriatic acid, tartaric acid, and water, and finally mixing the two liquors.

394,446—December 11, 1888. V. G. BLOEDE. *Process of tinting fabrics.*

Yarn and fabrics are tinted with insoluble coloring matter by subdividing the color until it is fine enough to permeate the interstices of the yarn and attach itself to the individual fibers thereof, then suspending the color in an aqueous bath, which may contain a gummy or viscous matter, and passing the yarn or fabric through the bath.

394,447—December 11, 1888. V. G. BLOEDE. *Process of dyeing.*

The fabric is first impregnated with, or there is applied thereto, a mixture of soluble fatty matter, such as potash soap, and coloring matter, which may be incorporated with gum, or starch, or glue, and the fatty matter is then rendered insoluble by treating the fabric with chloride of calcium or other equivalent compound.

394,448—December 11, 1888. V. G. BLOEDE. *Tinting or finishing cotton fabrics.*

The interstices of the fabric are filled with starch and coloring matter thoroughly incorporated together, and the paste is then removed from the exposed surface of the threads by scraping.

409,520—August 27, 1889. J. BRACEWELL. *Pigment-resist.*

The process consists in printing the resist compounded of a pigment color and alkali on the cloth in a pattern and drying it; afterwards printing, padding, or blotching over the same the steam aniline black color, and lastly developing and fixing the aniline-black and pigment-resist colors by steam under pressure.

419,331—January 14, 1890. S. HODGSON. *Process of scouring and dyeing.*

In dyeing, scouring, or washing, the staple is intermittently fed to the operating liquid, and the liquid and the staple are subjected to intermittent forward impulses.

429,151—June 3, 1890. J. J. HART. *Process of printing calico.*

The fabric containing the lake or fixed color is passed through a bath of a solution of a developing reagent maintained at a temperature below the point necessary to effect the chemical reaction between the lake or fixed color and the developing reagent (preferably cold), and then the fabric is exposed to heat to effect the chemical reaction between the lake and fixed color and developing reagent.

433,780—August 5, 1890. T. INGHAM. *Process of dyeing.*

Fabrics of mixed vegetable and animal fibers are submitted to a bath of the required coloring matter or solution without any mordant, then dried, and the coloring matter is then oxidized on the dried fabric by passing the material through a solution that will fix the colors upon both the vegetable and animal fibers at one and the same time.

439,953—November 4, 1890. R. HOLLIDAY. *Process of producing azo colors on cotton or other vegetable fiber.*

The fiber is first subjected to a mixture composed of oil, a phenolic body, and an alkali, dried, and then subjected to an azo compound.

440,414—November 11, 1890. F. ZEMAN. *Process of dyeing.*

Method of dyeing silk consists in first washing the same, subjecting to a dyeing bath, drying, steaming, subjecting to vaporized acetic acid for setting the color, then subjecting to a heated bath of silicate of soda, and washing.

449,104—March 31, 1891. V. G. BLOEDE. *Process of coloring and finishing fabrics.*

Starched fabrics or yarn are treated with a solution of caustic lime or other equivalent compound which has the property of rendering the starch insoluble.

457,488—August 11, 1891. A. FISCHESSER AND J. POKORNY. *Process of dyeing.*

In the direct production of insoluble azo coloring matters upon fabrics, either by dyeing or printing, the fabric is alternately impregnated or coated with diazotized amido substance and with beta-oxynaphthoic acid, the melting point of which is 216° C.

472,267—April 5, 1892. E. MICHAËLIS AND C. HENNING. *Process of dyeing.*

Textile material is immersed in a bath consisting of an acid solution formed by treating zinc with sodium bisulphite mixed with caustic soda and indigo, and then immersed in oxygenated water to oxidize the indigo, to which a percentage of ammonia may be added.

484,080—October 11, 1892. E. ZILLESSEN. *Process of dyeing.*

Silk goods are dyed in contrasting colors, by treating part of the threads to be woven with a mordant before weaving, then weaving in combination with silk not so prepared, to form the desired pattern, and finally dyeing in the piece the fabric thus formed.

491,673—February 14, 1893. W. BROWNING. *Process of printing colors with aniline-black.*

A mordant formed by an astringent solution and a metallic salt is first applied to the material; second, the material is padded with an aniline mixture suitable for producing aniline black; third, a resist for aniline black mixed with coloring matter, which will enter into chemical combination with such mordant, is printed upon the material in any desired design; and, finally, the material so mordanted, padded, and printed, is steamed or aged to develop and fix the colors.

493,286—March 14, 1893. C. F. X. NOROY. *Process of dyeing black.*

The goods (of animal or vegetable fiber or skins) are first submitted to a bath composed of water, logwood, and a copper salt, and then immersed in a fixing bath composed of water, metallic sulphates, bichromate of potash, and neutralized nitrated starch, the solution being rendered slightly alkaline by the addition of soda potash or ammonia.

499,649—June 13, 1893. V. G. BLOEDE. *Process of dyeing and printing.*

The goods are first immersed in a solution composed of a dye and mordant suitable to fix it and a free acid which will hold them both in solution, and the saturated goods are then subjected to the action of a bath of alkaline vapor that will neutralize the acid and allow the mordant and dyestuff to combine.

499,689—June 13, 1893. W. T. WHITEHEAD. *Aniline-black resist.*

The pattern is printed upon the cloth in a resist containing a zinc compound as its essential or active element, with or without a color; it is then suitably dried, and thereafter the cloth is treated with a solution of analine black by blotching, slop-padding, or dyeing.

499,691—June 13, 1893. W. T. WHITEHEAD. *Aniline-black discharge.*

The cloth is first treated with a solution of aniline black, dried sufficiently to keep the color from running, and the pattern is then printed in a discharge containing zinc as its essential or active element (with or without a color), before oxidation of the aniline-black color, thereby producing the pattern on an aniline-black ground.

499,692—June 13, 1893. W. T. WHITEHEAD. *Aniline-black resist.*

The pattern is first printed upon the cloth in a resist containing zinc as its essential or active element (with or without a color), and thereafter the cloth is treated with a solution of aniline black by blotching, slop-padding, or dyeing producing the pattern on an aniline-black ground.

500,558—July 4, 1893. J. BRACEWELL. *Printing aniline-black.*

The fabric or fiber is first padded or covered with an aniline-black mixture; it is then printed with a color mixture consisting of an aniline-black discharge, a coal-tar color, and an alumina hydrate as mordant for the color, and then steamed or aged to such a degree that the analine black and the color pattern are simultaneously developed and fixed. The said color mixture is claimed, the insoluble salts of which have an affinity for both color and cotton fiber, whereby heat and moisture will cause the mixture to discharge the aniline black on the fiber and deposit the insoluble double salt of the alumina and color.

501,160—July 11, 1893. W. PFITZINGER. *Process of dyeing black.*

Cotton is first dyed by a coloring matter, such as is obtained by the combination of one molecule of tetrazo diphenyl or analogous compounds thereof, with two molecules of amido naphthol monosulpho acid G, second, the dyestuff on the fiber which contains one or two free amido groups is diazotized, and third, the resulting diazo compound is combined with phenol.

506,966—October 17, 1893. C. BASWITZ. *Method of removing copper from textile parchments (fabrics).*

Copper is removed from textile fabrics and the same rendered uninflammable by dipping them in a solution of vegetable parchment in ammoniacal oxide of copper, then evaporating the ammonia, and finally treating with a mixture of sulphate of ammonia and acetate of alumina to remove the copper.

529,498—November 20, 1894. F. V. KALLAB. *Dyeing aniline black.*

Aniline black is produced on wool, hair, and other animal substances or mixed textile fabrics by first oxidizing the goods, second padding or printing with a mixture suitable for producing steam-aniline black on cotton, and finally developing the black by steaming.

529,499—November 20, 1894. F. V. KALLAB. *Producing figures on aniline-black.*

White or colored figures are produced on aniline black on fabrics of wool, hair, or other animal substances or mixed fabrics containing such substances, by subjecting the goods to such feeble oxidation that the white of the wool is but little affected, then padding or printing with mixtures suitable for producing steam-aniline black on cotton and for producing discharging white or colors, and finally steaming to develop the black and fix the discharge colors.

542,022—July 2, 1895. E. LAUBER AND L. CABERTI. *Process of dyeing.*

Fabrics are first treated with beta naphthol and antimonious oxide in alkaline solution, and subsequently treated with diazo compounds.

545,420—August 27, 1895. F. BAMFORD. *Process of dyeing pile fabrics.*

The pile fabric is embossed to lay flat portions of the pile; then a mordant, resist, or dye is applied to the erect portions of the pile, and, after steaming and washing, the pile is raised. Two or more colors are produced by applying a dye to the erect portions of the embossed fabric and subsequently, after raising the pile, dyeing the piece.

557,324—March 31, 1896. G. D. BURTON. *Art of electric dyeing.*

See Group X, Electro-chemistry.

558,718—April 21, 1896. H. L. BREVOORT. *Art of fixing dyes in fabrics.*

See Group X, Electro-chemistry.

559,163—April 28, 1896. E. CABIATI. *Process of dyeing with indigo.*

A fine network in aniline black is printed on the fabric before or after treatment in the indigo bath, to economize indigo.

569,392—October 13, 1896. F. STORCK. *Process of producing azo colors on fiber.*

The fiber to be dyed or printed is impregnated with a sodium salt of phenol and subsequently submitted to the action of mixtures of diazo compounds of aromatic bases with cupric chloride.

570,115—October 27, 1896. V. G. BLOEDE. *Process of vapor-dyeing.*

Fibers or fabrics are subjected to the action of the vapors of volatile coloring matters or color-producing compounds.

570,117—October 27, 1896. V. G. BLOEDE. *Process of dyeing aniline-black.*

The fiber is first saturated with a salt of aniline or its homologues (combined in the usual manner with chlorates or metallic salts), then dried, and then, without previous aging, it is brought in contact with an oxidizer, applied in such quantity that the fiber or fabric will not become supercharged with moisture until the color developed has become insoluble.

574,401—January 5, 1897. C. & P. DUPOULLY. *Process of crinkling silk.*

Silk thread or fabric is subjected to the action of an acid of a density sufficient to contract the silk fibers.

577,295—February 16, 1897. W. J. S. GRAWITZ. *Process of dyeing.*

Vegetable fibers, prepared wool, or silk are dyed or printed by first treating the fibers with a mixture of a salt of aniline and a soluble cyanate, such as sulpho-cyanate of barium, capable of forming the sulpho-cyanate of aniline by double decomposition, and then developing the color by oxidizing the chlorate in presence of a salt of vanadium.

580,331—April 6, 1897—J. WEIDMANN. *Process of dyeing silk.*

Unmanufactured silk in the condition of souple is subjected to a bath of bichloride of tin of from 20° to 30° Baumé for an hour, more or less, then washed, then for an added weight of 50 to 300 per cent passed one to five times through the tin bath, then subjected to a solution of phosphate of soda, again washed, passed back and forth in a bath of silicate of soda, again subjected to the tin bath for an hour, and then dyed black, after grounding if desired.

586,865—July 20, 1897. E. VON PORTHEIM. *Process of dyeing black.*

The dyestuff is formed on the fiber by mordanting the same first with beta-napthol sodium and then applying thereto a diazo combination of an amidochrysoidin base—formed by diazotizing a base of an amidochrysoidin—adding to the diazotized liquor acetic-starch paste, oxalic acid, and acetate of sodium.

588,203—August 17, 1897. A. WEINBERG. *Process of developing azo colors.*

Dyeings produced by means of those direct-dyeing cotton dyestuffs which contain free primary amido groups are developed by treating the goods in a bath containing diazo compounds. The process appears to be an inversion of the well-known method of diazotizing amidized direct-dyeing coloring matters upon the fiber.

588,387—August 17, 1897. V. G. BLOEDE. *Process of dyeing.*

The fiber or fabric is first treated with a composition of aniline, its homologues or analogues, and then subjected to the action of an oxidizer in gaseous form.

592,022—October 19, 1897. H. N. F. SCHAEFFER. *(Reissue: 11,647—February 1, 1898.) Process of dyeing mixed goods.*

Mixed goods composed of wool and cotton are first dyed with a black dye which dyes the wool only and which is unaffected by aniline-black: the cotton is then dyed by padding the goods with an aniline-black liquor, and the black developed in the cotton after it has been padded.

593,192—November 9, 1897. V. G. BLOEDE. *Process of dyeing.*

Colors are developed or modified by diazotization by subjecting the fiber or fabric treated with such colors or color-producing compounds to the action of nitrous acid in gaseous form.

595,894—December 21, 1897. H. SEYBERTH AND M. VON GALLOIS. *Process of producing diazonaphthalene on fiber.*

Process of producing diazonaphthalene for the production of a claret-red color on the fiber consists in applying to the fiber a pasty aqueous solution of pulverized alpha-naphthylamin sulphate, and then diazotizing the same.

601,420—March 29, 1898. H. ZUBLIN AND A. ZINGG. *Process of discharge printing.*

In the art of producing white and color discharge of finished dyed paranitranilin red and similar azo coloring matters, produced directly upon the fiber, the coloring matters are reduced by means of an alkaline solution and of glucose in the presence of a body of the hydroxyl group, as glycerine.

606,776—July 5, 1898. S. F. CARTER. *Process of producing white effects on fabrics.*

The fabric is first subjected to the action of a sulphocarbonate of cellulose, such as viscose, the design is then printed upon the fabric with a suitable pigment, as tungstate of barium, and it is then subjected to heat to decompose the viscose. The design may be first printed with a mixture of viscose and tungstate of soda, and the fabric then heated and afterwards passed through a bath of barium chloride to form upon the fabric tungstate of barium in the form of the design.

606,777—July 5, 1898. S. F CARTER. *Process of producing white effects on fabrics.*

The design is printed upon the fabric with tungstate of barium and albumen, or like binding agent, and then heated to coagulate the albumen, thereby binding the pigment to the fabric.

612,274—October 11, 1898. J. T. REID AND H. THORP. *Dyeing textile fibers, yarns, and fabrics.*

Vegetable fibers are dyed "khaki" shades by passing the material through a bath of olein-oil, drying, impregnating with a mixed solution of alizarin-blue S (or like product of anthracene), chromium and iron salts, then drying, steaming and developing the color by treatment with an alkali.

614,237—November 15, 1898. H. N. F. SCHAEFFER. *Process of printing on mixed goods.*

Printed effects are produced on mixed woven goods of animal and vegetable fibers, by dyeing with a substantive color or colors, rendering the substantive color fast on the vegetable fiber by a substantially colorless compound metallic mordant (as salts of zinc, magnesia, and alumina), and a fixing agent not sufficiently alkaline to affect the animal fiber, and printing in design on both fibers a discharge reagent which reacts on both the animal and vegetable substantive color and produces a colored design on both of said fibers.

615,232—December 6, 1898. H. ALT AND E. CULMANN. *Process of dyeing with quinonoxim colors.*

Process of producing and at the same time fixing nitrosophenols on textile fiber consists in impregnating the goods with a mixture consisting of a phenol, a suitable acid or acid salt, and a mordant adapted for the fixation of nitrosophenols, and subsequently passing the fabric through a hot nitrite solution.

617,772—January 17, 1899. F. RETTIG. *Process of making colored designs on woven fabrics.*

Embroidery-like woven material having a raised and colored portion is produced by weaving such fabric with a raised design on its face, protecting the back by applying a resist thereto, applying a color on the other side, fixing said color on the raised pattern, and subsequently removing the resist and unfixed color. A color may be incorporated with the resist.

620,578—March 7, 1899. J. W. FRIES. *Process of dyeing.*

The dyeing compound consists of starch and caustic soda in semifluid condition, acetic acid, a substance such as acetate of lime capable of precipitating the basic dyes, and a basic dye, the whole forming a viscous material capable of producing insoluble precipitates of the dyes upon the fabric and stiffening of the tetxile material treated on application of heat.

623,697—April 25, 1899. M. BECKE AND A. BEIL. *Process of dyeing unions.*

The wool and cotton in half-woolen goods is simultaneously subjected in one acidulated bath to the action of basic polyazo dyestuffs and saffraninazo dyestuffs.

625,198—May 16, 1899. A. PHILIPS AND M. VON GALLOIS. *Process of dyeing on fiber.*

Azo colors, insoluble in water, are produced on the fiber, from violet-black to black, by grounding the goods with naphthol and combining therewith the tetrazo compounds of diamidodimethylcarbazol by way of printing or dyeing.

630,507—August 8, 1899. F. I. HORROCKS. *Process of dyeing.*

Products made of vegetable fibers are impregnated with a solution of a salt of copper and iron, and the same is precipitated upon the fibers in the form of oxides by a suitable reagent, as a solution of a suitable salt of an alkali metal. Figures or patterns are produced by removing the excess of solution to a greater extent from some portions of the fabric than from others prior to precipitation.

631,806—August 29, 1899. J. T. REID AND H. THORP. *Process of dyeing khaki.*

The fibrous material is impregnated with a mixed solution of alizarin-blue S, chromium and iron salts, dried, steamed, and the color developed by treatment with an alkali. (The preparatory steps of No. 612,274 are omitted.)

632,503—September 5, 1899. A. PHILIPS. *Process of dyeing.*

Brown to brown-black colors are produced on the fiber by treating the naphthol-grounded fabric with the tetrazo solutions of the diamidocarbazols

633,438—September 19, 1899. F. ERBAN. *Process of dyeing.*

To dye with alizarin the fiber is first treated with a soluble modification of alizarin—a solution of the coloring matter mixed with an alkaline medium—then the alizarin color is fixed on the fiber by drying, the fiber is treated with a mordant, and finally steamed.

634,824—October 10, 1899. P. JULIUS AND R. LAIBLIN. *Dyeing wool fast black.*

The wool is dyed from an acid bath with the secondary diazo dyes from ortho-amido-phenol-para-sulpho-acid (those having alphanaphthylamin as middle component and a naphthol or dioxynaphthalene or sulpho-acids thereof as end components), and the dyeings treated with a chrome salt.

646,379—March 27, 1900. G. TAGLIANI. *Process of dyeing fabrics.*

To deepen the shade of color upon one side of fabrics of vegetable fiber a concentrated alkaline solution—as a concentrated caustic solution containing metallic salts—is applied only to the side that is to take the deeper color, then the fabric is dyed, and finally subjected to the washing action of an acid.

647,268—April 10, 1900. F. JUST. *Process of dyeing.*

Colors developed by chromium compounds are produced on wool fiber by dyeing the fiber with an azo dyestuff, oxidizing with chromic acid, and subjecting the dyestuff simultaneously to the action of a reducing agent, such as lactic acid, tartaric acid, etc.

649,227—May 8, 1900. E. ULLRICH. *Process of dyeing quinonimid dyes.*

The tannin-antimony compounds of the quinonimid dyestuffs are produced from their components on the fiber by printing or padding the fiber with a color containing a nitroso compound of aromatic bases, a phenol-like body (as betanaphthol), an acid, a thickening agent, and tannin, then drying, steaming, and passing the fiber through an antimony bath, and washing and soaping.

649,228—May 8, 1900. E. ULLRICH. *Process of fixing quinonimid dyes.*

The chromium compounds of the quinonimid dyestuffs are produced on the fiber from their components by printing or padding the fiber with a color containing a nitroso compound of aromatic bases, a phenol-like body (such as betanaphthol), an acid, a thickening agent, and a suitable metallic salt to fix the dyestuff, then drying, steaming, washing, and soaping.

649,486—May 15, 1900. R. E. SCHMIDT. *Process of dyeing.*

Unmordanted wool is dyed with water-soluble amidoöxyanthraquinone sulphonic acids by means of an acid bath, which at the same time contains a sulphurous-acid compound as a reducing agent.

650,752—May 29, 1900. W. ELBERS. *Gray cloth and process of dyeing same.*

A gray-indigo coloring matter is produced on the fiber by printing with a paste of finely divided indigo, a suitable thickening and a quantity of oil on the fiber, and steaming, then freeing from thickening by washing and treating with malt, drying, and again steaming.

MORDANTS.

8,035—April 15, 1851. C. A. BROQUETTE. *Improvement in material for transferring colors in calico printing.*

Extract of fibrine is used to form a mastic to thicken and retain on fibers archil color and such other colors as are incorporated with the mastic. The process is described of preparing and purifying the extract of caseine for use as a mordant.

13,915—December 11, 1855. R. PRINCE AND A. LOVIS. *Improvement in processes for calico printing.*

A compound of silicates of soda or potash with neutral or alkaline salts is used, in lieu of dung, in dunging operations with carbonate of soda and neutral salts.

34,840—April 1, 1862. N. LLOYD AND J. G. DALE. *Improvement in dyeing and printing with aniline colors.*

Tannin and tartarized or other soluble salt of antimony capable of dilution with water, or a soluble salt of lead, mercury, or chromium, are used to fix colors derived from aniline or analogous substances on textile fabrics.

38,686—May 26, 1863. G. H. LEWIS. *Improvement in printing and ornamenting india rubber.*

Printing or engraved matter is impressed or transferred upon vulcanizable india rubber or allied gums, and then fixed by vulcanizing, as by pressure between heated metal plates.

41,066—January 5, 1864. R. H. GRATIX. *Improvement in dyeing and printing with aniline colors.*

A compound of tannin with the aniline color, formed either before or during the process of printing or dyeing, is used in combination with salts of tin or other suitable mordant.

46,200—January 31, 1865. T. CROSSLY. *Improvement in the dyeing, printing, and manufacture of waterproof flocked cloth.*

Before dyeing or printing, the cloth is submitted to a steam heat of 105° to 143° C., then to a bath of muriate of tin of 4° to 12° Twaddle, then to a neutralizing bath of aqua ammonia and salsoda, thèn to a solution of sulphuric acid and chloride of lime to oxidize the tin deposit, and afterwards to a dilute solution of sulphuric acid to remove the lime. The cloth then dyes and prints in uniform shades.

54,203—April 24, 1866. E. F. PRENTISS. *Improved mordant.*

A triple sulphate of iron, 746 parts; copper, 254 parts; and zinc, 110 parts. It is used for black and any desired shades of mulberry.

60,546—December 18, 1866. A. PARAF. *Improvement in dyeing and printing textile fabrics and yarns.*

Chromic acid is developed in dyeing and printing by the application to the fabric of an insoluble salt of chromium and the subsequent action of a moist atmosphere, or by aging or steaming.

63,084—March 19, 1867. A. PARAF. *Improvement in dyeing and printing textile fabrics, and in compounds therefor.*

The arsenite of glycerine, for fixing aniline colors; also the combination of the same with coal-tar colors and acetate of alumina, magnesia, or other metallic oxide.

69,121—September 24, 1867. A. PARAF. *Improved mode of producing black in dyeing and printing.*

Asphaltum is used and the black coloring matter precipitated in the article to be dyed or printed by means of albumen.

94,581—September 7, 1869. F. S. DUMONT. *Improved compound to be used as a mordant in dyeing and printing.*

A mordant made from the serum of blood, produced by adding arsenic acid, borax, sulphate of zinc, and essence of terebinthine.

99,105—January 25, 1870. A. PARAF. *Improved method of fixing pigments to fibrous and textile materials.*

The coloring matters are fixed by means of albuminous material, as lactarine, and a salt of lime, such as the saccharate of lime or the suchrate of lime.

106,479—August 16, 1870. F. GRAUPNER. *Improvement in composition to be used in dyeing.*

A coloring composition, of the nature of a mordant, consisting of a solution of sulphate of soda, sulphuric acid, and oxalic acid in water, to which is added a mixture of muriatic acid and nitric acid saturated with tin and then diluted with water.

128,302—June 25, 1872. E. A. D. GUICHARD. *Improvement in processes of printing fabrics.*

The colors are mixed with a compound of oil varnish, essence of turpentine, white or yellow wax, and resin and printed direct, without previous preparation of the fabric.

143,429—October 7, 1873. G. A. HAGEMANN. *Improvement in mordants for dyeing.*

Calcined and pulverized acetate of soda and sulphate of alumina are mixed in due proportions ready to be dissolved for the production of the mordant acetate of alumina.

144,952—November 25, 1873. R. O. BURGESS AND S. LA RHETT. *Improvement in mordants for dyeing.*

A compound of sodium chloride and binoxalate of potash.

152,903—July 14, 1874. A. GENDER AND W. THILMANY. *Improvement in treating textile fabrics to prevent mildew and decay.*

Textile fabrics are treated with sulphate of copper and chloride of barium, the salts forming a union with the fabric.

177,987—May 30, 1876. F. J. BIRD. *Improvement in mordants.*

A composition of gallnuts, tannin, alum, tin, and soda, as a mordant for woolen and cotton or other union goods.

186,620—January 23, 1877. J. RAU. *Improvement in processes for dyeing silks.*

Silks and half silks are dyed, without water or steam, by first soaking in a bath of benzine with aniline dissolved therein, and afterwards in a bath of pure benzine.

192,492—June 26, 1877. H. D. DUPEE. *Improvement in printed textile fabrics.*

A textile fabric has coloring matters fixed thereon by means of gelatine combined with chromic acid.

195,826—October 2, 1877. J. KOKESCH. *Improvement in treatment of seal skins.*

The skins are first sheared to the proper length of hair, then subjected to a process of fulling, then mordanted, and finally immersed a number of times in a dye, brushing after each immersion. The mordant consists of quicklime, beech ashes, sumac, and water; and the dye of gallnuts, green copperas, copper scales, litharge, sal ammoniac, verdigris, catechu, rotten stone, cinnabar, and water.

204,130—May 28, 1878. S. CABOT, Jr. *Improvement in compositions to be used as mordants and dye stuffs.*

It consists of gallic acid, sodic or potassic hyposulphite, hydrosodic or hydropotassic sulphate, and nutgalls, ground and mixed.

241,398—May 10, 1881. S. MELLOR. *Mordant.*

It consists essentially of stibio-fluorine salts, or any combination of fluorine and antimony by themselves, or in conjunction with any other metal or metalloid.

243,141—June 21, 1881. J. J. LELOIR. *Dyeing mixed fabrics.*

A mordant for mixed fabrics composed of water, muriatic acid, and sulphuric or nitric acid, with zinc or tin, together with bichromate of potash and a sulphate of iron or of copper.

243,378—June 28, 1881. A. M. JACOBS. *Turkey-red mordant.*

Process of preparing a mordant consists in uniting 220 parts of oil or fat and 50 parts of sulphuric acid, the mixture being stirred for three hours until 37° to 56° C. is reached and then settled for twelve hours, then a watery solution of crystallized soda is added and settled for twenty-four hours, when the neutralized oil is drawn off and 26 parts of aqua ammonia is added.

245,633—August 16, 1881. A. M. JACOBS. *Process of manufacturing oleaginous mordants.*

To produce an oxyoleic alkali mordant, for turkey-red dyeing, vegetable and animal oils, fats or oleic acid are treated with sulphuric acid, then double the quantity of cold water added, whereby sulpholeic acid is formed which is settled, separated, and boiled with three to six times the quantity of distilled water until the fatty acids and the sulphuric acid have separated and the former floats on the watery fluid; it is then poured off and the fatty acid is repeatedly boiled with fresh water, separated from the solid parts and mixed with cold water, and alkali added to neutralize or make slightly alkaline.

245,701—August 16, 1881. J. BURTON. *Thickener for mordants and colors.*

Glucose is added to either the mordant or color, or both.

254,713—March 7, 1882. T. SIMPSON. *Chroming fabrics.*

The fabric is passed through a chroming solution, then heated without drying, and then passed, before drying, through a water bath.

255,543—March 28, 1882. T. SIMPSON. *Process of and apparatus for aging fabrics.*

The suspended fabrics, properly prepared, are subjected to the action of currents of moist air directed downward.

263,040—August 22, 1882. T. H. GIBSON. *Mordant.*

A combination of acetate of lead and stannate of soda each one part and alum two parts.

263,366—August 29, 1882. C. TOPPAN. *Process of finishing colored or printed textile fabrics.*

The goods are passed into or through a solution of warm water and sinepetroline No. 2 (No. 186,640), with or without starch, and then calendered upon hot rolls.

270,868—January 16, 1883. F. B. WILKINS. *Finishing woven cotton fabrics.*

Ginghams and other cotton fabrics are wrapped in heavy woolen blankets and subjected to the action of steam under pressure, to render them pliable and improve the texture

287,112—October 23, 1883. A. N. DUBOIS. *Mordant for aniline black.*

A compound of water, hydrochloric acid, sulphate of soda, and bichromate of potash.

290,294—December 18, 1883. C. N. WAITE. *Mordant.*

A mixture of lactic acid, 4 parts, with oxalic acid, 1 part. It is specially intended for animal fibers.

309,016—December 9, 1884. G. WITZ. *Process of pattern dyeing.*

To produce figures of the same color as the ground, but of a different shade, the fabric, of vegetable fiber, is dipped in a solution of potassium bichromate, and dried, then printed with a solution of starch at about 30° C., in which is dissolved oxalic acid (whereby the cellulose is converted into oxycellulose) and dried, and then washed and dyed.

320,820—June 23, 1885. R. SILBERBERG. *Process of dyeing.*

Cotton fabric is first immersed in boiling water, then in a solution of oxalate of chromium and a solution of caustic soda, and then washed and dyed with an aniline dye in the usual manner.

320,821—June 23, 1885. R. SILBERBERG. *Mordant.*

A mordant for aniline dyes consisting of a mixture of a solution of oxalate of chromium and a solution of caustic soda.

320,963—June 30, 1885. O. PRINZ. *Mordant.*

Process of producing soluble antimony compounds consists in decomposing sugar or equivalent carbon hydrates by alkaline bodies, with or without the assistance of oxidizing agents such as a current of air and metallic oxides, either or both, acidulating the solution, and then treating the same with an antimony compound.

328,464—October 20, 1885. M. CONRAD. *Mordant.*

A compound of laevulinic acid (beta-acetyl-propionic acid), oil emulsion, a thickening—such as starch and acetic acid—and a solution of tannic acid.

339,778—April 13, 1886. C. HUGGENBERG. *Process of treating silk fiber.*

Silk threads are subjected to the action of a solution of a suitable tin salt, and then to a solution of tungstate of soda.

341,294—May 4, 1886. C. N. WAITE. *Mordant.*

An antimonious oxide dissolved in lactic acid, wholly or partially neutralized by an alkali, for use on cotton fabrics.

347,315—August 17, 1886. V. G. BLOEDE. *Process of improving the finish and durability of fabrics for window shades, etc.*

Fabrics sized with starch, or a mixture of starch, clay, and pigments, are impregnated, after sizing and coloring, with a solution of waxy or resinous matter in a volatile hydrocarbon.

352,236—November 9, 1886. B. FINKELSTEIN. *Process of mordanting.*

Vegetable fibers and fabrics impregnated or printed with tannin are mordanted with antimony by treating same with antimony oxalate suspended in water.

371,498—October 11, 1887. L. GRAISSOT. *Dressing silk.*

The effect of shrinkage is produced on fabrics containing silk by subjecting them to the action of a bath of chloride of zinc and drying in a tepid chamber. They may be then subjected to the action of a solution of carbonate of potash and finally boiled with soap.

392,659—November 13, 1888. C. T. BAZIN. *Mordant for dyeing.*

For indigo dyeing a preliminary bath is used consisting of carbonaceous material, as 25 pounds of lampblack or charcoal suspended in a saccharine sirup, as 2 gallons of molasses.

398,564—February 26, 1889. W. J. WILLIAMS. *Mordant.*

Fibers and fabrics are subjected to the action of trisodium phosphate to fix colors and prevent rust and crocking.

409,819—August 27, 1889. J. BRACEWELL. *Aniline-black discharge.*

The cloth is treated with the solution of the aniline-black color, dried to a moist state by steam or atmospheric heat above 32° C., the drying completed at a temperature below 32° C., and an alkaline discharge printed in patterns before the oxidation of the aniline color.

418,153—December 31, 1889. F. BAYER. *Process of fixing azo dyes.*

Goods of animal or vegetable fiber, dyed or printed in the usual way with the substantive cotton coloring matters, are fixed by boiling with a solution of a metallic salt.

421,847—February 18, 1890. C. WACHENDORFF. *Mordant.*

Chromium fluoride is used as a fixing agent in dyeing and printing fabrics and fibers.

437,295—September 30, 1890. E. O. FANKHAUSER. *Mordant.*

A mixture of castor oil, sulphuric acid, soda lye, ammonia, white soap, and extract of sumac, as a mordant for cotton or mixed yarns or fabrics.

499,687—June 13, 1893. W. T. WHITEHEAD. *Resist-mordant.*

The pattern or figure is printed in a resist-mordant containing a zinc compound as the essential or active element, with or without a color, and thereafter the cloth is dyed a plain color, thereby producing a pattern contrasting with the ground.

512,264—January 9, 1894. O. P. AMEND. *Process of mordanting fabrics.*

The fiber is first treated with a cold solution of free chromic acid in the presence of another nonoxidizing acid (such as acetic or hydrochloric acid), and the prepared fiber is then treated with a solution containing one or more reducing agents, such as sodium sulphite, when the fiber is ready for the color.

530,202—December 4, 1894. R. H. PICKLES. *Mordant.*

A mordant consisting of a solution of a salt of aluminum derived from sugar hydrated lime and a sulphate of alumina, the sugar and the metal being combined in almost equal proportions, and having the formula $C_{12}H_{22}O_{11}Al_2(OH)_6$. Process of preparing a metallic sucrate (of aluminum, iron, or chromium) consists in adding a sulphate of the metal to a solution of sucrate of an alkaline earth metal, thereby precipitating a sulphate of the alkaline earth metal, and separating the solution of the metallic sucrate.

549,257—November 5, 1895. C. RIS-KUMMER. *Process of treating raw silk.*

Raw silk having an insoluble sericin coating: produced by treating the raw silk with an aldehyde of the fatty series, such as formaldehyde, either in gaseous form or in solution.

568,344—September 29, 1896. A. GANSWINDT. *Mordanting textile fabrics.*

Cotton or other vegetable textile fibers are mordanted with lactate of zinc and subsequently dyed.

583,298—May 25, 1897. V. G. BLOEDE. *Process of dyeing.*

The yarn or fabric is treated with a starch containing a salt or salts, the base of which possesses the power of rendering the starch insoluble when the acid of combination is withdrawn (salts of lime, barium, iron, lead, etc.), then treating with an alkali or otherwise to extract part or all of the acid of combination and make the starch insoluble.

583,725—June 1, 1897. A. BIERMANN. *Process of weighting silks.*

The material is first treated in a stannic-chloride bath of 25° to 30° Baumé, the superfluous chloride of tin being removed; then with a soluble phosphate such as sodium phosphate dissolved in a warm bath and again washed; then treated in a warm bath of aluminum sulphate; then passed through a warm bath containing a solution (3° to 5° Baumé) of a silicate, such as sodium silicate, and finally washed and dried.

586,750—July 20, 1897. J. WEISS. *Printing and mercerizing cotton.*

Crêpe-like patterns or effects are produced on vegetable fibers or fabrics by impregnating the same with a caustic-alkali solution and then printing with a neutralizing substance, such as acetic acid, with or without dyestuffs, before the caustic alkali has commenced to act.

596,464—December 28, 1897. C. TUBBE. *Process of mercerizing.*

Vegetable tissues are padded with a mixture of alkaline lyes and collodial agents (such as British gum, sodium aluminate, etc.), then subjected to pressure, then rolled up to exclude the air, and lastly washed.

597,107—January 11, 1898. C. DREHLER. *Process of mordanting.*

A mordant of antimony oxide combined with acid lactate of calcium, produced by forming a bath of antimony oxide and acid calcium lactate, with which fibers treated with tannin substances are mordanted.

597,401—January 18, 1898. C. DREHER. *Process of mordanting wool.*

Wool and other animal fibers are treated in a lye comprising lactic acid, bichromate of potash, and sulphuric acid, in about the proportions of 2.65 kilos lactic acid, 1.35 kilos bichromate of potash, and 0.9 kilo sulphuric acid, yielding a complete reduction of the potassium bichromate.

600,826—March 15, 1898. R. THOMAS AND E. PREVOST. *Process of mercerizing under tension.*

Vegetable fiber is stretched, then subjected to the action of a mercerizing fluid until it assumes a parchment-like appearance, next subjected to a greater tension while under the action of the mercerizing fluid until a peculiar silky luster appears, and maintained under tension while washing or otherwise removing the mercerizing fluid.

600,827—March 15, 1898. R. THOMAS AND E. PREVOST. *Process of mercerizing under tension.*

The fiber is subjected to the action of a mercerizing fluid without tension, and then during the mercerizing action, after the fiber is wetted and before the removal or neutralization of the fluid, the material is subjected to a stretching action sufficient to produce a silky luster and prevent shrinkage. Vegetable fibers mixed with animal fibers are mercerized at a low temperature, about zero centigrade, in like manner, the fluid being of such a degree of dilution as to be without mercerizing effect on vegetable fiber at ordinary temperature and without deleterious action upon the animal fiber.

601,673—April 5, 1898. F. J. OAKES. *Process of mordanting.*

Fiber or fabric is first subjected to a solution of tannic acid and afterwards to a bichromate or chromic-acid bath, thus fitting it for dyeing with any desired color.

608,231—August 2, 1898. H. SEIDEL. *Mordant from sulfite-cellulose lyes.*

It consists of a solution of a salt of a metal of the alkalis or alkaline earths, with or without a mineral acid, and a sulpho-derivative of lignin- or sulphite-cellulose lye which contains said derivative can be added, either decolored and freed from calcium compounds or otherwise.

609,131—August 16, 1898. G. WENDLER. *Mordant.*

A composition of commercial sulphuric acid, 60 parts; calcined alkaline sulphate, such as sodium sulphate, 100 parts; and boracic acid, 15 parts.

615,045—November 29, 1898. E. PREVOST. *Process of mercerizing.*

Vegetable fibers and fabrics are mercerized, and during the process simultaneously subjected to tension and compression.

621,477—March 21, 1899. J. SCHNEIDER. *Process of mercerizing.*

The material is first treated with benzine to dissolve the oily matters, then with a strong (30 per cent) alkaline solution, then stretched, and washed while stretched.

629,780—August 1, 1899. P. DOSNE. *Process of mercerizing.*

Moiré effects are produced on striped fabrics of vegetable fiber by printing the fabric with a resist in stripes, distorting or pulling the fabric alternately from right to left and left to right during the resist printing, and then mercerizing the fabric.

643,923—February 20, 1900. E. UNGNAD. *Process of treating fibers, etc., to imitate silk.*

Vegetable fibers and fabrics after they have been soaked in an alkaline solution of silk are subjected to the action of carbonic acid, which combines with the alkali of the silk solution, forming an alkaline carbonate, and deposits the silk on the fiber.

646,760—April 3, 1900. A. F. POIRRIER. *Process of mordanting.*

Colors obtained from substantive sulphur coloring matters are fixed by subjecting the dyed material to the action of a bath of chloride of copper, with or without bichromate of potash.

GROUP XII.—TANNING.

NATURAL.

836—July 12, 1838. A. A. HAYES. *Improvement in the process for extracting tannin from bark.*

Bark in water is treated with a solution of alkaline salts of either ammonia, potash, soda, or lithia, with strong agitation, the quantity being sufficient to neutralize four-fifths of the acid naturally contained in the bark.

4,007—April 22, 1845. G. C. CLOSE AND E. FIELD. *Improvement in separating tannin and coloring matter in quercitron bark.*

A decoction of quercitron bark is partially evaporated, the coloring matter settled, and the astringent liquor drawn off and used for tanning or evaporated to an extract.

12,139—January 2, 1855. O. RICH. *Improvement in processes for extracting tannin from leather.*

Leather, washed and chopped into small pieces, is digested in a caustic alkali of ammonia, potash, or soda to extract the tannin, then subjected to pressure and the liquor acidulated with sulphuric, muriatic, or acetic acid, and used for tanning. The scraps are washed, digested in dilute acid to remove coloring matter, the acid neutralized, and are then converted into glue and manure.

34,873—April 8, 1862. J. BRAINERD AND W. H. BURRIDGE. (*Reissue: 2,523—March 19, 1867.*) *Improved process of extracting the strength of bark for tanning and other purposes.*

The material is introduced, in successive charges, into the bottom of a leaching column and the exhausted material is discharged at the top, the water or liquid being introduced at the top and filtering downward: applicable also to filter material.

41,782—March 1, 1864. S. W. PINGREE. (*Reissue: 1,922—March 28, 1865.*) *Improvement in extracting tan bark.*

The bark is first swelled with water or weak tan liquor and heated with steam, and afterwards steeped with cold water or weak tan liquor.

64,321—April 30, 1867. B. IRVING. *Improved process of concentrating the extract of bark for tanning and other purposes.*

The bark solution is concentrated by continuous distillation *in vacuo*, using a flat worm or evaporating tables.

64,323—April 30, 1867. B. IRVING. *Improved process for obtaining the extract of bark for tanning and other purposes.*

The bark fiber is disintegrated by means of heated pressure rollers and water baths, acting alternately, in a continuous operation, in lieu of grinding.

68,335—September 3, 1867. A. APPLEBY. *Improved mode of preparing tan bark for use.*

Bark is prepared for transportation by first steaming it to make it pliable, and then flattening it and removing the ross by running it through a planing machine.

75,608—March 17, 1868. G. WARREN. *Improvement in extracting tannin from bark.*

The bark is subjected to the successive steps of steaming, soaking, and pressing between rolls, the series of steps being repeated several times, and the pressings kept separate from each other.

81,587—September 1, 1868. G. BOSSIÈRE. *Improvement in decolorizing tannin-liquid.*

Tannin juices are decolorized by the addition of a glue made from refuse clippings or scraps, or by all-gelatine glues dissolved in from fifteen to twenty parts of water. Acetate of lead dissolved in acidulated water and also kaolin decolorize colored tannin.

82,121—September 15, 1868. T. W. JOHNSON. *Improvement in extracting tan bark.*

The bark is softened in chips, passed through rollers into a saturating tank where it is exposed to the action of beaters, then elevated and passed through a series of leaches and repeatedly washed.

96,345—November 2, 1869. J. PICKLES. *Improved solid or dry extract of bark for tanning, etc.*

Dry or powdered tannin extract, the product resulting from concentrating the liquid extract and reducing it to a dry state.

96,365—November 2, 1869. B. C. TILGHMAN. *Improvement in making tanning and dyeing extracts.*

The vegetable material, bark, roots, wood, etc., is digested with a solution of sulphurous acid, in water, with or without the addition of sulphites, as of lime, and either in closed vessels with high temperatures and pressure or in open vessels with temperature not exceeding 100° C.

117,455—July 25, 1871. N. C. PLATT. *Improvement in processes of separating tannin from solutions.*

Tannic acid is obtained by treating a bark infusion or solution with a solution of common salt or other saline crystalline substance.

174,110—February 29, 1876. E. BRADLEY. *Improvement in bleaching extract of hemlock bark.*

Hemlock-bark liquor is bleached by bringing same in intimate contact with sulphurous acid, as by forcing it up through the liquor.

178,919—June 20, 1876. J. FOLEY. *Improvement in processes for treating tannin juices.*

Tannin juices, aqueous solutions of tannin, and concentrated tannin extracts are bleached and prevented from souring by incorporating therewith sulphites, bisulphites, and double sulphites of sodium, calcium, potassium, aluminum, and ammonium, in the form of solid salts or as solutions.

182,965—October 3, 1876. J. SHERMAN, Jr. *Improvement in preparing tan bark for transportation.*

The bark is dried, ground, and compressed sufficiently to crush the cells, and also to form it into bricks.

184,638—November 21, 1876. R. LOERCHER. *Improvement in preparing tan bark for transportation.*

A block of compressed ground tan bark coated with a solution of tan bark.

193,443—July 24, 1877. J. FOLEY. *Improvement in tanning solutions.*

Ground bark is leached with water having bisulphite of lime in solution.

198,478—December 25, 1877. I. WELLS. *Improvement in extracts for tanning leather.*

May-weed (*Athemis cotula*) is cut up, ground, and pressed; then steamed and again pressed; the mass is then subjected to air suction, treated with diluted sulphuric acid, and the mass removed from the liquid, which latter is subjected to air exposure to remove trace of acid, and the three liquid products are then mingled.

230,398—July 27, 1880. E. BRADLEY. *Purifying extracts of bark.*

The leached extract is condensed by evaporation to about 10° Baumé, rapidly cooled, and then flowed through a series of tanks overflowing into one another, wherein the matter set free by the action of cooling is precipitated.

231,489—August 24, 1880. J. HOLTZ. *Obtaining tannic acid.*

See Group I, Acids, Tannic.

235,923—December 28, 1880. H. L. WILCOX. *Tanning extract.*

A solid block of the "tannin plant"—the *Polygonum amphibium*—consisting of a mixture—say of 50 pounds—of the freshly ground plant and a concentrated extract from 2,000 pounds of the same plant.

258,573—May 30, 1882. P. GONDOLO. *Process of manufacturing tannin extracts.*

The vegetable matter is macerated in a slightly acidulated bath, a coagulant or absorbent, such as blood, is added, then an alkali or an alkaline salt and a further quantity of coagulant or absorbent, and finally the coagulant or absorbent with the coloring matter and alkaline salts is precipitated by means of sulphuric acid.

258,574—May 30, 1882. P. GONDOLO. *Process of and apparatus for the manufacture of tannin extracts.*

The tannin material is first macerated in a bath containing a salt of sulphurous acid; sulphuric acid is then added to the resulting solution, and it is clarified with blood or other coagulant.

283,881—August 28, 1883. P. GONDOLO. *Process of clarifying tannin extracts.*

Blood, or albumen, is added to the tannin extract at a temperature below that at which it coagulates, the coagulant is diffused through the extract at such temperature, and then the temperature of the mixture is raised and the coloring matter and salts are caught by and precipitated with the coagulant.

284,738—September 11, 1883. B. HOLBROOK. *Preparing tan bark.*

The dry bark is crushed and then passed between rolls under heavy pressure, reducing it to thin flakes.

302,105—July 15, 1884. E. L. P. & G. C. COËZ. *Process of making tanning extracts.*

Tannin extracts are decolorized by first adding oxalic acid, 1 gram to every hundred liters of juice, then introducing alumina in the proportion of about 250 grams per hundred liters of juice and per degree of intensity, with violent agitation and filtration. To produce tannic acid the proportion of alumina is quadrupled.

313,177—March 3, 1885. T. F. COLIN. *Manufacture of tanning extract.*

Bark liquor is evaporated by passing carbonic-acid and sulphurous-acid gases and steam through the liquor in a vacuum pan, then shutting off the steam, and turning it on only at intervals when the liquor becomes too thick to permit the gases to pass freely through it.

351,540—October 26, 1886. E. TAVERNIER. *Process of extracting tannin from wood.*

The heavier and lighter portions of a tannin extract are separated by centrifugal action.

357,129—February 1, 1887. A. MORAND. *Manufacture of tannin extract from wood.*

The wood is cut into thin slices across the grain, broken into granules by a pneumatic blast in a conduit, and leached by percolation. Weaker solutions at successive higher temperatures are used as the wood becomes spent.

365,087—June 21, 1887. A. MORAND. *Process of and apparatus for clarifying extracts.*

Crude tannin extracts have mingled therewith a purifying agent or color absorbent, as caseine, and heated, and then pumped, with the substance in suspension, through a dense filtering fabric.

376,345—January 10, 1888. H. M. RAU. *Manufacture of tannin extracts.*

Tannin liquors are clarified and decolorized by treating with hydrosulphurous acid—which may be produced by the addition of zinc dust and a concentrated solution of bisulphite of soda with agitation in a closed vessel—and filtering.

404,440—June 4, 1889. L. SAARBACH. *Process of purifying tannic extracts.*

The extract, heated to about 60° C., is mixed with acetate of lead without the addition of any acid—125 grams per 100 liters of juice and per degree of density—the precipitate separated, and the solution then treated with acids, preferably oxalic acid, 10 grams per 100 liters per degree Baumé, thereby obtaining a further precipitate.

409,876—August 27, 1889. E. F. SMITH. *Process of leaching tan bark.*

Ground bark is delivered into a tank of fluid and intermixed, the intermixed bark and fluid conveyed into and through a steam box, and thence to the top of the leach.

462,694—November 10, 1891. A. FOELSING. *Process of purifying tannin solutions by electrolysis.*

See Group X, Electro-chemistry.

480,376—August 9, 1892. W. C. TIFFANY. *Process of making tannin extracts.*

Canaigre root, *Rumex hymenosepalum torr*, is comminuted or macerated, subjected to a bath of water at 60° C. or less, and the extract evaporated.

483,141—September 27, 1892. G. DELVAUX. *Process of purifying tannic extracts.*

Tannic extracts are decolored and clarified by the addition of a compound of strontium, as 6 kilograms of crystalline hydrate of strontium to 1,000 liters of tanning liquor marking above 2.5° Baumé.

495,768—April 18, 1893. P. T. AUSTEN. *Process of making solid extract of sumac, hemlock, and other tanning agents*

A brittle solid extract of sumac, produced by adding an alkaline nitrite to a liquid extract of sumacs, heated to about 50° C.—say 5 per cent of sodium nitrite—allowing the reaction to take place, and evaporating to dryness.

510,152—December 5, 1893. O. C. HAGEMANN. *Process of separating tannin from other bodies.*

Tannin is separated from other bodies by the use of amyl alcohol as a solvent, the tannin being subsequently separated from the solvent by the addition of benzine or an equivalent body.

517,626—April 3, 1894. B. REINUS. *Process of purifying tannic acid.*

A solution of tannic acid is treated with acetate of lead to precipitate the impurities, the precipitate separated by filtration, the filtered solution again treated with acetate of lead in excess to precipitate tannate of lead, and then the tannate of lead is subjected to the action of oxalic acid which forms an insoluble compound with lead, and the pure and concentrated tannic acid is filtered off.

531,752—January 1, 1895. H. SCHWEITZER. *Process of extracting tannin.*

Raw material containing tannin is treated with acetate of amyl, and the tannin then precipitated from the solvent by the action of benzine or other organic solvent.

571,635—November 17, 1896. J. S. ADRIANCE. *Process of decolorizing tannin extract.*

A solution of basic acetate of lead—acetate of lead litharge, and water—is added to liquid extracts to precipitate the coloring matter and the clear liquid is drawn off after settling, and evaporated.

578,334—March 9, 1897. M. HÖNIG. *Making tannin extracts.*

Tannin is extracted from sulphite cellulose lyes by neutralizing with lime, clarifying, concentrating to from 15° to 16° Baumé, converting the lime into an insoluble compound by means of sulphuric acid, eliminating from the lye the free volatile acids by heat, filtering, and concentrating the filtrate to from 28° to 30° Baumé.

601,170—March 22, 1898. H. M. RAU. *Process of extracting tannic acid.*

Tannic acid, with other ingredients, is extracted from sumac leaves by acetone at low temperatures, that is, below the boiling point of acetone; then the acetone solution is evaporated, the extract secured in a dry mass, and the pure tannic acid extracted therefrom by water.

614,929—November 29, 1898. G. D. BURTON. *Process of tanning hides or skins of animals.*

See Group X, Electro-chemistry.

616,882—January 3, 1899. J. BLAIR. *Process of making tannin extracts.*

Leaves of coniferous trees are steamed in a weak solution of potassium permanganate and an alkali, the resulting solution is clarified by a weak acidulated solution precipitating the resinous matters, and then evaporated.

626,100—May 30, 1899. P. G. SANFORD. *Method of making tanning extracts.*

To clarify, bleach, or decolorize tanning liquids, albuminous matter is subjected to the action of alkaline fluoride and dialyzed; the tanning liquid is then subjected to the action of this product and dialyzed, and the albumen finally coagulated.

642,081—January 30, 1900. G. D. BURTON. *Process of unhairing animal hides or skins.*

See Group X, Electro-chemistry.

ARTIFICIAL, INORGANIC.

219,637—September 16, 1879. C. S. GORMAN. *Improvement in the manufacture of chromates of potash and soda.*

Chrome ore mixed with lime and carbonate of potash is calcined, the charge cooled and a further quantity added, say from 10 to 20 per cent of carbonate of potash, or its equivalent alkaline carbonate, and the mass reheated at from 425° to 650° C.

234,145—November 9, 1880. H. PEMBERTON. *Manufacture of bichromates.*

Carbonic acid gas is passed into a calcined mixture of chrome ore, bases, and salts to convert the insoluble compounds of chromic acid into soluble chromates.

279,431—June 12, 1883. E. P. POTTER AND W. H. HIGGIN. *Manufacture of bichromate of soda.*

A mixture of sulphate of soda, chrome ore, and lime, in proper proportions, is furnaced, lixiviated, and the monochromate of soda solution formed treated with hydrochloric acid in exactly sufficient quantity to change the chromate into a bichromate. The sodic sulphate present is separated by precipitating with calcic or baric chloride, the solution evaporated to a pasty mass, the sodic chloride crystals removed and washed, adding the resulting liquor to the original mass, and finally drying the mass at a temperature a little above that of boiling water. The monochromate of soda solution may be treated with sulphuric acid and the sodic sulphate formed converted into chloride by the addition of chloride of calcium, strontium, or barium. The removed sodic chloride crystals are decomposed with sulphuric acid in a salt-cake furnace and the product used for the decomposition of the chrome ore in place of sodium sulphate.

307,994—November 11, 1884. W. SIMON. *Manufacture of bichromate of soda.*

A solution of neutral chromate of soda is evaporated to dryness, decomposed in this condition by a mineral acid, as sulphuric acid, and the concentrated solution of bichromate of soda is then mechanically separated from the anhydrous lye product in a centrifugal machine.

329,138—October 27, 1885. W. J. CHRYSTAL. *Manufacture of chromates and bichromates.*

Chromates and bichromates of potash and ammonia are produced from the chromate or bichromate of soda by decomposition with the sulphate of potash or the sulphate of ammonia, respectively.

342,578—May 25, 1886. W. J. CHRYSTAL. *Manufacture of bichromate of soda.*

Chrome ore is furnaced with lime and a soda salt, the mass lixiviated with an acid solution of a soda salt and washed with water, and the solution and washings treated with an acid to convert the neutral or monochromate into bichromate of soda. The solution is then concentrated to 150° to 180° Twaddle to eliminate the sulphate of soda, which is separated, and the concentration continued and the pure bichromate obtained.

342,646—May 25, 1886. W. SIMON. *Manufacture of bichromate of potash.*

Bichromate of sodium is decomposed by chloride of potassium, or chromate of sodium by chloride of potassium and hydrochloric acid.

342,647—May 25, 1886. W. SIMON. *Process of manufacturing ammonium bichromate.*

Sodium bichromate is converted into ammonium-sodium chromate by the addition of ammonia to a solution of the same, and this salt is decomposed into sodium chloride and ammonium bichromate by the addition of hydrochloric acid.

366,036—July 5, 1887. W. SIMON. *Process of making potassium bichromate.*

Bichromate of sodium is decomposed by sulphate of potassium.

442,109—December 9, 1890. W. J. A. DONALD. *Process of making chromates.*

The insoluble residue resulting from the ordinary manufacture of chromates is calcined, pulverized, and mixed with chrome ore, lime, and an aqueous solution of the salt to be produced, oxidized in a furnace, and lixiviated to extract the soluble chromates, and the residue again used as before.

463,841—November 24, 1891. J. MASSIGNON AND E. WATEL. *Manufacture of chromates and bichromates.*

A mixture of pulverized chrome mineral with carbonate of lime and chloride of calcium is heated to convert the carbonate of lime into caustic lime, and the mineral oxidized at a low temperature. This oxidated mixture can serve for the manufacture of chromates and bichromates, and of chromic and chlorochromic acids. To make chromate of lead the chloride of calcium is first washed out and subsequently the chromate of lime, which latter is precipitated by a lead salt.

527,563—October 16, 1894. E. A. STARKE. *Process of making ammonium bichromate.*

See Group XIV, Explosives, Nitro-substitution Compounds.

539,029—May 14, 1895. M. W. BEYLIKGY. *Process of making alkaline bichromates.*

A double chromate of lime and the alkali formed by calcining a mixture of chrome ore, lime, and an oxygenated compound of the alkali metal, is lixiviated and the liquor passed through a filter saturated with an insoluble fatty acid, such as oleic acid, to remove the lime and leave the alkaline bicarbonate in solution. The lime is removed from the filter by dilute hydrochloric acid.

574,391—January 5, 1897. G. H. CLAMER. *Process of making bichromates.*

To make alkaline chromates, powdered chrome ore and an alkaline nitrate are fused together, cooled and powdered, then mixed with a caustic alkali and sufficient alkali nitrate to complete the oxidation of the ore, the caustic alkali and alkali nitrate being first fused together, and the powdered ore and nitrate gradually added to the fused mass with stirring.

599,197—February 15, 1898. S. P. SADTLER. *Process of making chromates.*

Bichromates or chromates are regenerated from waste liquors—as those of primary batteries—by neutralizing the free acid with milk of lime and oxidizing with bleaching powder. The solution may then be filtered, concentrated, and crystallized.

620,935—March 14, 1899. H. J. KREBS. *Method of recovering chromates from tan liquor.*

The dissolved impurities are first precipitated, as by caustic lime, and removed, and the chromic acid is then precipitated as a chromate of lead or barium. The dissolved lime may be precipitated as a sulphate, oxalate, or carbonate prior to filtration or decantation.

GROUP XIII—PAINTS, COLORS, AND VARNISHES.

PIGMENTS.

2,910—January 16, 1843. R. A. TILGHMAN. *Improvement in making chromic yellow.*

Carbonate of lead is mixed or ground in a solution of chromate or bichromate of potassa, or other soluble chromate or bichromate, the solution being in excess.

6,327—April 17, 1849. T. SCHWARTZ. *Improvement in the manufacture of paris green.*

A hot saturated solution is formed of white arsenic, and sodium carbonate, and blue vitriol is dissolved therein, the compound solution being then cooled with constant stirring in a shallow vat, and reduced to a homogeneous arsenite of copper. Strong vinegar is then added and the liquor cooled to 37° C., water being added to keep the sulphate of soda in solution. After successive settlings and stirrings the product is collected and dried. The vitriol may be dissolved with the arsenic instead of the soda.

62,097—February 12, 1867. P. H. VANDER WEYDE. *Improvement in the manufacture of white lead.*

See Group VII, Wood Distillation.

75,861—March 24, 1868. W. W. CHIPMAN. *Improvement in the manufacture of whiting and paris-white.*

Limestone is burned, slacked, and recarbonized with carbonic-acid gas.

87,270—February 23, 1869. A. LEYKAUF. *Improvement in the manufacture of colors.*

See Group XI, Dyestuffs, Artificial, Inorganic.

88,291—March 30, 1869. E. HARRSCH. *Improvement in the manufacture of colors and pigments.*

See Group XI, Dyestuffs, Artificial, Inorganic.

90,359—May 25, 1869. E. HARRSCH. *Improvement in the manufacture of colors.*

Ores of zinc are dissolved in nitric, nitro-muriatic, or muriatic acids, and the solution mixed with soluble salts of baryta, or carbonate of baryta, or the same of strontia, or lime, or equivalents. Colors are then precipitated with various reagents.

93,817—August 17, 1869. L. D. GALE AND I. M. CATTMAN. *Improvement in the manufacture of sugar of lead and acetic acid.*

See Group VII, Wood Distillation.

138,685—May 6, 1873. F. OSGOOD. *Improvement in treating zinc dross and skimmings for the manufacture of pigments.*

Oxide of zinc or other pigments are produced from galvanizing dross or skimmings, by roasting at a nonfluxing heat, mixing with coal and subjecting to heat with a blast of air.

292,119—January 15, 1884. J. K. KESSLER. *Process of making white lead.*

See Group X, Electro-chemistry.

292,753—January 29, 1884. J. K. KESSLER. *Process of making sponge-lead.*

See Group X, Electro-chemistry.

305,389—September 16, 1884. C. E. HORE. *Process of making chrome red.*

Chrome red is produced by boiling a mixture of sublimed lead, 500 pounds, a solution of 90 pounds of bichromate of potash, and an alkali, such as soda ash, 38 pounds. A deeper red is produced by doubling the quantity of bichromate and alkali.

305,390—September 16, 1884. C. E. HORE. *Process of making lemon chrome.*

Lemon chrome is produced by mixing sublimed lead with an acid, such as nitric acid, then adding bichromate or a neutral chromate of potash.

305,391—September 16, 1884. C. E. HORE. *Process of making chrome yellow.*

Sublimed lead is mixed with a solution of bichromate of potash, boiled, and the insoluble coloring matter separated from the soluble products.

414,935—November 12, 1889. T. D. BOTTOME. *Manufacture of white lead.*

See Group X, Electro-chemistry.

431,026—July 1, 1890. M. ALSBERG. *Process of manufacturing red lead.*

Lead nitrate is incorporated into the oxide or carbonate of lead and the mixture heated sufficiently high to drive off any contained water and then decompose the lead nitrate and produce minium.

442,661—December 16, 1890. T. D. BOTTOME. *Process of desilverizing lead by electrolysis.*

See Group X, Electro-chemistry.

451,487—May 5, 1891. J. C. JESSUP. *Process of making paris green.*

A solution of sulphate of copper is first prepared by subjecting copper residue, or other crude material containing copper, to the action of sulphuric acid, and the proper quantities of arsenite of soda and acetic acid are then introduced directly into the solution.

457,028—August 4, 1891. F. W. IHNE. *Process of making chrome yellow.*

Pulverized galena is dissolved with nitric acid, the sulphur removed, and a solution of bichromate of potassa, neutral chromate of potassa or chromate of soda added, whereby chrome yellow is precipitated and a saltpeter-lye is formed, which is drawn off and condensed to form nitrate of potassium or saltpeter.

459,946—September 22, 1891. D. V. KYTE. *Manufacture of white lead.*

See Group X, Electro-chemistry.

477,733—June 28, 1892. J. BLAIR. *Process of making white pigments.*

See Group X, Electro-chemistry.

496,109—April 25, 1893. A. B. BROWNE. *Process of manufacturing white lead.*

See Group X, Electro-chemistry.

503,429—August 15, 1893. F. M. & C. H. M. LYTE. *Process of producing chlorine and purifying lead.*

See Group X, Electro-chemistry.

524,470—August 14, 1894. F. L. SLOCUM. *Process of making green oxid of chromium.*

A powdered chromate is moistened with hydrochloric acid and then 10 per cent of powdered carbon is mixed therewith and the mass again wet with hydrochloric acid and brought to a paste (an explosive mixture results if mixed dry), subjected to heat without air, and then further moistened with hydrochloric acid. The resultant chloride and any remaining chromate is dissolved out with boiling water.

538,998—May 7, 1895. A. B. BROWNE AND E. D. CHAPLIN. *Process of manufacturing chromate of lead.*

See Group X, Electro-chemistry.

554,718—February 18, 1896. R. McKENZIE. *Process of producing lakes or coloring compounds by electrolysis.*

See Group X, Electro-chemistry.

555,232—February 25, 1896. A. B. BROWNE AND E. D. CHAPLIN. *Process of manufacturing white lead by electrolysis.*

See Group X, Electro-chemistry.

560,518—May 19, 1896. J. METRUEIS. *Treatment of sodium chloride.*

See Group X, Electro-chemistry.

563,553—July 7, 1896. A. B. BROWNE AND E. D. CHAPLIN. *Process of manufacturing white lead.*

See Group X, Electro-chemistry.

563,554—July 7, 1896. A. B. BROWNE AND E. D. CHAPLIN. *Process of manufacturing oxids of lead.*

See Group X, Electro-chemistry.

563,555—July 7, 1896. A. B. BROWNE. *Manufacture of white lead.*

See Group X, Electro-chemistry.

588,883—August 24, 1897. P. G. SALOM. *Process of making litharge or protoxid of lead from lead ore.*

See Group X, Electro-chemistry.

589,801—September 7, 1897. H. C. WOLTERECK. *Process of manufacturing white lead.*

See Group X, Electro-chemistry.

602,872—April 26, 1898. J. W. RICHARDS AND C. W. ROEPPER. *Process of producing chemical compounds by electrolysis.*

See Group X, Electro-chemistry.

602,873—April 26, 1898. J. W. RICHARDS AND C. W. ROEPPER. *Process of electrolytically manufacturing metallic sulfids.*

See Group X, Electro-chemistry.

625,918—May 30, 1899. E. BAILEY, G. R. COX, AND W. T. HEY. *Process of and apparatus for producing white lead.*

See Group X, Electro-chemistry.

626,331—June 6, 1899. C. LUCKOW. *Process of producing neutral chromate of lead.*

See Group X, Electro-chemistry.

627,002—June 13, 1899. C. LUCKOW. *Process of producing white lead by means of electrolysis.*

See Group X, Electro-chemistry.

627,266—June 20, 1899. C. LUCKOW. *Process of producing acid chromate of lead.*

See Group X, Electro-chemistry.

631,939—August 29, 1899. H. C. WOLTERECK. *Process of manufacturing white lead or other pigments by electrolysis.*

See Group X, Electro-chemistry.

644,779—March 6, 1900. J. W. RICHARDS AND C. W. ROEPPER. *Process of manufacturing metallic carbonates by electrolysis.*

See Group X, Electro-chemistry.

651,306—June 12, 1900. E. A. G. STREET. *Production of chromium oxid.*

See Group X, Electro-chemistry.

PAINTS.

1,676—July 10, 1840. F. G. SPILSBURY, M. F. C. D. CORBAUX, AND A. S. BYRNE. *Improvement in the mode of applying distemper colors having albumen or gelatine for their vehicle, so as to render the same more durable, and preserving the same when not wanted for immediate use.*

Soluble vehicles, as gelatine or albumen, are used for paints, which vehicles, by an after application of chemical agents, as alum, are rendered insoluble in water. Soluble salts of zinc, manganese and lead are combined with gelatine to preserve it. Pigments may be prepared with resinous matters or wax dissolved in an alkaline lye or solution of borax. Vegetable products, as flour, may form the base mixed with pigments, the paint to be fixed after application with a solution of silicate of potassa or of soda.

2,252—September 11, 1841. J. RAND. *Improvement in preserving paints and other fluids.*

They are confined in closed metallic vessels constructed to collapse with slight pressure and force out the material.

10,714—April 20, 1886. A. KISSEL. *Hardening resins.*

See Group XV, Rubber and Rubber Substitutes.

197,453—November 20, 1877. J. F. WALTER, Jr. *Improvement in putting up calcimining materials.*

The liquid material, in a bottle, is placed within and surrounded by the pulverized pigment or body material.

200,228—February 12, 1878. G. I. STEVENS. *Improvement in distemper paints.*

The base, glue, and coloring pigment are ground together with as little water as possible, compressed into a cake, and dried; ready for use by the addition of water.

221,882—November 18, 1879. W. H. P. WEBB. *Improvement in paint for filling the seams of vessels.*

244,788—July 26, 1881. L. BECKERS. *Treating caoutchouc with hydrocarbon oils.*

See Group XV, Rubber and Rubber Substitutes.

A compound consisting of a quick-drying liquid-gum vehicle composed of resin and naphtha, combined with an earthy base, as red oxide of iron, and a hydraulic cement.

250,302—November 29, 1881. H. R. TOYE. *Process of preparing colors for ornamenting fabrics.*

Colors in the form of powders, for ornamenting fabrics, are produced by forming a pasty mixture of pulverized starch, powdered talc, and acid, adding colors to form the tint desired, drying by a moderate heat, and sifting or pulverzing.

391,927—October 30, 1888. J. A. TITZEL. *Rubber compound or mixture.*

See Group XV, Rubber and Rubber Substitutes.

VARNISHES.

146,587—January 13, 1874. P. FINDLEY. *Improvement in the preparation and treatment of india-rubber varnish.*

See Group XV, Rubber and Rubber Substitutes.

501,578—July 18, 1893. H. PFANNE. *Method of manufacturing varnish and apparatus therefor.*

See Group X, Electro-chemistry.

GROUP XIV—EXPLOSIVES.

GUNPOWDER, INCLUDING BLASTING POWDER.

669—April 2, 1838. R. I. L. WITTY. *Improvement in the manufacture of gunpowder.*

Bituminous coal is used in the place of charcoal, with sulphur and niter.

8,734—February 17, 1852. E. CALLOW. *Improvement in explosive compounds.*

The compound consists of 5 parts of chlorate or oxymuriate of potash, 2 parts of orpiment or red sulphuret of arsenic, and 1 part of ferrocyanuret or prussiate of potash.

10,260—November 22, 1853. W. SILVER, Jr. *Improvement in blasting powder.*

Unglazed powder, composed of charcoal, niter, and sulphur, is treated with potassium chlorate, as by moistening the granulated powder with a saturated solution and drying.

15,257—July 1, 1856. W. SILVER, Jr. *Improvement in blasting powder.*

The explosive compound consists of rags or paper saturated and coated with a mixture of gunpowder, potassium chlorate, and powdered calcined cork.

15,551—August 19, 1856. L. BUCHHOLTZ. *Improved blasting compound.*

A composition of saltpeter, 45 to 80 parts; charcoal, 20 to 10 parts; lycopodium, 20 to 5 parts; and white sugar, 15 to 5 parts.

16,580—February 10, 1857. E. B. DOBSON. *Improved gunpowder.*

Anthracite coal or coke, to prepare it for use in the manufacture of gunpowder, is ground to fine dust and exposed to the air, in a dry place, for twelve months.

17,291—May 12, 1857. A. MURTINEDDU. *Improved blasting powder.*

A composition of sulphur, 100 parts; saltpeter, 100 parts; sawdust, 50 parts; horse dung, 50 parts; and sodium chloride, 10 parts. Molasses, 4 parts, is added as a binder.

17,321—May 19, 1857. L. DU PONT. *Improvement in gunpowder.*

Sodium nitrate is used in the manufacture of gunpowder, which is glazed to prevent deliquescence, by rolling it in a barrel with black lead.

26,602—December 27, 1859. V. L. MAXWELL. *Improvement in the manufacture of gunpowder.*

Alcohol is employed, in the place of water, as the vehicle for uniting the particles.

32,016—April 9, 1861. W. R. THOMAS AND M. EMANUEL, Jr. *Improvement in compositions for blasting powder.*

A composition of sodium nitrate, 3½ pounds; flower of sulphur, 1½ pounds; ground bark, 4½ pounds; and water, 3 quarts. The composition is well dried.

33,069—August 20, 1861. J. H. BROWN. *Improvement in preparation of granulated gunpowder to serve as charges for firearms.*

A charge is made by combining and pressing grains of gunpowder with an adhesive solution into a solid form.

34,233—January 28, 1862. T. K. ANDERSON. *Improved composition for fuse or slow match for igniting powder under water.*

A compound consisting of niter, 8 parts; charcoal, 10 parts; sulphur, 2 parts; and sodium chloride, 1 part.

34,654—March 11, 1862. W. R. THOMAS AND M. EMANUEL, Jr. *Improved blasting powder.*

Potassium chlorate (2 pounds) is added to the composition of No. 32,016.

34,724—March 18, 1862. R. O. DOREMUS AND B. L. BUDD. *Improvement in treating gunpowder to form cartridges.*

Granulated gunpowder is compressed dry into solid shapes suitable for use as cartridges in molds. A cartridge of powder in strata of different degrees of combustibility is formed by introducing the powder into the mold in successive portions, and successively applying a diminished amount of pressure.

36,599—October 7, 1862. H. BIEBUYCK. *Improved blasting powder.*

Barium nitrate is employed in the manufacture of blasting powder, with or without potassium nitrate.

37,117—December 9, 1862. W. R. THOMAS AND M. EMANUEL, Jr. *Improved composition for blasting powder.*

A composition of sodium nitrate, sulphur, potassium chlorate, starch, and ground bark, or other absorbent carbonaceous material.

37,296—January 6, 1863. H. LEIBERT. *Improved composition for gunpowder.*

A mixture of prussiate of potash, 2 pounds; chlorate of potash, 1 pound; sodium nitrate or its equivalent, 10 pounds; sawdust or charcoal, 4 pounds; sulphate of soda, 1 pound; and sulphur, 4 pounds.

40,070—September 22, 1863. G. B. WIESTLING. *Improved gun and blasting powder.*

A composition of charcoal, sulphur, sodium nitrate, and potassium chlorate, either with or without potassium nitrate.

41,576—February 9, 1864. E. HARRISON. *Improved composition for gunpowder, etc.*

A mixture of ordinary gunpowder, 12½ parts, and amorphous phosphorus, 1 part.

41,578—February 9, 1864. E. HARRISON. *Improved explosive composition.*

A compound of potassium chlorate, charcoal, prussiate of potash, and flour starch, with or without cyanuret of zinc.

42,037—March 22, 1864. H. HOCHSTÄTTER. *Improved gunpowder, mining powder, etc.*

A composition of charcoal, potassium chlorate, half-calcined sea grass, stone coal, and sawdust, or certain named substitutes, is formed in boiling water and dried; or mixtures of wheat flour and potassium chlorate, and stone coal and charcoal, are made in mortars, intermixed in water, pressed into blocks, rubbed through a sieve and dried.

42,056—March 22, 1864. C. M. WETHERILL. *Improvement in gunpowder, etc.*

A mixture of a suitable oxygen compound of chlorine with carbonaceous material is to be used in the proportion of 8 to 16 parts by weight of the former to 6 parts of the latter, to form either carbonic oxide or carbonic acid or a mixture of the said gases. Dextrine or other gum is to be added to form a grained powder. Peroxide of manganese facilitates the liberation of oxygen from the chlorates, and oil of vitriol is designed to act on the chlorine compound, by appropriate means, to effect the explosion of the powder in shells as on striking an object.

42,869—May 24, 1864. M. NOWAK. *Improved blasting compound.*

A composition of manganese binoxide, 23 grams (or carbon 15 grams instead); potassium chlorate, 62 grams; potassium nitrate, 31 grams; and potassium ferrocyanide, 15 grams; applied to any vegetable material, as paper, cotton waste, or sawdust.

42,913—May 24, 1864. F. A. JAECKEL. *Improved blasting powder.*

It consists of potassium nitrate, sodium nitrate, sulphur, charcoal, mineral coal, and potassio-tartrate of soda.

43,021—June 7, 1864. H. HALVORSON. *Improved explosive compound.*

An organic sulphide and a cyanide or ferrocyanide is combined with an organic deflagrating ammoniacal salt and a chloric or perchloric salts of potassa and ammonia.

44,269—September 13, 1864. H. E. DRAYSON. *Improvement in the manufacture of gunpowder.*

The saltpeter is treated to the direct and quick action of a heavy volume of steam until it is dissolved, when the sulphur and charcoal are added and thoroughly mixed, when it is ready for the incorporating mill. The mill cake, after manipulation in the incorporating mill, is passed through sieves before it becomes dry, set, or hard, and then dried and glazed.

46,275—February 7, 1865. W. G. BATES AND C. S. SMITH, EXECUTORS OF J. S. SMITH, DECEASED. *Improvement in drying and glazing gunpowder.*

Heat is applied to the drum or cylinder during the process of glazing to glaze and dry at one operation.

48,303—June 20, 1865. F. G. MURRAY. *Improvement in the manufacture of gunpowder.*

A compound of potassium chlorate, 45 parts; saltpeter, 15 parts; ground bark, 30 parts; charcoal, 8 parts; and lampblack, 2 parts; mixed in boiling water, evaporated, and dried.

50,104—September 26, 1865. L. DU PONT. *Improvement in plates for pressing gunpowder.*

The plates are made of hard or indurated rubber.

50,313—October 3, 1865. J. GALE, Jr. *Improved mode of keeping gunpowder.*

Gunpowder is mixed with a fine, dry, inexplosive powder, finer than the grains of the gunpowder. It is separated from the gunpowder, for use, by sifting or winnowing.

50,568—October 24, 1865. L. DU PONT. *Improvement in presses for pressing gunpowder.*

Powder dust is compressed into cakes by horizontally applied pressure.

55,795—June 19, 1866. L. H. G. EHRHARDT. *Improved gunpowder.*

A safety powder formed of mineral carbon, mixed with cutch, tannin, or gambier, to be mixed with a mixture of potassium chlorate and nitrate for use, in the proportion of five parts of the cutch mixture to three parts of the potassium mixture.

58,567—October 9, 1866. F. S. ALLEN. *Improvement in the manufacture of gunpowder.*

Paper or other fibrous material is saturated with an explosive compound, as a mixture of manganese binoxide, potassium chlorate, potassium nitrate, and potassium ferrocyanide, by boiling them together in a solution and evaporating the liquid wholly or partially.

58,656—October 9, 1866. H. S. LUCAS. *Improved blasting cartridge.*

A cartridge of solidly compressed gunpowder, with a central perforation extending partially or wholly through, for interior ignition.

61,659—January 29, 1867. W. & E. FEHLEISEN. *Improved blasting powder.*

It is composed of sawdust or other finely divided cellulose material, 9 parts; potassium nitrate, 45 parts; charcoal or carbon, 3 parts; and postassium ferrocyanide, 1 part.

61,957—February 12, 1867. C. SEIDEL. *Improved chemical composition for blasting rocks.*

A powder and fluid to be combined when used; the powder consisting of sulphuret of antimony, 1 part, and potassium chlorate, 2 parts; the fluid of phosphorus, 1 part, dissolved in bisulphuret of carbon, 4 parts. It is exploded by friction or a fuse.

66,378—July 2, 1867. G. A. NEUMEYER. *Improved powder for firearms and for blasting.*

Blasting powder is made of saltpeter, flower of sulphur and charcoal (from freshly cut wood), gunpowder of saltpeter, flower of sulphur and brown coal. The mixing is made with the addition of water, and the mass is subsequently dried.

70,359—October 29, 1867. A. T. RAND. *Improved compound for blasting powder.*

It consists of sodium nitrate, 60 parts, and charcoal, 40 parts.

71,004—November 19, 1867. E. E. HENDRICK. *Improved method of drying gunpowder.*

Gunpowder is dried by exposing it *in vacuo.*

73,786—January 28, 1868. L. H. G. EHRHARDT. *Improvement in gunpowder.*

A finely pulverized mixture of potassium chlorate, 1 part; potassium nitrate, 2 to 4 parts; and mineral coal, 3 to 5 parts.

76,133—March 31, 1868. E. H. ASHCROFT. *Improved compound for use in safes and powder magazines.*

Bicarbonate of soda, carbonates of ammonia, or other volatile salts, with or without a liquid acid, are placed in the inner compartments of safes and around the chambers of powder magazines, to develop incombustible gases, in case of undue heating.

79,010—June 16, 1868. F. M. RUSCHHAUPT. *Improved explosive powder.*

A mixture of chlorate of potassa, say 75 parts, and naphthalene 25 parts.

79,229—June 23, 1868. W. H. JACKSON. *Improvement in the manufacture of gun powder.*

A solution of potassium nitrate, or equivalent thereof, is mixed with a soluble vegetable extract, as of logwood or other soluble vegetable matter, and evaporated to dryness, with or without the addition of sulphur or pulverized charcoal.

80,004—July 14, 1868. P. A. OLIVER. *Improved powder for blasting and other purposes.*

A powder made from peat, instead of charcoal, with saltpeter, sulphur, and chlorate of potash.

81,670—August 25, 1868. G. A. NEUMEYER. *Improvement in the manufacture of gunpowder and blasting powder.*

A mixture of saltpeter, flowers of sulphur, and brown coal, or brown coal and charcoal, is made in the dry state, then ground in water for one and a half to two and a half hours, and grained and dried.

81,894—September 8, 1868. J. HAFENEGGER. *Improvement in explosive compounds.*

The powder may consist of mixtures of potassium chlorate, sulphur, and light charcoal; or potassium chlorate, white sugar, and potassium ferrocyanide; or potassium chlorate, powdered charcoal, sulphur or sugar, and potassium ferrocyanide; or potassium chlorate, sugar, charcoal, and sulphur. A self-igniting fluid therefor consists of 1 to 2 parts of phosphorus dissolved in 2 parts of bisulphuret of carbon, its effect being more or less instantaneous according to the degree of saturation.

85,482—December 29, 1868. W. SCHMITZ. *Improvement in explosive cartridges.*

A waterproof cartridge of special construction charged with a mixture of amorphous phosphorus, 1 part; potassium chlorate, 2 parts; gum arabic, 3 parts; and water, 1 part; which assumes a solidified form. The compound may be used for percussion caps.

85,576—January 5, 1869. L. H. G. EHRHARDT. *Improvement in the manufacture of gunpowder.*

A finely pulverized mixture of potassium chlorate with a vegetable extract, such as cutch, gambier, logwood, or of tannin.

86,980—February 16, 1869. E. GOMEZ. *Improved explosive compound.*

A solution of sugar of lead is added to a solution of prussiate of potash, and the ferrocyanide deposited; also a nitrate of iron is prepared with 2 pounds of nitric acid and 1 pound of iron in 1 gallon of water. The substances are mixed in the proportion of 1 pound of nitrate of iron to 3 pounds of ferrocyanide of potassium and the precipitate washed and dried and mixed with equal proportions of potassium chlorate.

87,382—March 2, 1869. P. H. VANDER WEYDE. *Improved application of Grahamite in the manufacture of gunpowder and lampblack.*

Grahamite is used as an ingredient in the manufacture of gunpowder; also for the production of lampblack, chlorine gas being introduced into the furnace.

88,171—March 23, 1869. W. H. JACKSON. *Improved powder for blasting and other purposes.*

Vegetable fiber, as tan bark, saturated with a niter salt or a chlorine salt in water, is combined with gunpowder or other explosive compounds.

97,566—December 19, 1869. T. TAYLOR. *Improved explosive compound for use in firearms, blasting, etc.*

A mixture of potassium chlorate and the yellow prussiate of potash with paraffine, say, in equal parts of the potash compounds with one thirty-second part by weight of paraffine.

97,567—December 7, 1869. T. TAYLOR. *Improved gunpowder.*

Paraffine is mixed with ordinary gunpowder in all proportions.

110,355—December 20, 1870. J. HAFENEGGER. *Improvement in explosive compounds.*

Fatty or oily substances, as Venice turpentine, are mixed with explosive compounds to prevent spontaneous explosion.

111,642—February 7, 1871. J. HAFENEGGER. *Improvement in explosive compounds.*

A mineral oxide, as an oxide of lead or manganese, and oily, fatty, or resinous substances are mixed with explosive compounds.

118,040—August 15, 1871. A. MOLFINO. *Improvement in gunpowders.*

It is composed of potassium chlorate, 772 parts; wheat starch, 228 parts, and charcoal, 150 parts.

120,862—November 14, 1871. C. W. CURTIS. *Improvement in the manufacture of gunpowder.*

The grains of "pellet" powder, for heavy ordnance, are split into halves, and afterwards stoved and glazed, thereby presenting one rough face.

122,245—December 26, 1871. E. GOMEZ. *Improvement in explosive compounds.*

Acetate of lead is mixed with prussiate of potash and the ferrocyanide deposit in a dry state is mixed with chlorate of potash; mucilage or other adhesive material may be added.

130,123—August 6, 1872. C. F. FUCHS AND A. CLEMENT. *Improvement in gun and blasting powders.*

A compound of potassium chlorate and ground tortoise or turtle shell, in addition to saltpeter, sulphur, and charcoal.

133,522—December 3, 1872. L. & E. DU PONT. *Improvement in the manufacture of gunpowder.*

Dampened powder is compressed in sheets between ribbed plates, to form indented lines, by which the cake is broken into uniform shapes or sizes.

145,149—December 2, 1873. F. BURNEY. (*Reissue: 5,773—February 24, 1874.*) *Improvement in the manufacture of gunpowder.*

Gunpowder is molded into pebbles or grains of large size by pressure between plates having cellular surfaces.

148,536—March 10, 1874. B. WEINER. *Improvement in the manufacture of gunpowder.*

Gunpowder, after mixture of the ingredients, in a dry state, is subjected to a sufficiently high temperature to liquefy the sulphur and agglutinate the mass.

150,543—May 5, 1874. J. H. DOLDE. *Improvement in explosive compounds.*

A mixture of prussiate of potash, white sugar, lime or soapstone, chlorate of potash, and tannin.

160,053—February 23, 1875. E. GREENE. *Improvement in the manufacture of gunpowder.*

The saltpeter or sodium nitrate is dissolved in hot water, and the other ingredients mixed with the heated solution, the heat being maintained during the mixing operation in a complete or partial vacuum.

161,325—March 30, 1875. R. CAHUC. (*Reissue: 6,601—August 17, 1875.*) *Improvement in explosive compounds.*

A mining powder, incombustible at low temperature and nonexplosive except when under pressure, produced by heating potassium nitrate, carbon, and sulphur, in the presence of sawdust or tanning bark and a solution of sulphate of iron, till a homogeneous liquid mass is produced, then cooling and drying.

172,647—January 18, 1876. C. FELHOEN. *Improvement in explosive compounds.*

It consists of sodium nitrate, 36 parts; potassium carbonate. 3 parts; potassium nitrate, crude, 24 parts, and refined, 9 parts; sulphur, 15 parts; and charcoal, 13 parts; combined in a dry powder with granulation.

177,818—May 23, 1876. J. H. DOLDE. *Improvement in explosive compounds.*

A sporting powder consisting of potassium chlorate, 9 ounces; gall, 3 ounces; and yellow prussiate of potash, one-half ounce.

177,819—May 23, 1876. J. H. DOLDE. *Improvement in blasting powder.*

A compound of silica, potassium nitrate, potassium chlorate, sodium nitrate, water, sawdust, sugar, and tannin.

182,421—September 19, 1876. L. DE SOULAGES AND R. CAHUC. *Improvement in explosive compositions.*

Same as No. 161,325.

184,020—November 7, 1876. J. P. R. POCH. *Improvement in explosive compounds.*

A blasting compound of spent tan, wood sawdust, sodium nitrate, barium nitrate, charcoal, sulphur, and saltpeter.

186,211—January 16, 1877. A. E. MILTIMORE AND C. A. L. TOTTEN. *Improvement in compensating powder.*

The grains are made up of concentric layers of different explosive substances of varying force and expansive intensity.

188,124—March 6, 1877. J. GOETZ. *Improvement in explosive compounds.*

A dry gas-producing or explosive base is mixed with glucose, uncrystallizable sugar, or sirupy solution to prevent premature or accidental discharge.

199,723—January 29, 1878. T. T. S. LAIDLEY. *Improvement in powder for cannons.*

Gunpowder is formed in cubical grains with rounded angles and perforated centrally through two opposite sides.

200,272—February 12, 1878. S. J. FOWLER. *Improvement in explosive compounds.*

It consists of the combination of nitrate of ammonia and sulphate of soda with an explosive.

201,520—March 19, 1878. W. GRAHAM AND E. WARD. *Improvement in blasting powder.*

A mixture of yellow prussiate of potash, potassium chlorate, white sugar, and red lead.

210,192—November 26, 1878. P. M. GALLAHER, W. LLOYD, AND G. S. WALKER. *Improvement in blasting powder.*

A combination of nitrate of soda or potash, sulphur, charcoal, ground bark, and sulphate of iron and sulphate of copper.

212,726—February 25, 1879. W. MILLER. *Improvement in explosive compounds.*

A blasting powder composed of complementary mixtures of sodium nitrate, 35 parts; potassium nitrate, crude, 25 parts, and refined, 10 parts; and starch, 2 parts, constituting one mixture, and potassium bichromate, 3 parts; sulphur, 13 parts; and charcoal, 12 parts, constituting the other mixture.

218,762—August 19, 1879. A. MONNIER. (*Reissue: 9,173—April 27, 1880.*) *Explosive compound.*

Coal tar or other tarry matter is mixed with explosive compounds containing potassium chlorate to cushion and segregate the particles of chlorate. The potassium chlorate and other soluble ingredients are dissolved in water, the insoluble ingredients which absorb the soluble substances are added, the dissolved salts crystallized by evaporation and agitation, the mass ground, and the coal tar added with heating and kneading.

220,304—October 7, 1879. J. PATTISON. *Improvement in explosive compounds.*

An oleaginous flour or meal is combined with an explosive compound having for its base chlorate of potash to prevent premature and spontaneous explosion.

220,534—October 14, 1879. O. B. HARDY. *Improvement in blasting powder.*

It is composed of crude nitrate of soda, 75 pounds; sulphur, 20 pounds; charcoal, 20 pounds; common salt, 10 pounds; sugar, 5 pounds; and paraffine, 3 pounds.

222,169—December 2, 1879. E. J. WILLIAMS. *Improvement in explosive compounds.*

It consists of potassium chlorate, 3 pounds; prussiate of potash, 1 pound; bichromate of potash, 2 ounces; nutgalls, 5 ounces; cannel coal, 2 ounces; starch, 6 ounces; and crude coal oil, 5 ounces.

241,165—May 10, 1881. T. P. SLEEPER. *Blasting powder.*

It consists of potassium chlorate, 8 parts; sugar, 7 parts; and charcoal, 1 part.

268,518—December 5, 1882. C. F MOHRIG. *Explosive compound.*

It consists of potassium chlorate, 50 to 70 parts; sugar, 12 to 15 parts; charcoal, 5 parts; black oxide of manganese, 5 parts; metallic zinc, 10 to 20 parts; water and wax, 10 parts.

273,209—February 27, 1883. N. WIARD. *Manufacture of gunpowder*

It is formed in perforated pellets or grains with tapering perforations, the exterior surface being of greater density than its interior surface.

281,565—July 17, 1883. M. E. SANLAVILLE AND R. LALIGANT. *Manufacture of explosive compounds.*

A composition consisting of carbonaceous matter, alkaline chlorate and nitrate, alkaline bisulphate, and glycerine.

289,756—December 4, 1883. S. R. DIVINE. *Explosive compound*

It consists of a solid ingredient, as potassium chlorate, about 7½ parts, and a liquid ingredient, as the heavy oil of coal tar (dead oil), 1 part; mechanically united.

289,760—December 4, 1883. S. R. DIVINE. *Explosive compound.*

It consists of potassium chlorate, about 8½ parts and turpentine, 1 part; mechanically mixed.

289,762—December 4, 1883. S. R. DIVINE. *Explosive compound.*

From 1 to 3 per cent of sulphur is combined with the moist mass of No. 289,756 (potassium chlorate and dead oil).

289,765—December 4, 1883. S. R. DIVINE. *Composition for preparing explosive compounds.*

A fluid mixture constituting the liquid ingredient of an explosive consists of the liquid ingredient of the explosive—as dead oil—and a volatile fluid, such as bisulphide of carbon having finely divided sulphur dissolved in the volatile fluid.

312,010—February 10, 1885. R. S. PENNIMAN. *Protected nitrate of ammonia for use in explosive compounds.*

Granulated or finely divided nitrate of ammonia is protected against deliquescence by a coating of petroleum or its soft and viscous products.

314,824—March 31, 1885. A. GACON. *Blasting powder.*

A mixture of nitrate of potash (or soda), 69 parts; flowers of sulphur, 19 parts; ashes, 12 parts; and tannin, 2 parts; all by weight.

320,583—June 23, 1885. R. S. PENNIMAN. *Explosive compound.*

A high explosive consisting of nitrate of ammonia coated with petroleum or its soft products—No. 312,010—combined with potassium chlorate as a detonator.

333,152—December 29, 1885. R. S. PENNIMAN. *Explosive compound.*

It is composed of protected grains of nitrate of ammonia—No. 312,010—and grains of potassium chlorate mixed with a dry powdered material—as carbonate of magnesia—to prevent the latter from caking.

352,611—November 16, 1886. E. DU PONT. *Explosive compound.*

It consists of a nitrate and sulphur combined with charcoal retaining its fibrous structure (baked wood).

362,899—May 10, 1887. T. NORDENFELT AND V. A. MEURLING. *Manufacture of gunpowder.*

Sulphur is incorporated with carbonaceous matter, by dissolving the sulphur in bisulphide of carbon, impregnating the carbonaceous matter with the solution, and evaporating the bisulphide. It is then impregnated with saltpeter or equivalent salt in solution, and the solvent evaporated. Cotton or other vegetable fiber is treated with hydrochloric acid (gaseous or liquid) to obtain carbonaceous matter.

363,887—May 31, 1887. E. DU PONT. *Explosive compound.*

A compound of a nitrate, sulphur, charcoal retaining its fibrous structure, and a carbohydrate, as sugar.

370,025—September 13, 1887. K. J. SUNDSTRÖM. *Blasting powder.*

A mixture of sodium nitrate, say 370 parts; wood tar, 70 parts; resin, 38 parts; and sulphur, 50 parts; produced by moistening the nitrate with a solution of the wood tar and resin, and then mixing with the coated nitrate a solution of the sulphur in a volatile solvent, as bisulphide of carbon.

374,740—December 13, 1887. L. G HEUSSCHEN *Explosive compound.*

It consists of coal oil and glycerine, together with potassium or sodium nitrate, sulphate of iron and sulphuric acid, carbonaceous matter and sulphur.

376,849—January 24, 1888. C. E. BICHEL. *Manufacture of explosives*

Sulphur and a hydrocarbon are distilled in the presence of one another, and potassium nitrate, or equivalent oxygen-bearing substance, is added to the resultant body.

381,507—April 17, 1888. C. J. OLDS. *Gunpowder.*

It consists of carbonized peas, combined with saltpeter, sulphur, and charcoal from willow or other trees.

393,634—November 27, 1888. A. FAVIER. *Explosive and method of making same.*

An explosive consisting of a highly compressed intermixture of a nitrate and a hydrocarbon, produced by mixing a pulverized nitrate, as ammonium nitrate, and a waterproof hydrocarbon fusible at a low temperature, and agglomerating the mixture under high pressure.

397,095—January 29, 1889. R. SJOBERG. *Blasting compound.*

It consists of ammonium oxalate, a nonnitrated hydrocarbon, as naphthalene, and potassium chlorate, with or without a liquid nonvolatile hydrocarbon, as astral oil.

418,635—December 31, 1889. A. F. WOODS. *Gunpowder.*

A mixture of potassium chlorate, 4 parts; yellow prussiate of potash, 1 part; and a carbohydrate, such as sugar, 1 part.

448,361—March 17, 1891. R. S. PENNIMAN. *Process of manufacturing nitrate of ammonia.*

Protected nitrate of ammonia is produced by mixing the protecting medium with the nitrate while in a melted condition, cooling, and graining by agitation. Nitric acid is mixed with ammoniacal liquor, settled, and concentrated by evaporating the main portion of the water, dehydrated, and then mixed, while in its initially melted condition, with the grain-protecting medium.

474,529—May 10, 1892. F. ROLLER. *Manufacture of explosives.*

A compound consisting of nitrate grains coated with colophony, with or without a solid, fatty substance, such as spermaceti, and an oil in which the colophony is dissolved, such as cottonseed oil.

483,125—September 27, 1892. F. AUCHMAN. *Blasting-powder.*

It consists of malt germs or cooms, ammonium nitrate, and potassium chlorate.

512,042—January 2, 1894. H. MAXIM. *Process of making chlorate blasting-powder.*

Potassium chlorate and sodium, or potassium nitrate, are combined in a state of fusion and reduced to a fine state of division prior to the admixture of combustible elements. The oxygen-bearing salt is first fused and the potassium chlorate then added.

542,723—July 16, 1895. F. G. A. BROBERG. *Blasting-powder.*

A free running powder consisting of particles of nitrate of soda coated with a mixture of resin and sulphur; produced by adding dry pulverized nitrate of soda to melted sulphur and resin and agitating the mixture.

546,552—September 17, 1895. B. C. PETTINGELL. *Blasting-powder.*

Process of manufacture consists in first immersing the powdered carbon singly and alone in an aqueous solution of niter, and afterwards adding and mechanically mixing the other ingredients, as sulphur and woodpulp.

565,593—August 11, 1896. M. BIELEFELDT. *Safety explosive.*

Formed of from 90 to 92 parts of ammonium nitrate, 5 parts of resin, and from 3 to 5 parts of a chromium compound, such as chromous hydroxid.

593,568—November 16, 1897. H. R. VON DAHMEN. *Blasting powder.*

It is composed of ammonium nitrate, phenanthrene, and potassium bichromate; produces a low explosion temperature.

598,096—February 1, 1898. T. IEVLEY. *Explosive.*

A compound consisting of potassium chlorate; a metallic oxid or oxides, as sesquioxid of iron and oxid of manganese; petroleum, and turpentine; with or without a moderator, such as an oil of the fatty-acid series, as oil of almonds.

608,316—August 2, 1898. G. BENEKE. *Explosive and method of making same.*

A compound of ammonium nitrate, resin, and an alkaline carbonate, with or without an oxidizing material such as alkaline chromate; produced by incorporating the alkaline carbonate (and the oxidizing material) with the resin when the latter is in a liquid state, cooling and pulverizing, and then incorporating with the ammonium nitrate.

647,606—April 17, 1900. R. S. PENNIMAN AND J. C. SCHRADER. *Resinous dope and method of making same.*

Vulcanized resin, adapted for use in explosive-compound dopes, produced by mixing resin and sulphur, highly heating for vulcanizing the resin, then cooling, breaking up, and pulverizing.

650,225—May 22, 1900. M. BIELEFELDT. *Explosive.*

A compressed mixture of sodium nitrate, potassium nitrate, sulphur, coal tar, and potassium bichromate, the proportion of sodium nitrate being greater than the aggregate of the other ingredients.

655,832—August 14, 1900. J. ROSS AND W. D. CAIRNEY. *Blasting powder.*

A mixture of potassium chlorate, 75 per cent; black oxide of manganese, 6 per cent; charcoal, 6 per cent; wax, 9 per cent; and vaseline, 4 per cent. Process of manufacture consists in granulating the potassium chlorate, mixing therewith the granulated charcoal and black oxide of manganese, then mixing in the wax, and heating until moist with the melted wax, then adding the vaseline to fill all crevices and supplement the coating.

656,048—August 14, 1900. J. ROSS AND W. D. CAIRNEY. *Explosive and process of making same.*

A mixture of potassium chlorate, 87 per cent; charcoal, 3 per cent; wax, 7 per cent; and vaseline, 3 per cent; the process being the same as No. 655,832.

656,678—August 28, 1900. J. A. STRANSKY. *Smokeless powder.*

A compound of potassium chlorate, 20 ounces; sugar, 16 ounces; alum, 1 dram; sulphur, 1 dram; and alcohol.

NITROGLYCERINE.

50,617—October 24, 1865. A. NOBEL. (*Reissues: Div. A, 3,377—April 13, 1869; 4,815, March 19, 1872; 5,621, October 21, 1873; 5,798, March 17, 1874. Div. B, 3,378—April 13, 1869; 4,816, March 19, 1872; 5,620, October 21, 1873; 5,800, March 17, 1874. Div. C, 3,379—April 13, 1869; 4,817, March 19, 1872. Div. D, 3,380—April 13, 1869; 4,818, March 19, 1872.*) *Improved substitute for gunpowder.*

Nitroglycerine is exploded, throughout its entire mass, by confining same and subjecting it to excessive pressure, or to an impulse of explosion, as by means of an auxiliary explosive, an electric spark or heat, or other means.

It is placed either within or around an exploding charge or igniter.

In the manufacture of nitroglycerine streams of acids and of glycerine are poured together into a mixing tube and discharged into water maintained at a low temperature.

57,175—August 14, 1866. A. NOBEL. (*Reissues: A 2,537—April 2, 1867, product; B 2,538—April 2, 1867, process; B, Div. 1, 3,381—April 13, 1869, process; B, Div. 2, 3,382—April 13, 1869, apparatus.*) *Improved explosive compound.*

Nitrine or crystallizing nitroglycerine, produced by the admixture of glycerine, sulphuric acid, and nitric acid, free, or nearly free, from hyponitric acid.

60,573—December 18, 1866. T. P. SHAFFNER. *Improvement in methods of blasting with nitroleum.*

The nitroglycerine may be mixed with sand, for blasting; or the charge is poured into the hole, tamped with water, and fired with a tamping charge near the top; or the water tamping may be omitted and the firing canister suspended near the top of the hole, with the blasting charge in the bottom, and space between, there being sand tamping above the former.

76,499—April 7, 1868. G. M. MOWBRAY. *Improvement in the manufacture of nitroglycerine.*

Compressed air, dried and cooled, is introduced during the process of manufacture, to preserve a low temperature, and convert any hyponitrous acid produced.

85,906—January 19, 1869. S. CHESTER AND O. BÜRSTENBINDER. *Improved method of preparing nitroglycerine.*

The ingredients are mixed under an atmosphere which will not support combustion, as carbonic-acid gas. The mixture is cooled by the ebullition of cool compressed carbonic-acid gas through it and caused to rotate by means of jets of escaping gas.

86,701—February 9, 1869. T. P. SHAFFNER. *Improvement in preserving nitroglycerine, etc.*

Water is placed in a vessel containing nitroglycerine for transportation or storage.

93,756—August 17, 1869. T. P. SHAFFNER. *Improvement in the manufacture of nitro-glycerine.*

A cold water jacketed tank is used, having curved agitating arms.

98,425—December 28, 1869. T. P. SHAFFNER. *Improvement in the manufacture of nitro-glycerine.*

It is washed and agitated by forcing water and air into it by means of a perforated pipe at the bottom of a tank.

98,426—December 28, 1869. T. P. SHAFFNER. *Improved process of preserving nitroleum and other explosive liquids.*

Sponge, or like elastic porous substance, is used to hold nitroglycerine in suspension for storage or transportation. It is released by immersing charged sponge in warm water—say 60° F.

112,848—March 21, 1871. E. A. L. ROBERTS. *Improvement in the manufacture of nitro-glycerine.*

The amount of sulphuric acid in the acid bath is gradually increased simultaneously with the pouring in of the glycerine. The proportionate amount of sulphuric acid used in the first instance is reduced.

112,849—March 21, 1871. E. A. L. ROBERTS. *Improvement in the manufacture of nitro-glycerine.*

The glycerine is introduced in a bath of mixed acids in which a rapid circulation of the fluid contents of the bath is maintained.

121,898—December 12, 1871. E. A. L. ROBERTS. *Improvement in the manufacture of nitro-glycerine.*

The acids and glycerine are mixed in a water-cooled tube so constructed as to produce the tumbling or cascading of the liquids within.

137,440—April 1, 1873. A. HAMAR. *Impovement in the manufacture of nitro-glycerine.*

The acid and glycerine flow through a trough and discharge upon a cooling-coil, into a solution of sodium chloride.

164,260—June 8, 1875. P. CASTELLANOS. *Improvement in the manufacture of nitro-sulphuric acid for manufacturing nitro-glycerine.*

See Group I, Mixed Acids.

164,261—June 8, 1875. P. CASTELLANOS. *Improvement in recovering acids from residuum of nitro-glycerine manufacture.*

See Group I, Mixed Acids.

226,867—April 27, 1880. F. MANN. *Process of manufacturing nitro-glycerine.*

Nitroglycerine is separated from its acid mother liquor by freezing the mixed acids and nitroglycerine and then separating the crystallized nitroglycerine by a centrifugal machine.

240,516—April 26, 1881. L. HINCKLEY. *Method of handling nitro-glycerine.*

Nitroglycerine is confined in closed vessels, tubes, cartridges, or shells under pressure, to render it nonexplosive by ordinary shocks or jars. It can be thus fired from a gun with ordinary gunpowder.

241,941—May 24, 1881. G. S. DEAN. *Method of preparing nitro-glycerine compounds.*

Nitroglycerine is mixed with a pulverulent nitro-compound and water (say 2 to 3 per cent of water) to increase the safety in handling and transportation.

262,769—August 15, 1882. W. N. HILL. *Process of and apparatus for the production of nitro-glycerine.*

Glycerine is mixed with a portion only of the acid, the reaction taking place with agitation by air or otherwise, then the partially converted mixture is passed into another and larger vessel, and the necessary quantity of acid added to complete the conversion.

413,070—October 15, 1889. E. LIEBERT. *Manufacture of explosives.*

Isoamyl nitrate is added to nitroglycerine, or a mixture of glycerine with isoamyl nitrate or isoamyl alcohol is nitrated, to lower the freezing point and make the nitroglycerine less sensitive to shocks.

432,336—July 15, 1890. S. D. SMOLIANINOFF. *Explosive compound.*

A mixture of nitroglycerine and an alcohol, as methyl alcohol, with or without an absorbent and a fulminate.

449,687—April 7, 1891. H. S. MAXIM. *Process of and apparatus for making explosives.*

The glycerine and the nitrating agent are separately atomized and then intermingled as spray, and the mixture quenched with water. Also claims for the apparatus.

457,002—August 4, 1891. E. K. MITTING. *Process of making nitro-glycerine.*

A charge of glycerine is nitrated, the spent acid drawn off and the product treated anew with a fresh charge of nitrating acid in excess, and finally the nitroglycerine separated from the fresh excess charge of acid, which is used to nitrate a second charge of glycerine, repeating the operation in the same nitrating vessel.

482,372—September 13, 1892. J. LAWRENCE. *Process of recovering nitro-glycerine from waste acids.*

The glycerine is nitrated and the nitroglycerine separated from the waste acids, then sulphuric acid may be added to the waste acids, and they are cooled to a temperature below the freezing point of nitroglycerine and above the freezing point of the acids, and the remaining nitroglycerine recovered.

CELLULOSE NITRATES AND OTHER ORGANIC NITRATES.

4,874—December 5, 1846. C. F. SCHÖNBEIN. *Improvement in preparation of cotton-wool and other substances as substitutes for gunpowder.*

Vegetable fibrous substances are treated with a mixture of nitric acid and sulphuric acid, or with pure nitric acid of greatest specific gravity. The explosive cotton may be impregnated with potassium nitrate or other chemical substitutes.

43,166—June 14, 1864. W. LENK. *Improved gun-cotton.*

Gun-cotton is produced by a process involving a specific series of steps, including, among others, the immersion of the gun-cotton in a solution of water-glass.

47,316—April 18, 1865. J. P. McLEAN. *Improvement in the manufacture of gun-cotton and lint.*

The fibers of the *Asclepias syriaca*, or milkweed, are used, either as fiber or in the form of yarn or fabric made thereof.

50,082—September 19, 1865. J. J. RÉVY. *Improvement in the manufacture of gun-cotton.*

The process calls for a specified series of steps, the acid mixture being formed of monhydrated nitric acid of a specific gravity not under 1.52 and monohydrated sulphuric acid of a specific gravity not under 1.84. It is spun into a lightly twisted yarn. The cotton yarn is boiled in a weak solution of water glass. The yarn is wound into the form of cartridges, or spun into ropes, woven into cloth, and then made up into cartridges.

50,083—September 19, 1865. J. J. RÉVY. *Improvement in the manufacture of gun cotton.*

The cotton is prepared by washing in an alkaline solution. In treating with acid, small and regular quantities are dipped in a considerable quantity of acid, fresh acid being added after each dipping to compensate for that removed. The acid is removed from the exterior of the fiber by saturating with water and treating in a centrifugal machine, and from the interior of the fiber by placing the fiber on perforated shelves and percolating water therethrough. Water glass is applied by means of a centrifugal machine, the solution being applied cool.

59,888—November 20, 1866. F. A. ABEL. *Improvement in the manufacture of gun-cotton.*

Gun-cotton is reduced to a pulp and consolidated, with or without pressure, into solid forms, with or without the admixture of binding materials. Soluble and insoluble gun-cotton may be combined, pulp mixed with fibrous cotton, and the compressed forms coated with soluble gun-cotton, or shellac.

60,571—December 18, 1866. T. P. SHAFFNER. *Improvement in the manufacture of gun-cotton.*

Saturation and washing are performed under pressure, to compel the fluids to thoroughly permeate the fiber.

93,757—August 17, 1869. T. P. SHAFFNER. *Improved method of blasting with gunpowder and other explosive substances.*

Non or partially explosive materials are interposed between the fibers of gun-cotton, grains of powder, or nitrated or explosive materials to spread the action of the gases.

124,510—March 12, 1872. R. PUNSHON. *Improvement in explosive compounds from gun-cotton.*

Sugar is mixed with gun-cotton; as by dissolving sugar equal to one-third of the weight of the cotton in a minimum quantity of boiling water, thoroughly mixing finely cut gun-cotton therewith, and drying.

128,450—June 25, 1872. J. B. MUSCHAMP. *Improvement in explosive substances and processes of manufacturing the same.*

Comminuted cellulose woody fiber, purified of sap and mineral salts by treatment in strong caustic soda under pressure and washed, is treated with the acid bath, washed, and steeped in an alkaline solution, washed, and dried; the first dip producing the strongest explosive. A second quantity of fiber is treated in the same bath (second dip) to produce a weaker explosive; and a third for a still weaker explosive. To retard the rapidity of explosion it is steeped in a solution of starch.

139,738—June 10, 1873. T. P. SHAFFNER. *Improvement in explosive compounds.*

Gun-cotton, or other nitrated fibrous substance, is combined with nitrated water, or liquids, or paraffine, or beeswax, or any oleaginous or resinous matter.

141,654—August 12, 1873. S. J. MACKIE. *Improvement in the manufacture of gun-cotton.*

Gun-cotton is crushed to destroy its capillary structure and reduce it to an impalpable mass, and then granulated. It is dried *in vacuo*.

143,865—October 21, 1873. H. T. ANTHONY. *Improvement in preparing soluble cotton for the manufacture of collodion.*

After the ordinary acid treatment and washing, soluble cotton is subjected to volatilized alkali, as ammonia, to remove traces of acid.

210,611—December 10, 1878. J. W. HYATT. *Improvement in apparatus and processes for the manufacture of nitro-cellulose.*

Soluble fiber is made from paper by successive steps of "disintegration" into minute flakes, "conversion" in an acid bath (with centrifugal and centripetal swirls); "desiccation" by drying in a centrifugal machine; and "ablution." Claims are made for the apparatus.

230,216—July 20, 1880. J. A. ARRAULT, J. AND C. SCHMERBER. *Process for manufacturing nitro-derivatives from cellulose, etc.*

Nitro derivatives are produced by treating the cellulose, starch, glucose, etc., with the fumes of nitric acid or nitric acid in a gaseous state.

238,916—March 15, 1881. F. C. KEIL. *Explosive compound.*

It is composed of nitroglucose (dextro-glucose made from starch) dissolved in a volatile solvent, such as alcohol, and mixed with potassium nitrate, potassium chlorate, and prepared vegetable fiber.

242,893—June 14, 1881. G. S. DEAN. *Process of making nitro-dextrine.*

Vegetable fiber is treated with dilute sulphuric acid, whereby its structure is destroyed and dextrination commenced, and afterwards it is nitrated with concentrated nitro-sulphuric acid.

244,575—July 19, 1881. C. A. FAURE AND G. TRENCH. *Explosive blasting material.*

It consists of intimately mixed carbonaceous and oxidizing materials in granular form, with finely divided nitrocellulose distributed around the granules.

249,490—November 15, 1881. C. W. VOLNEY. *Explosive compound.*

A mixture of monochlordinitrin or chlorpropenyldinitrate, and a nitrate of potassium, sodium, barium, or other suitable alkaline metal, in equivalent quantities to effect a mutual decomposition, with or without chlorates of the said metals, vegetable fiber, or charcoal.

251,145—December 20, 1881. G. VON PLANITZ. *Explosive compound.*

A base for explosives formed by the combination of nitric acid and resin, produced by spreading pulverized resin on a bath of nitric acid and water heated to the boiling point, and skimming off the resulting soft foamy product.

252,600—January 24, 1882. C. DITTMAR. *Explosive compound.*

"Chlornitrosaccharose," or nitro-sugar, produced by dissolving sucrose in chlorhydrin and then converting it into a nitro compound.

274,335—March 20, 1883. J. W. HYATT AND F. V. POOL. *Manufacture of pyroxyline.*

The fiber is treated with acid; the residual acid is then freed from matter in suspension by use of barium sulphate or otherwise, and the spent acid is analyzed and its strength restored according to the original formula.

276,833—May 1, 1883. A. J. LANFREY. *Manufacture of explosive compounds.*

An explosive compound consisting of nitrocellulose made from straw and oxidating substances, such as nitroglycerine, niter, or mixture of niter and carbonaceous matter. The straw is disintegrated, triturated, washed, treated with acid, washed, and disacidulated. It is formed into sheets or leaves and the paper converted into nitrocellulose.

299,857—June 3, 1884. E. SCHERING. *Preparation of collodion.*

Pure collodion cotton (free from acid) is dissolved in ether and alcohol, and distilled, after filtration, to an extent to permit of the mass being cast into forms It is nonexplosive.

304,861—September 2, 1884. J. SCHULHOF. *Explosive preparation made from gun-cotton.*

Gun-cotton is impregnated with fat, compressed, and coated with collodion.

306,519—October 14, 1884. F. V. POOL. *Manufacture of soluble nitro-cellulose.*

The strength of the spent acids is restored in bulk by introducing the proper quantity of a nitrate.

309,787—December 23, 1884. E. JUDSON. *Explosive compound.*

A mixture of nitrocellulose or other equivalent detonating or fulminating compound with a dope prepared by pulverizing, drying, and mixing sodium nitrate, 70 parts; and anthracite coal, 10 parts; and mixing same in a melted mixture of sulphur, 15 parts; resin, 3 parts; and asphalt, 2 parts; stirring and cooling the dope until the grains cease to adhere.

315,357—April 7, 1885. M. VON FÖRSTER. *Coating gun-cotton.*

Pure gun-cotton is compressed and then treated with a solvent, as ethylic acetate, which will dissolve part of the gun-cotton, and on drying leave a hard film or coating of gun-cotton.

333,872—January 5, 1886. M F. LINDSLEY. *Explosive compound.*

A mixture of nitrocellulose, 50 pounds; saltpeter, 38 pounds; charcoal, 5 pounds; potassium chlorate, 3 pounds; starch, 2 pounds; and potassium carbonate, 2 pounds.

336,822—February 23, 1886. F. V. POOL. *Art of manufacturing nitro-cellulose.*

In the manufacture of nitrocellulose a spent bath is restored and purified by introducing a suitable quantity of sulphuric acid and a nitrate, according to the requirements as shown by an analysis, and effecting the crystallization and removal of the resulting by-product.

340,276—April 20, 1886. M. BIELEFELDT. *Explosive compound.*

It consists of nitrocellulose, with or without nitroglycerine, with nitrate of ammonia in water of ammonia.

341,155—May 4, 1886. M. F. LINDSLEY. *Process of making explosive compounds.*

A mixture of wood fiber, charcoal, bituminous coal, and starch is formed into fine powder and then into grains, treated with acids, the free acid removed, and the grains then treated in a solution of potassium carbonate and saltpeter.

343,850—June 15, 1886. F. V. POOL. *Art of making nitro-cellulose.*

Spent acids are restored and purified by adding a suitable quantity of a nitrate, which is decomposed, the liberated nitric acid strengthening the bath, while the base forms, with sulphuric acid present, an insoluble compound which acts as a settling agent. Fresh sulphuric acid may be introduced with the nitrate or afterwards.

350,497—October 12, 1886. G. M. MOWBRAY. *Manufacture of pyroxyline*

The spent acid is restored in strength and bulk without precipitation and analysis by fortifying and adding to the drained spent acid of a previous nitration a mixture of concentrated sulphuric and nitric acids.

350,498—October 12, 1886. G. M. MOWBRAY *Manufacture of pyroxyline*

The use of steeled cast-iron pots is claimed for holding the mixed acids, and "Bessemer process steel" for tanks; also structural details of apparatus.

359,289—March 15, 1887. E. SCHULTZE. *Gunpowder.*

A composition of a nitro-hydrocarburet (such as nitro-colophony, tar, turpentine, or turpentine-oil), pyroxyline, and nitrates or salts furnishing oxygen in combination with nitrogen; as colophony, 12 parts pyroxyline, 60 to 80 parts; barium nitrate, 60 to 80 parts; and potassium nitrate, 8 to 10 parts.

363,197—May 17, 1887. R. BERNSTEIN. *Granular nitro-cellulose.*

Prepared from the pulverized nuts, fruits, or shells of nuts of the *Phytelephas macrocarpa*, or "vegetable ivory" and kindred plants, and forming smooth grains that pack without cohesion.

366,281—July 12, 1887. C. W. VOLNEY. *Explosive compound.*

A solution of nitro-starch in nitroglycerine; also the same with oxidants, as chlorates and nitrates.

371,376—October 11, 1887. H. SCHÖNEWEG *Explosive.*

Consisting in nitrated carburets of hydrogen and nitrated cellulose with an oxalate or oxalic acid.

417,577—December 17, 1889. J. F. A. MUMM. *Explosive compound*

A mixture of potassium chlorate, 1 pound; antimony, 8 ounces; charcoal, 1 ounce; flowers of sulphur, 2 ounces, glycerine, 1 ounce, collodion, 1 ounce; sulphuric acid, 4 drops; nitric acid, 2 drops; alcohol, 3 ounces; and water, 2 to 3 ounces.

420,445—February 4, 1890. J. R. FRANCE. *Soluble nitro-cellulose and process of manufacture.*

Soluble nitrocellulose composed of pure mechanically comminuted cotton fiber nitrated, produced by mechanically reducing cotton to a uniform and homogeneous dust-like condition and then treating with a bath of nitric and sulphuric acids, in the proportions, say, of nitric acid, 42° Baumé, 8 parts, and sulphuric acid, 66° Baumé, 12 parts.

420,446—February 4, 1890. J. R. FRANCE. *Insoluble nitrocellulose and preparing the same.*

Insoluble nitrocellulose consisting of pure mechanically comminuted cotton nitrated, produced by mechanically reducing cotton to a uniform homogeneous dust-like condition, treating it in a bath of nitric and sulphuric acids in the usual proportions and strength, at about 75° F., for about fifteen minutes, and pressing out the superabundant acids, and washing.

420,477—February 4, 1890. J. R. FRANCE. *Cotton-fiber dust and preparing the same.*

Mechanically comminuted cotton-fiber dust for the manufacture of nitrocellulose, produced by forming the cotton into a card or lap and cutting or otherwise reducing the fibers in their natural state to cotton dust by mechanical means.

430,215—June 17, 1890. H. S. MAXIM. *Recovering solvents from explosives.*

In the manufacture of explosive material, the dissolved material is exposed in receptacles in a drying chamber and a constant circulation of air or gas maintained through the drying chamber and a communicating condensing chamber, the air or gas being heated before entering the drying chamber.

434,287—August 12, 1890. G. M. MOWBRAY. *Process of manufacturing nitrocellulose.*

A continuous web of cellulose paper is moved through an acid bath, compressed, then through a washing fluid, dried, and a solvent is then distributed upon the continuously moving web, and it is formed into a roll to diffuse the solvent.

443,105—December 23, 1890. G. M. MOWBRAY. *Method of preparing nitrocellulose.*

Cellulose material, whether fibrous, felted, or textile, is impregnated by crystallizing a salt, preferably sodic nitrate, in the interstices of the material; the dry saline-impregnated cellulose material is then immersed in a bath of sulphuric and nitric acids, and then removed, washed, and dried.

454,281—June 16, 1891. H. S. MAXIM. *Method of making gun-cotton.*

Charges of cotton are treated in a given order in each of a series of acid vats, the excess of acid expressed from the cotton and returned to the vat from which it was taken, and as the acid in said vats becomes spent the weakest acid of the first vat of the series is replaced with fresh acid and the order of immersion changed in accordance with the relative strength of the acid in the several vats.

455,245—June 30, 1891. H. DE CHARDONNET. *Manufacture of pyroxyline.*

Process consists in the successive steps of nitration, centrifugal extraction of spent acids, washing of the pyroxyline, and neutralization of the wash water by an alkaline or basic material to recover the residue of nitric acid left in the pyroxyline by the centrifugal action, and reuse of the water with successive quantities of pyroxyline.

465,280—December 15, 1891. H. MAXIM. *Method of making nitrocellulose.*

Pyroxyline of a high grade is produced by immersing the cellulose for a short time in a bath of strong-acids mixture, then conveying said cellulose with contained acids (amounting to, say, six or more times the weight of cellulose) to a second bath containing many times the weight of the cellulose of a weaker acids mixture, and there completing the conversion by digesting for a considerable time.

474,778—May 10, 1892. H. MAXIM. *Process of making nitrocellulose.*

Cellulose is first converted into a lower nitro compound, such as dinitrocellulose, in a preliminary bath of suitable acids, the excess of acid removed by mechanical means and washing, then dried, and then immersed in a stronger bath of acids suitable to convert it into trinitrocellulose, or pyroxyline. The adhering strong acids are washed therefrom into the first bath by passing the weaker acids mixture through it and back into the bath.

479,988—August 2, 1892. H. MAXIM. *Method of restoring nitrating acids.*

A quantity of dry nitrate is added to the weakened mixture, the acid sulphate allowed to crystallize, the liquor is removed from the crystals by a centrifugal machine, and the crystals further washed by a portion of the weakened mixture.

487,080—November 29, 1892. J. V. SKOGLUND. *Explosive powder.*

It consists of dried grains of nitrated cellulose gelatinized by means of a solvent containing a fat or fatty acid, with or without saltpeter.

514,830—February 13, 1894. R. C. SCHÜPPHAUS. *Nitro compound and process of making same.*

A pyroxyline composition having urea incorporated therewith, to secure stability.

516,295—March 13, 1894. H. M. CHAPMAN. *Explosive.*

The combination with a nitro-explosive as an agglomerating agent of formic ether.

516,924—March 20, 1894. F. G. DU PONT. *Process of drying nitrocellulose.*

Wet nitrocellulose is placed in a hydrocarbon oil, as kerosene, and the oil vaporized, thereby removing the water from the fiber.

526,752—October 2, 1894. R. C. SCHÜPPHAUS. *Process of nitrating cellulose.*

The weakened acid bath is restored by adding sulphuric anhydrid and nitric acid; with oil of vitriol in certain cases.

541,899—July 2, 1895. B. THIEME. *Process of making nitropentaerythrit.*

Nitropentaerythrit, suitable for use as a smokeless explosive, is produced by treating pentaerythrit, which is produced by the condensation of acetyldehyde and formaldehyde in the presence of lime, with concentrated nitric and sulphuric acids.

544,924—August 20, 1895. H. MAXIM. *High explosive.*

An intimate mechanical mixture, in a fine state of division, of an explosive colloid of gun-cotton and nitroglycerine and wet fibrous gun-cotton; the latter may hold in suspension in its pores a solution of an oxygen bearing salt, such as nitrate of ammonia.

640,160—December 26, 1899. C. F. HENGST. *Explosive compound.*

Esparto grass is mechanically disintegrated, macerated in a sulphuric-acid and nitric-acid bath, the liquor expressed and the pulp washed, boiled in an aqueous solution of potassium bicarbonate, the product colored with hydrochloride of triamidoazobenzene, washed and strained, dried, ground with starch, charcoal, and potassium nitrate, dried, sifted, molded, and the grains waterproofed.

647,420—April 10, 1900. A. LUCK AND C. F. CROSS. *Process of increasing stability of nitrocellulose.*

The nitrocellulose is freed from the nitrating acid, treated with a solution of acetone and metallic salts and alcohol, and washed in successive washes to remove the acetone.

667,759—February 12, 1901. D. BACHRACH. *Nitrocellulose or similar substance and process of making same.*

A nitrocellulose containing a sulphate, as sulphate of lime, constituting 30 per cent or more by weight of the solid constituents of the compound, forming a noncombustible cellulose, may be formed by adding to the other constituents thereof carbonate of lime and sulphuric acid in proper proportions.

DYNAMITES.

78,317—May 26, 1868. A. NOBEL. (*Reissues: 5,619—October 21, 1873; 5,799—March 17, 1874; and 10,267—January 9, 1883.*) *Explosive compound.*

A combination of nitroglycerine with infusorial earth.

93,752—August 17, 1869. T. P. SHAFFNER. *Improved explosive compound for use in firearms, blasting, etc.*

Nitroglycerine is mixed with granulated plaster of paris.

93,753—August 17, 1869. T. P. SHAFFNER. *Improved explosive compound.*

A mixture of nitroglycerine with comminuted sponge or other vegetable fiber, with or without the admixture of plaster of paris.

93,754—August 17, 1869. T. P. SHAFFNER. *Improved explosive compound.*

Nitroglycerine is mixed with metallic powder, such as red lead, with or without an admixture of plaster of paris or any alkaline substance.

98,382—December 28, 1869. J. HORSLEY. *Improved nitro-glycerine compound for blasting.*

From 20 to 25 per cent of nitroglycerine is incorporated with a powdered mixture of Aleppo or other foreign gallnuts and potassium chlorate; or with galls, charcoal, and potassium chlorate; or galls, cream of tartar, and potassium chlorate; or galls, hard sugar, and potassium chlorate.

98,427—December 28, 1869. T. P. SCHAFFNER. *Improved explosive compound.*

Gun cotton is treated with nitroglycerine.

98,854—January 18, 1870. C. DITTMAR. *Improvement in explosive compounds.*

"Dualin," consisting of cellulose, nitrocellulose, nitro-starch, nitro-mannite, and nitroglycerine, mixed in different combinations, according to the strength desired.

99,069—January 25, 1870. C. DITTMAR. *Improved explosive agent, called "xyloglodine."*

It consists of glycerine-starch, or glycerine-cellulose, or glycerine-mannite, or glycerine-benzole, or analogous substances, treated with a mixture of nitric and sulphuric acids. It is a milky reddish or white fluid and may be mixed with cellulose or other porous substances.

120,776—November 7, 1871. E. A. L. ROBERTS. *Improvement in explosive compounds.*

Asbestos is combined with nitroglycerine, or other explosives, with or without infusorial earth or silica.

138,841—May 13, 1873. T. S. BEACH. *Improvement in explosive compounds.*

A compound formed of an alkaline nitrate, nitroglycerine or equivalent nitro-substitution product, wood-fiber or other material containing cellulose, and paraffine or equivalent wax-like material.

139,468—June 3, 1873. E. JUDSON. *Improvement in explosive compounds, or giant powder.*

A mixture of nitroglycerine with infusorial earth, sodium nitrate, resin and sulphur, or their equivalents.

139,746—June 10, 1873. T. VARNEY. *Improvement in explosive compounds.*

Dynamite is granulated while it is freezing or when frozen, and can then be used in its frozen state.

141,455—August 5, 1873. A. NOBEL. *Improvement in explosive compounds.*

A mixture of sodium nitrate and resin, or their equivalents, with or without sulphur, with nitroglycerine.

141,585—August 5, 1873. J. H. NORRBIN AND J. OHLSSON. *Improvement in explosive compounds.*

Nitrate or nitrite of ammonia is combined with a fulminate, as nitroglycerine.

146,530—January 20, 1874. W. N. HILL. *Improvement in blasting compounds or dynamites.*

A mixture of nitroglycerine and a silicious powder, prepared by precipitation from solutions of the silicates.

150,428—May 5, 1874. G. M. MOWBRAY. *Improvement in blasting powders.*

A mixture of nitroglycerine with finely divided mica.

153,086—July 14, 1874. C. L. KALMBACH. *Improvement in explosive compounds or dynamites.*

A mixture of a coarsely-ground farinaceous substance, such as corn meal, and nitroglycerine. Nitroglycerine is packed for shipment in nonmetallic vessels, holding, with the nitroglycerine, an equal amount in bulk of atmospheric air; when not in transit it is stored in perpendicular or flaring-sided nonmetallic open vessels, covered only with a film of water.

157,054—November 17, 1874. J. W. WILLARD. *Improvement in explosive compounds.*

It is composed of carbonate of magnesia, nitrate of potash, chlorate of potash, sugar, and nitroglycerine.

164,263—June 8, 1875. P. CASTELLANOS. *Improvement in explosive compounds.*

It consists of nitroglycerine, nitrobenzole, or benzine (to reduce the point of congelation), fibrous material, and pulverized earth.

164,264—June 8, 1875. P. CASTELLANOS. *Improvement in explosive compounds.*

It consists of nitroglycerine, potassium, or sodium nitrate, picrate, sulphur, carbon, and a salt insoluble and incombustible in nitroglycerine, such as the silicates of zinc, magnesia, and lime, carbonate of zinc, etc.

167,503—September 7, 1875. H. COURTEILLE. (*Reissue: 7,068—April 18, 1876.*) *Improvement in blasting powder.*

A safety blasting powder containing the elements of common gunpowder and also the uncombined elements of nitroglycerine; produced by treating the components of ordinary gunpowder in the presence of oleaginous or tarry matters, peat, and metallic sulphates.

173,961—February 22, 1876. W. F. JOHNSTON. *Improvement in explosive mixtures.*

An explosive containing salts which contain nitric acid and ammonia (as a mixture of sodium nitrate and ammonium sulphate), that by their decomposition at the time of the explosion will produce nitrate of ammonia; as a compound of salts containing nitric acid and ammonia, and a small percentage of gunpowder, nitroglycerine, or other common explosive, to produce a primary combustion.

175,735—April 4, 1876. A. NOBEL. *Improvement in gelatinated explosive compounds.*

Gelatinated nitroglycerine, produced by dissolving in nitroglycerine a substance capable of gelatinating it, such as nitrated cotton. The process is applicable to other explosive fluids, such as the nitrates of methyl and ethyl.

175,929—April 11, 1876. J. COAD. *Improvement in blasting compounds.*

A mixture of nitroglycerine and decayed wood.

177,988—May 30, 1876. C. G. BJORKMAN. *Improvement in explosive compounds.*

A mixture of potassium nitrate, 20 parts; potassium chlorate, 20 parts; cellulosa, 10 parts; pea-meal, 10 parts; sawdust, 10 parts; and nitroline, 30 parts.

183,764—October 31, 1876. E. JUDSON. (*Reissue: 7,481—January 30, 1877.*) *Improvement in explosive compositions.*

A powder consisting of particles or grains of a gas-producing material, rendered nonabsorbent by a coating of varnish or cement, as by mixing and stirring the sodium nitrate and the coal into a mixture of molten sulphur, resin, and asphalt, the powder then being rendered explosive by the admixture or incorporation of nitroglycerine.

184,762—November 28, 1876. C. DE LACY. *Improvement in explosive compositions.*

It consists of pyroxyline, sawdust, potassium nitrate and chlorate, and nitroleum. (Nitroleum is obtained by adding stearic oil mixed with honey, or coarse glycerine, to a mixture of nitric and sulphuric acids; the oleic mixture being removed, washed, and impregnated with soda.)

190,954—May 22, 1877. O. BÜRSTENBINDER. *Improvement in explosive compounds.*

Vegetable substances are inspissated with glycocole or chondrin and saltpeter, then soaked in nitroglycerine, and granulated and dried.

203,482—May 7, 1878. E. MONAKAY. *Improvement in explosive compounds.*

An explosive compound containing nitroglycerine and a liquid hydrocarbon, diluent, such as kerosene oil.

227,601—May 11, 1880. R. W. WARREN. *Explosive compound.*

It is composed of gunpowder mixed with a powder made of nitroglycerine, nitrocellulose, and trinitrocellulose, formed by first reducing nitrocellulose and nitroglycerine to a coagulated mass, then adding trinitrocellulose until a dry powder is produced, and finally combining therewith gunpowder.

234,489—November 16, 1880. C. A. MORSE. *Explosive compound.*

Nitroglycerine and a resinous or equivalent substance in a solid, granulated, or pulverized mass; produced by dissolving nitroglycerine and resin in a common solvent, as methyl alcohol, and then evaporating the solvent. The mass may be stirred during distillation to break down the mass and discharge it in a pulverized form.

235,871—December 28, 1880. W. HEICK. *Explosive compound.*

It is composed of honey and glycerine treated with nitric and sulphuric acid and then mixed with chlorate of potash, prepared sawdust, and prepared chalk.

236,714—January 18, 1881. C. A. MORSE. *Manufacture of explosive compounds.*

A compound composed of nitroglycerine, resinous substance, and oxidizing agents, as niter, produced as in No. 234,489, with the addition of the oxidizing agents to the solution.

242,788—June 14, 1881. J. M. LEWIS. *Explosive compound.*

"Forcite," a plastic gelatinized nitroglycerine compound, comprising an inexplosive gelatinizing material, such as cellulose (unnitrated), and an oxidizing salt, as niter, combined with nitroglycerine.

249,701—November 15, 1881. T. VARNEY. *Explosive compound.*

An absorbent for nitroglycerine is prepared by mingling with the fine particles of the powder a small proportion of a fusible, soluble, or paste-producing material, and causing the same to melt, dissolve, or become paste while in the mixture, so that each particle of such material becomes an adhesive nucleous to which the surrounding particles attach themselves, and are held in aggregations when hardened by cooling, drying, or crystallizing.

25[illegible]—January 10, 1882. W. R. QUINAN. *Blasting-powder.*

A high explosive composed of nitroglycerine, nitrocellulose, and potassium chlorate (or nitrate).

260,786—July 11, 1882. W. R. QUINAN. *Explosive powder.*

A low explosive, consisting of an untriturated nitrate—such as sodium nitrate—in the form of small masses or grains of determinate size, sulphur, pulverized or grained, carbonaceous material, either pulverized or in small nonporous grains of determinate size, the unpulverized ingredients remaining as separate grains, and a small proportion of nitroglycerine which forms a coating in contact with said small grains, whereby the surfaces of the ingredients are so limited in extent to retain the small proportion of nitroglycerine susceptible to detonation by the ordinary blasting-cap.

288,516—November 13, 1883. H. D. VAN CAMPEN. *Explosive compound.*

It consists of tan-bark, dextrine, cryolite, potassium, nitrate, and nitroglycerine.

289,759—December 4, 1883. S. R. DIVINE. *Explosive compound.*

It consists of a solid ingredient—potassium chlorate, 5 parts—and a liquid ingredient, consisting of a mixture of dead-oil and nitroglycerine (in the proportion of 2 to 1) 1 part, mechanically mixed.

300,281—June 10, 1884. W. R. QUINAN. *Explosive compound.*

A low-explosive powder composed of a small proportion of nitroglycerine, carbonaceous material, pulverized or in nonporous grains, and an explosive salt in the form of nonporous untriturated grains or crystals, the unpulverized ingredients remaining as separate grains in the mixture.

307,988—November 11, 1884. J. H. ROBERTSON. *Dynamite.*

A compound of an anhydrous salt and nitroglycerine, produced by expelling the water of crystallization from the salt, reducing it to a powder, and mixing with it nitroglycerine, whereby the latter takes the place of the water of crystallization and a granular compound is produced.

307,989—November 11, 1884. J. H. ROBERTSON. *Explosive compound.*

Anhydrous sodium sulphate is combined with nitroglycerine.

312,010—February 10, 1885. R. S. PENNIMAN. *Protected nitrate of ammonia for use in explosive compounds.*

Nitrate of ammonia in a finely divided or granulated condition is protected against deliquescence by a coating of petroleum or its soft and viscous educts or products.

323,088—July 28, 1885. R. W. WARREN. *Dynamite.*

A compound of nitroglycerine, sodium nitrate, and ground peat, with or without calcic hydrate.

333,149—December 29, 1885. R. S. PENNIMAN AND J. C. SCHRADER. *Dynamite.*

An explosive compound containing finely comminuted solid matter charged with nitroglycerine and protected grains of ammonium nitrate, the protecting coating being petroleum or its soft educts, as cosmoline, for which nitroglycerine has no affinity.

333,150—December 29, 1885. R. S. PENNIMAN AND J. C. SCHRADER. *Dynamite.*

An explosive compound composed of composite absorbent grains charged with nitroglycerine, and jacketed grains of an explosive salt.

333,151—December 29, 1885. R. S. PENNIMAN AND J. C. SCHRADER. *Gelatinated explosive.*

Composed of gelatinated nitroglycerine and grains of protected nitrate of ammonia.

333,544—December 29, 1885. J. C. SCHRADER. *Explosive compound.*

Porous-grained dope, embodying in each grain a cellular mass of sulphur and combustible or noncombustible matter (such as vegetable or woody fiber, coal, asbestus, furnace slag, or nitrates), produced, for example, by mixing wood pulp and finely ground sulphur, beating the mass until the sulphur is softened to an adhesive condition, cooling and graining.

333,545—December 29, 1885. J. C. SCHRADER. *Process of making explosive compounds.*

A dry-grained, free-running, high-explosive powder is produced by mixing with combustible ingredients, as wood pulp, powdered sulphur sufficient to adhesively control the mass when melted, heating, cooling, and graining into porous grains, and charging with the liquid explosive not greater than their capacity to receive and retain by capillary attraction.

333,546—December 29, 1885. J. C. SCHRADER. *Dynamite.*

A dry-grained explosive containing nitroglycerine housed and retained within hard cellular grains, composed in whole or in part of a cellular mass of sulphur and fibrous vegetable matter capable of resisting the softening influence of the liquid explosive.

333,547—December 29, 1885. J. C. SCHRADER. *Dynamite.*

An explosive compound containing nitroglycerine housed and retained within hard cellular grains composed in part of particles of solid carbonaceous matter held by a porous structure of suphur; formed, say, by heating a mixture of pulverized bituminous coal, sulphur, and sodium nitrate until the sulphur melts, cooling and graining.

333,548—December 29, 1885. J. C. SCHRADER. *Dynamite and process of making the same.*

A low-grade, dry-grained, free-running powder composed of absorbent grains charged with nitroglycerine and dry combustible uncharged grains.

335,006—January 26, 1886. C. W. A. ZADEK. *Explosive compound.*

A mixture of resinate of calcium or magnesium with trinitro-glycerine.

347,424—August 17, 1886. M. EISSLER. *Dynamite.*

It comprises coated nonabsorbent granules of nitrate salts, nitrocellulose and nitroglycerine, first chemically amalgamated, and rye flour as a binding agent.

354,345—December 14, 1886. T. PRICE. *Composition for neutralizing fumes of explosives.*

It consists of carbonate of ammonia, urate of ammonia, lime, and sulphate of iron, in equal proportions.

372,330—November 1, 1887. S. D. SMOLIANINOFF. *Dynamite.*

A combination of asbestos, potassium nitrate and potassium chloride, and nitroglycerine.

382,229—May 1, 1888. J. W. GRAYDON. *Explosive charge.*

It consists of a number of rounded pellets, each made of a small portion of explosive inclosed in a flexible envelope impervious to nitroglycerine.

383,420—May 22, 1888. C. W. VOLNEY. *Explosive compound.*

A mixture of charcoal and an oxidant, as sodium nitrate, combined with starch, and forming an absorbent granular powder, with nitroglycerine absorbed by the powder, the granules retaining their granular form.

397,285—February 5, 1889. G. E. F. GRÜNE. *Preparing dynamite.*

Kieselguhr (infusorial earth) is pressed into the form of cartridges, carbonized by heating to a red heat, either with or without the admixture of vegetable or animal carbon, and saturated with nitroglycerine. Water will not expel the nitroglycerine.

398,559—February 26, 1889. J. WAFFEN. *Dynamite.*

It consists of sodium nitrate, 22.5 parts; decayed wood, 36 parts; picric acid, 0.25 part; sulphur, 1 part and carbonate of soda, 0.25 part; combined with 40 per cent of nitroglycerine prepared with collodion.

420,626—February 4, 1890. E. JUDSON. *Dynamite.*

A protected powder consisting of a base of nitrate or equivalent gas-producing material, with the grains coated with a paste of barley meal combined with nitroglycerine.

427,679—May 13, 1890. P. GERMAIN. *Dynamite.*

Spongy cellular vegetable tissue, as pith, is compressed and used as an absorbent for nitroglycerine or other liquid explosive; it may be cut into small pieces.

437,499—September 30, 1890. D. MINDELEFF. *Explosive compound.*

A combination of nitro-glycerine, an alcohol, as methyl alcohol, and a soluble explosive, as pyroxyline.

438,816—October 21, 1890. C. O. LUNDHOLM AND J. SAYERS. *Manufacture of explosives.*

Cellulose nitro derivatives are mixed and incorporated with nitroglycerine by suspending or diffusing the ingredients in a liquid that is a nonsolvent, such as water, agitating them together in the liquid, and then separating the liquid.

440,921—November 18, 1890. D. MINDELEFF. *Explosive.*

A compound consisting of ethyl nitrate, methyl nitrate pyroxyline, nitroglycerine, and a nonsensitizing mixture, as nitro-benzene and methyl alcohol.

443,035—December 16, 1890. W. D. BORLAND. *Dynamite.*

Nitroglycerine and carbonized or charred cork.

466,900—January 12, 1892. L. BROWN. *Absorbent of nitro-glycerine.*

A mixture of sodium nitrate, wood pulp, glue, and magnesia.

478,366—July 5, 1892. S. ROGERS. *Explosive compound.*

A mixture of ammonium picrate, 4 parts; ammonium nitrate, 6 parts; and nitroglycerine, 6 parts.

478,844—July 12, 1892. L. BROWN. *Nitro-glycerine blasting-powder.*

A grading and coating mixture, consisting of sodium nitrate, 73 parts; wood pulp, 1 part; sulphur, 12 parts; resin, 11 parts; and paraffine, 3 parts; all by weight.

506,784—October 17, 1893. A. KRANZ. *Dynamite.*

A composition of nitroglycerine, camphor, and gun-cotton dissolved in acetone and sulphuric ether, combined with a composition of linseed oil and oil of turpentine treated with nitrate of ammonia and sulphuric ether.

517,396—March 27, 1894. W. Y. ROCHESTER AND J. McARTHUR. *Dynamite and process of making same.*

A composition of nitroglycerine, whiting, coal, slacked lime, pulverized copperas, sodium nitrate, gum camphor, alcohol, carbonate of ammonia, and water, in specified proportions. It produces no obnoxious gases.

524,776—August 21, 1894. G. J. BUECHERT. *Explosive compound.*

A compound consisting of a protectively coated salt of ammonia, as the sulphate or chloride, and sodium nitrate, with wood pulp and nitroglycerine.

525,188—August 28, 1894. H. A. CALLAHAN. *Dynamite.*

A mixture of nitroglycerine and acetate of lime, with or without pulverized coke.

525,996—September 11, 1894. B. C. PETTINGELL. *Explosive compound.*

Composed of nitroglycerine combined with nitrated coal dust as an absorbent base.

542,724—July 16, 1895. F. G. A. BROBERG. *High explosive.*

It consists essentially of nitroglycerine, nitronaphthalenes, wood-pulp, and sodium nitrate, with or without sulphur or nitro-cellulose.

612,707—October 18, 1898. R. CROWE. *Composition for preventing fumes in mining powders.*

A mixture of unbolted wheat flour, 50 per cent; common salt, 25 per cent; and bicarbonate of soda, 25 per cent; the salt and soda to be finely ground; to be used contiguous to but not mixed with the high explosive.

625,380—May 23, 1899. E. S. CLARK. *Tamping plug and process of and apparatus for making same.*

A new article of manufacture, a tamping plug, designed to neutralize the deleterious fumes of explosives and lessen the heat of the explosion, consists of a perforated cylinder of solid hydrated salt, as mono-carbonate of soda with a small amount of ferric oxide and mono-sulphate of soda, formed by pressing the salt into molds, filling the interstices with a hot saturated solution, cooling and then temporarily heating the mold to form a film of fused salt and admit of the discharge of the block.

644,403—February 27. 1900. E. CALLENBERG. *Explosive.*

It is composed of turpentine oil, 4 parts; collodion cotton, 1 part; and nitroglycerine, 30 parts: heated together to form a gelatine, and mixed with 27 parts of Epsom salts, and 1 part of soda.

647,607—April 17, 1900. R. S. PENNIMAN AND J. C. SCHRADER. *High-explosive compound.*

A mixture of nitroglycerine and a dope containing vulcanized resin—No. 647,606—(homogeneously united resin and sulphur in a pulverized condition).

648,222—April 24, 1900. H. E. STÜRCKE. *Explosive.*

An explosive consisting of an explosive organic nitro compound, as nitroglycerine, an oxygen-consuming absorbent material, ammonium nitrate, and an additional oxidizing material, as sodium nitrate, the oxidizing materials being combined in such proportions that the ammoniun nitrate will furnish from 5 to 20 per cent of the available oxygen.

649,852—May 15, 1900. A. LUCK. *Explosive.*

An explosive containing an explosive organic nitrate, as nitroglycerine and a nonexplosive ester of cellulose, as acetate of cellulose.

SMOKELESS POWDER.

38,789—June 2, 1863. J. F. E. SCHULTZE. *Improved gunpowder.*

Wood grains, formed by punching or cutting veneers, are successively treated to remove acids and easily soluble material, the proteine, albumen, etc., and bleached; then treated with nitric and sulphuric acid mixture, drained, and washed; and finally saturated with a salt or salts containing oxygen and nitrogen, as potassium nitrate with or without barium nitrate. The dust produced is made into a paste, formed into sheets, and then punched or cut into grains and dried, and powder produced therefrom.

89,910—May 11, 1869. O. H. BANDISCH. *Improved explosive compound.*

Schultze gunpowder, No. 38,789, is treated to bath of pure alcohol and ether (one of alcohol to five of ether), dried at 21° to 27° C., and then compressed.

145,403—December 9, 1873. C. DITTMAR. *Improvement in explosive compounds.*

Vegetable fiber is prepared with a solution of sugar, or mannite, or amylum, or inuline, or other described substances, and rendered explosive by nitric acid. The fiber is reduced to a pulp, compressed in a sheet or other compact form, and then reduced to a granulated or powdered condition and treated with acid to render it explosive.

145,403—Decemher 9, 1873. C. DITTMAR. (*Reissues: 5,759—February 10, 1874; 6,645—September 14, 1875.*) *Improvement in explosive compounds.*

Vegetable fiber is converted into a pulp, desiccated and reduced to powder, grains or compact forms, and then treated with nitric or nitric and sulphuric acids. The acid bath may be preceded by a soaking in a starchy or saccharine solution and followed by an alkaline solution. Potassium nitrate or chlorate or nitroglycerine may be added.

179,688—July 11, 1876. C. DITTMAR. *Improvement in explosive compounds.*

An explosive compound having its grains parchmented, whereby they are smooth and nonadhesive, produced by forming grains of vegetable fiber, parchmenting same by sulphuric acid, and then treating with nitric and sulphuric acid bath.

187,155—February 6, 1877. S. J. MACKIE, C. A. FAURE, AND G. FRENCH. *Improvement in explosive compounds.*

It consists of a mixture of nitro cellulose, say 25 parts, reduced to an impalpable powder, nitrate of baryta 18¼ parts, and nitrate of potassium 6¼ parts.

267,108—November 7, 1882. W. F. REID AND D. JOHNSON. *Hardening explosive granulated powders containing nitro-cellulose, etc.*

The granulated powder is moistened with a spirit, which is then evaporated.

376,000—January 3, 1888. D. JOHNSON. *Process of preparing explosives.*

Dinitro cellulose is incorporated with barium and potassium nitrates and carbon, the mixture treated with a solution of camphor in a volatile liquid not a solvent of dinitro cellulose—such as light petroleum or benzoline—the solvent evaporated at a low temperature, the camphorized material then subjected to a temperature high enough to change the mechanical state of the dinitro cellulose, and finally the camphor expelled.

409,549—August 20, 1889. F. A. ABEL AND J. DEWAR. *Nitro-gelatine explosive.*

Blasting gelatine or compounds thereof is pressed through holes and formed into wires, cut into lengths, and packed in cartridge cases.

411,127—September 17, 1889. H. MAXIM. *Method of producing high explosives.*

Gun-cotton or nitro cellulose is dissolved in a suitable solvent, such as acetone or ethylic acetate, the solution added to nitroglycerine, and the solvent evaporated from the mixture.

423,230—March 11, 1890. S. H. EMMENS. *Explosive.*

It consists of paper or paper stock converted into a nitro compound and impregnated with ammonia and picric acid.

425,648—April 15, 1890. F. A. ABEL AND J. DEWAR. *Gelatinous explosive.*

A gelatinous explosive consisting of nitroglycerine and nitro cellulose to which tannin is added (from 10 to 20 per cent).

429,516—June 3, 1890. R. VON FREEDEN. *Manufacture of gunpowder.*

Nitro cellulose, or a compound thereof with other substances, is gelatinized and granulated by adding a solvent of the nitro cellulose, kneading until it has become plastic and thoroughly gelatinized, and then introducing a liquid or vapor chemically indifferent to the constituents of the mass, as water or steam, and stirring until complete granulation.

430,212—June 17, 1890. H. S. MAXIM. *Manufacture of explosives.*

Gun-cotton is reduced to a pulp, washed and dried, confined in a receiver and the air exhausted therefrom, when the vapor of acetone or its equivalent is admitted to the receiver, and the dissolved gun-cotton is then expelled by pressure.

434,049—August 12, 1890. H. S. MAXIM. *Explosive compound.*

It consists essentially of gun-cotton or pyroxyline mixed with nitroglycerine and an oil such as castor oil; produced by mixing and agitating the same with a proportion of a solvent, such as acetone, insufficient to entirely dissolve the gun-cotton, and subjecting the product in a partial vacuum to the action of vaporized acetone, and then to pressure.

436,898—September 23, 1890. H. S. MAXIM. *Manufacture of explosives.*

Gun-cotton is reduced to pulp, dried, and subjected in a receiver to the action of a vaporized solvent, as acetone, until it is partially dissolved, when it is compressed by a high pressure—20 to 40 tons per square inch—and the sheet cut into pieces or grains.

456,508—July 21, 1891. A. NOBEL. *Celluloid explosive and process of making the same.*

Hard, horny grains, containing nitro cellulose and nitroglycerine, solid at ordinary temperatures; produced by uniting nitro cellulose and nitroglycerine by means of a volatile solvent, as acetone, camphor, or the like—say in the proportions of equal parts of nitro cellulose and nitroglycerine plus camphor—removing the volatile solvent, passing between steam heated rolls, and cutting the sheets into grains.

489,684—January 10, 1893. C. E. MUNROE. *Explosive powder and process of making same.*

It consists wholly of cellulose nitrate of high nitration in a colloidized and indurated condition; produced by first extracting from gun-cotton the lower products of nitration, then mixing and incorporating with it a liquid colloidizing agent capable of converting at ordinary temperatures the higher cellulose nitrates into viscous form, as nitro-benzene, then forming the material into strips or grains, and finally indurating it by the action of heated liquids or vapors, as water or steam, or both.

503,583—August 22, 1893. F. G. & P. S. DU PONT. *Process of making smokeless explosives.*

Nitro cellulose is suspended in a liquid, such as water, which is not a solvent of the same, and in which may be dissolved a suitable salt; granulated by agitating therewith in proper proportions a suitable solvent, as nitro-benzole, not miscible in the suspending liquid, with or without the injection of steam; the grains being hardened and rounded by rotation, and further solidified by rotation in an atmosphere of steam.

503,585—August 22, 1893. F. G. & P. S. DU PONT. *Process of making smokeless powder.*

As a modification of process No. 503,583, the grains are solidified by subjecting them to a heat ranging from 49° to 82° C., to remove the water contained in the grains, but not high enough to vaporize the solvent, and then to a heat sufficient to vaporize the solvent for removal of the excess of solvent.

503,587—August 22, 1893. F. G. DU PONT. *Process of making smokeless explosive.*

Process No. 503,583 is modified by forming an emulsion of the solvent, nitrobenzole, with water in proper proportions, and then adding it to the nitrocellulose suspended in water.

507,279—October 24, 1893. M. E. LEONARD. *Smokeless powder.*

Composed of nitroglycerine, gun-cotton, lycopodium, and a neutralizer of free acid, such as urea crystals or dinitrobenzol, with or without an oil, as cottonseed oil.

513,737—January 30, 1894. E. A. STARKE. *Smokeless powder.*

A combination of an ammonium chromate, potassium picrate, and ammonium picrate.

519,702—May 15, 1894. F. G. DU PONT. *Manufacture of smokeless powder.*

A volatile oil, and preferably a hydrocarbon oil, as benzine, is mixed with the solvent emulsion of processes No. 503,587 and 503,583. The excess of solvent and the oil is removed from the grains by distillation, after hardening.

522,987—July 17, 1894. F. G. DU PONT. *Smokeless explosive.*

Nitro cellulose is suspended in an oil, as hydro-carbon oil; granulated by agitating therewith in suitable proportions a solvent which, though soluble in the suspending oil, has a solvent action on the nitro cellulose, as acetone; the grains hardened by rotation; the excess of solvent removed; and finally the oil removed from the grains.

541,909—July 2, 1895. G. N. WHISTLER AND H. C. ASPINWALL. *Smokeless powder.*

A mixture of nitroglycerine, gun-cotton, a nitrate such as barium nitrate, petrolatum, and urea crystals.

541,910—July 2, 1895. G. N. WHISTLER AND H. C. ASPINWALL. *Smokeless gunpowder.*

Composed of nitroglycerine, trinitrocellulose, a nitrate and a neutralizer of free acid, such as urea crystals, the proportion of nitrate to the trinitrocellulose being about 45 to 100, so that the combustion of the gun cotton shall be substantially similar to that of the nitroglycerine.

541,911—July 2, 1895. G. N. WHISTLER AND H. C. ASPINWALL. *Smokeless powder.*

A compound of nitroglycerine, gun-cotton, a nitrate as barium nitrate, a resin and urea crystals. The fossilized or mineral gum kauri is claimed as a deterrent in a nitroglycerine, gun-cotton, and a nitrate mixture.

542,812—July 16, 1895. J. V. SKOGLUND. *Method of making smokeless powder.*

The drying of grains of powder containing nitrated cellulose is insured by combining with the solvent, water and a vehicle such as alcohol, and dissolving the nitrated cellulose in the liquid, rendering the material porous by the presence of the water as the solvent evaporates.

544,517—August 13, 1895. W. C. PEYTON. *Process and apparatus for making gunpowder.*

The plastic mass is forced through a die and formed into a tube, split, and spread into a flat sheet; passed between grooved rollers and formed into strips or rods connected by films, and then beneath a vertically reciprocating cutter, whereby the strips are cut into grains.

550,472—November 26, 1895. J. B. BERNADOU AND G. A. CONVERSE. *Process of making nitrocellulose powders.*

Two or more nitrocelluloses of known nitration strength are mixed in such proportions as to give a product of desired nitration strength, an oxidizing agent and camphor are added, the mass is colloided with a solvent capable of dissolving the highest form of nitrocellulose present, and it is made into regular forms of uniform least dimension.

552,919—January 14, 1896. H. MAXIM. *Cellular explosive charge.*

An amorphous explosive charge having a multiplicity of interior cells, formed by rolling a sheet of the colloid material, having regular cells or depressions, into a cylinder form. The cells may be filled with granular powder, and the charge exteriorly coated with celluloid or varnish difficult of ignition with respect to the interior of the mass.

559,638—May 5, 1896. M. VON FÖRSTER. *Process of making smokeless powder.*

Flakes having a corrugated or wavy surface are produced by forming a paste of incompletely gelatinized nitrocellulose into thin bands, cutting these bands into flakes, and rapidly drying the flakes.

568,902—October 6, 1896. F. A. HALSEY. *Smokeless powder.*

A compound of strontium nitrate, ammonium picrate, potassium bichromate and potassium permanganate.

570,705—November 3, 1896. F. A. HALSEY. *Smokeless powder.*

A compound of an ammonium picrate, potassium bichromate, and potassium permanganate.

575,765—January 26, 1897. G. G. ANDRÉ. *Manufacture of gunpowder.*

A compound of dinitro and trinitro cellulose is granulated or reduced to pellets in a wet state, and then subjected to the action of a solvent capable of dissolving the dinitrocellulose only, whereby the trinitrocellulose particles are coated with and cemented together by the dissolved dinitrocellulose, and the granules are then hardened by removal of the solvent.

576,532—February 9, 1897. G. G. ANDRÉ. *Manufacture of gunpowder.*

A base consists of 2 parts of trinitrocellulose and 1 part of dinitrocellulose; the same is combined with nitroglycerine, forming a tough, leathery, and translucent explosive.

583,289—June 1, 1897. H. KOLF. *Process of making smokeless powder.*

A carbohydrate is nitrated, then treated with an alkaline sulphide, then saturated with an alkaline nitrate, then a nitro product as nitro-molasses (or nitro-sugar or nitro-glycerine) is mixed therewith and the compound is converted into a gelatinous body by means of a suitable solvent.

586,586—July 20, 1897. J. B. BERNADOU. *Smokeless powder and process of making same.*

An ether-alcohol colloid of nitrocellulose of substantially uniform nitration, or 12.45 per cent nitrogen and corresponding to the formula $C_{30}H_{38}(NO_2)_{12}O_{25}$, with which nitrates of metallic bases and insoluble nitrocellulose, either or both, may be incorporated. It may be in form of strips or grains. It is insoluble in ethyl alcohol alone, soluble in 3 parts ethyl alcohol and 1 part ethylic ether, and is produced by immersing cellulose in a mixture of nitric and sulphuric acids and heating to between 42° and 46° C., freeing the product from excess of acid by washing and pulping in water below 71° C., dehydrating and washing in excess of alcohol, and then colloiding in a mixture of ethylic alcohol and ethylic ether.

590,951—September 21, 1897. F. G. DU PONT. (*Reissue: 11,651—February 15, 1898.*) *Process of and apparatus for making smokeless powder.*

Wet gun cotton is compressed until of equal porosity throughout, when the water is displaced with alcohol by percolation under pressure, the gun-cotton is compressed until only the alcohol desired to combine with a colloidizing solvent remains, which solvent, such as ether, is then mixed with the alcoholized gun-cotton.

592,285—October 26, 1897. C. W. VOLNEY. *Process of making gunpowder.*

Grains containing trinitrocellulose are given a surface coating of dinitrocellulose by reducing the trinitrocellulose upon such surface to dinitrocellulose by reducing agents, as by the sulphites or hyposulphites of potassium, sodium, or ammonium.

596,324—December 28, 1897. F. A. HALSEY. *Smokeless powder.*

A compound consisting of an alkaline-metal chromate, an alkaline earth metal nitrate, ammonium picrate, an alkaline-metal permanganate, and an alkaline-metal silicate.

597,565—January 18, 1898. C. QUINAN. *Process of making gun cotton.*

An essentially ash-free hydrocellulose is produced by steeping fiber in a bath of heated mineral acid capable of dissolving the mineral matter, washing out the mineral matter with a weak acid bath, and finally heating the same to complete the conversion. It is then pulverized and nitrated.

599,589—February 22, 1898. J. E. BLOMÉN. *Process of making explosives.*

Process consists in dissolving nitro, and nitrohydroxyl, hydrocarbon derivatives, preferably nitronaphthalene, with a volatile organic solvent, such as amyl acetate; then adding to the composite solvent thus obtained cellulose nitrates and an oxidizing agent; and finally drying and granulating the compound.

617,766—January 17, 1899. G. M. PETERS. *Explosive and process of making same.*

A powder composed of pulverized nitrated wood-pulp, 20 per cent; saltpeter, 60 per cent; charcoal, 12 per cent; and brimstone, 8 per cent; produced by separately reducing the ingredients to powder, nitrating, washing, and drying the cellulose dust, mixing the dust of the four ingredients, thoroughly incorporating the mass until it is worked into a single substance, and granulating.

622,777—April 11, 1899. F. H. McGAHIE. *Powder-grain.*

A multiperforated powder grain, designed to have powder partitions of equal thicknesses; as a central perforation and a surrounding concentric row of segmental-shaped perforations.

625,365—May 23, 1899. E. A. G. STREET. *Process of making explosives.*

Pitch or tar, with or without an azo or nitro derivative, is dissolved in oil, while heating the latter, and chlorate powder added while maintaining the solution fluid by heat.

625,682—May 23, 1899. F. W. JONES. *Process of making explosives.*

In the manufacture of a gelatinized smokeless powder of a nitrocellulose base the grains are swelled to regulate rate of combustion by acting on them with an aqueous solution of a nitrocellulose solvent, as a ketone; the same is saturated with any ingredients of the grain soluble therein which would otherwise dissolve out of the powder.

625,684—May 23, 1899. J. KARSTAIRS. *Explosive and method of making same.*

A compound, $CH_3N_3O_5$, consisting of a crystalline body soluble in water, sp. gr. 1.8, produced by slowly nitrating a mixture of urea and alcohol. It is combined with gum to form a protecting coating, and with nitrated cellulose.

625,685—May 23, 1889. J. KARSTAIRS. *Explosive.*

The combination of a chlorate with the crystalline body $CH_3N_3O_5$ (No. 625,684), the latter having a protective coating.

625,908—May 30, 1899. E. A. G. STREET. *Explosive and method of making same.*

A compound of a chlorate powder mixed with a solution of a nitric ether, as nitroglycerine, an analogous combustible substance wherein the former is soluble, as nitronaphthaline, and an oil derived from organic substance, as castor oil, produced by forming at an elevated temperature a solution of the nitroglycerine, nitronaphthaline, and castor oil, and adding thereto the chlorate powder

627,436—June 20, 1899. A. MOFFATT. *Process of making nitro-explosives.*

Nitrate of starch is produced by drying until practically free from moisture, cooling, nitrating in a bath at or below 1° C., diluting the mixture with water sufficient to lower its sp. gr. to below 1.25, washing, neutralizing, and drying, whereby the product consists of unruptured granules and its stability is insured.

633,611—September 26, 1899. F. G. & F. I. DU PONT. *Process of making explosives.*

Alcohol is mixed with nitrocellulose (displacing the water of wet cotton by percolation), and a solution of nitroglycerine in ether is then mixed with the alcoholized nitrocellulose.

640,213—January 2, 1900. H. MAXIM AND R. C. SCHUPPHAUS. *Process of making smokeless powder.*

Pyroxyline, preferably of varying degrees of nitration, pulped or reduced to a fine state of division, is treated with a solvent, and before it is completely freed from the solvent it is treated with a size, and then granulated and dried.

648,147—April 24, 1900. F. I. DU PONT. *Process of making gun-cotton*

Acid is removed from gun-cotton by applying pressure, and then, while under pressure, replacing the acid with water by percolation, which, in turn, may be replaced with an alkaline fluid by percolation.

652,455—June 26, 1900. J. B. BERNADOU. *Process of making smokeless powder.*

A colloid powder is formed by subjecting soluble nitrocellulose and a colloiding agent, as ether, in a closed vessel to a temperature equal to or below that of freezing water, mechanically agitating or kneading the cooled mixture, and then forming it into shapes and drying.

652,505—June 26, 1900. J. B. BERNADOU. *Smokeless powder.*

An ether colloid of ether-alcohol-soluble nitrocellulose of high nitration; produced by immersing ether-alcohol-soluble nitrocellulose in ethyl ether and exposing to a temperature of 0° C, or lower.

654,471—July 24, 1900. H. S. MAXIM. *Powder-grain.*

A nitro-compound explosive block or tablet (in part of a slow-burning and in part of a quick-burning character), has concentric annular depressions in each face, with tapered cavities in the walls, the cavities on opposite sides breaking joint.

NITRO-SUBSTITUTION COMPOUNDS.

76,173—March 31, 1868. G. DESIGNOBLE AND J. CASTHELAZ. *Improvement in explosive-powders.*

The use of picrate or carbazotate of potassa, as well as the salts formed from picric or carbazotic acid, the derivatives from such acid, and the acid itself, is claimed in the manufacture of powder; as 55 parts of carbazotate of potassa with 45 parts of azotate of potassa, for the greatest effect.

96,248—October 26, 1869. W. MILLS. *Improved explosive compound.*

The use of carbolic acid and aloes in explosive compounds· and an explosive formed of carbolic acid, nitric acid, potassa, and aloes.

112,163—February 28, 1871. W. MILLS. *Improvement in explosive compounds.*

"Oxidized carbolic acid," a wax-like product, produced by treating carbolic or cresylic acid with nitric acid, alone or combined with metal or metallic or earthy oxides or their carbonates, also with sawdust or other ligneous substances treated with niter. Combined with alcohol, spirits, or ether, and metal or metallic oxides it forms an explosive varnish.

124,397—March 5, 1872. C. W. VOLNEY. *Improvement in explosive compounds.*

A mixture of nitroglycerine and nitrotoluol or nitrobenzole, as by dissolving 3 parts of nitrotoluol in 7 parts of nitroglycerine.

178,277—June 6, 1876. A. DIECKERHOFF. *Improvement in explosive compounds.*

It is composed of sawdust which has been saturated with a solution of picric acid and potassium nitrate dissolved in boiling water and then desiccated, mixed with potassium nitrate, sodium nitrate, and sulphur. It is granulated while damp or formed into sticks.

215,199—May 6, 1879. A. DIECKERHOFF. *Improvement in explosive compounds.*

It consists of gunpowder, or the essential elements thereof—the charcoal not being essential—mixed with a small proportion (not over 15 per cent) of a precipitated alkaline picrate or picrates.

216,949—July 1, 1879. C. FELHOEN. *Improvement in blasting powder.*

A composition of niter, sulphur, and charcoal, in the usual proportions of gunpowder, mixed with nitro-naphthaline; 10 per cent or more should be used.

232,381—September 21, 1880. M. TSCHIRNER. *Explosive compound.*

It consists of picric acid and potassium chlorate, say in the proportion of 57 parts of the former to 43 of the latter. They are incorporated with the aid of 5 per cent of resin dissolved in a volatile solvent.

243,432—June 28, 1881. S. R. DIVINE. *Explosive compound.*

It consists of a solid ingredient, such as potassium chlorate, 3 to 4½ parts, and a liquid ingredient, such as nitro-benzole, 1 part, mechanically united.

263,824—September 5, 1882. E. TURPIN. *Explosive compound.*

A compound of peroxide of nitrogen or hyponitric anhydride with sulphuret of carbon, or its equivalent. If slowly ignited it produces an intense light, without explosion, and the flame instantly melts platinum.

289,755—December 4, 1883. S. R. DIVINE. *Process of preparing explosive compounds.*

An explosive composed of two ingredients, one a solid—such as potassium chlorate—and the other a liquid—such as nitro-benzole—is prepared by saturating the powdered potassium chlorate with a mixture of the nitro-benzole and a volatile fluid, such as carbon bisulphide, and then allowing the volatile fluid to evaporate; the proportions being such as to give the proper proportion of nitro-benzole for the mass.

289,757—December 4, 1883. S. R. DIVINE. *Explosive compound.*

From 1 to 3 per cent of sulphur is combined with the moist mass of No. 243,432 (potassium chlorate and nitro-benzene).

289,758—December 4, 1883. S. R. DIVINE. *Explosive compound*

It is composed of a solid ingredient—4 or 5 parts—such as potassium chlorate and a liquid ingredient—1 part—consisting of a mixture of nitro-benzole and dead-oil, the latter being mixed in about equal proportions.

289,763—December 4, 1883. S. R. DIVINE. *Explosive compound.*

From 1 to 3 per cent of sulphur is combined with the moist mass of No. 289,758 (potassium chlorate with nitro-benzole and dead-oil).

374,921—December 20, 1887. G. ANTHEUNIS. *Blasting powder.*

It consists of mahogany sawdust, 8 per cent; potassium nitrate, 50 per cent; sodium nitrate, 16 per cent; charcoal, 1.5 per cent; sublimated sulphur, 18 per cent; potassium ferrocyanide, 3 per cent; and ammonium picrate, 3.5 per cent. (Potassium nitrate is omitted in the claim.)

375,651—December 27, 1887. C. ROTH. *Explosive.*

The combination of a chlornitro-hydrocarburet of the aromatic series, as chlornitro-benzol, with an oxidant, such as ammonium nitrate.

376,145—January 10, 1888. S. H. EMMENS. *Explosive derived from phenol.*

A crystalline acid compound is produced by the action of heated concentrated or fuming nitric acid, of sp. gr. 1.52 or higher, upon picric acid in excess, and the crystallization of the liquid. Explosive compositions or pastes are produced by dissolving 2 parts of the same in 1 part of concentrated nitric acid.

403,749—May 21, 1889. J. A. HALBMAYR. *Manufacturing explosives.*

In the manufacture of explosives from tar oils the oils are introduced in a state of division below the surface of a body of nitrating acid, as by a perforated pipe, and cold air under pressure is introduced at the same point, to cool the liquid.

417,429—December 17, 1889. W. E. LIARDÊT. *Manufacture of explosives.*

In the manufacture of explosives containing picric acid and potassium nitrate, or its equivalents, the picric acid is mixed with boiling-hot glycerine, potassium nitrate is added and the mixture cooled, ground wood is then added to the cooled mass, boiling-hot potassium nitrate is added to the mixture, and finally flowers of sulphur.

421,662—February 18, 1890. B. BRONCS. *Explosive compound.*

It is composed of a double salt combination of sodium picrate with other picrates (No. 421,753), potassium nitrate, saccharine matter, a gummy or resinous substance, and soot, with or without nitrated naphthaline.

421,753—February 18, 1890. B. BRONCS, H. ORTH, ADM'R. *Explosive compound.*

A double picrate consisting of sodium picrate combined with barium or lead picrate.

422,514—March 4, 1890. S. H. EMMENS. *Manufacture of explosives.*

A suitable hydrocarbon substitution derivative, as trinitrophenol, is fused; a suitable alkaline nitrate, as sodium nitrate, is added thereto; and the heat gently raised until actual liquefaction of the mixture is attained, when it is allowed to cool.

422,515—March 4, 1890. S. H. EMMENS. *Manufacture of explosives.*

The crystalline acid of No. 376,145 is heated with an allied nitro-hydrocarbon, as dinitrobenzene, which reduces the fusing point of the acid; a pulverized oxidant is then mixed therewith, and the mixture is cooled.

435,142—September 2, 1890. C. LAMM. *Manufacturing explosive charges.*

Pulverized partially-fusible explosive material is introduced into molds surrounded by a heating chamber, then a heating medium is passed through said chamber to melt the contents of the molds, then cold water is passed through said chamber to solidify the explosive material, and finally the charges or cartridges are ejected.

455,217—June 30, 1891. C. LAMM. *Explosive compound.*

Composed of a nitrate salt, as ammonium nitrate, and dinitro-benzene or dinitro-benzol.

478,819—July 12, 1892. A. C. RAND. *Explosive compound.*

It consists of an oxidant, as chlorate of potash, in a powdered form, and manganese peroxide in the form of coarse grains mixed with the oxidant, say equal parts, and a fluid hydrocarbon, as nitro benzol, say 15 per cent by weight, incorporated therewith.

488,534—December 27, 1892. J. F. ALEXANDER. *Explosive.*

A powder composed of naphthaline or a suitable solid hydrocarbon, sulphur, a potassium salt or salts, and ammonium picrate, with or without ammonium sulphate.

492,089—February 21, 1893. B. LEPSIUS. *Preparing explosive compounds.*

A mixture of picric acid and an enveloping explosive agent, such as tri-nitrotoluol, is heated, in a mold, to a point above the fusing point of the latter ingredient and below that of the former—to avoid fusing the crystals of the acid—and then cooled, thus cementing the crystals together.

495,178—April 11, 1893. J. E. BLOMÉN. *Method of making blasting compounds.*

Picric acid and a hydrocarbon, as naphthalene, are separately dissolved in alcohol, the solutions mixed, and the resulting picrated hydrocarbon dissolved in nitroglycerine.

506,031—October 3, 1893. J. E. BLOMÉN. *Manufacture of blasting compounds.*

A hydrocarbon is first treated with nitric acid; the product is then treated with a mixture of nitric and sulphuric acids, and this second product is then treated with strong nitric acid, and finally incorporated with an oxidizing agent.

506,032—October 3, 1893. J. E. BLOMÉN. *Blasting compound.*

The granules of an oxidizing agent have a coating composed of a mixture of a hydrocarbon and dinitro-phenol.

521,020—June 5, 1894. W. EVELYN-LIARDÊT. *Explosive and process of making same.*

A mixture of tar, picric acid, sawdust, the chloride and the perchlorate of an alkali metal; produced by heating the tar to 120° C., adding the picric acid, gradually adding the sawdust, heating the mixture to about 100° C., cooling and passing through a sieve, adding to the sifted product a suitable mixture of the perchlorate and chloride of an alkali metal, at the same time heating the mass until it assumes a black color, cooling and granulating.

527,563—October 16, 1894. E. A. STARKE. *Process of making ammonium bichromate.*

A solution of ammonium picrate and a solution of potassium bichromate are mixed, through which crystals of potassium picrate form, which are removed, leaving an ammonium bichromate solution that is evaporated to dryness. An explosive compound is formed by mixing the solutions in proper proportions, ammonium picrate being in excess, and evaporating the resultant mixture of ammonium picrate, ammonium bichromate, and potassium picrate to dryness.

530,063—November 27, 1894. J. E. BLOMÉN. *High-power explosives.*

A mixture of nitro-naphthalenes, an oxidizing agent, a mixture of nitrophenols, sulphur, and charcoal.

540,141—May 28, 1895. F. G. A. BROBERG. *Explosive compound.*

A composition of nitro-resin, say, 6 to 10 per cent; nitro-naphthalenes, 5 to 10 per cent; sulphur, 14 or 15 per cent; and an oxidizing agent, such as sodium nitrate, 70 per cent.

540,647—June 11, 1895. S. R. DIVINE. *Explosive compound.*

It is composed of nitrate of lead and a nitrated hydrocarbon of the benzol series, which is of itself nonexplosive, such as dinitro-benzol; 1 part of the latter is melted and 4 parts of the former is mixed therewith.

567,536—September 8, 1896. E. DICKSON. *Gunpowder.*

It consists of a granulated mixture of barium nitrate, flour, potassium ferrocyanide, picric acid, ammonia, potassium chlorate, and lampblack, coated with refined petroleum which has been treated with nitric acid, sulphuric acid, and ammonia.

577,351—February 16, 1897. H. BOYD. *Explosive.*

A mixture of potassium nitrate, sulphur, barium nitrate, picric acid, wood-dust, and a fume absorbent, such as dry pulverized bog ore or other hydrated oxide of iron; characterized by firing without a detonator and absorbing the noxious gases.

594,268—November 23, 1897. F. MÜLLER, S. OBERLÄNDER, V. H. FUCHS, AND S. GOMPERZ. *Blasting powder and process of making same.*

A compound composed of picrate combined with sulphur, nitrate of potassium, and a carrier, such as nitrated cellulose, with or without a substance yielding free oxygen, such as pyrolusite. The process consists in mixing sulphur and carbolic acid; also mixing nitrate of potassium and nitric acid, and then combining the two mixtures and neutralizing with an alkali.

598,064—January 25, 1898. W. P. FERGUSON. *Blasting compound.*

In a granular blasting compound in which the oxidizing agent is coated with a film containing a nitrophenol and a hydrocarbon, lampblack is intermixed with the elements of the film.

598,618—February 8, 1898. E. A. G. STREET. *Explosive and method of making same.*

The combustible agent, such as nitro or azo derivative, or combination thereof, is mixed with an oil at an elevated temperature which is not a solvent thereof at ordinary temperature in such proportion that on cooling it assumes a pasty or solid consistence, and the chlorate powder is mixed therewith, the fluidity being maintained during maxilation. The combustible element is composed of a solution in oil of a less soluble combustible body, such as picric acid, combined with a more soluble body of the same class.

622,800—April 11, 1899. G. M. HATHAWAY. *Detonating compound.*

It is composed of the ingredients of gunpowder with nitronaphthalene, nitrophenol, sodium nitrate, and potassium chlorate, combined in such proportions as to form a detonating compound of low grade.

622,990—April 11, 1899. H. BOYD. *Blasting powder.*

A fumeless explosive, consisting of sodium nitrate, sulphur, picrate of ammonia, and potassium bichromate, with or without commercial lime, cottonseed oil, and peat dust, one or all of them.

625,499—May 23, 1899. F. A. HALSEY. *Gunpowder.*

It consists of picrate of ammonia, 47 per cent; potassium bichromate, 23 per cent, and barium nitrate, 30 per cent.

649,913—May 22, 1900. S. CLARK. *Explosive compound.*

A mixture of sodium nitrate, 19 parts; antimony, 2½ parts; sulphur, 3 parts; charcoal or coke, 3½ parts; picric acid, one-third part; nitric acid, one-third part, and a reducer, such as resin, one-half part.

FULMINATES, PRIMING COMPOSITIONS, AND FUSES.

August 21, 1834. S. GUTHRIE. *Improvement in the manufacture of percussion powder.*

Grains of powder are coated with shellac and before they are dry they are rolled in leaf metal, or any of the metallic powders, with bisulphuret of tin or other metal or metallic compound. After coating they may be again coated with a waterproof varnish.

18,016—August 18, 1857. M. KLING. *Improvement in percussion powder.*

A mixture of antimony, 1 ounce; and potassium chlorate, 1 ounce, with equal proportions of glue dissolved in boiling water, and oxalic acid dissolved in boiling water.

18,199—September 15, 1857. E. GOMEZ AND W. MILLS. *Improvement in safety-fuse compositions.*

A mixture of equal parts of potassium chlorate and ferrocyanide of lead. It is mixed with alcohol and applied as a paint to a strip of paper, and protected by a winding of tape of fibrous material.

35,477—June 3, 1862. F. M. RUSCHHAUPT AND J. SCHULTE. *Improved percussion powder.*

Tannin or pyrogallic acid, or analogous substances, are mixed in chemical proportions with potassium chlorate, a varnish being added as a binder.

38,424—May 5, 1863. L. SHORT. *Improved composition for filling shells.*

A mixture of saltpeter, 7 pounds; asphaltum, 6 pounds; antimony, 2 pounds; sulphur, 7 pounds; and naphtha, 2 gallons, is allowed to stand and settle, and the sediment is pressed into shells, forming combustible missiles to be used with explosive projectiles. The liquid combined with vegetable fiber is also packed in explosive shells.

38,994—June 23, 1863. I. P. TICE. *Improvement in concussion fuse for shells.*

An admixture of fulminates with cotton, gun cotton, wool, sawdust, or other soft material, prevents premature ignition, or the fulminate chamber is lined with soft material. Two fulminates are used, one sensitive and easily ignited and the other burning slower and with a stronger flame. The percussion-fuse plug is of special construction.

41,259—January 12, 1864. H. HOCHSTÄTTER. *Improved composition for percussion caps, etc.*

Chloride of lead, 12 parts, is combined with potassium nitrate, 8 parts, and gum amber, 3 parts.

47,677—May 9, 1865. J. S. BICKFORD. *Improved fuse for blasting, etc.*

A central strand or core of gun-cotton is used in a fuse as a substitute for gunpowder.

48,460—June 27, 1865. H. B. STOCKWELL. *Improved fulminating compound.*

A mixture of fulminating mercury, 4 parts, saltpeter, 3 parts; black sulphuret of antimony, 2 parts; and French chalk, 1 part.

49,574—August 15, 1865. H. HOLDEN. *Improved torpedo.*

A sheet of absorbent paper saturated wholly or in part with a solution of fulminate of silver or of mercury.

56,167—July 10, 1866. G. BOLDT. *Improved fulminating composition.*

Fifteen parts of fulminating silver—formed by dissolving 1 part of mercury, in weight, in 10 parts of nitric acid, then boiling with 12 parts of alcohol, cooling and drying—is mixed with 1½ parts of sulphur tin—formed by melting together 2 parts of sulphur and 3 parts of tin—and 3 parts of flour and 1 part of powdered charcoal, with a little gum water.

67,714—August 13, 1867. H. BUCHNER AND F. EBERTZ. *Improved fulminating powder for needle-guns.*

A mixture of potassium chloride, sulphur, charcoal, saltpeter, potassium chlorate, antimony, and gum, in about equal proportions.

69,206—September 24, 1867. J. GOLDMARK. *Improved fulminating compound.*

The sulphocyanite of a metal or other base, as the sulphocyanite of lead, is used in combination with potassium chlorate, either with or without other substances.

81,036—August 11, 1868. C. H. F. THIEME. *Improved priming for needle-guns.*

A composition having hyposulphite of any metal as a base, as a mixture of hyposulphite of silver or lead, 1 part; sulphureted antimony, 4 parts; potassium chloride, 10 parts; sulphur, 3 parts; and white sugar one-fourth part.

81,057—August 11, 1868. B. BURTON. *Improvement in the manufacture of waterproof percussion caps, etc.*

Shellac or other gum resin, mixed with alcohol or other readily evaporable solvent, is used in the compounding of fulminating matter.

93,113—July 27, 1869. G. M. MOWBRAY. *Improved method of exploding nitroglycerine.*

An electrical fuse is composed of a priming composition, inclosing circuit wires at their point of interruption, in combination with an intermediate priming charge of fulminate of mercury, all inclosed in a cylinder.

96,465—November 2, 1869. G. M. MOWBRAY. *Improved compound for priming electric fuses.*

A mixture of phosphorus, sulphur, silver, mercury, and potassium chlorate; so as to form a mixture of subphosphide of silver with subsulphide of silver and potassium chloride, to which is added sulphide of mercury.

97,843—December 14, 1869. R. WHITE. *Improvement in metallic cartridges.*

The fulminate powder is mixed with india rubber or similar elastic substance. The structure of the cup is claimed.

103,931—June 7, 1870. W. H. ROGERS. *Improved fuse composition.*

A composition of powdered charcoal, 20 parts; powdered glass, 10 parts; potassium chlorate, 10 parts; and dissolved india rubber, 30 parts; with sufficient bisulphide of carbon to impart a tough and waxy character.

128,221—June 25, 1872. G. M. MOWBRAY. *Improvement in compounds for priming electric fuses.*

A mixture of mercuric sulphide, amorphous or crystalline—preferably the crystalline—3 parts, and potassium chlorate, 1 part.

139,192—May 20, 1873. E. A. L. ROBERTS. *Improvement in treating explosive compounds to render them safe for blasting and other purposes.*

Explosives, such as fulminates, are combined with water or other liquid, or with a hygrometric salt, so as to form a paste. Moist compounds are exploded by igniting near them or in contact a fulminating or detonating material. Moist or wet compounds are combined in the same charge with dry powder capable of being exploded by a spark or with percussion powder.

152,790—July 7, 1874. C. A. & I. S. BROWNE. (*Reissue: 6,564—July 27, 1875.*) *Improvement in explosive compounds.*

An electrically explosive compound, consisting of pulverized fulminate of mercury intermixed with particles of metal, as antimony, with or without antimonic sulphide or other ingredients.

157,856—December 15, 1874. I. M. MILBANK. *Improvement in explosive compounds.*

A fulminating compound of potassium chlorate, 80 parts; charcoal, 35 parts; and red phosphorus, 4½ parts.

157,857—December 15, 1874. I. M. MILBANK. *Improvement in explosive compounds.*

A fulminating compound of potassium chlorate, 20 parts; prussiate of potash, 10 parts; and red phosphorus, 1 part.

161,430—March 30, 1875. G. M. MOWBRAY. *Improvement in primings for electric fuses.*

A composition of metallic antimony and fulminate of mercury, as a priming for electric fuses.

161,431—March 30, 1875. G. M. MOWBRAY. *Improvement in primings for electric fuses, etc.*

A composition of bismuth and fulminate of mercury.

161,432—March 30, 1875. G. M. MOWBRAY. *Improvement in primings for electric blastings, etc.*

A composition of cadmium and fulminate of mercury; being a mixture of the double-salt mercuric fulminate of cadmium, with an amalgam of mercury and cadmium.

170,066—November 16, 1875. H. J. DETWILLER. *Improvement in explosive compounds.*

A detonating compound consisting of ground bark or sawdust, 5 parts; potassium chlorate, 10 parts; and red phosphorus, 1 part. (Especially adapted for railroad-torpedoes.)

179,067—June 20, 1876. J. D. & W. C. SCHOOLEY. *Improvement in detonating compounds.*

A mixture of potassium chlorate, 3 parts; sulphur, 1 part; and broken glass, 1 part. (For railroad torpedoes.)

184,043—November 7, 1876. W. A. LEONARD. *Improvement in continuous fuse.*

Formed of xylonite, coated with a match composition. (To be used from an air-tight case.)

217,534—July 15, 1879. E. S. HUNT. *Improvement in pyrotechnic cartridges.*

A star having a drop of fulminate secured to its base by shellac dissolved in alcohol. The structure of the cartridge is claimed.

228,935—June 15, 1880. J. A. ROBINSON AND R. H. DIMOCK. *Deflagrating compound.*

Amorphous phosphorus combined with plumbic plumbate and potassium chlorate, produced by mixing the amorphous phosphorus with sufficient hot water to render the whole mixture of a fluid consistency, adding plumbic plumbate in small quantities with stirring till effervescence ceases, and then adding potassium chlorate in quantity equal to that of the amorphous phosphorus, and thoroughly mixing.

233,406—October 19, 1880. C. A. FAURE AND G. TRENCH. *Detonator.*

A detonating compound of fulminate of mercury, 6 parts, and gun cotton and potassium chlorate, each 1 part.

261,247—July 18, 1882. J. F. A. MUMM. *Compound for railway-signal torpedoes.*

A compound composed of potassium chlorate, gum tragacanth, alcohol, antimony, sulphur auratum antimonii, or golden sulphuret, sublimed sulphur, and French chalk, in the form of pellets or cakes, with packages of gravel interspersed.

269,769—December 26, 1882. A. WOEBER. *Fulminate.*

A mixture of potassium chlorate, 1 pound; washed flowers of sulphur, one-half pound; amorphous phosphorus, 2 ounces; and 12 fluid ounces of dissolved gum tragacanth.

309,441—December 16, 1884. J. C. DE CASTRO. *Explosive compound.*

Bran or other suitable form of cellulose—7 parts—is mixed with tersulphide of antimony, or natural sulphide of antimony—1 part—to which is added a saturated solution of potassium chlorate, and the whole formed into pellets or grains.

418,552—December 31, 1889. P. BUTLER. *Gunpowder.*

A mixture of fulminate of mercury, pulverized soapstone, and a suitable binding material, as black gunpowder.

489,761—January 10, 1893. S. RODGERS. *Detonating compound.*

It consists of potassium picrate, 43 per cent; potassium chlorate, 43 per cent; extract of logwood, 12 per cent; and a gallotannic ink, 2 per cent.

529,334—November 13, 1894. H. MAXIM. *Fulminating compound.*

A pliable, yielding, or elastic explosive, consisting of a fulminate with its particles agglutinated by a dissolved organic nitro compound, as pyroxyline, with or without nitroglycerine, or a deterring agent to lessen its sensitiveness to detonation.

634,716—October 10, 1899. G. P. BICKFORD-SMITH. *Composition for detonators.*

A composition of sodium tungstate, 4 parts; precipitated copper, 2 parts; strontium nitrate, 4 parts; antimony sulphide, 96 parts; precipitated silver, 108 parts; potassium chlorate, 192 parts; and electrotype plumbago, 20 parts.

PYROTECHNIC COMPOSITIONS.

39,746—September 1, 1863. J. P. PERRY. *Improved composition for explosive shells.*

A liquid shell-mixture formed of powdered sulphur, alcohol, and turpentine, used alone or with cotton or other fibrous matter. (The shell has a separate bursting charge.)

41,577—February 9, 1864. E. HARRISON. *Improved inflammable composition for filling projectiles.*

A mixture of gunpowder, amorphous phosphorus, and bisulphide of carbon; forming a thick paste or solid mass.

42,458—April 26, 1864. A. BERNEY. *Improvement in destroying forts, etc., by means of inflammable liquids.*

An inflammable liquid is to be projected by a hose and pump, the jet being ignited at the nozzle.

47,335—April 18, 1865. C. W. ROESLING. *Improved powder for lighting cigars, etc.*

A mixture of potash, 40 parts; burned alum, 30 parts; powdered charcoal, 20 parts; and rye flour, 10 parts, is heated in a closed cylinder to a red heat, then cooled and maintained dry. It ignites by simply breathing on it.

48,187—June 13, 1865. H. W. LIBBEY. *Improved incendiary compound.*

Powdered potassium nitrate, 1½ ounces, and spirits of turpentine, 1 ounce, are added to a mixture of nitric acid, 2 ounces; barium sulphate, one-fourth ounce; and sulphuric ether, 1½ ounces. After standing, the oily substance is treated with alcohol; and hydrocarbon oil, 1 ounce, and tar, one-half ounce, are added; and combustible fibrous material is saturated with the compound.

65,764—June 11, 1867. C. NELSON. *Improved toy torpedo and explosive compound.*

The explosive composition consists of amorphous phosphorus, one-third; potassium chlorate, one-third; sulphur, one-sixth; and pulverized chalk, one-sixth.

144,030—October 28, 1873. A. LAMARRE. *Improvement in pyrotechnic signals.*

Linseed-glue, produced by reducing linseed oil to one-half its volume, by evaporation or burning, is mixed with the chlorates and other chemicals.

309,948—December 30, 1884. J. HERZOG. *Colored-fire compound.*

Sawdust dyed to the color the fire will produce is mixed with the chemical ingredients.

323,662—August 4, 1885. C. GERHARD. *Composition for bengal lights.*

A mixture of strontium nitrate and chlorate, potassium chlorate, powdered glass, and flour, with an alcoholic solution of a resinous substance, such as shellac or resin, or a mixture of the two.

363,224—May 17, 1887. C. GERHARD. *Composition for bengal lights.*

A mixture of strontium nitrate or chlorate, 24 pounds, and shellac, 7 pounds, melted, mixed, and cooled, is pulverized, added to a solution of glue and gum, and 4 pounds of potassium chlorate is added to the paste thus formed.

384,927—June 19, 1888. H. G. PIFFARD. *Photogenic powder.*

It consists of magnesium powder intimately mixed with "wood powder" (Dittmar, No. 145,403), or similar nitro-lignin equivalent.

407,351—July 23, 1889. A. HEMSLEY. *Compound for producing flash-light.*

It consists of powdered or granulated metallic magnesium, one or more nitrates, and amorphous phosphorus.

411,714—September 24, 1889. A. DEL GRANDE. *Preparing pyrotechnic compounds.*

Picric acid is dissolved in hot water and magnesium carbonate added to form a solution of magnesium picrate; then potassium nitrate is dissolved in water and the two solutions mingled, producing a precipitate of potassium picrate $(C_6H_2(NO_2)_3OK)$, which is reduced to a granular condition and dried.

415,479—November 19, 1889. J. G. STUTTZ. *Colored fire.*

A mixture of potassium chlorate, gum-shellac, gum-camphor (pulverized),. brass filings, and magnesia, with or without strontium nitrate.

420,642—February 4, 1890. H. O. FRANK. *Solidifying colored fire.*

Pyrotechnic powders are converted into solid form by adding a small quantity of alcohol to the powdered ingredients and mixing the whole in a water bath, at about 93° C., and while still warm pressing the pasty mass into molds coated with vaseline, and cooling.

449,530—March 31, 1891. C. GERHARD. *Bengal-light compound.*

It consists of copal, ether, alcohol, strontium nitrate, and potassium chlorate, with or without a shellac solution or varnish.

475,897—May 31, 1892. C. SCHMIDT. *Fireworks.*

A composition for making star fireworks, consisting of steel chips, charcoal, lead nitrate, shellac, and spirits.

476,264—June 7, 1892. E. HACKH. *Magnesium-light composition.*

Fibrous material, as long carded unspun wool, is impregnated with vegetable oil, 2 parts; benzine, 2 parts and Venice turpentine 1 part, and sprinkled with magnesium powder.

523,614—July 24, 1894. J. AGOSTINI. *Pyrotechnic compound.*

A composition produced by mixing powdered magnesium and charcoal with starch, rendering the mixture adhesive, coating iron filings with a substance impervious to moisture, and adding them to the mixture.

528,515—October 30, 1894. A. HEMSLEY. *Flash-light compound.*

A mixture of aluminum, a nitrate or nitrates of the metals or alkaline earths, and amorphous phosphorus.

534,557—February 19, 1895. C. GERHARD. *Pyrotechnic compound.*

A mixture produced by dissolving camphor in alcohol, mixing lampblack therewith, adding gum tragacanth and glue, and mixing into these ingredients magnesium, starch, and iron.

535,495—March 12, 1895. J. GRAHAM. *Pyrotechnic compound.*

A mixture of powdered zinc, 320 grains; powdered selenium, 80 grains; in one gallon of carbon disulphide.

590,231—September 21, 1897. E. LEUSMANN. *Pyrotechnic compound.*

A compound for Bengal lights, consisting of an alcoholic solution of shellac, a nitrate of a metal of the alkaline earths, pulverized aluminum, sulphur, an alkaline chlorate—as potassium chlorate—and a binding agent.

594,594—November 30, 1897. J. A. BOSTWICK. *Flash-light composition.*

A sheet of collodion has combined therewith powdered flash-light material to produce an actinic light of brief duration and large area. A layer of powder may bé applied between two collodion films.

633,671—September 26, 1899. Z. VALDEZ. *Toy torpedo.*

A ball of clay has a coating of gum-shellac; a coating composed of gum-arabic, 4 parts; phosphorus, 4 parts; and potassium chlorate, 5 parts; and an outer coating of shellac.

MATCH COMPOSITIONS.

1,413—November 16, 1839. J. H. STEVENS. *Improvement in the composition of matter for friction-matches.*

A combination of litharge and the red oxide of lead, or either of them separately, with carbonate of lead, phosphorus, and a glutinous or viscid material, such as gum-arabic, or with black oxide of manganese, phosphorus, and the glutinous material.

1,414—November 16, 1839. J. H. STEVENS. *Improved friction-match for retaining fire, entitled "Stevens' fusee cigar-light."*

The match splint is saturated with a solution of saltpeter, dried, and the phosphoric composition is then applied to the end, without the intervention of brimstone.

2,402—December 23, 1841. N. T. WINANS, T. & T. HYATT. *Improvement in the composition of matter for the manufacture of friction-matches.*

Phosphorus, alone or in connection with other inflammables, is combined with glue or gum rendered damp-proof by being chemically united with shellac.

2,403—December 23, 1841. N. T. WINANS, T. & T. HYATT. *Improvement in the composition of matter for the manufacture of friction-matches.*

Shellac, 3 parts, and borax, three-fourths of a part—or like alkali—is dissolved in water, and three-fourths of a part of phosphorus is combined therewith.

2,494—March 18, 1842. S. BLAISDELL. *Improvement in ignitible compounds for friction-matches.*

The matches are dipped into a compound of sulphur and phosphorus formed into a paste with glue.

2,635—May 20, 1842. G. W. CARLETON. *Improvement in friction-matches.*

A paste formed of phosphorus, gum-arabic, or glue, and a fulminating compound composed of subcarbonate of potassa, 2 parts; nitrate of potassa, 3 parts; and sulphur, 1 part.

3,773—October 3, 1844. E. SMITH. *Improvement in friction-matches.*

Pulverized dried vegetable material, as bark, or nutgalls, is mixed with phosphorus, in place of mineral or earthy substances.

40,259—October 13, 1863. J. W. HJERPE. *Improvement in the manufacture of friction-matches.*

A safety match composition (not using phosphorus or other dangerous substance), igniting only on a prepared rubber composition, consisting preferably of potassium chlorate, 4 pounds; potassium chromate, 4 pounds; specular iron or colcothar, 2 pounds; and gum, 2 pounds. Rubber compound therefor, sulphuret of antimony, 20 pounds; potassium chromate, 2 pounds; red iron oxide or colcothar, 6 pounds; protosulphate of iron, 3 pounds; and gum, 3 pounds. Combined, the composition is friction lighting.

47,311—April 18, 1865. S. KRACKOWIZER. *Improvement in the manufacture of friction-matches.*

A metallic coating of sulphide of lead is formed around the phosphoric mass, by impregnating the friction mass with hyperoxide of lead and nitrate of oxide of lead, and exposing the tipped and moist matches to a stream of hydrothionic acid gas.

50,843—November 7, 1865. H. REIMAN. *Improvement in friction-matches for lighting cigars, etc.*

Pasteboard or other stock for friction-matches is treated with a solution of potassium chlorate and niter.

53,454—March 27, 1866. L. LANSZWEERT. *Improved match-compound.*

A mixture of potassium chlorate, 35 parts; hyposulphate of lead, 15 parts; glass or silex, 4 parts; bichromate of potash, 10 parts; and gum or cement, 4 parts. The matches ignite only on a prepared surface containing black antimony and phosphorus.

66,101—June 25, 1867. L. O. P. MEYER. *Improvement in the manufacture of safety-matches.*

A match mixture of potassium chlorate, gelatine, and quartz or pumice stone, in relative proportions, for example, of 56 per cent, 20 per cent, and 24 per cent. The igniting surface may be formed of the red or the yellow prussiate of potash, mixed with a binder and with powdered glass or aluminous earth (though it is inferior to Hjerpe's igniting surface).

69,891—October 15, 1867. E. ANDREWS. *Improvement in the manufacture of matches.*

Match splints are united in the form of a card by arranging them side by side and dipping the nonigniting ends in glue.

95,730—October 12, 1869. W. H. ROGERS. *Improvement in friction-matches.*

An inflammable coating is applied to a friction match below the ignitible end. The coating may be of potassium chlorate, 8 parts; powdered charcoal, 2 parts; and dissolved rubber, 5 parts.

125,874—April 16, 1872. F. ZAISS. *Improvement in parlor-matches.*

Phosphuret or phosphide of sulphur, white Russian glue, and white dextrine or purified starch, with or without coloring material, is used to produce white or colored matches; and benzoin, cascarilla, or cinnamon to give a perfume while burning.

128,626—July 2, 1872. J. HOWE. *Improvement in matches for lighting cigars, etc.*

A mixture of 1 pound each of benzoin, myrrh, and cascarilla bark; one-fourth ounce each of nutmeg, oil of cloves, and oil of musk; and 2 pounds each of charcoal and potassium nitrate; formed into a paste with a mucilage.

136,953—March 18, 1873. J. F. BABCOCK, W. A. LEONARD, AND E. B. CRANE. *Improvement in match compositions.*

A fuse-strip is formed of pyroxyline, pure or mixed. It is molded with serrations and with friction-match composition on the whole or a part of its surface.

149,324—April 7, 1874. L. O. P. MEYER. *Improvement in the manufacture of safety-matches.*

In the manufacture of safety matches—Nos. 66,101 and 111,075—the paste is prepared with acetates of iron or of alcohol.

150,203—April 28, 1874. C. B. STEPHENS. *Improvement in matches or arrows for use with toy pistols or toy guns.*

A projectile for toy pistols consisting of an explosive coating on a body of wood or other material not easily ignited, as a parlor match made with the omission of coal-wax or like material from the detonating compound and splint.

153,004—July 14, 1874. J. J. MACHADO. *Improvement in the manufacture of friction-matches.*

A match dipped to some length into a slow-burning composition, not liable to be extinguished by a draft of air, and having a head of rapidly combustible composition, igniting only on a chemical-affinity surface. The heads are waterproofed by dipping into a solution of alcohol and tannic acid.

153,181—July 21, 1874. G. C. J. SCHNEIDER. *Improvement in compositions for safety blazing fusees, etc.*

A mixture of glue and starch in water, to which is added powdered glass, potassium chlorate, pumice stone, sulphuret of golden antimony, saltpeter, cascarilla bark, and lampblack.

153,451—July 28, 1874. L. O. P. MEYER. *Improvement in surface compounds for igniting safety-matches.*

A compound of india rubber, or allied gum, sulphur, and gray sulphuret of antimony; in the proportion, for example, of 2, 1, and 23 parts, respectively.

156,328—October 27, 1874. W. S. BEECHER. *Improvement in ammunition-matches for toy pistols.*

The ends of splints have coatings of detonating material and silicate of soda. Either may be first applied.

157,873—December 15, 1874. G. C. J. SCHNEIDER. *Improvement in safety-match compositions.*

A mixture of brick dust, potassium chlorate, golden sulphuret of antimony, flowers of sulphur, starch, and water.

169,539—November 2, 1875. E. HAANEL. *Improvement in safety-matches.*

A match composition of potassium chlorate, 1.6 part; sulphide of antimony, 0.3 part; sesquioxide of iron, 0.35 part; binoxide of manganese, 0.35 part; potassium chromate, 0.05 part; and powdered glass, 0.05 part; formed into a paste with a gelatine mucilage. The friction-tablet composition consists of amorphous phosphorus, 1 part; sulphide of antimony, 0.02 part; and powdered glass, 0.25 part; formed into a paint with the gelatine mucilage.

177,001—May 2, 1876. J. RADFORD. *Improvement in compositions for lighting cigars.*

A mixture of pulverized charcoal, wheat flour, potassium chlorate, and diluted vinegar or acetic acid.

177,134—May 9, 1876. W. J. LITTLEFIELD. *Improvement in compositions for cigar-lighters.*

A compound of lime, charcoal, cascarilla bark, gum, and water.

196,062—October 9, 1877. H. R. WHITEMAN. *Improvement in cigar-lighters.*

A disk provided with a pin or peg and having an inflammable body and a fulminate, the inflammable body consisting of a mixture of charcoal, niter, sulphur, gum-arabic, and flour.

230,226—July 20, 1880. C. F. BONHACK. *Friction-match.*

A mixture of niter, Venetian turpentine, phosphorus, glue, powdered glass, and crocus metallorum or other coloring matter.

230,775—August 3, 1880. G. HAYES. *Compound for preparing the wicks or matches of miners' squibs.*

A mixture of oil, one half pint; sulphur, 32 ounces; camphor, 8 ounces; and red lead 2 ounces; boiled and thoroughly mixed.

241,780—May 24, 1881. W. W. BATCHELDER. *Continuous match.*

An igniting pencil, one-half formed of an igniting composition rich in oxygen—as a mixture of potassium chlorate and binoxide of lead—and the other half of inert material, with a core of an ignitible composition, as phosphorus, the latter being separated from the igniting composition by a septum. It is ignited by friction.

242,127—June 7, 1881. D. BLUMENKRON. *Manufacture of matches.*

A match compound consisting of red oxide of lead, phosphorus, sulphuret of antimony, and a gummy vehicle.

A match having a stem of cotton strands saturated and coated with a translucent inflammable water and air proof solution, and a head waterproofed with an alcohol lac varnish.

251,591—December 27, 1881. L. WAGNER. *Manufacture of friction-matches.*

A match composition of hyposulphite of lead, peroxide of lead, potassium chlorate, crude or gray sulphide of antimony, pulverized charcoal, pulverized glass, saltpeter, sulphur, dextrine, suitable gelatinous binding substances, and water.

275,017—April 10, 1883. H. ENDEMANN. *Manufacture of matches.*

A stick, strip, or sheet of paper, pasteboard, or wood, saturated with oleic acid and having a suitable lighting composition held by a basic binding material, such as protoxide of lead, either incorporated with the igniting composition or first applied to the stick.

284,651—September 11, 1883. J. H. MITCHELL. *Manufacture of friction-matches.*

An impalpable dry powder, such as pumice stone or chalk, is injected upon the freshly dipped heads to form a nonadhesive surface.

302,717—July 29, 1884. W. B. ELTONHEAD. *Match.*

A fusee having a head of an ignitable compound combined with a powder made by grinding up discarded crucibles, cupels, and scorifiers.

335,065—January 26, 1886. F. W. FARNHAM. *Match.*

The head is composed of two separate compounds, one a safety composition, and the other, or tip, an ordinary, frictionally ignitible composition.

340,747—April 27, 1886. C. WEIBACH. *Pyrotechnic match.*

A stick having its head coated with a friction-igniting compound and the portion of the body adjoining the head coated with a pyrotechnic compound, or a series of compounds to produce lights of different colors.

418,202—December 31, 1889. J. LUTZ. *Inflammable composition for matches.*

A solution of sodium chlorate, ammonium sulphate, and a carbohydrate. Matches light by frictional contact on a surface prepared with amorphous phosphorus and washed black trisulphide of antimony.

436,877—September 23, 1890. W. M. NIX. *Match.*

A double-headed waterproof match having the splint previously soaked in a bath of sodium phosphate, so that it will not carbonize, and heads composed of glue or other gelatinous binder, paraffine, potassium chlorate, peroxide of lead, sulphide of antimony, and potassium bichromate.

485,103—October 25, 1892. J. KLEIN. *Match-heading composition.*

A compound of dextrine, water, phosphorus, minium, lampblack, and nitric acid.

562,126—June 23, 1896. C. R. A. G. SCHWIENING. *Match.*

A compound of potassium chlorate, red phosphorus, and calcium plumbate, igniting on any frictional surface.

579,915—March 30, 1897. H. ALLDAY. *Match-striking composition.*

A composition of phosphorus, gritty matter, and gum; thus available for both safety and friction matches.

592,227—October 26, 1897. L. ARONSON. *Match and composition for same.*

A fusee consisting of a stem and a friction-igniting head, with a waterproof, persistently combustible compound, not ignitible by friction, enveloping the head and portion of the stem adjacent thereto. The compound consists essentially of potassium chlorate, chromate of lead, amorphous phosphorus, sulphuret of antimony, dextrine, charcoal, and one or more resinous gums.

594,133—November 23, 1897. G. FIRSCHING. *Manufacture of matches.*

In the manufacture of headless safety-matches the end or ends of the match-splints (both ends may be made ignitible), they having been assembled into bundles, are dipped into a solution consisting of sodium chlorate, gum arabic, a sulphate of a metal proper (as of copper or iron), and water; then thoroughly dried; and then dipped, to a greater depth, in a hydrocarbon waterproof solution, as of rosin, turpentine, oleic acid, and linseed oil.

594,677—November 30, 1897. A. CHATELAN. *Composition for lighting cigars.*

A combustible composition of peroxide of manganese, potassium permaganate, potassium chlorate (with or without powdered coke and cinnamon bark), and an outer frictional-igniting head is applied to the end of a cigar or cigarette. A waterproof cap may be added.

603,666—May 10, 1898. A. TACHAUER AND L. BRALY. *Composition for making matches.*

A mixture of an adhesive substance and plumbates of calcium and strontium, metallic aluminum, and monosulphide of calcium, in suitable proportions, with or without powdered glass, hyposulphite of lead, sodium chloride, and potassium chlorate at defined temperature and proportion.

613,021—October 25, 1898. Y. SCHWARTZ. *Flash-light composition.*

A mixture of a light material, as a quickly combustible magnesium mixture, is combined with a cementing medium, such as a solution of pyroxyline in ether and alcohol, and made into the form of a foil.

614,350—November 15, 1898. H. SEVÈNE AND E. D. CAHEN. *Match composition.*

Sesquisulphide of phosphorus is the essential ingredient, it being mixed with oxidizing bodies, inert matter, and glue.

622,109—March 28, 1899. E. G. BOHY. *Match.*

The match paste contains a hypophosphite, as hypophosphite of calcium, in addition to the usual materials.

625,299—May 16, 1899. G. HACKEL. *Match-paste composition.*

It consists of potash, gum arabic, amorphous phosphorus, potassium chlorate, a mineral coloring matter, hyposulphite of lead, and water, in specified proportions.

627,393—June 20, 1899. W. G. CORDES. *Match composition.*

A mixture of potassium chlorate, ground glass, whiting, plaster of paris, glue, and water, and amorphous red phosphorus, in specified proportions.

653,349—July 10, 1900. W. P. JONES AND H. M. BATES. *Match.*

A nonpoisonous composition, comprising potassium chlorate, sulphide of antimony, a metallic thiosulphate, oxide of manganese, potassium bichromate, an inert substance, red prussiate of potash, and adhesive material.

655,864—August 14, 1900. B. HEIMANN. *Self lighting cigar.*

The ends of the independent leaves, before being rolled into form, are saturated with a composition including potassium chlorate, lampblack, pentasulphide of antimony, charcoal, and gelatine.

GROUP XV.—PLASTICS.

PYROXYLIN PLASTICS.

65,267—May 28, 1867. W. H. PIERSON. *Improved plastic compound made from vegetable fibers.*

A plastic is formed of cotton, hemp, flax, grass, wood, starch, sugar, or other equivalent vegetable matter acted upon by acids (nitric or a mixture of nitric and sulphuric acids) to soften or render soluble or partly soluble said vegetable matter in other solvents than said acids, the vegetable matter not being necessarily dissolved, but softened or pulpified; and articles of manufacture formed therefrom. The plastic, wet with equal parts of alcohol and ether, is applied to cotton batting, or any equivalent fiber, or spread on any mold or surface. Fabrics are waterproofed therewith. The plastic with its solvents is combined with metals and various metallic, silicious, or argillaceous substances in the pulverulent state. The plastic is mixed with drying oils for waterproofing and transparencies. Fur, plush, or other short fiber is attached by means of the plastic to give a fur-like surface. A compound for painting and coloring is formed by admixture of plastic and solvents with paints, oils, dyestuffs, etc.

77,304—April 28, 1868. J. A. McCLELLAND. (*Reissues: 3,777, 3,778—December 28, 1869.*) *Improved material for dental plates and for other purposes.*

Sheets of collodion and its compounds with resinous substances are comminuted and formed into massive forms by treating with ether and alcohol or other solvent, molding, pressing, and drying.

79,261—June 23, 1868. C. A. SEELY. *Improvement in solidified collodion.*

Nitro-glucose is combined with collodion to increase the flexibility and toughness.

88,228—March 23, 1869. L. R. STREETER. *Improved method of veneering articles with pyroxyline.*

Plastic pyroxylin or xyloidin is veneered to a base, dental plates or gums, with or without cement, by compression, and with heat, if need be.

88,260—March 23, 1869. L. R. STREETER. *Improved composition for dental plates.*

Soluble pyroxylin, or xyloidin, or gun-cotton combined with substances that will give the necessary quantities, is used for dental plates, e. g., a compound formed of pyroxylin, 240 parts; wax, 50 parts; zinc white, 30 parts; and coloring matter.

89,253—April 20, 1869. L. R. STREETER. *Improved dental plate.*

Dental plates and gums formed of pyroxylin, reduced to a dough and forced or pressed into molds, brought under pressure, and the solvent evaporated.

89,254—April 20, 1869. L. R. STREETER. *Improved process of treating pyroxle, pyroxyline, and the like substance, for forming useful and ornamental articles.*

Pyroxylin and its compounds are treated with suitable nonsolvents, as alcohol, sulphide of carbon, or naphtha, with or without a cementive agent, and rendered distensible, compressible, and impressible.

89,582—May 4, 1869. J. W. HYATT, Jr., AND D. BLAKE. *Improved compound of ivory dust and other materials.*

Ivory dust or other pulverized material is agglutinized by combining collodion therewith and subjecting the composition to pressure during the evaporation of the volatile elements by means of heat.

90,766—June 1, 1869. J. A. McCLELLAND. *Improved machine for treating collodion and its compounds.*

Collodion and its compounds are mixed in a vacuum.

91,341—June 15, 1869. J. W. HYATT, Jr., AND I. S. HYATT. *Improved method of making solid collodion.*

Pyroxylin, with or without an admixture of ivory dust or other material, is dissolved in a small quantity of solvent, under great pressure, forming a hard and solid product.

91,377—June 15, 1869. D. SPILL. *Improvement in compounds containing xyloidine.*

Compounds are produced of xyloidine in conjunction with oils, camphor, paraffine, and gutta-percha; one or more of the ingredients, as camphor, is dissolved in the oil, the solution forming a nonvolatile solvent for xyloidine, which becomes a part of the resulting compound.

96,132—October 26, 1869. J. A. McCLELLAND. *Improved mode of producing useful articles from collodion and its compounds.*

A sheet of collodion and resinous matter is heated until soft and plastic, and then the article is stamped out between dies.

97,454—November 30, 1869. D. SPILL. *Improvement in dissolving xyloidine for use in the arts.*

Solvents are employed which are not necessarily in themselves solvents of xyloidine, but become so by the addition of other bodies or compounds. Eight specified solvents include as elements camphor or camphor oil, alcohol or spirits of wine, hydrocarbons having a b. p. 105° to 205° C., castor oil, bisulphide of carbon, and aldehyde.

101,175—March 22, 1870. D. SPILL. *Improvement in the manufacture of xyloidine and its compound.*

Cotton or other vegetable fiber or lignine is reduced to a finely divided state; mixed with the aid of mechanical means in a vessel having revolving arms or beating bars, with a suitable quantity of acid; the acid strained from the fiber; the product pressed to remove excess of acid, and the pressed mass then opened out, washed, drained, and dried. The xyloidine is bleached directly after the removal of the acids and before removing it from the vat by means of any bleaching solution, making use of alternate stirrings and rest. It is dyed after draining and before pressing, by any fiber-dyeing process, either before or after the solution of the same in suitable solvents. For spreading upon fabrics 1 part of xyloidine is dissolved in from 5 to 12 parts of solvent, strained through a fine sieve under pressure, and spread on the fabric or surface in a semifluid condition. To reduce it to a nearly dry condition the strained solution or paste is treated in a closed mixing vessel connected with an exhaust apparatus, the vessel being heated to about 100° C. The solvent vapors that pass off are condensed for re-use.

103,209—May 17, 1870. J. LEWTHWAITE. *Improvement in coating fabrics with parkesine.*

Parkesine or xylonite in a plastic state is spread upon the surface of the fabric and immediately subjected to pressure, which is continued for several days, when the material is to be pliant or supple. If the surface is required to be polished it is subjected to the action of rotating brushes after the parkesine has become fixed.

105,338—July 12, 1870. J. W. HYATT, Jr., AND I. S. HYATT. (*Reissues: 5,928—June 23, 1874; 10,546—December 23, 1884.*) *Treating and molding pyroxyline.*

Finely comminuted camphor gum is mixed with pyroxylin pulp and rendered a solvent by the application of heavy pressure in a heated mold.

105,823—July 26, 1870. J. A. McCLELLAND. *Improved process for coating objects with collodion and its compounds.*

Collodion is molded upon the article to be coated, so as to obtain the coating at one operation.

114,242—April 25, 1871. R. H. WINSBOROUGH. *Improvement in the preparation and application of pyroxyline for dental plates.*

Pyroxylin for dental purposes is bleached by the application of chlorine to render it highly translucent. The camphor of dental plates formed by the introduction of camphorated pyroxylin into plaster or porous moulds is expelled by artificial heat or evaporation, or extracted by chemical means.

127,656—June 4, 1872. V. SMITH. *Improvement in compounds for dental purposes.*

A dental plate made of gun-cotton, prepared gum shellac, gum camphor, with a compound formed of oxide of zinc, Chinese vermilion, and oxide of tin and gold, together with sulphuric ether and alcohol.

133,229—November 19, 1872. I. S. & J. W. HYATT. *Improvement in process and apparatus for manufacturing pyroxyline.*

A mixture of pyroxylin and camphor gum is dried by compressing it into cakes and subjecting them to pressure in a pile with interposed layers of absorbent material. Pyroxylin is transformed by means of camphor gum by subjecting the material to pressure in the upper part of a cylinder, kept sufficiently cool to prevent the melting of the solvent during the compression and expulsion of the air, while the lower portion is heated sufficiently high to melt the solvent and transform the pyroxylin, which is forced through the same and out of a discharge nozzle, as a rod, bar, or sheet.

133,969—December 17, 1872. L. DEITZ AND B. P. WAYNE. *Improvement in the manufacture of pyroxyline and articles therefrom.*

Pyroxylin made from ramie, *Bochmeria nivea.*

143,772—October 21, 1873. J. A. McCLELLAND. *Improvement in collodion compounds.*

The converted material is dried by the alternate application of pressure and exposure to the atmosphere. Absorbent pads of felt cloth or other material, with paper interposed, are used while the material is under pressure.

143,865—October 21, 1873. H. T. ANTHONY. *Improvement in preparing soluble cotton for the manufacture of collodion.*

Soluble cotton is subjected to the action of volatilized alkali, preferably ammonia, after the ordinary acid treatment and washing, to remove traces of acid.

150,722—May 12, 1874. D. D. SMITH. *Improvement in artificial coral for jewelry.*

A mixture of gun-cotton, 24 parts; gum copal, 5 parts; alcohol, 10 parts; perchloride of tin, one-twentieth part; gum-shellac, 1 part; ether, 20 parts; perchloride of gold, one-fortieth part; magnesium oxide, 1 part; protochloride of tin, one-twentieth part; and oxide of mercury, 1 part.

152,232—June 23, 1874. I. S. & J. W. HYATT. *Improvement in apparatus and processes for molding celluloids and the compounds of pyroxyline.*

Celluloid is molded in a closed vessel supplied with steam, in a porous or suitable mold. A safety valve regulates the pressure and temperature.

153,196—July 21, 1874. R. FINLEY HUNT. *Improvement in molding celluloids for dentists and others.*

Celluloid is softened and molded with dry heat.

156,352—October 27, 1874. I. S. & J. W. HYATT. *Improvement in manufacturing solidified collodion.*

Pyroxylin is mixed with a latent solvent which becomes active only upon the application of heat, e. g., pyroxylin mixed with 1 part of camphor and 8 parts of alcohol.

156,353—October 27, 1874. J. W. & I. S. HYATT. *Improvement in the manufacture of celluloid.*

A solvent of camphor, such as alcohol, is added to the mixture of pyroxylin and camphor previous to mastication, heat, and pressure, using, say, 100 parts of dry pyroxylin and 25 to 40 parts of gum camphor, with 20 to 40 per cent of alcohol after the aforesaid ingredients are mixed and the aqueous moisture has been expelled.

165,234—July 6, 1875. J. W. & I. S. HYATT. *Improvement in grinding-wheels.*

A grinding wheel made of emery or similar particles united by celluloid, or pyroxylin, or their components.

172,995—February 1, 1876. F. GREENING. *Improvement in the manufacture of soluble gun-cotton and products therefrom.*

A mixture of hydrochloric acid with sulphuric acid and nitric acid is used for the conversion of cotton; as sulphuric acid, 250 parts; hydrochloric acid, 35 parts; and nitric acid, 50 parts. Semitransparent products are obtained by the addition of finely divided and levigated silica, or powdered glass or sulphate of lime; insulating compounds by the use of creosote with soluble gun cotton and certain gums.

173,865—February 22, 1876. C. REAGLES. *Improvement in compositions for dental plates, etc.*

A compound of pyroxylin, 40 parts, by weight; compound ethylated camphor 25 parts; flexible lac, 15 parts; caoutchouc shavings, 5 parts; and cera alba, 5 parts; with Canada balsam and pigments.

184,481—November 21, 1876. P. SWEENEY. *Improvement in lubricating compounds.*

A lubricant consisting of plumbago and collodion, with paper pulp or equivalent fibrous material.

200,939—March 5, 1878. R. H. & A. A. SANBORN AND C. O. KANOUSE. *Improvement in collars and cuffs.*

A fabric for collars and cuffs having outer sheets or layers of celluloid and an interlining of textile or fibrous material.

204,227—May 28, 1878. J. W. HYATT. *Improvement in apparatus for covering cores and forming tubes of celluloid and other plastic materials.*

The composition is fed in equal quantities to all sides of a core, which core is withdrawn from the composition, leaving the tubular coating.

209,570—November 5, 1878. J. W. HYATT. *Improvement in varnishes.*

The solid extract of logwood dissolved in either alcohol or methylic spirit, or both, is combined with a resin soluble in alcoholic or methylic spirit or pyroxyline, and the tincture of the muriate of iron to produce an ebony varnish.

216,474—June 10, 1879. V. TRIBOUILLET AND A. DE BESAUCÈLE. *Improvement in processes of manufacturing solid collodion.*

Dried cellulose is treated with acids in closed glazed vessels followed by pressing, washing, and drying; and the pyroxyle so prepared is treated with solvents, liquid or solid, as camphor, with or without the addition of coloring or other materials.

217,232—July 8, 1879. W. McCAINE. *Improvement in processes for treating pyroxyline.*

Pyroxylin is reduced to a liquid by solvents without heat or pressure—as by dissolving it in a solution of camphor gum in sulphuric ether and then introducing spirits of turpentine—and then cast in porous molds. The product is treated with alcohol to render it plastic, compressed in any desired form, and hardened by immersion in olive oil.

220,502—October 14, 1879. J. S. SPENCER. *Improvement in frames for optical instruments made of celluloid and other fibrous plastic compositions.*

Frames for optical instruments are made from fibrous plastic composition by cutting the frames from the material when in sheets and forming them upon a mandrel. They are removed from the mandrel by introduction of heat into the mandrel.

221,070—October 28, 1879. J. W. HYATT. *Improvement in processes of manufacturing, polishing, and seasoning sheets of celluloid and other plastic material.*

Sheets of celluloid are subjected to pressure between a polished surface and a layer of absorbent material, to both dry and polish.

232,037—September 7, 1880. J. W. HYATT. *Manufacture of celluloid.*

Veneers of celluloid or other plastic material are applied to moldings and uneven surfaces by attaching a strip of the material so as to span the face of the article, then inserting the two in an elastic tube and contracting the tube by means of a vacuum pump or by external pressure.

233,558—October 19, 1880. J. & C. SCHMERBER. *Process of treating pyroxyline in the manufacture of plastic compounds.*

In the manufacture of plastic compounds from pyroxylin, danger of ignition is avoided by treating the nitro-derivative of cellulose, dextrine, or glucose while wet with a solvent, mixing gums, balsams, or pigments and reducing the product to a semi-liquid form by heat, grinding and mixing the semi-liquid mass, and finally drying the compound to a plastic consistency.

233,851—November 2, 1880. N. HART AND R. A. BACON. *Decorating celluloid.*

Celluloid surfaces are decorated and the color united with the celluloid, by the use of aniline colors dissolved in carbolic acid and alcohol.

234,675—November 23, 1880. C. M. JACOB. *Composition for coating surfaces.*

A composition of collodion, creosote from Norway-beech tar, boiled linseed oil, black oxide of manganese, and resin, as a protective coating for materials or for ornamentation. Pigments or mineral colors or bronze or other metal powders may be combined therewith.

237,279—February 1, 1881. S. J. HOGGSON AND G. C. PETTIS. *Method of producing and treating pyroxyline and the manufacture of articles therefrom.*

The fiber is prepared in a sheet form, and treated to the acid bath; the pyroxylin sheet is then applied to the surface to be covered and subjected to a pyroxylin solvent until converted into a gelatinous condition, when it can be rolled, or reëmbossed and finished.

239,423—March 29, 1881. L. S. BEALS. *Treating pyroxyline.*

A compound of mirbane, oil of lavender, benzole, and alcohol is employed as a solvent for pyroxylin, and olibanum frankincense is added, with or without paraffine or vegetable wax, to render it plastic without shrinking or warping.

239,424—March 29, 1881. L. S. BEALS. *Preparing pyroxyline.*

Soluble pyroxyline is rendered permanently plastic under heat by mixing therewith paraffine dissolved in mirbane and the essential oil of lavender.

239,425—March 29, 1881. L. S. BEALS. *Preparing pyroxyline.*

Pyroxylin is treated with vegetable wax, either with or without the addition of paraffine, and preferably by means of a solvent formed of mirbane, oil of lavender, benzole, and alcohol.

239,791—April 5, 1881. J. W. HYATT. *Process of and apparatus for molding celluloid, hard rubber, bonsilate, and analogous plastic materials.*

Molds or dies containing the material are immersed in liquid in a suitable vessel and heat and pressure applied to the liquid.

241,005—May 3, 1881. N. HART AND R. A. BACON. *Decorating celluloid.*

Surfaces composed wholly or in part of compounds of pyroxylin are decorated by applying colors mixed with a solvent of pyroxylin; as aniline colors, dissolved in alcohol and ether, with or without carbolic acid.

244,916—July 26, 1881. O. MONROE. *Process of treating pyroxyline scraps.*

A homogeneous pyroxylin compound is produced from scrap by treating it with a solvent, with or without the addition of a coloring agent, and then subjecting it to the action of a machine which mixes it and compresses it by forcing it through an outlet or nozzle

245,952—August 23, 1881. S. J. HOGGSON AND G. C. PETTIS. *Manufacture of plastic compounds from pyroxyline.*

Pyroxylin, after washing, is treated in a bath containing in solution hydrochlorate of ammonia, muriate of ammonia, or any of the ammoniacal salts, whereby it is rehydrogenized and rendered less explosive. Sulphate of alumina or any of the "octohedron" or isomorphous salts are combined with pyroxylin, alum being a natural base, working hot or cold or in any proportions, with or without the addition of gums, resins, balsams, oils, pigments, dyes, or coloring ingredients. Flour of steatite is added, acting as a lubricant, when the material is to be pressed in molds or dies.

246,891—September 13, 1881. C. S. LOCKWOOD. *Treatment of pyroxyline.*

Chloral is used as a solvent of camphor in a pyroxylin compound containing camphor, say from 5 to 20 parts of chloral to 100 parts of camphor; it lowers the liquifying temperature.

247,734—September 27, 1881. C. O. KANOUSE. *Manufacture of plastic composition from soluble fiber.*

Soluble fiber is mixed and dissolved in a volatile solvent in a heated state in an open vessel, the evaporation accelerating the solvent action.

248,413—October 18, 1881. I. W. DRUMMOND. *Compound of celluloid and luminous material.*

A solid luminous compound formed of celluloid and luminous or phosphorescent material, as sulphide of calcium.

249,690—November 15, 1881. J. B. EDSON. *Drying apparatus for treating pyroxyline, etc.*

Pyroxylin and similar substances are dried by the use of cold intensely dry air, maintained slightly above the freezing point, introduced through the material while in a finely divided condition, and thence discharged from the receiver.

251,410—December 27, 1881. W. B. CARPENTER. *Waterproofing paper with celluloid and other materials.*

A paper made of asbestos and plastic material such as celluloid, lignoid, coroline, shellac, resin, or gums. The paper may be put through a vapor bath of alcohol, when the substance used, as celluloid, is capable of being dissolved in alcohol, or through turpentine vapor when resin or gums are used, and then through heated rolls to thoroughly integrate the material.

253,480—February 21, 1882. W. B. CARPENTER. *Waterproof paper.*

A paper made of paper-pulp and a plastic waterproof material, such as celluloid, lignoid, etc. It may be put through a vapor bath of alcohol or rapidly through a weak alcoholic bath and then through heated rolls (see No. 251,410).

254,280—February 28, 1882. F. W. COTTRELL. *Manufacture of material to form artificial ivory.*

Fiber is rendered soluble in alcohol by immersion in a saturated solution of nitrous acid in sulphuric acid for a very short period, then slightly pressed and allowed to stand twenty minutes to an hour to complete its conversion. It is then washed, neutralized with a saline solution, afterwards adding strong solutions of alum, carbonate of soda, and silicate of soda.

254,751—March 7, 1882. L. WHITE AND K. WHITCOMB. *Apparatus for determining the nitration of cellular fiber.*

It is determined by the deflection of a galvanometer, using a cathode and anode on opposite sides of a mixing vessel, the deflection being compared with that of a standard quality.

256,597—April 18, 1882. P. REID AND J. EASTWOOD. *Manufacture of pyroxyline for use in topical printing.*

An ink or color for topical printing, or "calico printing," composed of dissolved pyroxylin and a coloring agent.

262,077—August 1, 1882. W. McCAINE. *Pyroxyline compound.*

The essential oil of cassia or cinnamon is used in the manufacture of compounds of pyroxylin; combined with alcohol alone or in conjunction with hydrocarbons, say in the proportion of 1 part to 8 of alcohol, it forms a latent solvent.

264,987—September 26, 1882. E. WESTON. *Plastic compound from soluble cellulose.*

Nonfibrous or amorphous cellulose; produced by reconverting or reoxidizing celluloid in a bath of ammonium sulphide, protochloride of iron, or equivalent reducing agents.

265,337—October 3, 1882. H. PARKES. *Manufacture of nitro-cellulose.*

Nitrocellulose is dyed prior to dissolving or softening and treatment with solvent. Tetrachloride of carbon, together with camphor, is employed as a solvent, or a solvent composed of bisulphide of carbon together with camphor, or sulphurous acid and camphor.

269,340—December 19, 1882. J. H. STEVENS. *Manufacture of compounds of pyroxyline or nitro-cellulose.*

In the manufacture of compounds of pyroxylin a new group of active liquid solvents or converting agents is used, comprising oil of spearmint, nitrate of methyl, butyric ether, valeric ether, benzoic ether, formic ether properly dehydrated, salicylate of methyl, formate of amyl, acetate of amyl, butyrate of amyl, valerianate of amyl, sebacylic ether, oxalic ether, amylic ether (amylic oxide), oxidized wood alcohol, oil of cassia, oil of cherry, laurel, heavy cinnamon oil, oil of melissa (balm), oil of birch tar (rectified), and oil of pennyroyal.

269,341—December 19, 1882. J. H. STEVENS. *Manufacture of compounds of pyroxyline or nitro-cellulose.*

In the manufacture of compounds of pyroxylin certain specified oils are used as latent liquid solvents, viz, oil of caraway seed, oil of hyssop, oil of sage, oil of tansy, oil of cloves, or oil of wintergreen, or mixtures of them.

269,342—December 19, 1882. J. H. STEVENS. *Manufacture of componds of pyroxyline or nitro-cellulose.*

In the manufacture of pyroxylin compounds dinitro-benzine or coumarine are used as latent solid solvents.

269,343—December 19, 1882. J. H. STEVENS. *Manufacture of compounds of pyroxyline or nitro-cellulose.*

In the manufacture of pyroxylin compounds certain new menstrua are used in conjunction with camphor, viz, acetone, acetate of ethyl, acetate of methyl, fusel-oil (amylic alcohol), oil of chamomile, oil of fennel-seed, oil of palmarosa, and oil of worm-seed, or mixtures of any of them.

269,344—December 19, 1882. J. H. STEVENS. *Manufacture of compounds of pyroxyline or nitro cellulose.*

In the manufacture of pyroxylin compounds fusel oil is employed as a solvent or menstruum in conjunction with the oils of hyssop, sage, tansy, wormwood, fennel seed, cloves, cinnamon, anise, sassafras, chamomile, wintergreen, caraway seed, or of dill, or with acetal, nitrate of amyl, or nitrite of amyl, or mixtures of any of them.

269,345—December 19, 1882. J. H. STEVENS. *Manufacture of compounds of pyroxyline or nitro cellulose.*

In the manufacture of pyroxylin compounds certain menstrua or mixtures of the same are employed in conjunction with alcohol, ethylic or methylic, viz, acetal, nitrate of amyl, nitrite of amyl, oils of chamomile, valerian, golden rod, sassafras, anise, cinnamon, cumin, [illegible] ether, dill, elecampane, fennel seed, wine (heavy), wormseed, myrtle, laurel, marjoram, peppermint, rue, cinnamon leaves, palmarosa, rosemary, and erigeron.

271,493—January 30, 1883. J. A. McCLELLAND. *Pyroxyline fabric.*

A fabric composed of a sheet or sheets of pyroxylin compound with threads, filaments, or fibers embedded therein and all extending in the same direction.

271,494—January 30, 1883. J. A. McCLELLAND. *Process of covering or coating articles with pyroxyline compounds, etc.*

A sheet or sheets of the plastic material is applied to the article and it is inclosed or surrounded by mobile or yielding material, such as sand or putty and subjected to pressure.

275,215—April 3, 1883. I. S. HYATT. *Process of manufacturing sheets of celluloid and other plastic material.*

A sheet of polished celluloid having a backing is produced by placing the sheet on a polished surface, laying upon the same a backing moistened or saturated with a solvent of pyroxylin, placing upon the backing absorbent material, and subjecting the whole to pressure.

276,443—April 24, 1883. W. McCAINE. *Process of treating pyroxyline compounds.*

A pyroxylin compound containing a latent solvent is reduced to a powder then thoroughly dried, and when dry subjected to heat and pressure, whereby a dry product is obtained free from air cells.

280,745—July 3, 1883. J. W. HYATT. *Press or mold for coating articles with celluloid, etc.*

The article is placed between sheets of celluloid and the whole between diaphragms or sheets of flexible material, when fluid pressure is applied to the upper or lower sides of the diaphragms, the fluid being first hot and then cold.

283,225—August 14, 1883. J. B. EDSON. *Manufacture of artificial ivory.*

Artificial ivory is formed by compressing a number of sheets of zylonite, formed of material of different densities or different characteristics of composition, into one entire mass, and then making sections across the several layers.

286,212—October 9, 1883. D. & D. McCAINE. *Process of treating pyroxyline, etc.*

Pyroxylin is dissolved in a suitable solvent, and it is then treated with benzine or equivalent light mineral oil and resin, producing a homogeneous product, free from air bubbles.

289,239—November 27, 1883. J. B. EDSON. *Apparatus for polishing sheets of zylonite, etc.*

The surface is slightly dissolved by any of the well-known solvents, and then the sheet is subjected to pressure, with the slightly dissolved surface in contact with a highly polished surface, such as glass.

289,240—November 27, 1883. J. B. EDSON, *Forming and finishing surfaces coated with zylonite.*

A sheet of fabric coated on one or both sides with thin sheets of zylonite through the medium of an interposed solvent; produced by passing a thin sheet of zylonite and a sheet of the material to be coated between rolls and introducing a solvent between the two sheets to slightly dissolve the surface of the zylonite, whereby the sheets are immediately compressed.

289,241—November 27, 1883. J. B. EDSON. *Patent leather and a substitute therefor.*

A base-forming material, having attached to one of its surfaces a thin sheet of zylonite having a highly polished surface. It is prepared by partially dissolving one surface of the zylonite and uniting it to the base, and then partially dissolving the exterior surface of the sheet of zylonite and compressing the partially dissolved surface next to a highly polished surface.

289,338—November 27, 1883. J. B. EDSON. *Treating material with zylonite to resemble pebble, goat, French calf, and alligator leather.*

A thin sheet of zylonite of a proper color is applied to a sheet of leather, such as are technically called "splits," by partially dissolving one surface of the zylonite by a suitable solvent and applying the partially dissolved surface to the base, then applying pressure for a period of time sufficient to imitate the kind of leather to be produced and to expel the surplus solvent and air. Then partially dissolving the exterior surface of the sheet of zylonite and compressing it against a highly polished surface.

294,557—March 4, 1884. W. V. WILSON. *Manufacture of material for electric insulation.*

Two hundred parts of wood or vegetable tar is combined with about 100 parts of nitrocellulose—the nitration of which has not been carried beyond the point which will effect its greatest solubility—the latter being softened by one or more of its solvents.

294,661—March 4, 1884. G. M. MOWBRAY. *Plastic compound from pyroxyline and mica.*

Mica is combined with soluble pyroxylin.

296,967—April 15, 1884. J. W. HYATT. *Art of manufacturing celluloid and other compounds of pyroxyline.*

Aqueous particles are removed from pyroxylin pulp by displacement, under pressure, with an unobjectionable liquid, as alcohol, which may be utilized as a solvent.

296,968—April 15, 1884. J. W. HYATT, W. H. WOOD, AND J. H. STEVENS. *Process of and apparatus for effecting the desiccation of pyroxyline pulp.*

A pile is formed of layers of pyroxylin and bibulous material, as blotting paper, and subjected to great pressure, the pyroxylin being subjected then to further pressure between dry sheets.

296,969—April 15, 1884. J. W. HYATT, J. H. STEVENS, W. H. WOOD, AND J. EVERDING. *Manufacture of pyroxyline material.*

Pyroxylin material is impregnated with liquid solvents by forming it into cakes or plates, placing them in a suitable vessel where they are held apart, introducing the liquid solvent, and agitating or rotating the vessel, whereby the solvent repeatedly passes over the surface of the cakes or plates.

296,970—April 15, 1884. J. W. HYATT, J. H. STEVENS, AND W. H. WOOD. *Manufacture of celluloid and other compounds of pyroxyline.*

Pyroxylin is formed into cakes and dried, and the cakes then softened with the required amount of liquid solvent by being formed into a pile with the solvent between the cakes, the material being afterwards mixed or masticated in heated rolls.

297,770—April 29, 1884. J. B. EDSON. *Finishing and glossing the surfaces of fabrics having a coating of some pyroxyline compound.*

The zylonite sheet is passed through a fluid acting as a solvent of the zylonite, which upon evaporation leaves a glossy surface. By passing the sheet or coated fabric around a roller in the solvent, one side only is exposed to the action of the solvent.

297,935—April 29, 1884. J. W. HYATT. *Process of desiccating pyroxyline in comminuted form.*

Nitrocellulose is ground in water and then agitated in contact with an absorbent, as bags of porous absorbent material in a closed revolving vessel.

299,857—June 3, 1884. E. SCHERING. *Preparation of collodion.*

An elastic and transparent composition for the preparation of collodion, becoming hard on drying, neither explosive on concussion nor spontaneously combustible; formed by dissolving pure collodion cotton in ether and alcohol and then freeing from its solvents, by distillation after filtration, sufficient to admit of the mass being cast into forms.

300,158—June 10, 1884. J. H. STEVENS. *Manufacture of material to imitate ivory from pyroxyline compounds.*

Strips are cut of one or more thin pieces of material of varied color, treated with a solvent and compacted on edge into a cake, welded together by heat and pressure, and the block then reduced to sheets.

307,032—October 21, 1884. J. B. EDSON. *Manufacture of artificial ivory from zylonite, etc.*

Two or more sheets of soluble pyroxylin having inert matters, and colored or otherwise, are rolled into scroll form, or assembled in block form, and forced through a nozzle or die, so that the several layers shall partially preserve their parallelism; or the scrolls are molded or consolidated into a cake which is then cut into sheets or sections.

309,831—December 30, 1884. J. B. EDSON. *Manufacture of artificial ivory.*

Imitation grain-ivory produced by combining two or more layers of a pyroxylin base pigmentized in slightly varying proportions; as one group of layers of transparent horn-colored pyroxylin with 7½ per cent of oxide of zinc and one-half of 1 per cent of yellow coloring matter, and another group of the same with 15 per cent of oxide of zinc and one-quarter of 1 per cent of yellow coloring matter.

311,203—January 27, 1885. I. V. REAGLES. *Composition of matter for waterproofing.*

A compound of wood alcohol, 1 gallon; castor-oil, 1 pound; gum camphor, 1 pound; pyroxylin, 1 pound; and gum shellac, one-fourth of a pound.

320,884—June 23, 1885. G. M. MOWBRAY. *Plastic-compound resembling ivory.*

A pyroxylin product composed of a series of sheets of pyroxylin and neutral matter of uniform composition, with one or both surfaces of the superposed sheets colored or tinted, and the sections united together by heat and pressure or solvents and pressure.

329,093—October 27, 1885. J. H. STEVENS AND W. H. WOOD. *Utilizing celluloid, etc., in the production of enameled goods or veneering.*

A sheet of seasoned pyroxylin material is attached to a backing and at the same time given a high polish by subjecting them to pressure accompanied by a high degree of heat, the exposed surface of the pyroxylin being in contact with a polished surface.

329,313—October 27, 1885. J. G. JARVIS. *Manufacture of pyroxyline compounds.*

Gum dammar, gum guaiacum, and gum mastic, separately or in mixtures of two or more of them, are used as solvents of pyroxylin with or without pigments or other coloring matters, fixed or volatile oils.

331,241—November 24, 1885. J. W. HYATT. *Method of combining pyroxyline and its solvents in the manufacture of solid compounds.*

Pyroxylin is reduced to a finely divided dry condition, as soluble paper to shreds, then moistened with vinous alcohol or its equivalent, when the powdered camphor is added and the mixture subjected to masticating rolls, or to heat and pressure.

331,242—November 24, 1885. J. W. HYATT. *Method of combining pyroxyline and its solvents in the manufacture of solid compounds.*

The solvent is sprayed against a moving stream of pyroxylin pulp, the sprayed pulp falling into a closed receptacle and resting until the solvent is diffused, when it is masticated.

331,713—December 1, 1885. J. W. HYATT. *Compounding pyroxyline with its solvents in the manufacture of solid compounds.*

Pyroxylin is formed into flock or pulp, and into thin sheets or films, and the solvent then applied to the sheets by spraying or dipping; the sheets are then massed in a closed receptacle and the conversion finally completed by means of masticating rolls or heat and pressure.

342,208—May 18, 1886. J. G. JARVIS. *Manufacture of zylonite and other pyroxyline compounds and articles made therefrom.*

A seasoned, pulverized, and comminuted pyroxylin compound is treated with a solution of camphor, the solvent of which is not a solvent of pyroxylin—such as coal tar naphtha—and the solvent of camphor is then eliminated from the mass. The mass may then be subjected to the action of heated alcoholic vapor.

346,376—July 27, 1886. M. C. LEFFERTS. *Process of printing upon or decorating the surface of celluloid.*

The design is printed or applied in ink or color and the surface is then subjected to the action of heat and pressure while in contact with a polished surface; to prevent displacement it may be confined in a mold or die.

348,222—August 31, 1886. M. C. LEFFERTS and J. W. HYATT. *Printing on pyroxyline compounds.*

The pyroxylin compound is subjected to heat and pressure while in contact with the engraved plates; the ink may contain or consist of a solvent of pyroxyline and a pigment.

349,658.—September 21, 1886. G. M. MOWBRAY. *Process of and apparatus for washing, decoloring, and draining pyroxyline.*

Pyroxylin is decolorized by the action of oxalic acid and hydrochloric acid; it is then subjected to washing by the flow of water through the mass from one side or end of a tank with overflow at the other.

349,659—September 21, 1886. G. M. MOWBRAY. *Method of drying pyroxyline.*

Pyroxylin is desiccated by means of warmed air (not to exceed 38° C.) which has been previously deprived of its moisture by chilling and passing over lime, either or both.

360,811—April 5, 1887. J. A. McCLELLAND. *Method of treating and ornamenting pyroxyline compounds.*

The surface of celluloid containing a pigment is treated, in proper design, with an acid that will dissolve the pigment. The grain of ivory is imitated by coating the surface with a resist, removing parts of the resist according to the graining, or design, and then applying the pigment solvent. Coloring matter may be afterwards applied, with or without a new resist.

366,231—July 12, 1887. J. A. McCLELLAND. *Plastic compound.*

A non volatile gum or resin is used as a solvent for pyroxylin, as kauri gum, with or without pigments, or fixed or volatile oils.

372,100—October 25, 1887. O. P. AMEND. *Compound for pyroxyline or nitrocellulose.*

Chloride of amyl in conjunction with camphor is used as a solvent for pyroxylin.

383,272—May 22, 1888. A. BENSINGER. *Process of ornamenting celluloid surfaces.*

The design, printed on paper with a suitable ink, is transferred to the celluloid surface, the latter being moistened with a solvent of the same and of the ink, under pressure.

408,344—August 6, 1889. F. GREENING. *Substitute for ivory, etc.*

A base is prepared by treating fibrous or cellulose substances, such as cotton combings, rags, paper, etc., with a mixture of fuming nitric acid and sulphuric acid, in the proportion of 30 per cent of the former and 70 per cent of the latter, then washing, and submitting the product to a bath of sodium chloride and ammonia alum, and then dissolving the base in a solvent composed of a distillation of acetate of lead, 2 parts, and anhydrous lime, 1 part, mixed with fusel oil; 2½ gallons of the distillate to 1½ gallons of fusel oil.

409,345—August 20, 1889. C. F. BRADY. *Process of printing pyroxyline compounds.*

Pyroxylin compounds are imprinted with indelible colors by applying the coloring matter to the sheets by pressure and subsequently subjecting them to the direct action of steam in a chamber.

417,727—December 24, 1889. J. G. JARVIS. *Process of ornamenting articles having a pyroxyline base.*

The design is embossed upon the plastic material, then it is stained or colored, and finally the article is submitted to heat and pressure to smooth the embossed surface.

418,136—December 24, 1889. C. H. KOYL. *Reflector or mirror.*

A sheet of transparent celluloid silvered on the back.

418,237—December 31, 1889. R. C. SCHUPPHAUS AND M. T. WHITE. *Process of manufacturing pyroxyline.*

The body of cellulose is confined in a perforated cage while being treated in a nitrating solution to secure it against disintegration or disarrangement.

421,367—February 11, 1890. W. H. WOOD AND G. C. GILLMORE. (*Reissue: 11,374—April 15, 1890.*) *Process of embossing sheets of celluloid.*

The material is embossed between a die and a "force" composed of celluloid or like material, with heat sufficient to cause them both to flow, the pressure being continued until the material to be embossed is forced into the die, and the die, "force," and material to be embossed retained in contact until cooled.

428,654—May 27, 1890. E. N. TODD. *Process of manufacturing thin sheets of nitro-cellulose, etc.*

Glass plates are vertically suspended in a tank of a solution of collodion or pyroxyline, and after standing until all bubbles have escaped, the solution is drawn off slowly from the bottom of the tank, causing a film of solution to adhere to the plates, which, after drying, is removed as a thin, uniform transparent sheet.

458,157—August 25, 1891. F. ECKSTEIN. *Composition of matter for use as a substitute for glass.*

A composition consisting of collodion-wool, a nonresinous oil, as castor oil, and a balsam or soft resin, with or without magnesium chloride to lessen inflammability.

460,086—September 22, 1891. W. HARVEY. *Artificial horn and method of producing the same.*

Artificial horn, produced by coloring sheets of plastic material, as celluloid or pyroxylin, in layers or strata, cutting the sheets into conical figures or forms, nesting or laminating and uniting them, and then rolling and turning off the projecting edges of the series of nested and united cones to constitute a solid laminated mass or rod.

465,784—December 22, 1891. W. SCHMIDT. *Process of polishing sheets of pyroxyline material.*

A sheet of pyroxylin material is subjected to the action of vapor of alcohol and then pressed between polished surfaces.

470,451—March 8, 1892. A. SEHER. *Manufacture of compounds of pyroxyline.*

As direct solvents of pyroxylin or nitrocellulose, there is used propion, butyron, valeron, capron, methyl-ethyl-ketone (acetyl-ethyl), methyl-propyl-ketone, methyl-butyl-ketone, methyl-valeral, ethyl-butyl-ketone, and methyl-amyl-ketone, singly or any mixtures thereof.

474,814—May 17, 1892. A. A. C. DE COËTLOGON. *Process of preparing celluloid and similar materials for printing.*

Celluloid having a surface adapted to be printed upon and absorb the ink; produced by forming on the surface a multitude of minute grains or pores, as by a sand jet, then washing the surface, then varnishing, applying an impalpable powder—as sulphate of magnesia and sulphate of baryta—and then producing a calender finish.

490,193—January 17, 1893. B. B. GOLDSMITH. *Process of producing nitro cellulose or celluloid surfaces.*

Wood or other absorbent material is first given a coat or coats of varnish containing pyroxylin or pyroxylin compound, then layers of varnish containing resin, with or without a finishing coat of varnish containing pyroxylin.

508,124—November 7, 1893. H. D. TURGARD. *Process of denitration of nitro-cellulose and its compounds.*

Nitrocellulose and its compounds are denitrated by immersing the material in a solution of hydro-sulphate of ammonia and a metallic sulphide, as sulphide of silver.

531,158—December 18, 1894. H. DE CHARDONNET. *Process of manufacturing artificial silk.*

Hydrated pyroxylin—differing from ordinary pyroxylin by containing at least 25 per cent of water and of greater solubility—is produced by treating pyroxylin while still moist with hydrated ether; which hydrated pyroxylin is dissolved to form collodion and spun into threads by discharging through nozzles; certain substances may be added to increase the fluidity. The spun collodion is denitrated by immersion in a bath formed by mixing calcium monosulphide, sulphate of ammonia and water, and removing the precipitate; the bath may be regenerated by adding sulphuric acid, and then calcium monosulphide and separating the precipitate.

546,360—September 17, 1895. J. H. STEVENS AND E. D. HARRISON. *Production of imitation onyx from pyroxylin compounds.*

A rod or sheet of pyroxylin composition in imitation of onyx, consisting of two or more light tints, with streaks of a darker color breaking through or interspersed with the lighter tints; produced by forming the light-tinted parts in solidified strata, cutting through these strata across the edges, inserting coloring matter or pyroxylin of a different color between the cut parts, and then solidifying the whole into blocks or masses.

559,392—May 5, 1896. F. LEHNER. *Process of making artificial silk.*

Two solutions are formed; first, of silk waste digested with caustic alkali, or a solution of copper or a copper salt in ammonia, precipitated from such solution and finally dissolved in concentrated acetic acid; and, second, of a substance containing cellulose macerated with a solution of copper or a copper salt in ammonia, nitrated, and then partially denitrated; which two solutions are mixed and caused to pass through a congealing solution, as of oil of turpentine or other hydrocarbon, to form a thread. The thread is laid in a solution containing soluble glass, whereby it is rendered incombustible.

562,626—June 23, 1896. F. LEHNER. *Art of preparing artificial silk.*

Cellulose is gradually introduced into a nitrating bath and the temperature of the bath progressively raised as the cellulose is added, whereby a homogeneous mixture of tri and tetra nitrocellulose is obtained. The whole mixture is then maintained at the final temperature for several hours; the nitrating liquid separated by centrifugal action; the acid-moist resultant mass immersed in sulphuric acid; a vulcanized drying-oil then added; the mixture finally dissolved in a suitable solvent, such as acetone, an alcohol, or alcohol ether; then the thread is drawn and the same immersed in warm water, then dipped in a solution of ammonium or other alkali hydrosulphide and a neutral magnesium salt at 40° C. (keeping the same therein until the rainbow colors of cellulose are visible under the microscope in polarized light), and finally washed, dried, and finished.

562,732—June 23, 1896. F. LEHNER. *Process of and apparatus for making artificial silk.*

A ground solution is passed into a bath free from oxygen—as of a hydrocarbon, such as oil of turpentine—and the thread drawn from the bath. The ground solution consists of resin, linseed oil, nitrocellulose, and an inorganic salt to render the thread incombustible.

563,214—June 30, 1896. H. M. TURK. *Composition of matter for manufacturing artificial silk.*

It consists of nitrocellulose, 96 parts; gelatin or isinglass, 2 parts; and albumin, 2 parts; dissolved in 1,600 parts of glacial acetic acid.

587,097—July 27, 1897. A. L. KENNEDY. *Composition of matter and article treated therewith.*

A coating solution for the surface of leather and other similar materials, consisting of 1 gallon of amylacetate, 12 ounces of nitrocellulose, 10 ounces of lanolin, and 3 ounces of corn oil, mixed and combined with aniline or other coloring matter.

590,842—September 28, 1897. A. L. KENNEDY. *Waterproof cloth and process of making same.*

A fabric having its face portions composed of natural fibers and its inner portions composed of threads or strands impregnated with a salt of cellulose, whereby ordinary unglazed or uncoated and nappy faces are presented, produced by entwining ordinary threads along with strands of undissolved soluble salt of cellulose to form a fabric, and then subjecting it to a solvent of the salt of cellulose to dissolve the extra strands and cause the dissolved salt to impregnate the ordinary threads.

600,824—March 15, 1898. J. H. STEVENS AND M. C. LEFFERTS. *Process of manufacturing pyroxylin sheets.*

A nonoxidizing solution of a pyroxylin compound is caused to flow in the form of a moving, continuous, fluid sheet, as onto a revolving drum, the thickness of the sheet being regulated by removing the surplus solution, and the volatile ingredients are then evaporated.

601,927—April 5, 1898. F. G. ANNISON. *Enameled paper and compound used to enamel same.*

An enameled paper adapted to receive and retain printing and lithographic impressions, the enamel consisting of a nitrocellulose compound containing oil and pigment, the latter being larger than or in excess of the nitrocellulose.

602,159—April 12, 1898. E. D. HARRISON AND C. H. THURBER. *Method of producing pyroxyline imitations of mosaic.*

Pyroxylin compounds are formed into sticks or rods; coated with a dyeing substance; arranged side by side; welded into a block; and sheets are then cut therefrom.

602,797—April 19, 1898. F. G. ANNISON. *Art of coating fabrics or permeable materials with nitrocellulose compounds and product produced thereby.*

A flexible permeable base is first impregnated to the desired depth with a liquid solution of the compound, dried, and then one or more coats of a heavier solution of the compound are applied, each dried in turn; the coat may be finally compacted by heat and pressure, with or without embossing.

603,001—April 26, 1898. W. H. WOOD AND J. H. STEVENS. *Waterproof fabric.*

A waterproof fabric having two or more successive coatings of a flexible pyroxylin compound, the under coating being more flexible than the upper coat or coatings, as, for example, the inner stratum being richer in oil than the outer stratum.

603,526—May 3, 1898. J. R. FRANCE. *Method of manufacturing pyroxylin compounds in imitation of marble.*

Pyroxylin compounds of different colors are produced; formed into fragments, dipped into a dye dissolved in a solvent of pyroxylin, and the dipped fragments calendered together to form sheeting; which may be compressed into blocks and cut.

608,726—August 9, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition of pyroxylin, and a lead salt of a volatile monatomic fatty acid, as lead acetate, capable of transparent effects.

608,727—August 9, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition of pyroxylin and lactamid, capable of transparent effects.

609,575—August 23, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition consisting of pyroxylin and a salt of camphoric acid, as sodium camphorate.

610,566—September 13, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition consisting of pyroxylin and a manganese salt of the volatile monatomic series of fatty acids, as acetate of manganese.

610,615—September 13, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition of pyroxylin and a lactophosphate, as lactophosphate of calcium.

610,953—September 20, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition of pyroxylin and a salt of hypophosphorous acid, as sodium hypophosphite; capable of transparent effects.

612,066—October 11, 1898. J. H. STEVENS. *Waterproof fabric.*

A fabric coated or impregnated with a pyroxylin compound containing a nondrying oil, as castor oil, and a salt containing a halogen element, as zinc chloride.

612,067—October 11, 1898. J. H. STEVENS. *Waterproof fabric.*

A fabric waterproofed by a pyroxylin compound which contains pyroxylin, castor oil, and a salt which contains an aromatic acid, as salicylate of soda.

612,531—October 18, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition of pyroxylin and a lithium salt of a volatile monatomic fatty acid, as lithium acetate; capable of transparent effects.

612,553—October 18, 1898. J. H. STEVENS. *Waterproof fabric.*

A fabric coated or impregnated with a pyroxylin compound consisting in part of castor oil and a salt or compound containing the phenoylic radical C_6H_5O, as sulphocarbonate of soda.

613,400—November 1, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition of pyroxylin and a salt of succinic acid having an inorganic base, as potassium succinate.

614,514—November 22, 1898. J. H. STEVENS. *Pyroxylin compound.*

A composition of pyroxylin and an inorganic salt of a halogen acid derived from the volatile members of the monatomic series of fatty acids, as an inorganic salt of chloracetic acid.

615,319—December 6, 1898. J. H. STEVENS. *Waterproof fabric.*

A fabric waterproofed by a pyroxylin compound which contains pyroxylin, oil, camphor, and naphthol.

615,446—December 6, 1898. B. B. GOLDSMITH. *Finishing fibrous or absorbent surfaces.*

A coat or coats of an aqueous solution of casein or casein compound is first applied, and then one or more coats of pyroxylin varnish, with or without finishing coats of gloss varnish.

617,450—January 10, 1899. J. H. STEVENS. *Pyroxylin composition.*

A composition containing pyroxylin and a urea salt of an acid of the aromatic series containing carboxyl (COOH), as urea benzoate; capable of transparent effects.

619,037—February 7, 1899. J. R. FRANCE. *Pyroxylin imitation of mosaic and method of manufacturing same.*

A pyroxylin imitation of mosaic, produced by forming pieces of pyroxylin compounds of different colors, form, and size, dipping them in a dye dissolved in a solvent of pyroxylin, pressing the dipped pieces into cakes, and cutting sheets therefrom.

621,382—March 21, 1899. J. H. STEVENS. *Pyroxyline compound.*

A composition containing pyroxylin and a salt of an acid of the aromatic series containing carboxyl (COOH), said salt having an inorganic base, as sodium benzoate, capable of transparent effects.

621,434—March 21, 1899. J. H. STEVENS. *Transparent pyroxylin plastic composition.*

A solid transparent composition consisting of pyroxylin, camphor, and a preserving potassium salt of a volatile monatomic fatty acid, as potassium acetate, the said salt not exceeding 3 per cent by weight of the pyroxylin.

622,290—April 4, 1899. J. H. STEVENS. *Transparent pyroxylin plastic composition.*

A solid transparent composition consisting of pyroxylin, camphor, and a preserving sodium salt of a volatile monatomic fatty acid, as sodium acetate, the said salt not exceeding 3 per cent by weight of the pyroxylin; the best effects being attainable with about 1 per cent.

622,291—April 4, 1899. J. H. STEVENS. *Transparent pyroxylin plastic composition.*

A transparent solid composition consisting of pyroxylin, camphor, and a preserving calcium salt of a volatile monatomic fatty acid belonging to the group which consists of calcium propionate and calcium butyrate; the said salt never more than 3 per cent and for proper proportions should not exceed 1 per cent.

622,292—April 4, 1899. J. H. STEVENS. *Transparent pyroxylin composition of matter.*

Barium butyrate is mixed with pyroxylin, not to exceed 5 per cent.

622,293—April 4, 1899. J. H. STEVENS. *Transparent pyroxylin plastic composition.*

It consists of pyroxylin, camphor, a liquid solvent, and an inorganic salt of lactic acid, as the lactates of potassium, strontium, calcium, sodium, and barium, the salt not to exceed 5 per cent of the pyroxylin; preferably about 1 per cent.

622,294—April 4, 1899. J. H. STEVENS. *Transparent pyroxylin plastic composition.*

A solid transparent composition consisting of pyroxylin, camphor, and a preserving zinc salt of a volatile monatomic fatty acid, as zinc formate, zinc acetate, zinc propionate, etc., the salt not exceeding 5 per cent of the pyroxylin.

622,727—April 11, 1899. J. H. STEVENS. *Flexible skin or fabric.*

A fabric waterproofed by a pyroxylin compound which contains pyroxylin, castor oil, beta-naphthol, and amyl acetate.

625,313—May 23, 1899. L. L. BÉTHISY. *Uninflammable nitrocellulose product*

It is composed of nitrocellulose with a binder rendered incombustible by the presence of zinc chloride, as alcohol, essential oil, vaseline oil, acetic ether, zinc chloride, and white gelatine.

626,732—June 13, 1899. J. H. STEVENS. *Pyroxylin composition.*

A composition of pyroxylin and strontium butyrate; capable of transparent effects.

651,364—June 12, 1900. I. KITSEE. *Compound useful as a substitute for rubber.*

A composition consisting of a glue compound—as employed for printers' rolls—and celluloid.

657,535—September 11, 1900. C. G. HAGEMANN AND F. O. C. ZIMMERMANN. *Manufacture of celluloid.*

A product consisting essentially of gelatinized nitrocellulose and a hydrate or hydroxid of a metal, as sulphate of alumina, produced by molecularly combining with a solution nitrocellulose; a concentrated solution of a hydrate or hydroxid of a metal; reacting with a concentrated solution of caustic soda; removing the cellulose solvent and soluble constituents: drying, and gelatinizing the compound with a solvent of nitrocellulose holding camphor in solution.

662,961—December 4, 1900. A. N. PETIT. *Solvent material for treating surfaces of celluloid.*

A mixture of a solvent of celluloid and a fatty acid or like material, as amyl acetate and oleic acid.

663,739—December 11, 1900. J. DUQUESNOY. *Process of making artificial-silk thread.*

Nitrocellulose is dissolved in a solvent composed of equal parts of acetone, acetic acid, and amyl alcohol, and expressed from a capillary orifice.

665,975—January 15, 1901. A. PETIT. *Composition of matter for manufacturing artificial silk threads.*

The composition consists of 100 pounds of dry nitrocellulose, 7 pounds of india-rubber solution, and 5 pounds of stannous chloride, mixed with sufficient solvent to bring it to the required consistency.

VISCOSE.

520,770—June 5, 1894. C. F. CROSS, E. J. BEVAN, AND C. BEADLE. *Plastic compound of cellulose.*

A soluble plastic compound derived from cellulose, caustic alkali, and carbon di-sulphide: as by treating cellulose, saturated with a strong solution of caustic soda, in a chamber with carbon di-sulphide.

530,826—December 11, 1894. C. F. CROSS AND E. J. BEVAN. *Manufacture of cellulose acetate.*

The intermediate product manufactured by mixing cellulose hydrate with zinc acetate solution and drying and dehydrating, is treated with acetyl chloride, the crude product of the reaction washed, pressed, and dried, and then treated with chloroform, whereby a solution of cellulose acetate is obtained free from cellulose and the solvent finally evaporated.

571,530—November 17, 1896. R. LANGHANS. *Method of and composition for making artificial silk.*

A noninflammable silk, produced from cellulose and other analogous carbohydrates by purifying the material, subjecting it to the action of phosphosulphuric, sulphuric, and phosphoric acids until a viscid syrup is obtained, increasing the stability of the syrup by treatment with an ethyl ester, drawing it into a filament, removing the acid, and hardening.

604,206—May 17, 1898. C. F. CROSS, E. J. BEVAN, AND C. BEADLE. *Modification of cellulose and method of preparing same.*

A structureless insoluble modified cellulose, obtained by first treating cellulose with caustic alkali and carbon di-sulphide (No. 520,770), and then decomposing the soluble mass thus obtained, as, for example, by exposure to heat above 100° C. or by exposure to steam at the same temperature.

617,009—January 3, 1899. M. FREMERY AND J. URBAN. *Process of manufacturing artificial silk.*

Cellulose is dissolved, without decomposing the same, in a cupro-ammonium salt solution and caused to flow in a thread or fiber-like stream into a bath containing a precipitant of cellulose, such as an acetic-acid solution, whereby the cellulose is precipitated from its solution in a thread or fiber-like form. The thread is wound within the bath as precipitated, then unwound and wound outside the bath, and simultaneously subjected to the action of a drying agent.

625,033—May 16, 1899. J. F. HOYNE. *Process of manufacturing fiberless thread.*

Cellulose is dissolved in a basic solution of zinc nitrate, chloride, or other zinc salts, filtered, and pressed through small holes into methylated spirits—thereby coagulating the cellulose—when the threads are strained nearly to breaking and dried under strain.

634,571—October 10, 1899. J. C. CHORLEY. *Method of producing cellulose films for photographic or other purposes.*

Films of any desired length are produced by a continuous operation by supplying viscose in a regulated and evenly distributed quantity or film, heating the gradually moving film, and simultaneously subjecting it to a current of air traveling in the opposite direction, and subjecting the film to the action of boiling brine to decompose the viscose and regenerate the insoluble cellulose in film form.

646,044—March 27, 1900. E. THOMAS, J. BONAVITA, AND M. OLIVIER. *Manufacture of viscose.*

To alkali cellulose there is added 25 to 30 per cent of sodium sulphite, and about 30 per cent of zinc oxide, calculated on the cellulose contained in the alkali cellulose, and the mixture is then treated with carbon disulphide; the product being free from the objections of color and odor heretofore attaching to viscose.

646,351—March 27, 1900. E. BRONNERT. *Production of cellulose solution for manufacturing threads.*

Clean cellulose is treated with a concentrated caustic alkali lye, washed with much water, treated for two to four hours with a weak bleaching liquor, submitted to centrifugal action, and finally dissolved while wet in an ammoniacal solution of cupric oxide.

646,381—March 27, 1900. E. BRONNERT. *Production of cellulose solutions for manufacturing threads.*

Cellulose in a finely divided state is treated for about one hour with a cold, concentrated solution of caustic alkali, then the product is mixed with a powdered copper salt—such as copper sulphate—in proportion equivalent to the caustic alkali used, avoiding a rise in temperature, and finally the product is dissolved in strong ammonia solution.

646,799—April 3, 1900. E. BRONNERT. *Process of producing solutions of cellulose.*

Cellulose, freed from fat and bleached, is treated with concentrated caustic-alkali solution, as in the mercerizing process, at a low temperature, then submitted to centrifugal action and washed, then treated with an oxidizing agent, and after again washing and submitting to centrifugal action, it is dissolved directly in concentrated zinc-chloride solution.

648,415—May 1, 1900. W. H. KRUG. *Substitute for horn and process of manufacturing same.*

A vegetable tissue, as pith, is subjected to the action of an alkali solution, washed and ground, the nongelatinized fibers removed by washing, and the resultant mass drained and dried.

650,715—May 29, 1900. M. FREMERY AND J. URBAN. *Process of manufacturing cellulose products.*

Cellulose products, as threads and films, are subjected for a short time to the action of water at an elevated temperature of from 60° to 100° C., and then dried at a comparatively low temperature not exceeding 40° C., to impart a glossy appearance and a comparatively great strength.

665,975—January 15, 1901. A. PETIT. *Composition of matter for manufacturing artificial silk threads.*

It consists of about 100 pounds of dry nitrocellulose, 7 pounds of india-rubber solution, and 5 pounds of stannous chloride, mixed with a sufficiency of solvent to bring it to the required consistency.

RUBBER AND RUBBER SUBSTITUTES.

240—June 17, 1837. C. GOODYEAR. *Improvement in the process of divesting caoutchouc, gum-elastic, or india-rubber of its adhesive properties, and also of bleaching the same, and thereby adapting it to various useful purposes.*

The adhesiveness of the surface of caoutchouc is destroyed by the application of an acid solution of the metals, as, for example, a nitrate of copper or a nitrate of bismuth. Caoutchouc paste is bleached by incorporating therewith lime, preferably quicklime.

1,090—February 24, 1839. N. HAYWARD (ASSIGNOR TO C. GOODYEAR). *Improvement in the mode of preparing caoutchouc with sulphur for the manufacture of various articles.*

Sulphur is combined with caoutchouc, either in solution, as in oil of turpentine, or in substance, causing the gum to dry more perfectly and to improve the whole substance.

3,633—June 15, 1844. C. GOODYEAR. (*Reissues: 156 and 157—December 25, 1849; 1,084—November 20, 1860.*) *Improvement in process for manufacture of india-rubber.*

India rubber, combined with or in the presence of sulphur, is cured by subjecting it to a high degree of artificial heat, say, from 212° to 350° F., or approaching 270° F.; or a carbonate or other salt or oxide of lead is added, as india rubber 25 parts by weight, sulphur 5 parts, and white lead 7 parts. Layers of cotton batting may be interposed between those of the gum.

4,005—April 22, 1845. N. GOODYEAR. *Improved method of manufacturing india-rubber cloth and sheet india rubber.*

The gum is impregnated with grit, iron or other metal filings, or other hard substances.

5,592—May 23, 1848. R. A. BROOMAN. *Applications of the substance called gutta-percha alone or in combination with other substances to certain manufacturing uses and purposes and the modes or processes of preparing, combining, and applying the same.*

Gutta-percha is freed of foreign matter by soaking in water and squeezing between rolls, then kneaded in a machine, when it may be mixed with caoutchouc or sulphur or both, and pigments. If caoutchouc is added, a degree of heat not less than 150° F. is necessary to effect the amalgamation. Pulverized chalk or other soft powder may be added, or ground emery, sand, or other hard substance. It is employed in manufacture by molding, stamping, or is used for enveloping. It is reduced to a powder and employed in the making of casts, forms, and impressions in relief, the mold or surface being heated until the material becomes ductile and fills all parts of the mold or form.

8,075—May 6, 1851. N. GOODYEAR. (*Reissues: May 18, 1858—556–557.*) *Improvement in the manufacture of india rubber.*

A combination of india rubber, sulphur, and magnesia, or lime, or a carbonate, or a sulphate of magnesia, or of lime, with or without shellac for making a hard and inflexible substance.

10,714—April 20, 1886. A. KISSEL. *Hardening resins.*

Resins or resinous products are hardened by partially or wholly neutralizing the contained acid or acids with caustic lime or other caustic alkaline earth.

11,096—June 13, 1854. THOMAS, EARL OF DUNDONALD. *Improvement in compositions for coating telegraph wires and for other purposes.*

A compound of bitumen, asphaltum, or mineral pitch, 75 parts; india rubber, 15 parts; and 10 parts of a mixture formed by dissolving gum shellac (1 part) and resin (4 or 5 parts) in oil of petroleum, dead-oil, or naphtha, with steam heat.

15,067—June 10, 1856. A. G. DAY. (*Reissues: 756 and 757—July 12, 1859.*) *Improvement in cleansing caoutchouc.*

Alkali or its equivalent is used for separating bark, sticks, etc., from crude caoutchouc and other vulcanizable gums. The caoutchouc is charged with alkaline liquor by means of an exhausting apparatus.

21,122—August 10, 1858. A. G. DAY. (*Reissues: 620—November 9, 1858; 5,230, 5,231, and 5,232—January 14, 1873.*) *Improvement in hard rubber.*

A mixture of 2 parts by weight of india rubber or other vulcanizable gum, and 1 part of sulphur, vulcanized at a temperature commencing at about 275° F. and carried to 300° or upward.

25,110—August 16, 1859. C. GOODYEAR. *Porous india-rubber cloth.*

A woven or equivalent fabric having a thin porous coating of india rubber or allied gum.

25,192—August 23, 1859. C. GOODYEAR. *Porous napped india rubber fabric.*

A fabric composed of cloth and india rubber rendered pervious to air, by having fibers incorporated therewith and impervious to water, with a face of flocks, clippings, or shavings of woolen or other fibers.

26,698—January 3, 1860. J. MURPHY. *Improvement in treating waste and inferior gums.*

The process consists in: First, the manufacture of hard stock of vulcanizable gum by blending it with sulphur and vulcanizing; second, the reduction of the hard stock to powder; third, the formation of a compound of the ground stock and raw gum by blending; and, fourth, the vulcanization of this compound.

27,770—April 10, 1860. J. M. BATCHELDER. *Improvement in insulation of submarine telegraph wires.*

A telegraph wire or other conductor of electricity insulated with a compound substance composed of pulverized silex, glass, or other nonconducting material mixed with india rubber and sulphur and subsequently vulcanized.

27,837—April 10, 1860. C. F. E. SIMON. *Improvement in restoring waste vulcanized rubber.*

Ground or cut waste of vulcanized india rubber is mixed with chloride of lime (100 parts of rubber waste and 2 parts of chloride of lime) and exposed to a heat of 900° to 1,200° F., with stirring, till the volitilization of the sulphur is complete.

29,717—August 21, 1860. A. C. RICHARDS. *Improvement in devulcanizing waste rubber.*

Rubber waste is ground to powder and treated with steam in a closed vessel at a temperature of over 600° F.

30,181—September 25, 1860. DU B. D. PARMELEE. *Improvement in restoring waste vulcanized rubber.*

Waste rubber is powdered and then combined with india rubber which has been modified by heat, so as to obtain it either in a semiliquid or melted condition or in a liquid or vaporous condition.

31,240—January 29, 1861. R. F. H. HAVEMANN. *Improvement in compositions of caoutchouc.*

A substitute for ivory and bone produced by the admixture of oxide of zinc with chlorine-treated rubber or its chlorine-treated allied gums, in the proportion, say, of one part of zinc oxide to two parts of gum.

31,241—January 29, 1861. R. F. H. HAVEMANN. *Improvement in compositions of caoutchouc.*

A substitute for wood, ivory, and bone produced by the admixture with chlorine-treated rubber or its chlorine-treated allied gums, of one-eighth of a dram of aqua-ammonia, one-eighth of a dram of powdered carbonate of ammonia, and half a pound of lime, per pound of gum, with pressure and heat.

33,094—August 20, 1861. C. McBURNEY. *Improvement in utilizing waste vulcanized rubber.*

Comminuted waste rubber is treated with an oil having no solvent action upon the gum, such as resin oil, castor oil, etc.

34,309—February 4, 1862. T. J. MAYALL. *Improvement in restoring waste rubber.*

Vegetable tar or pine oil is combined or incorporated with waste vulcanized rubber.

40,407—October 27, 1863. C. H. & D. E. HAYWARD. *Improvement in treating waste rubber.*

Waste rags of fibrous material and rubber are boiled in an acid or alkali to destroy the tenacity of the fibers of the rags, so that the rubber may be reground and the material will not blister when reused.

40,491—November 3, 1863. T. J. MACKALL. *Improvement in restoring waste rubber.*

Rubber waste is reduced to a fine condition and then subjected to the direct action of the flames of gas or inflammable liquids.

46,610—February 28, 1865. E. L. SIMPSON. *Improvement in the process of manufacturing india rubber, gutta-percha, etc.*

A concentrated preparation of sulphur and linseed or other vegetable oil is employed in the manufacture of india rubber, to produce a product free from the disagreeable odor and deleterious effects of vulcanized rubber.

46,750—March 7, 1865. S. C. BISHOP. *Improved composition for insulating telegraph wires.*

A mixture of gutta-percha or india rubber, 4 parts; paraffine, 1 part; wheat flour, 2 parts; and resin, 1 part; or in lieu of this gutta-percha or india rubber, 6 parts; paraffine, 2 parts; white-oxide of zinc, 1 part; catechu, 1 part; and gelatine or glue, 2 parts; mixed in solution or by heated rolls.

51,331—December 5, 1865. F. MARQUARD. (*Reissue: 2,180—February 20, 1866.*) *Improvement in the manufacture of white rubber.*

After bleaching with chlorine gas the rubber or like gum is washed with hot water. It is then subjected to distillation. The product after straining, pressing, and drying, is redissolved in a small quantity of chloroform mixed with phosphate of lime, and subjected to pressure in hot molds.

51,332—December 5, 1865. E. MARQUARD. (*Reissue: 2,179—February 20, 1866.*) *Improvement in the manufacture of white rubber.*

Rubber dissolved in chloroform (or other solvent) is bleached by treatment with caustic ammonia gas or chloride of ammonia. It is then washed with hot water, subjected to distillation, and redissolved as in No. 51,331, and combined with phosphate of lime or a carbonate of zinc by means of pressure in hot molds.

54,523—May 8, 1866. C. L. FRINK. (*Reissues: 4,942—June 11, 1872; 6,014—August 11, 1874.*) *Improvement in vulcanized rubber compounds for packings and other purposes.*

A vulcanized rubber compound formed of rubber, 10 parts; plumbago, 20 parts; carbonate of lead or litharge, 6 parts; sulphur, 4 parts, and brass or other metal filings, 6 parts.

54,554—May 8, 1866. N. JENKINS. (*Reissue: 3,579—August 3, 1869.*) *Improvement in the manufacture of elastic packing.*

An elastic packing, composed of at least four-tenths of finely pulverized refractory earthy material, such as French chalk, mingled with rubber, prepared for vulcanizing and then vulcanized.

58,615—October 9, 1866. A. G. DAY. (*Reissues: 6,707—October 19, 1875, product; 6,708—October 19, 1875, process.*) *Improvement in artificial caoutchouc.*

Vegetable and mineral oils are combined with gum resins or other resinous bodies, and sulphur at a temperature sufficient to produce vulcanization; the oils and resins are first mixed under heat and the sulphur then added and the temperature increased. It may be mixed with india rubber or gutta percha.

62,055—January 26, 1867. W. MULLEE. *Improvement in process of preparing india rubber.*

Thin sheets of rubber are suspended in a bath of melted sulphur heated to 220° to 290° F., then removed, the crystals of sulphur formed thereon removed, and a pile of the sheets are then kneaded, worked, and vulcanized.

83,031—October 13, 1868. S. C. BISHOP. *Improved compound for insulating telegraph and electric wires.*

It consists of 2¼ pounds of asphaltum, one-quarter pound of gutta-percha, one-quarter pound of crude resin, half a gallon of spirits of turpentine, with about 1 gill of boiled linseed oil and 2 ounces of umber.

94,631—September 7, 1869. S. MOULTON. *Improved printers' inking roller from rubber sponge.*

To obtain a substance of a mossy nature, vulcanized india rubber is pulverized and subjected to a second vulcanization.

97,880—November 17, 1869. E. CHESTERMAN. *Improvement in the manufacture of rubber sponge.*

Artificial sponge is made by incorporating into a homogeneous mass, on hot rolls, specified ingredients—salt, salts of soda, alum, or other deliquescent or soluble solid not affected by moderate heat, either with or without such liquids as molasses, etc.—and afterwards expanding, revulcanizing, and setting. It is expanded by treatment in a hot water, steam, or other bath. Color is imparted by the use of golden sulphuret of antimony incorporated with the compound.

137,509—April 1, 1873. W. A. TORREY. *Improvement in vulcanized rubber compounds.*

Mica is combined with rubber prior to vulcanization.

140,281—June 24, 1873. D. M. LAMB. *Improvement in the production of waterproof gum.*

Waterproof gum made from the inspissated juice of plants of the asclepias or milkweed family, or any of the analogous plants possessing like properties.

140,282—June 24, 1873. D. M. LAMB. *Improvement in the production of waterproof gums.*

A waterproof gum is extracted from plants of the asclepias or milkweed family, by subjecting the plants to fermentation, and inspissating the resulting liquid by evaporation.

140,283—June 24, 1873. D. M. LAMB. *Improvement in preparing waterproof gums from flaxseed, etc.*

A vulcanizable gum is produced from flaxseed or other seeds possessing similar properties—as rape and cottonseed—by maceration, straining, and subsequent inspissation.

142,908—September 16, 1873. C. L. FRINK. *Improvement in rubber compounds for the manufacture of packings, etc.*

A mixture of india rubber or other vulcanizable gum with sulphur and other solid materials, such as various earths, oxides, metal filings, and the like, forming a nonvulcanized but vulcanizable compound; that is, vulcanized in the place to be packed.

146,158—January 6, 1874. S. W. ANDREWS AND L. GODFREY. *Improvement in compositions of rubber for use in separating cockles from grain.*

A vulcanized composition of 8 ounces of linseed oil and 2 ounces of chalk; 8 pounds of zinc white; and 4 pounds of rubber gum, with sufficient sulphur. It is vulcanized at 260° F. for not to exceed 3 hours and then subjected to a heat of about 212° F. for two hours, more or less.

146,387—January 13, 1874. P. FINLEY. *Improvement in the preparation and treatment of india-rubber varnish.*

Dehydrated or baked india rubber, produced by heating sliced or comminuted india-rubber at a temperature of from 138° to 160° C. for seven to ten hours. It is combined with sulphur and benzine or other solvent of india rubber to form a varnish.

153,447—July 28, 1874. L. O. P. MEYER. *Improvement in processes of producing vulcanized soft india-rubber goods.*

Paraffin is used in covering the plastic compound with sheets or forms of metal preparatory to vulcanization.

153,448—July 28, 1874. L. O. P. MEYER. *Improvement in soft vulcanized india rubber with glossy surface.*

Soft vulcanized rubber having a glossy surface: produced by process No. 153,447.

153,449—July 28, 1874. L. O. P. MEYER. *Improvement in processes for the production of hard rubber or vulcanite with cloth surface or surfaces.*

A thin coat of soft vulcanizable india rubber is applied between the cloth and the hard compound and then vulcanized.

168,129—September 28, 1875. M. W. BEYLIKGY. *Improvement in extracting rubber from waste.*

Rubber solutions are solidified through the agency of a current of air circulating over the surface of the solution, through a condenser to deposit the volatile solvent, then through a heater and back to the solution vessel.

179,576—July 4, 1876. W. D. LATHAM. *Improvement in cement.*

A cement composed of 1 ounce of crude gutta-percha, 5 grains of india rubber, and 1 pound of chloroform.

180,484—August 1, 1876. G. MAGNUS. *Improvement in compositions for billiard balls and processes of manufacturing the same.*

A mixture of india rubber, sulphur, sulphate of baryta—the latter in quantity at least 50 per cent of the rubber—and coloring matter; the composition is subjected, in molds, to a slowly increasing heat for ten hours or more.

210,405—December 3, 1878. A. G. DAY. *Improvement in the combination of vegetable oils and grahamite for the manufacture of vulcanized compounds.*

A kerite product, formed by the combination of grahamite or its equivalent with another resinous body, and with vegetable oil and sulphur, as by mixing cottonseed oil, liquid coal tar, and grahamite with a small quantity of oxide of zinc, heating to about 330° F., cooling to 200° F., and adding linseed oil, and then raising the temperature slightly and adding the sulphur.

210,406—December 3, 1878. A. G. DAY. *Improvement in compounds for the manufacture of kerite.*

Clay or other equivalent earth is mixed as an absorbent with the oils, resinous bodies, and sulphur in the manufacture of kerite.

210,407—December 3, 1878. A. G. DAY. *Improvement in compounds of india rubber and kerite.*

A vulcanized product consisting of the combination of crude kerite with natural india rubber.

210,408—December 3, 1878. A. G. DAY. *Improvement in the manufacture of kerite from gums and oils.*

A vulcanized compound composed of vegetable or mineral oils, a resinous body or bodies, and sulphur; as cottonseed oil, linseed oil, coal tar, and sulphur, and preferably wax with or without paraffin or ozocerite.

210,409—December 3, 1878. A. G. DAY. *Improvement in the manufacture of kerite.*

The process of making a vulcanized product by combining crude kerite or artificial caoutchouc with natural india rubber.

210,410—December 3, 1878. A. G. DAY. *Improvement in preparing vegetable oils for the manufacture of kerite.*

Vegetable oils are subjected to the action of sulphur at a high temperature, as 520° F.

210,411—December 3, 1878. A. G. DAY. *Improvement in the manufacture of artificial caoutchouc or kerite.*

The process of making a vulcanized compound by combining cottonseed oil, coal tar (or pitch or bitumen), linseed oil, and sulphur, with or without vegetable or animal wax, ozocerite, and oxide of iron.

211,340—January 14, 1879. J. MURPHY. *Improvement in vulcanized india-rubber valves.*

Composed of vulcanized rubber and gutta-percha, in the proportions of 2 parts of the former to 1 part of the latter, with or without the addition of metallic earths and oxides; it will resist the action of oils.

216,153—June 3, 1879. D. F. CONNELL AND E. FAGAN. *Improvement in hard rubber compounds.*

Strips or shreds of metal foil are incorporated with caoutchouc prior to vulcanization.

218,842—August 26, 1879. J. W. WATTLES. *Improvements in treating vulcanized india rubber or caoutchouc.*

Vulcanized rubber is treated in a bath of acetic acid, or it is otherwise applied to increase its strength and elastic force.

219,033—August 26, 1879. J. STEPP. *Improvement in the modes of covering wooden and other articles with india rubber.*

Gum is first applied in solution, then the article is covered with a vulcanizable compound and the article subjected to liquid pressure during the process of vulcanization.

226,017—March 30, 1880. C. V. BEACH. *India rubber and other gum compounds for surfacing cloth, and for other purposes.*

Rubber and other gum compounds are deoderized by combining therewith gum benzoin, say 5 per cent, or benzoic acid alone.

226,057—March 30, 1880. H. GERNER. *Process of the treatment of india rubber, etc.*

The process consists in washing india rubber and like gums in warm water in which is dissolved some soda, then cutting into small particles, then freezing, then grinding in a frigid mill, again washing in cold water, then subjecting to the action of solvents in a closed vessel and mixing with desired substances and completing the manufacture.

226,058—March 30, 1880. H. GERNER. *Manufacture of goods from caoutchouc, etc.*

The process consists in first mixing dissolved camphor and sulphur, then evaporating the moisture of the camphor solvent and mixing with caoutchouc and vulcanizing. The rubber compound consists of equal parts of dissolved camphor, sulphur, and caoutchouc.

226,070—March 30, 1880. L. M. HEYER. *Treating waste vulcanized caoutchouc.*

Rubber waste, after the removal of the sulphur by the direct action of heat, is subjected to the action of boiling water or steam until sufficiently fluid to strain, and then strained.

229,038—June 22, 1880. H. GERNER. *Manufacture of vulcanized india-rubber compounds.*

Camphor is mixed with sulphur—as by melting them together, cooling, and grinding—and incorporated with india rubber, with or without the addition of glycerine, and the mass vulcanized.

229,794—July 13, 1880. A. B. ALLEN. *Manufacture of substitutes for hard rubber.*

Hard wood and articles made therefrom are treated with resin oil at a slow heat, and afterwards coated with a solution of gutta-percha vulcanized on the wood.

229,817—July 13, 1880. H. GERNER *Manufacture of vulcanized india-rubber products.*

A mixture of india rubber, camphor, and flour made from the seed of agricultural germs for the purpose of vulcanization

232,974—October 5, 1880. A. B. & C. JENKINS. *Vulcanized plastic compound.*

Diatomaceous silica or insuferial earth is mixed with india rubber and gutta-percha, or either, and sulphur, and vulcanized.

233,296—October 12, 1880. E. M. STEVENS. *Enameled rubber cloth.*

The surface consists of substantially equal parts of boiled linseed oil, plastic rubber, and suitable body or coloring matter, combined together by heat before applying to the cloth, and hot calendered after application.

233,600—October 26, 1880. J. H. CHEEVER. *Process of reclaiming rubber from old and waste vulcanized rubber and utilizing the same in manufacturing rubber goods.*

Old vulcanized rubber is boiled with raw petroleum and the resulting product then mixed with new rubber and sulphur and exposed to vulcanizing temperature.

236,240—January 4, 1881. G. M. MOWBRAY. *Method of treating caoutchouc.*

Caoutchouc is treated with naphthaline to preserve the properties of elasticity, durability, etc., and the naphthalized caoutchouc mixed with elements not soluble in naphthaline for the formation of articles. The naphthaline is removed by spontaneous evaporation.

236,709—January 18, 1881. P. KROPP. *Composition for treating rubber cloth, etc.*

A composition for covering the rubber surface of cloth before printing, consisting of linseed oil boiled to a tough paste, with a small proportion of oxide of manganese, and of gum copal added, and then coloring matter equal in weight to the mass.

236,778—January 18, 1881. H. A. CLARK. *Process of desulphurizing and devulcanizing waste vulcanized india rubber.*

Vulcanized india rubber waste is first moistened with water and the water evaporated, and then moistened with turpentine, camphene or equivalent substance and the turpentine evaporated by heating.

236,779—January 18, 1881. H. A. CLARK. *Process of desulphurizing and devulcanizing waste vulcanized india rubber.*

Vulcanized india rubber is treated to the vapors of turpentine or camphene, after it has been boiled in water, to reduce the whole to a cohesive condition.

237,249—February 1, 1881. H. A. CLARK. *Treatment of vulcanized india rubber and gutta-percha.*

Waste vulcanized india rubber is treated with a vegetable oil, such as palm oil, and with a resinous matter.

243,782—July 5, 1881. T. J. MAYALL. *Compound substance for electric insulators.*

It consists of 1 pound of rubber, one-quarter of a pound to 2 pounds of graphite, and one-half pound to 2 pounds of sulphide or sulphuret of antimony, commingled and cured by heat.

244,788—July 26, 1881. L. BECKERS. *Treating caoutchouc with hydrocarbon oils.*

A waterproof compound consisting of, say, 1 part of caoutchouc to 4 parts of hydrocarbon oil of a boiling temperature of about 250° to 300° C.

245,328—August 9, 1881. J. H. TUTTLE. *Process of making sheet packing of rubber, paper, etc.*

Sheet packing provided with a metallic facing; formed by attachment to the face of any suitable fabric by means of rubber cement, or other adhesive material, metal filings or grindings, and subjecting the sheet to pressure. Sulphur may be added to the cement and the sheets vulcanized.

247,834—October 4, 1881. T. J. MAYALL. *Manufacture of hard rubber.*

The sulphides or sulphurets of antimony are mixed with rubber (without the addition of free sulphur) and cured by heat.

247,835—October 4, 1881. T. J. MAYALL. *Rubber veneer.*

A compound of rubber and sulphide (or sulphuret) of antimony, colored and cured by heat.

247,840—October 4, 1881. T. J. MAYALL. *Hard rubber compound called "artificial horn."*

A compound of rubber and sulphide (or sulphuret) of antimony and graphite, hardened by heat.

249,889—November 22, 1881. A. B. & W. P. BROWN. *Composition for coating metals.*

Composed of india rubber, gutta-percha, gum dammar, and wax, dissolved in benzole.

249,970—November 22, 1881. N. C. MITCHELL. *Recovering rubber from rubber waste.*

In the boiling of rubber waste in strong sulphuric or muriatic acid, steam is injected into the acid, whereby the steam penetrates the mass and carries the acid with it.

250,943—December 13, 1881. N. C. MITCHELL. *Recovering rubber from rubber waste.*

Rubber waste is first subjected to the action of hydrocarbon vapors to soften or disintegrate the mass, and then to the action of strong and highly heated sulphuric or muriatic acid.

252,216—January 10, 1882. H. W. HENDRICKS. *Elastic compound for truss-pads.*

It consists of glue, honey, sugar, gutta-percha, glycerine, borax, alum, black lead, sulphur, and saltpeter, in certain specified proportions.

254,205—February 22, 1882. G. A. FOWLER. *Temporary stopping for teeth.*

A composition of wax, 4 parts; oxide of zinc, 15 parts; gutta-percha, 8 parts; and chalk or whiting, 6 parts.

254,462—March 7, 1882. J. D. CHEEVER. *Waterproof and plastic composition.*

Waste rubber is rendered plastic by treatment with vaseline and sulphur, and mixed with short jute fiber or powdered bark, either or both.

254,463—March 7, 1882. J. D. CHEEVER. *Waterproof and plastic compound.*

To a compound of disintegrated fibrous material, earthy materials, sulphur, and vaseline there is added siccative oil treated with chloride of sulphur, the use of vaseline being claimed with any of the products derived from the siccative or drying oils. Also the products derived from the siccative or drying oils in combination with the plastic products obtained by heating waste vulcanized rubber with vaseline, for cementing pigments and fibers.

254,465—March 7, 1882. J. D. CHEEVER. *Waterproof and plastic compound.*

A product of the siccative oils, vaseline, and "pickum gum," produced by treating a solution formed of, say 160 pounds of linseed oil, 20 pounds of vaseline, and 40 pounds of pickum gum, dissolved with heat, with 9 pounds of protochloride of sulphur and 9 pounds of bisulphide of carbon, and granulating after cooling, and washing. A compound of the same is formed with powdered cork, tan bark, short fibers, and coloring matter.

256,470—April 18, 1882. G. S. EVANS. *Plastic composition and vulcanite.*

A plastic material suitable for waterproofing or vulcanization is formed from gums, such as gum kauri or gum manila, by mixing such gum with palm oil and then heating the mixture to about 400° F. The material is vulcanized by treating with chlorite of aluminum and heating.

258,021—May 16, 1882. C. CONNOR. *Rubber compound.*

It consists of a vulcanized mixture of india rubber, 1 pound; soda, 2 pounds; lime, 4 ounces; camphor, 3 drams; and sulphur, 1 ounce and 10 drams. It will stand a high degree of heat.

260,441—July 4, 1862. C. E. W. WOODWARD. *Process of treating india rubber.*

The surface of india rubber is subjected for a limited time to the action of concentrated sulphuric acid and immediately washed to prepare it for adhesion to other objects.

262,079—August 1, 1882. C. J. McDERMOTT. *Restoring rubber waste.*

Rubber waste or scrap is boiled in a solution of acid, bichromate of potash, and manganese, by means of live steam injected into the mass.

265,021—August 22, 1882. H. A. CLARK. *Treatment of india rubber and gutta-percha.*

Restored or devulcanized india rubber or gutta-percha with water is subjected to heat sufficient to evaporate the oils or spirits.

264,821—September 19, 1882. W. O. CALLENDER. *Composition of matter for insulating telegraph wires and for other purposes.*

It consists of 40 to 80 parts of bitumen and 20 to 60 parts of elastikon, or a residual product of vegetable oils, with sulphur or other vulcanizing agents.

265,184—September 26, 1882. J. C. TITZEL. *Process of treating vulcanized india rubber.*

Vulcanized india rubber is dissolved in turpentine and linseed oil; then sulphuric acid is added until the pigment or filling is all dissolved, when the mass is washed. A caustic potash solution is then added to saponify the oil, and the rubber is precipitated from the soapy mass.

276,916—May 1, 1883. W. SMITH. *Insulating electrical conductors and a new compound suitable to be used for this and other purposes.*

A mixture of gutta-percha and ground coal.

277,977—May 22, 1883. E. BAUER. *Process of and composition for the manufacture of substitutes for leather, horn, tortoise shell, etc.*

It is composed of gelatine or glue, 2¼ to 5 parts; glycerine, 3 parts to one-half part; fat or oil, 3 parts to one-half part; and caoutchouc, one-half to 1 part; when dried it is treated with tannic acid, the tanning process being accelerated by electric currents.

281,769—July 24, 1883. A. W. KENT. *Separating foreign substances from india-rubber waste.*

Ground or subdivided india-rubber waste is agitated in water within a sieve that supports the rubber, which allows the heavier substances to subside and the loose fibers to wash away.

284,760—September 11, 1883. H. A. ROBINSON. *Metallized rubber compound.*

A compound consisting of 10 parts of finely divided metal and 1 part of vulcanizable gum rendered plastic by a suitable solvent.

285,980—October 2, 1883. W. E. DOUD. *Rubber cement for the manufacture of memorandum blocks and tablets.*

It is composed of 1 part of pure rubber, 6 pounds of bisulphuret of carbon, and 1 pound of ultramarine.

286,442—October 9, 1883. M. HUGHES. *Plastic composition for tailors' cutting-boards, and for other purposes.*

A mixture of sawdust, 10 parts: rubber or gutta-percha, 5 parts; flour, 4 to 5 parts; and linseed oil or soap-boilers' waste, with or without the addition of a bituminous substance.

288,013—November 6, 1883. J. L. CHADWICK. *Method of reclaiming india rubber and fiber from scraps of india-rubber cloth.*

The scraps are first subjected to the action of muriatic acid to destroy the cotton fibers and release the wool from the rubber, leaving the wool intact; and then subjected to a beating and picking action to detach the wool from the rubber.

290,909—December 25, 1883. N. C. MITCHELL. *Rubber compound.*

Particles of leather are incorporated with the rubber compound previous to vulcanization.

292,891—February 5, 1884. A. O. BOURN. *Process of treating fibrous rubber waste.*

Rubber waste containing cotton fiber is subjected to the action of a sulphuric-acid solution of sufficient strength to operate as a solvent of the fiber—3 or 4 per cent solution—and permit its removal with the solvent.

295,615—March 25, 1884. A. O. BOURN. *Process of treating fibrous rubber waste for the recovery of the rubber or caoutchouc therefrom.*

Waste containing cotton fiber is treated with nitric or muriatic acid in solutions of sufficient strength to convert the fiber into soluble matter and permit its removal with the solution.

300,720—June 17, 1884. N. C. MITCHELL. *Recovering rubber from waste.*

Rubber waste is boiled in sulphuric or muriatic acid of a strength sufficient to eliminate and destroy the fibrous material including woolen fiber.

305,184—September 16, 1884. J. J. HAUG. *Substitute for caoutchouc.*

Skins and glycerine are boiled under pressure, then there is mixed with the mass glycerine and chromate or bichromate of potash or other suitable salt acted upon by light, with or without the addition of ground cork, oxgall, and color.

308,189—November 18, 1884. J. J. MONTGOMERY. *Devulcanizing and restoring vulcanized rubber.*

Finely cut particles of the rubber are heated in a closed vessel with hydrocarbon oils obtained from petroleum to above 350° F. until it is reduced to a complete solution, from which the oils remaining in the mass may or may not be extracted.

308,209—November 18, 1894. J. J. C. SMITH. *Manufacture of rubber compositions.*

A rubber compound, consisting of mineral wax or paraffin combined with resin, sulphur, and rubber: formed by first melting together resin, one-fourth to one-half pound, and ozocerite, or similar material, 1 pound, and mixing the same with 4 pounds of caoutchouc and 1 pound of sulphur.

311,135—January 20, 1885. C. J. McDERMOTT. *Recovering rubber from rubber waste.*

Fiber is eliminated from rubber scrap by boiling the scrap in dilute acid—say sulphuric acid of 12° Baumé—and afterwards washing the rubber, or a solution of sulphuric acid, salt, and manganese is used

312,803—February 24, 1885. C. S. BRADLEY. *Electrical conducting material*

It consists of gas retort carbon or other carbon which has grit, and gutta-percha or india rubber vulcanized, may be vulcanized with bromine. The material is nonporous.

315,633—April 14, 1885. H. KELLOGG. *Electrical insulator*

A mixture of 4 pounds of asphaltum, 4 ounces caoutchouc of oil, 1 ounce of asbestos, and 4 ounces india red, the asbestos and india red, either or both, may be omitted.

318,233—May 19, 1885. J. L. CLARK. *Manufacture and preparation of materials to be employed for insulating.*

A compound of oxidized oil and asphalt, pitch, or bitumen, with a small quantity of hydrocarbon oil or hydrocarbon spirit, with or without india rubber or gutta-percha, black wax or other elements to cheapen the mixture.

319,079—June 2, 1885. J. W. ELLIS. *Composition of matter for the preservation of paper or vegetable tibing used for the insulation of telegraph wires.*

A mixture of asphaltum, 40 parts; resin, 14 parts; petroleum or dead oil, 6 parts; vulcanized rubber, 3 parts, and sulphur, 1 part.

320,921—June 30, 1885. R. S. FERGUSON, W. SCHUMACHER, AND W. TUBMAN. *Compound for insulating electric wires.*

A mixture of pine pitch, 300 pounds; hard or soft rubber, 1¼ pounds; and liquid asbestos, 1 gallon, to which is added beeswax or tallow or linseed oil until of the proper consistency to render the compound hard and yet flexible when cool.

321,410—June 30, 1885. F. WILHÖFT. *Vulcanized soft rubber and process of making same.*

Vulcanized soft rubber in which all the sulphur is chemically combined with the rubber: produced by mixing it with 3¼ or less per cent of sulphur and subjecting it to a heat of 330° F. or over.

321,548—July 7, 1885. J. J. VARLEY. *Plastic composition.*

Articles made of a plastic composition—of the class containing resins, gums, etc.—are subjected to heat, gradually applied, whereby they are rendered tough, hard, and heat resisting.

322,802—July 21, 1885. A. G. DAY. *Process of making the compound termed "kerite."*

In the manufacture of kerite (see No. 210,411) in place of sulphur, sulphide of antimony, or other suitable sulphide is added, either alone or united with a greater or less proportion of sulphur, to enable the chemical heat to be controlled by the sulphide and to prevent oxidation of the finished product.

322,804—July 21, 1885. A. G. DAY. *Process of manufacturing crude kerite compounds.*

In the manufacture of kerite according to Nos. 210,411 or 322,802, a vegetable astringent—such as tannin or tannic acid, extract of gambia, extract of pine, spruce, or oak bark, extract of nut galls or sumac—is added either before or after, or with the sulphur or sulphide; it imparts a more fibrous character to the product.

327,286—September 29, 1885. S. LOEWENTHAL. *Manufacture of ornamental wall covering, leather cloth, etc.*

A mixture of 100 pounds of African flake, 10 pounds of rubber, 100 pounds of rubber substitute, 10 pounds of ozocerite, 100 pounds of infusoria, and 100 pounds of wood pulp or ground cork, with 2¼ per cent of sulphuric acid and 5 per cent of muriatic acid, is spread on a fabric printed with a pattern or design, with or without embossing, and dried.

335,495—February 2, 1886. J. B. WILLIAMS. *Composition of matter for insulating material.*

It consists of gutta-percha, india-rubber, colophony, gum dammar, and asphalt, all in solution, and anhydrous paraffin oil with or without powdered silica.

336,018—February 9, 1886. W. J. RIGNEY AND J. WOLFF. *Composition for insulating electric wires.*

An outer coating of balata, or of a mixture containing balata—obtained from the milky juice of the *Sapota muelleri*, and resembling india-rubber—is employed in connection with an inner coat of adhesive material, as tuna—a substance resembling gutta-percha—or tar.

337,466—March 9, 1886. R. P. WALLIS. *Flexible lead pencil.*

An elastic composition formed of graphite and caoutchouc.

339,787—April 13, 1886. E. D. KENDALL. *Composition of matter for electric insulation.*

A compound of wax tailings of petroleum refining, 32 parts; chicle, 16 to 32 parts; sulphur, 4 to 8 parts; and oil, 1 to 2 parts.

346,224—July 27, 1886. T. C. ROCHE. *Composition for holding photographic paper on its supports; etc.*

A mixture of rubber, pitch, and a solvent, as benzole; also a mixture of rubber, beeswax, and a solvent; the mixtures being combined or used alone.

343,591—June 15, 1886. O. LUGO. *Vulcanite and process of producing the same.*

A vulcanized mixture of hair or horny material, sulphur, and india rubber.

349,885—September 28, 1886. G. W. HOLLEY. *Manufacture of paint.*

A paint consisting of a given quantity of mineral oxides, earths, or other pigments, combined with from one-tenth to one-half its weight of pulverized sulphur and linseed oil: formed by mixing the sulphur with the pigments, then gradually adding with constant stirring about one-third of its weight of linseed oil previously heated to 80° C. and at the same time gradually raising the temperature to 120° or 125° C.; then cooling slowly under constant stirring, and lastly grinding.

350,459—October 5, 1886. A. KISSEL. *Substitute for india rubber, caoutchouc, etc.*

A compound of the hardened resin and balsams of the coniferae and oil and sulphur; formed by hardening the resin and balsams by means of caustic lime or other caustic alkaline earth; dissolving the hardened resin or balsam in oil; adding to the solution a second solution composed of sulphur and oil; adding sulphur to the mixed solutions; and heating the mass.

358,082—February 22, 1887. A. W. SPERRY. *Composition of matter as a substitute for hard rubber, etc.*

It is composed of ivory dust or like material, forming 50 per cent of the compound; a starch mixture consisting of starch, tannin, and an alkali, as alum; a binder mixture consisting of a resinous gum dissolved in alkali, as caustic soda, and milk, glue, shellac, and alcohol.

359,825—March 22, 1887. C. M THOMPSON. *Insulating material.*

A compound of dead-oil of pitch 1 part, and desulphurized old rubber, commonly known as "shoddy," 7 parts; pitch and desulphurized rubber are mixed with cold rollers, then steam is introduced and it is rolled into thin sheets and thoroughly dried.

359 907—March 22, 1887. C. M. THOMPSON. *Process of curing india rubber.*

A compound consisting of india rubber and lampblack, produced by subjecting india rubber to the action of hot rollers, adding from 5 to 20 per cent of lampblack, and then continuing the action of the rollers.

36 137—June 21, 1887. H. W. LIBBEY. *Rubber-covered elastic compound.*

It consists of particles of sponge and india rubber; rubber is reduced by heat and particles of sponge are distributed in the mass and mingled therewith.

368,174—August 9, 1887. H. VOGLEY. *Composition for cementing rubber.*

A composition formed by mixing and dissolving 2¼ ounces of pure rubber gum, 3 ounces of pulverized gum gamboge, and 11 ounces of dry white lead, in 1 gallon of benzine; and subsequently adding a mixture of 2 ounces of pulverized sulphur and 2¼ ounces of sulphuric ether, with or without one-half ounce of alum and one-fourth pound of burnt brown sugar.

375,405—December 27, 1887. F. WILHÖFT. *Method of manufacturing nonblooming vulcanized soft rubber.*

Rubber is mixed with a sulphur preparation in which this body is in a lastingly-amorphous condition by the addition of a greasy, fatty, resinous, or turpentine body, and vulcanized. The said sulphur preparation is formed by fusing 1 pound of sulphur, say, with one-fourth of a pound of Canada balsam.

375,436—December 27, 1867. S. M. ALLEN. *Recovering and utilizing waste rubber.*

Disintegrated rubber waste is treated in a mixture of nonvolatile oil, asphalt, resin, and sulphur, and heated until the mass is devulcanized, and the fiber converted into gelatine.

378,395—February 21, 1888. S. HEIMANN. *Process of treating peat.*

A vulcanized mixture of dry pulverized peat, caoutchouc and sulphur, with or without plaster of paris.

380,993—April 10, 1888. G. W. COOPER. *Compound oil dressing for rubber belts.*

To a mixture of 8 pounds of crude rubber, one-half gallon oil of turpentine, 1 pound oil of lemon-grass, 1 pound of citronelle, and 6 ounces gum arabic, there is added 8 gallons of light pressed fish oil, and cooked for eight hours; after cooling there is added the condensed product of 4 gallons of linseed oil boiled down to 2¼ gallons, and the composition is cooked for six hours.

383,098—May 22, 1888. D. BROOKS, JR. *Covering for electric wires and cables.*

Electric wires are first covered with a fibrous tape saturated with an insulating compound, then with a plastic rubber preparation with interlying canvas wrappings and powdered sulphur, and then subjected to heat to vulcanize the rubber.

383,137—May 22, 1888. W. B. McGARVEY. *Composition for converting india rubber or its compounds into hardened rubber.*

A mixture of oxide of iron and petroleum or rocky oil is incorporated with pure rubber or any of its compounds, and the mass fused and subjected to pressure.

391,927—October 30, 1888. J. A. TITZEL. *Rubber compound or mixture.*

Composed of gilsonite asphaltum, 90 pounds; vulcanized rubber (scrap or waste), 130 pounds; manganated linseed oil, 3½ to 7 gallons; spirits of turpentine, 9 gallons; deodorized petroleum naphtha, 9 gallons; and powdered sulphur, 10 to 15 pounds; for use as a paint, baking-japan, or coating.

393,838—December 4, 1888. W. KIEL. *Vulcanized plastic compound.*

A vulcanized compound of pumice stone, india rubber, and sulphur, with or without oil or beeswax, the pumice stone being from one to five times the weight of the crude rubber.

395,987—January 8, 1889. N. C. MITCHELL. *Process of recovering rubber from waste.*

Rubber waste is immersed in a reclaiming solution containing for each 100 pounds of waste about 15 to 25 pounds of hydrochloric acid, or its specified substitute, in excess of the quantity requisite to combine with the decomposable mineral compounds, and heated in a close vessel under pressure to about 240° F.

396,774—January 29, 1889. A. SOMMER. *Paint-oil.*

A solution in hydrocarbons of the sulpho-chlorinated marine-animal oils.

401,269—April 9, 1889. F. GREENING. *Process of production of material as substitute for india-rubber, etc.*

Fibrous material is steeped or saturated with a mixture of sulphuric acid and nitrate of potash—3 parts of the former to 2 parts of the latter by weight—washed, and then subjected to a bath of liquid carbonic acid or carbonic-acid gas and dried. The converted fiber is then treated with a suitable solvent, as a distillate composed of a mixture of methylated alcohol, resin, or colophony, gum benzoin or benjamin, castor oil, and light hydrocarbon.

411,171—September 17, 1889. C. A. A. H. SIEBERT. *Substitute for gutta-percha.*

A mixture of 1 part of asphaltum, one-fourth to 1 part of balsam of sulphur, and up to one-half part of an easily-melting solid hydrocarbon, such as paraffin.

412,264—October 8, 1889. W. KIEL. *Vulcanized plastic compound.*

Wood is used as a constituent part of a vulcanizable compound.

412,265—October 8, 1889. W. KIEL. *Process of manufacturing vulcanized plastic compound.*

Wood is soaken in oil and subsequently combined by vulcanizing with sulphur and crude rubber.

412,266—October 8, 1889. W. KIEL. *Process of manufacturing vulcanized plastic compounds.*

Wood and sulphur are vulcanized and the product commingled with sulphur and crude rubber and vulcanized.

412,267—October 8, 1889. W. KIEL. *Process of manufacturing vulcanized plastic compounds.*

Wood is mixed with crude rubber dissolved by any solvent, and the product combined with sulphur oil, and beeswax, with or without crude rubber, and vulcanized.

412,268—October 8, 1889. W. KIEL. *Process of manufacturing vulcanized plastic compounds.*

A mixture of wood, sulphur, oil, and crude rubber is vulcanized to a hard state, the product pulverized and combined with sulphur, oil, and crude rubber, ready for vulcanization.

412,269—October 8, 1889. W. KIEL. *Process of manufacturing vulcanized plastic compounds.*

A mixture of wood, sulphur, and oil, or other commingling vulcanizable substance, is vulcanized and the product subsequently combined with crude rubber by vulcanization.

418,044—December 24, 1889. N. C. MITCHELL. *Art of restoring rubber.*

Rubber stock is subjected to the action of live steam in a close vessel; air is drawn through the mass to remove surplus moisture, and finally the rubber is rolled while in a moist condition, until dry.

418,208—December 31, 1889. A. E. MEUNUEZ. *Insulating and waterproofing composition.*

A composition consisting of shoemaker's wax, gutta-percha with or without india-rubber, a suitable solvent, such as chloroform, bisulphuret of carbon, and japan; to which may be added a hardening wax, such as beeswax or paraffin wax.

419,697—January 21, 1890. N. C. MITCHELL. *Process of reclaiming rubber from waste rubber goods.*

First, the stock is ground; second, particles of iron are eliminated by magnetic attraction; third, the fiber is separated from the rubber; fourth, it is washed with water to remove soluble matter; fifth, it is sifted to separate raw sand and other fine particles; sixth, the mass is acted on with a stream of water to float off the rubber from the heavier foreign substances; and finally, it is devulcanized and sheeted.

420,648—February 4, 1890. J. B. WILLIAMS. *Insulating compound.*

A compound of india-rubber, say 40 parts; paraffine, preferably that obtained from ozocerite or mineral wax, 15 parts; a resinous body, as shellac, 40 parts; and sulphur, 5 parts; with or without silica or bituminous matter, produced by dissolving the india-rubber in a volatile solvent, dissolving the paraffine in the india-rubber solution, distilling therefrom the volatile solvent, and then incorporating therewith the remaining ingredients.

420,820—February 4, 1890. N. C. MITCHELL. *Process of restoring rubber.*

Rubber, after reduction to small pieces, is mixed with heavy oil and sulphide of calcium, then subjected to the action of steam until devulcanization is completed, when air is drawn through the mass before its removal from the devulcanizer.

423,071—March 11, 1890. N. C. MITCHELL. *Production of restored or devulcanized rubber.*

The rubber is devulcanized by the action of live steam, then while the rubber is yet moist it is rolled until reduced to a powder, and then dried, at the same time agitating it to preserve the powdery condition.

428,544—May 20, 1890. E. ANDREWS. *Composition of matter for use in the mechanic arts.*

Finely ground or comminuted leatheroid or parchmentized paper mixed with rubber in proportions varying from 40 to 90 per cent of the former to 60 to 10 per cent of the latter, and vulcanized.

430,958—June 24, 1890. W. KIEL. *Vulcanized plastic compound.*

A hard vulcanized plastic compound, consisting of crude rubber, sulphur, and mineral oil, as kerosene; the sulphur being in proportion of not less than approximately 80 per cent of the rubber by weight.

430,959—June 24, 1890. W. KIEL. *Process of manufacturing vulcanized plastic compounds.*

A mixture of sulphur and rubber, with or without oil—the sulphur being in the proportion of not less than about 80 per cent of the rubber by weight—is vulcanized with an initial temperature of not less than about 300° F. and for stated periods of time.

431,104—July 1, 1890. J. H. CHEEVER. *Protective covering for electric cables.*

A compound of 11 parts of rubber, 9 parts of plumbago, 9 parts of asbestos, and 2 parts of sulphur; it is vulcanized after application to a conductor.

433,893—August 5, 1890. J. FOTTRELL. *Insulating material.*

A mixture of india-rubber and aluminium oleate, say in equal parts by weight. It is susceptible of vulcanization.

438,313—October 14, 1890. O. A. ENHOLM. *Composition for cells or retaining vessels.*

A composition of asbestos, mineral wax, and gutta-percha (No. 438,311 with the omission of the hardening medium, shellac).

438,595—October 14, 1890. W. H. ALLEN AND C. LOVELL. *Rubber compound.*

A plastic compound composed of rubber, sulphur, and lithargite (pulverized calcined magnesic silicate).

452,439—May 19, 1891. R. A. LOEWENTHAL. *Production of reclaimed rubber.*

The fiber is decomposed and eliminated from the rubber waste, which is then partially dried and reduced to a fine powder before devulcanization.

452,760—May 19, 1891. F. SALATHÉ. *Composition of matter for insulating purposes.*

A composition consisting of the hydrocarbon product of No. 452,764, with sulphur, with or without the addition of india-rubber, gutta-percha, or oxidized linseed oil. It is subjected to a heat of from 121° to 162° C.

452,765—May 19, 1891. F. SALATHÉ. *Composition of matter for insulating purposes.*

A composition of gutta-percha, gum shellac, and a new hydrocarbon product, a resinoid hydrocarbon of the $C_{10}H_{16}$ series.

454,442—June 16, 1891. N. C. MITCHELL. *Production of waste rubber goods.*

The devulcanized rubber is impregnated with moisture and kept wet during the rolling or pressing process.

454,489—June 23, 1891. G. W. MELVILLE. *Composition of matter.*

A vulcanized mixture of fine Para rubber, 60 per centum; flowers of sulphur, 6 per centum, oxide of antimony, 14 per centum, and magnesia 20 per centum. It will resist a high heat, and withstand the action of salt water, grease, or oil.

454,548—June 23, 1891. A. W. SPERRY. *Compound for the manufacture of insulators, packings, etc.*

A compound of 8 pounds of mineral wool, 1¼ pounds of rubber and linseed oil combined, and 3 pounds of oxide of zinc.

458,551—August 25, 1891. J. L. MARMAUD. *Insulating compound.*

To a mixture of 1 part of calcined lixiviated infusorial earth, a third of 1 part of pulverized talc or soapstone, one thirty second part each of lampblack, pulverized sulphur and litharge, one-sixteenth part of pulverized resin, and one sixty fourth part of silicate of soda in solution, there is added 22 parts of rubber dissolved in benzine or naphtha, one-fifth part of bisulphide of carbon, and one-fifth part of fir balsam.

460,765—October 6, 1891. E. THOMSON. *Composition for insulating material.*

A mixture of asbestos, rubber, and soapstone, say 15 to 25 per cent of rubber and 5 to 15 per cent of soapstone, molded in a heated state with great pressure.

467,520—January 26, 1892. D. H. PIFFARD. *Composition of matter for insulating purposes.*

A mixture of 5 parts of rubber, 24 parts of resin, and 26 parts of plaster of paris; the rubber and resin are first mixed and heated until the readily volatilizable parts are driven off.

468,627—February 9, 1892. A. I. RATH. *Manufacture of india rubber.*

A composition consisting of india rubber mixed with finely-reduced silk fiber.

490,500—January 24, 1893. J. M. RAYMOND. *Process of treating vulcanized rubber to render it adhesive.*

Vulcanized rubber first soaked in benzine or a substance having an analagous action to open the pores, then immersed in a solution of potassium permanganate to secure superficial desulphurization, and again treated with benzine. In certain cases, to give tenacity, before the last-named operation, it may be given a bath of acetic acid or pyroligenous acid.

495,757—April 18, 1893. D. RIGOLE. *Process of and apparatus for the extraction of gutta-percha from the leaves and twigs of the gutta-percha tree.*

The condensed vapors of a solvent are passed through a mass of the leaves and twigs, thereby dissolving the gum; the solvent with gum in solution is conveyed away, and heated to vaporize the solvent and the vapors condensed for reuse.

508,560—November 14, 1893. P. C. BEIERSDORF. *Process of treating gutta-percha or balata.*

To obtain gutta-percha or balata of uniform qualities, a certain quantity is deprived of the whole of its resinous contents by subjecting it to the action of a solvent of said contents, and then there is mixed with the so-deprived quantity a proper quantity of gutta-percha or balata, which is richer in resinous matter than the quality desired.

510,888—December 19, 1893. J. BURBRIDGE. *Procss of producinq variegated rubber.*

Variegated sheets are formed by twisting strips of consolidated layers of different colored compounds, making up the twisted strips into rings or cylinders, and cutting shavings or sheets before or after vulcanization.

518,046—April 10, 1894. J. M. RAYMOND. *Composition of matter for vulcanizing rubber.*

It consists of benzene, or its derivatives, 30 to 50 parts in weight; camphor, 2 to 5 parts; and chloride of sulphur, 1 to 2 parts; with or without oleic acid, 1 to 2 parts.

518,817—April 24, 1894. R. HUTCHISON. *Gutta-percha or rubber compound.*

A composition consisting of gutta-percha or rubber or mixtures thereof and wool cholesterine.

520,196—May 22, 1894. J. THOMSON. *Method of manufacturing hard rubber articles.*

The crude compound is subjected to combined heat and pressure in a mold until the plastic compound assumes the form of the mold cavity, when the pressure is wholly or partially removed, allowing the material to expand while subjected to heat but not pressure, and then cooling under these conditions.

522,312—July 3, 1894. A. A. BLANDY. *Process of and composition for manufacturing substitutes for india rubber, etc.*

A composition consisting of a drying oil, as linseed oil, a solvent for the same, such as carbon bisulphide, sulphur chloride, asphalt, rubber, and sulphur, with or without a metallic oxide, such as lime. It is formed by mixing together the drying oil, solvent, and sulphur chloride, gently heating the mixture, then adding the asphalt and heating the product, and then incorporating rubber and sulphur, and finally vulcanizing.

525,086—August 28, 1894. J. PATTIGLER. *Elastic or plastic composition.*

A composition consisting of vegetable or mineral oil, caoutchouc, zink white, soluble glass, minium, and asbestos.

528,264—October 30, 1894. H. TRAUN. *Process of vulcanizing hard rubber articles.*

Pulverized metallic aluminum, or an alloy of aluminum, with tin, cadmium, or nickel, is added to the soft rubber before vulcanization. It increases the heat-conducting power of the rubber and secures uniform vulcanization.

529,730—November 27, 1894. W. GRISCOM, JR. *Hard, vulcanized compound.*

It is composed of candle tar as a vulcanizable adhesive element, sulphur, petroleum residuum, and finely divided solid matter.

538,147—April 23, 1895. C. BARUS. *Process of manufacturing vulcanized rubber.*

Rubber, at any stage of vulcanization, is impregnated with carbon disulphide (with or without sulphur) and the mass subjected to the action of heat (which never exceeds 200° C.) in a hermetically closed vessel until it is melted down to a homogeneous mass.

544,934—August 20, 1895. H. E. SÉRULLAS. *Process of extracting and purifying gutta-percha.*

The parts of the tree are treated with an alkali or its carbonates; the residue then treated with dilute sulphuric acid; next the residue is spread out into sheets, and the sheets treated first with a stream of ammoniacol copper liquid, and afterwards with a current of carbonic-acid gas or hydrogen gas.

547,120—October 1, 1895. S. HEIMANN. *Insulating compound*

To a mixture of equal quantities of pulverized asbestos and glass there is added 10 to 16 per cent of rubber (the mixture rolled into sheets and dissolved in benzine), 5 per cent of castor oil and 20 per cent each of resin oil and mirbane oil, and then 10 to 15 per cent of celluloid dissolved in amyl acetate. In coating a wire it is first given a coat of a mixture of water glass and pulverized glass.

549,855—November 12, 1895. R. N. PRATT AND H. W. JOHNS. *Composition of matter for compressed or molded articles.*

It consists of asbestos and rubber, or other cementing insulating substance, and an insulating natural lubricant, as soapstone.

551,230—December 10, 1895. R. N. PRATT. *Composition of matter for insulating purposes.*

A composition consisting of dense hard rubber, laminated mica, and fibrous asbestos, produced by dissolving rubber and sulphur in naphtha, incorporating therewith mica and asbestos fibers, molding and vulcanizing.

563,379—July 7, 1896. C. W. JEFFERSON. *Flexible mica insulating sheet.*

The sheet consists of layers of mica scales and adhesive gutta-percha tissue, with or without fibrous layers, as of paper.

563,716—July 7, 1896. C. W. JEFFERSON. *Electrical insulating sheet.*

A sheet formed of layers of asbestos and mica, or paper, asbestos, mica and paper, with adhesive gutta-percha tissue between any and every two of said layers.

575,739—January 26, 1897. H. E. SÉRULLAS AND F. E. HOURANT. *Process of extracting and purifyiug gutta-percha.*

The leaves or other parts of gutta-percha plants are pulverized, the powder dissolved in a hydrocarbon solvent, and the three principal constituents of gutta-percha, viz—gutta-hydrocarbon, fluavil, and alban—then precipitated by the addition of acetone.

580,139—April 6, 1897. W. MORISON. *Composition of matter for manufacturing battery cases, etc.*

A composition of asphaltum with or without a small quantity of gutta-percha, as much asbestos as can be absorbed, and a little sulphur; compounded by melting the asphaltum and adding the gutta-percha, then intimately mixing therewith the asbestos, spreading out the mass on a hot surface and working, beating, and pounding, to drive out moisture and foreign substances; dusting with sulphur and again beating, pounding, and working; the mass being kept hot throughout the process; and finally forming into shape.

581,319—April 27, 1897. P. W. WIERDSMA AND J. KUIPERS. *Substitute for vulcanite, hard woods, etc., and process of manfacturing same.*

The refuse remaining after the manufacture of potato flour is mixed with water, passed through a sieve, washed, bleached, and dried, with or without the addition of waterproofing material, ground into a powder, sifted, and molded dry by great pressure.

584,959—June 22, 1897. C. V. PETRALUS. *Rubber compound.*

A rubber compound having in admixture with caoutchouc and sulphur, finely-powdered native lead sulphide or galena, with or without lead oxide.

598,550—February 8, 1898. B. G. WORK. *Process of treating rubber.*

For the manipulation of raw vulcanizable india rubber in the formation of covered articles in hollow shapes, tubes, etc., the rubber is given a condition of temporary inherent abnormal rigidity by freezing it.

599,694—March 1, 1898. F. FENTON. *Process of producing artificial gutta-percha.*

Tar or other pyroligneous substance is mixed with an oxidizable vegetable oil either in the raw state or more or less oxidized, and the product placed in a bath of diluted nitric acid to form a magma or base, which is then roasted.

601,091—March 22, 1898. P. L. CLARK. *Process of devulcanizing rubber.*

It is saturated with a solvent of rubber and sulphur adapted to vaporize at a temperature below the melting or disorganizing point of rubber (such as gasoline) and maintained in such saturated condition by the pressure of vapor of such solvent while heating it in such vapor, to a temperature adequate to maintain the pressure therein, but lower than the melting or disorganizing point of rubber, until devulcanization is effected.

601,828—April 5, 1898. O. B. DODGE. *Leather ana rubber substitute.*

A compact sheet consisting of chemical wood fibers uniformly mixed with and enveloped in a firmly adherent mass of cured rubber and pulverized material; produced by drying chemical wood pulp, separating the fibers into a flocculent mass; mixing the flocculent mass with a mass of rubber cement and a pulverized material, as chalk, lampblack, and sulphur; forming into shape; and subjecting to a degree of heat which is less than that usually employed for vulcanization, preferably about 95° to 105° C.

615,863—December 13, 1898. W. K. LEONARD. *Process of producing rubber substitutes and compositions of matter therefor.*

A composition consisting of 76 per cent of corn oil, 21 per cent of sulphur, and 3 per cent of paraffin wax, formed by subjecting the mass to heat until the oil is vulcanized or the process of vulcanization begins, about 310° F., then shutting off the heat and allowing the process of vulcanization to continue until complete and the mass cools.

615,864—December 13, 1898. W. L. LEONARD. *Process of producing rubber substitutes and compositions of matter therefor.*

A rubber substitute consisting of a mixture of corn oil, say 64 per cent, and castor oil, 13 per cent, combined with a mixture of chloride of sulphur, naphtha, and oxide of magnesia, say in relation to the entire mass of 21 per cent of chloride of sulphur, 0.5 per cent of naphtha, and 1.5 per cent of oxide of magnesia; percentages by weight.

618,166—January 24, 1899. T. CLARKE. *Composition of matter for producing enamel for refixing dental plates of artificial teeth.*

It consists of 1½ parts of dental rubber dissolved in machine oil and scented with attar of roses; 5 parts of yellow gum shellac; 3 parts of plaster of paris colored with carmine; and one-twentieth part of pure Condy's fluid.

619,615—February 14, 1899. C. RATH. *Composition of matter.*

It consists of 76 parts of pure india rubber, 17 parts of bran of almonds, and 7 parts of calcined chalk, combined by kneading while the rubber is in a soft, plastic state; for rubber implements for therapeutic treatment, it combines hardness with elasticity, has a smooth, glossy surface, is moderately porous, and readily absorbs a lubricant.

621,060—March 14, 1899. E. GARNIER. *Manufacture of rubber or other gums.*

Alum treated with a spiritous solution of a gum, as a solution of gum tragacanth in benzol, is incorporated with rubber and the usual vulcanization dispensed with.

626,092—May 30, 1899. J. C. PETMECKY. *Rubber compound.*

A viscous compound, for repairing pneumatic tires, etc., consisting of a mixture of pure rubber dissolved in a quick-drying solvent, as bisulphide of carbon, ground and slightly vulcanized rubber, and cotton fiber cut to one-eighth to one-sixteenth of an inch in length.

626,479—June 6, 1899. P. C. BELL. *Elastic compound.*

A compound of vegetable oil, 59 parts; flower of sulphur, 15 parts; liquid tar, 1 part; petroleum residue, 20 parts; and powdered talc, 5 parts. The petroleum residue is heated to 112° F., the powdered talc and tar is mixed therewith, and the vegetable oil then gradually added while maintaining the said temperature, next raising the temperature to 200° F. and adding the flower of sulphur, and finally raising the temperature to 340° F. and stirring until viscid.

627,689—June 27, 1899. C. HEINZERLING. *Treatment of old or waste vulcanized rubber.*

Waste rubber is dissolved by the action of anilin, toluidin, or xylidin, and the solvent separated from the india rubber.

630,435—August 8, 1899. M. ZINGLER. *Composition for treating decayed or other rubber.*

A solution for treating decayed or other rubber by long immersion, consisting of 30 or 40 gallons of boiling water containing about 5 pounds of tartar emetic, mixed afterwards with 7½ pounds of tannic acid and about 2½ pounds of a metallic sulphite salt such as calcium sulphite.

632,022—August 29, 1899. C. RÉPIN. *Process of treating india rubber, gutta-percha, etc.*

It consists in raising wood oil (expressed out of seeds of *elaeococea vernicifera*), with which may be mixed a cheaper oil having greater density and lighter color, to a suitable heat, as 250° C., whereby the same will be coagulated; pulverizing the solidified oil and mixing with india rubber and the like.

635,141—October 17, 1899. A. H. MARKS. *Process of reclaiming rubber from vulcanized rubber waste.*

Finely ground rubber waste is submerged in a dilute alkaline solution in a sealed vessel and subjected to a temperature of 344° to 370° F. for about twenty hours

637,776—November 28, 1899. A. GENTZSCH. *Plastic felt.*

An intimate conglomeration of gutta-percha with shredded or macerated animal skins and hair.

638,775—December 12, 1899. A. E. J. V. J. THEILGAARD. *Process of devulcanizing caoutchouc, india rubber, etc.*

The comminuted vulcanized material is treated with a solution of sodium sulphite—the amount being in proportion to the contained sulphur—under the influence of heat, and then washed.

639,926—December 26, 1899. O. LUGO. *Rubber substitute or artificial rubber.*

It consists of sulphurized oil practically free from glycerine compounds. Seventy-five per cent of the substitute may be mixed with rubber.

639,927—December 26, 1899. O. LUGO. *Manufacture of rubber substitutes.*

Process consists in subjecting sulphurized oil to hydrosaponification until it becomes liquid, then dehydrating the liquid vulcanite, adding sulphur, and then heating the mass.

640,735—January 9, 1900. P. C. BELL. *White elastic compound.*

It consists of vegetable oil, 65 parts; chloride of sulphur, 20 parts; mineral matter, such as lime, 5 parts; and zinc oxide, 5 parts; and bisulphide of carbon, 5 parts. The vegetable oil is heated to 80° F., the chloride of sulphur and bisulphide of carbon added at 60° F., the mass stirred until it foams and kept in agitation until the maximum bulk is reached, then the mass is broken, the mineral matter added, whereupon it hardens, when the product is pulverized and bleached.

642,764—February 6, 1900. A. E. J. V. J. THEILGAARD. *Process of devulcanizing caoutchouc, india rubber, etc.*

The comminuted vulcanized rubber is treated with a cyanide solution (potassium cyanide) in proportion to the amount of contained sulphur, the temperature being eventually raised; the material is then washed and dried.

642,814—February 6, 1900. R. COWEN. *Process of cleaning rubber.*

Rubber is reduced to a plastic condition by heating, and then strained under pressure to remove foreign materials.

645,331—March 13, 1900. W. PRAMPOLINI. *Composition of matter.*

As a substitute for india rubber, the gummy matter of the shrub *Synantheroeas Mexicanas* (known also by the Indian names of "Tule," "Copalin," "Terba del Negro," "Guayle," "Jiguhite," and "Hule"), combined with the residual oil of a volatile hydrocarbon solvent.

647,112—April 10, 1900. J. J. PEARSON. *Composition of cork and rubber for boot-heels, etc.*

An intimate mixture of cork and rubber, the cork being held under great compression in the rubber.

651,640—June 12, 1900. H. L. RUSSEGUE. *Elastic waterproof composition.*

A composition of balata and vegetable fiber—a sheet of balata is united with dry vegetable fiber by pressure.

651,582—June 12, 1900. H. SCHNEIDER. *Substitute for gutta-percha.*

A composition formed of 45 per cent of asphalt tar, 40 per cent of resin, 10 per cent of spirits of turpentine, and 5 per cent of linseed oil.

651,753—June 12, 1900. B. C. FOWLKES. *Dental compound.*

The compound comprises a solvent, vehicle, and drying constituents, as carbon bisulphide, 2 ounces; benzin, 1 dram; and chloroform, 1 dram; with black dental rubber, one-eighth of an ounce; and powdered aluminum, 1¼ ounces.

CASEIN PLASTICS.

86,710—February 9, 1869. J. & W. THIEM. *Improved composition for moldings.*

A mixture of sawdust, 4 pints; milk curd, 1 pint; slaked lime, one-third of a pint; and cotton, 1 ounce, more or less.

153,939—August 11, 1874. J. FRAUENBERGER. *Improvement in artificial ivory, corals, etc.*

A composition made of casein 2 parts, heated in a closed vessel on a water bath and then boiled under suitable heat with 1 part of a varnish-like solution of copal in concentrated liquid ammonia and alcohol.

169,053—October 19, 1875. J. G. W. STEFFENS. *Improvement in compositions for ornaments.*

A composition of curd, alkali, and resinous matter; fixed by steeping in whey or milk before pressing, and in cold water containing oil of vitriol after pressure.

182,431—September 19, 1876. J. FRAUENBERGER. *Improvement in compositions and processes for making artificial coral, ivory, etc.*

Casein is mixed with sal soda and water and dissolved under the action of heat; the oily matter is removed; and after cooling and coloring, acetic acid is added, and the resulting pasty, gummy mass is freed from moisture by pressure and evaporation.

307,179—October 28, 1884. E. E. CHILDS. *Preparation of casein and of articles made therefrom.*

Casein prepared from milk curd or cheese is worked or kneaded in water at or near the boiling point until it reaches a tough and glutinous consistency.

307,269—October 28, 1884. E. E. CHILDS. *Preparation of casein and of articles made therefrom.*

Casein is prepared from milk curd, having washed or eliminated from it fatty and other objectionable matters, by working or kneading the curd in its naturally saturated condition, sufficient water of saturation being retained to admit of the working, at a temperature below the boiling point of water, until it reaches a tough and glutinous consistency.

353,697—December 7, 1886. L. R. MESTANIZ. *Making artificial bone, ebony, marble, etc.*

Skim milk is treated with salt, caustic soda, terra alba, hydrochloric, nitric, and sulphuric acids, and coloring matter, or with an alum solution and glycerine in lieu of a mixture of hydrochloric and nitric acids. Pot cheese may be used as the base, with borax in place of caustic soda.

610,626—September 13, 1898. P. H. HENSEN. *Composition containing casein for electric insulating or other purposes.*

A composition consisting mainly of casein, india rubber, and asphalt, subjected to pressure in a hot mold.

632,408—September 5, 1899. W. A. HALL. *Process of producing casein.*

See Group XVIII, Fine Chemicals, Proteids.

646,844—April 3, 1900. W. KRISCHE AND A. SPITTELER. *Process of manufacturing water-resisting products from casein.*

Soluble casein is rendered insoluble by the action of acids or salts, as by dissolving casein in water containing 5 per cent of sodium carbonate and coagulating by gradually adding a weak solution of lead acetate, and is then treated with formaldehyde, either while wet or after it has been dried.

649,690—May 15, 1900. W. A. HALL. *Solid casein.*

Solid homogeneous casein produced by hydrating the casein by grinding and thoroughly agitating the same in water so that the water is beaten into every cell thereof, thus forming a thin pulp, and then draining and drying the product and permitting the same to shrink together.

662,444—November 27, 1900. C. JUNG. *Insulating composition.*

A mixture, say, of equal parts of crude caoutchouc and casein, with a minor quantity of a resin, is vulcanized.

OTHER PLASTICS.

3,598—May 25, 1844. E. DEUTSCH. *Improvement in waterproof cements, etc.*

Bitumen, asphaltum, and like material is distilled, the residuum cooled and used as a base to mix with various ingredients as protoxide of lead, siccative oil, resin, wax, sulphur, etc., to form different coating and protecting products.

4,362—January 23, 1846. C. BRANWHITE. *Improvement in compositions for making handles, molds, etc.*

Half a pound of starch in one pint of cold water is added to one quart of boiling water and well mixed, then allowed to cool, when finely sifted dry mahogany sawdust (or wood ashes or whitening) is mixed therewith to form a dough.

17,949—August 4, 1857. W. M. WELLING. *Improvement in factitious ivory.*

A mixture of shellac, ivory dust, and camphor, with pigments, as impalpable white, vermilion, etc., according to the color, mixed and heated, preferably by steam under pressure, to 115° to 138° C.

19,778—March 30, 1858. J. BURROWS HYDE. *Improvement in compositions for coating telegraph wires.*

A composition formed by mixing 1 part of boiled linseed, cotton seed, or resin oil with 8 parts of asphaltum, the latter to be melted and the oil gradually stirred in.

45,518—December 20, 1864. I. N. PEIRCE. *Improved composition for crayons.*

A compound, using kaolin as the base, as kaolin 48 parts, calcined plaster of paris 16 parts, white glue 1 part, and water.

50,658—October 24, 1865. H. J. GRISWOLD. *Improved transparent composition for tablets.*

A coating formed of 5 pounds of chemically prepared soapstone incorporated with 18 pounds of white shellac varnish is applied to a card or other foundation.

51,009—November 21, 1865. R. BORCHERDT AND H. BERGMAN. *Improved composition for the manufacture of toys.*

A mixture of glue, 5 pounds; sugar or honey, 10 pounds; glycerine, 2½ pounds, and Perry's white, 3 pounds.

60,984—January 1, 1867. H. WURTZ. *Improved composition of glue or gelatine, and other materials, called durogel.*

A combination of bichromate of potash with glue or gelatine, as solutions of 250 parts of glue with 5 parts of bichromate of potash, heated together.

63,087—March 19, 1867. A. PELLETIER. *Improved composition for coating wood, cloth, metals, and for forming various articles.*

The compound consists of vegetable fiber, soapstone, silicate of soda, red lead, and litharge. It is made impervious to water when coated by treatment with diluted muriatic acid, 1 part acid and 3 parts water.

71,210—November 19, 1867. A. PELLETIER. *Improved composition for coating wood, iron, paper, etc.*

A mixture of vegetable fiber pulp, silicate of soda, and soapstone, in about equal proportions by weight, made into sheets or used as a coating; it may be given a coat of coal tar and covered with powdered steatite.

71,893, December 10, 1867. R. O. LOWREY. *Improvement in composition of matter for the manufacture of waterproof paper and other articles.*

A new compound, produced by treating vegetable fiber or pulp, or article made therefrom, first, with solution of gelatine or animal glue, soap, and glycerine or saccharine water, and then with a suitable astringent solution which will render it insoluble in water, as of alum and salt in about equal proportions.

72,727—December 31, 1867. A. B. ELY. (*Reissue: 2,969—June 9, 1868.*) *Improvement in heel stiffeners.*

Fiber and resin are mixed and rolled, pressed or molded into form, or felted and woven fabrics are saturated with gums or analogous substances, and heated and pressed in molds.

76,775—April 14, 1868. H. W. JOHNS. *Improved compound for roofing and other purposes.*

The combination of asbestos with pigments, oleaginous or resinous matters or varnishes, or spirits, or ground or powdered minerals, or rubber.

77,958—May 12, 1868. W. M. WELLING. (*Reissue: 5,940—June 30, 1874.*) *Improvement in artificial ivory.*

A mixture of shellac 16 parts, camphor 1 part, and talc 16 parts, all by weight; mixed, heated, ground and molded while in a heated state.

77,991—May 19, 1868. R. O. LOWREY. *Improved plastic compound for roofing and other purposes.*

Vegetable fiber, with or without the addition of sand, clay, or similar substances, is mixed with silicate of soda, and after rolling, pressing, or molding, the article is treated with a solution of chloride of calcium: it may be saturated therewith, and, when hard enough to handle, treated in a hot solution.

79,794—July 7, 1868. S. WHITMARSH. *Improved composition for forming moulded and coated articles.*

A composition of blood with asbestos or other mineral or earthy matter, mixed or ground together and exposed to a temperature of 176° C. to give it a hard and waterproof character.

85,018—December 15, 1868. J. M. MERRICK, JR. *Improved material for the manufacture of boxes, picture frames, buttons, insulators, inkstands, and other articles.*

Powder of silica chemically prepared or in the form of diatomaceous deposits or infusorial earth is mixed with gum shellac or other gums.

85,055—December 22, 1866. C. E. BONNET. *Improved composition for ornamental mouldings.*

One-fourth of a pound of paper pulp is added to a solution of 2 pounds of glue in 5 pints of water, then a mixture of zinc white or white lead and 1 gill of linseed oil, and then sufficient whiting to form a tough dough.

88,516—March 30, 1869. R. W. RUSSELL. *Improved fibrous composition, slab and panel for roofs, floors, walls, tanks, and for other purposes.*

Disintegrated cane fiber is charged with or mixed with bitumen and formed into slabs, sheets, etc.

89,100—April 20, 1869, W. M. WELLING. *Improved elastic composition to imitate ivory and similar materials.*

An elastic compound is formed by a mixture of 1 pound of shellac, and, say, 3 ounces of india rubber; with this base there may be mixed gum-camphor, kaoline, ivory dust, bone dust, or dust of holly, satin, or other woods.

89,531 April 27, 1869. W. M. WELLING. *Improved composition for artificial ivory.*

A mixture of kaolin, 2 parts, and shellac, 1 part, with or without a small portion of gumcamphor. The mixture is passed through heated rolls and molded while warm.

91,090—June 8, 1869. W. COMPTON. *Improved composition-crayon.*

A mixture of about 6 pounds paris white, 3¾ ounces starch, 3 ounces of soap, and from one-half to 2¼ ounces of gum or glue.

92,303—July 6, 1869. G. F. GOETZE. *Improved papier-maché compound.*

A mixture of paper pulp 5 parts, glue 5 parts, turpentine 2 parts, oil 2 parts, flour 4 parts, and whiting to suit; forming a petrified compound.

99,355—February 1, 1870. G. SCHLUETER. *Improvement in compositions for molding from plaster of paris.*

Dry pulverized gum is mixed with dry plaster and coloring matter, after which water is added.

101,101—March 22, 1870. J. R. COLE. *Improved composition for the manufacture of tobacco pipes, stems, and cigar holders.*

Paper pulp is mixed with a solution of alum or other salts that will render it incombustible, and molded.

121,152—November 21, 1871. M. W. BROWN. *Improvement in composition stoppers for vessels.*

A mixture of 30 parts of glycerine and 40 parts of gelatine, with or without 4 parts of an alkaline solution of 10° Baumé.

122,962—January 23, 1872. C. H. POND. *Improvement in insulating compounds for telegraphs, etc.*

A mixture of coal tar, 1 part, and charcoal, or sawdust, tanbark, or other organic body having fiber or structure, 2 parts. The woody matter may be baked or thoroughly kiln dried.

124,201—March 5, 1872. M. G. FARMER. *Improvement in compounds for insulating telegraph wires, etc.*

A mixture of resin, 24 parts; beeswax, 16 parts; spermaceti, 8 parts; and oil, 1 part; for saturating porous insulators.

129,217—July 16, 1872. A. K. EATON. *Improvement in compounds of gelatine, tannin, and cellulose.*

A compound resulting from the chemical union of cellulose, tannin, and gelatine: say, glue, 54 parts; tannin, 46 parts, in the form of catechu or any of the crude tannin gums, and cellulose, 150 parts.

142,595—September 9, 1873. A. THIELE. *Improvement in composition mastic.*

A mixture of 40 parts of sand, 100 parts of chalk, 15 parts of tallow, and 6 parts of tar.

144,548—November 11, 1873. J. L. KENDALL. *Improvement in paper products.*

Paper pulp and sponge is saturated with linseed oil and subjected to pressure.

148,829—March 24, 1874. I. I. JACKSON. *Improvement in compositions for printers' inking rollers.*

A mixture of glue, 16 pounds, glycerine, 16 pounds, borax, 1 pound, and japan, 1 pound.

148,910—March 24, 1874. A. WILKINSON. *Improvement in compositions for coating telegraph wires.*

A mixture in, say, the proportions of white lead, 1 pound, japan, 1 ounce, pitch, 4 ounces; shellac, 8 ounces; tallow, 1 ounce; naphtha, 1 ounce; and linseed oil, 1 ounce.

149,615—April 14, 1874. D. G. AND S. STAIGHT. *Improvement in artificial ivory for piano keys and other articles.*

Alabaster, gypsum, or other variety of sulphate of lime is treated with heat and subsequent immersion in white hard varnish, olive oil, or other oleaginous, fatty, or waxy matter, and then repeatedly immersed in heated water or alum water; the hardness being varied by the use of the alum.

149,749—April 14, 1874. J. G. HALEY. *Improvement in compounds for a waterproof material.*

A compound made of limesoap, prepared of hydraulic cement and linseed oil, mixed with sulphate of zinc, bisulphuret of carbon, alum, asbestos, and clay.

150,194—April 28, 1874. A. SCHMIDT. *Improvement in composition moldings.*

A composition of ground tanbark, ground eggshells, and slacked lime, with an admixture of glue and linseed oil, is molded under a steam-heated dye with a sheet of veneer for the face of the molding.

168,086—September 28, 1875. F. B. DUFFEY. *Improvement in plastic compounds for making ornamental articles.*

A mixture of Spanish whiting, 8 pounds; white lead ground in oil, 1 pound; coach varnish, 6 drams; dammar varnish, 6 drams; Japan drier, 3 drams, and boiled linseed oil, 10 ounces.

174,527—March 7, 1876. F. HICKMAN. *Improvement in materials for chair seats, backs, veneers, floorings, etc.*

Sawdust or fine shavings, saturated with dissolved glue or melted shellac, is spread upon a backing of cloth or other material, and rolled or pressed before it is completely dry.

189,339—April 10, 1877. B. J. CLARKE. *Improvement in crayons for marking on glass, etc.*

A mixture of 6 ounces of beeswax, 7 ounces of suet, and 1 pound of dry color, with half an ounce of oil of cedar.

190,769—May 15, 1877. A. KIESELE. *Improvement in compositions for casting ornamental figures.*

A composition consisting of paraffin, 1 pound; stearine, 4 ounces; and pulverized sugar, 12 ounces.

192,773—July 3, 1877. O. LONG AND P. H. DRAKE. *Improvement in adhesive substances.*

It consists of a solution of worn-out printers' inking rollers (composed of glue and molasses, or glue, glycerine, and molasses) with the addition of tobacco to render it insect proof.

193,213—July 17, 1877. H. BAYLE. *Improvement in compositions for molded articles.*

A compound consisting of 100 pounds of papier-maché, 20 pounds of gum arabic, and 5 to 6 ounces of bronze powder.

198,884—January 1, 1878. J. B. HAYDEN. *Improvement in composition for molded articles.*

Flexible threads or strips of wood cut with the grain and irregularly crossed—as excelsior—is saturated with glue and compacted under pressure.

201,067—March 5, 1878. J. W. SWARTS. *Improvement in crayons.*

Composed of glue, 8 parts, and an alkali, as a solution of carbonate of soda, 1 part, boiled to a hard saponification of the mass; and 1 part of the same mixed with 3 parts of paraffine wax and coloring matter.

201,283—March 12, 1878. C. C. PARSONS. *Improvement in compositions for crayons.*

Composed of clay, fatty matter, resin, and coloring matter melted together, as hard tallow, 4 parts; resin, 1 part; powdered clay, 1½ parts, and lamp black, one-half part.

201,348—March 19, 1878. J. W. & C. M. HYATT. *Improvement in siliceous material to imitate ivory and similar substances..*

An alkaline silicate, as silicate of soda, is used to agglutinize a solid animal tissue. Comminuted bone, horn, or ivory is mixed with the silicate of the consistency of sirup, and molded or rolled into sheets and dried, or treated with heat and pressure. The composition is treated with calcium chloride to render the silicate insoluble.

202,636—April 23, 1878. W. H. DIBBLE. *Improvement in composition for manufacturing molded articles.*

A dry pulverulent composition formed by indurating and pulverizing blood in combination with animal, vegetable, or mineral solids—about equal parts by weight when dried

206,007—July 16, 1878. G. R. EVANS. *Improvement in nonconducting compounds.*

A fire-resisting and nonconducting compound, consisting of 3 or 4 parts of pulverized petrified wood, 1 part of mica, and 1 part of talc, with sufficient clay or other material to make a pasty mass.

208,036—September 17, 1878. J. ROBLEY. *Improvement in manufacture of floor cloth.*

A mixture of sawdust, ground wood, or other vegetable matter, with copal varnish and dry paint or mineral coloring matter, spread on a canvas, textile, or fibrous base.

209,528—October 29, 1878. C. WALPUSKI. *Improvement in the manufacture of colored crayons.*

A composition consisting of a suitable base, as kaolin, with starch and gelatinous matter combined with coloring matter; (the colors can be worked in a dry state and fixed on paper with water).

210,204—November 26, 1878. A. KEMPENNER. *Improvement in plastic composition for the manufacture of aquarium frames, etc.*

A mixture of sand, fire clay, coal tar, and asphaltum.

215,757—May 27, 1879. A. KIESELE. *Improvement in compositions for casting ornamental figures.*

A mixture of 5 parts of paraffin with 2 parts of starch.

217,360—July 8, 1879. J. C. FRIEDRICHS. *Improvement in compounds for forming letters, figures, or ornaments.*

A mixture of one-half pound of umber, one-quarter pound of litharge, 5 pounds of plaster of paris, 1 pound of clay, one-quarter pound of terra-sienna, 2 pounds of boiled oil, 1 pound spirits of turpentine, and one-half pound of Japan drier.

217,705—July 22, 1879. W. F. NILES. *Improvement in the manufacture of ornamental buttons from blood and other materials.*

A compound formed of powdered blood and colored, lumped, powdered blood with a gelatine or albumin substance, molded with pressure and heat.

218,538—August 12, 1879. J. B. KING. *Improvement in compositions for walls and ornaments.*

A mixture of 3 parts of clay; 1 part pulverized lava; 1 part dextrine or similar gum; 1 part fibrous material, as cotton, paper, wool, or asbestos; 1 part ground plumbago, and 1 part pulverized glass, with sufficient water to render the mass plastic, with or without a small quantity of plaster of paris.

221,825—November 18, 1879. L. E. JANNIN. *Improvement in composition for stereotype molds.*

A mold or matrix for forming stereotype plates is made of a cement composed of protoxide of lead and glycerine.

221,881—November 18, 1879. H. P. WEBB. *Improvements in paints for filling the seams of vessels.*

A quick drying liquid-gum vehicle, composed of resin dissolved in naphtha, combined with an earthy base, as red oxide of iron.

223,593—January 13, 1880. A. KRYZINSKI. *Composition for covering moldings.*

Composed of a solution of glue, 4 pounds; rye-flour, 8 pounds; and whiting, 190 pounds.

223,869—January 27, 1880. N. ULLMAN AND M. D. STILES. *Crayon compound.*

Formed of lampblack, 16 parts; alcohol (95 per cent), 48 parts; and Siberian lead or graphite, 1 part; all by weight.

223,880—January 27, 1880. J. BURBRIDGE, R. C. THORPE, AND T. OAKLEY. *Composition for elastic rollers.*

Composed of sulphurized oil, fibrous material, and gum-resin or pitch; as from 3½ to 4½ pounds of fibrous material added to 1½ pounds of gum-resin and combined with 6 pounds of sulphurized oil. The rollers are subjected to a heat of about 150° C. for about three hours.

225,261—March 9, 1880. O. F. WOODWARD. *Composition of matter for making molded articles of manufacture.*

Gypsum and resin mixed together under heat—say in the proportion of 5 parts of the former to 4 of the latter.

225,679—March 16, 1880. A. T. WOODWARD. *Plastic compound.*

A mixture of pulverized silica—such as flint, glass, or sand—and a mineral or vegetable resin or pitch, with or without boiled linseed oil or other drying oil, or turpentine, or benzine; impervious to water and suitable for insulating purposes.

225,817—March 23, 1880. T. FLETCHER. *Composition for filling teeth.*

A paste composed of alumina pyrophosphate or phosphate triturated with phosphoric or pyrophosphoric acid and mixed with a substance capable of combining therewith and taking up excess of acid and solvent, as powdered hydrate of alumina, magnesia, or heavy oxide of lead.

226,547—April 13, 1880. J. L. POPE. *Composition of matter.*

A mass of pulverized cork mixed with a suitable binder (colored or not), with or without any suitable substance susceptible of taking a polish, and solidified by pressure.

226,583—April 20, 1880. I. B. ABRAHAMS. *Plastic composition of matter for the manufacture of jewelry and fancy articles.*

One part of glue is dissolved in 2 parts of slightly acidulated water and mixed with 1 part of resin or shellac liquefied by heat and the addition of turpentine, when 4 parts of starch and a dilute acid is added with heating.

226,738—April 20, 1880. T. FLETCHER. *Composition for filling teeth.*

A solution of phosphate of tin in phosphoric acid is combined with the powdered product of a mixture of lime 1 part, and silica and alumina each 5 parts, fused together.

227,291—May 4, 1880. E. L. ORMSBEE. *Substance for mounting stuffed birds, etc.*

A mixture of glue, sand or sawdust, and Marseilles green, in about equal proportions; it forms an imitation of wood.

227,352—May 11, 1880. E. EVERHART. *Composition for insulating telegraph wires, coating metals, covering roofs, and for other purposes.*

A mixture of 250 pounds of asphalt and 100 pounds of resin, with 20 pounds each of powdered charcoal and infusorial earth.

229,491—June 29, 1880. P. L. SYLVESTER. *Manufacture of buttons from plastic material.*

An ornamental coating of tinsel, foil, brocade, or gold sand, combined with shellac; produced by mixing shellac and the tinsel, etc., with heat, then pulverizing, and sprinkling the surface of the mold with the powder.

229,494—June 29, 1880. P. L. SYLVESTER. *Manufacture of buttons from plastic material.*

A plastic material composed of bleached shellac, 1 part, and mineral white (carbonate of lime), 2 parts, without pigments.

231,540—August 24, 1880. J. COLLINS. *Lining gas generators, acid chambers, and fountains for mineral waters.*

Powdered asphaltum with sufficient deodorized benzine to form a thick paste is heated until the asphaltum is dissolved and powdered plumbago added, pound for pound.

231,736—August 31, 1880. J. TAYLOR. *Manufacture of flexible tubes.*

A coating composition consisting of 4 ounces of a product, obtained by dissolving 1 ounce of alum with 1 pound of linseed oil and boiling, mixed with 1 pound of molasses and 1 pound of gum arabic.

235,909—December 28, 1880. G. F. SENTER. *Composition from mineral wool for journal bearings.*

Three parts of mineral wool and 1 part of plumbago are mixed and ground together and sufficient water glass added to form a paste, which is molded into a compact mass with heavy pressure, dried, and dipped in melted paraffin or other unctious material.

236,034—December 28, 1880. J. W. HYATT, C. S. LOCKWOOD, AND J. H. STEVENS. *Factitous material to imitate ivory, horn, etc.*

Bone dust is welded by heat and pressure, with or without the admixture of a water repellant, as a gum solution, or an acid, as boracic acid, to facilitate the welding.

236,480—January 11, 1881. S. BARR. *Compound for manufacture of gas tubing.*

A mixture of glue, 10 pounds; glycerine, 12 pounds; soap, 4 ounces; borax, 1 ounce; and copperas, three-fourths of an ounce; with sufficient water, using heat, to form a paste.

237,569—February 8, 1881. H. B. MEECH. *Dry-ground pulp.*

The pulp of rags, jute, straw, or other wet-pulped vegetable fibers, is dried and then ground or pulverized to a fine powder for admixture with varnishes, gums, or oils.

238,980—March 15, 1880. J. B. SPENCE. (*Reissues: 9,982, 9,983, and 9,984—December 30, 1881.*) *Manufacture of metallic compounds from sulphur and sulphides.*

"Spence's metal," composed of metallic sulphides, as sulphide of iron and sulphide of copper, and sulphur; formed by pulverizing the sulphide and combining it with fused sulphur.

239,409—March 29, 1881. W. A. WALLER AND J. P. HITCH. *Composition for slating surfaces of blackboards.*

A mixture of 1 pound of lampblack and 1 pound of gum arabic in water with 8 pounds of Spanish white and 16 pounds of plaster of paris added.

239,466—March 29, 1881. E. J. DE SMEDT. *Insulating or nonconducting compound for electrical purposes.*

Telegraph wires and electrical conductors are insulated or covered with an oxidized hydrocarbon obtained by treating coal tars and the heavy oils of petroleum with an oxidizing agent.

239,951—April 12, 1881. W. M. GRAZE. *Plastic composition from paper-pulp for floors, brake-shoes, journals, etc.*

A composition of matter, and articles made thereof, consisting of a mixture of paper-pulp and metallic fillings (with or without a sizing of oil, resin, paraffin or the like) solidified under pressure.

242,758—June 14, 1881. C. CRABTREE. *Composition to be used in making squibs waterproof.*

A mixture of 1 pound of beeswax, 3 pounds of flowers of sulphur, 1 pint of alcohol and one-half pound of gum shellac.

244,321—July 12, 1881. J. C. SELLARS. *Composition for molds and composition-mold for forming concrete.*

A lubricating binding material not affected by alkalis, such as paraffin, combined with sand or charcoal.

244, 486—July 19, 1881. E. ROSENZI. *Composition of matter for molded articles to resemble glass and iron.*

It consists of sand, 100 parts; coal ashes, 40 parts; lime (burned), 10 parts; with arsenic, magnesia, borax, and soda, in variable quantities, fused in a crucible and cast.

246, 391—August 30, 1881. J. R. HOWELL. *Composition of matter to be used in the ornamentation of moldings and picture frames and the manufacture of light hollow ware, toys, trays, etc.*

A mixture of 8 pounds of glue, 6 pounds of resin, 2 pounds of paper pulp, and 2 quarts of linseed oil, thickened to a paste while hot by the addition of whiting.

247,797—October 4, 1881. M. W. BROWN. *Composition of matter.*

A composition consisting of skin glue or gelatine, water, glycerine, carbonate of lime, and earth paint, to be applied to paper or fabrics to render them flexible, tenacious, and resistant to wear.

248,324—October 18, 1881. H. W. JOHNS. *Asbestos material and process of manufacturing the same.*

Asbestos is reduced to fibers; formed into a bat, with or without wires or cords placed therein; moistened, as with a glutinous or waterproofing solution; and subjected to pressure.

250,257—November 29, 1881. O. O. KARSCH. *Composition for artificial-wood ornaments.*

Ten pounds of glue dissolved in 4 quarts of water is combined with 6 pounds of resin dissolved in 1 quart of linseed oil with heat, and sifted whiting and plaster of paris added and molded while warm and plastic.

251,473—December 27, 1881. F. W. SCHROEDER. *Insulating composition or compound for coating electric and other wires or conductors.*

A compound formed from 2 pounds of glue, 16 ounces of mastic, 14 ounces of dextrine, 9 ounces of asbestos, 2½ ounces of chrome-alum, one-fourth of an ounce of chloride of iron, and 16 ounces of glycerine, with or without the addition of 8 to 20 ounces of albumen.

251,474—December 27, 1881. F. W. SCHROEDER. *Insulating composition or compound for coating electric and other wires or conductors.*

The composition is like that of No. 251,473, with the omission of asbestos.

251,970—January 3, 1882. J. TAYLOR. *Coating and insulating wire for electrical purposes.*

A coating of benzoin is applied directly to the wire or outside of a fibrous coating.

253,200—February 7, 1882. T. GUILFORD. *Composition for buttons, etc.*

A mixture of pulverized horn or hoof and steatite, with or without coloring pigments.

254,461—March 7, 1882. J. D. CHEEVER. *Waterproof composition.*

A composition, consisting of short fibers, as of jute, 30 pounds; spent tan bark powdered, 50 pounds; pulverized pagodite or agalmatolite, 30 pounds; powdered red chalk or red oxide of iron and clay, 20 pounds; and flour sulphur, 1½ pounds, mixed in a mill, with the addition of 10 pounds of vaseline and 20 pounds of caoutchouc—the latter made miscible with coal tar or petroleum naphtha. Burlap is prepared to receive a coating of the above by applying to the same, by hot calendering, a composition of glue, yellow soap, and alum.

254,964—March 14, 1882. B. HARRASS. *Plastic compound.*

For making imitation wood objects, a mixture of 3 parts of paper pulp or cellulose, 1 part of starch, and 2 parts of flour, boiled, and converted into a fibrous paste, is mixed with sawdust; or a mixture of 2 to 10 parts of cellulose, 6 to 30 parts of sawdust, 1 to 5 parts of binding material—as dextrine, albumen, etc.—1 to 5 parts of flour and one-eighth to 2 parts of clay, chalk, etc., for backing veneers.

255,937—April 4, 1882. M. B. CHURCH. *Plastic material.*

For wall covering, a mixture of 5 to 8 pounds of glue, with 1 to 1½ pounds of sulphate of zinc, and 100 pounds of plaster.

257,706—May 9, 1882. W. C. HORNE. *Crayon.*

A luminous substance, such as a phosphorescent powder, is combined with a base or vehicle to form a paste which is molded and dried. It makes luminous marks.

258,549—May 30, 1882. F. BOREL. *Insulating material for electrical conductors.*

A siccative oil, such as linseed oil, transformed by heat into a solid elastic mass, with or without an admixture of a resinous matter, such as colophony.

259,878—June 20, 1882. C. S. LOCKWOOD. *Plastic composition for the cores of billiard balls, and for other purposes.*

Comminuted and desiccated glue, with or without glycerine, is welded and agglutinated by heat and pressure.

261,623—July 25, 1882. H. W. MORGAN. *Preparation of whalebone.*

A solution of whalebone, formed by dissolving shavings, cuttings, etc., in an alkali.

262,427—August 8, 1882. W. M. JACKSON. *Gas-proof cement.*

A compound of glycerine, 24 parts; gelatine, 1 part; and litharge or yellow oxide of lead, 30 parts.

264,771—September 19, 1882. M. W. SAMUEL. *Method of and means for the production of figures in relief on various substances.*

An adhesive plastic, consisting of 45 per cent of wax and 50 per cent of powdered resin, combined with heat, to which 5 per cent of Venice turpentine is added, with boiling.

266,053—October 17, 1882. J. J. SACHS. *Production of materials for castings, cements, lead pencils, etc.*

A composition consisting of sulphur and plumbago or other nonmetallic substances or mixtures, in the proportion of 4 parts of the former to 3 parts of the latter, or thereabout.

266,493—October 24, 1882. W. MATT. (*Reissue: 10,343—June 19, 1883.*) *Artificial stone for veneers, etc.*

A mixture of glue, 6 pounds; resin, three-fourth of a pound; linseed oil, 1½ pounds; paper pulp, 1 pound; glycerine, one-fourth of a pound; and steatite or its equivalent, and coloring pigments.

267,045—November 1, 1882. R. S. WARING, AND J. B. HYDE. (*Reissue: 10,350—July 3, 1883.*) *Insulating material for electric uses.*

An insulating compound composed of two or more of the heavier products arising from the redistillation of the residuum of petroleum, as obsidine tempered with a softer residuum product to give flexibility.

267,046—November 7, 1882. R. S. WARING. (*Reissue: 10,351—July 3, 1883.*) *Insulating compound for electric wires.*

A compound consisting of the liquid distillates of the residuum of petroleum with resinous or bituminous substances, together with clay, chalk, pulp, or like material.

271,120—January 23, 1883. W. F. RIKEMAN. *Composition for covering piano keys, etc.*

It consists of a mixture of gypsum, 60 parts; shellac, 30 parts; silica, 10 parts; and ivory black, 10 parts.

271,994—February 6, 1883. D. M. STEWARD. (*Reissue: 10,344—June 19, 1883.*) *Electrical insulator.*

Steatite, in a natural block cut into the desired form, or in the form of powder, is hardened or vulcanized by treating it with ammonia and muriatic acid and then subjecting it to heat. The vulcanized powdered steatite is mixed with a binding material, as plaster of paris, and molded.

274,622—March 27, 1883. J. F. MARTIN. *Insulating compound for electrical work.*

A mixture of marble dust, plaster of paris, and glue size; it is formed into tubes.

275,123—April 3, 1883. I. R. BLUMENBERG. *Indestructible compound for lining and coating tubes, cylinders, and other vessels, electric wires; also for joint packing, taking impressions, making castings, molds, and ornaments, and ornamental work.*

A compound of lampblack, about 4 per cent; asbestos, 20 per cent; litharge, 45 per cent; and glycerine, 31 per cent.

275,422—April 10, 1883. S. F. SHELBOURNE. *Insulating compound for electric conductors.*

A compound of paraffine and one or more of the heavier and separate distillates passing over in the redistillation of the residuum of petroleum.

275,904—April 17, 1883. C. GRUNZWEIG AND P. HARTMANN. *Artificial cork.*

A composition formed of boiled starch and powdered cork.

276,607—May 1, 1883. G. J. LESSER. *Plastic and elastic composition for forming elastic rolls, elastic pads, and for other useful purposes.*

A compound of glue, 25 pounds; gelatine, 6 pounds; glucose, 25 pounds; extract of lead, 1 pound; and glycerine, 15 pounds; formed by first forming a glue or gelatine with the lead compound and combining said compound with a compound of glue and glucose with the glycerine added.

276,891—May 1, 1883. J. G. SANDERSON. *Insulating electrical conductors.*

A pulverulent mixture of nonconducting metallic oxide—as the sesquioxide of iron—and sulphur is mixed with melted bitumen.

276,998—May 8, 1883. S. BARR. *Compound for coating gas tubing.*

A mixture of glue, 30 pounds; glycerine, 30 pounds, and bichromate of potash, 1½ ounces.

277,707—May 15, 1883. P. E. GONON. *Manufacture of lead-pencils.*

A pencil consisting of a marking core surrounded by material, as wood pulp, pressed around the core in a plastic or semifluid state. (Claims for the apparatus.)

278,481—May 29, 1883. S. M. ALLEN. *Material for roofing purposes.*

Powdered or pulped fiber is mixed with heated asphalt and the paste formed into sheets, or applied to a web or backing of paper or other fabric.

278,536—May 29, 1883. J. GREIVES. *Electrical insulating material.*

A compound consisting of chalk and colophony, and containing from 40 to 90 per cent of chalk.

279,492—June 12, 1883. A. MEUCCI AND T. DENDI. *Plastic paste.*

A composition consisting of gelatine or a substance containing gelatine, 2 to 4 parts; fiber deprived of its mineral, gummy, and resinous substances, one-fourth to one-half part; an acid, as dilute muriatic acid, 1 to 2 parts; starch or analogous substances, 1 to 2 parts; varnish, 1 to 2 parts; oxide of zinc, 6 to 8 parts; and terra-alba, 2 to 4 parts.

281,999, July 24, 1883. J. B. HYDE. (*Reissues: 10,403; 10,404—November 6, 1883.*) *Insulating compound for electrical conductors and apparatus for compounding and applying the same.*

A compound composed of petroleum or mineral oils combined under heat, in a closed vessel, with the hard bituminous residuum from petroleum distillation.

282,014—August 7, 1883. J. F. MARTIN. *Compound for electric-wire insulators.*

A compound of asphaltum and from 40 to 60 per cent of fine marble dust.

283,044—August 14, 1883. D. B. TURNER. *Composition to insulate, preserve, and protect wire for electrical purposes.*

A compound formed of 1 part by weight of castor oil, and 5 parts of the black resinous substance obtained as a residuum of oil distillation, and known as "Nubian pitch," "Nubian gum," and "colophony niger."

283,200—August 14, 1883. H. R. BRISSETT AND J. HOWE. *Composition for coating and insulating underground wires.*

A composition of cottonseed oil, 30 ounces; Venetian turpentine, 30 ounces; resin, 18 ounces; asphaltum, 39 ounces; steatite, 48 ounces; paraffine, 16 ounces; pine tar, 12 ounces; sulphur, 17½ ounces; and red lead, 15 ounces.

283,526—August 21, 1883. J. W. STANSBURY AND J. M. HEDRICK. *Lining for burial caskets, etc.*

A compound composed of 3 pounds of alcohol, 4 pounds of white lead, 3 pounds of gum shellac, 1 pound of white glue, and plaster of paris.

283,793—August 28, 1883. C. S. LOCKWOOD. *Plastic material.*

A compound consisting of 8 pounds of powdered bone or similar material, 2 ounces of phosphate of ammonia or its elements, and 2 pounds of powdered shellac, may be subjected to pressure in heated molds or mixed with a solvent and mixing rolls.

283,794—August 28, 1883. C. S. LOCKWOOD. *Plastic material.*

Eight pounds of pulverized and desiccated bone is mixed with 2 ounces of phosphate of ammonia and subjected to pressure in heated molds.

283,796—August 28, 1883. C. S. LOCKWOOD. *Zincated bone.*

Bone dust or like material is mixed with sulphate of zinc, the mixture submitted to a water bath, and then the free acid washed out to render the gelatine insoluble.

283,797—August 28, 1883. C. S. LOCKWOOD. *Plastic material.*

A mixture of tannate of iron and bone or horn dust is subjected to pressure in a heated mold, as 8 parts of bone dust and 2 parts of tannate of iron, or a mixture of 16 parts of bone dust, 4 parts of solid extract of logwood, and 1 part of sulphate of iron made into a solution, and the moisture expelled.

284,098—August 28, 1883. R. S. WARING. *Insulating material and preparation of the same.*

An insulating material for lead-covered cables: produced by subjecting natural asphaltum, or the heavier distillates or residual products of petroleum to a degree of heat above the vaporizing point of water, to eliminate the latter and the light and easily decomposed products—approximate, 175° C.—but below the point at which destructive distillation or cracking begins.

287,346—October 23, 1883. C. J. VAN DEPOELE. *Insulating material.*

A mixture of silicate of soda with earthy substances or metallic oxides, as zinc white or red lead; paper is saturated therewith.

287,994—November 6, 1883. H. ARMSTRONG AND J. A. LOUDON. *Boiler-covering.*

Fibrous peat, separated or disintegrated from the bulk of its earthy matter, is mixed with cement as a covering for steam-pipes, boilers, etc.

288,112—November 27, 1883. W. MATT. *Artificial stone for veneers, molded articles, etc.*

A compound consisting of glue, 10 pounds; asbestos, 10 pounds; linseed oil varnish, one-half pound; colophony, one-half pound; glycerine, 1 pound; turpentine, 1½ pound; with steatite or kaolin and pigments.

289,237—November 27, 1883. L. EBERLE. *Composition for gilt moldings.*

A mixture of one-half pound each of stick-lac and sandarac, and one-eighth pound each of galipot, gamboge, and dragon's blood in alcohol.

290,057—December 11, 1883. J. BURROWS HYDE. *Insulating compound for electric conductors.*

Mineral and coal-tar bitumens are melted and combined with petroleum or mineral oil. In coating thread-covered electric wires with an insulating medium, the covering is saturated with a volatile fluid, as crude petroleum, before the wire enters the heated insulating composition. The waste vapors evolved are stored in a sealed and floating holder and used for heating the furnace.

290,058—December 11, 1883. J. B. HYDE. *Insulating compound for electric conductors and the process of compounding the same.*

A compound of dry powdered peat with bituminous substances and hydrocarbon fluid added under heat; short lengths of vegetable fiber may be added to the melted composition.

290,888—December 25, 1883. F. J. KALDENBERG. *Manufacture of articles from waste amber.*

Articles made of pieces of amber and gum animé molded together: formed by pulverizing the gum, mixing it with pieces of amber, and subjecting it to heat and pressure.

291,164—January 1, 1884. A. DICKMAN AND M. HEINTZ. *Veneer.*

A composition veneer built up in alternate layers or wood shavings and glue; the shavings are cut to particles of a uniform size.

291,284—January 1, 1884. E. BRADY. *Composition of matter for molding fruits, fancy-topped tables, birds, etc.*

It consists of 1 pound of pulverized hard stone, 1 pound of pulverized slate stone, one-quarter pound of common sand, one-quarter pound of white sand, one-sixth pound of pulverized clam shells, one-quarter pound of common brick, one-quarter pound of charcoal, 3 pounds of blue clay, 1 pint of linseed oil, and water.

291,716—January 8, 1884. J, GREIVES. *Electric insulating material.*

Caustic lime in powder, hydrated or otherwise, is combined with resin in a fused state, the lime being in excess; from 2 to 5 per cent of a fixed oil, as resin oil, may be added, to render the compound flexible.

291,717—January 8, 1884. J. GREIVES. *Electric insulating material.*

A compound of resin and natural silicate of magnesia—as talc or soapstone—combined by fusion, the silicate being in excess; from 5 to 10 per cent of a fat or oil is added to temper the compound.

291,718—January 8, 1884. J. GREIVES. *Electrical insulating material.*

It is composed of crystalline lime carbonate, as marble, spar, etc., reduced to powder and combined with resin by fusion of the latter, with or without the addition of powdered asbestos.

292,770—January 29, 1884. P. H. VANDER WEYDE. *Manufacturing a rot-proof covering for underground telegraph cables.*

The fibrous envelope of a metallic conducting wire is saturated with Utah elaterite or mineral wax, combined with from 5 to 10 per cent of bitumen.

292,956—February 5, 1884. M. SCHÜTZ. *Compound for preserving the soles of boots and shoes.*

It consists of 25 parts of shellac and 25 parts of alcohol, mixed with 50 parts of boiled linseed oil.

293,784—February 19, 1884. W. S. RAVENSCROFT. *Pulp caster-wheel.*

A caster wheel made of paper or wood pulp.

294,457—March 4, 1884. J. FOTTRELL. *Composition for electrical insulation.*

Metallic soap, which may be formed from a common brown soap and an alum solution, alone or combined with benzine, turpentine or gasoline, and linseed oil and varnish, and with or without a thickening material, as white lead.

297,626—April 29, 1884. J. H. PAGE. *Indestructible compound for coating wires for electrical purposes.*

A compound of litharge and glycerine, formed into a thick paste.

298,072—May 6, 1884. D. H. DORSETT. *Insulating material.*

The residuum of 50 gallons of coal tar, distilled until it will resist 55° to 60° C. without softening, combined with 2 gallons of crude petroleum paraffine, 100 pounds of fine silicious sand, and 50 pounds of pulverized coal-ashes and cinders, with or without one-half pound of black oxide of manganese and one-fourth pound of ammonia chloride.

300,464—June 17, 1884. L. HAAS. *Compound material for the manufacture of sheets, boards, blocks, artificial wood, etc.*

Eighty per cent of wood or vegetable fiber and 20 per cent of scrap leather and shoe waste or shoddy waste and crude asbestos are ground or reduced to a fiber, the moisture evaporated, and mixed with thinned asphaltum blended with a suitable quantity of pitch, sulphur, whiting, crude asbestos, and litharge.

300,729—June 17, 1884. O. F. PARSONS. *Fire and water proof compound.*

A mixture of 20 gallons of coal tar, 12 pounds of air-slacked lime, 7 pounds of Spanish brown, 6 pounds of sulphur, 2 pounds of litharge, 8 pounds of salt, and 7 pounds of American ocher.

302,977—August 5, 1884. W. M. BRASHER. *Floor-covering.*

One hundred and twenty pounds of litharge is added to a solution of 120 pounds of sugar of lead in 100 gallons of water, and 10 gallons of the same is then mixed with 300 pounds of whiting, 300 pounds of ocher, 10 gallons of glue size, 10 pounds of wood pulp, and 20 gallons of linseed oil (three-fourths raw and one-fourth boiled). It is spread on a textile base.

303,301—August 12, 1884. C. LORTZING. *Art of making artificial asphaltum from the residue of tanneries.*

The precipitated residuum of the waste waters of tanneries and the like is dried, powdered, mixed with powdered limestone, and subjected to heat and pressure; the product possesses all of the qualities and appearance of asphaltic mastic.

304,020—August 26, 1884. C. G. MUSKAT. *Composition for covering and insulating electric wires.*

One pound of castor oil is boiled with 2 pounds of gum copal and incorporated with 3 pounds of powdered slate.

304,775—September 9, 1884. S. BARBIER AND C. H. COIFFIER. *Composition to be used as a substitute for hard india-rubber, celluloid, iron, and the like.*

A mixture of ivory waste, or dust, and horn agglomerated by means of albumen.

305,205—September 16, 1884. C. S. LOCKWOOD AND J. W. HYATT. *Plastic material to imitate ivory, etc.*

Organic or analogous material is thoroughly comminuted, say to one twenty-thousandth of an inch, and then subjected to heat (160° C.) and great pressure in a mold; a homogeneous mass being formed without the use of adhesives.

307,184—October 28, 1884. A. DERROM. *Composition mastic for covering roofs, telegraph-wires, and the like.*

A mixture of "crude, hard Venezuelan bitumen" and purified, soft Venezuelan bitumen.

308,778—December 2, 1884. C. T. LEE. *Composition for making nonconducting handles for sad-irons, etc.*

Powdered mica, or like material, is combined with glue which has been treated with acetate of iron, so that the mass does not soften with moisture.

310,899—January 20, 1885. M. MACKAY. *Plastic compound suitable for molding into various useful articles, such as screw-stoppers for bottles, jars, etc.*

It consists of a compound of 75 pounds of lac, 38 pounds each of gum-sandarac, resin, and ivory-black, and 168 pounds of asbestos or other suitable fibrous material or silicates.

311,875—February 10, 1885. R. P. COUGHLIN. *Manufacture of clock-cases, statuary, vases, and other articles from plastic materials.*

A composition of Keene's cement, resin, and alum, with or without coloring matter. A composition for dyeing artificial marble consists of extract of logwood, copperas, tincture of iron, and water.

316,374—April 21, 1885. S. KRAUS. *Artificial slate pencil.*

Colored slate pencil, formed of coloring matter, 10 pounds; talc, 5 pounds; and potters' clay, 10 pounds; mixed, formed, and baked.

317,388—May 5, 1885. C. S. LOCKWOOD AND J. W. HYATT. *Process of treating silicate of soda in combination with zinc oxide, etc.*

A composition, and articles formed thereof, consisting essentially of silicate of soda and zinc oxide, combined, comminuted and partly dehydrated; produced by forming an aqueous solution of the silicate of soda with an admixture of zinc oxide in the proportion of 4 parts of silicate (26° Baumé) to 1 part of zinc oxide, comminuting it, and subjecting it to treatment in an ammoniacal bath.

319,084—June 2, 1885. J. A. FLEMING. *Preparation and production of insulating materials.*

Finely divided wood, or other vegetable fibrous material, is desiccated and impregnated with a mixture of melted bitumen or asphalt incorporated with silicates of magnesia, or lime, iron, alumina, or of two or more of them, and with amber resin, or other resin having a high melting point, as kauri, and molded under pressure.

321,956—July 14, 1885. J. W. ELLIS. *Composition of matter for the preservation and insulation of wires.*

A compound of roofing pitch with sulphur, one thirty-second part; resin, one-sixteenth part; and lime, one thirty-second part.

322,803—July 21, 1885. A. G. DAY. *Vulcanized product, termed "kerite."*

A compound formed by the mixture of cottonseed oil, linseed oil, coal tar or bitumen, and the sulphide of antimony or other suitable sulphide (product of No. 322,802).

322,805—July 21, 1885. A. G. DAY. *Vulcanizable compound, or crude kerite.*

A compound formed by the mixture of vegetable astringents with cottonseed oil, linseed oil, and coal tar or bitumen (product of No. 322,804).

322,996—July 28, 1885. S. P. M. TASKER. *Manufacture of leathery compound.*

Fibrous material—animal, vegetable, or mineral—is saturated with gelatine, molded or worked into the desired form, and then treated with tannic acid.

325,890—September 8, 1885. I. P. WENDELL. *Composition of matter for use as insulating material.*

A mixture of 2½ pounds of asbestos, one-half a pound of antimony, one-eighth of a pound of sulphur, and 2½ pounds of liquid silicate of soda.

325,891—September 8, 1885. I. P. WENDELL. *Composition of matter for use as insulating material.*

A mixture of 2 pounds of asbestos or talc, 1 pound of litharge, one-half a pound of antimony, and 3 pounds of liquid silicate of soda.

327,462—September 9, 1885. H. C. SPALDING. *Insulating compound for electrical cables, etc.*

A permanently viscous or plastic insulating compound consisting of boiled linseed oil and crude turpentine.

327,477—September 29, 1885. H. C. SPALDING. *Compound for insulating underground electric conductors.*

A permanently plastic insulating material, as a filling for underground conduits containing electric conductors, consisting of refined asphalt, 90 parts, and petroleum residue, 10 parts.

328,366—October 13, 1885. C. WALPUSKI. *Composition for pencil-leads and crayons.*

A composition consisting of a base—such as potter's clay—a binding medium, and two distinct colors—a writing color and a copying color.

329,349—October 27, 1885. W H. WIGGINS. *Substitute for billiard-cue chalk.*

Finely granular barytes is mixed with liquid dextrine, with or without a small percentage of gypsum, and molded into blocks.

334,782—January 26, 1886. F. KIMBLE. *Making targets.*

Composed of pitch, 100 pounds, and plaster of paris, or whiting, 25 to 75 pounds.

334,974—January 26, 1886. A. A. OLIVER. *Composition of matter for roofing, furniture, etc.*

A composition of manila or other fibrous stock, say, 1,000 pounds; asbestine powder, 1,000 pounds; linseed oil, 170 pounds; oil of tar, 170 pounds, and tungstate of soda, 90 pounds; with or without ground emery, 50 pounds.

337,472—March 9, 1886. S. M. ALLEN. *Composition of matter for making molded articles.*

A mixture of, say, 100 pounds of asphalt, resin, or equivalent substance, with 10 pounds of a suitable nonvolatile oil—as Trinidad asphalt oil—and 700 pounds of wood pulp or other vegetable or animal fiber. The fiber is saturated with water or spirits preparatory to mixing with the resinous or gummy matter.

339,519—April 6, 1886. W. W. BARNES AND J. D. EMACK. *Composition of matter suitable for casting medallions, tiles, picture frames, moldings, etc.*

A mixture of soluble glass, 100 parts; ground flint, 80 parts; ground iron, 30 parts; and roll sulphur, 40 parts; combined by heating up to 180° C.

339,777—April 13, 1886. J. HOWE. *Composition to be used for insulating wires.*

A mixture of cottonseed oil, 1 quart; asphaltum, 5 pounds; white resin, 4½ pounds; paraffin wax, 1½ pounds, and Venetian turpentine, 2 pounds.

341,072—May 4, 1886. E. C. C. STANFORD. *Manufacture of useful products from seaweed.*

Algic acid is produced from seaweed by an admixture of an alkali with the seaweed from which the salts have first been extracted. One hundred parts of the washed seaweed is mixed with 5 parts of an alkali as carbonate or hydrate of soda or biborate of soda, and the gelatinous solution separated from the undissolved ingredients.

341,757—May 11, 1886. G. A. LINDGREN. *Compound for preventing window frost.*

It comprises 1¼ ounces of sodium chloride, 3½ ounces of water, 7¼ ounces of glycerine, 2¼ ounces of isinglass, 1 ounce of cologne spirit, and one-half ounce of sulphuric acid.

342,377—May 25, 1886. R. F. NENNINGER. *Composition for floor and wall coverings, etc.*

A mixture of paper pulp in a dry state and the gummy viscous residue derived from heating linseed oil.

342,378—May 25, 1886. R. F. NENNINGER. *Process of manufacturing composition for floor and wall coverings, etc.*

Any fibrous material is molded or pressed into desired shape and dried, then treated with a gummy or resinous waterproof substance, as linseed oil, after heating to a high temperature, dissolved in a volatile solvent, such as naphtha, and finally the volatile solvent is evaporated.

342,684—May 25, 1886. J. W. & F. R. HOARD. *Insulating and protecting electric wires and cables.*

An electric conductor insulated with a covering of linseed or equivalent drying oil, highly oxidized throughout its mass by exposure to air or oxygen to the consistency of a jelly, and applied without a solvent.

344,823—July 6, 1886. J. FOTTRELL. *Composition of matter for the electrical insulation of wires covered with cotton, silk, or worsted braid or tape.*

A compound of boiled linseed oil, 6 gallons; oxide of zinc, 10 pounds; Venetian turpentine, 1 pound; lead shavings, 2 pounds; to which is added, after mixing and boiling, copal varnish, 1 gallon, and sandarac varnish, 1 pint.

345,542—July 13, 1886. A. L. REINMANN. *Cement for securing metal rings to electric-lamp bulbs and for other purposes.*

A mixture of 8 ounces of calamine and 4 ounces of chalk, and a suitable adhesive material, as glue, with or without a small amount of glycerine.

346,002—July 20, 1886. C. N. WAITE. *Marking crayon.*

A hygroscopic substance, such as glycerine or chloride of zinc, is combined with the crayon material, so that the marks formed will not form a dry powder or impair the surface of the board.

346,841—August 3, 1886. E. G. CHORMANN. *Composition for decorative purposes.*

It consists of a mixture of silex, an alkaline salt, carbon, clay, a metallic chloride, and a flux; to be used for coating purposes or to be molded.

347,565—August 17, 1886. O. BRACH. *Porous mass for blotting purposes and for making cigar pipes, etc.*

A porous compound consisting of vitreous sand, coarse river sand, pipeclay, and hogs-bean meal. The molded material is dried and burned at nearly the melting point of silver.

348,994—September 14, 1886. T. J. PEARCE AND M. W. BEARDSLEY. *Insulating wire and conductors for electrical purposes.*

A mixture of bisulphide of carbon and maltha is employed as an insulating coating.

349,751—September 28, 1886. A. H. ROWAND AND R. S. HUNZEKER. *Composition of matter for packing the joints of gas pipes, etc.*

It is composed of pitch and molasses.

351,611—October 28, 1886. R. ALEXANDER. *Compound for insulating telegraph wires, etc.*

A compound of mineral wool or glass-flock, say, 100 pounds; asphaltum, 60 to 70 pounds; and cement or carbonate of lime, 20 to 30 pounds. The glass-flock is treated to a hot bath of boracic acid previous to mixture to anneal or soften the fibers.

352,445—November 9, 1886. J. W. BUTLER. *Composition for the manufacture of blocks for containing electric wires or cables.*

A compound ot trinidad or other bitumen, say, 15 pounds; crude paraffin, 12 ounces; Portland cement, 6 ounces; Aylesford sand or finely powdered limestone, 8 pounds; roughly pulped wood, or sawdust, or tan-yard waste, 8 pounds; with or without Taranaki sand, 8 ounces.

352,449—November 9, 1896. C. W. COLLINS. *Cement for pipe-joints.*

Composed of plaster of paris and limewater; the latter neutralizing any free acid.

352,852—November 16, 1886. D. BROOKS, Jr. *Insulating material for electric wires.*

Resin and resin oil are combined in about equal proportions.

353,653—November 30, 1886. C. J. VAN DEPOELE. *Composition of matter for insulating electric conductors.*

A mixture of pulverized mica, silicate of soda, and a pulverulent earthy substance.

355,776—January 11, 1887. W. J. MICHELS. *Plastic composition for wall-hangings, etc.*

One hundred pounds of a vulcanized composition composed of a vegetable oil, as castor oil or castor oil and cottonseed oil, say 100 pounds; kauri gum, 25 pounds; resin, 6 pounds; camphor gum, 1¼ pounds; and 25 pounds flowers of sulphur is mixed with 100 pounds of wood pulp and 1 pound of paraffin.

356,363—January 18, 1887. J. JAMETON. *Composition for blackboards.*

A mixture of coke-dust, 50 parts; soap-plaster, 39 parts; carbon-black, 10 parts; and graphite, 1 part.

356,411—January 18, 1887. T. McSWEENEY. *Composition for packing joints and other purposes.*

It consists of resin, 1 part, and mineral asphaltum, 4 parts, mixed together and melted, and 6 parts of the mixture combined with 6 parts of black wax-tailings, and 6 parts of thick yellow wax-tailings.

358,746—March 1, 1887. H. S MEYERS. *Copying pencil, etc*

It consists of a soluble color (described), a soluble color with lime (described), mineral wool, soap, oxgall, and soap-paste. It gives copies in black

361,347—April 19, 1887. C. T. CROWELL. *Dielectric composition.*

A mixture of sand or marble dust, 4 parts, pulverized glass, 1 part, lime, 2 parts; resin, 1 part; isinglass, 1 part; and coal tar or "uintite" 2 parts.

362,076—May 3, 1887. S. H. GILSON. *Composition for insulating and other purposes.*

A compound of gilsonite, 90 parts, and oil or fat, 10 parts; with or without india rubber.

366,263—July 12, 1887. R. F. SILLIMAN. *Underground cable for telegraph wires.*

Wires are coated with powdered mica mixed with caustic potash or soda, dried, and heated to a red heat.

366,336—July 12, 1887. H. W. MERRITT. *Compound for covering electric wires.*

A compound of quicklime, 1 pound, slaked in 1 quart of water; 1 pound of fir-balsam; 4 pounds of ground asbestos; 1 ounce of sugar, and a small quantity of oxalic acid, 3 grains, dissolved in hot water.

366,337—July 12, 1887. H. W. MERRITT. *Semielastic compound for covering electric wires, etc.*

Two pounds of fluid silicate of soda is substituted for the quicklime of No. 366,336.

366,898—July 19, 1887. J. TATHAM. *Insulating compound.*

A compound of 4 to 6 parts of resin to 1 part of cottonseed oil.

366,967—July 19, 1887. W. MATT. *Plastic compound for use in the decorative arts, etc.*

It consists of gelatine, 10 pounds; water; digested skins, cut into small pieces; Venetian turpentine, 2 pounds; linseed oil, 2 pounds; and resin, 6 pounds; thickened with the addition of 20 pounds of paper pulp, with or without marble dust.

369,099—August 30, 1887. N. J. CLAYTON. *Composition to be used as a nonconductor of heat and for other purposes.*

Cottonseed hulls, or waste or refuse of cottonseed oil mills are saturated with a solution of alum to render them incombustible, and then combined with sawdust treated with a hydrate of lime, and mixed with plaster of paris, in the proportion of 1 of plaster to 4 of hulls.

371,406—October 11, 1887. W. W. BARNES. *Plastic composition for insulating electric wires, etc.*

A mixture of mineral coal, 50 parts, and sulphur, 10 parts, each reduced to an impalpable powder and then mixed, and fused by heat. Also available for building and paving blocks, etc.

371,681—October 18, 1887. J. GRANT. *Conductor for electric wires.*

A compound of resin and petroleum residuum, forming a semiplastic mass.

372,552—November 1, 1887. T. McSWEENEY. *Composition for the manufacture of structural articles.*

A mixture of asphaltum, 60 pounds; resin, 20 pounds; and coal tar 20 pounds; the latter reduced to one-fourth of its bulk by boiling; 1 part of the aforesaid mixture being combined with 7 parts of paper pulp and 3 parts of pulverized glass or fine sand.

375,633—December 27, 1887. DE WITT C. JAMES. *Underground electric conductor.*

An inclosing and insulating compound of resin, pulverized glass, and sulphur.

376,456—January 17, 1888. C. WALPUSKI. *Copying pencil.*

Composed of nigrosine, tannate of iron, a suitable oleate, and a binding medium.

377,072—January 31, 1888. C. E. HAYNES. *Compound for making paper leather-board, etc.*

To a mixture in water of silicate of soda, 1.42 parts; rosin, 1.42 parts; alum, .76 parts; crude potassa, .4 parts; and fish glue, 2 parts; assisted by electro-chemical action, and heated, there is added 89 parts of pulp, and it is then manipulated in the ordinary way.

377,081—January 31, 1888. J. F. MARTIN. *Compound for coating iron, wood, canvas, etc.*

A base or body composed of glue, sulphureted water or sulphur in solution, paris-white and zinc white, with or without shellac and alcohol, and coloring matter.

377,343—January 31, 1888. I. P. WENDELL. *Compound for safe linings, etc.*

A mixture of fiber or powdered asbestos, fossil meal or infusorial earth, and silicate of soda; say in the proportions of 1 part each of asbestos and the earth, and 1 to 2 parts of the silicate.

382,882—May 15, 1888. J. A. KIESELE. *Composition of matter.*

Composition for castings, consisting of ozocerite and sugar; say 5 parts of the former and 5 to 7 parts of the latter.

383,096—May 22, 1888. D. BROOKS, Jr. *Anti-induction composition for electric cables.*

A composition of low induction capacity, consisting of a powdered electrical conducting material, as plumbago, gum copal, linseed oil, and turpentine, in about equal parts.

383,698—May 29, 1888. C. F. BROADBENT. *Composition of matter to be used in the manufacture of medallions, etc.*

Sulphur and powdered pumice stone constitutes the base, with powdered antimony and boneblack.

386,064—July 10, 1888. H. F. FERRIS. *Material for railway-rails, building-blocks, paving-blocks, etc.*

A mixture of paper pulp 500 parts, silicate of soda 25 parts, and barytes 10 parts.

387,017—July 31, 1888. W. A. SNYDER. *Putty for making ornamental moldings.*

It consists of dissolved glue, resin, and whiting, combined with paraffine oil and spirits of turpentine.

387,041—July 31, 1888. W. S. BLAKE. *Tobacco-pipe bowl.*

A mixture of ground corncob and silicate of soda, with or without earthy material.

389,519—September 11, 1888. C. T. LEE. *Composition of matter.*

A laminated substance, such as mica, in a comminuted state, is mixed and incorporated with a resinous gum, such as shellac.

393,029—November 20, 1888. A. POITEVENT. *Insulating composition.*

A mixture of common lime, say 2 parts; crude turpentine, 1 part; and pine tar, 2 parts.

393,382—November 27, 1888. F. A. MEYER. *Plastic compound.*

A composition consisting of sulphur, fibrous material, finely divided mineral, and a waxy or similar substance, such as paraffine, whose fusion point is below that of the sulphur.

393,644—November 27, 1888. S. HEIMANN. *Non-conducting compound.*

A mixture of 60 pounds of dry, pulverized peat, 25 pounds of ground asphaltum, 2½ pounds of pulverized plumbago, and a thin solution of 5 pounds of plaster of paris and of soluble glass; compacted by heat and pressure.

394,937—December 18, 1888. C. M. REQUA. *Composition of matter for marking pencils or crayons.*

A mixture of 7 pounds of paraffine, 1 pound of beeswax, and 1 pound of resin, with coloring matter.

395,241—December 25, 1888. E. LANGEN. *Substitute for cork.*

Powdered pith is mixed with an adhesive material—as starch, paste, and linseed oil or tar, to render the mass elastic—and dried; a fireproof material, such as water glass, may be added.

396,300—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

A refractory crystalline compound, for incandescent illumination: formed of magnesia oxide or carbonate, 37 per cent; caustic strontia, 37 per cent; calcium fluoride, 26 per cent; and feldspar (added after first heating), 3 grains to 100 grains of the prior mixture. The resulting powder is mixed in glycerine, molded or coated, and subjected to heat, it being white or opalescent, rough on the surface, and practically infusible.

396,301—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

A refractory crystalline compound for incandescent illumination: composed of magnesia oxide or carbonate, 50 grains; caustic strontia or carbonate, 55 grains; alumina oxide or carbonate, 10 grains; calcium-fluoride, 30 grains; and feldspar, five one-hundredths grain.

396,302—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

A refractory crystalline compound for incandescent illumination: composed of calcium oxide or carbonate, 210 grains; magnesia oxide or carbonate, 40 grains; caustic strontia or carbonate, 180 grains; alumina oxide or carbonate, 15 grains; calcium fluoride, 100 grains; and feldspar (added after first heating), 2 grains to 100 grains of the prior mixture.

396,303—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

A refractory crystalline compound for incandescent illumination: composed of calcium oxide or carbonate, 65 grains; magnesia oxide or carbonate, 50 grains; strontia oxide or carbonate, 30 grains; alumina oxide or carbonate, 15 grains; and cryolite, 20 grains.

396,304—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

A refractory crystalline compound for incandescent illumination: composed of calcium oxide or carbonate, 480 grains; magnesia oxide or carbonate, 96 grains; strontia oxide, 110 grains; strontia carbonate, 65 grains; feldspar, 100 grains; and aluminite or ammonia alum, 32 grains.

396,305—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

A refractory crystalline compound for incandescent illumination; composed of arragonite, or the caustic lime from arragonite, 80 grains; magnesia oxide, 160 grains; celestine or strontia sulphate, 350 grains; barium sulphate, 17 grains; and calcium fluoride, 142 grains.

396,306—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

A refractory crystalline compound for incandescent illumination: composed of celestine or strontia sulphate, 131 grains; magnesia carbonate, 96 grains; silica or silicic acid, 15 grains; carbonate of soda, 24 grains; and carbonate of potassa, 32 grains.

396,307—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

A refractory crystalline compound for incandescent illumination: composed of magnesia oxide or carbonate, 438 grains; strontia oxide (caustic), 342 grains; strontia carbonate, 90 grains; strontia sulphate, 90 grains; calcium oxide or carbonate, 208 grains; glucinium oxide or carbonate, 24 grains; with or without zirconium oxide, 20 grains; and fluor spar, as a flux, 230 grains.

397,612—Februrary 12, 1889. F. S. RANDALL. *Composition for making articles of commerce and art.*

A mixture of 2 parts of sawdust, 4 parts asbestos, 1 part alum, 2 parts dextrine, and 6 parts of glue mixed with 1 part of acetic acid.

400,335—March 26, 1889. J. L. HASTINGS. *Plastic mineral composition.*

A composition for forming a refractory compound for incandescent illumination, consisting of magnesium oxide, 250 grains; uranium oxide, 2½ grains; calcium fluoride (for flux), 60 grains; starch, 50 grains; and gum-tragacanth, 100 grains; the gum being treated in a solution of one or more salts of acetate, chloride; or nitrate of magnesium, strontium, calcium, or aluminum.

400,336—March 26, 1889. J. L. HASTINGS. *Plastic mineral composition.*

A refractory compound for incandescent illumination, containing strontia oxide, strontia carbonate (native rock), strontia sulphate (native rock), calcium oxide, calcium carbonate, magnesium oxide, magnesium carbonate, calcium fluoride, magnesium chloride, magnesium sulphate, uranium oxide, and starch, in varying proportions.

401,014—April 9, 1889. A. DE FIGANIÈRE. *Insulating and coating compound.*

A hard fusible compound consisting of 6 parts of pulverized semibituminous coal, 2 parts of unslaked lime, and 7 parts of coal tar pitch.

403,548—May 21, 1889. B. E. OLSEN AND C. GABRIEL. *Compound for piping, bowls, etc.*

It consists of sand, 43 per cent; sulphur, 33 per cent; pitch, 1 per cent; and an earth, such as ground burnt clay, 23 per cent; mixed together under the action of superheated steam.

403,631—May 21, 1889. A. T. WOODWARD. *Plastic compound for use in various arts.*

It consists of 100 pounds of powdered silica or silicate—such as glass—50 pounds of mineral or vegetable resin or pitch, 150 ounces of oxide of lead or zinc, and the same of animal or vegetable wax, and 75 ounces of boiled linseed oil, with a slight admixture of drying oil.

406,427—July 9, 1889. J. R. CLUXTON. *Compound for the scrubbing surfaces of washboards.*

A mixture of 4 pounds of powdered fire clay, 1 pound of litharge, 1 pound of Spanish white, one-half pound finely granulated or powdered wood, one-fourth pound of pitch, and one-fourth pound of gum shellac, with a solvent oil, mixed with heat and molded.

407,271—July 16, 1889. A. T. WOODWARD. *Plastic compound.*

A compound of 50 pounds of silica, 10 pounds of sulphur, 2 pounds of arsenic, 5 pounds of manganese, and 25 pounds of resin, or gum, with or without 8 pounds of wax, and 5 pounds of oil.

407,896—July 30, 1889. F. MARQUARD. *Insulating composition.*

A compound of 20 pounds of wood pulp, 1 pound extract of logwood, one-eighth pound of bichromate of potash, one-eighth pound of sulphate of iron, 4 pounds of animal glue, 10 pounds of rosewood sawdust, and 2½ pounds of an albuminous substance, as bullock's blood with or without vegetable fiber, such as flax, hemp, etc.; forming a dark, almost black material.

407,938—July 30, 1889. F. MARQUARD. *Insulating composition.*

A compound of 20 pounds of fine rosewood sawdust, 1 pound extract of logwood, one-eighth pound bichromate of potash, one-eighth pound sulphate of iron, and 5 pounds of an albuminous substance, such as bullock's blood, with or without vegetable fiber.

408,222—August 6, 1889. M. L. DEERING. *Composition of matter.*

It consists of fibrous material, blood, waterproof gum, and creosote, in the general proportions of 1 pound of fiber to 1 quart of blood.

408,951—August 13, 1889. C. S. BUSHNELL. *Process of packing roofing composition.*

The base material is placed in a shipping case and a tubular jacket introduced to form a chamber within said material. The ingredients with which the base is to be mixed are then melted and poured into said chamber, and the jacket removed, leaving the ingredients in the center surrounded by the base material.

409,584—August 20, 1889. J. L. HASTINGS. *Plastic mineral composition.*

A composition for forming a refractory compound for incandescent illumination, containing two or more metallic compound substances—such as oxides, carbonates, or sulphates of metals—a flux, a moistening fluid, and one of flame or light coloring substances, such as oxide of uranium, strontium, and lead chromate or chromium oxide, permanganic acid, cadmium sulphide, sodium salts, or indium oxide, and calcite.

409,985—August 27, 1889. C. T. LEE. *Composition of matter.*

A composition consisting solely of comminuted mica (in flakes or scales) and silicate of soda.

414,208—November 5, 1889. P. E. GONON. *Composition of matter for moldings.*

It consists, essentially, of a mixture of dry fibrous or cellulose material treated with coloring matter, with one-third pulverized soapstone, and an adhesive material composed of one-third glue and two-thirds starch; 20 to 30 grains of the binding material is used for 500 grains of the pulp and coloring matter.

414,209—November 5, 1889. P. E. GONON. *Composition of matter for moldings.*

It consists of fibrous or cellular material, soapstone, an adhesive material composed of glue and starch, and bronze powders.

415,648—November 26, 1889. S. H. GILSON. *Composition for overhead insulators.*

A compound of gilsonite, 20 parts; granulated material, as sand, 74 parts; and petroleum-still wax, 6 parts.

415,962—November 26, 1889. O. A. ENHOLM. *Composition for lining electric-battery jars.*

It consists of mineral wax, say, 50 per cent; sulphur, 25 per cent; ground glass, 15 per cent; and resin, 10 per cent.

418,947—January 7, 1890. A. HART. *Crayon.*

Composed of a pigment and carnauba wax, 1 pound; stearic acid, 1 pound; and paraffine wax, 1½ pounds.

425,615—April 15, 1890. A. A. KNUDSON. *Insulating compound.*

A plastic compound of substantially equal proportions of carbolic acid and shellac, or like material, capable of being brought to a viscous condition.

426,202—April 22, 1890. J. F. MUNSIE. *Insulating compound.*

A composition consisting of paper pulp treated so as to be noninflammable, fire clay, Portland cement, and a noninflammable agglutinating or binding agent, as white glue and silicate of soda. Molded articles after drying are immersed in a hot bath of india rubber or fireproof paint.

427,167—May 6, 1890. N. C. FOWLER. *Heat-insulating compound.*

The base consists of sifted or lixiviated ashes (or carbonate of magnesia, diatomaceous earth, or clay) and carbonate of calcium, with which may be incorporated finely fiberized fiber, lampblack, and pumice stone.

431,646—July 8, 1890. W. A. BURROWS. *Composition for the soles of boots and shoes.*

Leather waste reduced to flock is mixed with an aqueous solution of gelatine, to which not more than one-tenth per cent of chrome alum has been added to render the mixture nonabsorbent of water when dry.

431,743—July 8, 1890. C. R. GOODWIN. *Composition for porous carbon structures.*

A composition of finely divided gas or other hard carbon, with agglomerants forming moldable paste and with organic matter of cellular or fibrous structure that when baked will form a highly porous structure.

438,215—July 29, 1890. I. RABINOWICZ. *Insulating compound.*

A composition of 70 pounds of palm starine pitch, 40 pounds of gilsonite, 9 pounds of potassium bitartrate, and 2 pounds of tartaric acid.

436,733—September 16, 1890. J. W. EASTON. *Insulating material.*

Powdered soapstone, from 60 to 70 per cent, is mixed with fibrous material, as jute, and waterproofing material, as paraffine.

438,311—October 14, 1890. O. A. ENHOLM. *Composition of matter for making cells or retaining-vessels.*

A mixture of asbestus fibers, say, 40 parts; mineral wax, 30 parts; gutta-percha, 30 parts; and shellac, 10 parts.

438,698—October 28, 1890. A. E. MENUEZ. *Insulating compound.*

A composition of equal parts, by measure, of powdered mineral wool, powdered graphite or a hardening clay, and asbestus fiber, with liquid silicate of soda to form a thick paste. The graphite may be omitted.

439,526—October 21, 1890. O. KLETTE. *Composition for paper stucco.*

Vegetable pulp is impregnated with glue, plaster or whiting, siccative, sulphuric acid, and linseed oil. A finished stamped piece is covered with silk, by applying a coat of gelatine and affixing the silk, first steamed, by pressure under heat.

439,796—November 4, 1890. T. D. BOTTOME. *Insulating composition.*

Finely powdered silicon dioxide is mixed into a stiff paste with a solution of orthosilicic acid.

440,391—November 11, 1890. F. E. BLAISDELL. *Insulating composition.*

Seventy-two parts of asbestos and 18 parts of plastic clay, mixed dry, are mixed with a flux, as of feldspar and borax.

444,775—January 13, 1891. A. & S. DU PONT. *Process of manufacturing artificial ivory.*

Hydrate of lime is treated with an aqueous solution of phosphoric acid to form phosphate of lime; there is then mixed therewith carbonate of lime, magnesia, alumina precipitate, gelatine, and albumen. The mass is desiccated and subjected to great pressure until solidified.

445,111—January 20, 1891. J. GROTE. *Composition for treating articles made from paper.*

A composition comprising starch, water glass, and a fatty substance, such as beeswax.

446,502—February 17, 1891. E. G. WRIGHT. *Composition of matter for cable-filling.*

A mixture of crude petroleum, 1 pound 7¾ ounces; tallow, 1 pound 10 ounces; gypsum, 8 ounces; whiting, 3 ounces; pine tar, 2 pounds; and paraffin wax, 1 pound.

447,412—March 3, 1891. J. S. PALMER. *Composition of plastic material.*

A mixture of stearine, bitumin, wood-flour, and ground fiber, with or without whiting, or pigment, or coloring substance.

452,182—May 12, 1891. F. C. GOODALL. *Marine cement.*

A mixture of 40 parts by weight of hard asphaltum, 40 parts of liquid asphaltum, 8 parts of boiled or other siccative oil, and 12 parts of finely ground cork.

452,763—May 19, 1891. F. SALATHÉ. *Composition of matter.*

It consists essentially of pulp or fibrous material and a certain resinoid hydrocarbon of the $C_{10}H_{16}$ series.

452,869—May 26, 1891. G. W. TOOKER. *Artificial ivory.*

A compound of albumen, bone-ash powder, and talc, with fibrous material when it is desired to show a grain.

454,547—June 23, 1891. A. W. SPERRY. *Insulating material.*

A compound of, say, 3 parts of mineral wool, 6 parts of liquid silicate of soda, and 1 part of zinc white.

460,249—September 29, 1891. R. F. FLYNN. *Floor covering.*

A base of palm-oil pitch with the addition of coarse granules of cork is applied to a textile backing.

461,467—October 20, 1891. M. O. FARRAR AND C. C. HOWE. *Composition of matter for insulating purposes.*

It consists of silica, 434.7 to 478.4 parts; alumina, 297.6 to 362.3 parts; peroxide of iron, 13.4 to 88 parts; magnesia, 3.7 to 21 parts; lime, 2.9 to 13.8 parts; soda, 3.2 to 41 parts; potash, 55.1 to 124.4 parts; water, 14.5 to 62.2 parts; asphaltum, 50 to 75 per cent; mixed with the aid of heat and molded under pressure.

464,367—December 1, 1891. S. W. KIMBLE. *Insulating composition.*

It consists of pulverized mica, say, 40 parts; a mineral substance, such as talc free from lime, 40 parts; and silicate of soda, 3 parts; combined and molded under pressure.

464,369—December 1, 1891. S. W. KIMBLE. *Composition of matter for insulating purposes, etc.*

A mixture of pulverized mica, say, 50 parts; a mineral substance, such as asbestos or feldspar, 50 parts; soluble glass, from 3 to 10 parts; and sulphur or sulphur compound, as iron or copper pyrites, 2 parts; molded under high pressure without heat.

471,438—March 22, 1892. G. SCHWARZWALD. *Composition of matter for pencils or crayons.*

It consists of 100 ounces of paraffin wax, 2 to 10 ounces of dammar gum, 2 ounces of bichromate of potassium, 100 ounces of bronze powder, and 25 ounces of naphthol.

472,352—April 5, 1892. I. HILL. *Compound for insulating electric wires.*

A mixture of 1 pound each of pittizite pitch, candle tar, and coal tar, and one-half pound each of asphalt pitch and resin.

474,865—May 17, 1892. P. VON SLAMA. *Composition for use as ornamental moldings, etc.*

It is composed of dextrine, sulphate of lime, silicate of soda, and vegetable fibers; 10 parts of soluble glass is mixed with a 40 per cent solution of dextrine in water, 40 to 60 parts of sulphate of lime added, and vegetable fibers worked in.

479,967—August 2, 1892. R. G. DE VASSON. *Plastic composition.*

It consists of 1 to 2 volumes of fragments or powder of cork, and 2 to 1 volumes of an agglutinant composed of plaster of paris, dextrine, and sesquioxide of iron, with an oxychloride, such as the oxychloride of zinc, when it is to be used in damp places.

480,094—August 2, 1892. S. D. HOFFMANN. *Composition for and method of making heads and limbs of dolls.*

A compound of 100 parts of glue and 25 parts each of glycerine, zinc oxide, and Japanese wax.

484,345—October 11, 1892. J. T. SMITH. *Process of treating cork.*

It is confined in a mold and subjected to heat under pressure, whereby the resinous matter is vaporized and the pieces are cemented and solidified.

490,641—January 31, 1893. M. H. DEVEY. *Insulating compound.*

A mixture of slag, 8 parts, and glass, 2 parts, ground fine, with a binding medium, as boiled linseed oil, driers, shellac, and paraffin, to form a paste.

495,581—April 18, 1893. W. P. EMERY. *Composition of matter for railroad ties, etc.*

A mixture of 479 parts of paper pulp, 10 parts of albumen, 5 parts of sour milk, 1 part of lime, and 5 parts of chloride of zinc.

503,425—August 15, 1893. J. W. KIDWELL. *Non-corrodible plastic composition.*

A mixture of titanic minerals or natural oxide of titanium (as from the phosphate ores of Nelson county, Va.), 8 parts; and asphaltum or like hydrocarbon, 2 parts. To render it extremely refractory it may be heated to about 1,400° C.

504,988—September 12, 1893. J. MELLINGER. *Method of manufacturing artificial wood.*

To a mixture of 150 pounds of fibrous material—as tan bark—and 15 pounds of slaked lime, there is added a solution formed of 1 pound of borax, 2 pounds of alum, one-half pound carbonate of potassium, one-half pound zinc sulphate, 8 pounds sodium chloride, and 1 pound of sodium bicarbonate, in water, with 30 pounds of liquid silicate of sodium and 25 pounds of lye of 35 per cent; the pulp is molded and subjected to pressure.

505,916—October 3, 1893. J. HOFFMAN. *Insulating compound and method of manufacturing the same.*

A compound of asbestos fiber with a binding material composed of asphaltum, beeswax, and shellac; produced by spraying the asbestos with a mixture of beeswax and asphaltum with a suitable solvent, as benzine; drying, then mixing powdered shellac, with or without albumen, with the mealy substance thus formed; and molding under heat and pressure.

507,678—October 31, 1893. J. J. FANNING. *Insulating compound.*

A mixture of 6 ounces plaster of paris, 5 ounces pulverized asbestos, 4 ounces dextrine, and 1 ounce of linseed or other oil.

508,107—November 7, 1893. H. HAYNES. *Insulating compound for printing-presses.*

A mixture of 1 gallon of machine oil, 1 quart of glycerine, three-quarters of an ounce of paraffine wax, and 2 ounces of castor oil; to be applied to the tympan sheet of the press.

514,015—February 6, 1894. J. L. MILLER AND W. T. CROSSE. *Composition of matter for making chalk engraving-plates.*

It consists of 2½ drams of silicate of soda, 4 drams of silicate of magnesia, one-half pound of French chalk, and 1 pound of barytes.

515,192—February 20, 1894. G. A. CANNOT. *Material for insulating electric wires.*

An insulating coating for electric wires consists of, first, a coating of bitumen; second, of peat fiber; third, of spermaceti; fourth, of tar; and, fifth, of peat fiber. The wire is passed through a guide, by which its surface is leveled and made uniform.

517,452—April 3, 1894. A. GENTZSCH. *Insulating compound.*

The volatile elements of the fossil resins ozokerite, asphalt, and amber are driven off by distillation, and the residuums are mixed in the proportion, say, of ozokerite, 50 parts; amber, 45 parts; and asphalt, 5 parts.

522,745—July 10, 1894. J. L. TRUSLOW, JR. *Insulating composition.*

It is composed of ground cork, 90 parts, infusorial earth, 5 parts, and a binder, binder, as resin, 5 parts.

523,582—July 24, 1894. C. KÖSTER. *Process of manufacturing veneers.*

Concentric layers of a plastic mass in contrasting colors are formed on a core, and then veneers are cut therefrom in a direction transverse to the length of the core. The composition consists of glue, glycerine, and fossil meal.

524,021—August 7, 1894. A. HAGELE. *Floor-cloth.*

A composition consisting of dried and ground leaves, and a binder, such as an oil, resin, and gum, applied to a textile backing.

528,744—November 6, 1894. O. STILES. *Insulating compound.*

A mixture of 6 parts of alcohol, 3 parts of shellac, 3 parts of asbestos, and 1 part each of mica and alum.

529,728—November 27, 1894. W. GRISCOM, JR. *Vulcanizable compound.*

It is composed of substantially equal parts of animal fat candle tar (a residual product from the distillation of animal fats, oils, etc.), and a hard or nearly hard residual product from petroleum distillation, and sulphur in proportions of from 2 to 8 per cent of the mass.

537,321—April 9, 1895. A. C. THOMPSON. *Insulating compound.*

A mixture of 1 gallon alcohol, 5 pounds of gum shellac, 6 pounds pulverized asbestos, 4 pounds pulverized French chalk, 1 pound balsam tolu gum, and 4 pounds ground mica.

538,614—April 30, 1895. J. W. KIDWELL. *Insulating material.*

A mixture of titanic mineral (see No. 503,425), asphaltum, and silicious material, say 5 per cent, such as rice hulls or other organic material rich in silicic acid.

551,588—December 17, 1895. H. R. KNOCH. *Artificial building-block.*

A mixture of 50 parts of paper pulp with 12 parts of peanut shells, 2 to 3 parts of gum-tragacanth, and 2 to 5 parts of dissolved caustic soda.

551,530—December 17, 1895. G. DOEBRICH. *Composition for hands and feet of dolls, etc.*

A mixture of glue, 1 pound; glycerine, one-fourth pound; saccharine material, one-half pound; flour, 1 tablespoonful; albumen and coloring matter.

552,269—December 31, 1895. W. L. WOODS. *Plastic composition and process of combining same.*

A composition consisting of silica, 60 parts; magnesia, 30 parts; sulphur, 60 parts; and mineral wax, 3 to 10 parts; produced by grinding the silica and magnesia to a powder and expelling the moisture therefrom, repeatedly melting the sulphur and the mineral wax and pouring them into cold water, remelting the sulphur and mineral wax at about 150° C., adding the silica and magnesia, and then gradually increasing the temperature to 260° C., and cooking until the sulphurous fumes are expelled.

559,376—May 5, 1896. A. GENTZSCH. *Composition for electric insulation and process of making same.*

A composition of shellac, 50 parts; resin, 50 parts; birch-tar oil. 5 parts; aniline oil, 5 parts; and anthracene, 20 parts; produced by treating the shellac and resin with repeated washings to dissolve out all soluble matter, then melting and boiling together, melting the anthracene, mixing in a molten state, and adding the aniline oil and birch-tar oil, which have been previously freed of water and matter soluble in water.

560,321—May 19, 1896. J. J. MURPHY. *Composition of matter for making and sealing joints between pipes, etc.*

A compound of flower of sulphur, 100 pounds; fine flint sand, 100 pounds; antimony, 2 pounds; lead, 9 pounds; bismuth, 1 pound; powdered glass, 10 pounds; and borax, 2 pounds.

586,683--September 29, 1896. L. HONIG. *Insulating compound.*

It consists of alcohol, 30 parts; gum shellac, 25 parts; wheat flour, 20 parts; powdered asbestos, 20 parts; glue, 2 parts; varnish, 2 parts; and glycerine, 1 part.

571,117—November 10, 1896. F. R. HALL. *Composition of matter.*

A mixture of 9 parts by weight of prepared pitch—roofing pitch which has been distilled until a portion of its oil has been driven off and the melting point raised to about 170° F.—5 parts of asbestos fiber, and 4 parts of gum kauri.

572,016—November 24, 1896. C. KÖSTER. *Composition of matter for manufacturing artificial veneers.*

It consists of 11 grams of sawdust, 14 grams zinc-white, 40 grams flour paste (from 4 grams of flour), 1 gram resin glue, 20 grams boiled linseed oil, and 10 grams grape sugar or like saccharine matter. (See No. 523,582.)

578,514—March 9, 1897. W. HOSKINS AND W. A. SPINKS. *Substitute for billiard chalk.*

A compound of normally white pulverized silica, with or without corundum, a binding agent, as glue, and a coloring agent.

594,888—December 7, 1897. A. MILLAR. *Process of obtaining useful products from silkworms.*

The large intestines of silkworms, when they have attained the maximum size and are about to begin spinning, are subjected to pressure, without preliminary treatment, and the gelatin product drawn into threads and dried.

595,776—December 21, 1897. H. D. HOLBROOK. *Sheet material of cork and mechanism for producing same.*

A flexible, elastic sheet consisting of a homogeneous body of granulated cork and elastic cement molded under pressure, with threads running through the body of the material, and with the cork protuberances removed by sandpapering or otherwise.

597,283—January 11, 1898. M. HOCQUET. *Method of producing plastic composition from cork, etc.*

A plastic composition consisting of cork impregnated with borax, a gelatinous substance, tannin, and bichromate of potash; produced by treating comminuted cork with a solution of borax, drying and then mixing with a solution consisting of gelatin, 40 parts; Dutch glue, 25 parts; glycerin, 15 parts; crystallized sugar, 16 parts; ammonia, 2 parts; and sulphur, 2 parts; with a tannin solution and potassium bichromate solution added.

597,806—January 25, 1898. H. MARANGOLO. *Compound for treating glass.*

A fluid compound composed of 40 per cent of alcohol, 40 per cent of glycerine, and 20 per cent of water. To impart luster and prevent formation of frost.

606,921—July, 5, 1898. G. B. FRALEY. *Composition of matter for electric heaters.*

A mixture of talc, say, 60 parts; silicate of soda, 20 parts; carbonate of soda, 10 parts; and water, 10 parts.

611,814—October 4, 1898. A. MILLAR. *Insoluble gelatine thread or filament.*

An insoluble thread or filament composed of gelatine: produced by dissolving the gelatine in hot water and adding the proper chemical substances, such as bicromate of potash, either directly or in the form of a solution. The mixed solution is then concentrated to a suitable degree of thickness and forced through nipples in the form of threads. The threads may be formed of simple gelatine and then hardened.

613,763—November 8, 1898. J. C. GRAFT. *Plastic compound.*

It is composed of 2 parts of shellac, 1 part of French chalk, 1 part rice flour, and a small part of beeswax.

615,000—November 29, 1898. S. R. THOMPSON. *Composition for pipe-joints or the like.*

A mixture of 12 parts of paris white (calcium carbonate), 5 parts of oxide of iron, 2½ parts of brick dust, and one-half part of plumbago, with boiled linseed-oil to form a stiff putty.

616,560—December 27, 1898. H. REDHEAD AND G. W. EMMERSON. *Composition for making tight joints.*

A mixture of cement, 50 parts; boiled oil, 20 parts; venetian red, 10 parts; litharge, 5 parts; and chalk 15 parts.

619,019—February 7, 1899. J. HAVERSTICK. *Composition for floor-coverings, etc.*

It consists of a base or filling of ground corn-cob with a binding material.

619,337—February 14, 1899. W. PAINTER. *Gluten compound.*

A compound of gluten and a ground or pulverized body material, produced by mixing gluten in the plastic state with pulverized cork, wood pulp, or other material—say in the proportions of 2 parts of gluten to 1 of cork—rolling or molding into form, and subjecting to heat, as a temperature of 120° C., for about ten hours.

619,338—February 14, 1899. W. PAINTER. *Gluten compound.*

Gluten in its plastic state is mixed with glycerine, and then with a body material—as gluten 65 per cent, glycerine 5 per cent, and ground cork 30 per cent—and the product subjected to heat—about 100° C. for seven hours.

621,807—March 28, 1899. B. FORD. *Insulating compound.*

A liquid insulating compound heavier than water, composed of a mixture of 2 parts by weight of asphalt and 1 part of paraffin oil.

625,345—May 23, 1899. A. MILLAR. *Insoluble thread or filament.*

A thread or filament composed of a proteid strand insoluble in water; produced by treating threads of albumen or casein or the material before it is formed into threads, with chromic acid, tannic acid, picric acid, etc.

625,894—May 30, 1890. J. J. NUGENT. *Composition for blackboards.*

It consists of slacked lime, 100 pounds; black stain, 25 pounds; ground quartz, of a plurality of grades, 39 pounds; plaster of paris, 40 pounds; cement, 18 pounds; and glue, 6 ounces.

626,479—June 6, 1899. P. C. BELL. *Elastic compound.*

A compound consisting of vegetable oil, 59 parts; flour of sulphur, 15 parts; liquid tar, 1 part; petroleum residue, 20 parts; and powdered talc, 5 parts; produced by heating the petroleum to 112° F., adding the talc and liquid tar, then gradually adding the vegetable oil while maintaining the same temperature, raising the temperature to 200° F., adding the sulphur, and finally raising the temperature to 340° F., and stirring the mass until viscid.

627,008—June 13, 1899. G. OLNEY. *Composition of matter.*

A mixture of sodium silicate, in a plastic or liquid state, say, 2 pounds; dry paper pulp, 4 ounces; and powdered glass, 8 ounces.

627,207—June 20, 1899. D. ROGERS. *Plastic material for manufacturing shuttles, bobbins, etc.*

A mixture of wool flock, resin, terra alba, china clay, Brits white, grated potatoes, aluminum, shellac, alcohol, and coloring matter in equal or varying proportions according to the hardness required.

627,367—June 20, 1899. H. TZSCHUCKE. *Translucent plastic compound.*

A composition prepared by forming a milk of chalk or gypsum and separate solutions of glue, alum, magnesium sulphate and coloring matter, mixing and stirring the same, then adding glycerine, oil, and alcohol, stirring, straining, or filtering, heating to near the boiling point, and cooling slowly.

629,600—July 25, 1899. R. PLATZ. *Composition of matter for molding purposes.*

A mixture of saw dust, 17 parts; pulverized chalk, 27 parts; and water-glass, 56 parts.

632,014—August 29, 1899. S. HACKELBERG. *Composition for protecting panes of glass.*

A mixture of water, 30 parts; glycerine, 60 parts; sugar, 9 parts; and cumarin, 1 part; to prevent the deposit of vapor and hoar frost.

636,367—November 7, 1899. A. P. TSCHIRNER. *Dental cement.*

A cement free from substances soluble in water, formed of phosphoric acid, ammonia, and metallic oxides, such as zinc, tin, and aluminum.

636,657—November 7, 1899. F. GATZSCHE. *Composition of matter for soles and heels of boots or shoes.*

A mixture of waste of paper manufactories, 4 to 5 pounds; asphaltum, 1 pound; resin, one-half pound; turpentine oil, one-fourth pound; peroxide of iron, 2 ounces; and tallow, one-fourth pound.

636,818—November 14, 1899. P. H. A. LEDER. *Packing.*

An elastic and compressible packing, consisting essentially of asbestos fibers, cellulose, and paraffine.

637,106—November 14, 1899. F. GATZSCHE. *Composition for making floor-cloth.*

A mixture of water, 7 gallons; glue, 1 pound; wax, one-fourth pound; plumbic ocher, one-fourth pound; linseed oil, one-half pound; and tungstic acid, 1 ounce; made at a temperature of 80° C.

638,003—November 28, 1899. T. H. BLACKNALL AND W. T. JORDAN. *Composition for blackboards.*

It consists of emery flour, about 3 per cent; pumice stone, 2 per cent; lampblack, 3 per cent; and chrome green, 1 per cent; mixed with an adhesive liquid. and incorporated with 91 per cent of paper stock.

642,319—January 30, 1900. F. GATZSCHE. *Composition for making artificial leather fabric.*

A mixture of glue, 1 part; wax, 1 part; oil, one-half part; turpentine, one-fourth part; and alcohol, one-half part.

643,251—February 13, 1900. G. McKAY. *Composition of matter for sealing purposes.*

It consists of 45 per cent of sulphur, 25 per cent of brick dust, 10 per cent of foundry sand, 2 per cent of tin, 2 per cent of lead, 2 per cent of bismuth, 4 per cent of plaster of paris, 5 per cent of iron filings, and 5 per cent of borax.

643,989—February 20, 1900. F. SEHR. *Manufacture of cement.*

It consists of 50 per cent of powdered hard porcelain, 35 per cent half-burnt porcelain, 15 per cent of raw feldspar, and water glass to form a paste.

647,764—April 17, 1900. O. H. SCHNEPPER. *Plastic compound.*

A composition consisting of a gelatin solution, calcium chloride, coloring matter, and ether. Adapted to be applied to glass and give the effect of stained glass, or as a backing for mirrors.

654,688—July 31, 1900. J. E. THORNTON AND C. F. S. ROTHWELL. *Substitute for celluloid, etc., and process of manufacturing same.*

A transparent substance consisting of a dissolved and hardened salt of aluminum and a fatty acid, as aluminum oleate treated with benzole.

645,689—July 31, 1900. J. E. THORNTON AND C. F. S. ROTHWELL. *Article applicable for various purposes, together with process of manufacturing same.*

A transparent substance consisting of a dissolved and hardened salt of zinc and a fatty acid, as zinc oleate treated with benzole.

656,252—August 21, 1900. F. G. KLEINSTEUBER. *Compound for dissolving resins.*

A compound to be used with solvents of resin, consisting of 3 parts of dammar dissolved in 5 parts of oil of turpentine, with a mixture of 50 parts of tung or wood oil, 23 parts of benzole, and 5 parts of oil of turpentine added thereto; a suitable proportion is added to the resin solvent, of benzole, alcohol, oil of turpentine, or the like.

663,572—December 11, 1900. S. HEIMANN. *Substitute for gutta-percha.*

A compound of finely-pulverized peat, resin-oil, say, equal parts, and about 2 per cent of amyl acetate.

PROCESSES.

2,048—April 16, 1841. S. GOODWIN. *Improvement in the mode of hardening manufactures of cement and rendering them impervious to moisture.*

Cement casts are rendered impervious to air, moisture, or decay by boiling in a mixture of oil and resin.

47,068 March 28, 1865. A. MEUCCI. *Improved process for removing mineral, gummy, and resinous substances from vegetable fibre.*

The material is treated, first, in a dry state with the gases produced by the action of nitromuriatic acid upon carbonate of lime and iron, second, in a wet state with the same substances; and third, with a caustic alkali, with or without oil.

61,267—January 15, 1867. A. T. SCHMIDT. *Improvement in the manufacture of paper and treatment of paper pulp.*

Paper, paper pulp, and textile fabrics of vegetable fiber are treated with a mixture of glycerine, oil of vitriol, and water, and subsequently with an alkaline bath, rendering them water proof and like parchment.

102,484—May 3, 1900. W. M. BRYANT. *Improvement in preparing the pith of corn stalks for use in the arts.*

Vegetable pith is compressed and then coated with tenacious material, such as cloth, paper, varnish, paint, etc.

103,199—May 17, 1870. S. KINGAN, administrator of J. Anderson, deceased. *Improvement in the manufacture of roofing-felt.*

Roofing sheets formed by saturating fibrous material with a mixture of purified asphaltum and oil, or tar, at or immediately before the felting operation.

113,454—April 4, 1871. A. T. SCHMIDT. *Improvement in treating paper and vegetable fibrous substances.*

Paper (sized or unsized), paper pulp, and other vegetable fabrics and substances are treated with a bath of the mother water of the chlorides of zinc, tin, calcium, magnesium, or aluminium, or either of them, with or without the admixture of carbonates and oxides or other substances, and washed with water or alkaline solution, to render them tough, impervious to water, and resistant to the action of acids and alkalis. To impart flexibility and softness the material is then treated with a solution of glycerine and water, or sugar and water. Layers of treated paper are combined with layers of vegetable cloth similarly treated for the manufacture of belting, packing, etc.; also with emery, powdered glass, sand, or other pulverized or granular metal or mineral for use in the arts.

114,880—May 16, 1871. T. TAYLOR. *Improvement in the treatment of paper and paper pulp.*

Paper is treated in a concentrated solution of chloride of zinc, followed by thorough washing.

120,880—October 31, 1871. D. W. HANNA. *Improvement in methods of utilizing the waste chloride of zinc in treating paper.*

After paper has been treated in a bath of the solution as per No. 113,454, it is washed in water until the amount of the liquor washed from the paper raises it to from 30° to 40° Baumé. The waste or surplus mother-water is then concentrated by boiling to from 65° to 75° Baumé, at which gravity it is used for treating paper.

166,475—August 10, 1875. W. F. NILES. *Improvement in processes of manufacturing articles from horn and hoof.*

Horn or hoof is powdered, mixed with boneblack, bolted or sifted, then slightly moistened and subjected to pressure in heated molds.

186,924—February 6, 1877. B. CARPLES AND J. M. KOEHLER. *Improvement in processes of treating animal bones and making artificial whalebones therefrom.*

Bones are boiled in an acid bath, to remove the earthy salts, then repeatedly washed in cold water, cut into shapes and sizes, and pressed until dry.

192,863—July 10, 1877. W. H. DIBBLE. *Improvement in processes of making composition articles.*

Either organic or inorganic, pulverized or granulated substances, as sawdust or clay or slate, are mixed with blood, as in equal quantities by weight, the mass heated, and then subjected to great pressure in heated molds, forming articles of great hardness.

193,322—July 24, 1877. W. COURTENAY. *Improvement in making hollow articles of vulcanized fiber.*

Tubular articles are formed from vulcanized fiber by partially dissolving the edges in chloride of zinc, forming the tube upon a mandrel, cementing the edges under heat and pressure, and wetting and shrinking upon a mold, or mandrel, to impart the desired contour while drying.

193,846—August 7, 1877. J. BLISS AND F. O. BADGER. *Improvement in processes of treating blood for forming ornamental articles.*

Blood alone is reduced to a dry and powdered condition and subjected to heat and pressure in molds or dies.

196,894—November 6, 1877. T. HANNA. *Improvement in the manufacture of waterproof vulcanized fiber.*

Vulcanized fiber having its substance rendered moisture proof is formed by submitting the article or the material to a bath of nitric acid or a mixture of nitric and sulphuric acids, or sulphuric acid and nitrate of potash, or the fumes arising in the manufacture of bisulphate of potash.

196,895—November 6, 1877. T. HANNA. *Improvement in the manufacture of vulcanized fiber.*

The waste or cleansing bath holding chloride of zinc in solution is utilized by submitting it to the action of chemical reagents, as by adding to it a solution of carbonate of soda, or any of the alkaline carbonates, carbonate of zinc being precipitated and sodium chloride remaining in solution.

197,088—November 13, 1877. J. F. BOYNTON. *Improvement in ornamentation of the surfaces of hard material.*

The surface of shell, bone, marble, or other hard substance is dried and then impregnated, to a greater or less depth, with one or more halogens, such as iodine or bromine.

210,617—December 10, 1878. W. J. LEWIS. *Improvement in the manufacture of buttons and other articles from vegetable ivory, etc.*

Vegetable ivory is pulverized and subjected to pressure in heated molds, with or without agglutinizing matter.

213,735—April 1, 1879. J. BLISS. *Improvement in the treatment of albumen for the production of molded articles.*

Vegetable or animal albumen is dried, pulverized, and sifted, and compressed in heated molds or dies.

217,418—July 8, 1879. G. H. SMITH. *Improvement in treatment of bone, vegetable ivory, etc.*

Bone, vegetable ivory, and other porous hard material is treated with a solution of gum or other converting agent—as a solution of gum in bisulphide of carbon or like volatile solvent—and the material then drained and the superfluous converting agents removed by volatile solvents, whereby the pores are filled with transparent or translucent material.

221,852—November 18, 1879. W. F. NILES. *Improvement in manufacturing buttons, etc.*

Paper pulp is dried; separated into a linty mass; saturated with albumen or gelatin; dried; broken up into small pieces or bunches, and subjected to great pressure in molds at a heat of 100° C. or upward.

224,036—February 3, 1880. W. F. NILES. *Process of manufacturing buttons and other articles from fibrous material and powdered hoof.*

Paper pulp is dried; separated into a linty mass; saturated with albumen or gelatin; broken into small pieces or bunches; mixed with dried powdered hoof, one fourth part by weight, and molded with great pressure at a heat of 100° C. or upward.

225,556—March 16, 1880. J. BLISS AND F. O. BADGER. *Manufacture of buttons and other articles.*

Coarsely powdered hoof is moistened with a pigment, dried, mixed with dried blood, and finely ground, and subjected to high pressure in heated dies.

233,322—October 19, 1880. L. A. BRODE. *Manufacture of slabs or blocks from wood or paper pulp, or from sheets made from such pulp.*

Slabs or blocks are formed of pulp, treated with a solution of gum tragacanth or tragacanthin, and a paste formed of rye or wheaten flour, pitch powder litharge, alum, and gelatine, and submitted to heat and pressure.

233,885—November 2, 1880. W. H. SMITH. *Art of preparing waste vegetable products for use and transportation.*

Loose fibrous or granulated vegetable material, as sawdust, bran, etc., is heated to 65° to 150° C., to dry and soften the natural gums or resins, and then subjected to impact in molds.

237,497—February 8, 1881. A. R. DAVIS. *Method of making articles from waste amber.*

Amber is reduced to a plastic condition by the agency of solvents—as bisulphide of carbon—and then subjected to pressure under heat. Mottled or blotched amber is produced by molding together ground amber with large fragments.

239,776—April 5, 1881. W. T. HENLEY. *Mode of insulating electrical conductors.*

Submarine telegraph cables are insulated by first covering the wires with india rubber and then vulcanizing the same in ozocerite, paraffine, or similar hydrocarbon.

239,794, April 5, 1881. J. W. HYATT. *Manufacture of factitious material to imitate ivory.*

Articles are formed from an inert material, as zinc oxide, and an adhesive agent, as shellac, by mixing, say, 8 parts of powdered shellac with 32 parts of a solvent, as aqua ammonia, and 40 parts of zinc oxide, subjecting the mixture to the action of a mill, then desiccating the solid elements of the mixture with, in some cases, a second grinding in a dry state, and finally compressing and solidifying the powder in heated molds.

243,963—July 5, 1881. J. PATHE. *Method of treating horn shavings.*

Horn shavings are soaked in a solution of boracic acid and arsenious acid, first cold and then warm, and the swelled horn shavings are then heated up to 120° C., under pressure, and united into a solid mass.

244,170—July 12, 1881. S. BARR. *Manufacture of gas tubing.*

Bichromated oil varnish is applied to the surface of a glue and glycerine compound to render the same indestructible by heat and insoluble in water.

247,477—September 27, 1881. W. V. BRIGHAM. *Art or method of making ornamented or variegated gelatinous sheets to imitate tortoise shell, etc.*

A solution of gelatine, suitably colored, is flowed upon glass, and sprinkled with a second solution of gelatine or analagous substance, suitably colored or prepared, while liquid or semiliquid, which solutions are then mingled or blended. The film is backed by covering it with paper or cloth, which is permitted to dry thereon, the film being detached from the glass after drying.

256,043—April 4, 1882. C. POPPENHUSEN. *Molding articles of india-rubber and other vulcanizable gums.*

The mold is filled with a liquid, as linseed oil, to exclude all air therefrom, and the liquid is then displaced by pressing the compound into the mold so filled.

256,872—April 25, 1882. F. BODINE. *Method of treating pulp and the resultant material.*

Vegetable pulp is saturated with linseed or other vegetable or drying oil, and rolled, pressed, or molded, with or without coloring material.

257,607—May 9, 1882. A. PARKES. *Treatment of cellulose and the manufacture of articles therefrom.*

In the manufacture of articles of cellulose, or coating therewith, the cellulose is dissolved in a solution of iodide or nitrate of zinc or nitrate of lime, molded to the form required; the solvent then removed by washing and treating with an alcoholic or vegetable naphtha solution, and the article rolled, pressed, or calendered.

259,271—June 6, 1882. J. A. FLEMING. *Preparation of materials for use in electric insulation.*

Finely pulverized wood, desiccated, is saturated or impregnated with paraffine wax or with a mixture of wax and resin, and molded under pressure.

268,034—November 28, 1882. M. MACKAY. *Manufacture of insulating compounds.*

A mixture of mineral wax, such as paraffine wax or ozocerite-wax, 1 part; vegetable tar, 24 parts; and shellac and asbestos or other dry fibrous substance, 32 parts of each. Ground slate or silica or clay free from iron is sometimes employed in place of wax.

279,384—June 12, 1883. C. HEMJE AND T. C. BRECHT. *Machine for compressing plastic and other material.*

The materials are subjected to a bath of a sprayed fluid and then to compression.

284,289—September 4, 1883. J. A. FLEMING. *Preparation or production of insulating materials or articles.*

Finely pulverized wood, desiccated, is impregnated, under pressure, with a mixture of melted bitumen or asphalt incorporated with a substance of the resin type, and with or without a substance of the paraffin type or of the anthracene type, or of both paraffin and anthracene types.

288,300—November 13, 1883. B. BOROWSKY. *Method of uniting small pieces of amber into a large block.*

The pieces of amber are hermetically closed in a receptacle, subjected to a light pressure, heated to a high degree of heat, about 500° C., a strong pressure then applied, and finally it is slowly cooled.

297,639—April 29, 1884. R. SCHIMMEL. *Process of manufacturing chair-seats of vegetable fiber and chromic acid.*

Ground rags and vegetable fiber, in equal parts, are mixed and formed into a paste with the addition of chromic acid, 3 parts to 100 parts of water; formed into sheets; backed with textile fabric; molded and pressed; varnished and dried.

301,405—July 1, 1884. F. THIEMER. *Method of producing molded articles from substances containing ligneous fibers.*

Molded articles are produced from sawdust, wood shavings, wood pulp, straw, etc., by treatment with chloride of zinc and basic chloride of magnesium, compression into molds, and drying.

302,795—July 29, 1884. F. TAYLOR. *Method of treating vulcanized fiber and like material.*

To impart softness and flexibility to vulcanized fiber, the fiber, after the organic change has been produced, is subjected to the action of a solution of deliquescent salt, as chloride of zinc, with or without glycerine or sugar water combined therewith.

317,387—May 5, 1885. C. S. LOCKWOOD AND J. W. HYATT. *Process of treating alkaline silicates, etc.*

Articles are formed of an alkaline silicate with or without an inert material, by forming a solution of the silicate, and introducing, if preferred, the inert material, desiccating the solution, comminuting the compound, and subjecting the powder to pressure in heated molds, with or without subsequent treatment in a bath.

317,390—May 5, 1885. C. S. LOCKWOOD, J. W. HYATT, AND J. H. STEVENS. *Process of treating gelatine when combined with tannic acid, etc.*

One hundred parts of gelatine, say, are combined with 5 to 10 parts of tannic acid, the compound dried and comminuted, and the desiccated powder subjected to pressure in heated molds.

326,220—September 15, 1885. A. H. HUTH. *Manufacture of compounds of india-rubber, gutta-percha, and like materials.*

Earth wax and gums and resins are fused and maintained in a state of fusion until all matters volatile at the fusing temperature are expelled, then cooled, powdered and mixed with india rubber, gutta-percha, or analogous substances.

330,019—November 10, 1885. A. HAMANN. *Process of rendering billiard and writing chalk unbreakable.*

Cubes or pieces of chalk are saturated with fluid-oil varnish or boiled linseed oil or other drying oil.

343,590—June 15, 1886. O. LUGO. *Producing solid compounds resembling vulcanite from hair, etc.*

Hair is subjected to heat and pressure.

349,760—September 28, 1886. E. C. C. STANFORD. *Algin and other useful products.*

Seaweed is mixed with a solution of carbonate of soda and boiled to produce a cellulose residue; the solution is treated with sulphuric acid, or hydrochloric acid may be used, producing alginic acid as a precipitate; the remaining solution is neutralized with alkaline earth, producing a precipitate of sulphate of lime; the remaining solution is evaporated to a density at which sulphate of soda crystallizes out as Glauber's salts; and the mother liquor is finally evaporated to dryness and the residue carbonized, forming kelp substitute.

355,998—January 11, 1887. M. KAMAK. *Treating horn.*

Horn is subjected to the action of a solution of water, sugar of lead, and vinegar until it assumes a light brown hue. To give it the appearance of mother-of-pearl it is then introduced into a solution of muriatic acid.

359,156—March 8, 1887. C. JACKSON. *Manufacture of hardened asbestos.*

Fibrous asbestos is combined with a binding material, as shellac, rendered liquid in a solvent; the solvent is evaporated; the material pressed in molds; exposed to heat to perish the binding material or change it so that it is no longer soluble in the solvent; when the article is simultaneously subjected to heat and heavy pressure.

366,341—July 12, 1887. H. W. MORROW. *Method of treating vulcanized fiber.*

To impart softness and flexibility to vulcanized fiber, the fiber, after the organic change has been produced, is subjected to the action of a solution of deliquescent salt, as chloride of calcium, with or without glycerine or sugar water combined therewith. (See 302,795.)

370,645—September 27, 1887. H. ORDENSTEIN. *Manufacture of articles from plaster-of-paris or other compositions or materials.*

A formed article of plaster of paris or other porous material is treated with carnaub-wax to fill the pores and strengthen and harden and give a polishable surface.

371,550—October 18, 1887. E. T. L. CLARK. *Process of hardening and preserving plaster-of-paris casts and molds, and making them impervious to water.*

The casts or molds are immersed in a solution of borax and then treated with white or paraffine wax.

389,210—September 11, 1888. C. A. FAURE. *Method of preparing asbestos.*

A sheet of asbestos is immersed in a soluble salt, as chloride of calcium or chloride of barium, dried, and again immersed in a second solution containing a silicate, such as the silicate of soda or a fluosilicate, whereby it is rendered insoluble in water and acid and its strength is increased.

395,083—December 25, 1888. W. SIEMENS. *Process of manufacturing insulated conductors.*

The fibrous matter covering wire strands is impregnated with caoutchouc, oil, or similar liquid, by drying the covered wires under vacuum by means of sulphuric acid or other hygroscopic substance, and then admitting the heated caoutchouc, oil, or other substance into the vacuum chamber containing the wire.

405,201—June 11, 1889. B. E. CHURCH. *Process of treating asbestos.*

Broken asbestos is mixed with a solution of rubber and naphtha which has been mechanically distended by water—as by mechanically mixing a solution of rubber in naphtha with water—then the water is removed by pressure, and the mass is formed into shape by heat and pressure; the asbestos may be soaked with water and the india-rubber solution then mixed therewith.

410,042—August 27, 1889. J. L. STEWART AND J. L. HASTINGS. *Process of producing refractory compounds.*

A refractory crystalline compound for incandescent illumination is produced by pulverizing and mixing a strontium compound or salt with one or more pulverized mineral substances and with a flux composed of a fluoride or a fluorine compound, making the mixture plastic and molding it into shape, then subjecting the molded material to a moderate drying heat, and finally to a high temperature.

419,779—January 21, 1890. G. KOLLER. *Process of treating glue and gelatine molds.*

Glue or gelatine molds are treated with strong oxidizers, as an aqueous solution of anhydrous chromic acid, and afterwards exposed to light; or the glue may be dissolved in an aqueous solution of an energetic oxidizer, the mold formed, and afterwards exposed to the action of light.

420,763—February 4, 1890. W. BOOTH. *Art of manufacturing articles from wood pulp.*

Wood pulp is reground, after it has been subjected to the indurating pickle and dried, and the ground product is then compressed into the desired form.

422,760—March 4, 1890. R. P. FIRST. *Article of chemically treated fibrous material and mode of making the same.*

Shaped articles composed of laminated forms of chemically treated fibrous material are produced by producing a laminated body from a chemically treated sheet of fiber, and then subjecting these laminæ to endwise pressure, whereby they are swaged into the desired form.

428,925—May 27, 1890. I. W. MARSHALL. *Process of treating fibrous material.*

In washing sheets of fibrous material which have been treated with acids, the sheets are confined under pressure between plates having corrugated faces with or without perforations.

429,999—June 10, 1890. C. A. CATLIN. *Plastic composition.*

A fibrous material is combined with a cementing agent in a pulverulent state by mixing the substances together with water and after a thorough mixture, removing the surplus moisture, and compacting with heat and pressure.

437,044—September 23, 1890. F. L. RAWSON. *Method of impregnating parts of electrical apparatuses.*

Hollowed or cored insulating parts of electrical apparatus formed of hydraulic cement are impregnated with heavy, oily, or resinous matter, by means of a closed, heated vessel placed with the molded article with the impregnating matter around it.

438,309—October 14, 1890. T. A. EDISON. *Method of insulating electrical conductors.*

Balata or similar gum is prepared for insulating purposes by dissolving in a solvent of chloroform and passing chlorine gas through the solution until the hydrogen of the material is sufficiently replaced by the halogen. if the chlorination is carried so far that the material is brittle, a small quantity of the gum solution not chlorinated is mixed therewith.

441,870—December 2, 1890. E. T. GREENFIELD AND J. NAGEL. *Process of working high-boiling hydrocarbons for impregnating purposes.*

For impregnating fibrous, porous, or cellular bodies, a high-boiling hydrocarbon is maintained in a liquid condition by adding from time to time a lower-boiling hydrocarbon to supply the volatile matters evaporated.

441,951—December 2, 1990. G. W. GOETZ. *Process of and apparatus for comminuting materials of a viscous or pasty nature.*

Material of a viscous, pasty, or gummy nature is comminuted by subjecting it to motion and attrition in a closed receptacle under a reduced temperature, where the material becomes friable.

445,285—January 27, 1891. F. EGGE. *Method of molding amber.*

Pieces of amber are molded into an integral article by the application of heat and an automatic pressure constantly and uniformly applied; as by the action of a weight applied through a lever.

460,056—September 22, 1891. E. FAHRIG. *Process of manufacturing a composition applicable for electrical insulating purposes, etc.*

Properly prepared pulp—cellulose or linen pulp—is beaten up with manila fiber; then there is added a soap solution and the mass is treated with a precipitate until precipitation shows in the whole mass; the pulp formed into sheets; powdered with an insulating powder; subjected to pressure and dried; treated with an insulating solution; and again subjected to heavy pressure.

468,222—February 2, 1892. H. B. GARRIGUES. *Process of molding plastic material.*

Plastic material is packed in foil by introducing the material into molds of thin foil while the latter are suspended in open-mouthed pockets, reducing the diameter of the article by means of cold, and afterwards closing the open ends of the molds by turning the edge of a blank over the end of the core and mold.

483,646—October 4, 1892. A. H. S. DYER. *Process of making artificial mica sheets for electrical insulation.*

Overlapping mica scales are laid on a freshly varnished foundation plate, the sheet is varnished, and additional layers of mica are laid in a similar manner until the required thickness is obtained, when the sheet is heated to evaporate the solvent of the varnish, rolled, submitted to heavy pressure, and cooled.

483,653—October 4, 1892. C. W. JEFFERSON. *Molding mica forms for electrical insulators.*

Laminated mica sheets are formed and set by cementing together laminæ of mica scales with overlapping edges, compressing the sheet into the desired form while the cement is wet, drying the cement by evaporating the solvent thereof, and chilling while under compression.

492,056—February 21, 1893. M. SICHEL. *Method of producing dental cement.*

Metallic aluminum is first dissolved in glacial phosphoric acid to produce a phosphate of aluminum; next oxide of zinc is subjected to a white heat to reduce it to a gummy condition, the two are mixed and the compound subjected to heat, then cooled and pulverized, more of the gummy oxide added, and the whole mixed in a powdered condition; and finally, when ready for use, sufficient of the said phosphate of aluminum is added to reduce the whole to a plastic condition.

494,891—April 4, 1893. R. REIMAN. *Process of manufacturing artificial bone.*

Natural bone or bone meal is chemically dissolved, the elements precipitated, filtered, and washed, and then mixed with albumen, alumina sulphate, and cellulose in solution, and subsequently partly dried and subjected to a high temperature, at the same time keeping the mass under strong pressure.

497,324—May 16, 1893. C. W. JEFFERSON. *Process of making mica insulating plates.*

Mica sheets are distributed evenly upon and within liquid cement by showering them thereon through the air at a sufficient height so that the sheets become substantially parallel to a horizontal plane before reaching the cement—say 18 feet—and the excess of cement is then expelled by pressure, the plates dried, and the surface ground until parallel; successive showerings of mica sheets are made into the cement, iron foundation sheets being introduced between the showerings, and the mass divided up into separate parts.

501,222—July 11, 1893 P. C. DAME AND L. PRUD'HON. *Method of making artificial whalebone.*

Animal hair is subjected to a softening bath, as of lime and potash, then immersed in a bath of acetic acid, and finally subjected to pressure.

508,653—November 14, 1893. E. THOMSON. *Insulating composition.*

Silicious or like material, as fine kaolin and soluble silicate of soda, is applied to sheets of paper, the sheets piled together and dried; they may be baked and the paper carbonized, with layers formed of more or less vitrified silicious material.

517,011—March 20, 1894. J. C. PEABODY. *Method of making indurated articles from plastic material.*

Wood fiber or paper stock in dry condition is mixed in the presence of heat with linseed oil and resin, and then powerfully compressed, while still warm and plastic, in cold molds.

520,283—May 22, 1894. K. WITZ. *Manufacture of plastic articles.*

Paper board or like material is impregnated with hellebore juice to increase its elasticity and tenacity, prior to subjection to pressure between dies.

522,242—July 3, 1894. A. F. TINNERHOLM AND C. F. PETERSON. *Process of manufacturing insulating material.*

Mica plates are built up by forming superposed layers of mica scales covered with finely powdered gum or resin, and subjecting the combined layers to heat and pressure.

529,905—November 27, 1894. W. GRISCOM, JR. *Method of compounding vulcanizable compounds, and vulcanizing and applying same.*

Vulcanizable compounds containing such plastic material as candle tar are compounded by heating the plastic matter to a melted condition, separately melting the sulphur, and then mixing the melted masses; the compound is then applied in permanent adherence to fabricated material.

530,517—December 11, 1894. A. N. FORD. *Process of manufacturing insulating compositions for electrical purposes.*

Fibrous material is saturated with a partially oxidized drying oil, then dried, and then repeatedly saturated or coated and dried until the mass has increased in weight from 50 to 200 per cent; when the material is ground to a homogeneous mass, mixed with gutta-percha or like material, reground, and formed into blocks or sheets.

530,958—December 18, 1894. B. McCABE AND A. THAYER. *Method of molding vegetable fibrous material.*

Vegetable fibrous material is first treated with acid, then forced through apertures in a head, whereby it is formed into strips or strings, which are deposited in a plastic condition in a mold, compressed, and finally immersed in water.

533,746—February 5, 1895. R. REIMAN. *Process of manufacturing artificial bone.*

Natural bone is macerated, the liquid separated from the organic solids, the gelatine separated from the residue of the organic matter, and the gelatine product is then combined with a chromate and a drying oil, and a material that will give body to the composition.

538,265—April 30, 1895. H. P. LANE AND E. FOLK. *Process of making molded articles from wood pulp.*

The article is molded of wood pulp, then impregnated with oil and resin, baked, and then subjected to heavy pressure between smooth mold surfaces, warmed sufficiently to soften the coating, but not the material.

539,928—May 28, 1895. J. A. WHEELER. *Process of molding fibrous pulp.*

Fibrous pulp, moistened with water, is mixed with sodium silicate, and then with pulverized calcined magnesite sufficient to convert it into a doughy body; then with pulverized quicklime; then pulverized resins or gums are added, and the mass heated and molded, dried or baked, and subjected to a bath of a solution of chloride of magnesia or other chlorides.

549,254—November 5, 1895. C. F. PETERSON. *Method of making insulator-rings.*

In forming flanged insulator rings of built-up pieces of mica, the pieces of mica are bent and assembled to form the predetermined ring and cemented together as the irregular structure is built up; the structure is then subjected to pressure and heat in a mold, and chilled.

561,938—June 9, 1896. T. G. B. GOLDMANN. *Process of making articles from homogeneous plastic compositions.*

A binding substance is dissolved in a water-soluble solvent, such as alcohol; then mixed with a filling material and pigment in finely divided state, in proportion to their specific weights in dry state; next water is added to the mixture under continuous stirring until the intimately mixed mass of binding substance and filling material is separated from the solvent and precipitated as a thick paste; when the water is removed, the paste dried, pulverized, and compressed while subjected to heat.

574,793—January 5, 1897. A. N. FORD. *Art of making oil fabrics.*

Fibers are loosely separated and repeatedly immersed in boiling oil so as to coat the separate fibers; the oil oxidized after each immersion by the action of air, with the fibers maintained in their loosely separated condition, and the coated fibers finally ground to form a homogeneous mass.

589,256—August 31, 1897. J. GRAY AND C. H. CASE. *Process of making insulating material.*

Pulp is formed into shape, heated in a bath of molten sulphur, then subjected to heat under pressure, and subsequently immersed in a cold bath.

589,637—September 7, 1897. W. G. BRISTOW. *Method of and means for molding plastic material.*

A partial vacuum is created beneath a flexible tissue placed over a pattern, the plastic material is then cast within the tissue thus drawn into the mold; hardened; and the pressure is then restored beneath the tissue, forcing it from the pattern and releasing the cast from the tissue.

595,168—December 7, 1897. L. GROTE. *Process of manufacturing moldable mass or articles from asbestos.*

Asbestos is steeped in a bath composed of a solution of 1 part of glue, 6 parts of a solution of soluble glass of 20° to 30° Baumé, and 7 to 9 parts of a solution of 40 per cent formaldehyde; it is then compressed to remove superfluous moisture, subjected to a bath of a salt of alumina, dried, pulverized, compressed, and then dried first in the open air and then in an oven.

618,692—January 31, 1899. F. LAMPLOUGH. *Process of manufacturing a substance having insulating properties.*

Vegetable fiber is submitted in presence of oxidizable resinous bodies and a proportion of nonoxidizable oil to a gradually-increasing heat until all air, dampness, and volatile matters are driven off; the action of the heat is continued until the nonoxidizable oil is destroyed and until the vegetable fiber is changed into a homogeneous mass, when the fluid portion is removed, air is introduced under pressure to oxidize the material, and it is pressed and desiccated.

622,325—April 4, 1899. H. BRUNSWIG. *Method of transforming fibrous cellulose into a dense material.*

Fibrous cellulose is reduced to an impalpable condition in water, the water drained from the mass, with or without boiling to expel the air, and molded and dried.

623,608—April 25, 1899. C. IVES. *Process of treating gelatin, glycerin, and bichromate of potash.*

A substance of rubber or gutta-percha like character is produced from a composition of gelatine, glycerine, and bichromate of potash, with which adulterating material may be combined, by mixing the ingredients in as nearly an anhydrous state as possible, whereby chemical action between the bichromate of potash and gelatine is sufficiently inactive to allow time for molding the composition under pressure, and heating it while under pressure to 95° to 150° C.

625,372—May 23, 1899. J. A. WHEELER. *Process of molding fibrous pulp.*

To give more body and increase the solidity, fibrous pulp is mixed with pulverized incombustible material; moistened with hot water; sodium silicate added, the mass kneaded, and quicklime added thereto; and pulverized resins are mixed with the mass while heated, with or without the subsequent addition of calcined pulverized magnesite soaked in chloride of magnesia.

625,450—May 23, 1899. J. KAISER. *Process of manufacturing materials similar to wood from fibrous refuse.*

Fibrous refuse is fluxed with lye, then saponified with resin, and subjected to pressure, when ground wood and an agglutinant, as grape sugar, is mixed with the said material and the mixture dried and kneaded.

631,719—August 22, 1899. A. IMSCHENETZKY. *Refractory material.*

The process of forming refractory material consisting of asbestos, with or without the admixture of other material, bound together by means of silica, consists in first saturating articles of asbestos with a solution of sodium silicate mixed with sodium bicarbonate, then saturating the same first with a sodium-silicate solution, and then with a sodium-bicarbonate solution.

640,725—January 2, 1900. P. W. WIERDSMA AND J. KUIPERS. *Process of treating vegetable waste.*

Vegetable waste—produced in the manufacture of potato flour—is treated for the removal of dirt and matters soluble in water; then dried and disintegrated; mixed with resin or other gum to render the mass waterproof; dried; reduced to a powder; and molded under pressure.

643,012—February 6, 1900. A. SMITH. *Process of producing material suitable for electric insulation or other purposes.*

Two parts (by measure) of acetic paraldehyde and 1 part of methylated spirit are mixed; 3 parts of liquid carbolic acid, which has been liquified by adding 5 per cent of water, added: and to the mixture, in a closed vessel, there is added in small doses, while cooling, 3 to 6 parts of methylated spirit, which has been saturated with hydrochloric-acid gas; and the material is molded; the molded article may be impregnated with paraffin.

647,119—April 10, 1900. T. SEEHAUSEN. *Process of compounding fillings for rubber tires.*

Light ground vulcanized rubber is mixed with resin oil, heated for two hours at a pressure of 45 pounds per square inch; then there is added a second mixture of ground vulcanized patent rubber waste, which has first been washed in water and dried with loofah fibres, solar oil, and turpentine; and finally there is added to this mass a mixture of india rubber, sulphur, ammonia, soda, and neutral acetate of lead.

652,144—June 19, 1900. A. SKROBANEK. *Process of producing artificial wood.*

It is produced by cleaning and carding peat, separating the humic and ulmic acids as borates and silicates, mixing the peat-mull with a filler and a hardening material—such as a composition of silica, alumina, and sodium borate and silicate—forming alternate layers therewith and with the carded fiber laid in different directions, and molding the compound; the mull is treated with a hot solution of sulphuric acid and alum.

654,646—July 31, 1900. F. G. KLEINSTEUBER. *Method of dissolving resins.*

There is mixed with the resin solvent a suitable quantity—2 to 10 per cent of the resin—of a compound composed of a solution of dammar and tung or wood oil in benzole, and oil of turpentine with or without oil of rosemary.

654,951—July 31, 1900. W. J. CORDNER. *Process of manufacturing composition applicable for electric insulation.*

Rhea fiber is treated in a solution of silicate of soda of 15° to 20° Baumé, dried, saturated with a heavy hydrocarbon, such as resin oil and the like, the surplus heavy hydrocarbon removed, the saturated fiber treated with heat to transform it into a heavy hydrocarbon cellulose, which is disintegrated and mixed with gums, resins, oxidizable oils, and the like to form a composite material.

655,130—July 31, 1900. R. M. THOMPSON. *Method of treating wurtzilite.*

The mineral is subjected to the action of steam heat to reduce it to a softened or fused state.

655,131—July 31, 1900. R. M. THOMPSON. *Wurtzilite method and product.*

The mineral is softened, as by the action of heat, and combined with a hardening material, as mica, asbestos, or soapstone, and afterwards a quantity of sulphur.

657,818—September 11, 1900. M. FREMERY AND J. URBAN. *Manufacture of cellulose.*

Cellulose material, such as cellulose, hydrate of cellulose or hydrocellulose, is subjected to an energetic preliminary treatment with reducing or oxidizing bleaching media, such as sulphurous-acid salts or chlorine in the form of hypochlorite, and then subjected to the action of an ammoniacal solution of copper.

659,358—October 9, 1900. J. G. BIERICH. *Process of producing homogeneous horn substances.*

Horn cuttings and shavings are cleaned, mixed with glycerine, and the mixture subjected to a temperature of 100° C. for about forty minutes and at a pressure of about two hundred atmospheres, the process being carried on under exclusion of air.

662,929—December 4, 1900. W. GELINEK. *Process of manufacturing solid substances from fibrous material and product thereof.*

A composition of fibrous material, with coal tar, colophony, asbestos, kaolin, infusorial earth, and lime, compressed when hot in molds under high pressure.

GROUP XVI.—ESSENTIAL OILS.

ESSENTIAL OILS, PERFUMES, AND FLAVORS.

162,529—April 27, 1875. A. G. CAMPBELL. *Improvement in portable toilet waters and extracts.*

Fragrant attars are absorbed by carbonate of magnesia and then reduced to a powder, the same being adapted to readily produce toilet waters and extracts by lixiviation with alcohol. Thus, for cologne water, a mixture of 3 ounces of attar of bergamot, 2 drams of attar of neroli, and 1 dram of attar of rose is poured on 4 ounces of carbonate of magnesia.

200,168—February 12, 1878. D. M. BUIE. (*Reissue: 10,338—June 5, 1883.*) *Process of manufacturing oils from organic substances.*

Steam and carbonic acid are injected into the retort containing the materials, such as pitch pine, sassafras, juniper, myrtle, peanuts, cottonseed, etc., and heated to a high temperature.

330,274—November 10, 1885. A. M. TODD. (*Reissue: 10,705—March 30, 1886.*) *Process of obtaining menthol.*

A crystalline product is obtained from the oil of *mentha piperita* by congealing it to a jelly-like form and draining the oil therefrom; the crystals may be fused and subjected then to a second congealing and draining and a gradual raising in temperature.

556,944—March 24, 1896. J. C. W. F. TIEMANN. *Process of converting compounds of the citral series into isomers.*

Compounds of the citral (geranium) series are subjected for some time to the action of dilute sulphuric acid, producing isomers having a lower b. p. and a higher sp. gr. than the original bodies.

557,431—March 31, 1896. L. R. SCAMMEL. *Process of obtaining eucalyptol.*

A solution of phosphoric acid is added to the eucalyptus-oil or other volatile oil containing eucalyptol, and the eucalyptol phosphate formed is then decomposed by hot water.

588,766—August 24, 1897. M. EKENBERG. *Process of making perfumes.*

Perfumes, contained in closed vessels, have an inodorous hydrocarbon or ether added, as butane, having a boiling point below 30° C., to be readily vaporized at the temperature of the hand or the air of a living room.

600,429—March 8, 1898. E. DE LAIRE. *Ionone derivative.*

A new product, an isomerid of ionone, b. p. 140° C., of the odor of violets, is produced by treating ionone or pseudo-ionone with a concentrated condensing-acid, such as sulphuric acid.

601,193—March 22, 1898. J. ZIEGLER. *Essence of violets.*

Citral, or an oil containing citral, is treated in a mixture of acetone and diluted alcohol, with an active oxidizing agent, as a saturated solution of chloride of lime or barium peroxide, and the product further oxidized by boiling with ferric chloride.

617,552—January 10, 1899. P. BARBIER. *Synthetic violet-oil and process of making same.*

A new product, $C_{11}H_{24}O$, a yellowish oil, b. p. 162° C., under pressure of 10 m. m., is produced by condensing an aldehyde of the formula $C_{10}H_{16}O$, as citral, with methylpentenone (oxide of mesityl) under the influence of an alkaline reagent, and transforming the product into an isomeric ketone by the action of an acid condensing agent.

626,585—June 6, 1899. J. ZIEGLER. *Synthetic violet-oil and process of making same.*

A new product, b. p. 138° to 149° C., under pressure of 12 m. m. It is produced by heating a mixture of acetone, lemon-grass oil, alcohol, cobaltous nitrate, and chloride of lime; distilling off first the lighter and bad-smelling portions, then the essential oils, mixing these oils with sodium bisulphate and fractionally distilling.

637,209—November 14, 1899. I. KLIMONT. *Process of making ionone.*

Citral and acetylacetone in acid solution are heated with reagents adapted to combine with the water, and the oily matter is separated and purified.

650,028—May 22, 1900. J. C. W. F. TIEMANN. *Process of decomposing ionone.*

The ionone is boiled with an alkali sulphite in the presence of a binding agent for any liberated alkaline hydrate; the solution subjected to steam distillation; and alkali added to the remaining solution to liberate the alpha ionone.

ARTIFICIAL MUSK.

412,545—October 8, 1889. E. SCHNAUFER AND H. HUPFELD. *Process of making artificial musk.*

An oil having the formula $C_{12}H_{17}NO_2$, adapted for use as a substitute for musk, is made by digesting a mixture of metaxylol and isobuty alcohol with chloride of zinc, nitrating the resulting hydrocarbon, and separating the oil by dissolving out extraneous matter.

416,710—December 10, 1889. A. BAUR. *Process of making artificial musk.*

Toluol is mixed with butyl chloride; the product of the reaction diluted with water and distilled with steam; the vapors treated with a mixture of fuming nitric and sulphuric acid; and the product, a substitute for musk, crystallized from alcohol.

451,847—May 5, 1891. A. BAUR. *Artificial musk.*

A new product, being a trinitrated hydro carbon derived from toluene or its homologues, in solid crystalline form. It is made, for example, from toluene, or xylene mixed with a butyl halogen compound, distilled, treated with fuming nitric and sulphuric acid, and crystallized with alcohol.

481,685—August 30, 1892. A. BAUR. *Artificial musk and process of making the same.*

A new product, being a trinitro-derivative of the butylated or analogous metacresol in a white crystalline form, is produced by mixing an ether of metacresol or other substituted phenol, with a metallic chloride, as aluminium chloride; heating, mixing with water, and isolating the butylated cresolether, thereby obtaining an aromatic, colorless liquid; introducing the ether into fuming nitric (or nitric and sulphuric) acid; heating, and crystallizing from a solvent, as alcohol.

536,324—March 26, 1895. A. BAUR. *Artificial musk.*

A new compound, the trinitro-derivative of butylhydrindene, in the form of white needles, sparingly soluble in alcohol having a m. p. 139°–140° C., is produced by heating an ethol-aromatic hydrocarbon, such as hydrindene, with a chloride, such as butylic chloride, in presence of a metallic chloride, and nitrating the product.

546,086—September 10, 1895. A BISCHLER. *Artificial musk and process of making same.*

A new compound, a white crystalline body, insoluble in water and soluble in alcohol and ether, is produced by forming a cyanide derivative of an aromatic butylic hydrocarbon—such as cyanide of butyl toluene—heating the same in a mixture of fuming nitric and sulphuric acid, and cooling and precipitating from a solvent, as alcohol.

559,783—May 5, 1896. A. MÜLLER-JACOBS. *Process of making artificial musk.*

A saturated solution of the soluble parts of kerosene or naphtha in ice-cold sulphuric acid is nitrated, then gradually heated to 65° to 82° C., neutralized with ammonia or other alkali, and the neutralized product, mixed with a neutral resin soap, is precipitated by means of a solution of a metallic salt, as sulphate of aluminum.

560,771—May 26, 1896. A. BAUR. *Artificial musk.*

A new product, crystallizing in white needles, m. p. 137° C., insoluble in water and soluble in organic solvents as alcohol, is produced by treating butylxylene in the presence of aluminium chloride with homologous fatty chlorides such as acetyl chloride, and nitrating the ketone thus obtained.

602,961—April 26, 1898. C. SCHMID. *Process of making artificial musk.*

A new product, derived from resins, a heavy orange-red oil, is produced by distilling certain fossil resins, such as copal, amber, or retin resin, with superheated steam; treating the distillate of wax-like or oily consistency with oxidizing reagents, as a mixture of potassium bichromate and sulphuric acid; neutralizing the filtered mass by ammonia and alcohol; driving off the alcohol, and extracting with ether.

For other products of this group, see Group XVIII, "Fine Chemicals."

GROUP XVII.—COMPRESSED AND LIQUEFIED GASES.

HYDROGEN.

229,339—June 29, 1880—C. M. TESSIÉ DU MOTAY. *Process and apparatus for manufacturing hydrogen gas.*

A current of watergas and steam is passed through a body of highly heated lime, thereby converting the mixture into hydrogen and carbonic acid, and then through a body of lime at a lower temperature whereby the carbonic acid is absorbed. The carbonate of lime is reconverted for reuse by burning in its presence a gas containing hydrogen.

229,340—June 29, 1880. C. TESSIÉ DU MOTAY. *Process for the production of hydrogen gas.*

A current of coal gas is passed through a secondary highlyheated converting-generator, thereby increasing its volume, subsequently said gas is passed through a highly heated body of lime, decomposing during the passage the hydrogen compounds contained in the gas, in connection with water vapor, and then the products are passed through lime at a lower temperature.

366,081—July 5, 1887. H. H. EDGERTON. *Obtaining hydrogen from water gas.*

Hydrogen is separated from the heavier constituents of water gas by dialysis.

CHLORINE.

506,640—October 10, 1893. R. KNIETSCH. *Package of liquid chlorine.*

A new article, liquid chlorine in an iron or steel vessel, and sufficiently anhydrous not to attack the iron or steel.

649,565—May 15, 1900. C. E. ACKER. *Process of manufacturing caustic alkali and halogen gas.*

See Group X, Electro-chemistry.

OXYGEN.

66,279—July 2, 1867. H. A. ARCHEREAU. *Improved mode of preparing oxygen and applying the same to useful purposes.*

Sulphuric acid is heated and decomposed into sulphurous acid, water, and oxygen, and the oxygen collected and compressed for use in producing high temperatures in metallurgic operations.

71,657—December 3, 1867. B. R. SMITHSON. *Improved apparatus for generating oxygen gas.*

Sulphuric acid is fed into a retort filled with pumice stone maintained at a red heat; a washer absorbs the sulphurous-acid vapors, the oxygen passing to a receiver.

86,248—January 26, 1869. O. M. PHILLIPS. *Improvement in the manufacture of oxygen-gas.*

In the production of oxygen gas from alkaline manganates a partial vacuum is formed at certain intervals in the retort to facilitate gas generation.

307,041—October 21, 1884. M. HERZOG. *Apparatus for the dialysis of air.*

A dialyzing apparatus for air has a series of chambers separated by a series of colloid or caoutchouc septa with an air pump for creating a suction and eliminating the nitrogen and producing superoxygenated air.

452,815—July 22, 1890. A. BRIN. *Process of obtaining oxygen from air.*

Barium oxide is heated in a retort to from 650° to 800° C.; air is then admitted until peroxidation takes place, when the air supply is shut off, and the barium is deoxidized by reducing the pressure without changing the temperature of the retort.

440,777—November 18, 1890. F. SALOMON. *Process of obtaining oxygen.*

A mixture of a metallic oxide, such as lead monoxide or lead carbonate, and an alkaline earth, such as lime, is heated in a current of air so as to cause oxygen to be absorbed, which is then expelled by a current of carbonic-acid gas.

500,697—July 4, 1893. G. WEBB, JR., AND G. H. RAYNER. *Process of making oxygen.*

For the production of ogygen gas from air a composition is used, formed of caustic soda dissolved in hot water with oxide of manganese and manganate of soda added, all in equal parts; the mass being then heated and evaporated to dryness, and then heated to a temperature in excess of that of the oxygen manufacture. After cooling, the mass is broken into pieces and rolled in powdered oxide of manganese prior to use.

545,973—September 10, 1895. J. PURVES. *Process of making gas and apparatus therefor.*

Fuel gas is made with denitrogenized air to increase its calorific power. Oxygen produced from air by the action of a metallic oxide—as barium oxide, which will absorb oxygen from air when heated, and liberate the absorbed oxygen when raised to a higher temperature—is fed to the producer, the heat of the hot gases being used to heat the oxygen retorts. The latter are made double and revolvable, and the generation of oxygen continuous by the periodic reversal of the retorts and alternate raising and lowering of their temperatures.

576,915—February 9, 1897. A. SWEETSER. *Apparatus for making oxygen.*

As a new article of manufacture for feeding into an oxygen-generating apparatus, oxygen-yielding material is formed into cakes or rods provided with a covering that is nonconductive of heat.

588,613—August 24, 1897. E. B. STUART. *Compound for separating oxygen and method of making same.*

A manganate and an alkali—as binoxide of manganese, 24 parts, and caustic soda, 76 parts—the alkali being in excess of that necessary to form a manganate, are melted; the compound being liquid and nonvolatile above the temperature at which steam forms and below that which decomposes steam.

588,615—August 24, 1897. E. B. STUART. *Process of and compound for separating oxygen.*

Atmospheric air and steam are alternately passed through a fused mixture of a manganate and an alkali salt, as a chloride of an alkaline earth capable of fusing and remaining in a permanent liquid form when fused.

588,616—August 24, 1897. E. B. STUART. *Oxygen-separating compound and method of making same.*

A nonaqueous oxygen-absorbing preparation, containing an oxygen-absorbing material, as oxide of manganese, and sufficient fusible material, as caustic soda, to cause the mass to liquefy and remain so at a temperature below that which decomposes steam, is formed by heating manganese, its oxide or salt, with fusible material, in the presence of oxygen at a temperature between that at which a manganate forms and that at which steam decomposes, and adding the fusible material until the mass becomes liquid.

588,617—August 24, 1897. E. B. STUART. *Method of obtaining oxygen and nitrogen from air.*

Air and steam are alternately passed through a fusible chemical, such as a manganate of soda, in liquid form.

NITROGEN.

207,086—August 13, 1878. G. A. TREUTLER. *Improvement in processes for the continuous preparation of nitrogen gas.*

Nitrogen gas is continuously prepared by forcing air through iron filings mixed with a hygroscopic material and moistened with ferrous sulphate, whereby the oxygen is absorbed from the air and the iron salt is converted into ferric sulphate, and the latter is then deoxidized by the action of the metallic iron.

225,730—March 23, 1880. T. B. STILLMAN. *Manufacture of nitrogen gas.*

In the manufacture of nitrogen gas, to remove all traces of oxygen, the gas is passed through melted sodium, potassium, or other metal having a high affinity for oxygen.

226,632—April 20, 1880. T. B. STILLMAN. *Manufacture of nitrogen gas.*

Nitrogen gas is purified and oxygen removed therefrom by passing it through an apparatus containing anhydrous phosphoric acid, anhydrous sulphuric acid, or anhydrous chloride of zinc, and then over or in contact with melted sodium, potassium, or other metal having a high affinity for oxygen.

281,002—July 10, 1883. J. F. BENNETT. *Apparatus for separating nitrogen from atmospheric air.*

It employs a series of annular chambers with porous walls, together with an air pump, to remove a part of the nitrogen from air by reason of its more ready diffusion through the porous walls.

NITROUS OXIDE.

87,319—March 2, 1869. W. P. BARKER. *Improvement in the use of nitrous oxide as an anæsthetic agent.*

Nitrous oxide is mixed with chloroform, or other anæsthetic.

120,978—November 14, 1871. W. F. & W. A. JOHNSTON. *Improvement in methods of compressing and liquefying nitrous oxide and other gases.*

Claims the apparatus of process No. 120,977; a hydraulic pump with one or more tanks or series of tanks.

SULPHUR DIOXIDE.

127,008—May 21, 1872. N. P. AKIN. *Improvement in the manufacture of sulphurous acid.*

Sulphur or pyrites is burned in a closed water-jacketed chamber under pressure, which is maintained likewise in the washing chamber and condenser. Liquid sulphurous acid and an aqueous solution of sulphurous acid from the unliquefied gases are simultaneously produced.

187,413—February 13, 1877. R. P. PICTET. *Improvement in processes of producing artificial cold by means of anhydrous sulphurous oxide.*

Anhydrous sulphurous oxide is used as a refrigerating agent.

191,778—June 12, 1877. R. P. PICTET. *Improvement in manufacturing sulphurous anhydride.*

Sulphur and sulphuric acid are heated, the product passed through a cleansing medium and a dehydrating medium, and liquefied by pressure, in a continuous operation.

376,883—January 24, 1888. E. HÄNISCH AND M. SCHROEDER. *Process of obtaining sulphurous acid.*

Liquid sulphurous acid is produced by passing the furnace gases through a spray of water, heating the resulting solution of sulphurous acid to evaporate the sulphurous-acid gas therefrom, cooling the separated gases, and converting the same into liquid form by compression and condensation.

CARBON DIOXIDE.

55,038—May 29, 1866. J. S. BALDWIN. *Improved method of collecting and separating carbonic acid from mixtures of gases.*

Water is sprayed through mixed gases in a chamber under pressure, taking up the carbonic-acid gas; the surcharged water then passing into a second chamber under a partial vacuum, where the gas is set free.

359,996—March 29, 1887. S. CABOT. *Process of and apparatus for making carbon dioxide.*

Limestone is alternately heated to redness by gaseous products of combustion at a high temperature, and with superheated steam with exclusion of air, until its carbon dioxide is expelled, the steam being condensed and removed from the carbon dioxide evolved. A reduced atmospheric pressure is produced and maintained in the closed furnace pending the passage of superheated steam.

383,957—June 5, 1888. H. LEFFMANN. *Manufacture of carbonic acid and heavy magnesia.*

Native magnesite, or magnesium carbonate, is decomposed by heat in a closed retort, producing carbonic acid and extra-heavy magnesia.

496,546—May 2, 1893. W. WALKER. *Process of and apparatus for recovering carbon dioxide.*

Impure carbonic-acid gas is passed through retorts containing a solid carbonate, as carbonate of soda, which absorbs the carbonic acid with the production of a bicarbonate. The nitrogen and other gaseous impurities are thus removed by exhaustion and the temperature raised to cause the pure carbonic-acid gas to pass off. Water is sprayed upon the carbonate and the solution obtained removed, and the carbonate crystallized out for reuse.

523,651—July 24, 1894. E. W. ENEQUIST. *Process of obtaining carbonic acid, sodium sulphate, and magnesium sulphate, etc.*

A solution of niter-cake (containing 24 to 28 per cent of free sulphuric acid) or an alkaline acid sulphate is employed as a solvent for magnesite in the production of carbonic acid. Iron and other impurities are precipitated and removed, sodium carbonate is added, and the resulting magnesium carbonate separated from the sodium sulphate.

APPARATUS.

17,394—May 26, 1857. W. A. ROYCE. *Reissued December 24, 1872. No. 5,201—Improvement in machinery for compressing gaseous bodies. No. 5,202—Improvement in machinery for compressing gaseous bodies.*

Reissue 5,201 relates to the compression of gaseous mediums with means for absorbing the evolved heat and for holding and transmitting the power; the metallic reservoir, pipes, etc., are coated on the inside with close-grained metals, vegetable gums, resins, or oils to retain the gas. Under reissue No. 5,202, serial compression is employed with refrigeration.

120,977—November 14, 1871. W. F. & W. A. JOHNSTON. *Improvement in apparatus for liquefying nitrous oxide and other gases.*

Gaseous or aeriform matter is liquefied by pressure transmitted from a pump by means of a liquid.

214,161—April 8, 1879. F. LITTMANN. *Improvement in apparatus for preparing water for ice machines.*

The process consists in converting water into steam, freeing the steam from impurities, then condensing the steam, and finally heating the water resulting from such condensation by means of a succeeding current of steam to drive off any remaining air.

320,310—June 16, 1885. J. J. SUCKERT. *Method of and apparatus for separating a liquefiable gas from a condensable vapor.*

The process consists in first reducing the temperature of a solution of the gas by the vaporization of a liquefied gas, and then passing the liquefiable gas and intermingled vapor through such cooled solution, thereby liquefying the vapor and separating it from the gas.

389,521—September 11, 1888. E. LUHMANN. *Apparatus for removing gases from liquids.*

A vacuum pan having a spiral channel for the liquor, forms, with two vertical pipes, a siphon, the pipes connecting with the respective ends of the spiral channel.

491,699—February 14, 1893. E. B. CUTTEN. *Preparing liquid chlorine.*

Chlorine gas is dehydrated by steps of cooling, by contact with calcium chloride, and by contact with anhydrous sulphuric acid, and is then liquefied by pressure. The noncondensed gases are then separated, and flasks are charged with liquid chlorine by drawing off from the bottom of the chlorine vessel to the bottom of a flask coupled thereto, causing the air in flask to compress until it attains the pressure of chlorine liquefaction, and then allowing the compressed air in the flask to escape.

503,556—August 15, 1893. E. SOLVAY. *Apparatus for treating pulverulent material with gases.*

Apparatus for process No. 503,558.

503,558—August 15, 1893. E. SOLVAY. *Treating pulverulent material with gases.*

The gas is passed from top to bottom through a body of the material contained in a closed vessel; then the ends of the vessel and the body are reversed and fresh material is added at the temporary top and treated material removed from the temporary bottom, when the vessel with the body of material is returned to its normal position and the passage of gas from top to bottom resumed.

506,639—October 10, 1893. R. KNIETSCH. *Process of and apparatus for making liquid chlorine.*

Chlorine gas is forced through a body of heated sulphuric acid into a confined space and is liquefied by pressure transmitted through the sulphuric acid. The sulphuric acid is cut off from the parts of the apparatus exposed to the air by a body of mineral oil.

575,714—January 26, 1897. C. HEINZERLING. *Process of recovering volatile substances from air or other gases.*

The air or gas (as gases from coal distillation, distillation of peat and bituminous shale to obtain oils, distillation of wood, preparation of water-proof texture or tissue and in the production of smokeless powder, and in the production of chloroform, carbon bisulphide, or carbon tetrachloride) is compressed; indirectly cooled by water while compressed; further cooled by indirect contact with previously expanded portions of the air or gas, a portion of the volatile substances being separated by the latter reduction of temperature; and finally the air or gas is permitted to expand to substantially normal pressure, whereby the remaining volatile substances are separated.

625,759—May 30, 1899. E. C. HARGRAVE. *Liquid air conveying conduit.*

The liquefied air is piped from one point to another, a portion being allowed to evaporate, and conveyed through an annular space around the main body of the air or gas to maintain said body in a liquefied state and prevent undue pressure therefrom.

650,608—May 29, 1900. T. J. McTIGHE. *Method of cooling gases.*

A compressed gas, with the heat of compression removed, is caused to act expansively in elevating within a heat-insulated tube a suitable liquid cooler than itself, thereby doing work and falling in temperature in proportion to the work done, the expanded and cooled gas cooling a further body of compressed gas.

GROUP XVIII—FINE CHEMICALS—INORGANIC.

BROMINE AND IODINE.

12,077—December 12, 1854. E. STIEREN. *Reissued June 1, 1869. No. 3479—Improved process of treating the mother-water of salines to obtain useful products. No. 3480—Improved apparatus for obtaining bromine and other products from the mother-water of salines.*

Sulphate of magnesia is obtained from bittern water of saline springs by evaporating to 36° Baumé, treating with lime, filtering, washing the precipitate, treating with sulphuric acid, concentrating and crystallizing. Iodine is obtained from the lye separated from the hydrate of magnesia by treating with soda sulphate, removing the sodium chloride, treating the liquor with sulphate of copper and iron, and the precipitate thereof with manganese and heat. Bromine is obtained from the liquor after heating with soda carbonate or caustic soda.

62,464—February 26, 1867. D. ALTER. *Improved apparatus for the manufacture of bromine and iodine.*

The retort consists of a stone box and lid with a leaden heating flue.

62,988—March 19, 1867. D. ALTER. *Improvement in the distillation of bromine and iodine.*

The fumes of bromine and hydro-bromic acid are absorbed by an alkali.

82,309—September 22, 1868. G. A. HAGEMANN. *Improvement in the manufacture of bromine from bittern.*

A sandstone trough or vessel is used, furnished with a bore, for the introduction of steam to dispense with the insertion of metallic pipes into the liquor. Naked steam is introduced into the body of the liquor to combine the mechanical action of the steam with the physical effects of its heat.

110,662—January 3, 1871. J. J. JÜHLER. *Improvement in apparatus for the manufacture of bromine.*

Stills are made of wood, or with a lining of wood, which chars to a certain depth, and then the destructive action of the bromine ceases.

217,076—July 1, 1879. J. N. J. DUBREUIL. *Improvement in manufacture of iodine and bromine.*

To prepare green seaweed for the extraction of its useful salts, the weeds are first disintegrated, then lime is mixed with the pulped mass and the liquid extracted by straining or pressing. The salts are then precipitated from the solution.

219,004—August 26, 1879. R. MÜLLER AND H. BÖCKEL. *Improvement in the manufacture of iodine and bromine.*

To obtain iodine and bromine from bittern or other liquids containing them, the liquor is subjected in a finely divided and heated state to the action of chlorine gas.

356,291—January 18, 1887. F. C. PHILLIPS. *Process of obtaining iodine from bittern.*

Iodine is first set free from its chemical combination in the bittern and is then absorbed with dead-oil or equivalent oily or tarry substance, and the iodine extracted from the oil by means of an alkali and distillation. The resulting bittern liquor is distilled to extract the bromine therefrom.

356,292—January 18, 1887. F. C. PHILLIPS. *Extracting bromine and iodine from bittern.*

Bromine and iodine are first set free from the chemical combination in which they occur in salt-water bittern, and dead oil, or heavy oil from coal tar, is then mixed therewith to absorb them; the oil is then separated from the bittern, and the bromine and iodine extracted from the oil by means of an alkali, as caustic soda.

447,926—March 10, 1891. H. H. WING. *Process of obtaining bromine and iodine.*

Bittern, concentrated to a sirupy consistency, is mixed with silicious material and calcined, producing fumes of chlorine, bromine, and iodine, which fumes are brought in contact with bittern water in a tower, whereby the bromine and iodine of the latter are liberated by the chlorine, and the iodine and bromine collected.

448,541—March 17, 1891. T. PARKER AND A. E. ROBINSON. *Process of making iodine by electrolysis.*

See Group X, Electro-chemistry.

456,183—July 21, 1891. H. H. WING. *Process of obtaining iodine.*

The mother-liquor resulting from the purification of sodium nitrate is mixed with silicious material and calcined, and the sublimed iodine collected from the fumes. The uncondensed vapors are brought in contact with a further quantity of said mother-liquor to effect a further purification of iodine.

460,370—September 29, 1891. H. H. DOW. (*Reissue: 11,232—April 12, 1892.*) *Process of extracting bromine.*

Bromine in brine or bittern water is first freed from its chemical combination, the bromine is then separated from the brine by means of an air blast, and the bromine-laden air is forced through a metal or substance that will combine with the bromine, producing a bromide, which is boiled to dryness out of contact with the air.

461,681—October 20, 1891. J. C. KAUTZ. *Process of purifying bromine.*

The bromine vapors, before condensation, are passed through a solution of the bromide maintained at the proper temperature.

SODIUM AND POTASSIUM.

342,897—June 1, 1886. H. Y. CASTNER. *Manufacture of sodium and potassium.*

The reduction of the alkali is effected by the carbide of a metal diffused through the alkali in a state of fusion at moderate temperatures. An easily reducible metal or its oxide mixed with a hydrocarbon and coked will serve as a carbide.

380,775—April 10, 1888. O. M. THOWLESS. *Process of obtaining sodium, etc.*

The substance containing the sodium or potassium, as caustic soda, is heated and gradually supplied to heated carbonaceous matter, and the vapors condensed.

380,776—April 10, 1888. O. M. THOWLESS. *Apparatus for obtaining sodium, etc.*

Apparatus for the practice of process No. 380,775.

391,110—October 16, 1888. H. S. BLACKMORE. *Manufacture of sodium.*

A mixture of calcium hydrate, 27.5 pounds; ferric oxide, 31.1 pounds; sodium carbonate, 30.9 pounds; and carbon, 10.5 pounds; is heated and the vapors collected and condensed.

460,985—October 13, 1891. C. NETTO. *Process of making sodium or potassium.*

Caustic alkali is brought into contact with reducing carboniferous matter at such a low temperature that only the caustic alkali is reduced to a metallic state, while the alkali carbonate simultaneously formed remains undecomposed and is withdrawn out of reach of the carboniferous matter without interruption of the reducing process.

SELENIUM.

235,616—December 21, 1880. A. G. BELL AND S. TAINTER. *Process of treating selenium to increase its electric conductivity.*

To increase the electrical conductivity and sensitiveness to light of selenium it is gradually heated to a point where the selenium is beginning to fuse and then allowed to cool, the proper moment for stopping the heating being shown by the ceasing of the increase of deflection of a galvanometer needle, and also by a change from a leaden color to blackish or nearly black.

RARE EARTHS.

87,477—March 2, 1869. C. M. TESSIÉ DU MOTAY. *Improvement in preparing zirconia for use in producing light, and for other purposes.*

The silicate of zirconium is treated with chlorine in the presence of charcoal, transforming it into the double chloride of zirconium and of silicum; the latter is volatilized off and the chloride of zirconium is then converted into an oxide; the zirconia is then moistened and molded; an agglutinating agent can be used; the pencils, disks, etc., are then highly heated and annealed.

377,701—February 7, 1888. C. A. VON WELSBACH. *Process of obtaining salts of cerium, etc.*

Compounds of the rarer metals—cerium, lanthanum, and didymium—are obtained from their earths by heating the mineral earth, plunging the heated earth into water, crushing, dissolving the fragments in a mineral acid, as concentrated hydrochloric acid, and precipitating by oxalic acid, washing and filtering the precipitate, heating it and afterwards dissolving it in nitric acid, digesting the solution with excess of the earth, separating the precipitate and the solution, dissolving the precipitate in nitric acid, and so producing cerium nitrate, concentrating the solution and heating it with nitric acid and ammonium nitrate, and then separating by fractional crystallization the ammonium double nitrates of lanthanum and of praseodymium and neodymium.

396,300—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

See Group XV, Plastics, Other Plastics.

396,301—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

See Group XV, Plastics, Other Plastics.

396,302—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

See Group XV, Plastics, Other Plastics.

306,303—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

See Group XV, Plastics, Other Plastics.

396,304—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

See Group XV, Plastics, Other Plastics.

396,305—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

See Group XV, Plastics, Other Plastics.

396,306—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

See Group XV, Plastics, Other Plastics.

396,307—January 15, 1889. J. L. STEWART AND J. L. HASTINGS. *Plastic mineral composition, etc.*

See Group XV, Plastics, Other Plastics.

396,693—January 22, 1889. J. L. HASTINGS. *Process of producing refractory compounds.*

A refractory crystalline compound, available for incandescent illumination, is produced by forming a base from two or more pulverized mineral substances—such as oxides, carbonates, or sulphates of metals, e. g., an intimate mixture of strontium oxide (caustic) and carbonate, calcium oxide and carbonate, and magnesium oxide and carbonate—mixing said base with a flux composed of one or more haloid salts—such as chlorides, iodides, fluorides, or bromides of metals, e. g., a mixture of calcium iodide, magnesium chloride, strontium chloride, and calcium fluoride—moistening the mixture with perchloric acid, molding and drying, and finally exposing to a high temperature.

400,335—March 26, 1889. J. L. HASTINGS. *Plastic mineral composition.*

See Group XV, Plastics, Other Plastics.

400,336—March 26, 1889. J. L. HASTINGS. *Plastic mineral composition.*

See Group XV, Plastics, Other Plastics.

409,584—August 20, 1889. J. L. HASTINGS. *Plastic mineral composition.*

See Group XV, Plastics, Other Plastics.

409,653—August 20, 1889. C. A. VON WELSBACH. *Process of obtaining zirconium nitrate.*

Zirconium nitrate in a form suitable for an incandescent body is produced by first converting the zirconium into a sulphate, and after treating with ammonia dissolving the same in nitric acid, thereby obtaining a precipitate which is digested with ammonia, dissolved in nitric acid, and evaporated.

410,865—September 10, 1889. F. THIELE. *Process of making zirconium nitrate.*

Water-soluble nitrate of zirconium is produced by subjecting zirconium ores to the action of hydrochloric acid, heating the residue with sulphuric acid for several hours to form zirconium sulphate, and adding a concentrated solution of barium nitrate to form by reaction therewith zirconium nitrate, barium sulphate being precipitated.

571,531—November 17, 1896. R. LANGHANS. *Process of producing coatings composed of earthy oxids.*

See Group X, Electro-chemistry.

571,532—November 17, 1896. R. LANGHANS. *Process of producing coatings composed of earthy oxids.*

See Group X, Electro-chemistry.

617,636—January, 10, 1899. W. BUDDEUS. *Process of obtaining thorium oxids.*

Monazite sand is comminuted and introduced into molten alkali hydrate; the resultant mass dissolved in hot water; the resultant alkali phosphate crystallized out; the mother liquor evaporated; water added to the residue, stirred, and the liquor containing the oxides of thorium and of the cerium bases is decanted or otherwise removed from the heavy sediment of ferrous titanate and zircon. The mixture of the oxides of thorium and of the cerium bases is treated with sulphurous acid to dissolve out the oxides of the cerium bases and leave the thorium oxide.

PLATINUM METALS.

241,216,—May 10,1881. J. HOLLAND. *Process of fusing and molding iridium.*

The metal is subjected to a high heat and then about one-fourth its weight of phosphorus is added, when it quickly fuses and is cast in highly heated molds. As soon as set it is placed in a crucible with lime, and again highly heated to eliminate the phosphorus.

HYDROCARBONS.

CARBON COMPOUNDS.

130,909—August 27, 1872. H. J. FENNER AND F. VERSMANN. *Improvement in the manufacture of anthracene.*

Anthracene is obtained by the distillation of coal-tar pitch by a regulated temperature of from 315° to 425° C. from heat externally applied. A partial vacuum assists the distillation.

173,862—February 22, 1876. C. LOWE AND J. GILL. *Improvement in processes for separating mixed coal-tar products.*

Carbolic acid is crystallized from mixed tar acids by successive steps of refrigeration, crystallization, and dehydration, the mixed tar acids being in a state of partial or complete hydration.

227,588—May 11, 1880. F. SALATHÉ. *Manufacture of anthracene.*

Anthracene tar, produced by treating petroleum or its derivatives in the presence of charcoal at a dull red heat (400° to 550° C.), and condensing the tarry matter produced.

372,243—October 25, 1887. J. VAN RUYMBEKE. *Aniline tar.*

Tar containing about 7 per cent of nitrogen and available for the direct production of aniline by treatment with acid is obtained from concentrated tank waters by distillation.

386,830—July 1, 1888. W. KELBE. *Process of obtaining retene.*

Retene ($C_{18}H_{18}$) is produced by heating resin-oil—a product of the dry distillation of colophony—with sulphur until the formation of hydrogen sulphide is finished. The raw retene obtained by distillation of the residue. or by extraction by a solvent, is purified by repeated crystallizations.

563,528—July 7, 1896. T. L. WILLSON. *Process of manufacturing hydrocarbon gas.*

See Group X, Electro-chemistry.

588,230—August 17, 1897. E. F. MACKUSICK. *Process of generating gas from carbides.*

The carbide is treated with a mixture of water and glycerine, or other nonvolatile, noninflammable, and recoverable fluid which does not react upon the carbide, the whole mass of carbide being exposed to the action of the liquid, which is compounded in accordance with the desired strength of the current of gas.

596,139—December 28, 1897. W. BOLTON. *Process of generating acetylene gas.*

Calcium carbide is impregnated with a substance substantially insoluble in water—such as stearine, the rate of gas generation being regulated by the degree of impregnation.

625,479—May 23, 1899. F. ULLMANN. *Process of purifying acetylene gas.*

Impure acetylene gas is treated with oxidizing chrome compounds in which the chrome is present as an acidifier—for instance, with chromic acid or aqueous or acidified chromic-acid solution or acidified bichromate solution—for the purpose of oxidizing the impurities.

635,017—October 17, 1899. C. B. JACOBS. *Process of making benzine and homologues.*

Hydrocarbons are produced by mixing together a metallic carbide and a fusible metallic hydrate of molecular equivalent weights—as barium carbide and barium hydrate—and subjecting the mass to a heat sufficient to fuse the hydrate, forming an oxide and benzene and its homologues, anthracene, napthalene.

638,175—November 28, 1899. E. S. DOLAN. *Method of generating acetylene gas.*

Small quantities of calcium carbide are tightly wrapped in a plurality of thicknesses of pliable, porous material—as coarse cheesecloth—and several of the packages are placed within a gas-generating chamber in contact with each other and water is applied.

641,444—January 16, 1900. E. DE FAZI. *Manufacture of gas.*

A mixture of calcium monoxide, colophony, and calcium carbide—as calcium monoxide, 80 parts; colophony, 10 parts; and calcium carbide, 5 parts—is treated with water.

646,019—March 27, 1900. E. DE FAZI. *Manufacture of gas.*

A mixture of calcium monoxide, bitumen, and calcium carbide—as calcium monoxide, 80 parts; bitumen, 10 parts; and calcium carbide, 5 parts—is treated with water.

647,295—April 10, 1900. O. ERNST AND A. PHILIPS. *Material for purifying acetylene gas.*

A solid, highly porous metal containing a salt of hypochlorous acid; as bleaching powder stirred into a sludge with slacked lime and calcium chloride and dried at such a temperature that the salt of hypochlorous acid does not decompose.

647,559—April 17, 1900. J. A. DEUTHER. *Process of producing ethylene gas.*

Ethylene gas, C_2H_4, is produced by decomposing water in the presence of a compound composed of a metal capable of decomposing water, and the carbide of such metal, whereby the nascent hydrogen transforms the generated acetylene into ethylene.

648,683—May 1, 1900. J. H. GREEN. *Process of manufacturing gas.*

Calcium carbide and liquid hydrocarbons, as gasoline, are placed in a vessel and water fed at intervals to the mixture, whereby the generated gas will pass through the liquid hydrocarbons and collect gas from the same.

659,448—October 9, 1900. M. P. E. LETANG. *Process of generating acetylene gas from carbide of calcium.*

Calcium carbide and glucose, or like substance, which will render lime soluble or fluid, are simultaneously subjected to the action of water.

661,401—November 6, 1900. E. FOUCHÉ. *Process of storing explosive gases.*

The receiver is filled with a porous substance provided with numerous separate small bores or perforations, filled with a suitable fluid, and the compressed gas is charged into the receiver where it is absorbed by the liquid and stored in isolated quantities; or the gas itself is compressed into liquid form and stored thereby in isolated quantities in the porous substance.

622,258—November 20, 1900. E. N. DICKERSON. *Process of storing acetylene gas.*

Liquefied acetylene gas is mingled, in miscible proportions, with a solvent, such as fusel oil, and maintained under a reduced pressure.

HALOID COMPOUNDS

CHLORIDES

218,671—August 19, 1879. J. F. GESNER. *Improvement in manufacture of ethylchloride.*

A current of hydrochloric-acid gas is passed through a boiling alcoholic solution, the water and alcohol separated from the resulting gas, and the chloride-of-ethyl vapor purified and condensed as a continuous operation.

220,397—October 7, 1879. J. W. MALLET. *Improvement in the manufacture of chloroform and allied products.*

Chlorine, or other analogous element, and methane, ethane, or other hydrocarbon gas, are passed through a body of porous material not acted upon by the chlorine, as prepared carbon. The temperature should be between 30° and 90° C.

322,194—July 14, 1885. G. MICHAELIS. *Manufacture of chloroform and of purified acetates.*

Crude acetates are subjected to dry distillation at high temperatures to remove the fluid products therefrom, which are subjected to the action of a hypochlorite and the chloroform condensed, the residual products of the dry distillation being suitable for conversion into acetic acid or purified acetates.

383,992—June 5, 1888. G. RUMPF. *Manufacture of chloroform from acetone.*

Acetone in a dilute state is periodically introduced into the bottom of a still containing cloride of lime solution with agitation of the solution. The chloride of lime employed is more than five times the weight of the acetone, resulting in the chloroform produced equaling the acetone in volume.

427,744—May 13, 1890. T. F. COLIN. *Process of obtaining chlorine compounds from natural gas.*

See Group X, Electro-chemistry.

435,862—September 2, 1890. E. G. SCOTT. *Process of making carbon tetrachloride.*

Chlorine is passed into iodine and carbon bisulphide and the resultant mass fractionally distilled, whereby the tetrachloride is separated from the sulphur bichloride, the latter being left as a by-product. The iodine is separated from the tetrachloride by caustic alkali, and a mixture or compound of carbon sulphide and iodine is produced, suitable for use in the first step.

489,592—January 10, 1893. R. P. PICTET. *Process of purifying chloroform.*

Commercial chloroform is cooled to −80° to −82° C. and the solid bodies removed by filtration. It is then cooled below −80° C. and the noncrystallizable parts, which contain impurities, removed. The chloroform is then distilled at a very low temperature and the middle 80 per cent of the product taken as chemically pure.

535,270—March 5, 1895. R. AUSCHÜTZ. *Process of obtaining chloroform.*

Chemically pure chloroform is produced by decomposing by heat double compounds of chloroform and lactid-like condensation products, derived from ortho-phenol carbonic acids, as salicylid, and condensing the pure chloroform. Salicylid-chloroform is prepared by boiling salicylid in chloroform.

551,131—December 10, 1895. P. MONNET. *Process of making toluenesulphochlorids.*

Liquid or ortho-toluenesulphochloride is produced by the direct action of chlorsulphonic acid on toluene at a temperature not exceeding 5° nor below 0° C., in the presence of a large excess of said acid and with constant agitation.

554,974—February 18, 1896. H. BAUM. *Process of making orthohalogenphenol.*

Orthohalogens of phenol, particularly the bromine and chlorine combinations, are produced by the action of the desired halogen upon phenol heated to about 150° C. It is purified by binding a portion of the product to an alkali base and the ortho compound is separated in a pure state by distillation.

573,483—December 22, 1896. O. PORSCH. *Process of making chloroform and apparatus therefor.*

Vapors from the dry distillation of an acetate, and chlorine gas, are continuously discharged, in opposite directions, under pressure, in an aqueous bath of an alkaline earth, as milk of lime, subjected to heat. The hydrochloric acid is separated from the resultant vapors and the chloroform vapors condensed.

578,839—March 16, 1897. B. R. SEIFERT. *Process of making aromatic nitrosulfo chlorids.*

Aromatic nitro compounds are heated with chlorhydrin sulphuric acid in excess of one molecule. The liquid mass is then poured onto ice and the precipitated nitrobenzenesulpho-chloride strained off. The acid in the mother-lye is converted into sodium salt, and then treated with the chloride of a mineral acid to obtain a further quantity of the chloride.

603,195—April 26, 1898. W. MAJERT. *Process of purifying orthotoluenesulfochlorid.*

A part of the orthotoluene-sulpho-chloride is distilled out from a mixture of the ortho and para-chlorides; the residue is then cooled to crystallize out a part of the paratoluene-sulpho-chlorides, when the liquid is again distilled and again cooled.

606,470—June 28, 1898. P. P. MONNET. *Process of making chlorin derivatives of toluene.*

The ortho or paratoluene-sulpho-chloride when heated to 150° C. is treated with a current of dry chlorine gas and the reaction maintained at 150° to 200° C. until the required chlorine has been absorbed.

BROMIDES.

462,544—November 3, 1891. F. H. FISCHEDICK AND C. E. KOECHLING. *Bromine compound.*

Bromamid, (tribrom bromanilid), a new compound for use as an antiypyretic, of the formula $C_6H_2B_3$, NH. HBr; m. p. 115° C. It is formed by the action of bromine on a solution of aniline in alcohol.

621,319—March 21, 1899. J. BREDT. *Bromin derivative of phthalimid, and process of making same.*

A new compound, $C_8H_4NO_2$ Br, a white crystalline powder, m. p. 206° to 207° C., yielding bromine when strongly heated, is produced by dissolving phthalimid in dilute caustic lye, stirring the solution into an ice-cold aqueous solution of bromine, and filtering and drying at a low temperature.

IODIDES.

322,940—July 28, 1885. T. KEMPF. *Manufacture of iodoform, bromoform, and chloroform.*

See Group X, Electro-chemistry.

436,250—September 9, 1890. J. MESSINGER AND G. VORTMANN. *Substitute for iodoform.*

A new product; a red brown odorless powder; m. p. 225° C. It is derived from iodine and salycylic acid.

446,875—February 24, 1891. J. MESSINGER AND G. VORTMANN. *Compound of iodine with thymol.*

A new iodine substitution product of thymol; an amorphous odorless brown-red powder; m. p. 110° C. It is produced by the action on an aqueous solution of thymol to which soda lye has been added, of a solution of iodine in an alkaline iodide at a temperature of 15° C.

454,223—June 16, 1891. E. OSTERMAYER. *Compound of antipyrine and iodine.*

A new compound for medicinal purposes, having the formula $C_{11}H_{11}IN_2O$; m. p. 160° C. It is formed by the action of potassium carbonate and iodine upon a solution of antipyrine.

472,828—April 12, 1892. L. SCHOLVIEN. *Iodine derivatives of acetyl paramidophenetole.*

Tri-iodine-diacetyl paramidopenetole, or "iodophenin," is a new product of the formula $C_{20}H_{25}N_2O_4I_3$; M. P. 130°. It is produced by combining a solution of acetyl paramido-phenetole with a solution of iodine.

509,617—November 28, 1893. F. GOLDMANN. *Pharmaceutical compound.*

A new compound, of the formula $C_7H_5OI_3$, a white crystalline powder, m. p. 121.5° C., soluble in ether, etc., but with difficulty in alcohol, is produced by treating one molecular proportion of creosotinic acid with three of iodine.

561,531—June 2, 1896. L. C. URBAN. *Carvacrol iodid.*

A new product, an amorphous yellowish-gray or buff powder, m. p. 153° C., insoluble in water and alkali, is produced by dissolving in water a mixture of carvacrol 1 part, and sodium hydroxide 2 parts, and adding an aqueous iodine solution with constant stirring at 15° C.

575,175—January 12, 1897. A. SCHUFTAN. *Iodoform substitute.*

A new product, a yellow, light powder, insoluble in water, soluble in alcohol, etc., decomposing at 127° C., is produced by dissolving methylenebisphenyldimethylpyrazolon in hydrochloric acid and adding bromine water to the solution.

576,494—February 2, 1897. A. CLAUS. *Metaiodinorthoöxyquinolinana-sulfonic acid.*

A new product, m. p. 285° C, with separation of iodine, sparingly soluble in water; is produced by subjecting an alkaline solution of orthoöxyquinolinana-sulphonic acid to the action of an iodine, and then to the action of hydrochloric acid.

618,167—January 24, 1899. A. CLASSEN. *Sodium salt of iodin compound.*

See Group X, Electro-chemistry.

618,168—January 24, 1899. A. CLASSEN. *Iodin derivatives of phenols and bismuth salts thereof.*

See Group X, Electro-chemistry.

627,981—July 4, 1899. A. CLASSEN. *Iodin compound and process of making same.*

New compounds, odorless, derived from phenolphtalein in the form of powders, of the general formula $C_{20}H_{10}I_4O_4$, in which the hydrogen atoms of the hydroxyl groups may be replaced by metallic atoms, as tetraiodophenolphtalein. They are produced by reacting with iodating agents upon a solution of phenolphtalein. The product is treated with an acid; the precipitate dissolved in sodium hydrate, and treated with a metallic salt.

627,982—July 4, 1899. A. CLASSEN. *Iodin derivatives of aromatic amins and process of making same.*

New odorless compounds are produced by treating a secondary aromatic amin, as diphenylamin, with iodine, and absorbing the hydroiodic acid formed with mercury oxide. The product is combined with a substance, such as acetyl chloride, adapted to form a derivative containing the iodine atoms in the nucleus.

641,491—January 16, 1900. A. BISCHLER. *Iodochloroxyquinolin.*

A new product, a greyish-yellow, scentless powder, almost insoluble in water, is obtained by treating an aqueous solution of an alkaline salt of the chlor-5-oxy-8-quinolin with potassium iodide and hypochlorites.

143,144—February 13, 1900. L. LEDERER. *Process of preparing haloid derivatives of acetone.*

A halogen is caused to react with acetone dicarbonic acid in the presence of a substance adapted to act on the corresponding halogen hydrogen acid

FLUORIDES.

643,835—February 20, 1900. F. VALENTINER. *Process of making fluoroform.*

An intimate mixture of iodoform, fluoride of silver, and inert granular material, as sand, is warmed.

ALCOHOLS AND PHENOLS.

252,782—January 24, 1882. A. LIEBMANN. *Manufacture of the higher homologues of phenol, naphthol, and resorcin.*

Phenol, naphthol, and resorcin are transformed into their higher homologues by subjecting them in a suitable still to the action of the corresponding fatty alcohols in the presence of chloride of zinc.

407,442—July 23, 1889. E. MEYER. *Process of obtaining methyl alcohol from wood-pulp lyes.*

Lyes produced in the manufacture of wood pulp are concentrated, mixed with charcoal, briquetted, distilled, and the methyl products condensed. The charcoal is revived for further use by lixiviation. The distillate is free from formic, acetic, and other tar acids.

427,620—May 13, 1890. K. SCHOLZ. *Obtaining permanent hydroquinone.*

Permanent or durable hydroquinone in citron yellow crystals is obtained by recrystallizing in the presence of sulphuric acid.

466,913—January 12, 1892. B. R. SEIFERT. *Carbonate of guaiacol and creosol.*

New medical compounds obtained by the action of phosgene on guaiacol or the homologue creosol. Carbonate of guaiacol, having a m. p. of 85° C., is of the formula $CO\ (OC_6H_4OCH_3)_2$. If creosol is used, the homologous carbonate has a m. p. of 145° C.

479,781—August 2, 1892. C. W. BRUNSON. *Process of purifying liquids.*

See Group X, Electro-chemistry.

482,101—September 6, 1892. B. R. SEIFERT. *Process of making disinfectants.*

Phenols difficultly soluble in water, as cresol or crude carbolic acid, are converted into soluble disinfecting mixtures by mixing with water and a metallic salt of an aromatic compound of the classes of aromatic acids and phenols, as salicylate of soda.

495,204—April 11, 1893. J. MESSINGER, G. VORTMANN AND H. JANSSEN, *Compound of cresol, etc.*

A new compound, para-isobutyl-ortho-cresoliodide, a yellow powder, insoluble in water and caustic alkalis, decomposing above 60° C., is produced by treating para-isobutyl-alpha-cresol in alkaline solution with iodine.

501,235—July 11, 1893. B. R. SEIFERT. *Creosote compound.*

A new compound, creosote chemically united with carbon dioxide, being a semi-fluid oil, not caustic, is produced by treating creosote dissolved in soda lye with phosgene, or by heating creosote with ethers of carbonic acid.

516,358—March 13, 1894. B. R. SEIFERT. *Phenol-bismuth compound.*

New antiseptic compounds of phenols in chemical combination with bismuth, nearly non-poisonous, neutral and insoluble in water, alcohol and ether, are produced by treating the poisonous phenols in an acid, neutral or alkaline solution with bismuth salts, filtering and washing.

526,786—October 2, 1894. O. MANASSE. *Process of making phenol alcohol.*

Formaldehyde is caused to act on phenol or phenol-like substances in the presence of alkaline or neutral condensing agents, such as soda lye, potassa lye, potassium cyanide, etc.

541,096—June 18, 1895. E. R. KOBERT. *Process of precipitating blood by pyrogallic acid.*

A blood-forming iron preparation is formed by treating blood with pyrogallic acid and washing the precipitate with alcohol.

543,214—July 23, 1895. W. MAJERT. *Aromatic glycocol derivative.*

Glycocol derivatives, crystalline or crystallizable, and having but one acetamid remainder bound to one nitrogen atom, and containing the group $NHCOCH_2NH_2$, are produced by treating a glycocol ether or glycocolamid, preferably the hydrochlorides, with primary aromatic amins, and separating the derivative by means of an excess of ammonia.

548,719—October 29, 1895. P. P. MONNET. *Process of making rhodinol.*

Raw rhodinol, obtained by fractional distillation of oil of geraniums, is treated with acetic acid; the acetic ether of rhodinol is purified by washing and distillation, and the rhodinol regenerated by saponification of this acetic ether of rhodinol by digesting it with alcoholic caustic alkali. The product is then subjected to several fractional distillations, with the separation as a by-product of a mixture of licaréol and an acetone, having an odor of menthene.

554,938—February 18, 1896. L. LEDERER. *Process of obtaining phenols.*

Substances containing phenols, as crude cresols, etc., are subjected to the action of choloracetic acid in the presence of soda lye. The alkaline salt produced is then treated with a suitable dilute mineral acid to produce free phenoxacetic acids, which are treated with mineral acids to produce phenols.

563,975—July 14, 1896. L. LEDERER. *Process of obtaining oxybenzylic alcohol.*

An aromatic phenol is caused to react with formic aldehyde in the presence of a nonacid condensing agent: the free phenol is removed by steam, and the oxybenzylic acid extracted with ether.

574,421—January 5, 1897. L. O. HELMERS. *Process of obtaining aqueous solutions of phenols.*

A new product, of a viscid brown color, smelling of phenol, consisting of a phenol and the sulphonic-acid compound of ichthyol or thiol (a chemical combination of a sulphureted hydrocarbon compound, containing at least 5 per cent of sulphur and sulphuric acid) and soluble in water, is produced by the reaction of the said constituents in a solvent, and evaporation.

577,302—February 16, 1897. A. HESSE. *Terpene alcohol.*

A new product, $C_{10}H_{20}O$, (b. p. at air pressure 226° C.), noncombining with calcium chloride, is produced from volatile saponified oils, particularly African, Reunion, and other geranium oils, by heating with an acid anhydrid, removing the nonalcoholic ingredients by distillation with steam, saponifying the residual esters with alkalies, also under pressure, and distilling the terpene alcohol with steam.

607,494—July 19, 1898. G. TOBIAS. *Process of making pyrocatechin.*

Salts of the phenoltrisulpho-acid are heated with caustic alkali to above 200° C., and the alkaline salt of the pyrocatechindisulpho-acid thus obtained is heated with water in a closed vessel to about 160° C. for several hours.

625,480—May 23, 1899. H. VIETH. *Process of rendering ichthyol odorless.*

Ichthyol compounds are distilled with steam under a pressure less than an atmosphere.

651,061—June 5, 1900. A. WEINBERG. *Diamidonaphthol.*

A new diamidonaphthol, having the constitution $NH_2:NH_2:OH=2:8:7$, melting at 220° C. while decomposing, is produced by the combination of the 2-7-amidonaphthol with diazo bodies in an alkaline solution, and reduction of the thus obtained azo dyestuffs.

ALDEHYDES AND THEIR PRODUCTS.

483,290—September 27, 1892. I. ROOS. *Process of making salicylaldehyde-alpha-phenylmethyl hydrazone.*

A new compound, being a white crystalline powder, insoluble in water, of m. p. 73° C. It is produced by combining salicylaldehyde and alphamethylphenyl hydrazine in a solvent, such as methyl alcohol.

504,626—September 5, 1893. J. SCHMID. *Medical compound.*

A new compound, crystallizing in yellowish flat needles, m. p. 90°–91° C., and insoluble in water, is produced by the action of salicylaldehyde on paraphenetidin.

543,193—July 23, 1895. A. SCHMIDT. *Production of protocatechuic aldehyde-meta-alkyl ethers.*

A new group, as protocatechuic aldehyde-meta-ethyl-ether, which crystallizes out of water in small glittering scales and has a m. p. of 77.5° C., is produced by the reaction of a compound of the type of benzenesulpho chloride upon a mono-metallic salt of protocatechuic aldehyde, alkylating a salt of the so-formed compounds of the type of para-benzene-sulphoprotocatechuic aldehyde, and splitting off the ether product from the compounds of the type of para-benzene-sulphoprotocatechuic aldehyde-meta-alkyl ether obtained in that way by means of saponification agents, such as potassium or soda lye.

545,099—August 27, 1895. A. SCHMIDT. *Protocatechuic aldehyde-meta-alkyl ethers and process of making same.*

The ethers are produced by causing a suitable compound of the type of benzyl chloride to act upon a mono-metallic salt of protocatechuic-aldehyde, alkylating a salt of the so-formed compounds of the type of para-benzyl-protocatechuic-aldehyde, and separating from the product the protocatechuic-aldehyde-meta-alkyl ether by decomposition, as by hydrochloric or hydrobromic acid.

575,237—January 12, 1897. B. HOMOLKA. *Process of manufacturing aromatic aldehydes.*

Monobenzylanilin, its homologues or nitro products, is oxidized in the presence of a dilute mineral acid, such as an acidulated bichromate solution.

581,053—April 20, 1897. F. ACH. *Process of obtaining cinnamic aldedyde.*

Benzaldehyde and acetic aldehyde are dissolved in alcohol, cooled to 10 C., and treated with concentrated soda lye with agitation.

598,914—February 15, 1898. E. H. C. DÜRKOPF. *Formaldehyde tannin.*

New compounds, methylene-di-tannins—as methylene-di-gallotannic acid, $C_{29}H_{20}O_{18}$,—a reddish-white light powder, decomposing at 230° C.—are produced by reacting upon tannin with formic aldehyde in the presence of a condensing agent, as hydrochloric acid, the formic aldehyde being molecularly equivalent to one-half the amount of tannin.

601,072—March 22, 1898. E. H. C. DÜRKOPF. *Formaldehyde proteids containing iodin.*

New compounds, reddish-yellowish powders, liberating iodine on decomposition, are produced by allowing iodine or an iodine solution, as that of potassium iodide, to act upon a formaldehyde-proteid—as for instance casein—combination.

602,697—April 19, 1898. A. CLASSEN. *Formaldehyde starch and method of making same.*

New chemical compounds of formaldehyde and starch, not decomposed by heating to 180° C., are produced by heating the said substances together under pressure to about 100° C., the compounds obtained being again treated with formaldehyde, and excess of formaldehyde removed.

613,460—November 1, 1898. P. P. MONNET. *Process of making aromatic aldehydes.*

The methyl group in compounds of the aromatic hydrocarbon series is aldehydized by treating the compound, such as nitrotoluene, with an oxidizing agent, such as manganese binoxide (Weldon mud) and sulphuric acid, in such a proportion that the agent is insufficient for the oxidation of the total methyl to aldehyde, and then separating out the aldehyde produced.

636,994—November 14, 1899. B. HOMOLKA AND A. STOCK. *Process of obtaining ortho and para nitro benzaldehyde.*

Nitrobenzylidenanilinsulphonates, where the nitro group is in ortho or para position to the CH group, are made to react with the salts of a primary aromatic base, and the nitrobenzyliden bases thus obtained are treated with dilute mineral acid.

640,564—January 2, 1900. B. HOMOLKA AND A. STOCK. *Process of making amidobenzaldehyd.*

The elements of water are linked to the amidobenzylideneanilin compounds, and the mixture of aniline base and aldehyde thus obtained separated in the usual manner

650,022—May 22, 1900. H. OPPERMANN. *Volatile chloral compound, and process of making same.*

Bromine is first treated with menthol, slowly and while keeping them cool, and then chloral is added.

VANILLIN

151,119—May 19, 1874. W. HAARMANN. *Improvement in the manufacture of artificial vanillin.*

Artificial vanillin is produced by treating a solution formed of coniferin or the cambium of coniferous woods, with chromate of potassa and sulphuric acid, heating, distilling, and treating the residuum with ether.

192,542—June 26, 1877. F. TIEMANN. *Improvement in manufacture of vanillin.*

The process consists, first, in adding to an etheric solution of oil of cloves, hydrate of sodium (or potassium) and acidulating with sulphuric or hydrochloric acid, eliminating the ether by distillation; second, heating the eugenol so obtained with the addition of acetic anhydride, adding warm water to the cooled liquid, and permanganate of potassium, eliminating therefrom the manganese dioxide; third, adding an excess of hydrate of sodium to the filtered liquid, and evaporating; and, finally, adding sulphuric or hydrochloric acid to the concentrated solution, agitating the same with an addition of ether, and purifying the vanillin so obtained by any of the known methods.

457,863—August 18, 1891. G. DE LAIRE. *Process of making isoeugenol.*

Isoeugenol, for use in the production of vanillin, is made by heating eugenol or essence of cloves with hydrate of potassa and alcohol, expelling the alcohol with steam, and separating the isoeugenol by treating the mass with acid and decanting it. It is an oily substance, boiling at from 252° to 262° C.

457,864—August 18, 1891. G. DE LAIRE. *Process of making compounds of isoeugenol.*

Monomolecular derivatives of isoeugenol are obtained by heating a mixture of isoeugenol and an organic anhydride acid, as anhydrous acetic acid. Acetyl isoeugenol melts at 80° C., benzoyl isoeugenol at 104° C.

487,167—November 29, 1892. F. ACH. *Eugenol benzyl-ether and process of preparing same.*

A new compound, a colorless oil, solidifying in thick prisms, m. p. 29° to 30° C., is produced by dissolving eugenol in rectified spirits, adding caustic potash and benzyl chloride, heating the mixture, and then distilling off the spirits, and precipitating eugenol benzyl-ether with water. It is purified by shaking with dilute alkali and distilling in a partial vacuum.

487,204—November 29, 1892. F. ACH. *Process of preparing vanillin.*

The process consists in the following steps: First, dissolving eugenol in alcohol, adding thereto alkaline hydrate and a halogen compound of benzyl, and heating the mixture; second, dissolving the resulting eugenol benzyl-ether in alcohol, adding thereto alkaline hydrate, keeping the same at the boiling point for some time, then partially distilling off the alcohol, and adding water to the residue; third, adding to the resulting isoeugenol benzyl-ether a mixture of sodium chromate, sulphuric acid, and water; and, finally, adding hydrochloric acid to the resulting vanillin benzyl-ether.

Vanillin benzyl-ether, a new compound, has a m. p. of 63° to 64° C. and a formula of C_6H_3, CHO, OCH_3, $OCH_2C_6H_5$.

487,205—November 29, 1892. F. ACH. *Isoeugenol benzyl-ether and process of preparing the same.*

A new compound, crystallizing in fine felted needles, m. p. 58° to 59° C., and used in the preparation of vanillin, is produced by dissolving eugenol benzyl-ether in rectified spirits, adding caustic potash, keeping at the boiling point for from sixteen to twenty-four hours, and then partially distilling off the alcohol and adding water to the residue. The isoeugenol benzyl-ether is purified by pressing and recrystallizing from alcohol.

497,546—May 16, 1893. G. DE LAIRE. *Process of making vanilloyl-carbonic acid and vanillin.*

Crude vanillin is first treated with bisulphite of soda in water; alcohol is then added little by little until the latter takes up the vanillin salts; when the alcoholic and aqueous solutions are separated and the aqueous liquor is treated with sulphuric acid to set free the vanilloyl-carbonic acid, which is dissolved out with ether and the solvent evaporated. Vanilloyl-carbonic acid is heated above 134° C., its M. P., when it separates into vanillin and carbonic acid; the fused mass is dissolved in ether, agitated with an aqueous solution of carbonate of magnesia, and the ether which holds the vanillin in solution evaporated.

519,693—May 15, 1894. J. BERTRAM. *Process of making vanillin.*

Vanillin and its isomers are produced by treating the metallic compounds of protocatechuic aldehyde, such as sodium protocatechnic aldehyde, with haloid compounds of methyl, as methyl-iodide, or methyl sulphates.

553,039—January 14, 1896. M. OTTO AND A. VERLEY. *Process of obtaining vanillin, etc.*

A carbon compound, as isoeugenol, having a benzene nucleus with a lateral chain C_3H_5, in order to produce its corresponding aldehyde, as vanillin, is oxidized by ozone (as by passing a current of ozone through it), and the resulting aldehyde is then isolated.

553,583—January 21, 1896. M. OTTO AND A. VERLEY. *Manufacture of vanillin.*

See Group X, Electro-chemistry.

560,494—May 19, 1896. W. HAARMANN. *Process of obtaining vanillin.*

Isoeugenol is oxidized in a strong alkaline solution by means of a peroxide, as sodium peroxide.

561,077—June 2, 1896. F. ACH. *Process of obtaining vanillin.*

Vanillin benzyl ether is decomposed by treating it with an acid in the presence of an alcohol, then distilling off the alcohol, driving off the benzyl-ethyl-ether and separating the vanillin.

565,918—August 18, 1896. J. L. NOVARINE. *Process of obtaining vanillin.*

A solution of eugenol in a suitable solvent, such as a carbon bisulphide, is subjected to the action of a solution of chromylchloride, the dichlorochromyl-eugenic compound thus obtained is decomposed by water, the products extracted, and the vanillin isolated. The dichlorochromyl-eugenic compound, a new product, is a brown or greenish brown powder, more or less crystalline and easily decomposed by water.

565,919—August 18, 1896. J. L. NOVARINE. *Process of obtaining vanillin.*

A solution of eugenol, or its ether in glacial acetic acid, is subjected to the action of chromyl-chloride in the same solvent; the solution diluted with water; the products extracted, saponified, and the vanillin isolated.

571,917—November 24, 1896. C. BERGMANN. *Process of obtaining vanillin.*

Paraoxybenzaldehyde is changed into the meta-nitro and meta-amido combination, and the latter is then transformed into metamethoxy-paraoxybenzaldehyde (vanillin) by the action of nitrous acid in alcoholic solution.

572,890—December 8, 1896. C. GOLDSCHMIDT. *Vanillin paraphenetidin.*

A new compound, $C_{16}H_{23}O_6N$, yellow crystals, m. p. 97° C., soluble in water, insoluble in ether, is produced by acting upon vanillin with paraphenetidin.

575,070—January 12, 1897. B. R. SEIFERT. *Isohomovanillin.*

New aromatic substances of the formula $C_6H_2(OC_nH_{2n}+1)1(OH)2(CH_3)4(COH)5$, whereby the general group $C_nH_{2n}+1$ is limited to the special cases CH_3 and C_2H_5, soluble in soda-lye, ether, and alcohol, forming colorless or yellowish scales and needles, and being especially characterized by a vanilla-like scent and taste. They may be produced by the action of chloroform on isohomopyrocatechinether of the formula $C_6H_3(OC_nH_{2n}+1)1(OH)2(CH_3)4$ or by chloroform on an alkaline solution of isocresol with successive treatment of the product by acid, ether, and sodium bisulphite.

585,584—June 29, 1897. W. MAJERT. *Process of obtaining vanillin.*

An aqueous solution of isoeugenol sodium and a sodium salt of halogen nitrobenzene sulpho-acid is boiled, producing isoeugenol-phenylether nitrosulphate of sodium; the isoeugenol phenylether nitrosulphonic acid is oxidized to a salt of vanillin phenylether nitrosulphuric acid, and the vanillin separated by means of an alkali.

631, 756—August 22, 1899. F. ACH. *Process of making iso-eugenol and derivatives thereof.*

A new compound, mono-eugenol-phosphoric acid, m. p. when hydrated 105° C., is produced by treating eugenol in a neutral condition with phosphorous-oxy-chloride; making an alkaline solution of the product, and acidifying. Treated with alkali, iso-eugenol-phosphoric acid is produced, melting in a dehydrated condition at 133° C. An acid alkali salt is prepared from the last acid, dried and heated, producing iso-eugenol.

ETHERS.

516,766—March 20, 1894. F. KRAFFT AND A. ROOS. *Process of making ether.*

Sulphonic acids, or their ethers, are heated with alcohols producing ethers; as ethyl alcohol added to benzene-sulphonic acid and heated to 135° to 145° C. produces ethyl ether.

475,640—January 19, 1897. P. FRITZSCHE. *Process of obtaining ether.*

Gases containing ethylene, after removal of tar, ammonia, benzol, and hydrogen sulphide, are washed with dilute sulphuric acid to remove hydrocarbons of condensation, then treated with concentrated sulphuric acid at from 100° to 140° C., to absorb the ethylene, and, after dilution, to distillation; the vapors of ether, alcohol, and water, according to their alcohol and ether contents, being passed through ethyl sulphuric acid of varying degrees of dilution.

580,575—April 13, 1897. F. H. HÄHLE. *Catechol ether.*

Monoethyl ether of pyrocatechin, a new substance of the formula $C_6H_4.OH.OC_2H_5$ having a b. p. of 215° C., solidifying at 26° to 27° C., and crystallizing easily into colorless, bright transparent prisms. It is easily soluble in alcohol, in ether, and in diluted aqueous soda-lye, solidifying with concentrated soda-lye into a white salt having an agreeable aromatic smell resembling thymol.

ACIDS.

332,829—December 22, 1885. H. PRINZ. *Manufacture of beta-naphthylamine sulpho-acid.*

See Group XI, Dyestuffs, Artificial, Organic.

333,034—December 22, 1885. H. VOLLBRECHT AND C. MENCSHING. *Manufacture of color-producing acids.*

See Group XI, Dyestuffs, Artificial, Organic.

518,989; 518,990—May 1, 1894. H. A. FRASCH. *Petroleum sulfo-acid.*

See Group XI, Dyestuffs, Artificial, Organic.

563,382—July 7, 1896. F. KRECKE AND I. ROSENBERG. *Amidonaphtholdisulpho-acid K.*

See Group XI, Dyestuffs, Artificial, Organic.

569,419—October 13, 1896. H. LAUBMANN. *Dinitroanthrachrysone-disulphonic acid and method of making same.*

See Group XI, Dyestuffs, Artificial, Organic.

569,425—October 13, 1896. A. PIUTTI. *Paraethoxyphenylsuccinamic acid and method of making same.*

A new product, easily soluble in alcohol and acetic acid, crystallizing in lustrous colorless plates, m. p. 160°–161° C., is produced by heating succinic acid with paraphenetidin until formation of water ceases, dissolving the product in caustic soda, and precipitating by a mineral acid.

606,437—June 28, 1898: F. BENDER. *Amidonaphtholdisulpho-acid and process of making same.*

See Group XI, Dyestuffs, Artificial, Organic.

607,056—July 12, 1898. J. KOETSCHET. *Process of making aldehydo-benzoic acid.*

A new anilin salt, slightly soluble in water, m. p. 165° C., with evolution of gas, becoming on melting an insoluble body with m. p. above 250° C., is obtained by treating ortho-oxalyl-benzoic acid with anilin in aqueous solution. Anilido-benzylidene-ortho-carboxylic acid is obtained by boiling this new anilin salt with a neutral solvent, such as toluene or xylene, and the acid thus obtained is converted into aldehydo-benzoic acid by extracting with ether and vaporizing the ether.

616,123—December 20, 1898. I. LEVINSTEIN AND C. MENSCHING. *Process of making alphylamidonaphthol-sulfonic acids.*

See Group XI, Dyestuffs, Artificial, Organic.

621,679—March 21, 1899. M. H. ISLER. *Oxyanthraquinone sulfo acid and process of making same.*

See Group XI, Dyestuffs, Artificial, Organic.

625,637—May 23, 1899. H. A. MERNTHSEN. *Oxynaphthindophenolthiosulfonic acid and process of making same.*

See Group XI, Dyestuffs, Artificial, Organic.

ESTERS OR SALTS.

93,817—August 17, 1869. L. D. GALE AND I. M. GATTMAN. *Improvement in the manufacture of sugar of lead and acetic acid.*

See Group I, Acetic Acid.

172,999—February 1, 1876. J. W. HAAS. *Improvement in processes for manufacturing cream of tarter.*

Argols with hydrochloric acid, chloride of potassium, and water are treated in a closed vessel with superheated steam for about three hours and the solution then allowed to crystallize.

183,597—October 24, 1876. G. SCHNITZER. (*Reissue: 10,004—January 3, 1882.*) *Manufacture of cream of tarter.*

Argols with hydrochloric acid, chloride of potassium, and water are subjected to steam pressure for the necessary length of time, and the cream of tarter separated from the residual solution after it has crystallized. (Same as No. 172,999.)

217,235—July 8, 1879. E. MULLER. *Improvement in the manufacture of bitartrate of potassa.*

Hydrochloric acid is added to the solution of argols and water—one equivalent by weight of hydrochloric acid to the contained tartrate of lime—and after crystallization of the cream of tarter chalk is added to the mother water to precipitate the tartrates.

222,598—December 16, 1879. E. MUELLER. (*Reissue: 10,011—January 17, 1882.*) *Manufacture of cream of tartar.*

Argols are boiled in water, in the proportion of about 3 pounds to a gallon of water, under pressure of 60 pounds, by steam injected into the water and which is allowed to escape from the converter, the cream of tartar being separated by crystallization.

277,016—May 8, 1883. A. DREYFUS. *Apparatus for treating argols in the manufacture of cream of tartar.*

In the boiling of argols with steam under pressure, boneblack and china clay are successively introduced into the vessel after the boiling has commenced, but before the settling of the solution. The steam is permitted to partially escape during the boiling.

294,592—March 4, 1884. F. DIETRICH. *Manufacture of cream of tartar.*

Dissolved argols are treated with phosphoric acid or its compounds to precipitate iron and alumina, clarified and decolorized.

313,629—March 10, 1885. R. SILBERGER. *Manufacture of cream of tartar.*

The mother liquor obtained in the manufacture of tartaric acid from argols is treated with soda and potassium chlorate to obtain potassium bitartrate, and chlorate of sodium as a by-product.

335,485—February 2, 1886. E. SCHAAL. (*Reissue: 10,823—March 29, 1887.*) *Manufacture of resin-acid ethers.*

Raw resin acids are freed from volatile or soft constituents by distillation or extraction; the hard resin-acid residues are then condensed to ether by treatment with alcohols or phenol at a high temperature, with or without pressure or the addition of substances favoring the reaction, and finally the resin-acid ether is separated into softer and harder resin-like bodies by distillation *in vacuo.*

338,365—March 23, 1886. R. SCHMITT. *Manufacture of salicylic-acid compounds.*

The application of the process of No. 334,290 to the substituted phenolates results in the production of substituted salicylic salts, likewise without any separation of phenol.

348,483—August 31, 1886. H. VON PERGER. *Production of phenyl-methyl oxyquinicine.*

A new product; m. p. 122° C. It is produced by the action of hydrazobenzole upon acetylacetic ether.

350,012—September 28, 1886. M. V. NENCKI AND R. SEIFERT. *Production of salol.*

A new product; m. p. 43° C. It is produced by the action of oxychloride of phosphorous upon a mixture of salicylic acid and a phenol.

350,468—October 5, 1886. R. SCHMITT AND C. KOLBE. *Manufacture of naphthol-carbonic alkaline salts.*

They are produced by the action of dry carbonic acid at atmospheric temperature, either without pressure or with pressure, in conjunction with a cooling process, upon naphthol alkaline salts; the dry naphthol-carbonic alkaline salts thus obtained being converted into alpha or beta carbonaphthol-acid alkaline salts by heating in an hermetically closed vessel at from 120° to 140° C. Carbonaphthol-acid salts are produced direct by the reaction of carbonic acid upon the alkaline salts of alpha or beta naphthol under pressure at 120° to 145° C.

361,690—April 26, 1887. R. GNEHM. *Production of a new ethyl-ether.*

A new ethyl-ether, of the formula $C_{14}H_{24}N_2O_4$; m. p. 126° C. It is produced by the action of acetyl-acetic ether upon ethylenediamine.

366,885—July 19, 1887. E. SCHAAL. *Process of making ethers from petroleum.*

Liquid petrol acid, obtained from petroleum by the process of No. 335,962, is mingled with an alcohol, heated, and the petrol ethers, separated by distillation, are washed and purified.

377,311—January 31, 1888. C. KOLBE. *Manufacture of salicylic acid ester.*

Salol is produced from a mixture of salicylic acid and a phenol by passing a current of phosgene gas therethrough at a temperature of about 170° C.

383,306—May 22, 1888. C. KOLBE. *Manufacture of salicylic-acid esters.*

Salol is produced from a mixture of salicylic acid and a phenol, which may be melted or dissolved in a solvent—as benzole—by the action of trichloride of phosphorus.

391,248—October 16, 1888. P. W. HOFMANN. *Process of manufacturing salol.*

Salol is produced by heating phenolate of sodium in an atmosphere of phosgen gas. Salicylate of sodium, previously produced, may be mixed therewith.

439,805—November 4, 1890. A. MARTIGNIER. *Process of obtaining cream of tartar.*

Lyes, argols, tartars, and other tartarous matters are treated with an alkaline sulphate, as of soda or potash, the residuum separated from the liquid and cream of tartar precipitated from the latter with sulphuric acid.

453,035—May 26, 1891. J. BONGARTZ. *Guaiacol ether.*

A new product, the benzoic ether of guaiacol, having the composition $C_6H_4\left\{\begin{matrix}O.CO.C_6H_5\\O.CH_3\end{matrix}\right\}$ and m. p. 50° C. Crude guaiacol is converted into a salt, preferably its potassium salt, and purified, heated with benzoyl chloride and the benzoyl compound recrystallized from alcohol.

486,770—November 22, 1892. P. ERNERT. *Process of making salicylate of phenyl.*

Salicylic acid is heated at or about 230° C., with exclusion of air and vaporization of water.

492,868—March 7, 1893. H. JANSSEN. *Salicylic-acid compound.*

A new compound, crystallizing out of alcohol in small white scales, insoluble in cold water, m. p. 187° C., is produced by reacting upon paranitrophenol in the presence of dehydrating agents with salicylic acid, reducing the nitro phenylester of salicylic acid thus obtained, and treating the formed amido phenylester of salicylic acid with acetic acid anhydride, or acetyl chloride in such quantity as is necessary to replace one hydrogen atom of the amido group by an acetyl group.

495,497—April 18, 1893. A. LIEBRECHT. *Basic bismuth gallate.*

A new compound, a yellow powder, without odor, soluble in a large excess of mineral acids, and containing 55 per cent to 56 per cent of bismuth oxide—a suitable substitute for iodoform—is produced by dissolving neutral bismuth nitrate in dilute nitric acid, adding a solution of gallic acid in alcohol and water, and to the mixture adding caustic alkali, alkali carbonate or the like until the whole remains but slightly acid, and precipitating with acetate of soda or by diluting with water.

501,446—July 11, 1893. E. SCHAAL. *Manufacture of resin-acid esters.*

The aqueous vapors formed during the heating of a resin acid in the presence of an alcohol or hydroxyl derivative are drawn off by suction as soon as the formation of the esters begin, and the alcohols distilled off are replaced by a fresh supply until the formation of the product is completed.

503,743—August 22, 1893. F. GEROMONT. *Lactyl-paraphenetidid and process of making it.*

A new compound, of the formula $C_{11}H_{15}NO_3$, crystallizing in white needles, m. p., 117.5° C., and soluble in an abundance of water, is produced by heating the lactate of paraphenetidin to 130° to 180° C. until the resulting watery vapors are completely driven off. The said lactate is formed by dissolving paraphenetidin in dilute sulphuric acid, mixing with a solution of calcium lactate, precipitating the calcium sulphate with alcohol, filtering, and evaporating to dryness.

509,055—November 21, 1893. H. THOMS. *Salicylate of tolyldimethylpyrazolon.*

A new crystalline compound, having the formula $C_{12}H_{14}N_2O.\,C_7H_6O_3$, and m. p. 106.5° C., is produced by heating together aceto-acetic ether and orthotolylhydrazin, methylating the product, and combining therewith salicylic acid.

509,520—November 28, 1893. P. FRITSCH. *Salicylic ester of acetol.*

An alkaline salicyate, as salicylate of soda, is heated with mono-halogen-acetone and the alkaline chloride separated from the resulting acetol.

511,143—December 19, 1893. W. H. HIGGIN. *Process of making sodium acetate.*

Esparto-liquor and similar alkaline liquors are evaporated and the residue treated by regulated heat, so that the temperature shall exceed 200° C., but shall never reach the heat at which sodium acetate is decomposed (about 400° C.), thereby producing a mass of "char," which upon treatment with water yields a solution of acetate of sodium along with other matters.

253,018—July 17, 1894. C. STOEHR. *Dimethylpiperazin tartrate.*

A new compound, having the formula $C_6H_{14}N_2C_4H_6O_6$; a white powder when water free, easily soluble in water, insoluble in alcohol, and m. p. 242°–243° C.; is produced by combining tartaric acid and dimethylpiperazin in equal molecular proportions.

530,826—December 11, 1894. C. F. CROSS AND E. J. BEVAN. *Manufacture of cellulose acetate.*

A compound, or intimate mixture, of cellulose and zinc acetate is produced by mixing cellulose hydrate with zinc acetate solution, drying and dehydrating the compound. This product is treated with chloroform, whereby a solution of cellulose acetate is obtained free from cellulose, and the solvent is evaporated.

533,718—February 5, 1895. J. MEYER. *Tannin compound.*

A new compound, consisting of a mixture of mono-and diacetyl tannin, an amorphous light-yellow powder, soluble in alcohol and insoluble in water; is produced by heating tannin with a mixture of glacial acetic acid and acetic acid anhydride.

537,841—April 23, 1895. J. F. VON MERING. *Process of making ethers of para-oxyphenylurethane.*

New compounds, acidyl combinations of the para-oxyphenylurethans, crystallizing readily, are produced by heating para-oxyphenylurethan with an acidyl reagent.

541,489—June 25, 1895. J. F. VON MERING. *Acidyl compound of para-oxyphenylurethan ethers.*

New compounds, readily crystallizable and more or less soluble in alcohol and benzene, are produced by heating the ethers of para-oxyphenylurethans with reagents containing the acidyl group, as acetic acid anhydrid.

541,899—July 2, 1895. B. THIEME. *Process of making nitropentaerythrit.*

The pentaerythrit produced by condensation in the presence of lime of acetaldehyde and formaldehyde, is treated with concentrated nitric and sulphuric acids.

544,104—August 6, 1895. F. LÜDY. *Bismuth oxyiodidgallate and process of preparing same.*

A new product, a grayish-green amorphous powder, insoluble in water and ordinary solvents and decomposing slowly in moist air, is produced by the reaction of gallic acid upon bismuthoxyiodid.

549,728—November 12, 1895. F. KRAFFT AND A. ROOS. *Process of making esters.*

Esters are produced by the action of an alcohol and a carbon acid at a temperature above 100° C., in the presence of an aromatic sulphonic acid.

558,197—April 14, 1896. A. MÜLLER-JACOBS. *Process of manufacturing tannate of zirconium.*

A hot saturated solution of tannic acid is slowly added to a hot solution of a soluble salt of zirconium, and the precipitate is washed and dried.

561,730—June 9, 1896. B. R. SEIFERT. *Substituted salol.*

New compounds, solid, crystalline, colorless, without smell, soluble in alcohol, insoluble in water, and M. P. from 56° to 170° C., are produced by heating a mixture of a substituted phenol and salicylic acid to 140° C., adding a dehydrating agent as phosphorous pentachloride; continuing the heating until generation of hydrochloric acid ceases, and then washing and recrystallizing from alcohol.

562,195—June 16, 1896. M. OTTO AND A. VERLEY. *Process of obtaining ether.*

The acid ethers of geraninol are produced by heating the natural essences which contain this alcohol with the chlorides of organic acids, as butyric chloride, and an alkaline metal, as sodium, in the presence of a neutral solvent and separating the ether by distillation. The acid ethers are transformed into new perfumes by partial saponification by heating in an aqueous solution of calcium carbonate for some days in a closed vessel.

563,993—July 14, 1896. G. A. WELTER. *Amidoalkylsalicylic acid.*

It is produced by treating nitroalkylsalicylic acid with reducing agents, such as tin and hydrochloric acid. When the product is treated with an acetyl compound, such as glacial acetic acid, acetylamidoalkylsalicylic acid is produced; a new compound, characterized by antipyretic and antineuralgic properties.

569,415—October 13, 1896. O. HINSBERG. *Antipyrin mandelate and method of making same.*

A new product, m. p. 52° C., soluble in nearly all solvents and separating out as an oil, and solidifying as an opaque powder, is produced by the reaction of antipyrin with phenylglycollic acid.

569,429—October 13, 1896. R. SCHIFF. *Salicylic compound and method of making same.*

A new white crystalline product, a compound of salicylic acid and hexamethylenetetramin, easily soluable in alcohol and water, M. P. 95° C., is produced by simultaneously dissolving the constituents in benzene while heating the mixture and crystallizing.

571,362—November 17, 1896. E. FISCHER. *Method of obtaining tetra-alkyl uric acid.*

The salt of a dialkyl uric acid is treated with a haloid ether in an indifferent or inert diluting agent, such as ethyl ether, as by warming an alkaline solution of a dimethyl uric acid with a solution of potassio-tartrate of copper in excess, then treating the resulting cuprous salt of dimethyl uric acid, mixed with powdered glass, with a haloid ether.

572,345—December 1, 1896. H. T. JARRETT. *Process of making potassium bitartrate.*

Argols are first dissolved in a solution of caustic soda and its carbonate to the point of neutralization, one-tenth of the weight of argols added in potassium chloride, filtered, a decolorizing agent added, and the potassium bitartrate precipitated directly from the mixture by an acid.

575,227—January 12, 1897. A. GALLINEK AND E. COURANT. *Process of manufacturing esters of diiodosalicylic acid.*

New products, as the alkyl ester of the diiodosalicylic acid, a white crystalline compound, m. p. 132° C., of the formula $C_6H_2I_2{<}^{OH}_{COOAlk.}$ are produced by subjecting salicylic acid esters to the action of iodine in the presence of a compound, as mercury oxide, which combines with the hydroiodic acid formed.

580,575—April 13, 1897. F. H. HÄHLE. *Catechol ether.*

A new product, monoethyl ether of pyrocatechin, m. p. 26°–27° C., b. p. 215° C., solidifying with concentrated soda-lye into a white salt, is produced by the ethylization of pyrocatechin by means of caustic soda and sodium ethyl sulphate.

580,630—April 13, 1897. G. WENDT AND J. LEHMANN. *Valeric esters of creosote.*

New products, slightly yellow oily liquids, soluble in alcohol, b. p. 260° C., and in vacuum between 117° and 121° C., are produced by boiling a mixture of the main constituents of creosote—creosol and guaiacol, respectively—with valerianic acid.

580,744—April 13, 1897. G. H. WEISS. *Carbonyl metadiamido salicylic acid.*

A new product, crystallizing in white laminæ, m. p. 252° C., soluble with difficulty in water and alcohol, is produced by treating nitroamido salicylic acid with phosgene and reducing the product. The diazo compound forms azo dyestuffs which are easily mordanted.

581,833—May 4, 1897. L. SELL. *Salicin compound and process of making same.*

An extract from the fruit of the *Aesculus hippocastanum* in combination with salicin, saligenin, glucose, and free hydrochloric acid, a stable, grayish-yellow powder freely soluble in water; is produced by subjecting salicin incorporated in the vegetable extract to the action of hydrochloric acid, and then adding more salicin.

585,068—June 22, 1897. A. WELLER. *Quinin-carbonic ether and process of making same.*

New products, derivatives of the levogyrate alkaloids of cinchona bark, tasteless, soluble with difficulty in water, readily soluble in chloroform and in acid; are produced by the action on the said alkaloids with an ether of chlorocarbonic acid.

588,412—August 17, 1897. E. FISCHER. *Trimethylbenzyl-uric acid and process of making same.*

New compounds, as trimethylbenzyl-uric acid, m. p. 171° to 173° C., crystallizing from alcohol in large crystals, insoluble in alkalis, are produced by treating a trialkyl-uric acid together with an alkali, with a haloid ether.

591,485—October 12, 1897. G. MERLING. *Compound of gamma-oxypiperidincarboacids and process of making same.*

New products, containing acidyl as well as alkyl groups, mostly colorless crystals, nearly insoluble in water, adapted to combine with inorganic and strong organic acids, are produced by combining triacetonamin and its analogous combinations, as, for instance, benzaldiacetonamin-vinyl-diacetonamin, with hydrocyanic acid, and then saponifying the so-obtained cyanhydrins (nitryls). Gamma-oxypiperidin-carbo acid is heated with both acidyl and alkyl reagents.

599,123—February 15, 1898. H. ENDEMANN. *Glycerol ether of aromatic compounds.*

New products, the glycerin ethers of aromatic substances containing oxygen in the form of hydroxyl, such as guaiacol, and which split and liberate a phenol-like substance and glycerin, are produced by combining the phenol-like substance with sodium hydrate and causing same to act upon monochlorhydrin in molecular proportions, generally at 140° to 150° C.

602,646—April 19, 1898. C. F. M. SCHAERGES AND P. SCHWARZ. *Process of making alkaline acetosulfanilate.*

A new product, soluble in water, is produced by acetylizing an alkaline salt of sulphanilic acid by means of glacial acetic acid, and removing free sulphanilic acid and alkaline acetate with water and alcohol.

602,834—April 26, 1898. O. DOEBNER. *Condensation product from salicylic and gallic acids.*

A new compound, $C_{14}H_{10}O_7$, a white amorphous powder, is produced by the reaction of phosphorous oxychloride on a equimolecular mixture of salicylic and gallic acids, which may be in the presence of a solvent and diluent, as toluene; subsequently removing the formed metaphosphoric acid by pouring the mixture on ice water and then washing and drying.

605,246—June 7, 1898. E. DÜRKOPF. *Bismuth methylene-di-gallate and process of making it.*

A new chemical compound, characterized by a voluminous powdery form, a blue-gray color, insoluble in water, and soluble in alkaline solutions with an orange color, is produced by precipitating bismuth hydroxid from a bismuth salt by an aqueous solution of ammonia, washing the precipitate, and acting upon it by methylene-di-gallic acid and water by gradual addition and slow digestion at a slightly elevated temperature.

606,930—July 5, 1898. L. LEDERER. *Process of obtaining hydroxylized phenyl ethers.*

Mixtures of hydroxylized phenyl ethers with phenols, such as wood-tar oils, guaiacol, etc., are mixed with potassium carbonate, and the resulting mixture is then treated with ether.

607,172—July 12, 1898. K. HOCK. *Pharmaceutical compound and process of making same.*

A new condensation product is produced by the reaction of cold concentrated solutions of one molecule of hexamethylenetetramin and of three molecules of tannin. The precipitate, of a yellowish-brown color, is rendered insoluble, odorless, and tasteless, by heating in a porcelain pan until it forms a hard lump.

610,348—September 6, 1898. A. EINHORN. *Ester of paraämidometaoxybenzoic acid.*

Obtained by heating paraämidometaoxybenzoic acid in alcoholic solution with mineral acids; a white crystalline product, m. p. 120° to 122° C.; useful as an ointment.

614,991—November 29, 1898. P. SCHIDROWITZ AND O. ROSENHEIM. *Piperidyl carbamate of piperidin and process of making same.*

A new product, $C_{11}H_{22}N_2O_2$, white, crystalline, soluble in water, alcohol, etc., m. p. 79° to 80° C., is produced by treating piperidin dissolved in a solvent, as acetone, with carbonic acid.

615,051—November 29, 1898. P. SCHIDROWITZ AND O. ROSENHEIM. *Piperidin salts and process of making same.*

New products, dicarboxylic salts of piperidin, having the form of prismatic plates and soluble in water, as tartrate of piperidin, $C_9H_{17}NO_6$, m. p. 136° to 137° C., are produced by treating piperidin with a dicarboxy fatty acid, such as tartaric acid.

615,307—December 6, 1898. H. REINHARDT. *Orexin tannate and process of making same.*

A new product, an odorless, tasteless, white, or slightly yellow powder, insoluble in water, is produced by mixing an aqueous solution of orexin hydrochlorate with an aqueous solution of tannin at 45° to 50° C., and precipitating with an aqueous solution of sodium acetate.

616,656—December 27, 1898. E. FISCHER. *Process of obtaining alkyl-uric acid.*

The ester of an acid possessing considerable electrical conductivity, such as nitric acid, is added to a solution of uric acid proper with an alkali; the solution is heated under pressure and with agitation, and after adding hydrochloric acid to the hot solution it is cooled and crystallized.

616,700—December 27, 1898. E. FISCHER. *Alkyl derivatives of uric acid and process of making same.*

New compounds, mixed alkyl derivatives of uric acid, as dimethyl-benzyl-uric acid, $C_5(CH_3)_2(C_6H_5CH_2)O_3$, m. p. 282° to 283° C., soluble only in alcohol, are produced by acting upon a mixture of an alkali solution and uric acid with a haloid ether; cooling and separating the monoalkyl derivative of uric acid; then acting upon a mixture of the said derivative and an alkali solution with a haloid ether; cooling; adding more alkali, etc., whereby the tetraälkyl derivative is obtained.

619,549—February 14, 1899. A. EINHORN. *Glycocol ester and process of making same.*

New products, as the methyl ester of diethyl-glycocol-para-amidosalicylic acid, a thick colorless oil, soluble with difficulty in water. They are produced by treating amidocarbonic-acid esters with halogen-substituted acid chlorides and allowing an amin to act upon the resulting halogen-alkyl derivatives.

620,141—February 28, 1899. H. JANSSEN. *Bismuth compound and process of making same.*

A new compound, a brown powder, insoluble in benzene and ligroin, dissolving partially in alcohol under decomposition, is produced by heating a mixture of bismuthoxyiodide and dibromgallic acid at 60° to 80° C. until development of carbon dioxide has ceased.

620,563—March 7, 1899. R. BLANK. *Process of obtaining indoxylic compounds of amido malonic esters.*

The aromatic amido malonic acid esters are heated to 200° to 270° C. until one molecule of alcohol is eliminated.

621,804—March 28, 1899. E. FISCHER. *Alkyl derivative of uric acid and process of obtaining same.*

A sufficient amount both of an alkali and a haloid-ether, such as methyliodid, is added to uric acid proper to make the ratio each of the reagents to the uric acid proper as 4 to 1, whereby tetra-alkyl-uric acid and trialkyl-uric acid are directly obtained.

621,805—March 28, 1899. E. FISCHER. *Process of making alkyl derivatives of uric acid.*

Uric acid is reacted on with an alkali and a haloid ether, as potash lye and methyl iodide, under heat and agitation, in the proportions of two molecules each of the alkali and the haloid ether to one of the uric acid.

622,456—April 4, 1899. H. C. FEHRLIN. *Process of manufacturing salol.*

Basic salicylate of soda with the necessary quantity of phenol is treated with phosphorus oxychloride at from 120° to 140° C. The product is then treated with carbonate of soda, and salol distilled off with steam.

623,789—April 25, 1899. E. KAUDER. *Process of making alkyl-ethers of morphine.*

A neutral alkyl-ester of phosphoric acid is caused to act on a suitable solution of morphine whose replaceable hydroxyl-hydrogen has been replaced by a metal whose hydroxide possesses alkaline reaction.

624,772—May 9, 1899. A. EINHORN. *Glycocolphenolester and process of making same.*

Glycocolphenolesters of the general formula alphyl—O—$COCH_2$—NX_2, wherein NX_2 represents the residue of a secondary amin, are produced by mixing halogen-aceticacidphenolesters with secondary amins, as by mixing chloracetylguaiacol with diethylamin, forming thick oils easily soluble in alcohol, ether, and benzine, little soluble in water, and with acids forming salts soluble in water, and which act as powerful antiseptics.

625,158—May 16, 1898. A. EINHORN. *Esters of para-oxy-meta-amidobenzoic acid and process of making same.*

A new product, a white crystalline compound, m. p. above 100° C., is produced by the action of mineral acids upon the alcoholic solutions of para-oxy-meta-amidobenzoic acid.

625,159—May 16, 1899. A. EINHORN. *Glycocolamidocinnamic-acid ester and process of making same.*

Alkyl-amidoacetyl-meta-amidocinnamic-acid esters produced by first combining meta-amido-cinnamic-acid ester with chloracetylchloride and then with amins; an oil soluble in alcohol, ether, and benzene, with difficulty in water, forming with acids salts soluble in water, its chlorhydrate having the M. P. 165° C.

626,910—June 13, 1889. E. KAUDER. *Process of making alkyl ethers of morphine.*

A suitable alkaline solution of morphine is acted upon by a nitric-acid ester of the desired alkyl.

627,031—June 13, 1899. C. O. WEBER AND C. F. CROSS. *Method of making cellulose tetracetate.*

The reactions of acetylchloride and acetic anhydride on a mixture of cellulose and magnesium acetate are controlled by adding regulated quantities of nitrobenzene after the reaction has started.

629,433—July 25, 1899. A. EHRENBERG. *Process of making alkyl ethers of morphin.*

A neutral inorganic oxygen-acid-ester of an alkyl, as methyl sulphate, is caused to act upon an alkaline solution of morphine.

630,522—August 8, 1899. L. SELL. *Saligenin compound and process of making same.*

A new preparation of saligenin is produced by the reaction of same with a physiological tannic acid (a tannic acid that is not reconverted into gallic acid on boiling with dilute acids) in the presence of a dilute acid at an elevated temperature.

631,761—August 22, 1899. F. ACH. *Process of preparing alkyl-uric acid.*

An oxymethylene uric acid is dissolved in an acid, as hydrochloric acid, and reduced by tin, producing 7-methyl-uric acid.

631,762—August 22, 1899. F. ACH. *Process of making oxymethylene-uric acid.*

An alkaline solution of an oxymethelene-uric acid is treated with methyliodide.

632,605—September 5, 1899. C. O. WEBER AND C. F. CROSS. *Process of making cellulose esters*

Structureless cellulose is mixed with a salt of a fatty acid and the mixture treated with the acid chlorides and a minimum of 10 per cent of the anhydrides of the said acid.

636,384—November 7, 1899. F. HOFMANN. *Process of making carbonates of aromatic series.*

One of the chlorocarbonyl derivatives of the pyridin base series is first made to act on an aromatic phenol, and the so-formed carbonate is then separated from the reaction mixture.

639,174—December 12, 1899. F. HOFMANN. *Ethyl ether of salicylo-carbonic acid.*

A new product, a white crystalline powder, m. p. 95° C., is obtained by the action of the ethylic ether of chloro-carbonic acid having the formula $C_2H_5O.CO.Cl$, on salicylic acid in the presence of a suitable basic compound, such as dimethyl-anilin.

642,218—January 30, 1900. H. C. FEHRLIN. *Process of making salol.*

Alkaline and earthy alkaline salts of acid-phenyl-carbonic ether are subjected to the action of phosphorus oxychloride.

643,280—February 13, 1900. A. WELLER. *Salicylates of the yttrium group.*

New antiseptic products, consist of a metal of the yttrium group, as didymium salicylate, obtained from the double earth didymium in the form of a pale pink powder, insoluble in water, of the formula $Di_2(C_6H_4(OH)COO_6)$.

646,631—April 3, 1900. A. WELLER. *Phenol ether of quinin carbonic acid.*

A further series of new products is produced according to the process of No. 585,068, a phenyloxy group taking the place of the alkyloxy group.

647,263—April 10, 1900. B. HEYMANN. *Ester of acetylphenylglycinortho carbonic acid.*

New compounds, yielding an indigo leuco compound when heated with dry caustic alkalis. They are produced by subjecting the neutral esters of phenylglycinortho carbonic acid to the action of acetylizing agents.

648,580—May 1, 1900. A. BÉHAL. *Process of making ethereal salts of formic acid.*

Equimolecular proportions of formic acid free from water and the anhydride of another organic acid are mixed at a moderate temperature.

650,408—May 29, 1900. E. MENNEL. *Process of making acidyl morphin esters.*

An alpha-mono-acidyl compound of morphine, whose acidyl constituent is of the fatty-acid series, is treated with a chloro-carboxylic ester and an alkali, producing a carboxy-alkylic ester of an acidyl-morphine.

KETONES.

275,128—April 3, 1883. J. BRONNER. *Method of purifying impure anthrachinone and alizarine.*

The solvent is vaporized and the vapor condensed and percolated through the mass, the quantity of solvent used being such as to retain the soluble impurities in solution as well as the pure anthrachinone, whereby the repeated evaporations, condensations, and percolations dissolve out the soluble impurities and the pure anthrachinone, the insoluble impurities being retained by filtration, and the soluble impurities are separated from the pure anthrachinone by the crystallization of the latter.

385,777—July 10, 1888. G. RUMPF. *Manufacture of acetone.*

An acetate is subjected to slow destructive distillation in a closed vessel at a low temperature (about 300° C.), with stirring and steam to prevent too high a temperature. The crude acetone is diluted to separate oily matters, treated with lime to remove higher ketones and other compounds, and rectified in a column still.

390,523—October 2, 1888. M. J. SCHREITER. *Process of refining camphor.*

Camphor is rectified by dissolving it with heat in camphor oil in such proportions that the camphor is separated as fine crystals; filtering the solution with animal charcoal, asbestos, or cellulose; and separating the remaining crystals by centrifugal force.

393,079—November 20, 1888. G. RUMPF. *Manufacture of acetone.*

An acetate is purified by passing it continuously through a system of externally heated tubes with stirrers, and is then subjected to destructive distillation to make acetone.

443,402—December 23, 1890. M. V. NENCKI. *Gallacetophenone.*

A new product, corresponding to $C_8H_8O_4$; m. p. 168° C. It is obtained by the action of pyrogallic acid with glacial acetic acid and zinc chloride.

444,004—January 6, 1891. H. LÜTTKE AND L. SCHOLVIEN. *Salicylate of phenyldimethylpyrazolone.*

A new compound of the formula $C_{18}H_{18}N_2O_4$; m. p. 91.5° C. It is produced by heating—preferably under pressure—phenylhydrazine, acetyl, acetic ether, and methyl-salicylic ether in the presence of a haloid hydric acid.

460,186—September 29, 1891. L. SCHOLVIEN. *Process of making dimethylphenylpyrazolone.*

Molecular quantities of methylphenylpyrazolone and sodium methyl sulphate are heated under pressure, with hydriodic acid and alcohol as a diluent.

464,861—December 8, 1898. G. EBERT. *Process of making phenylethylmethylpyrazolone.*

A new product, a homologue of antipyrine, of the formula $C_{12}H_{14}N_2O$; m. p. between 71° and 72.5° C. It is obtained by heating phenylmethylpyrazolone with iodethyl; decomposing the product by soda lye; taking up the oil with benzine; treating with hydrochloric acid and dissolving the hydrochlorate in alcohol; treating with ether, filtering and drying the product; then treating it with soda lye and separating and drying the oil as a final product, which sets in crystalline form.

503,066—August 8, 1893. H. THOMS. *Salicylate of para-tolyldimethylpyrazolon.*

A new compound, m. p. 101° C., not readily soluble in water, is produced by combining para-tolylhydrazin with acetic acid ether, heating, methylating the resulting para-tolylmethylpyrazolon, and melting the product with salicylic acid in equi-molecular proportions.

516,707—March 20, 1894. L. KNORR. *Paratolyldimethylpyrazolone.*

Paratolyldimethylpyrazolone of the formula $C_{12}H_{14}N_2O$, m. p. 137° C., crystallizing in colorless prisms soluble in water, of difficult solubility in ether, is produced by condensing paratolyl hydrazin with acetyl acetic ether, separating water and heating to eliminate alcohol, and methylizing the product of the condensation.

535,552—March 12, 1895. O. PORSCH. *Process of making acetone.*

Commercial acetate of lime mixed with calcium hydrate in excess is subjected to distillation under addition of superheated steam and constant agitation to separate the acetone vapors from the carbonated lime. The condensed vapors mixed with water are allowed to stand to separate out tar oils and sediments, and are then purified by fractional distillation and rectification.

548,352—October 22, 1895. A. BOEGLIN. *Antipyrin compound.*

A new medicinal compound, $(C_{11}H_{12}N_2O)_3Fe_2Cl_6$, brittle, nonhygroscopic crystals, of a reddish-brown color, soluble in water and m. p. 225° C., is produced by the combination of aqueous solutions of antipyrine and ferric chloride.

556,943—March 24, 1896, J. C. W. F. TIEMANN. *Aromatic ketone and process of making same.*

A new product of the formula $C_{13}H_{20}O$, insoluble in water, soluble in alcohol, is produced by treating a mixture of citral and acetone with alkaline agents, dissolving the product in ether, purifying by fractional distillation, and converting into a fragrant isomeric ketone by dilute acids and subsequent fractional distillation.

559,635—May 5, 1896. J. C. W. F. TIEMANN. *Process of making ketone from orris-root.*

A new product, $C_{13}H_{20}O$, insoluble in water, soluble in alcohol, etc. It is produced by distilling orris-root extract in a current of steam; treating the distillate with alkali and subsequent distillation; treating with oxidizing agents to eliminate the alkali; treating the resulting ketone with phenylhydrazin; and separating the pure fragrant ketone with a dilute acid.

574,725—January 5, 1897. J. R. FRANCE. *Process of purifying camphor.*

Crude camphor is dissolved in a hydrocarbon of less sp. gr. than water, as naphtha; the supernatant solution of pure camphor is drawn off, filtered, the solvent distilled off, and the pure anhydrous granular camphor crystallized.

579,412—March 23, 1897. F. STOLZ. *Pyrazolon compound and process of making same.*

A new product, the phenyl 2.3 dimethyl 4 dimethylamido 5 pyrazolon, a white crystallized compound, easily soluble in water and alcohol, m. p. 107°–108° C., with m. p. of its salicylate of 69° C., is produced by methylating 1 phenyl 2 3 dimethyl 4 amido 5 pyrazolon.

582,221—May 11, 1897. O. NAGEL. *Process of making artificial camphor.*

Hydrochlorinated terpene, $C_{10}H_{16}HCl$, is first produced by saturating anhydrous turpentine with anhydrous hydrochloric acid gas while both are cooled by ice. The resulting crystals are then treated with lime to remove chlorine, and oxidized by nitric acid, producing camphor, $C_{10}H_{16}O$.

583,719—June 1, 1897. J. C. W. F. TIEMANN. *Process of making aromatic ketones.*

Citral and the homologues of acetone are treated with an alkaline condensing agent to form new ketones (methylized, ethylized, etc., ketones), which are then converted, by means of acids, into ketones isomeric with those first formed.

583,720—June 1, 1897. J. C. W. F. TIEMANN. *Fragrant ketone*

The process of No. 583,719 is applied to citronellone, an aldehyde containing two atoms more of hydrogen than citral.

608,019—July 26, 1898. A. BAUSCHLICHER. *Process of and apparatus for making acetone.*

A dry mixture of acetate of lime and calcium hydrate is treated with superheated steam under continuous stirring and constant temperature to separate the acetone vapors, which are condensed and rectified, the crude acetone mixed with water in excess, settled, and rectified. The secondary products, or acetone oils, are injected into water under pressure and the mixture rectified.

610,361—September 6, 1898. O. MANASSE. *Oxycamphor and process of making it.*

A new product, $C_{10}H_{16}O_2$, white, crystalline, m. p. 203° to 205° C., volatile with steam vapor, and having a weak pepper-like taste, is produced by dissolving camphoquinone in acetic acid, adding zinc dust until the yellow color disappears, then treating with soda lye, and then with ether, and evaporating the ether.

610,664—September 13, 1898. W. SCHMIDT. *Process of refining camphor.*

Crude camphor is dissolved in a closed chamber in a solvent that does not mix with water and of less sp. gr., as benzine or naphtha, the supernatant solution being withdrawn and filtered in a closed filtering chamber, the solvent distilled off, and the pure anhydrous camphor crystallized.

628,293—July 4, 1899. R. WILLSTÄTTER. *Tropin ketone and process of making same.*

New products, ketones of tropin bodies, are produced by adding chromium trioxide in small installments to a tropin body, in the presence of acetic acid, with agitation; the amount just equaling two-thirds of the molecular equivalent of the tropin body; then heating to 100° C., cooling, neutralizing the acid with fixed alkali, and separating.

648,389—May 1, 1900. H. O. CHUTE. *Process of making acetone.*

The pulverulent material is continuously conveyed in a thin film or layer over a heated surface maintained at the proper temperature, and the acetone is removed by a current of oxygen-free gas moving in the opposite direction, under a partial vacuum, the gas being reheated and reused.

650,347—May 22, 1900. A. VERLEY. *Process of making ozonized terpinol.*

Ozone is caused to act upon terpinol and the ozonized terpinol is isolated with ether.

SULPHUR COMPOUNDS.

318,662—May 26, 1885. E. W. R. SCHRÖTER. *Topical remedy.*

Icthyolsulphur acid, a new product, applicable for medicinal uses, is an oil containing sulphur and sulphuric acid chemically combined, formed by the action of sulphuric acid on an oil containing sulphur.

319,082—June 2, 1885. C. FAHLBERG. (*Reissue: 10,667—December 1, 1885.*) *Manufacture of saccharine compounds.*

A new saccharine compound, benzoic sulphinide, of the formula $C_7H_5O_3SN$; sweeter than cane sugar; m. p. 200° C. It is made from the derivatives of coal-tar by converting toluene into toluene-sulphonic acid, oxidizing said acid or its salts into sulphobenzoic acid or its salts, then evaporating the latter and treating it with phosphorpentachloride and caustic or carbonate of ammonia, and finally separating the pure saccharine from the ammonia salts thus obtained.

Toluene is regenerated and hydrochloric and sulphurous acids generated at the same time from the solid toluene-mono-sulphochloride by the action of carbon, water, and superheated steam under pressure. Chlorine is generated for the preparation of phosphor-pentachloride from phosphor-oxychloride, bleaching powder, and water, respectively, hydrochloric and phosphoric acids, or one of them.

391,875—October 30, 1888. E. A. BAUMANN. *Medical compound.*

Diæthylsulphondimethylmethan, a new product of general composition of $C_7H_{16}S_2O_4$; m. p. 126° C., b. p. 300° C. It is formed by the oxidation of acetonæthylmercaptol with an aqueous solution of potassium permanganate.

393,388—November 27, 1888. E. OSTERMAYER. *Production of iodized sulpho-acids of phenols, etc.*

Iodinized phenol, cresol, or thymol sulpho-acids are produced by treating the respective sulpho-acids or their salts with iodine or a salt of iodine in presence of an oxidizing agent.

396,526—January 22, 1889. E. BAUMANN. *Sulphur compound.*

Diethylsulphonemethylethylmethane, a new product, of the formula $C_8H_{18}S_2O_4$; m. p. 76° C. It is produced by the oxidation with potassium permanganate to a sulphone of a new mercaptol formed from a mixture of methylethylketone with ethylsulphohydrate, with addition of hydrochloric acid.

401,500—April 16, 1889. F. KRÜGER. *Medical compound.*

A new product having the formula $C_6H_5CH(SO_2C_2H_5)_2$, m. p. 133° C., which is formed by the oxidation of the ethylmercaptol of the benzaldehyde $C_6H_5CH(SO_2H_5)_2$ by means of permanganate of potassium.

401,501—April 16, 1889. F. KRÜGER. *Medical compound.*

A new product, tetramethyl-disulphonmethane, having the formula $(CH_3)_2C(SO_2CH_3)_2$, m. p. 120° C., is produced by the action of gaseous hydrochloric acid on a mixture of methylmercaptan and acetone well cooled, the methylmercaptol formed being transformed into the disulphonate by oxidation with permanganate of potassium.

431,472—July 1, 1890. M. LANGE. *Process of making thio-oxydiphenylamine.*

A new product, useful as a medicament; m. p. 155° C. It is formed by heating together a salt of metaoxydiphenylamine, water, and sulphur. The reaction is promoted by adding an alkali or alkaline carbonate in excess.

442,094—December 9, 1890. E. A. BAUMANN. *Sulpho compound.*

A new product, diethylsulphone-diethyl-methane, of the formula $C_9S_2O_4H_{20}$; m. p. 87° C. It is obtained by the action of diethylketone with ethyl-mercaptan in the presence of hydrochloric acid, the product being oxidized with permanganate.

495,124—April 11, 1893. A. SPIEGEL. *Sulphur compound.*

Hydrocarbons, such as mineral oils, are first treated with caustic soda, then with sulphuric acid, the product then washed with water and brine successively, neutralized with alkaline lye, and the salt and sulphones separated by treatment with a solvent of the sulphones.

495,343—April 11, 1893. E. JACOBSEN. *Sulphur compound of hydrocarbon.*

New compounds, being neutral hydrocarbon bodies, nonhygroscopic, of a foliated or pulverulent form, soluble in water, nearly devoid of taste or smell, and consisting of unsaturated paraffins, or mixtures containing unsaturated paraffin, combined with sulphur, are produced by combining sulphur by means of heat with a hydrocarbon free from sulphur, treating with sulphuric acid, separating the crude soluble product, and purifying, neutralizing, and drying.

496,112—April 25, 1893. C. FAHLBERG. *Process of making pure saccharin.*

Saccharin, or anhydro-ortho sulphamin-benzoic acid, is purified by introducing the dry crude product—a mixture of the said acid with para sulphamin-benzoic acid—into an aqueous solution of an alkali, as caustic potash, containing such quantity of the alkali as will neutralize and dissolve only the said ortho-acid—e. g., 55 parts by weight of caustic potash for 185 parts of ortho-acid—filtering, and adding to the filtrate an acid, as a mineral acid, stronger than the ortho-acid, whereby pure saccharin is precipitated.

496,113—April 25, 1893. C. FAHLBERG. *Process of purifying saccharin.*

A solution of a mixture of the alkaline salts of anhydro-ortho sulphamin-benzoic acid and para-sulphamin-benzoic acid is treated with an acid, as hydrochloric or oxalic, which is stronger than the para-acid, in such quantity as is requisite to separate out the para-acid only; heated, cooled, and then filtered, when the ortho-acid, or pure saccharin, is precipitated from the filtrate by the addition of a stronger acid, preferably a mineral acid.

497,740—May 16,1893. J. ZIEGLER. *Quinolin compound.*

A new antiseptic, oxyquinolin phenol sulphonate of oxyquinoline, soluble in water and forming amber-colored hexagonal crystals, is produced by digesting a mixture of phenol, oxyquinolin and sulphuric acid, then treating the so-obtained oxyquinolin-phenolete with a solution of sulphuric acid in water at a temperature near the boiling point.

513,204—January 23, 1894. E. W. R. SCHRÖTER. *Process of making pure sulfonic compounds.*

A hydrocarbon containing sulphur in chemical combination is treated with concentrated sulphuric acid, and the crude sulphonic compound obtained is several times treated with hydrochloric acid and the acid eliminated.

564,784—July 28,1896. C. FAHLBERG. *Process of making saccharin.*

Toluene is treated with sulphuric acid, and the ortho and para toluene-sulphonic acids are converted into their magnesium salts by means of a magnesium salt. The greater part of the para-magnesium salt is separated from the ortho by crystallization of the former, and the ortho salt and the remainder of the para salt are converted into salts of sodium or potassium by treatment with carbonate of sodium or potassium and oxidized into the corresponding neutral ortho and para sulphobenzoates of sodium or potassium. The neutral salts are treated with acid, and the acid salts treated with alcohol and hydrochloric acid gas and converted into ortho and para ester-acids, which are neutralized with sodium carbonate and treated with phosphorous pentachloride to convert them into ester-benzosulphochlorides. These are transformed into their amids by ammonia and saponified into para-sulphaminbenzoates and a salt of saccharine, which is then separated out.

579,898—March 30, 1897. G. L. SCHAEFER. *Medical compound.*

New compounds, comprising an alkaloid base, such as quinine and guaiacol sulphonic acid, are produced by heating guaiacol with concentrated sulphuric acid, diluting, neutralizing with a carbonate or hydrate, as potassium carbonate, and treating the salt with a mineral acid, and thus forming guaiacol sulphonic acid and then dissolving the alkaloid therein.

584,471—June 15, 1897. L. O. HELMERS. *Water-soluble compound of ethereal oils.*

A new compound, consisting of an ethereal oil or a camphor and the sulphonic-acid compound of ichthyol and thiol—and the process applies to like insoluble substances—is produced by causing the constituents to react, said sulphonic-acid compound being soluble in water.

602,682—April 19, 1898. W. DIETERLE. *Process of producing orthotoluene sulfonic acid.*

Orthothiocresol is subjected to the action of an oxidizing agent, as potassium permanganate, producing orthotoluene sulphonic acid. A continuance of the oxidation converts the latter into orthobenzene sulphonic acid.

602,942—April 26, 1898. L. O. HELMERS. *Iodin derivative of ichthyol and thiol.*

A new compound, soluble in water, is produced by reacting upon iodine with a sulphonic-acid compound of a sulphureted hydrocarbon that is soluble in water.

622,854—April 11, 1899. B. HOMOLKA AND A. STOCK. *Nitrobenzyliden sulfonic acid and process of making same.*

New products, as the ortho or para-nitro-benzylidenanilin-sulphonic acids and their homologues, are produced by oxidizing the ortho or para-nitrobenzylanilin sulphonic acids or their homologues. They are soluble in water, with a yellowish color, insoluble in alcohol, ether, etc., and give, on decomposition with diluted mineral acids, nitrobenzaldehyde.

624,027—May 2, 1899. L. O. HELMERS. *Tasteless compound from sulfureted hydrocarbons, and process of making same.*

New products, pulverulent neutral salts, insoluble in water and devoid of taste and smell, consist of an alkaline-earthy and metallic base, and a sulphonic-acid compound derived from sulphureted hydrocarbons combined with sulphuric acid. They are produced by extracting the salts with a solvent, such as alcohol, adapted to dissolve only the bitter substances.

624,028—May 2, 1899. L. O. HELMERS. *Tasteless compound from sulfureted hydrocarbons, and process of making same.*

New products, sulphonic-acid salts of alkaline-earthy metals and metals proper derived from sulphureted hydrocarbons combined with sulphuric acid, devoid of taste and smell, are produced by heating the salts up to 130° to 140° C.

625,332—May 23, 1899. L. O. HELMERS. *Deodorized compound of mineral oils, and process of making same.*

Sulphonized compounds derived from sulphureted mineral oils by treatment with sulphuric acid are made odorless, or nearly so, by treating aqueous solutions thereof, while cool, with an oxidizing agent, and then concentrating by heating.

628,503—July 11, 1899. E. TWITCHELL. *Fatty aromatic sulfo compound and process of making same.*

A new compound, a sulpho-fatty-aromatic acid, a combination of the sulphonic radical with the stearic radical and one of the aromatic radicals of the general formula $R(HSO_3)C_{18}H_{35}O_2$, a stable, viscous, nonvolatile oil. It forms water-soluble salts with the alkali metals, and insoluble salts with the other metals, and is produced by mixing any member of the fatty-acid series with a member of the aromatic series and treating with sulphuric acid.

628,881—July 11, 1899. G. WENDT AND J. LEHMANN. *Process of making sulfo-acids of aliphatic creosotesters.*

The esters, under continuous stirring, are subjected to the action of concentrated sulphuric acid at below 150° C., the mixture allowed to stand for two hours, neutralized, and the sulpho-acids separated out.

646,772—April 3, 1900. A. VERLEY. *Process of making sulfonates.*

Pyridin and chloro-sulphonic acid are caused to react in a neutral solvent; a phenol is added; the solvent removed, and the resulting mixture is treated with potash and the pyridin driven off, and the potassium salt obtained is saturated with an acid.

647,237—April 10, 1900. F. SCHMIDT. *Diamidodiphenylamin sulfonic acid and process of making same.*

A new product, yielding dyestuffs, is produced by condensing molecular quantities of para-chlornitrobenzenesulphonic acid or its salts with para-phenylenediaminsulphonic acid or its salts and subsequent reduction.

648,261—April 24, 1900. B. HOMOLKA AND A. STOCK. *Nitrobenzylanilin sulfonic acid and process of making same.*

A new product, where the nitro group is in the ortho or para position, being a yellow powder, is produced by heating nitrobenzyl-chloride—where the nitro group is in ortho or para position—with an aqueous solution of a salt of anilin-sulphonic acid in the presence of alkaline substances.

648,568—May 1, 1900. J. KOETSCHET. *Process of making toluene sulfochlorid.*

Toluene is treated with three or more parts by weight of chloro-sulphonic acid free from sulphuric anhydride, the temperature being maintained between 5° and 35° C. or about 10° C.

650,218—May 22, 1900. E. BARELL. *Orthoguaiacol sulfo-acid and process of making same.*

A new product, crystallized in small laminæ which do not melt up to 270° C., is produced by treating pure guaiacol with concentrated sulphuric acid at from 70° to 80° C., isolating a solution of the barium salt thus formed, decomposing same with sulphuric acid, concentrating and crystallizing out by refrigeration.

651,045—June 5, 1900. J. LAGUTT. *Process of making saccharin.*

Orthosulphamidobenzoic acid is dissolved in a dehydrating agent, as sulphuric acid, and after standing at ordinary temperature it is poured upon ice and water, thereby causing the precipitation of saccharine.

NITROGEN COMPOUNDS.

NITROSUBSTITUTION COMPOUNDS.

252,473—January 17, 1882. J. A. KENDALL. *Manufacture of dinitro-benzole from gas obtained by distillation of coal.*

It is obtained from benzole or nitro-benzole existing in gas produced from carbonaceous substances, by passing the gas through a mixture of nitric and sulphuric acids, the latter being in excess.

412,680—October 8, 1889. C. SAVIGNY. *Process of treating the mother liquors of phenol nitrates.*

The mother liquors resulting from the manufacture of nitro-phenols are heated, and nitric acid distilled therefrom; then cooled, and picric or nitro-cresylic acid precipitated; then heated, and the sulphuric acid concentrated, and nitrates added to effect the nitrification of phenols, cresols and the like.

650,332—May 22, 1900. M. MANDT AND R. HOLDMANN. *Process of oxidizing orthonitrotoluene.*

Ortho-nitro-toluene is oxidized in the side chain by treatment with sulphuric acid and maganese peroxide at a temperature above 100° C.

SUBSTITUTED AMMONIAS.

295,825—March 25, 1884. Z. H. SKRAUP. *Manufacture of parachinanisol.*

A new product; an oily liquid. It is obtained from the methylic ether of phenol by heating mixtures of nitro and amido anisol with glycerine and sulphuric acid.

308,286—November 18, 1884. Z. H. SKRAUP. *Production of tetrahydro-parachinanisol.*

A new product; m. p. 43° C., b. p. 283° C. It is obtained from parachinanisol by the action of nascent hydrogen, and develops an intensely green color by the action of perchloride of iron, bichromate of potash, or an aqueous solution of chlorine upon the free base or its saline compounds; hence it is also styled "thalline."

343,803—June 15, 1886. C. FAHLBERG. *Medicated benzoic sulphinide compound.*

A medicated compound, consisting of benzoic sulphinide and an organic alkaloid, as quinine, produced by dissolving benzoic sulphinide and the alkaloid in alcohol or water and crystallizing out the salt.

400,086—March 26, 1899. O. HINSBERG. *Phenacetine.*

A new product of the general composition $C_{10}H_{13}O_2N$; m. p. 135° C. It is obtained by reducing nitrophenetole and fusing the phenetidin-chlorhydrate thus formed with dried sodium acetate and glacial acetic acid.

422,251—February 25, 1890. S. RADLAUER. *Process of preparing a hypnotic.*

Chloral-urethane and alcohol are caused to act upon each other in a vacuum at a temperature of 100° C, and the product, having the formula $C_7H_{12}Cl_3O_3N$, with m. p. 42° C., is crystallized in water.

422,334—February 25, 1890. T. CURTIUS. *Hydrazin.*

A new product, expressed by the formula N_2H_4, which, in the form of a gas, is set free from its hydrate by metallic sodium. The hydrate is formed by the action of sodium nitrite on the chlorhydrate of glycocoll ether, the diazo-acetic ether produced being converted into the triazo acetate and the salt of hydrazin derived therefrom and converted into the hydrate of this hydrazin.

425,039—April 8, 1890. J. F. VON MERING. *Chloralformamide.*

A new product, having anæsthetic properties and m. p. 115°-116° C., of the formula $C_2HCl_3O.CHO.NH_2$.

425,040—April 8, 1890. J. F. VON MERING. *Chloralformamide.*

The process of producing the same (No. 425,039) consists in treating chloral with formamide, in the proportion of their molecular weights.

428,286—May 20, 1890. C. PAAL. *Phenyldihydroquinazoline.*

A new medical compound, having the formula $C_{14}H_{12}N_2$, and m. p. 95° C. It is produced by acting with reducing agents upon the formyl derivative of the orthonitrobenzyl analine.

489,728—January 10, 1893. J. BERLINERBLAU. *Paraphenetol-carbamide and process of making same.*

A new compound, having a sweet taste, crystallizing in white needles and soluble in hot water and the ordinary solvents, is produced by treating paraphenetidine or para-anisidine with phosgene, each in a solvent, as benzole, filtering, adding ammonia to the filtrate, distilling off the solvent, and crystallizing.

502,504—August 1, 1893. H. THOMS. *Process of making para-phenetol carbamide.*

A compound having a strong sweet taste, and a m. p. of 170° C., is produced by boiling an aqueous solution of para-phenetidin-hydrochloride (three molecules) with common urea (two molecules), or the carbamide salt of ammonia or ammonium carbonate may be used.

503,748—August 22, 1893. L. LEDERER. *Amido-crotonylanilid and process of making it.*

A new compound, of the formula $C_{10}H_{10}(NH_2)NO$, moderately soluble in most solvents, crystallizing in colorless needles, and having a m. p. of 146°-147° C., is produced by treating acetylacetanilid with ammonia and allowing it to stand twenty-four to thirty hours.

526,258—September 18, 1894. S. RADLAUER. *Salicyl-anilid.*

A new compound, soluble in alcohol, but not in water, m. p. 100° C., is produced by heating acetanilid with salicylic acid in molecular proportions.

535,846—March 19, 1895. J. F. VON MERING. *Substitution product of phenetidin.*

New compounds, antipyretic bodies, difficult of solution in water, are produced by heating together phenetidin, a suitable acid such as propionic or butyric acid, and a condensation product, such as zinc chloride, in such proportions that one hydrogen atom of the amido group in the phenetidin is replaced by an acid remainder of greater molecular weight than acetyl.

536,524—March 26, 1895. W. HERZBERG. *Amidotriazin.*

See Group XI, Dyestuffs, Artificial, Organic.

540,732—June 11, 1895. M. FREUND. *Hydrastinin.*

A new product, $C_{11}H_{13}NO_3$, m. p. 116°-117° C., combining with one equivalent of an acid, is produced by subjecting hydrastine to the action of an oxidizing agent.

543,579—July 30, 1895. L. LEDERER. *Process of producing phenoxacetic anilids, etc.*

The anilids of the phenoxacetic acids, as phenoxacet-para-phenetidids, are produced by reacting on phenoxacetic acids with aromatic amido-compounds, as para-phenetidin, and crystallizing out with alcohol.

558,863—April 21, 1896. F. VALENTINER. *Process of making acetophenonphenetidin.*

Molecular weights of acetophenon and para-phenetidin are heated together.

563,009—June 30, 1896. A. BISCHLER. *Methoxy-acetphenetidin.*

A new product, crystallizing in white needles, m. p. 102° C., of general formula $C_{11}H_{15}NO_3$, and soluble in cold water. It is formed by heating the alkyloxy-fatty acids or the chlorides of the amids thereof, with primary and secondary aromatic amins, as by heating para-phenetidin with methoxy-acetic acid.

567,968—September 22, 1896. A. EICHENGRÜN. *Iodoform combination with hexamethylentetramine.*

New compounds, crystalline inodorous additive combinations of iodoform with hexamethylentetramine, or its haloidalkyl derivatives, which are not soluble in water and are decomposed by acids or alkalis, liberating iodoform, are produced by the reaction of the constituent in a solvent, as iodoform and hexamethylenamine in absolute alcohol.

569,416—October 13, 1896. O. HINSBERG. *Ester of alkoylamidophenols and method of making same.*

Carbonic esters of alkoylamidophenol, colorless compounds, m. p. 80° to 161° C., easily soluble in hot water or alcohol, are produced, together with their derivatives, by treating alkoylamidophenols, and their derivatives, the nitrogen atom of which is alkylated, in the form of their salts with esters of chlorcarbonic acid.

574,395—January 5, 1897. R. W. CORNELISON AND W. H. WARREN. *Process of obtaining aceto derivatives of aromatic amins.*

They are produced directly by the reaction of an acetic-acid salt and an aromatic-amin salt upon each other; the acetic-acid radical being replaced with another acid radical, such as a sulphuric-acid radical, and the acetic-acid radical thus liberated caused to react finally with an aromatic amin, as anilin.

574,396—January 5, 1897. R. W. CORNELISON AND W. H. WARREN. *Process of obtaining aceto derivatives of aromatic amins.*

They are produced by the reactions of an acid salt of acetic acid with the desired aromatic amin.

574,874—January 12, 1897. H. BAUM. *Paraphenetidin compound.*

New medicinal paraphenetidin compounds, as meta-alkyloxy, salicylidenparaphenetidin, are produced by condensing gentisinaldehyde with paraphenetidin, and alkylating the product of condensation.

576,379—February 2, 1897. I. ROOS. *Salicyl paraphenetidin.*

New products, as the orthoöxybenzyliden-alkyl derivative of amido phenol, insoluble in water, soluble in alcohol, etc., m. p. 94° C., of the formula Alk. $OC_6H_4N(CHC_6H_4OH)$ are produced by condensing salicylaldehyde with an alkyl derivative of amidophenol.

578,384—March 9, 1897. P. T. AUSTEN AND H. C. TUTTLE. *Process of making acetanilid, etc.*

Acetanilid or the acetoluids are formed by heating anilin or the toluidins with dilute acetic acid, or even with crude pyroligneous acid, under pressure.

586,551—July 20, 1897. F. W. FRERICHS. *Process of manufacturing acetanilid*

Acetic acid and anilin oil are subjected to distillation with agitation under reduced pressure until most of the free anilin oil and acetic acid has been removed; the last traces are then removed by distillation under the action of live steam.

586,854—July 20, 1897. W. MAJERT. *Process of making ammoniacal casein*

A new compound, in dry solid form, easily soluble in water, is produced by treating finely powdered dry casein with ammonia gas.

595,897—December 21, 1897. H. R. VIDAL. *Process of making paramidophenol.*

Oxyazobenzol is reduced by sodium sulphide in the presence of a caustic alkali.

596,797—January 4, 1898. E. TAUBER. *Process of making amidins.*

New products, the amidins of amidophenol ethers, as ethenylparaparadiethoxydiphenylamidin, m. p. 121° C., are produced by heating the acetyl compounds of amido-phenol ethers with amidophenol ethers themselves and a dehydrating agent, such as a halogen compound of phosphorus, phosphorous sulphide, and hydrochloric acid.

602,109—April 12, 1898. I. ROOS. *Process of making salts of paramidophenol.*

New products, the primary salts of citric acid with alkyl ethers of paramidophenol, white or crystalline compounds, m. p. 186°-187° C., soluble in water and less so in alcohol, are produced by dissolving molecular quantities of citric acid and amidophenol alkyl ether in a solvent, as alcohol, and crystallizing.

602,690—April 19, 1898. C. F. M. SCHAERGES AND P. SCHWARZ. *Acetyl derivative of phenetidin.*

New products, the acetyl derivatives of alkaline phenetidin sulphonates, as sodium acetyl phenetidin sulphonate, a reddish-white microcrystalline, hygroscopic body, soluble in water, are prepared by treating phenetidin with concentrated sulphuric acid, converting the phenetidin-sulphonic acid into a salt, and acetylizing this salt by means of glacial acetic acid and acetic anhydrid.

605,977—June 21, 1898. B. R. SEIFERT. *Oxyphenyl-guanidin and process of making same.*

Certain new oxyphenyl-guanidins adapted to cause anesthesia, are produced by melting or dissolving together a carbodiimid with an amidophenol body.

615,828—December 13, 1898. H. C. FEHRLIN. *Process of purifying acetanilid.*

Crude acetanilid is distilled, preferably under diminished pressure, by a current of superheated vapors of acetic acid of a temperature not lower than the boiling point of acetanilid at the vacuum used.

615,829, December 13, 1898. H. C. FEHRLIN. *Process of making acetanilid.*

A current of superheated vapors of acetic acid at 185° C. is passed through anilin oil heated to 160° C., and the water simultaneously removed, until the conversion of the anilin-oil into acetanilid is satisfactorily completed.

618,809—January 31, 1899. H. R. VIDAL. *Process of making amidophenols.*

An amido-sulphonic acid of the aromatic series in a concentrated sulphuric acid solution is reacted upon by an oxidizing agent, as manganese peroxide.

629,099—July 18, 1899. F. VALENTINER. *Process of making acetophenonphenetidid.*

Acetophenone and paraphenetidin in molecular proportions are heated in a vacuum to the combination temperature, when the desired product is distilled off in vacuum.

640,563—January 2, 1900. B. HOMOLKA AND A. STOCK. *Process of making amidobenzyliden anilin compounds.*

Nitrobenzylanilins are subjected to the action of alkali sulphids while heated.

641,100—January 9, 1900. H. GUSSMANN. *Process of making para-oxy-para-amido-ortho-oxydiphenylamin.*

Para-oxy-para-amido-diphenylamin-ortho-sulphonic acid is heated with caustic alkalis at 150° to 200° C.

641,870—January 23, 1900. L. KNORR. *Naphthalanmorpholin.*

New products, as ethylnaphthalanmorpholin, a thick oil, distilling at 320° C., forming crystals, m. p. 237° to 238° C., are produced by the action of ethanolamins upon dihydronaphthalene oxide, and heating of the naphthol product with acids.

647,075—April 10, 1900. W. H. CLAUS, A. RÉE, AND L. MARCHLEWSKI. *Process of making compounds of paraphenetidin.*

A solution of paraphenetidin and glucose in a solvent is heated, the solvent thereafter separated, and the uncombined constituents dissolved out with solvents.

PURINS AND DERIVATIVES.

Purins.

559,347—April 28, 1896. E. FISCHER. *Chloro-theophyllin ana process of preparing it.*

A new compound, $C_5H\,(CH_3)_2ClN_4O_2$; m. p. 300° C., soluble in hot alcohol. It is produced by heating 1 part dimethyl-uric acid with 2 parts phosphorus pentachloride and 4 parts phosphorus oxychloride to 150° C. for several hours.

571,353—November 17, 1896. E. FISCHER. *Bromotheophyllin and process of making same.*

A new compound, $C_5H\,(CH_3)_2BrN_4O_2$, m. p. 315° to 320° C., soluble with difficulty in alcohol and water, is produced by heating a mixture of theophyllin, 1 part, and bromine, 5 parts, under pressure; driving off the excess of bromine, and purifying the residue.

598,502—February 8, 1898. E. FISCHER. *Process of making purins.*

A new product, trichloropurin, $C_5HN_4Cl_3 + H_2O$, m. p. 184° to 188° C., is produced by heating dichloroxypurin, 1 part, with phosphorus oxychloride, 70 parts; and agitation; then evaporating *in vacuo*. To purify the crude product ether is added, the ether removed, and the residue boiled in water.

607,028—July 12, 1898. E. FISCHER. *Process of making purin derivatives.*

New crystalline compounds, amido purin derivatives which have the amido radical bound to the alloxan nucleus of the purin residue, are produced by the action of ammonia upon a chlorine derivative of purin having chlorine bound to the alloxan nucleus. They dissolve with difficulty in alcohol or water and decompose at high temperature before or while melting.

607,029—July 12, 1898. E. FISCHER. *Adenin and process of making same.*

A new compound, methyl-adenin, m. p. 347° C., is produced by agitating amido dichloropurin with hydriodic acid and phosphonium iodide for several hours at ordinary temperature, then heating to the boiling point and until a clear solution results; filtering and treating with ammonia.

617,985—January 17, 1899. E. FISCHER. *Alkyl-purin and process of making same.*

A new compound, 7-methyl-2-6-dichloropurin, m. p. 196° to 197° C., is prepared by heating theobromine with phosphorus oxychloride under pressure, then removing excess of phosphorus oxychloride, adding water, and treating with dilute soda lye. Methylized oxypurins are prepared by treating methyldichloropurin with an alkali, and paraxanthin by subsequent treatment of the foregoing with a mineral acid.

625,441—May 23, 1899. E. FISCHER. *Thio derivative of purin and making same.*

New compounds, a thiopurin having the group SH bound to one or more of the carbon atoms of the purin molecule, as 1-3-7-trimethyl-2-6-dioxy 8-thiopurin or thiocaffein, crystallizing in fine flexible needles, m. p. 308° C. They are produced by heating under pressure a halogen-purin derivative with the solution of an alkaline sulphydrate and then acidulating the solution.

631,705—August 22, 1899. E. FISCHER. *Process of making theobromin.*

3-7-dimethyl-6-amido-2-8-dioxypurin is treated with phosphorous-oxy-chloride, the resulting oxychloropurin is isolated and treated with a reducing agent, and the then resulting 3-7-dimethyl-6-amido-2-oxypurin, a new product, is isolated and acted upon with nitrous acid.

631,706—August 22, 1899. E. FISCHER. *Oxypurin and process of making same.*

Trichloro-purin is acted upon with an alcoholic alkali; the 2-8-dichloro-6-alkyl-oxypurin is then acted upon with hydrochloric acid and the resulting dichloro-oxypurin alkalized; the product, 1-7-dimethyl-6-oxy-2-8-dichloro purin, being a new compound, m. p. between 245° and 255° C. Subsequent treatment produces alkylized hypoxanthins, etc.

631,708—August 22, 1899. E. FISCHER. *Oxypurin and process of making same.*

A new compound, 8-chloro-2-6-diethoxypurin, m. p. 205° C., is produced by heating trichloropurin with excess of sodium-ethylate. This product is dissolved in hydriodic acid and treated with phosphonium-iodide to produce xanthin.

631,709—August 22, 1899. E. FISCHER. *Oxypurin and process of making same.*

A new compound, 6-oxy-2-8-dichlor-purin, is produced by treating 2-8-dichlor-6-ethoxy-purin with fuming hydrochloric acid and heat. This product is treated with hydriodic acid and phosphonium iodide to obtain hypoxanthin.

632,828—September 12, 1899. F. ACH. *Process of making uric-acid derivatives.*

An alkaline solution of a uric acid is treated with a haloid ether at a low temperature.

647,392—April 10, 1900. E. FISCHER. *Oxypurin and process of making same.*

2-8-dichloro-6-ethoxy-purin, a new compound, m. p. 200° C., is produced by dissolving trichloropurin in ethyl alcohol, treating with a sodium solution, and finally supersaturating with acetic acid. Said compound is treated with a reducing agent to produce hypoxanthins.

Xanthins.

569,489—October 13, 1896. E. FISCHER. *Process of making xanthin derivatives.*

Dialkyl uric acid is treated with a pentahalogen compound of phosphorus in the presence of a solvent, such as phosphorus oxychloride, and the resulting halogen derivative is treated with a reducing agent to convert it into a homologue of xanthin of the type of theophyllin.

569,490—October 13, 1896. E. FISCHER. *Process of making derivatives of xanthin.*

A halogen dialkyl derivative of xanthin (No. 569,489) is converted into its salt, which salt is then alkylized and the resulting halogen trialkyl derivative of xanthin reduced, whereby the homologue of xanthin of the type of caffein is produced.

588,327—August 17, 1897. E. FISCHER. *Process of obtaining xanthin derivatives.*

Tetramethyl-uric acid is heated with five times its weight of phosphorus oxychloride in a closed vessel to 160° to 165° C. for ten hours, and the crude product then subjected to the action of fuming hydrochloric acid, the solution evaporated to dryness, and treated with soda lye. The chlorocaffein remaining is acted upon by reducing agents to obtain caffein.

617,986—January 17, 1899. E. FISCHER. *Process of making heteroxanthin.*

7-methyl-2-6-dichloropurin is heated with hydrochloric acid under pressure.

618,045—January 17, 1899. E. FISCHER. *Alkyl-hypoxanthin and process of making same.*

A new compound, methyl hypoxanthin, m. p. 353° C., readily soluble in water, assuming a brown color when heated to 340° C., is produced by heating 7-methyl-6-oxy-2-chloropurin with hydriodic acid and phosphonium iodide. The product is methylated to produce dimethyl-hypoxanthin.

631,707—August 22, 1899. E. FISCHER. *Xanthin derivatives and process of making same.*

A new product, chloroxanthin, or 8-chloro-2-6-dioxy-purin, is produced by treating an 8-chloro-2-6-dialkyl-oxpurin with hydrochloric acid. The product is subsequently alkylized and treated with methyl iodide.

631,757—August 22, 1899. F. ACH. *Xanthin derivative and process of making same.*

Certain alkyl-uric acids, as 3-methyl-uric acid, are treated with phosphorus-oxy-chloride, producing a new compound, 3-methyl-chloro-xanthin, having no melting point, but decomposing at 345° C. This compound is submitted to the action of reducing and methylating agents.

631,758—August 22, 1899. F. ACH. *Alkyl-xanthin derivative and process of making same.*

A 7-alkyl-uric acid, as 7-methyl-uric acid, is heated with phosphorus-oxy-chloride alone and the product purified and crystallized. The new compound, chloro-heteroxanthin, has no melting point, but decomposes at 340° C. It is alkylized and reduced.

631,759—August 22, 1899. F. ACH. *Alkyl-xanthin and process of making same.*

A new product, chloro-theo-bromin, m. p. 292° to 293° C., is produced by heating 3-7-dimethyl-uric acid with phosphorus-oxy-chloride alone, crystallizing, dissolving in alkali, and precipitating with acid. This product is alkylized and reduced.

631,760—August 22, 1889. F. ACH. *Alkylized xanthin and process of making same.*

A new compound, 3-methyl-xanthin, having no melting point, but decomposing at 400° C., is produced by heating 3-methyl-chloro-xanthin with hydriodic acid and phosphonium-iodide. This product is alkylized and reduced.

PYRAZOLES.

307,399—October 28, 1884. L. KNORR. *Preparation of dimethyl-phenyl-oxypyrazol.*

A new product, m. p. 113° C. Acetylacetic ether is mixed with a molecular quantity of phenyl-hydrazine, water is eliminated, and the condensed product, phenyl-hydrazine-acetylacetic ether, is heated to 100° to 150° C. and crystallized, forming methyl-phenyl-oxypyrazol. This is heated with methyl chloride, bromide, or iodide and converted into dimethyl-phenyl-oxypyrazol.

CHINOLINES OR QUINOLINES.

237,917—February 15, 1881. Z. H. SKRAUP. *Production of oxychinoline.*

A new product, for the manufacture of blue dyestuffs and other purposes, produced by the action of glycerine and sulphuric acid upon a mixture of ortho-nitro-phenol and ortho-amido-phenol.

237,918—February 15, 1881. Z. H. SKRAUP. *Production of oxychinoline.*

A new product, for the manufacture of blue dyestuffs and other purposes, produced by the action of glycerine and sulphuric acid upon a mixture of para-nitro-phenol and para-amido-phenol.

241,738—May 17, 1881. Z. H. SKRAUP. *Manufacture of artificial chinoline.*

A new product. It is produced by the action of glycerine and sulphuric acid upon a mixture of nitro-benzole and aniline.

252,846—January 24, 1882. W. PICKHARDT AND H. ENDEMANN. *Preparation of chinoline.*

Citrate of chinoline, a new product, is made by treating purified artificial chinoline (No. 241,738) with citric acid.

252,847—January 24, 1882. W. PICKHARDT AND H. ENDEMANN. *Preparation of chinoline.*

Sulphate of chinoline, a new product, is made by treating purified artificial chinoline dissolved in alcohol with sulphuric acid.

254,097—February 21, 1882. W. PICKHARDT AND H. ENDEMANN. *Medical compound.*

Hydrochlorate of chinoline, white and free from lepidine, is made by dissolving purified artificial chinoline in aqueous hydrochloric acid and evaporating.

254,098—February 21, 1882. W. PICKHARDT AND H. ENDEMANN *Manufacture of chinoline.*

The artificial chinoline of Skraup is refined and purified by treatment with tartaric acid, the acid tartrate of chinoline being separated from the solution, and the chinoline liberated by the action of caustic alkalis.

256,444—April 11, 1882. W. PICKHARDT AND H. ENDEMANN. *Salicylate of chinoline.*

A new product. It is made from purified artificial chinoline by treatment in alcohol with salicylic acid.

256,445—April 11, 1882. W. PICKHARDT AND H. ENDEMANN. *Benzoate of chinoline.*

A new product. It is made from purified artificial chinoline by the distillation of a mixture of pure benzoic acid and chinoline.

257,828—May 9, 1882. W. PICKHARDT AND H. ENDEMANN. *Tartrate of oxychinoline.*

It is prepared by the action of tartaric acid upon the oxychinoline of Skraup, (No. 237,918).

257,829—May 9, 1882. W. PICKHARDT AND H. ENDEMANN. *Hydrochlorate of oxychinoline.*

It is prepared by the action of hydrochloric acid upon the oxychinoline of Skraup.

260,317—June 27, 1882. W. PICKHARDT AND H. ENDEMANN. *Acid tannate of chinoline.*

A new product. It is prepared by evaporating a mixture of tannic acid, 5 pounds, and artificial chinoline, 1 pound, in a minimum quantity of water.

260,318—June 27, 1882. W. PICKHARDT AND H. ENDEMANN. *Neutral tannate of chinoline.*

A new product. It is prepared by evaporating a mixture of tannic acid, 5 pounds, and artificial chinoline, 2 pounds, in a minimum quantity of water.

260,319—June 27, 1882. W. PICKHARDT AND H. ENDEMANN. *Basic tannate of chinoline.*

A new product. It is prepared by evaporating a mixture of tannic acid, 5 pounds, and artificial chinoline, 3 pounds, in a minimum quantity of water.

270,045—January 2, 1883. O. FISCHER. *Method of preparing oxyquinoline.*

Oxyquinoline, a new antiseptic, is obtained by treating quinoline-sulphonic acid with caustic soda or potash, under the action of heat.

273,498—March 6, 1883. O. FISCHER. *Process of preparing oxyhydro-ethyl chinoline.*

Oxyhydro-ethyl chinoline, a new product, is made by first converting chinoline into oxychinoline, then treating the same with tin and hydrochloric acid and converting the oxyhydro-chinoline produced into oxyhydro-ethyl chinoline by treatment of the isomeric oxyhydro-chinoline with ethyl iodide by heat in a water bath, and extracting the base with water and precipitating with caustic soda.

276,796—May 1, 1883. O. FISCHER. *Preparation of oxyhydro-methyl chinoline.*

Oxyhydro-methyl chinoline, a new product, is produced by substituting methyl iodide for ethyl iodide in the process of No. 273,498.

282,488—August 7, 1883. A. BÖHRINGER. *Method of producing monalcylised hydro-bases.*

They are produced by first converting the tertiary bases (as chinoline) into salts of the ammonium bases (as chloride of methyl chinoline) by alcylisation, and then hydrogenizing said salts to produce acid salts which liberate the monalcylated hydro-bases (as mono-ethyl-hydro-chinoline).

355,842—January 11, 1887. R. SCHMITT. *Manufacture of oxychinoline carbonates.*

They are produced by treating the oxychinoline alkalies and earthy alkalies with carbonic acid under pressure and at an elevated temperature.

466,707—January 5, 1892. J. ZIEGLER. *Process of preparing phenol sulphonates of oxychinoline.*

The ortho and para phenol sulphonates of ortho-oxychinoline are formed by the production of ortho-oxychinoline by digesting orthoamido-phenolparasulphonic acid with orthonitrophenolparasulphonic acid and with glycerine and sulphuric acid; precipitating the oxychinoline from the product of the reaction by means of soda and purifying it; and then heating it with ortho or para phenol sulphonic acid in molecular proportions. The phenol sulphonate of oxychinoline is a yellow sirup, solidifying in crystals at a low degree of cold or in a vacuum chamber.

466,708—January 5, 1892. J. ZIEGLER. *Process of preparing oxychinoline sulphate.*

The substitution of sulphuric acid for the ortho or para phenol sulphonic acid of process No. 466,707 (in the proportion of two molecules of oxychinoline to one of sulphuric acid) results in the production of the sulphate of ortho-oxychinoline, a new product of the formula $C_{18}H_{14}N_2O_2.\ H_2SO_4$: m. p. 172°-173° C.

478,495—July 5, 1892. J. ZIEGLER. *Antiseptic quinoline.*

A soluble antiseptic, consisting of quinoline combined with a saponaceous solution. It is formed by saponifying oils or fats in the presence of quinoline; boiling until the solution is complete; and thereafter adding water to the solution.

486,363—November 15, 1892. J. ZIEGLER. *Chinolinchinophenol-sulphate and method of obtaining same.*

A new compound, a sulphur-yellow powder, soluble in water, m. p. 114° C., is produced from ortho-oxychinoline and chinoline by heating a mixture of one of the said substances and a sulphate of the other.

512,590—January 9, 1894. G. N. VIS. *Orthooxyethyl-alpha-benzoylamido-quinolin.*

A new compound, crystallizing in small needles, m. p. 206° C., and scarcely soluble in water, is produced by treating æthoxy amido quinoline or a hydrochloric acid salt thereof with benzoyl-chloride.

563,116—June 30, 1896. J. ZIEGLER. *Process of making quinolin compounds.*

An antiseptic disinfectant, soluble in water, is produced by boiling for ten hours two molecules O-oxyquinoline in alcohol with one molecule pyrosulphate of potassium, separating and drying the product.

CHINALDINES.

309,935—December 30, 1884. O. DOEBNER AND W. VON MILLER. *Manufacture of bases called chinaldines.*

New products applicable for the manufacture of coloring matters or for antiseptics and medicinal uses. They are obtained by combining an acid and a metallic salt, acting as a reducing agent, with aldehyde or its equivalents, and a primary aromatic base; purifying the base obtained by the reaction. Chinaldine is a fluid, b. p. 240° C.

316,248—April 21, 1885. O. DOEBNER AND W. VON MILLER. *Formation of methoxy and ethoxy chinaldine.*

New products, derivatives of chinaldine and applicable for the manufacture of coloring matters, or for antiseptic and antipyretic purposes. They are obtained from the sulpho-acid of the chinaldines by melting the same with alkali, and subsequent alkylation of the oxychinaldines formed; or by the action of aldehyde or the salts of amidophenols, amidophenol methyl, and amidophenol ethyl ethers. Methoxy-chinaldine, m. p. 125° C.; ethoxy-chinaldine, m. p. 72° C.

316,249—April 21, 1885. O. DOEBNER AND W. VON MILLER. *Formation of the hydrobase of chinaldine.*

Chinaldine bases or the oxymethoxy and althoxy chinaldines are boiled with tin and concentrated sulphuric acid, the product freed from tin, and the hydrobase separated by treatment with soda lye and distillation. They are new products applicable for the manufacture of grey coloring matter or as antiseptic or medicinal agents. Hydrochinaldine is an aromatic fluid, b. p. 246° C.; methoxy-hydrochinaldine, b. p. 270° C.

ISATINS.

310,604—January 13, 1885. P. J. MEYER. *Manufacture of isatins and substituted isatins.*

Isatins and substituted isatins, available for the manufacture of artificial indigo, are obtained from dihalogenized acids, their salts, amides, ethers, and aldehydes, or from aromatic amines or substituted amines, by directly fusing or boiling their solutions, and treating the product with a strong acid.

618,096—January 24, 1899. B. HEYMANN. *Diacetyl-indoxyl and process of making same.*

A new product, a white powder, nearly insoluble in water, m. p. 82° C., on heating with caustic lyes transformed into indoxyl, the latter yielding indigo by oxidation. It is produced by heating an alkaline salt of phenylglycinorthocarbonic acid with acetic anhydrid.

ALKALOIDS.

379,298—March 13, 1888. L. B. WELD. *Preparing hydrochlorate of quinia.*

Sulphate of quinine is dissolved in boiling alcohol with sodium chloride; sulphate of soda and excess of sodium chloride is precipitated by concentration; and the alcohol evaporated to deposit the hydrochlorate of quinine as crystals.

450,887—April 21, 1891. C. T. LIEBERMANN AND F. GIESEL. *Process of obtaining ecgonine.*

Ecgonine is produced from the amorphous alkaloids contained in coca leaves or in crude cocaine, by decomposing the amorphous alkaloids by a suitable medium, as by boiling in hydrochloric acid, into organic acids and ecgonine, separating the organic acids by filtration, evaporating the solution, and crystallizing the ecgonine with alcohol. The ecgonine is converted, by treatment with benzoyl or benzoic anhydride, into benzoyl-ecgonine, and the latter may be converted into cocaine.

501,066—July 11, 1893. E. GRIMAUX. *Process of making salts of quinine.*

Chlorhydro-sulphate or bromhydro-sulphate of quinine, double salts possessing great solubility, are prepared by adding to and incorporating with basic quinine sulphate, hydrochloric and hydrobromic acids, respectively, and removing the excess of the reagent.

584,388—June 15, 1897. J. F. F. VON MERING. *Benzyl morphin.*

A new product, $C_{17}H_{18}NO_2OC_6H_4CH_3$, crystallizing in large brilliant prisms, but slightly soluble in water, easily soluble in alcohol, etc., is produced by heating morphin in presence of an alkali—as sodium alkylate—a benzyl halogen and a suitable solvent, as alcohol, separating the precipitate, neutralizing it by an acid, as hydrochloric acid, and then purifying.

585,610—June 29, 1897. R. WILLSTÄTTER. *Process of making pseudotropin.*

Tropin is treated with alkalies at an elevated temperature, as by boiling with a concentrated amyl-alcoholic solution of sodium amylate.

597,804—January 25, 1898. J. U. LLOYD. *Method of and apparatus for extracting nicotine.*

A column of tobacco in a closed chamber is burned from the bottom, the products of combustion being drawn up through the mass of unburned tobacco, and the nicotine vapors absorbed in an acid solution.

605,491—June 14, 1898. E. LANGHELD. *Quinine derivative and process of making same.*

A new derivative, $C_{19}H_{20}N_2O_3$, a yellowish amorphous powder, very soluble in water, alcohol, etc., and having an acid reaction, is produced by treating a quinine solution with ozonized gas until precipitation will not be caused by an alkali.

620,406—February 28, 1899. F. D. BANNING. *Process of extracting nicotine.*

Steam and ammonia are passed through the tobacco fiber and then into reclaiming acid.

623,798—April 25, 1899. R. MACKILL. *Extracting nicotin.*

A tobacco extract is first agitated with a caustic-soda solution, then gasoline is added and again agitated, when the gasoline with the nicotine in solution is decanted and distilled.

625,075—May 16, 1899. A. WELLER. *Carbonic esters of cinchona alkaloids and process of making same.*

New, tasteless products, insoluble in water and benzene, soluble in alcohol and acids. They are produced by reacting with phosgene upon sufficient cinchona alkaloid to displace both chlorine molecules of the phosgene with the cinchona alkaloid; then adding an acid to form the corresponding salt.

629,264—July 18, 1899. F. J. VON MERING. *Process of making ethyl morphin.*

Ethyl bromide is caused to act upon an alkaline solution of morphine.

637,839—November 28, 1899. A. WELLER. *Tasteless quinin compound.*

Tasteless products, derivatives of the quinine or cinchonidin carbonic acid, are prepared by causing the cinchona alkaloids or their salts to act either upon substituted isocyanates or upon substituted carbonic chlorides.

640,977—January 9, 1900. H. THRON. *Process of making quinin carbonic ether.*

The salts of the alkaloids of the cinchona bark are acted upon with an ether of chlorocarbonic acid.

PYRAZINES AND PIPERAZINES

471,520—March 22, 1892. W. MAJERT. *Process of making piperazin.*

It is obtained from its hydrocarbon compounds, as dinaphthylpiperazin, by isolating the piperazin by means of an alkaline solution, distilling off the piperazin into a suitable acid to form salts, and crystallizing out the salts.

482,108—September 6, 1892. P. VOLKMANN. *Process of making piperazin.*

The dinitroso compounds of diphenylpiperazin, ditolylpiperazin, dixylylpiperazin, dinaphthylpiperazin, or the sulpho acids or other substitution products thereof, are treated with sulphurous acid, sulphur dioxide, or alkaline bisulphites.

500,665—July 4, 1893. W. MARCKWALD. *Process of obtaining piperazin.*

A salt of ethylene or an aromatic amide is caused to act upon an aromatic sulpho-compound of an amide in the presence of an alkali at a temperature above the normal, producing an aromatic disulphonic piperazide. This product is mixed with water or an inorganic acid solution and heated, whereby the piperazin is split off as an acid sulphate, and the acid salt is neutralized at a temperature above the normal, whereby free piperazin is obtained.

509,087—November 21, 1893. W. MAJERT. *Process of making piperazine.*

Diphenyl or ditolyl piperazine, or a salt thereof, is subjected to the action of the fumes of anhydrous sulphuric acid, the sulpho product is treated with fuming sulphuric acid, and an alkali or alkaline earth is then mixed therewith and the mixture heated.

511,303—December 19, 1893. W. MAJERT AND A. SCHMIDT. *Piperazin.*

Anhydrous piperazine, a new compound, of the formula $C_4H_{10}N_2$, a yellowish crystalline substance, m. p. 104° to 112° C., and a strong solvent of uric acid, is produced by distilling a mixture of piperazine hydrate and a solid alkali hydrate, several times repeated, then heating the distillate in a closed vessel with an alkali-hydroxide or barium oxide, and finally distilling the mixture over sodium.

514,632—February 13, 1894. C. STOEHR. *Dimethylpiperazin.*

A new compound, $C_6H_{14}N_2$, forming white crystals, m. p. 118° C., and b. p. 162° C., and easily soluble in water and alcohol, is produced by distilling glycerine with ammonium chloride and ammonium carbonate, or agents giving off ammonia, and then isolating the thus formed dimethylpyrazine and reducing it, as by metallic sodium alcohol.

597,454—January 18, 1898. W. B. & A. BISHOP. *Process of making piperazin salts.*

Stable salts are produced by thoroughly mixing piperazine or piperazine hydrate and an organic hydroxy acid, as citric or tartaric acid, by melting or in solution, crystallizing slowly, and afterwards heating to expel moisture.

597,745—January 25, 1898. P. SCHIDROWITZ AND O. ROSENHEIM. *Piperidin derivative.*

New products, as a derivative of piperidin with guaiacol of the formula $(C_7H_8O_2)_2C_5H_{11}N$, are produced by acting upon piperidin or its homologues with an ether of a monoxyphenol.

615,488—December 6, 1898. L. KNORR. *Morpholin and process of making same.*

A new product, the morpholin C_4H_9NO, a liquid with b. p. 128° C., soluble in water, alcohol, etc., having an odor similar to piperidin, is produced by heating certain derivatives of dioxyethylamin with acid condensation agents, then making the solution alkaline and distilling with steam.

PROTEIDS.

544,912—August 20, 1895. N. R. FINSEN. *Process of making hæmatin albumen.*

A new food product is produced by mixing defibrinated blood with nitric acid, coagulating with heat, washing and drying the albumen, heating the product *in vacuo*, and powdering.

566,280—August 18, 1896. O. SCHMIEDEBERG. *Process of obtaining iron derivatives of albumen.*

An iron derivative of albumen is extracted from the liver or other animal organ by slowly heating with water to the boiling point, separating the coagulum and treating it with dilute tartaric acid.

567,706—September 15, 1896. D. FINKLER. *Method of obtaining albumen.*

The fatty constituents of albuminous substances being first saponified and washed out, the other undesirable constituents are decomposed by boiling with a suitable reagent, as peroxide of hydrogen; the products of decomposition are washed out with a neutral salt solution, the albumen separated from the solution, and traces of the latter removed with alcohol.

632,408—September 5, 1899. W. A. HALL. *Process of producing casein.*

The curd is precipitated from milk by means of muriatic acid, and the casein thus formed is subjected to a temperature sufficient to volatilize the acid—about 120° F.—and preferably in the presence of a current of air.

GROUP XIX.—CHEMICALS NOT OTHERWISE ENUMERATED.

INORGANIC.

SULPHUR.

166,279—August 3, 1875. S. H. JOHNSON. *Improvement in methods of and apparatus for separating free sulphur.*

The sulphur-bearing substance in a dry state is mixed with carbon bisulphide and heated in a closed vessel with agitation; the agitation stopped, and the liquid contents forced through the settled granular residuum forming a filter by the vapor pressure generated. A fresh charge of carbon bisulphide is then admitted into the extractor, mixed with the residuum by agitation, settled, the liquid contents discharged into a separate receiver, and the resultant product applied to a fresh charge of sulphur-bearing material, thus securing a strong solution for evaporation.

182,362—September 19, 1876. E. J. FRASER. *Improvement in processes and apparatus for refining and packing sulphur.*

Fused sulphur is run into wet sacks.

349,981—September 28, 1886. C. F. CLAUS. *Obtaining sulphur from hydrogen sulphide.*

Hydrogen sulphide mixed with a chemical equivalent of atmospheric oxygen is passed through anhydrous oxide of iron preheated to not less than 93° C., whereby the desired heat of the oxide is maintained, and free sulphur is continuously formed.

354,393—December 14, 1886. C. F. CLAUS. *Process of obtaining sulphur from sulphureted hydrogen.*

As an improvement on the process of No. 349,981, the iron oxide is mixed with lime, magnesia, alumina, or like substances to prevent the formation of clinkers.

359,164—March 8, 1887. H. L. LIGHTNER. *Apparatus for atomizing sulphur.*

Sulphur is reduced to an impalpable powder by atomizing liquid sulphur with a jet of hot air or steam.

361,761—April 26, 1887. E. HÄNISCH AND M. SCHROEDER. *Process of obtaining sulphur from furnace-gases.*

The furnace gases are passed through water or a water-tower; which water is then heated, and the sulphurous acid gas thereby absorbed and given off is passed through or over a glowing bed of fuel, and then through a glowing mass of fire-brick in the absence of a reducing agent.

443,629—December 30, 1890. E. F. WHITE. *Manufacture of flowers of sulphur.*

Liquid sulphur, melted by a steam coil without boiling, is fed through a siphon into a retort and boiled under less than an atmospheric pressure, the vapor being passed to a condenser and the condensed sulphur forced by an air blast to a receiver. The air blast creates the partial vacuum in the retort and the flow of liquid sulphur thereinto.

493,193—March 7, 1893. C. W. STICKNEY. *Process of roasting sulphur-bearing ores.*

One portion of the ore is roasted with steam generating hydrogen sulphide, and another portion is roasted with air generating sulphurous acid gas, and the gases are mingled in contact with a solution of a sulphate of iron, copper, or zinc, resulting in the deposition of the sulphur.

502,431—August 1, 1893. H. H. EAMES. *Process of desulphurizing metallic ores.*

See Group X, Electro-chemistry.

616,391—December 20, 1898. V. DE BARANOFF AND E. HILDT. *Process of obtaining sulfur from sulfates.*

Sulphur, sulphurous acid, and sulphides are simultaneously produced direct from sulphates by reducing a metallic sulphate by means of carbon under heat, causing the carbonic acid generated to act in presence of water upon a metallic sulphide to generate hydrogen sulphide; and then treating a metallic sulphate with the hydrogen sulphide under heat and decomposing the sulphate into sulphur, sulphurous acid, and sulphides.

PHOSPHOROUS.

171,813—January 4, 1876. A. G. HUNTER. *Improvement in retorts for distilling phosphorous.*

The phosphoric-acid mixture is heated in a retort and the volatilized products are caused to pass through carbon in another portion of the retort heated to a white heat before passing to the condenser.

417,943—December 24, 1889. J. B. READMAN. *Process of obtaining phosphorous.*

See Group X, Electro-chemistry.

452,821—May 26, 1891. H. H. WING. *Manufacture of phosphorus.*

A mixture of a phosphate and a silicate is calcined by a reducing flame at a high temperature, whereby phosphoric anhydride is expelled and reduced, the fumes passing to a depositing chamber maintained at about 260° C., in which red phosphorus is deposited, the remaining fumes being conducted through water chambers in which yellow phosphorus is condensed.

527,163—October 9, 1894. A. SHEARER AND R. R. CLAPP. *Process of making phosphorus.*

A pulverized mixture of a metallic chloride—as sodium or potassium chloride—and carbon and calcined phosphate of alumina is heated in a retort in the presence of dried hydrochloric acid gas.

602,747—April 19, 1898. C. K. HARDING. *Process of smelting phosphorus.*

See Group X, Electro-chemistry.

CARBON.

90,824—June 1, 1869. J. DICKINSON. *Improvement in the preparation of mineral carbon for use in the arts.*

Black diamonds are shaped with drill points and cutting edges and faces for dressing or cutting stones, etc., and firmly setting in metal tools, by rubbing or abrading one diamond or carbon against another.

263,758—September 5, 1882. C. F. BRUSH. *Process of baking carbon rods.*

For baking, the rods are stacked in pyramidal form in a receptacle and the interspaces and spaces at ends and sides of the pyramidal pile filled with sand.

379,960—March 27, 1888. C. H. LAND. *Manufacture of refractory carbon.*

Carbonaceous matter is subjected in an open muffle, located in a furnace, to the products of combustion under pressure, whereby a counter-resistance is offered to expel oxygen from the muffle, prevent ignition of said matter, and drive off determined elements therefrom.

568,323—September 29, 1896. E. G. ACHESON. *Manufacture of graphite.*

See Group X, Electro-chemistry.

598,549—February 8, 1898. H. H. WING. *Process of manufacturing graphite.*

See Group X, Electro-chemistry.

617,979—January 17, 1899. E. G. ACHESON. *Method of manufacturing graphite articles.*

See Group X, Electro-chemistry.

645,285—March 13, 1900. E. G. ACHESON. *Method of manufacturing graphite.*

See Group X, Electro-chemistry.

HALOID COMPOUNDS.

696,573—October 8, 1867. J. E. MILLS. *Improvement in the manufacture of chloride of zinc.*

Zinc chloride is produced direct from its oxide, carbonate, or silicate ores by digesting same with muriatic acid. In the case of silicate ores the chloride is freed from the gelatinous silica by evaporating the water and excess of acid and redissolving the zinc chloride. Iron and manganese, when present, are separated by drying the digested mass, oxidizing, and redissolving the zinc chloride.

175,583—April 4, 1876. J. WYETH. *Improvement in compressed chloride of ammonium.*

Chloride of ammonium is compressed into a rod or cylinder, for convenience in use.

196,464—October 23, 1877. C. LENNIG. *Improvement in manufacture of sal ammoniac and sulphate of soda or potash.*

A mixture of sulphate of ammonia and muriate of soda, or potash, is continuously fed into and through a furnace chamber heated to a dull cherry-red heat, and sulphate of soda, or potash, continuously withdrawn; sal ammoniac being continuously condensed in a condensing chamber in the form of flaky particles.

212,596—February 25, 1879. W. GENTLES. *Improvement in manufacture of muriate of ammonia.*

Suitable ammoniacal liquor is distilled and the volatilized carbonate of ammonia passed into a solution of calcium chloride, the resultant solution heated, the remaining clear liquor treated with hydrochloric acid, and the arsenic of the calcium-chloride and hydrochloric acid precipitated as tartar-sulphide of arsenic plus a little sulphur. The clear and settled liquor is rendered alkaline with the ammoniacal liquor evolved, the iron settled, and the liquor condensed to crystallization.

220,449—October 7, 1879. W. H. WAHL AND E. Y. ELTONHEAD. *Improvement in the manufacture of chloride of zinc.*

Crude chloride of zinc is made from precipitated dross by granulating the same and treating with hydrochloric acid.

231,860—August 31, 1880. E. SOLVAY. *Manufacture of chloride of lime.*

The hydrate of lime is formed into small fragments of uniform size, as little balls.

234,595—November 16, 1880. J. F. N. MACAY. *Manufacture of ferric oxide and cupric chloride.*

See Group XIX, Inorganic, Oxides.

236,051—December 28, 1880. E. J. MALLET, JR. *Manufacture of chloride of zinc.*

A refrigerant is applied to the surface stratum only of a solution containing zinc sulphate and a salt, such as sodium chloride, and the crystallization excited extends throughout the warmer body of the solution as well as the cold top stratum.

319,118—June 2, 1885. A. PATCHEN. *Solution of dichloride of copper, etc., for treating ores.*

A solution of sulphate of copper with sodium chloride and metallic copper is subjected to pressure and heat in a closed retort.

330,155—November 10, 1885. T. SCHMIDTBORN. *Process of making ammonium chloride.*

Ammonium sulphate and potassium chloride are brought together in an aqueous solution and heated to about 150° C. for an hour, cooled until needles begin to form, when the supernatant liquor is removed and evaporated to obtain the ammonium chloride, while the precipitate—potassium sulphate—is freed from adhering liquor.

338,061—March 16, 1886. R. GRÄTZEL. *Process of making fluorine salts.*

Fluoride of aluminium and double fluorides of aluminium and potassium, or of aluminium and sodium, are produced from fluorides of alkali metals by treatment with chloride of aluminium.

351,184—October 19, 1886. C. F. MABERY. *Producing anhydrous aluminium chloride.*

Hydrochloric-acid gas is passed over aluminium or aluminium alloy heated to from 200° to 300° C., and the vaporized aluminium chloride formed is condensed; or hydrochloric-acid gas is passed through an electric furnace where aluminium is being reduced from its ore or compounds.

356,153—January 18, 1887. G. JÁRMAY. *Separating ammonium chloride from solutions by refrigeration.*

Sodium chloride is added to the warm liquor obtained in the ammonia-soda process, containing ammonium chloride, sodium chloride, and carbonates of ammonium and of sodium, and it is then refrigerated and ammonium chloride deposited. The liquor may be then warmed, more sodium chloride added and again refrigerated with deposition of ammonium chloride; the mother liquor being then used in the ammonia-soda process instead of brine.

359,601—March 22, 1887. W. FRISHMUTH. *Process of making aluminium chloride.*

An intimate mixture of aluminium oxide, sodium chloride, and carbon, in equal parts by weight, with a carbonizable agglutinating material, as molasses, is molded into lumps and subjected to a temperature high enough to carbonize without disintegrating the lumps, and then distilled in a retort in the presence of chlorine gas.

385,345—July 3, 1888. C. A. FAURE. *Process of obtaining aluminium chloride.*

An aluminium ore is heated in direct contact with the flame to a proper combining temperature, then a mixture of hydrochloric-acid gas and hydrocarbon vapor is passed over the heated ore and the resulting vapor condensed.

386,137—July 17, 1888. G. JÁRMAY. *Separating ammonium chloride.*

To the residual liquor from the ammonia-soda process there is added at one operation the requisite quantity of sodium chloride to replace the ammonium chloride, such amount being greater than what would saturate the original ammonium chloride liquor. The salt is kept in suspension by constant agitation, and at the same time cooled, whereby ammonium chloride separates out. The mother liquor is applicable in the ammonia-soda process in the place of brine.

386,704—July 24, 1888. L. GRABAU. *Manufacture of aluminium fluoride.*

The alkali fluoride in cryolite is converted into aluminium fluoride by treating cryolite with sulphate of ammonia, evaporating the solution, heating the product to redness and finally washing the same.

393,578—November 27, 1888. L. PAGET. *Production of zinc chloride, etc.*

See Group X, Electro-chemistry.

409,668—August 27, 1889. H. Y. CASTNER. *Purifying aluminium chlorides.*

Anhydrous double chlorides of aluminium are melted with a suitable quantity of a metal, as aluminium or sodium, adapted to reduce the contained iron to a metallic state, which is then separated.

412,800—October 15, 1889. W. SHAPLEIGH. *Process of making lead chloride.*

Finely divided lead is introduced into an aqueous solution of nitric acid, a blast of air being forced through the liquor while it is undergoing chemical action. Lead chloride is then precipitated by the addition of hydrochloric acid together with a blast of air to oxidize the lower oxides of nitrogen given off, and lead nitrate is then added to remove the excess of hydrochloric acid.

414,835—November 12, 1889. F. W. A. FRERICHS. *Process of making bromides of the alkalis.*

Bromides of potassium, of sodium, and of ammonium are produced from their respective sulphates by mixing the sulphate with calcium hydroxide, calcium sulphite, or calcium bisulphite, water, and bromine. By evaporation and crystallization the pure bromides are obtained.

422,500—March 4, 1890. H. Y. CASTNER. *Process of purifying aluminium chloride.*

The anhydrous double chloride compounds of aluminium containing iron are melted and passed through a series of electrolytic tanks, the iron chlorides being decomposed and metallic iron deposited. The electric current gradually decreases in quantity proportioned to the gradually decreasing quantity of iron.

434,044—July 1, 1890. O. O. B. FROELICH. *Process of making antimony fluorides.*

A powdered mixture of antimony ore, alkaline nitrates, and fluor spar is treated with oil of vitriol, and the soluble matter then extracted with water and steam. After neutralizing with alkalis the liquor is evaporated to crystallization.

447,063—February 24, 1891. E. RICHTER. *Process of making artificial cryolite.*

Gaseous silicic fluoride, obtained in treating phosphates containing fluorine with sulphuric acid, is converted with water into a solution of hydrofluosilicic acid, and treated with alumina hydrate and a caustic alkali or an alkali carbonate to form artificial cryolite and silicic acid, which are separated by filtration.

479,925—August 2, 1892. C. WACHENDORFF. *Double salts of fluoride of antimony and sulphate of ammonia.*

A new double salt of fluoride of antimony and sulphate of ammonia having the formula $(SbFl_3)_2.1\frac{1}{2}(NH_4)_2SO_4$, is produced by pouring into not too much water the product obtained by heating crude antimony with sulphuric acid, producing a basic sulphate of antimony which is put into the theoretical quantity of ammonium fluoride in aqueous solution, heated, and then crystallized out. Also by charging fluoride of antimony with less than the theoretical quantity of ammonium sulphate for crystallization.

508,796—November 14, 1893. W. ACKERMANN. *Process of making aluminum fluoride.*

To produce an aluminium fluoride solution free from silicious bodies, calcined silicate of aluminium is treated with an acid, as hydrofluoric acid, whereby the silicon is converted into insoluble silicic acid which is removed by filtration.

509,478—November 28, 1893. T. MAYER. *Antimony compound and process of making same.*

A new series of double salts, crystalline compounds corresponding to the type $2SbF_3 . M_2 SO_4$, are produced by causing an alkali sulphate to act upon antimonious fluoride in quantities of two molecules of the latter to one of the former. Oxide of antimony is dissolved in a mixture of one-third hydrochloric acid and two-thirds hydrofluoric acid and then the alkali metal sulphate is added.

513,001—January 16, 1894. H. S. BLACKMORE. *Process of making alkali salts.*

Soluble non-silicious salts of the alkalis are produced from insoluble combinations or mixtures containing alkali silicates by exposing the alkali silicate (as orthoclase) to the action of the oxide and salt of an earth metal (as calcium oxide and calcium chloride), at a high temperature, say 1,100° C., in the presence of super-heated steam under super-atmospheric pressure, then cooling and separating the soluble alkali salt or salts.

513,971—February 6, 1894. W. ACKERMANN. *Process of making aluminum fluoride.*

Iron is removed from solutions of aluminium fluoride by converting it into a ferrous combination by means of hydrosulphuric acid, and then crystallizing out the aluminium fluoride.

514,125—February 6, 1894. F. M. LYTE AND G. LUNGE. *Process of making caustic alkali and lead chloride.*

See Group II, Caustic Soda.

523,715—July 31, 1894. A. SOMMER. *Process of making liquid chlorides.*

Chlorides are made from solid substances by exposing the same to chlorine and allowing the liquid chloride to drain away as rapidly as formed without previous volatilization. In flowing through a cooler in a thin stream to a receiver it is subjected to the action of chlorine gas.

529,070—November 13, 1894. P. GREDT. *Process of recovering iodides, chlorides, or other salts from blast-furnace gases.*

The gases are subjected to water showered as fine rain, the same liquid being pumped up and used until a strong lye is produced, which is evaporated down, the volatile constitutents being driven off, and the solid residue containing iodide and chloride of potassium is dissolved in water and separated by fractional crystallization.

532,150—January 8, 1895. O. O. B. FROELICH. *Double salts of antimony.*

A new antimony mordant, a soluble crystalline compound of antimony fluoride with a double oxalate of antimony and alkali, is produced by combining solutions in water of antimony fluoride and of oxalate of antimony and alkali, in the proportion of one molecule of oxalic acid to three molecules of hydrofluoric acid.

535,601—March 12, 1895. C. SCHILL AND C. SEILACHER. *Double salt of antimony and process of obtaining same.*

A new compound, a double salt of antimonious fluoride, having the formula $3SbF_3.NH_4F$, forming rhombic prisms and soluble in the proportion of 10 parts of salt to 8 parts of water, is produced by dissolving 100 parts of antimonious oxide in excess of hydrofluoric acid, then adding 4 parts of ammonia, filtering and crystallizing.

558,725—April 21, 1896. F. A. GOOCH. *Process of producing hydrous chloride of aluminium.*

Aluminous material heated and under pressure is treated with dilute hydrochloric acid of half strength; the filtered solution is treated with gaseous hydrochloric acid to the point of saturation, and the resulting precipitated hydrous aluminium chloride is separated out and washed with concentrated hydrochloric acid.

558,726—April 21, 1896. F. A. GOOCH. *Process of producing hydrous chloride of aluminium.*

A suitable aluminous earth is heated with sulphuric acid until the acid fumes cease to be evolved, and the process is then proceeded with according to No. 558,725.

582,938—May 18, 1897. W. MILLS. *Process of making fluorides.*

Metallic fluorides are prepared from aqueous solutions of metallic chlorides by heating together a mixture of ammonium sulphate and calcic fluoride (fluorspar) at about 350° C., and then adding the ammonium fluoride thus obtained to the chloride solution.

599,111—February 15, 1898. F. RAYNAUD. *Process of making aluminium-sodium chloride.*

A current of hydrogen sulphide and a current of atmospheric air are passed alternately through a mass of blocks of a porous mixture of bauxite, carbon, and sea salt heated to redness until the whole of the aluminium is converted into chloride.

640,908—January 9, 1900. H. K. HESS. *Process of and apparatus for making chloride of zinc.*

Hydrogen gas is produced by heating chloride of zinc above its melting point by contact with a body of incandescent carbon in a state of combustion, introducing steam into the carbon, and reducing the zinc chloride, thereby forming hydrochloric acid and zinc, vaporizing the hydrochloric acid which passes over to a condenser, the metallic zinc passing through the carbon into a receptacle, and finally uniting the zinc and the acid, and re-forming chloride of zinc and producing hydrogen.

641,406—January 16, 1900. J. G. A. RHODIN. *Process of obtaining soluble potassium salts from feldspar.*

A pulverized mixture of feldspar (orthoclase), lime, both equal parts, and sodium chloride, one-fifth part, is heated to a bright yellow heat and maintained for a considerable time without melting or fusion. After cooling the potassium readily combines with acids to form salts. For fertilizer purposes an excess of lime is advantageous.

648,809—May 1, 1900. O. J. STEINHART, J. L. F. VOGEL, AND H. E. FRY. *Process of making anhydrous zinc chloride.*

A zinc chloride solution is boiled in a partial vacuum. A current of previously dried air is passed through and over the molten chloride.

OXIDES.

151,219—May 26, 1874. R. GUENTHER. *Improvement in the manufacture of dry soluble silica.*

Concentrated silicate of soda or potash is added to hyposulphite of soda which has been heated until the water of crystallization is nearly evaporated, causing the liquid glass to coagulate. The latter is taken out, freed of adhering hyposulphite by pressure while yet warm, and subsequently pulverized. The hyposulphite is evaporated and again used.

206,635—July 30, 1878. R. & C. STEINAU. *Improvement in preparation of peroxide of iron.*

Water is caused to alternately rise and fall through a layer or mass of iron scraps, as lathe turnings, and the peroxide formed is collected.

234,595—November 16, 1880. J. F. N. MACAY. *Manufacture of ferric oxide and cupric chloride.*

Modified hydrated ferric oxide, after being calcined, known as "colcothor" or "jewelers' rouge," and cupric chloride are produced at one operation by the mutual reaction, in the presence of air, of cupric oxychloride and solution of ferrous chloride; or ferrous or ferric sulphate and cupric oxychloride are digested in a solution of sodium chloride with access of air.

239,346—March 29, 1881. C. SCHEIBLER. *Process of obtaining magnesia.*

Dolomite or other lime and magnesia compound is burned and then treated with a saccharine solution, 10 to 15 per cent of sugar, to dissolve out the lime, the magnesia being separated from the other insoluble constituents after precipitation by decantation, filtration, or otherwise. The caustic product may be comminuted by slaking to a pulverulent hydrate and then treated with the saccharine solution.

252,982—January 31, 1882. J. WEBSTER. *Manufacture of soluble alumina.*

Aluminous material, as commercial alum, is mixed with carbonaceous material, as gas pitch, and roasted; then treated with dilute hydrochloric acid and allowed to give off sulphureted hydrogen; then steam and air is passed through the compound while heated to carry off sulphur and ferric sulphide; and finally the residuum is boiled and the liquor drawn off after cooling, leaving the soluble alumina as a precipitate. The vapors of sulphur and ferric sulphide are condensed for use in the manufacture of colors, etc.

266,115—October 17, 1882. A. K. EATON. *Preparing peroxide of lead.*

Red lead is treated with acetic acid, by which the peroxide component of the red lead is removed, producing acetate of lead and leaving the peroxide of lead as a residuum.

266,970—November 7, 1882. J. B. M. P. CLOSSON. *Manufacture of magnesia.*

Crude or artificially recarbonated dolomite is digested with a solution of chloride of calcium and the resulting solution of magnesium chloride is heated with calcined dolomite or ordinary burned lime.

267,551—November 14, 1882. C. MARCHAND. *Manufacture of binoxides of barium and calcium.*

Barium or calcium binoxide is produced by subjecting baryta or lime, heated to a red heat, to the action of ozonized oxygen or ozonized air.

285,579—September 25, 1883. J. D. DARLING. *Process of producing alumina.*

Alumina is obtained from alum salts or compounds, or from aluminum sulphate by forming a gelatinous hydrated precipitate, subjecting the precipitate to a suitable heat to convert it into a calcined oxide and expel therefrom the sulphate of ammonia contained therein, and finally leaching therefrom the remaining sulphates or other impurities.

294,051—February 26, 1884. J. K. KESSLER. *Process of making copper salts by the aid of electricity.*

See Group X, Electro-chemistry.

305,828—September 30, 1884. C. MARCHAND AND V. M. PICABIA. *Manufacture of anhydrous caustic baryta.*

Barium nitrate is subjected in a closed vessel to the direct action of gases heated to 1,000° to 1,300° C., driving off the oxide of nitrogen and liquefying the baryta. The retort has a removable top and is mounted on trunnions and, after solidification, the cake is dumped.

318,603—May 26, 1885. G. DEUMELANDT. *Process of separating basic compounds from slags.*

The free bases contained in basic slag are separated by treating the pulverized slag at the boiling temperature with a solution of a suitable ammonium salt, filtering off the solution, and treating the filtered solution with a mixture of air and carbonic acid in the presence of ammonia, to precipitate the dissolved oxides.

338,628—March 23, 1886. L. Q. & A. BRIN. *Manufacture of anhydrous oxide of barium.*

In the manufacture of anhydrous oxide of barium or baryta by calcining barium nitrate, moisture and carbonic acid are excluded from the baryta while cooling by exhausting the air of the cooling chamber, or filling same with a gas, such as nitrogen, destitute of moisture, and carbon dioxide.

359,423—March 15, 1887. A. BRIN. *Process of making barium bioxide.*

Barium nitrate is first heated to form caustic baryta, then the caustic baryta is reheated in a closed vessel with an exhaust to remove the nitrous and other gases given off, and when the vapors cease to be given off atmospheric air is admitted to form barium bioxide.

370,511—September 27, 1887. C. L. & W. J. WIGG AND M. STEELE. *Obtaining ferric oxide from the waste liquors of copper-works.*

The residual liquors obtained in the precipitation of copper by the wet process and the residual chloride-of-calcium liquor obtained in the manufacture of chlorine by the Weldon process are mixed and agitated, the precipitate and supernatant liquor separated, and the liquor treated with an equivalent of lime to precipitate the iron, which is oxidized and furnaced. The white precipitate first formed is treated with dilute hydrochloric acid, washed, pressed, and gently heated to purify and prepare the sulphate of lime for use as a by-product.

382,197—May 1, 1888. F. J. SEYMOUR. *Method of obtaining alumina from clay.*

Clay or aluminous earth mixed with a deoxidizing agent, as pulverized carbon, and a flux, such as chloride of sodium, and with copper or other metal of greater specific and atomic weight than aluminum, is heated to a temperature of 1,400° to 2,000° C., and the mixed vapors are condensed and collected in a conduit, silica first depositing, and beyond, alumina mixed with the metallic oxide.

382,273—May 1, 1888. F. J. SEYMOUR. *Method of obtaining alumina from clay.*

A modification of the process of No. 382,197, the clay being mixed with zinc, carbon, and a flux.

382,505—May 8, 1888. K. J. BAYER. *Process of obtaining alumina.*

Pure alumina compounds are obtained from bauxite and other materials containing alumina, by subjecting the aluminate lye under constant stirring and at ordinary temperature to the action of hydrate of alumina, so as to decompose said solution and precipitate hydrate of alumina, the remaining mother liquor being concentrated, mixed with bauxite or other material containing alumina, and the mixture calcined.

440,539—November 11, 1890. F. CANDY. *Process of preparing iron ore for filters.*

Argillaceous carbonate of iron is subjected in a closed retort to a carbonizing but not a fusing heat, gradually cooled and then pulverized for use for filtering purposes.

455,229—June 30, 1891. L. MOND. *Process of making compounds of nickel and carbon monoxide.*

Oxidized nickel ore is exposed to the reducing action of carbon monoxide, hydrogen, or a hydrocarbon, at from 300° to 350° C.; then the reduced oxide is cooled to below 150° C. and treated with carbon monoxide (free from uncombined oxygen and halogens) till the nickel is extracted and the vapors are condensed.

455,229—June 30, 1891. L. MOND. *Compound of nickel and carbon monoxide.*

Nickel-carbon oxide, a compound of nickel and carbon monoxide of the formula NiC_4O_4, is a colorless liquid, B. P. about 43° C., but very volatile in the presence of other gases. Solidifies at −25° C.

455,611—July 7, 1891. P. A. EMANUEL. *Process of reducing kaolins and clays to their component oxides.*

The clay, stirred in with water until in a state of suspension, is treated with sulphuric acid and heat, and the sulphate of alumina separated from the silica, iron being removed with binoxide of lead or manganese, and the solution evaporated to recover the sulphate of aluminium. Sulphate of aluminium is reduced to alumina by mixing with sulphur and heating, the fumes being conducted to sulphuric-acid chambers.

461,416—October 20, 1891. J. A. BRADBURN AND J. D. PENNOCK. *Process of obtaining alumina from bauxite.*

The iron and organic matter in ferrous bauxite is oxidized by mixing the ground mineral with a solution of hypochlorite and then passing carbonic-acid gas into the solution. The oxidized bauxite is then treated with a caustic-soda solution, filtered, and the hydrate of aluminium precipitated and calcined.

494,757—April 4, 1893. H. Y. CASTNER. *Manufacture of oxides of the alkaline metals.*

The alkaline metals, heated to about 300° C., are oxidized by the action of air with a decreasing proportionate mixture of nitrogen, the material being moved through a tubular retort in one direction with a current of air moving in the opposite direction.

514,039—February 6, 1894. H. F. D. SCHWAHN. *Process of purifying aluminous minerals.*

Minerals containing alumina are roasted, ground, and mixed with hydrochloric and nitric acids—or crude material as sodium chloride and sodium or potassium nitrate to produce the same—then sulphuric acid is added, the decomposed mass is heated, the waste nitro-hydrochloric acid and produced ferric chloride are evaporated and expelled, and the remaining soluble and insoluble impurities respectively removed by washing and floating.

515,895—March 6, 1894. K. J. BAYER. *Process of making alumina.*

Alumina is dissolved direct from bauxite by mixing pulverized bauxite in a concentrated aluminate lye formed by subjecting an aluminate lye under constant stirring and at ordinary temperature to the action of hydrate of alumina so as to decompose said solution and precipitate hydrate of alumina, then filtering off the precipitate and concentrating the remaining aluminate lye. The mixture is subjected to constant agitation at a pressure of three to four atmospheres at a temperature of 160° to 170° C.

519,704—May 15, 1894. A. G. FELL. *Obtaining lead salts from native ores.*

Ground lead ores are treated in an acid solution containing free sulphuric acid and formed of sulphuric acid, another inorganic acid, as muriatic or nitric acid, sulphate of soda, and water. The undissolved residue is separated from the solution of soluble salts, any contained silver is removed, and the residue is subjected under a moderate heat to a compound, as sal-soda, which contains an alkaline base. The insoluble lead salts are separated from this solution, nitric acid or nitrate is mixed with the residue, and it is roasted if an oxide is to be produced.

544,319—August 13, 1895. A. W. NIBELIUS. *Process of extracting aluminium oxid.*

The raw material—clay, clay-slate, anthracite-slate, minerals, and rocks, alone or mixed with pyrites—is mixed with the sulphate or bisulphate of an alkali and subjected while heated to a petroleum air flame, the acid being condensed and utilized for lixiviating the alumina, which is finally precipitated.

585,522—June 29, 1897. H. JAEGER. *Process of making tin oxid.*

Metallic tin is raised to a high temperature, 1,200° C., in the absence of air; then, when at said high temperature, abundance of air is admitted to the molten metal, and the tin oxide formed is removed.

624,041—May 2, 1899. C. B. JACOBS. *Process of manufacturing soluble barium compounds.*

See Group X, Electro-chemistry.

626,330—June 6, 1899. C. LUCKOW. *Process of producing peroxide of lead.*

See Group X, Electro-chemistry.

626,547—June 6, 1899. C. LUCKOW. *Process of producing oxid of copper.*

See Group X, Electro-chemistry.

641,550—January 16, 1900. M. E. ROTHBERG. *Process of making magnesia and plaster-of-paris.*

Limestone containing carbonate of magnesia is dissolved in hydrochloric acid producing a solution of the chlorides of calcium and magnesia; calcium oxide is added to precipitate magnesia and form additional calcium chloride; the liquor is drawn off, leaving the magnesia to be washed and dried, and sulphuric acid is added to precipitate calcium sulphate, which is separated, dried, and calcined. The hydrochloric-acid solution is reused.

644,050—February 27, 1900. H. BECKMANN. *Manufacture of lead peroxide and its application to electrical storage batteries.*

See Group X, Electro-chemistry.

647,320—April 10, 1900. S. B. NEWBERRY. *Process of making strontia.*

A mixture of strontium sulphate, or celestite, and an oxide of an alkaline earth, as lime, is calcined at a high temperature. The calcined product is leached.

650,023—May 22, 1900. H. OPPERMANN. *Process of making magnesium superoxid.*

Magnesium hydrate, 50 parts, moistened to such an extent only that it retains its powdery form, is mixed with dry, pulverized, sodium superoxide, 10 to 12 parts. An excess of dry, pulverized magnesium hydrate is added during the reaction to reduce the temperature of the mixture below that at which oxygen is liberated.

650,518—May 29, 1900. C. SAVIGNY. *Process of making dioxid of barium.*

A mixture of hydrated crystallized baryta and finely divided carbon in equal parts is heated to 150° C. to drive off the greater part of the water; the mixture is then heated in a metallic basin for two to three hours at 100° to 150° C., when the magma is transferred to and heated in a crucible lined with carbonaceous material, as cardboard, to 1,000° to 1,200° C. for from five to eight hours, producing porous anhydrous oxide of barium, which is then deoxidized.

650,763—May 29, 1900. E. RAYNAUD. *Method of obtaining alumina from its ores.*

A mixture of crushed aluminous ore, ores which resist attack wholly or partially by sulphurous acid, and a quantity of a sulphureted compound of an alkaline metal, as sodium sulphide, smaller than would be necessary for forming aluminates, is heated to a dark red heat for about two hours; then lixiviated, and the residue treated to the action of a current of sulphurous-acid gas in combination with water, the alumina dissolving as a sulphite. The solution is then filtered, heated, and the precipitate calcined, yielding alumina and sulphurous gas.

SULPHIDES.

126,275—April 30, 1872. A. K. EATON. *Improvement in the manufacture of sulphide of sodium.*

Crude sulphate of soda is melted in a heated tube and percolated through highly heated carbon, whereby it is decomposed and sodium sulphide produced.

233,680—October 26, 1880. E. C. E. & L. L. LABOIS. *Manufacture of carbon bisulphide and sulphuric acid from pyrites, and apparatus therefor.*

See Group I, Acids, Sulphuric Acid.

278,816—June 5, 1883. C. E. PARSONS. *Method of producing golden sulphuret of antimony.*

Native sulphide of antimony (antimony glance) and sulphur are separately dissolved in saturated solutions of caustic alkali, which solutions are then mixed and the mixture treated with acid.

332,736—December 22, 1885. H. J. F. NIEWERTH. *Metallic alloy or compound in producing the same.*

Heavy metals are alloyed with the sulphurets of metals by first dissolving the sulphuret of the metal in molten zinc, and then mixing the product with the heavy metals desired to form the alloy in their molten condition, and finally cupelling off the zinc. In the formation of alloys of heavy metals with the sulphuret of metals, small quantities of the sulphuret of an alkaline metal are added to the heavy metals in their molten condition, so that the decomposition of the sulphuret takes place gradually, and the sulphur and nascent alkali are enabled to combine with the heavy metals.

343,674—June 15, 1886. E. W. PARNELL AND J. SIMPSON. *Process of treating ammonium sulphide to obtain hydrogen sulphide.*

A mixture of ammonium sulphide and ammonium sesquicarbonate in solution is subjected to the action of heat—or of a partial vacuum—hydrogen sulphide being evolved.

425,081—April 8, 1890. A. KEILLER. *Process of making zinc sulphide.*

In the precipitation of zinc sulphide from neutral hydrated solutions of zinc salts by means of hydrothionic acid, a precipitation of all of the zinc is secured by the addition of an alkaline sulphate which is soluble in water and indifferent to the hydrothionic acid, as potassium sulphate.

463,143—November 17, 1891. P. A. EMANUEL. *Process of, and apparatus for, preparing aluminium sulphide.*

Dry aluminium sulphate mixed with sulphur is heated in a retort, and carbon bisulphide is injected into the residual product. An angular entrance for the carbon bisulphide jet gives a rotary movement to the charge.

513,660—January 30, 1894. C. T. J. VAUTIN. *Process of making aluminum sulfid.*

Metallic aluminium, slightly in excess, and lead sulphide (galena) are melted together at a bright red heat, producing metallic lead and aluminium sulphide.

586,567—July 20, 1897. B. VON SCHENK. *Process of making polysulfids.*

A mixture of sulphur and hydrated lime in the proportions, respectively, of 60 and 40 per cent, is boiled in water and a lye formed of 10° Baumé, descanted, and reduced to about 5° Baumé, when an alkali carbonate is added, and the solution descanted and evaporated to dryness, cooled, and ground, thus producing alkaline polysulphides by a reaction between soluble polysulphides of calcium and alkaline carbonates, or sulphates.

605,378—June 7, 1898. H. S. BLACKMORE. *Process of making aluminium sulfid.*

A heated mixture of aluminium oxide and carbon bisulphide is blown into a retort containing a chemically inert molten bath capable of dissolving aluminium sulphide, as cryolite, with a mixture of potassium and sodium chlorides.

605,458—June 7, 1898. H. S. BLACKMORE. *Process of making sulfids.*

Carbon-bisulphide vapor is passed through a molten aluminate of an alkali or other metal—as sodium aluminate or a mixture of sodium and potassium aluminate—producing aluminium sulphide with sulphides of the alkali or other metals. Aluminium oxide is added to molten sodium hydroxide to saturation, and the vapor passed therethrough.

605,812—June 14, 1898. H. S. BLACKMORE. *Process of making aluminium sulfid.*

Carbon bisulphide vapor is introduced into a fused bath—a mixture of cryolite and potassium fluoride—containing dissolved aluminium oxide, transforming the latter into aluminium sulphide.

606,576—June 28, 1898. D. A. PÉNIAKOFF. *Aluminium sulfid and process of making same.*

A new substance, porous aluminium sulphide, is produced by treating heated dehydrated sulphate of aluminium, alone or mixed with other metallic sulphates, by means of bisulphide of carbon or oxysulphide of carbon at a temperature below the fusing point of aluminium sulphide.

648,772—May 1, 1900. A. MOFFATT. *Process of making hydrosulfids.*

To produce in solution a hydrosulphide of an alkaline-earth metal, such as barium, calcium, or strontium, two equivalents of the sulphide of an alkaline-earth metal are mixed with one equivalent of a magnesium salt. A dry mechanical mixture of the ingredients is suitable for shipment and storage.

BASIC HYDROXIDES.

Ammonia.

67,447—August 6, 1867. A. PARAF. *Improvement in the manufacture of ammonia.*

Ammoniacal liquor is distilled and the vapors purified by passing through charcoal.

127,470—June 4, 1872. R. J. EVERETT. *Improvement in the preparation of ammonia, sulphur, and other products from gas-lime.*

Spent gas-purifying materials are heated in a retort, the liquefied sulphur collected, and the sulphur vapors and ammonia condensed. The condensed product is washed to obtain therefrom sulphur and a solution of the ammonia salts, which latter, on boiling, filtering, and evaporating, gives sulphate of ammonia.

132,264—October 15, 1872. H. H. & C. J. EAMES. *Improvement in treating ammoniacal liquors of gas-works, etc.*

Ammoniacal liquor is subjected to the direct action of steam or superheated steam, while flowing in a stream, to eliminate the contained volatile substances by vaporization.

137,059—March 25, 1873. T. CHRISTY, JR., AND A. BORROWNICKI. *Improvement in processes for treating sewage and ammoniacal waters for the production of fertilizers, etc.*

Ammoniacal and other liquids of gas works, sewage, etc., are treated with a solution of a hydrated silicate to agglomerate suspended or dissolved matter. Ammonia is recovered and the product may be treated to produce cyanogen and other matters.

150,007—April 21, 1874. C. M. TESSIÉ DU MOTAY. *Improvement in transforming atmospheric gases into oxygen and ammonia, etc.*

Ammonia is produced by the reaction of carbureted hydrogen upon nitride of titanium—the latter being formed by the reduction of oxides of titanium or the spent nitride of titanium from a former operation—with coke in a blast furnace. Cyano-nitride of titanium is produced by prolonging the operation in the retort. The cyano-nitride is removed and treated with a soda or potash solution, setting free ammonia and forming the cyanides of sodium or potassium and titanic acid. The cyanides are obtained by evaporation. Pure hydrogen gas combined with light carbon vapors at a low temperature—e. g., zero—may be used in place of carbureted hydrogen for producing cyanogen compounds.

156,181—October 20, 1874. J. E. SIEBEL. *Improvement in recovering phosphoric acid and purifying ammonia.*

A solution of phospate of lime obtained in the treatment of bones with phosphoric acid is saturated with ammonia, phosphate of lime precipitated, and the solution evaporated, the ammonia collected, and the phosphoric acid recovered. By using crude ammonia the same can be purified.

158,265—December 29, 1874. L. S. FALES. *Improvement in processes and apparatus for the manufacture of aqua ammonia.*

The spent liquor of gas works is heated in a closed vessel, and so long as sulphureted hydrogen escapes the gas is conducted into a vessel charged with sulphuric acid, and after sulphureted hydrogen is no longer apparent it is conducted through a cold worm into a closed receiver, from thence into the lower compartment of a filter charged with alternate beds of charcoal and caustic alkalis, from the top of the filter into an oil chamber, and from thence into an ascending series of closed vessels containing water, having communication from one to another consecutively, and also with a common branched pipe, which conducts into one or more settlers.

161,137—March 23, 1875. F. MAXWELL-LYTE. *Improvement in processes of manufacturing ammonia.*

A triad or pentad element, as antimony or bismuth, combined with a readily-oxidizable element, as potassium or sodium, is used as a body for the synthetic manufacture of ammonia from aqueous vapor and nitrogen. A temperature between 100° and 400° C. should be maintained. The alloy is regenerated by means of a reducing agent at a red heat.

193,920—August 7, 1877. S. CABOT, JR. *Improvement in processes for obtaining ammonia salts.*

Salts of ammonia and bicarbonate of soda are produced as independent products by spraying a saline soda solution through volatilized mono-carbonate of ammonia charged with carbonic-acid gas.

230,303—July 20, 1880. J. L. MARSH. *Manufacture of aqua-ammonia.*

A mixture of sulphate of ammonia, lime and water is heated and volatilized in a steam jacketed vessel, with agitation around a horizontal axis, to expose a maximum area of surface to the heat.

232,991—October 5, 1880. H. P. LORENZEN. *Method and apparatus for obtaining ammonia.*

In the recovery of ammonia from nitrogenous substances by distillation, ammonia is developed from the gases by contact with incandescent oxide of calcium. It is then subjected to a cooling agent and to the action of sulphuric acid.

253,045—January 31, 1882. H. J. E. HENNEBUTTE. *Process of treating ammoniacal salts.*

In the treatment of ammoniacal salts the liquor is acidulated to prevent the formation of froth and foam before adding lime to decompose the fixed ammoniacal salts.

258,498—May 23, 1882. O. A. STEVENS AND E. L. DU BARRY. *Combined furnace and stack for destroying noxious or poisonous gases.*

Noxious gases evolved in the treatment of gas liquor are first passed in ascending currents over moist retarding surfaces and through a spray of water, and are then burned at an intense heat.

259,145—June 6, 1882. H. J. E. HENNEBUTTE AND C. J. F. R. DE J. MENARD. *Process of treating ammoniacal liquors.*

Salts of ammonia are produced from ammoniacal liquors by subjecting the liquor to the action of the mixed chlorides of calcium and iron and evaporating or concentrating the resulting liquor. A small quantity of the double chloride of ammonium and lead is added when evaporating in sheet metal vessels to preserve the same.

263,856—September 5, 1882. H. Y. & E. B. CASTNER. *Manufacture of ammonia and bone-black.*

Boneblack and ammonia are produced by passing the bone continuously through a closed, highly heated chamber, drawing off the volatile portions and heating the same mixed with air, then passing the gases over hot slaked lime through a cooler and finally in contact with acid.

264,801—September 19, 1882. R. W. WALLACE AND C. F. CLAUS. *Utilization of by-products in the manufacture of coal-gas.*

Ammonia is separated from ammoniacal liquor by treating the liquor with sodium chloride and carbonic acid, then separating the ammonium chloride from the solution and decomposing it by lime.

265,792—October 10, 1882. T. B. FOGARTY. *Process of, and apparatus for, manufacturing gas.*

In the manufacture of water gas cyanogen and cyanides are produced and the gas freed from nitrogen by burning in a combustion chamber the carbonic oxide and hydrogen produced in a generator furnace, and then passing the incandescent products of such combustion through a mass of carbon and alkali. Ammonia is then produced by decomposing the cyanides in another chamber with steam. The charge is then returned to the cyanidizing chamber.

265,793—October 10, 1882. T. B. FOGARTY. *Process of manufacturing gas.*

The claim is for the specific production of cyanogen by process No. 265,792.

267,550—November 14, 1882. J. G. MACFARLAN. *Process of and apparatus for the manufacture of ammonia and animal charcoal.*

Superheated steam, decomposed by being passed through carbonaceous matter, is passed into the bone retorts, accelerating the carbonization and increasing the ammonia product.

269,309—December 19, 1882. L. MOND. *Manufacture of cyanogen compounds and ammonia.*

In the manufacture of cyanogen compounds or of ammonia therefrom, the materials—carbon, carbonate or oxide of barium, and a basic absorbing material, as magnesia—are mixed and molded into blocks and calcined out of contact with air before exposing them in a heated state to the action of nitrogen.

277,041—May 8, 1883. F. LORENZ. *Process of and apparatus for obtaining ammonia.*

Relates to a series of consecutive steps for treating the hot gases of bone and other furnaces; moistening, cooling, passing through towers, heating, contact with acid, reusing fluid products for collecting ammonia, etc.

278,823—June 5, 1883. J. P. RICKMAN AND J. B. THOMPSON. *Manufacture of ammonia and its salts.*

Ammoniacal salts are produced from urine or like animal excreta by mixing therewith stale urine, or a portion of similar material in a state of fermentation, and distilling the ammoniacal gases into a vessel containing acid. The impure solution thus formed is then drawn off into a still, and the ammoniacal substances volatilized through an intercepting still to remove impurities, into a vessel containing sulphuric acid, for the formation of sulphate of ammonia.

282,411—July 31, 1883. B. TERNE. *Process of treating tank-waters of slaughter-houses.*

The liquor is concentrated to a semi-solid condition and then passed into and upon the floor of a heated retort, whereby it is rapidly distilled to dryness; the ammonia being collected and the residual partly nitrogenized animal matter utilized as a fertilizing compound.

288,323—November 13, 1883. T. b. FOGARTY. *Process of and apparatus for making ammonia.*

The process involves the formation of incandescent generator gas and the decomposition of the undecomposed steam in the crude gas by the carbonic oxide contained in the gas, the conversion of the nitrogen into ammonia by contact with a falling column of pulverized carbon and alkali, and the decomposition of the cyanogen produced by steam; the temperature being controlled by an adjustment of the amount of falling cyanidized carbon and the volume of steam.

288,324—November 13, 1883. T. B. FOGARTY. *Process of and apparatus for manufacturing ammonia.*

The process consists in treating a falling shower of pulverized alkalized carbon with a current of highly-heated nitrogenous or furnace gases to form cyanogen and cyanogen salts, then transferring these compounds to separate chambers, in which they are decomposed by steam with the formation of ammonia.

291,264—January 1, 1884. J. & J. ADDIE. *Process of obtaining ammonia from furnace-gases.*

Sulphurous acid, or the gas of sulphuric acid, is mixed with the gases from blast and other furnaces to fix the ammonia, and the ammonia salts are then recovered by condensing or dissolving.

304,260—August 26, 1884. E. CAREY, H. GASKELL, JR., AND F. HURTER. *Process of obtaining ammonia from ammonium sulphate.*

Sulphate of ammonia is intimately mixed with sulphate of soda and at an elevated temperature—about 300° C.—ammonia and bisulphate of soda are produced, in which latter form the sulphuric acid may be utilized for many purposes. A current of steam is required to make the reaction complete.

337,246—March 2, 1886. C. F. CLAUS. *Process of purifying coal-gas and obtaining ammonia and other products therefrom.*

Coal gas is purified by passing it with gaseous ammonia, supplied by the process, through a mixing chamber and a series of gas scrubbers, showering the liquor successively through a series of coke towers against an ascending flow of carbonic acid, separating the sulphide of hydrogen from the carbonated ammonia liquor, and then heating the latter from 75° to 90° C.—using the carbonic acid in the coke towers—and distilling the heated liquor and condensing the carbonate of ammonia.

337,387—March 9, 1886. A. FELDMANN. *Process of manufacturing ammonia.*

In the manufacture of spirits of sal ammoniac, a liquor free from lime and lime combinations is obtained by mechanical filtration—by a filter press or a centrifugal machine—in contradistinction to precipitation and decanting.

342,237—May 18, 1886. J. VAN RUYMBEKE. *Process of obtaining ammonia.*

Ammonia compounds are produced from liquids containing organic substances in solution by showering them through forced air currents over porous substances charged with putrid ferments, and subjecting the putrefied liquor mixed with an alkali to heat in closed boilers, and collecting the gases in refrigerating and sulphuric-acid condensers.

342,722—May 25, 1886. W. C. WREN. *Process of and apparatus for distilling ammonia.*

The process consists in vaporizing aqua ammonia, cooling the vapor and discharging it into a receiver, the vapor being under constant pressure during the entire operation.

343,675—June 15, 1886. E. W. PARNELL AND J. SIMPSON. *Recovery of ammonia in ammonia-soda manufacture.*

Ammonia and sulphureted hydrogen are produced by heating alkali waste—from the Le Blanc process—with a solution of chloride of ammonium producing sulphide of ammonium, which latter is decomposed by acid sulphate of ammonia evolving sulphureted hydrogen. The neutral sulphate of ammonia is heated till it parts with a portion of its ammonia, leaving acid sulphate of ammonia available for another charge.

351,412—October 26, 1886. J. VAN RUYMBEKE. *Process of obtaining ammonia and illuminating gas from tank waters.*

Concentrated tank waters are distilled at a heat not exceeding 260° C., and the volatile products collected, whereby highly-illuminating and ammoniacal gases are obtained and decomposition of valuable substances are avoided.

351,865—November 2, 1886. C. W. ISBELL. *Process of concentrating ammoniacal liquor.*

A suitable quantity of the weak liquor is supplied to a closed heating vessel, and also a further quantity of the weak liquor to a receiving vessel submerged in cooling water, then the liquor is heated in the heated vessel, the ammonia vapor driven off passed through a cooling worm above the heating vessel, so that all aqueous vapor will be condensed and returned to the heating vessel, and finally the ammonia vapor is introduced into the weak liquor in the receiving vessel to increase the strength thereof.

352,287—November 9, 1886. J. YOUNG, DEC'D. *Process of producing currents of liquids in vacuo.*

In the separation of ammonia from sewage or other liquids in a vacuum, the force of the liquid entering the vacuum chamber is employed to operate a pump for the removal of the liquid from the chamber.

356,610—January 25, 1887. W. YOUNG AND G. T. BEILBY. *Process of and apparatus for obtaining ammonia from coal.*

The process of treating coal, shale, and other substances to obtain ammonia and ammoniacal compounds consists in heating the material to a temperature sufficient to separate its volatile matter, which latter is exhausted from the retort, passed through a condenser, and the noncondensable gases returned to the retort to aid the combustion and prevent the carrying off of air or fire gases by supplying any excess of the exhaust.

367,992—August 9, 1887. P. J. McMAHON. *Process of preparing anhydrous ammonia.*

The method consists in evaporating concentrated ammonia, separating the weaker solution resulting from said evaporation and conducting it to a receptacle, and continuously and directly conducting any aqueous vapors arising therefrom to and re-evaporating the same with the concentrated ammonia being treated. Impurities taken up by the reabsorbing liquid of a motor or other apparatus are removed and a uniform strength of liquid ammonia maintained in the system, by heating the same to expel the gases therefrom and conducting said gases to the ammonia tank, discharging the residuum, and adding to the liquid in the system water sufficient to absorb the quantity of gas collected from the reabsorbing liquid.

371,187—October 11, 1887. T. B. FOGARTY. *Process of and apparatus for making ammonia.*

Relates to modifications of No. 371,186 (Sulphites and Sulphates); as a subprocess steam is introduced in excessive volumes simultaneously with the nitrogen gas in the same superheated retort and at about the same point.

374,618—December 13, 1887. W. F. NAST. *Obtaining ammonia from manure, etc.*

Ammonia is extracted from manure or other organic matters by adding an alkaline base, treating with sodium chloride (5 per cent, lime and 2 per cent sodium chloride) in a closed vessel at a high temperature—about 150° C.—and passing the vapors through an acid bath.

379,487—March 13, 1888. L. MOND. *Obtaining ammonia and hydrochloric acid.*

The vapor of ammonium chloride is passed through a vessel containing one or more salts or oxides—as the protoxide of nickel—whereby ammonia is produced and collected. The residual ammonia is then driven off by means of a neutral gas, and collected, and superheated steam is then injected to form hydrochloric acid and complete the cycle of operations. The process is then repeated.

379,488—March 13, 1888. L. MOND. *Obtaining ammonia and chlorine from ammonium chloride.*

Process No. 379,487 is modified by injecting hot, dry air in lieu of steam, producing chlorine instead of hydrochloric acid.

381,832—April 24, 1888. F. EGNER. *Process of obtaining ammonia and bone-black.*

In the manufacture of bone-black and ammonia, the gaseous products of the bone retorts are mixed with gas from a gas producer, the ammonia is then removed therefrom, and the gas is then consumed in the furnaces, to heat the retorts.

389,781—Sepember 18, 1888. W. WEBSTER, JR. *Process of electrolyzing sewage and sea-water.*

See Group X, Electro-chemistry.

396,705—January 22, 1889. E. MEYER. *Obtaining ammonia and oxalic acid from sugar waste.*

A solution of a caustic akali is heated and a predetermined quantity of concentrated desacharized lye, or its equivalent, in the form of molasses, is gradually added at intervals with continued heat. The caustic alkali must be in excess of the organic matter—at least 8 times, but not to exceed 20. The oxalic salts are separated from the resultant mass, and the alkaline residue rendered caustic and again used.

417,777—December 24, 1889. T. B. FOGARTY. *Process of making ammonia.*

In the manufacture of ammonia by the cyanide process, incandescent gases and air to burn the gases are introduced into a moving mixture of pulverized carbon and alkali and they travel together, as in a descending column, producing alkaline cyanides and cyanates, steam being subsequently introduced to produce ammonia and other products.

417,778—December 24, 1889. T. B. FOGARTY. *Process of making ammonia.*

As a modification of the process of No. 417,777, the air is in excess of the quantity required to burn the gases.

417,779—December 24, 1889. T. B. FOGARTY. *Apparatus for making ammonia*

Apparatus for the processes Nos. 417,777 and 417,778.

454,108—June 16, 1891. H. E. BAUDOUIN AND E. T. H. DELORT. *Manufacture of ammonia from sodium nitrate.*

Nitrate of soda is mixed with a suitable hydro-carbon, as tar or coal, and heated to a temperature sufficient to decompose the hydro-carbon, 800 to 900° C., whereby the resulting hydrogen decomposes the nitrate and forms ammonia with carbonate of soda as a by-product.

459,193—September 8, 1891. A. HENNIN. *Process of making ammonia and gas.*

Gas and ammonia are simultaneously produced from coal by injecting air and steam into a bed of incandescent fuel and controlling the temperature of the generator by regulating the proportions of steam and oxygen or air, and by regulating the supply of fresh fuel above the zone of combustion.

477,089—June 14, 1892. H. VON STROMBECK. *Process of purifying ammonia.*

Crude ammonia-gas is purified by exposing it to the action of comminuted metallic sodium, which combines with the alcholic bodies.

486,647—November 22, 1892. L. STERNBERG. *Process of obtaining ammonia or other salts from molasses.*

The waste lyes resulting from the extraction of sugar or the manufacture of alcohol from molasses are freed from any excess of lime, strontia, and baryta, and concentrated to, say, 45° Baumé, then mixed with a carrier, as granulated coke, dried, and calcined in an atmosphere of superheated steam, producing ammonia gas, which is condensed and treated for the production of ammonia sulphate or otherwise, and the potassium and other salts recovered.

488,207—December 20, 1892. P. KUNTZE. *Process of and apparatus for making ammonia.*

Nitrogenous material, such as peat, is dried and then calcined, and the aqueous and the tarry vapors conducted off separately; the latter passed through incandescent material—as calcareous porous tar coke—forming tar, ammonia, and combustible gas. The calcined material is simultaneously treated with heated air and the aqueous vapor to form ammonia and heating gases, the latter being utilized for heating the air and calcining the nitrogenous material.

500,650—July 4, 1893. T. B. FOGARTY. *Apparatus for and process of obtaining combined nitrogen and fuel gases.*

A producer gas, consisting chiefly of the oxides of carbon, free nitrogen, and hydrogen, is formed and mingled with hydrocarbon vapors and highly heated, and then passed along with a falling pulverized carbon-alkali mixture and in the same direction, producing alkali cyanides, ammonia, and fuel gas.

500,651—July 4, 1893. T. B. FOGARTY. *Method of and apparatus for producing cyanides and ammonia.*

Nitrogenous gas, hydrocarbon gases and vapors, and a suitable alkali are passed together in a falling column through an incandescent retort, and produce alkaline cyanides, ammonia, and fuel gas.

505,427—September 19, 1893. G. L. VAIL AND T. CHARLTON. *Process of purifying ammonia gas.*

The process consists in passing the gas under a pressure of nine to twelve atmospheres, approximately, through a quantity of aqua ammonia at a temperature sufficiently low, as 56° F., to remove by condensation the moisture and other impurities with which the gas is laden; the aqua ammonia containing such a per cent of ammonia gas, say from 29 per cent to 32 per cent by weight, that it has practically reached the limit of gas absorption.

515,909—March 6, 1894. H. A. FRASCH. *Art of manufacturing ammonia.*

The ammoniacal liquor is distilled, the vapors cooled and the condensed matter separated, and the cooled and dehydrated ammoniacal vapors are then passed through a saturated solution of ammonia maintained at a temperature which adapts it to take up the pyridin and kindred impurities and thus act as a washer for the ammonia gas. The vapors are then absorbed.

518,428—April 17, 1894. E. SOLVAY. *Process of purifying ammonia.*

The process of purifying a flowing stream of ammonia liquor consists in raising the temperature of separate portions of said stream to unequal heat increasing in the direction of flow, and thereby evolving carbonic anhydride and sulphureted gases from the warmer portion, passing the evolved gases through the cooler portions of said liquor for preventing the escape of ammonia, evolving similar gases from said cooler portions, passing said gases through an independent cooler portion of said liquor, and finally passing the heated vapors thereof in proximity to and in a direction opposite to the flow of said stream of liquor for heating the same unequally.

521,401—June 12, 1894. T. CHARLTON AND K. M. MITCHELL. *Process of and apparatus for manufacturing aqua ammonia.*

A superheated mixture of air and steam is passed through ammoniacal liquor and through a condenser and absorbers; the strong liquor withdrawn from the first absorber; and the residuum liquor returned in the reverse direction from the last to the first absorber.

522,357—July 3, 1894. L. STERNBERG. *Apparatus for obtaining ammonia.*

Apparatus for process No. 523,819.

523,819—July 31, 1894. L. STERNBERG. *Process of making ammonia.*

Ammonia is produced from nitrogenous organic matter by calcining such material in a retort in an atmosphere of steam and of hot nonoxidating gas or gases. The gases and vapors discharged from the retort are freed from ammonia by means of sulphuric acid and returned to the retort.

528,999—November 13, 1894. L. TRALLS. *Process of obtaining fertilizers from waste lyes.*

Lyes—obtained by leaching brown coal ashes—containing acid salts of alumina and oxide of iron, and waste ammoniacal liquor are mixed in such proportions as to convert the sulphuric acid combined with the aluminium and iron oxide into ammonium sulphate and leave the alumina in the form of a hydrate, and the peroxide of iron in the form of a hydroxide, and evaporated to dryness.

547,276—October 1, 1895. L. MOND. *Process of and apparatus for obtaining ammoniacal products.*

In the extraction of ammonia and tar from producer gases, the hot gases are cooled with water, and the air for the producer is heated by the water, the cooling and heating alternating. The free ammonia is separated by a weakly acid solution of a salt of ammonia, the tar separated from the solution, and the solution brought up to the required strength of acid and again utilized.

557,166—March 31, 1896. L. STERNBERG. *Process of obtaining ammonia from waste sugar lyes.*

Gaseous nitrogenous organic compounds are transformed into ammonia by conducting the gases over a glowing contact body composed essentially of an aluminate, as the aluminate of potassium. Waste lyes from the extraction of sugar or the manufacture of alcohol from molasses are concentrated to, say, 75° Brix, then mixed with alumina and an aluminate forming a plastic mass, molded into bricks, dried, and heated in a retort to incandescence.

578,457—March 9, 1897. C. KELLNER. *Process of and apparatus for simultaneously producing ammonia, sodium hydroxid, and chlorin.*

See Group X, Electro-chemistry.

583,262—May 25, 1897. H. J. KREBS. *Process of and apparatus for distilling ammonia.*

An aqueous solution of ammonia is continuously fed into a still and a current of high pressure steam from a steam boiler is discharged into the still; the gas is conveyed away and cooled, and the residual water and the condensed steam are fed back to the steam boiler.

586,950—July 20, 1897. F. W. A. FRERICHS. *Process of purifying ammonia.*

Commercial water of ammonia, while under pressure, is subjected to a temperature of at least 180° C. and preferably higher, to set free all of the permanent gases which can develop under conditions prevailing in ice machines, which gases are removed and the resulting ammonia gas liquefied. It may then be subjected to distillation at a low temperature, preferably from 10° to 20° C. to condense and separate out the carbon compounds.

598,195—February 1, 1898. T. F. COLIN. *Process of making cyanids and ammonia.*

Powdered heated alkali is continuously showered into a closed furnace shaft, into the base of which there is directly and separately introduced, under pressure, highly heated air and fuel gas, and above the latter a heated liquid hydrocarbon; the successive steps effected being the combustion of air and gas, the dissociation of the liquid hydrocarbon, and the dissociation of the alkali and formation of cyanides, followed, outside of the furnace, by the decomposition of the cyanides by steam, and the formation of ammonia.

598,918—February 15, 1898. T. B. FOGARTY. *Process of and apparatus for making cyanids and ammonia.*

Prior to bringing producer gas into contact with a shower of pulverized alkalized carbon to form alkaline cyanides, an adjusted quantity of highly heated air is added to effect further combustion, and pulverized anthracite coal or coke or material rich in free carbon is showered through the gases to remove all oxygen and carbonic-acid gas.

607,943—July 26, 1898. H. MEHNER. *Method of producing ammonia.*

See Group X, Electro-chemistry.

Other hydroxides.

144,517—November 11, 1873. C. M. T. DU MOTAY. *Improvement in the manufacture of baryta.*

Sulphate of barium, mixed with coal, is reduced to sulphuret of barium and then transformed into hydrated baryta, or into carbonate of baryta, the intermediate reagents used being revivified and reused.

159,446—February 2, 1875. C. H. PHILLIPS. *Improvement in manufacturing milk of magnesia.*

Magnesia hydrate is prepared by subjecting a soluble salt of magnesia—as magnesia sulphate—to the action of ammonia.

326,066—September 8, 1885. W. G. STRYPE. *Process of making hydrates of barium and of strontium.*

A solution of sulphide of barium or strontium is subjected to the action of air forced up through the solution in the presence of an oxide of iron, such as ochre or other hydrated ferric oxide.

328,478—October 20, 1885. H. C. FREIST. *Manufacture of hydrate of alumina.*

A mixture of pulverized aluminous material, sulphate of soda, carbonate of lime, coal dust, and fluorspar is subjected to a high heat; the mass leached, and the solution, either before or after removal of insoluble impurities, treated with a metallic peroxide, sesquioxide, or hyperoxide to precipitate the iron in insoluble form; which precipitate is removed and the clear liquor subjected to the action of carbonic-acid gas to form a carbonate of soda and precipitate the alumina as hydrate of alumina.

331,182—November 24, 1885. G. F. BIHN. *Method of obtaining hydrate of alumina for paper makers' use from bauxite, etc.*

To produce an artificial hydrate of alumina free from iron, an intimate mixture of bauxite, salt cake, and coal is calcined, the mass lixiviated with water, and the liquor, separated from the insoluble matter, boiled with finely divided metallic copper or a suitable copper compound. The resulting liquor, separated from insoluble matter, is then treated with carbonic-acid gas or bicarbonate of soda, precipitating hydrate of ammonia.

539,889—May 28, 1895. M. N. D'ANDRIA. *Process of making magnesium hydrate.*

Calcined and slacked dolomite is subjected to the action of water, repeatedly agitated, settled, and decanted until the residue is mainly magnesium hydrate. Large tanks into which the tide can flow are preferably used.

571,533—November 17, 1896. R. LANGHANS. *Electrolytic process of converting hydroxids of earth and earth alkali metals into indissoluble organic or inorganic salts, etc.*

See Group X, Electro-chemistry.

CHLORATES.

388,217—August 21, 1888. E. K. MUSPRATT AND G. ESCHELLMANN. *Manufacture of sodium-chlorate.*

Magnesia suspended in water by agitation is treated with chlorine, the resulting magnesian liquor boiled down to crystallize out magnesium chloride, and the liquor then decomposed by means of caustic soda or carbonate of soda, or mixtures of the same, to produce sodium chlorate.

388,997—September 4, 1888. E. K. MUSPRATT AND G. ESCHELLMANN. *Manufacture of potassium chlorate.*

In the manufacture of potassium chlorate by means of magnesia and chlorine the magnesia liquor is boiled down to crystallize out magnesium chloride, the liquor is then heated with potassium chloride, and the potassium chlorate separated from the magnesium chloride by crystallization. The mother liquor is now treated with hydrochloric acid and steam to obtain chlorine and magnesium chloride.

480,492—August 9, 1892. E. B. CUTTEN. *Method of electrolytically producing potassium chlorate.*

See Group X, Electro-chemistry.

480,493—August 9, 1892. E. B. CUTTEN. *Method of electrolytically producing potassium chlorate.*

See Group X, Electro-chemistry.

491,701—February 14, 1893. E. B. CUTTEN. *Method of electrolytically producing potassium chlorate.*

See Group X, Electro-chemistry.

492,003—February 21, 1893. H. GALL AND A. DE VILLARDY DE MONTLAUR. *Manufacture of chlorates of the alkaline metals and metals of the alkaline earths.*

See Group X, Electro-chemistry.

493,023—March 7 1893. W. T. GIBBS AND S. P. FRANCHOT. *Process of obtaining chlorates of the alkalis or of the alkaline earth metals by electrolysis.*

See Group X, Electro-chemistry.

519,400—May 8, 1894. H. BLUMENBERG, JR. *Electrolysis.*

See Group X, Electro-chemistry.

636,848—April 2, 1895. H. BLUMENBERG, JR. *Electrolysis.*

See Group X, Electro-chemistry.

537,179—April 9, 1895. H. BLUMENBERG, JR. *Electrolysis.*

See Group X, Electro-chemistry.

538,314—April 30, 1895. K. J. BAYER. *Process of producing potassium chlorate.*

Zinc oxide (used in place of lime) is treated with chlorine gas; the hypochlorite of zinc obtained is split into zinc chlorate and zinc chloride; the solution is mixed with potassium chloride, and the potassium chlorate separated by crystallization, while the zinc is obtained in the liquor in the form of zinc chloride.

543,326—July 23, 1895. K. J. BAYER. *Process of producing potassium chlorate.*

Potassium chloride is added to a mixture of zinc oxide and water up to the saturation point of the mixture, the solution is heated to near the boiling temperature, and chlorine is introduced until the zinc oxide is dissolved, when the potassium chlorate is crystallized out and the zinc chloride liquor is concentrated.

565,324—August 4, 1896. H. BLUMENBERG, JR. *Electrolysis.*

See Group X, Electro-chemistry.

587,437—August 3, 1897. F. HURTER. *Apparatus for manufacturing chlorate of potash by electrolysis.*

See Group X, Electro-chemistry.

620,683—March 7, 1899. T. A. UEHLING. *Process of and apparatus for reducing and oxidizing salts.*

See Group X, Electro-chemistry.

627,000—June 13, 1899. P. IMHOFF. *Process of making oxyhalogen salts.*

See Group X, Electro-chemistry.

627,063—June 13, 1899. P. IMHOFF. *Manufacture of oxyhalogen salts.*

See Group X, Electro-chemistry.

633,272—September 19, 1899. T. PARKER. *Process of manufacturing chlorates by electrolysis.*

See Group X, Electro-chemistry.

NITRITES AND NITRATES.

249,275—November 8, 1881. T. VARNEY. *Process of drying nitrates.*

A portion is melted and mixed with an unmelted crystalline portion, thereby expelling the water from the crystals.

400,207—March 26, 1889. C. N. HAKE. *Process of making ammonium nitrate.*

Nitric-acid vapor is combined with ammonia gas in an air chamber or ammonia-gas with fine spray of nitric acid with the temperature maintained below 120° C. Nitrate of ammonia is produced in the first case as a fine powder and in the second case as a supersaturated liquid which solidifies on cooling.

448,361—March 17, 1891. R. S. PENNIMAN. *Process of manufacturing nitrate of ammonia.*

Protected nitrate of ammonia is produced by dehydrating the nitrate and while it is in a melted condition mixing therewith a protecting medium, as any of the soft products of petroleum distillation—e. g., vaseline—then cooling and graining by agitation.

448,362—March 17, 1891. R. S. PENNIMAN. *Preparing nitrate of ammonia.*

The nitrate is dehydrated while in a melted condition by mechanical agitation accompanied with the injection of air. It is then cooled and grained by mechanical agitation and a protecting medium, as vaseline, is applied to the mass.

478,067—June 28, 1892. R. S. PENNIMAN. *Method of manufacturing nitrate of ammonia.*

Nitrate of ammonia liquefied under a high temperature is subjected to mechanical agitation together with injected blasts of air to prevent decomposition from overheating and to fully eliminate watery vapors.

500,914—July 4, 1893. J. LANDIN. *Process of making ammonium nitrate.*

Alcohol is percolated through a mixture of sodium nitrate and ammonium sulphate to produce an alcoholic solution containing ammonium nitrate plus some sodium nitrate, and a residue of sodium sulphate plus some ammonium sulphate. The alcoholic solution is treated, by passing it first through ammonium sulphate, and next through ammonium chloride, producing an alcoholic solution of ammonium nitrate and a precipitate of sodium sulphate and sodium chloride, and the sodium chloride is then sublimed with the mixture of sodium sulphate, and ammonium sulphate to produce sodium sulphate and ammonium chloride.

572,819—December 8, 1896. L. G. PAUL. *Process of making nitrites.*

An alkaline nitrate is melted together with the caustic compound of the same alkali, and sulphur is gradually added to the melted mass.

573,964—December 29, 1896. G. CRAIG. *Process of purifying ammonium nitrate.*

Nitrate of ammonia is dissolved out of mixtures by percolating or digesting with anhydrous or high-strength ammonia, and then the solvent is evaporated off.

595,178—December 7, 1897. A. KNOP. *Process of making nitrites.*

A nitrite is manufactured by heating a mixture of a nitrate, a caustic alkali, and carbon. Fused caustic soda, 120 parts, and coke, 31 parts, are first mixed and cooled. Then 300 parts of saltpeter are melted with 120 parts of 90 per cent caustic soda, and the first mixture added in fragments.

597,006—January 11, 1898. R. N. LENNOX. *Process of making ammonium nitrate.*

A mixture of sulphate of ammonia, 13 parts, and a nitrate of a metal capable of double decomposition, as sodium nitrate, 17 parts, is distilled at less than atmospheric pressure, and at a temperature not exceeding 230° C.

632,394—September 5, 1899. H. K. BAYNES. *Process of decomposing alkali nitrates.*

See Group I, Acids, Nitric.

623,893—April 25, 1889. T. FAIRLEY. *Process of making ammonium nitrate.*

Bicarbonate of ammonium is subjected to the action of a saturated solution of sodium nitrate, the liquid separated from the moistened solid, and the former cooled to about 15° C. to crystallize out the ammonium nitrate.

SULPHITES AND SULPHATES.

17,830—July 21, 1857. L. GAMOTIS AND S. MARTIN. *Improved apparatus for making acid sulphite of lime.*

The fumes from burning sulphur are drawn by suction successively through a series of vats filled with milk of lime.

59,239—October 30, 1866. G. T. LEWIS. *Improvement in the manufacture of sulpho-acetate of alumina.*

Alumina (obtained from cryolite) is treated with acetic acid and sulphuric acid, or in place of the latter sulphate of alumina or alum.

82,154—September 15, 1868. W. M. PAGE AND E. B. KRAUSSE. *Improved process of preparing sulphate of barytes.*

Sulphate of baryta is first boiled in water to render it more friable, then dried, and boiled in a weak acid solution—as of sulphuric acid—followed by a weak solution of silicate of soda to purify, then boiled in a saturated alum solution to whiten, and dried and pulverized, to be subsequently mixed in distilled water and floated for a fine product.

108,177—October 11, 1870. H. PEMBERTON. *Improvement in the manufacture of paper.*

Sulphate of lime, for use in paper manufacture, is made from a solution of calcium chloride, for which bittern may be used, and a solution of impure soda sulphate or niter cake.

11,305—January 31, 1871. R. DE WITT BIRCH. *Improvement in the manufacture of copperas.*

The waste liquor from manufactures using sulphuric acid for cleaning iron is settled, the free acid neutralized with wrought iron, concentrated to from 28° to 40° Baumé, the vapors being passed over lime to a condenser, the liquor settled and crystallized on crystallizing sticks, and the crystals dried with air warmed by the hot vapors.

125,153—April 2, 1872. H. A. WHITING. *Improvement in processes and apparatus for the manufacture of sulphate of lead.*

Sulphate of lead is manufactured by the direct action of hot concentrated sulphuric acid upon an alloy of lead and zinc, 1 per cent zinc. The dried sulphate of lead is whitened by calcining at a red heat.

151,389—May 26, 1874. J. HARGREAVES AND T. ROBINSON. *Improvement in the manufacture of sulphate of soda and potassa.*

Mixed sulphurous-acid gas, air, and water vapor are used in the proportions of 2 volumes each of gas and water vapor, and air to furnish 1 volume of free oxygen, the mixture being passed through the chambers in series, each in turn being the first of the series. Sodium chloride, or potassium chloride, is used in pieces containing about three-quarters of a cubic inch, with the smaller pieces packed near the sides of the chamber, or tower.

195,998—October 9, 1877. L. S. FALES. *Improvement in treating gas-liquor for ammonia salts.*

The incoming ammoniacal liquor is heated by means of the sulphureted-hydrogen gas, and the latter thereby cooled previous to passing it into water to absorb it, in the manufacture of sulphate of ammonia.

200,134—February 12, 1878. C. FAHLBERG. *Improvement in processes for utilizing zinc sulphate.*

Zinc sulphate is treated with sodium carbonate or bicarbonate to precipitate the zinc as a carbonate, and the sodium bicarbonate is then recovered by an ammonio-soda process.

216,323—June 10, 1879. H. GROUVEN. *Improvement in the manufacture of sulphate of ammonia.*

Sulphate of ammonia is made from turf and similar material by decomposing the vapors and gases obtained from heating a mixture of turf and chalk by means of a contact mass; converting the carbonate of ammonia to sulphate of ammonia in the presence of sulphate of lime, and purifying and crystallizing the sulphate of ammonia.

220,005—September 23, 1879. Z. C. WARREN. *Improvement in the manufacture of sulphate of lime.*

Sulphate of lime, of about the specific gravity of paper pulp, is made by commingling cooled streams of milk of lime and sulphuric acid prepared in combining proportions.

224,101—February 3, 1880. W. J. MENZIES. *Process for the maufacture of sulphate of soda.*

A pure sulphate of soda is obtained from niter cake and muriatic-acid cylinder-cake, by neutralizing the free acid of the one and the free sodium chloride of the other, treating them in a reverberatory furnace, either together or singly, with the addition, respectively, of sodium chloride or sulphuric acid, and then precipitating the iron salts and impurities from a hot saturated solution of the product with an alkali or alkiline earth and bleaching-powder. An anhydrous sulphate of soda is produced, white and free from iron.

229,249—June 29, 1880. C. N. HAKE. *Manufacture of potassium sulphate from kainit.*

A solution of magnesium sulphate is added to ground kainit, the chlorides of magnesium and sodium going into solution while a residue of schönit is formed, the schönit being separated from the said chlorides by decantation. Caustic lime, baryta, or strontia is added to pulverized schönit and the product calcined, lixiviated, and concentrated to secure the potassium sulphate.

243,310—June 21, 1881. C. SCHEIBLER. *Process of separating gypsum from the solutions of starch-sugar produced by treating the latter with sulphuric acid.*

The solution is neutralized by means of lime, the bulk of the gypsum removed by filtration or decantation, and the solution then treated with an excess of barium-oxalate or other insoluble barium salt obtained from a soluble oxalate and which forms an insoluble combination with lime, the remaining gypsum being removed with the scum during concentration.

247,046—September 13, 1881. H. GROUVEN. *Process of and apparatus for making ammonium sulphate.*

As an improvement on the process of No. 216,323, the peat, or animal refuse rich in nitrogen, is charged successively into a series of retorts, and the vapors and gases are passed through all in series ending with the one longest charged.

259,150—June 6, 1882. F. HOHLWEG. *Process of obtaining magnesium sulphate from crude mineral.*

Crude mineral containing carbonate or silicate of magnesia is powdered and treated with a solution of sodium bisulphate and the magnesium sulphate separated by crystallization. With the addition of carbonate of soda the magnesia is precipitated from the solution as a carbonate in the usual manner.

267,582—November 14, 1882. R. N. R. PHELPS AND W. A. CLARK, JR. *Process of treating the waste pickle-liquor of iron-works.*

See Group I, Acids, Sulphuric.

286,735—October 16, 1883. H. RÖSSLER. *Process of making cupric sulphate.*

Gases containing sulphurous acid, as the waste gases of chemical works, are injected jointly with air and steam into an oxidizing solution of cupric sulphate containing free copper, as cement copper.

292,260—January 22, 1884. C. SEMPER. *Utilizing waste calcium chloride and sulphate.*

Waste calcium sulphate, produced in the manufacture of acetic acid from acetate of lime, is calcined at a high temperature and the impurities driven off.

318,972—June 29, 1885. E. A. FALES. *Process of making ammonium sulphate.*

In the distillation of ammoniacal liquor and the passage of the vapor through sulphuric acid, the acid is covered with a layer of coal oil to give white sulphate of ammonia crystals and avoid discoloration.

321,341—June 30, 1885. E. CAREY, H. GASKELL, JR., AND F. HURTER. *Process of making sodium sulphite.*

Salts—monohydrated carbonate of soda—are exposed to the action of sulphurous-acid gas.

329,216—October 27, 1885. E. B. RITTER AND C. KELLNER. *Process of making solutions of bisulphites.*

The carbonate of a base is first subjected to the action of sulphurous acid, whereby carbonic acid is expelled and the sulphite formed is dissolved in the weakened acid solution. The sulphite solution is then reimpregnated with sulphurous acid and a combination with the second base effected and the formation of a double salt.

338,558—March 23, 1886. E. B. RITTER AND C. KELLNER. *Process of manufacturing sulphites.*

In the manufacture of sulphites, sulphurous-acid gas is purified, prior to making a solution of the same, by passing it through a solid material, as limestone, which will combine with sulphuric acid, and a filter of solid material for dry particles, and then cooling the acid.

339,974—April 13, 1886. W. O. & W. P. CROCKER. *Producing sulphite or bisulphite of sodium.*

For the production of sulphite-of-sodium liquor from sulphate of sodium for the reduction of wood to pulp, the sulphate of sodium mixed with carbonaceous matter is roasted, leached, evaporated to dryness, and the product granulated, and heated with agitation in contact with air or oxygen until incandescence ceases, when it is made into a solution. It may be charged with an additional portion of sulphurous or other acid before introduction into the digester. By the addition of a small quantity of bisulphite of calcium any sulphide or sulphate of sodium is decomposed, sulphate of calcium being precipitated.

339,975—April 13, 1886. W. O. & W. P. CROCKER. *Process of making bisulhites.*

Bisulphite-of-sodium liquor is produced by roasting the acid sulphate of sodium to reduce it to neutral sulphate and recover one proportion of sulphuric acid, suspending neutral sulphite of calcium in the solution by agitation, and finally charging the mixture with sulphurous acid, which may be obtained by decomposition of the sulphuric acid recovered. The neutral sulphite of calcium is obtained by treating the used bisulphite-of-sodium liquor with oxide or carbonate of calcium.

365,318—June 21, 1887. W. M. PAGE AND E. B. KRAUSSE. *Process of and apparatus for treating barium sulphate.*

The crude material is subjected to successive steps of grinding, boiling with dilute acid, washing, drying, regrinding, agitation in hot water, screening, settling in water, and drying.

371,186—October 11, 1887. T. B. FOGARTY. *Process of and apparatus for making ammonium sulphate.*

Highly heated nitrogenous generator gas is mixed with adjusted volumes of superheated steam and air and mingled with a falling mass of pulverized carbon and alkali in a retort, producing cyanogen, which in turn is decomposed by the steam to ammonia, hydrogen and carbon oxides; the ammonia and carbonic acid being then treated with sulphuric acid and lime of gypsum to produce sulphate of ammonia and carbonate of lime.

373,264—November 15, 1887. H. BAUM. *Process of making pyrosulphates.*

Pyrosulphates of the alkali metals, as also of ammonia, are produced by heating the acid sulphates thereof in a vacuum to a temperature of from 200° to 400° C.

376,189—January 10, 1888. A. FRANK. *Production of sulphite solutions.*

Free as well as combined sulphurous acid is recovered from the lyes resulting from the manufacture of cellulose by the sulphite process, by converting the sulphurous acid into a monosulphite by means of calcium or a calcium salt, separating the monosulphite from the lye and purifying the same by washing in a solution of sulphurous acid or of an alkali sulphite or an alkaline earth.

376,190—January 10, 1888. A. FRANK. *Production of sulphite solutions.*

Acid sulphite solutions are produced from calcium monosulphite (a product of the process No. 376,189) with calcium sulphate as a by-product, by treating the calcium monosulphite with sulphuric acid or with acid sulphate of soda.

379,820—March 20, 1888. A. SCHANSCHIEFF. *New mercuric salt for battery-fluids.*

A new salt, yellow basic sulphate of mercury combined with bisulphate of mercury, substantially of the formula $2HgO.SO_4+HgSO_4+3H_2O$, is produced by dissolving mercury in sulphuric acid, evaporating excess of acid, adding water, separating the precipitate and treating it with acid and again with water and so on, either retaining the solution in the liquid form or evaporating to obtain the solid salt

392,286—November 6, 1888. H. PEMBERTON, JR. *Dehydrating sodium sulphate.*

The crystals of natural or artificial Glauber's salt are treated with a hot saturated solution of sodium sulphate until they melt; the anhydrous salt not in solution is then allowed to settle, and the saturated solution is run off or allowed to recrystallize to be used again

395,159—December 25, 1888. W. MANNING. *Process of treating gypsum.*

In the treatment of gypsum for the production of an impalpable opaque anhydrous powder, it is given a second calcination and subsequent grinding to expel all water of crystallization.

407,925—July 30, 1889. C. J. E. DE HAËN. *Double sulphate of antimony.*

A new product, the double salt of fluoride of antimony and sulphate of ammonia, having the formula $SbFl_3,(NH_4)_2SO_4$—available in the dyeing art in lieu of tartar emetic—is produced by mixing fluoride of antimony and sulphate of ammonia and evaporating the mixture.

415,739—November 26, 1889. H. A. SEEGALL. *Process of making chromium sulphates.*

Chromic or chromous sulphates are produced from chrome materials by heating the same to 600° C. in closed receptacles with the acid sulphates of any fixed alkali, such as sodium bisulphate, with the chrome materials held in suspension by agitation; and then condensing the vapors and regaining the sulphuric acid which has not entered into the reaction. The quantity of vapor is reduced by mixing with the mass a substance that does not melt or decompose at 600° C., as barium sulphate.

452,378—May 19, 1891. P. DE LACHOMETTE. *Process of making ammonium-sulphite.*

Crude ammoniacal liquor is first purified with oxide of iron and then distilled; the oxide of iron used is roasted, and the dry ammonia from the distillation and the sulphurous gas from the roasting, conducted in suitable proportions into a saturating tank, form ammonium sulphite or bisulphite.

452,386—May 19, 1891. H. PENNINGTON. *Process of making lead sulphate.*

Metallic lead in shreds or flakes is subjected to the alternate action of dilute acetic acid and of atmospheric air; the mass of lead is drained and loosened up after the acetic solution is drawn off; and the said solution is mixed with a sufficient quantity of sulphuric acid to thoroughly reduce the lead acetate to a lead sulphate without excess of free sulphuric acid, the solution being agitated to prevent the formation of acicular crystals and leave the sulphate practically amorphous.

453,137—May 26, 1891. J. VAN RUYMBEKE. *Process of makingbasic persulphate of iron.*

Pulverized iron ore—oxide of iron—is first mixed with sulphuric acid and then heated to from 190° to 260° C. until the water has been expelled and a persulphate of requisite basicity is produced.

503,900—August 22, 1893. W. E. CASE. *Process of making aluminium fluosulphate.*

Aluminium fluosulphate free from iron is produced by adding calcium fluoride to an aqueous solution of crude aluminium sulphate, then adding a quantity of the freshly precipitated white product obtained by adding a solution of an alkaline carbonate to an aluminium fluosulphate solution which has been freed from iron. The resulting ferruginous precipitate is separated from the fluosulphate solution by mechanical means.

504,324—September 5, 1893. W. E. CASE. *Process of making aluminium compounds.*

An insoluble aluminium compound is produced by combining aluminium sulphate and calcium fluoride to form an aluminium fluosulphate solution, and adding an alkali carbonate. If iron is present the alkali carbonate is added until a filtered test sample shows the solution free of iron in the ferric form; the iron precipitate is then removed and additional alkali carbonate added to precipitate the aluminium compound.

504,325—September 5, 1893. W. E. CASE. *Process of making aluminum fluosulphate.*

An aluminium alkali fluosulphate free from iron is produced by adding calcium fluoride to an aqueous solution of crude aluminium sulphate, then adding a solution of an alkaline carbonate, as of sodium carbonate, to precipitate iron, and separating the aluminium fluosulphate solution from the solid products.

512,103—January 16, 1894. W. E. CASE. *Process of making aluminum compounds.*

An insoluble aluminium compound is formed by combining aluminium sulphate and calcium fluoride to form an aluminium-fluo-sulphate solution, adding thereto a caustic alkali, as ammonium hydrate, to precipitate the iron, removing the iron, and then adding a further quantity of the caustic alkali to precipitate the aluminium compound.

514,040—February 6, 1894. H. F. D. SCHWAHN. *Process of purifying native sulfate of barium.*

The process of No. 514,039 (Group XIX, Oxides) is specifically applied to the purification of native sulphate of barium from iron, etc.

515,763—March 6, 1894. C. VON GRABOWSKI. *Process of and apparatus for purifying sulfate lyes.*

See Group X, Electro-chemistry.

526,076—September 18, 1894. M. L. GRIFFIN. *Process of making calcium bisulfite liquor.*

To prepare "lime sludge," resulting from the treatment of carbonated-soda liquors with lime in the manufacture of caustic soda, for use as a substitute for lime in the manufacture of bisulphite liquors, it is washed to remove the alkali, flowed over riffles to remove heavy impurities, and the precipitate of carbonate of lime thus purified is separated from the water by settling or filtering. The sludge is then charged with sulphurous-acid gas.

541,598—June 25, 1895. J. D. DARLING. *Process of utilizing niter-cake or other acid sulfates.*

See Group X, Electro-chemistry.

542,429—July 9, 1895. E. A. STARKE. *Process of making neutral alkaline sulfates from bisulfates.*

Neutral alkaline sulphate is made by adding a portion of sulphur to the acid sulphate and heating the mass. The sulphurous acid fumes are collected and converted into sulphuric acid.

543,002—July 23, 1895. S. H. EMMENS. *Process of making ferric sulfate.*

The gases from a sulphuret or sulphate roasting or calcining furnace are passed into water in which ferric hydrate is suspended.

565,953—August 18, 1896. E. ANDREOLI. *Apparatus for indirect electrolysis.*

See Group X, Electro-chemistry.

601,006—March 22, 1898. H. E. STURCKE. *Preparing sulfate of lime from residues.*

Residues from the manufacture of caustic soda, and comprising essentially carbonate of lime, are dissolved in muriatic acid, filtered, precipitated with sulphuric acid to form sulphate of lime, filtered, and the sulphate of lime washed and dried. The last filtrate is used for treating fresh quantities of residues. A waste calcium-chloride solution from the ammonium-soda process is filtered, precipitated with sulphuric acid to form sulphate of lime, and filtered, and the last filtrate used for caustic soda residues.

601,179—March 22, 1898. H. E. STURCKE. *Process of and apparatus for making sulfate of lime.*

Residues from the manufacture of caustic alkali, comprising essentially carbonate of lime, are made into a thin milk, the insoluble impurities are mechanically removed, and the milk of carbonate is then treated with sulphuric acid to convert the carbonate into sulphate of lime, which is separated out and dried.

605,697—June 14, 1898. R. E. CHATFIELD. *Process of utilizing acid sulfates of soda.*

Residue acid sulphate of soda solutions are acted upon by ammoniacal compounds from gas liquor or other sources to produce mixed sulphates of ammonia and soda. The solution is then evaporated to a specific gravity of 1.380 at boiling temperature to crystallize out sulphate of soda; the evaporation is then continued to crystallize out the mixed salts, which latter crystals are dissolved in cold mother liquor to a specific gravity of 1.285 and evaporated to crystallize out sulphate of ammonia.

634,751—October 10, 1899. O. HOFMANN. *Method of refining cupric-sulfate solutions.*

A cupric-sulphate solution containing salts of iron, arsenic, antimony, etc., is neutralized and heated to 75° to 80° C., when pulverized cupric oxide is added and air is injected to precipitate the impurities.

640,026—December 26, 1899. A. S. RAMAGE. *Process of and apparatus for making copperas.*

Carbonate of magnesium is added to the waste liquor of pickling vats to neutralize the free sulphuric acid, and the liquor is then filtered, evaporated, and crystallized, giving a copperas mixed with a little magnesium sulphate which improves the same for the manufacture of venetian red.

641,550—January 16, 1900. M. E. ROTHBERG. *Process of making magnesia and plaster of paris.*

See Group XIX, Oxides.

650,980—June 5, 1900. O. MEURER. *Process of making metallic sulfates.*

To produce sulphates free from iron from sulphide ores containing sulphide of iron, the ores are heated with polysulphides of the alkalis, cooled and caused to be crumbled in the air, after the addition of water; dried and subjected to spontaneous oxidation in air preferably at 205° C. The mass is then lixiviated with water and the sulphates are dissolved.

PHOSPHATES.

42,140—March 29, 1864. E. N. HORSFORD. *Improved double phosphate of lime and soda for culinary and other purposes.*

To a mixture of 5,000 pounds of water and 500 pounds of oil of vitriol there is added 700 pounds of burned bones and constant agitation is continued for sixteen to eighteen hours, when the mass is leached and lixiviated, forming a liquid acid phosphate of lime, in which about two-ninths of the lime of the original phosphate of lime remains in combination with the phosphoric acid. This is concentrated with the addition of hydrate of soda in the proportion of 0.0144 of a pound for each degree of Baumé until it becomes an emulsion of crystals. The product is rendered nonhygroscopic by diluting the emulsion of crystals with gelatinized water, and subjecting to slow crystallization, and potato starch is mixed therewith, or it is treated with a weak solution of boiled starch.

62,277—February 19, 1867. J. E. LAUER. *Improved acid compound for use in baking and cooking.*

An acid salt, obtained by treating boneblack with hydrochloric acid and then adding sulphuric acid to the liquor.

75,271—March 10, 1868. E. N. HORSFORD. *Improved preparation of acid phosphate of lime.*

Sulphuric acid is added to a solution of acid phosphate of lime in a solution of a salt of lime, the acid of which salt is volatile, as nitric acid, and the volatile acid driven off by heat, leaving acid phosphate of lime mixed with or feebly combined with sulphate of lime, which is separated by leaching.

75,328—March 10, 1868. G. F. WILSON. *Improvement in the manufacture of acid phosphates.*

Farinaceous matter is mixed with acid phosphate of lime by feeding a coarse mixture of the material between rollers, preferably of dressed granite.

75,329—March 10, 1868. G. F. WILSON. *Improvement in preparing bones for the manufacture of acid phosphates.*

Bones are distilled in horizontal retorts with condensation of the products of distillation, the remaining gases being conveyed to the furnace and burned. Each charge of distilled bone is raked from the retort into an iron cooler which is sealed and the bone cooled under exclusion of air.

75,330—March 10, 1868. G. F. WILSON. *Improvement in drying acid phosphates.*

Granulated acid phosphate of lime is exposed to continuous currents of heated air on both sides of vertical columns thereof, which are progressively fed downward.

75,332—March 10, 1868. G. F. WILSON. *Improvement in burning bones for the manufacture of acid phosphates.*

Bones are burned white by subjecting them to a steady, long-continued, uniform heat, with sufficient regulated air to secure perfect combustion without cooling off the furnace, the temperature of distillation being not for once intermitted.

75,336—March 10, 1868. G. F. WILSON AND E. N. HORSFORD. *Improvement in the manufacture of phosphates and in extracting phosphoric acid from bones.*

Burned bones are treated with sulphuric acid diluted with a weak solution of acid phosphate of lime to or beyond the point of precipitating the sulphate of lead present, and the mixture is treated with continuous agitation.

The material is leached in broad shallow pans with alternate affusion of water and tamping to secure leaching of the whole mass.

76,763—April 14, 1868. E. N. HORSFORD. *Improved method of preparing acid phosphate of lime.*

Sulphuric acid purified of sulphate of lead is employed in the manufacture of pulverulent acid phosphate of lime, to be used for raising bread.

86,289—January 26, 1869. A. DUVALL. *Improved method of mixing liquids with dust or powder for the manufacture of phosphates, and for other purposes.*

The pulverized material and the acid are fed into a blast of air or jet of steam, either or both, and thereby thoroughly mixed and projected into a receiving chamber.

110,680—January 3, 1871. N. B. RICE. *Improvement in the manufacture of acid phosphates for use in baking-powders, etc.*

To 1,000 pounds of pulverized phosphate of lime, as contained in apatite or bone, there is added 1,400 pounds of terhydrated phosphoric acid, diluted with 2,800 pounds of water, with enough more phosphoric acid to neutralize and saturate all carbonates, oxides, etc. After standing a week with frequent agitation the superphosphate of lime in solution is decanted or leached out. Part of the liquor is treated with sulphuric acid to deposit the lime in solution and leave a dilute phosphoric acid, and part is treated with alkaline sulphates depositing the lime as a sulphate and leaving a superphosphate of the base.

123,743—February 13, 1872. B. TANNER. *Improvement in the manufacture of phosphates of the alkalis.*

Monosodic, bisodic, or trisodic phosphates, or like phosphates of potash or ammonia, are produced by mixing sodium chloride, or potassium or ammonium chloride, with phosphoric acid in the proper combining proportions, and subjecting the mixture to the action of steam, superheated steam, or mixtures of hot air and steam.

123,744—February 13, 1872. B. TANNER. *Improvement in the manufacture of superphosphates of lime.*

See Group VIII. Fertilizers.

130,298—August 6, 1872. E. N. HORSFORD. *Improvement in the manufacture of phosphate of lime and yeast-powders.*

Solid monocalcic phosphate, produced by evaporating, with a current of heated air, a solution of monocalcic, orthophosphate, and free phosphoric acid, mingled with a solution of the phosphate of lime of burned bones in hydrochloric acid, in such proportions that the total number of lime atoms equals the total number of atoms of phosphoric acid. The monocalcic phosphate is mixed with starch to preserve its available strength, with alkaline carbonates to form a yeast powder, and the latter with flour for the production of self-raising flour.

137,635—April 8, 1873. F. M. LYTE AND H. STORCK. *Improvement in the manufacture of acid phosphates.*

Soluble acid phosphates are produced by attacking earthy phosphates, especially phosphate of calcium, with properly diluted phosphoric acid, precipitating the earthy matter by means of alkaline sulphates, as sulphate of ammonium, and then extracting the sulphuric acid of the residual liquor with the phosphate of barium, lead, or strontium, or the carbonates or other suitable salts of these bases. The residues are either treated with sodium carbonate, caustic soda, and the phosphoric acid precipitated from the liquid with lime, or in certain other specified ways.

140,051—June 17, 1873. J. E. LAUER. *Improvement in manufacturing crystalline acid phosphate of lime for yeast-powders.*

Boneblack is first treated with dilute sulphuric acid to deposit the sulphate of lime, and it is then treated with muriatic acid evaporated and crystallized. (See No. 62,277.)

164,457—June 15, 1875. A. JAS. *Improvement in dissolving tribasic phosphate of lime in water containing carbonic acid.*

Tribasic phosphate is dissolved in water by means of a current of carbonic acid gas, at a greater or less pressure, according to the quantity to be dissolved.

178,146—May 30, 1876. J. V. HECKER. *Improvement in acid-powders and processes of producing them.*

An acid powder consisting of monocalcic ortho-phosphate, sodium chloride, and calcium chloride: produced by treating boneblack with sulphuric acid and then with hydrochloric acid and sodium chloride, leaching and evaporating to dryness.

196,771—November 6, 1877. J. E. SIEBEL. *Improvement in processes of producing the mono or acid phosphate of ammonia.*

A mixture of ground bone-ash and sulphate of ammonia in water is subjected to a boiling heat for a sufficient length of time to form sulphate of lime and monophosphate of ammonia, which latter is leached out and evaporated to dryness. The evolution of free ammonia is avoided by replacing a proper amount of the sulphate of ammonia with sulphuric acid.

229,518—July 6, 1880. C. A. CATLIN. *Acid phosphate for baking-powders.*

An acid phosphate in which the active ingredient has an excess of base over a dihydrogen calcic phosphate, and in which both the phosphoric acid and the sulphate of lime are completely hydrated: produced by treating bone-ash or other tricalcic phosphate with oil of vitriol diluted with an excess of water under agitation and heat.

229,573—July 6, 1880. G. F. WILSON AND C. A. CATLIN. *Preparation of potassium phosphate for baking-powder.*

An acid powder containing as the active ingredient an acid potassium phosphate with an excess of base over a dihydrogen potassic phosphate, and having both the acid phosphate and the sulphate of lime completely hydrated; produced by treating tricalcic phosphate with dilute oil of vitriol under agitation and heat, decomposing the hydrogen dicalcic phosphate into hydrogen dipotassic phosphate with potassium sulphate, and converting the mass into a dry powder.

229,574—July 6, 1880. G. F. WILSON AND C. A. CATLIN. *Preparation of sodium phosphate for baking-powder.*

An acid powder in which the active ingredient is an acid sodium phosphate having an excess of base over a dihydrogen sodic phosphate, and with the acid phosphate and sulphate of lime completely hydrated: produced by decomposing tricalcic phosphate with dilute oil of vitriol, and then effecting a double decomposition with sodium sulphate under agitation and heat, and converting the mass into a dry powder.

301,406; 301,407—July 1, 1884. S. G. THOMAS. *Manufacture of alkaline phosphates.*

See Group VIII, Fertilizers.

313,369—March 3, 1885. C. V. PETRAEUS. *Solution of acid phosphates.*

A combination of free phosphoric acid with phosphate of soda, consisting of dihydrogen, sodic phosphate, phosphoric acid, and water, is produced by leaching a mixture of bone ash, 100 parts, with sulphuric acid of 49° Baumé, 100 parts, diluted to 20° or 25° Baumé; and adding to the solution 161 parts of Glauber's salts for each 28 parts of lime therein.

322,698—July 21, 1885. F. DIBBEN. *Manufacture of superphosphates.*

One part of acid soda sulphate is dissolved in 4 parts of water at a temperature of 130° F., allowed to stand until the neutral sulphate is crystallized out of the mother liquor, when 3½ pounds of the mother liquor is added to 1 pound of phosphate of lime, and heated until the surplus water is evaporated.

324,471—August 18, 1885. L. IMPERATORI. *Extraction of phosphate soda from slags.*

Slags from phosphatic materials, as from the Thomas Gilchrist process, are smelted with sulphate of potash or soda and carbon, and subsequently treated with carbonic acid.

374,201—December 6, 1887. C. V. PETRAEUS. *Process of making acid potassium phosphates.*

Impure acid phosphate of lime, produced by decomposing bone or similar phosphate with a suitable acid and leaching, is decomposed by sulphate of potash; then carbonate of potash or caustic potash is added in excess, that is, in sufficient quantity to form in the solution an acid phosphate of potash containing an excess of potash over that in the dihydrogen potassium phosphate; and, after filtration, the solution is evaporated to crystallization.

389,566—September 18, 1888. C. GLASER. *Process of making acid phosphate.*

Insoluble phosphoric acid contained in mineral and petrified phosphates is converted into available phosphoric acid by finely pulverizing the mineral and then applying phosphoric acid directly thereto. The ground mineral may be divided into 2 parts, and the phosphoric acid extracted from 1 portion, by any method, and applied to the other portion.

412,792—October 15, 1889. J. REESE. *Crystalline calcic tetraphosphate and the process of making the same.*

Crystallized tetrabasic phosphate of lime; produced by oxidizing phosphorus at a high temperature while in the presence of lime, until the lime is charged with phosphoric acid, and then withdrawing the charged lime and subjecting it to slow cooling. It is pulverized and used as a fertilizer.

412,793—October 15, 1889. J. REESE. *Process of making phosphates.*

In the manufacture of calcium phosphate from phosphoritic iron, the molten phosphoritic iron is blown with an air blast, in a basic-lined vessel and in the presence of lime additions, until the phosphorus has been reduced to not less than one-half of 1 per cent (but little iron being oxidized when the phosphorus is in excess thereof), when the phosphate so formed is withdrawn. After lime is charged to the desired amount of phosphorus it is withdrawn and a charge of fresh lime added, whereby phosphates having any desired percentage of phosphoric acid may be produced.

417,820—December 24, 1889. C. GLASER. *Process of making acid phosphate.*

Mineral and petrified phosphates are ground and exposed to the action of dilute phosphoric acid, and the moisture subsequently evaporated; the amount of acid used is theoretically insufficient to convert all of the tricalcic phosphate (or corresponding compounds) into monocalcic phosphate, but exceeds the theoretical amount necessary to convert the same into bicalcic phosphate, thus forming a mixture of monocalcic and bicalcic phosphates, or equivalents. (See No. 389,566.)

418,259—December 31, 1889. C. E. D. WINSSINGER. *Process of making bicalcic phosphate.*

In the production of bicalcic phosphates, a mother liquor of monocalcic phosphate of lime is produced by forming a phosphoric-acid solution—by treating suitable phosphatic material with an excess of sulphuric acid—filtering, and treating the solution with carbonate of lime, or milk of lime, to convert it into a monocalcic-phosphate solution free from iron, etc. The solid residue from the filtration may be treated with a phosphoric-acid solution and sulphate of lime obtained as a by-product. The monocalcic solution is converted into a monosodic solution by treatment with sulphate of soda, which is then treated with carbonate of soda, and the resulting neutral solution is treated with lime; the phosphate of lime separated from the resulting caustic-soda solution (a by-product), and the separated phosphate treated with an aqueous monocalcic solution, and the bicalcic phosphate separated.

445,567—February 3, 1891. A. MEMMINGER. *Process of making acid phosphates.*

The drying of a compound of phosphatic material and acid is accelerated by adding thereto a fluoride compound, as calcium fluoride, and the drying period is graduated by comminuting to a definite degree and adding a greater or less proportion of the fluoride compound, or by varying the degree of comminution.

446,815—February 17, 1891. C. GLASER. *Process of making alkaline phosphates.*

Pure phosphates of the alkalis are obtained from crude commercial phosphoric acid by decomposing the salt of an alkali and an acid volatile at higher temperature (as nitrate of soda) by fusing same with crude commercial phosphoric acid in excess of the amount required to form a pyrophosphate; then dissolving the fused mass in water and boiling until conversion of meta and pyro phosphoric acid is effected; then treating with the carbonate of an alkali (or free alkali) till alkaline reaction is obtained; and finally separating the solution from insoluble impurities and crystallizing.

493,889—March 21, 1893. S. L. GOODALE. *Method of treating hydrated phosphates of alumina.*

Insoluble hydrated phosphates of alumina and iron are heated by indirect heat in suitable receptacles until all the water of constitution is expelled, or usually until the entire mass has a temperature of about 325° C., when the heat is arrested and the mass cooled before unfavorable molecular rearrangement is developed.

502,424—August 1, 1893. H. PRECHT. *Process of obtaining meta or pyro phosphoric-acid combinations.*

To produce a soluble potassium phosphate the insoluble potassium metaphosphate is melted and rapidly cooled to prevent crystallization. A basic body, as potash or soda, is added either before or during the melting, so that phosphoric acid in the form of pyrophosphate will in part be present in the molten salt.

572,512—December 8, 1896. H. ALBERT. *Process of manufacturing phosphates of alkalis.*

See Group X, Electro-chemistry.

598,182—February 1, 1898. H. POOLE. *Process of making phosphates.*

Pulverized native aluminum phosphate is mixed with a boiling solution of caustic soda to decompose the native phosphate, then filtered; then silica is added to the boiling solution while open to the atmosphere, whereby the alumina is precipitated as a silicate, the tribasic sodium phosphate crystallized out; and finally the aluminum silicate treated with sulphuric acid, whereby aluminum sulphate is formed.

601,089—March 22, 1898. J. G. WIBORG. *Phosphate and method of making same.*

A tetra-calcium-sodium (or potassium) phosphate. See Group VIII, Fertilizers, Products.

627,267—June 20, 1899. C. LUCKOW. *Process of producing basic phosphates of copper by means of electrolysis.*

See Group X, Electro-chemistry.

CARBONATES.

200,134—February 12, 1878. C. FAHLBERG. *Improvement in processes for utilizing zinc sulphate.*

See Group XIX, Sulphites and Sulphates.

235,231—December 7, 1880. F. GUTZKOW. *Manufacture of carbonate of magnesia.*

It is obtained in a light and flocculent form by forcing carbonic acid gas through the pulp of magnesium hydrate in a heated state.

278,283—May 22, 1883. D. SIDERSKY AND H. PROBST. *Process of obtaining carbonate of strontium.*

To recover the strontium salts from the residues of the treatment of saccharine solutions with strontium, the strontianite is dissolved in said residues with an excess of hydrochloric acid, the strontium solution filtered off, the strontium in the solution converted into a sulphate, and the latter finally reconverted into a carbonate.

280,172—June 26, 1883. H. GROUVEN. *Manufacture of strontium carbonate.*

Powdered celestine, or strontium sulphate, is mixed with a double sulphate of potassium and magnesium, and powdered carbon or coal, and the mixture furnaced in crucibles with exclusion of air. The mass is then lixiviated with exclusion of air, and the solution evaporated with introduction of carbonic-acid gas until the development of hydrogen sulphide stops. The precipitated strontium carbonate is separated from the potassium carbonate left in the solution.

301,383—July 1, 1884. E. A. MEBUS AND J. W. DE CASTRO. *Manufacture of carbonate of strontium.*

Sulphate of strontium is finely ground, mixed with water, and treated with carbonate of ammonia, or ammonia and carbonic-acid gas—water may be used—producing carbonate of strontium and sulphate of ammonia. Ammonia is recovered by distillation of the sulphate of ammonia with lime.

303,962—August 19, 1884. A. WÜNSCHE. *Method of obtaining carbonate of magnesia.*

Ammonia and carbonic acid are introduced into a solution of soluble magnesic salts, whereby ammonium-magnesium carbonate is formed, which is separated from the lye and heated to drive off the ammonia and a part or all of the carbonic acid. Caustic magnesia may be added to the compound salt of ammonia and magnesia to drive off the ammonia separately.

510,979—December 19, 1893. G. LUNGE AND C. H. M. LYTE. *Process of making basic lead salts and caustic alkali.*

Basic lead carbonate is formed and caustic soda.
See Group II, Sodas, Caustic Soda.

534,177—February 12, 1895. E. RUEFF. *Process of making light basic magnesium carbonate.*

Carbonic-acid gas is introduced with agitation into a mixture of magnesia, 1 part, and water, 25 parts, until about 1 part by weight of gas has been absorbed, when the mixture is boiled down.

534,212—February 12, 1895. H. ENDEMANN. *Process of making light magnesium carbonate.*

A mixture of magnesia, 20 parts; carbonate of ammonia, 30 parts; and water, 500 parts, is agitated and allowed to harden into a cake. The ammonia may be expelled by exposing to a temperature of 60° C. in a partial vacuum, or the cake can be broken up and washed.

534,213—February 12, 1895. H. ENDEMANN. *Process of making light carbonate of magnesia.*

A mixture of magnesia, 10 parts, and the bichromate of a fixed alkali, as of soda, 32 parts, in 250 parts of water, is subjected to agitation under a gradually-rising temperature to about 65° C., the light carbonate of magnesia then being collected.

601,007—March 22, 1898. H. E. STURCKE. *Amorphous carbonate of lime and method of and apparatus for obtaining same.*

A new product: dry powdered carbonate of lime, in extremely fine particles having a specific weight of from 78 to 94 grams per 100 c. c. when dried at not exceeding 100° C., is produced from the residues of the manufacture of caustic alkali by removing the caustic lime, mixing the residue with water, mechanically separating the impurities, then subjecting the carbonate and water to the action of a vacuum filter and drying.

603,225—April 26, 1898. H. E. STURCKE. *Process of preparing amorphous carbonate of lime from residues.*

Amorphous calcium carbonate is produced from residues by first removing the insoluble impurities from calcium oxide and alkali carbonate by mechanical separation, then causing the oxide and carbonate to react upon each other in water, and separating the calcium carbonate formed from the alkali hydrate and from all soluble impurities including calcium hydrate. The calcium carbonate is then mixed with water, passed through a mechanical separator, filtered, and dried.

603,226—April 26, 1898. H. E. STURCKE. *Process of preparing amorphous carbonate of lime from residues.*

Calcium carbonate, when made from residues according to No, 603,225 and separated from insoluble impurities, is dried, ground, and bolted.

SILICATES.

28,540—May 29, 1860. G. E. VAN DERBOURGH. *Reissue April 1, 1862. No. 1297. Reissue May 17, 1864; 1,674. (A). Improved mode of reducing silicates to a liquid or gelatinous state. 1,675 (B). Improvement in apparatus for treating silicious substances.*

Superheated steam is employed in a digester to reduce silicious and other refractory substances to a liquid or gelatinous state.

39,135—July 7, 1863. T. ELKINTON. *Improvement in the manufacture of alkaline silicates.*

The ingredients are fed through roof openings onto the sloping bed of a furnace, down which the fused silicate flows in a continuous stream to an outlet, subject to the direct heat of the furnace.

304,044—August 26, 1884. S. G. THOMAS. *Manufacture of alkaline salts.*

Alkaline chlorides are decomposed, and alkaline silicates and other nonhaloid alkaline salts and hydrates produced, together with chlorine and hydrochloric acid, by acting on sodium chloride in a Bessemer converter or Siemens or puddling furnace by the silicon contained in molten pig iron in presence of oxygen, oxide of iron, or any oxygen-yielding body. The chlorides are submitted to treatment inclosed in iron cases or compressed into shapes with or without oxide of iron to render the reaction more effective and prevent volatilization.

360,840—April 12, 1887. J. T. ADAMS. *Batch for making glass.*

A substance containing volatile hydrocarbon, as coal or sawdust, is mixed with a glass batch to clarify the bath.

376,409—January 10, 1888. A. KAYSER. *Process of making alkaline silicates and carbonates.*

The oxide of sodium or potassium is obtained from the chloride by mixing the chloride with clay, heating the mixture in a converter directly by passing highly-heated gases containing steam through the converter, smelting the converted material together with an alkali, and then extracting the sodium or potassium combinations by lixiviation.

376,410—January 10, 1888. A. KAYSER. *Process of making alkaline silicates.*

Silicate of sodium or potassium is made from the chloride thereof by mixing the chloride with silica, molding into bricks, and heating in a converter with highly-heated gases containing steam passed through the converter.

445,091—January 20, 1891. P. SIEVERT. *Process of dissolving water-glass.*

A clear solution of water glass is made by softening and partially dissolving the lumps by intimate contact with a jet of steam and treating them with a spray of alkaline lye, the solution being enriched by flowing over the glass lumps and continuously discharged as it forms.

448,772—March 24, 1891. M. W. BEYLIKGY. *Silicate compound.*

A new product, an alkaline-magnesian silicate solution, in which the silicate has the general formula, $7(Na_2O, 5SiO_2)$, $2(Mg'' OSiO_2)$, insoluble after perfect drying, is produced by the action of a compound salt of fluosilicate of magnesium and hydrocarbonate of magnesia on a solution of tersilicate of soda.

590,143—September 14, 1897. W. GARROWAY. *Process of making alkaline silicates and nitric acid.*

Silica and an alkaline nitrate are heated with superheated steam passed through the retort or furnace.

633,841—September 26, 1899. F. HENKEL. *Process of making soluble alkaline silicates.*

Six parts of a solid alkaline silicate is mixed with 1 part of water and heated at from 100° to 120° C. until the water disappears and a homogeneous mass forms which is easily soluble in cold water. Or the solid alkaline silicate is mixed with a hot concentrated solution of the silicate. Sawdust, peat, or other substance may be added as a loosening agent when it is to be used as a fertilizer.

ALUMINATES.

454,137—June 16, 1891. A. KAYSER. *Process of making sodium aluminate.*

A mixture of insoluble sodium silico-aluminate—produced by process No. 376,409 (see Group II, Sodas, Sodium Carbonates)—and lime is subjected to a decomposing temperature and the product leached.

472,668—April 12, 1892. E. FLEISCHER. *Process of making aluminates of alkalies.*

In the manufacture of alkali aluminates from aluminous substances and alkaline sulphates, thiosulphates, or sulphides, the ingredients are mixed with iron and lime and heated in the presence of a reducing agent, the iron and lime being so proportioned that the sulphur present is taken up by the iron and the silicic acid by the lime, while the latter is in excess to prevent the formation of soluble combinations of sulphide of iron with the alkalis.

572,026—November 24, 1896. D. A. PÉNIAKOFF. *Process of making aluminate.*

A mixture of an alkaline sulphate and an alkaline sulphuret and a substance containing alumina is heated to incandescence, producing an alkaline aluminate. The gas mixed with heated air is passed into retorts filled with calcined alkaline chloride to produce chlorine and alkaline sulphate.

603,657—May 10, 1898. D. A. PÉNIAKOFF. *Process of making alkaline aluminates.*

Aluminates, free from sulphides of iron and the like, are produced by calcining a mixture of bauxite, alkaline sulphate, and carbon in the proportions indicated by the formula $2\ (4Al_2O_3.Fe_2O_3) + 3Na_2SO_4 + 5C$, the proportions of the carbon being such that only one-fourth of the oxygen in the alkaline sulphate will be combined therewith.

612,364—October 11, 1898. F. RAYNAUD. *Process of making alkaline aluminates.*

Alkaline aluminates free from silicates are produced by passing steam through a heated mixture of aluminous ore and any sulphide, the base of which is capable of combining with alumina, sulphureted hydrogen being simultaneously produced. Preferably, briquets are formed of aluminuous ore (alumina 640 parts); carbon, 207 parts; and an alkaline sulphate, as sulphate of soda, 900 parts; and dried for treatment.

618,772—January 31, 1899. H. S. BLACKMORE. *Process of making alkali aluminates.*

An alkali aluminate is produced by gradually introducing aluminium hydroxide, or aluminium hydrated oxide into a molten alkali salt. With sodium chloride, sodium aluminate and hydrochloric acid are produced.

MANGANATES AND PERMANGANATES.

326,657—September 22, 1885. T. KEMPF. *Process of manufacturing permanganates.*

Solutions of the manganic-acid salts are electrolyzed in the positive compartment of a cell having a porous diaphragm, producing permanganic-acid salts and free metallic hydroxides.

515,443—February 27, 1894. J. H. PARKINSON. *Porous permanganate block and process of making same.*

Permanganate of potash or soda is thoroughly mixed with kaolin—say from 10 to 12½ per cent—and formed with water into a stiff paste, which is baked hard and dry in a partial vacuum for use in the production of oxygen.

588,614—August 24, 1897. E. B. STUART. *Manganate and process of producing same.*

A double manganate of sodium and calcium, for use in extracting oxygen from air, is produced by subjecting sodium hydrate 80 parts, calcium oxide 56 parts, and binoxide of manganese 88 parts, with oxygen 128 parts, to a temperature of from 300° to 400° C. An excess of from 5 to 15 per cent of caustic soda is preferred.

631,228—August 15, 1899. R. H. REEVES. *Method of disinfecting.*

Sulphuric acid is mixed with a dry mixture of manganate of soda and carbon or wood dust to evolve gases for suppressing noxious vapors. After the gases are evolved water is added to form permanganic acid, which acts on sewage.

PROCESSES AND APPARATUS.

9,145—July 27, 1852. H. W. ADAMS. *Process for the manufacturing of metallic zinc in the form of a fine powder by the use of steam.*

Vaporized zinc is brought into contact with steam, the temperature of the steam being less than the melting point of the zinc, whereby the zinc vapor is instantly cooled and reduced to an impalpable metallic powder.

12,819—May 8, 1855. B. HARDINGE. (*Reissue; 344—January 22, 1856.*) *Improvement in apparatus for dissolving silica.*

The solvent is taken from the upper part of the charge in the digester, passed through a heater, and the vapor discharged into the bottom of the charge in connection with a stirrer.

45,684—December 27, 1864. E. SONSTADT. *Improvement in the manufacture and purification of magnesium.*

A solution of magnesium chloride and potassium chloride is evaporated to dryness and the residue heated to redness and acted upon by sodium, producing magnesium, which is distilled and purified, using an iron retort with exclusion of air.

54,266—April 24, 1866. C. H. WING. *Improved method of preparing magnesium for burning.*

Magnesium wire or ribbon is formed into a spiral coil.

77,987—May 19, 1868. C. KUEHN. *Improved mode of utilizing tin scrap or waste.*

The scrap is boiled in water and 25 per cent of muriatic acid and 2½ per cent of nitric acid (of weight of scrap metal) is added, and the tin dissolved. Successive charges are treated in the same bath with additions of acid until it is saturated with chloride of tin, which may be deposited on zinc plates, or the bath is evaporated and the chloride of tin is obtained.

96,524—Novmber 2, 1869. F. WILCOX. *Improved process of refining the waste from German silver and other metals.*

It is carbonized by pouring the molten waste into a crucible containing nitrate of soda, or other material supplying oxygen.

96,525—November 2, 1869. F. WILCOX. *Improved process of utilizing the waste formed in cleaning copper and brass goods.*

The waste is settled and the sediment dissolved with the aid of steam and the copper deposited out by means of iron plates. The liquor is then filtered, evaporated, and the sulphate of iron obtained. The deposited copper is washed, fused, and cast.

102,148—April 19, 1870. D. D. PARMELEE. *Improvement in treating tin scrap to obtain useful products.*

Tin is removed from tin scrap by treating the same in an inclosed vessel with chlorine gas, carrying off the fumes and condensing them as chloride of tin.

107,711—September 27, 1870. A. OTT. *Improvement in treating tin scrap for the manufacture of stannate of potash, etc.*

Fifty pounds of tin scrap is digested with 8 quarts of a lye of caustic soda 18° Baumé, 10 pounds of litharge, 1½ pounds of sodium nitrate, and 1½ pounds of sodium manganate along with steam. The liquor is decolorized by filtering through boneblack evaporated to 18° Baumé and cooled when stannate of soda chrystallizes. For stannate of potash in place of the soda compounds, 14 pounds of a lye of caustic potash, 2 pounds of potassium nitrate and 2 pounds of potassium manganate are used.

112,839—March 21, 1871. A. OTT. *Improvement in preparing tin salts from tinners' waste.*

Scrap tin is digested with muriatic acid and steam. The liquor is evaporated to 60° Baumé, and bichloride of tin formed by heating it with muriatic acid, sulphuric acid, and water. It is then distilled, bichloride of tin going over and chloride of iron remaining. The bichloride is reconverted into chloride by heating it with granulated tin.

119,267—September 26, 1871. F. W. DORN. *Improvement in processes of utilizing tinners' clippings.*

Scrap metal is treated with a mixture of muriatic acid gas, hyponitric-acid gas, and steam, or muriatic-acid gas and steam alone, followed by a jet of steam to wash off the muriate of tin.

121,948—December 19, 1871. C. LENNIG. *Improvement in removing tin from tin scrap.*

A solution of caustic soda or potash is poured over the scrap metal, drawn off and then air forced through the mass of metal, and the operation successively repeated. Stannate of soda or potash is deposited out of the liquor.

128,265—June 25, 1872. T. F. WELLS. *Improvement in processes of separating tin from iron in tinners' clippings.*

Tin is separated from iron by means of hydrochloric acid to which nitric acid is gradually added in conjunction with chlorate of potash when the original bath gets exhausted. The tin is deposited out of the charged solution by zinc or otherwise, and the remaining liquor—a solution of the chloride of iron and zinc—is available for the preparation of paints, for a disinfectant, or for the preservation of wood.

129,417—July 16, 1872. D. McDANIEL, W. B. SPEAR, AND J. W. RICHARDS. *Improvement in methods of utilizing waste tin scrap and galvanized iron.*

Tin scrap is first treated with muriatic acid to dissolve the tin, and the iron metal being removed, galvanized iron scrap is immersed in the bath. Then to the liquor is added waste sal-ammoniac skimmings, and a chemical equivalent of waste ammoniacal liquor from gas works, the iron precipitated, and the liquor cooled and crystallized, yielding a substitute for sal ammoniac as a flux for zinc coating baths.

146,286—January 6, 1874. H. SIEGER. *Improvement in recovering zinc from zinc fumes.*

The fumes of zinc and the gases evolved during the operation of treating alloys of zinc in a dry state are passed through a chamber containing carbonic oxide, and the zinc fumes condensed in a metallic state.

155,043—September 15, 1874. W. S. SAMPSON. *Improvement in methods of preserving lime.*

Lime is compressed into a solid mass, the barrel being held in an adjustable clamp. It preserves it from air slacking and reduces bulk.

160,018—February 23, 1875. J. HOLLIDAY AND H. M. BAKER. *Improvement in processes for removing tin from tin scrap.*

Tin scrap is heated in a bath of fused alkaline nitrate and then plunged into water.

190,550—May 8, 1877. C. A. CATLIN AND G. F. WILSON. *Improvement in processes of utilizing tin scrap.*

The scrap metal is sprinkled with dry chloride of sodium or potassium and nitrate of sodium or potassium, and then immersed in a caustic alkaline solution. Stannate crystals of the alkaline base are obtained from the evaporation of the saturated solution.

191,530—June 5, 1877. C. HORNBOSTEL. *Improvement in processes of applying oxygenated air in blast furnaces.*

Oxygen gas is supplied by forcing a current of air through a mixture of black oxide of manganese and sulphuric acid.

196,831—November 6, 1877. J. M. SANDERS. *Improvement in manufacture of oxide of tin.*

Scrap tinned iron is subjected to a heat that will volatilize the tin, which is oxidized by the admission of air, and the tin oxide settled in a condensing chamber.

200,587—February 19, 1878. P. C. VOGELLUS. *Improvement in separating tin from tin-scrap.*

Scrap metal is treated in a dilute nitric-acid bath, the iron being in contact with the positive pole of an electric battery, or otherwise rendered passive.

208,735—October 8, 1878. J. HOLLIDAY AND J. LAMBERT. *Improvement in utilizing tin scrap and manufacture of stannates.*

Tin scrap is treated in a bath composed of a solution of caustic soda or potash and an alkaline arsenite, nitrate or nitrite. The saturated solution of stannate of soda or potash is evaporated.

251,588—December 27, 1881. C. C. HUGHES. *Preparation of whitewash from lime.*

A whitewash free from grit is made by mixing lime with water and then grinding it. The product may be evaporated to a paste and packed in cans or barrels.

265,974—October 17, 1882. F. B. NICHOLS. *Apparatus for evaporating or concentrating liquids and saturating liquids with gases.*

Siphon slips, operating by surface attraction, are used to feed fluids out of troughs.

268,701—December 5, 1882. J. A. MATHIEU. *Process of and apparatus for evaporating liquids.*

Solid matter is separated from a heated solution thereof by showering it into a vacuum.

277,884—May 22, 1883. J. CLARK. *Method of reducing metals from their ores.*

Refractory ores or material compressed into a bar or block, is exposed to concentrated solar heat at the focus of a lens or reflector and suitable reagents applied.

277,885—May 22, 1883. J. CLARK. *Method of reducing metals from their ores.*

Ores are melted or disintegrated by concentrated solar heat and simultaneously carbonaceous reagents are applied, whereby ores containing chlorides may be reduced without the use of sodium or potassium.

298,149—May 6, 1884. C. R. A. WRIGHT. *Process of dissolving metals in ammoniacal solutions.*

Cuprammonium hydrate, or "copperized ammonia," or an analogous ammoniacal solution containing zinc, is produced by passing air through a solution of ammonia in water having fragments of the metal immersed therein.

322,157—July 14, 1885. C. A. CATLIN. *Process of recovering tin from tin-scrap.*

The tin is dissolved in an alkaline bath, and an oxide or salt, such as oxide of lime, is added, which will precipitate the tin as an insoluble stannate.

334,207—January 12, 1886. J. P. WETHERILL. *Apparatus for filtering and separating metals.*

A furnace for process No. 334,208. It has a chamber filled with refractory filtering material on which the metal to be filtered is placed, and one or more settling chambers with loosely built fire-brick division walls.

334,208—January 12, 1886. J. P. WETHERILL. *Process of filtering and separating metals.*

Metals and alloys of metals are heated to a temperature intermediate between the fusing points of the metals, and the metal having the lower fusing point is fused and passed through filtering material at the intermediate temperature.

344,575—June 29, 1886. W. HASENBACH. *Process of separating the tin from scrap or pieces of tin-plate or tinned iron by means of hydrochloric acid.*

The scrap metal is heated and treated with gaseous hydrochloric acid. The protochloride of tin formed distills off and is caught in a condensing chamber.

363,136—May 17, 1887. W. HASENBACH. *Recovery of tin from scraps of tinned plate.*

Protoxide of tin is obtained from lyes containing protochloride of tin and iron, obtained in the recovery of tin from tin-scrap by hydrochloric acid, by treating the lyes in closed vessels with pulverized carbonate of lime in excess, then separating the formed insoluble oxyprotochloride of tin from the dissolved oxyprotochloride of iron, and afterwards treating the oxyprotochloride of tin with carbonate of lime at a high temperature in a closed vessel, whereby the oxyprotochloride of tin is converted into a protoxide of tin.

363,173—May 17, 1887. G. SCHENCK. *Process of and apparatus for charging liquids with gases.*

For charging liquids with gases, as in the manufacture of bisulphites, the gases are forced into the liquor in a tank through tubes revolving therein beneath the surface of the liquor, and simultaneously the liquor, drawn from an upper to a lower tank, is discharged in spray through the gases in the top of the lower tank.

366,118—July 5, 1887. A. LAMBOTTE. *Process of recovering tin from tin plate and other materials.*

The scrap metal is subjected to a continuous current of chlorine gas diluted with air at a temperature above the boiling point of stannic chloride, and the vapors are conducted into a stannic chloride solution. The concentrated solution is evaporated down with a current of warm air.

370,220—September 20, 1887. O. M. THOWLESS. *Process of extracting aluminium.*

Aluminium chloride is mixed with sodium-producing substances, as a mixture of aluminium chloride, 10 parts; chalk, 3 parts; coal, 10 parts; and carbonate of soda or soda-ash, 10 parts; with or without 1 part of cryolite as a flux, and heated in a vessel; then ground and washed to remove the carbon and other matter.

375,606—December 27, 1887. G. G. CONVERS. *Process of treating sal-ammoniac or flux skimmings.*

The raw skimmings of a galvanizing bath are subjected to the action of steam, which is injected into the mass, and simultaneously the condensed vapor containing the soluble chlorides of zinc is drained off. The drained skimmings are then calcined and reduced.

389,618—September 18, 1888. E. WALSH, Jr. *Art of condensing metallic zinc from the vapors or fumes arising in the process of zinc-smelting.*

The zinc vapors and associated vapors from the smelting furnace are permitted to expand and separate by gravity in a condenser, the temperature of which is maintained at a point above the melting point and below the vaporizing point of zinc, whereby the fixed gases absorb heat from and liquefy the zinc vapors.

405,368—June 18, 1889. E. MENNEL. *Process of making double salts of mercury.*

A uni or multi valent phenol is treated with an acidulated solution of a persalt of mercury.

407,818—July 30, 1889. C. A. CATLIN. *Process of charging liquids with gas.*

A current of mixed gas is continuously passed through a series of tanks in one direction, while the liquid is intermittingly passed through the tanks in the opposite direction, with agitation of the liquid and gas.

409,409—August 20, 1889. C. LANGER. *Apparatus for treating solids with gases.*

It has a plurality of parallel intersecting spirals or Archimedian screws, having intersecting circles of rotation.

410,067—August 27, 1889. H. BOWER. *Process of facilitating chemical reactions.*

Two or more substances to be combined are subjected to the effect of impact and attrition from opposing jets. A finely divided solid may be used to intensify the impact and attrition.

412,247—October 8, 1889. W. W. FRANTZ. *Process of preserving lime.*

Quicklime, hot from the kiln, is pulverized and hermetically sealed in boxes in a hot state.

412,780—October 15, 1889. J. McNAB. *Process of filtering.*

A soluble salt is leached from a mixed mass of soluble and insoluble material, by grinding the mass with water into a thick homogeneous paste, adding sufficient water to dissolve the soluble portions, and forming a thoroughly-fluid homogeneous mixture in an agitating tank, and then forcing the mixture into the fibrous bags of a filter press by means of a force pump.

421,935—February 25, 1890. J. HOLLIDAY. *Process of making alkaline salts of antimony.*

Alkaline antimonites, or antimoso-antimonates, are made by treating pulverized metallic antimony in a hot aqueous solution of an alkaline nitrate or nitrite and caustic alkali.

430,653—June 24, 1890. G. KASSNER. *Process of producing plumbates of alkaline earths.*

Plumbates of alkaline earths are produced by roasting in free air a mixture of lead oxide (or a mixture of such salts of lead as are reduced to oxides by heat) and the carbonate or hydrate or caustic compound of an alkaline earth.

435,280—August 26, 1890. E. CAREZ. *Process of making ammonium nitrate.*

Barium sulphate is calcined out of contact with air, with a mixture of charcoal and a hydrocarbon, as resin-oil, and the product boiled with sulphur and water to produce polysulphide, which is transformed into barium nitrate by means of sodium nitrate, then crystallized and decomposed with ammonium sulphate to produce ammonium nitrate on the one hand and to recover the barium sulphate.

450,243—April 14, 1891. C. LIESENBERG. *Process of clarifying liquids.*

A clarifying liquid for solutions is prepared by treating a phosphate in the presence of water with sulphurous acid.

459,034—September 8, 1891. J. M. G. BONNET. *Process of recovering tin from waste tin-plate.*

Stannates are formed by agitating the plated scrap in an alkaline solution and simultaneously forcing hot air into the solution. The solution is then drawn off and sulphurous acid introduced, precipitating the tin as stannic acid.

485,035—October 25, 1892. H. C. W. HARMSEN. *Process of separating tin from tin-plate waste.*

The tin is dissolved in a bath of dilute sulphuric acid and nitric acid, and the saturated tin sulphate solution is then mixed with heated dilute nitric acid, and temperature maintained at not less than 90° C., whereby the dissolved tin is precipitated as stannic acid.

489,624—January 10, 1893. C. L. C. BERTOU. *Process of precipitating oxide of tin from solutions.*

Carbonate of lime is gradually added to the solution with the latter at a temperature near but below ebullition and exposed to the air until the precipitation of tin is complete. It is then cooled, the precipitate collected and washed with cold water and suspended in solution of a carbonate of an alkali metal, the strength of which is gradually increased until it presents a slightly alkaline reaction.

491,254—February 7, 1893. T. TWYNAM. *Process of separating tin from iron or steel.*

The metal is first coated with a film which will form a scale when heated, as by dipping in a slightly glutinous solution of calcium chloride; it is then heated until the tin is oxidized and plunged into a water bath, the film of oxide falling off. The oxides may then be treated to separate the iron and tin oxides.

497,256—May 9, 1893. M. WANNER. *Process of reducing sulphide ores and manufacturing carbon bisulphide.*

Sulphide ore, cleaned from gangue and pulverized, is mixed with carbon or hydro-carbon and subjected to destructive distillation; the carbon-bisulphide vapor is collected and condensed and the reduced metal obtained.

519,391—May 8, 1894. J. REESE. *Method of utilizing iron ore.*

The entire contents of phosphoretic iron ores are utilized by magnetically separating therefrom the larger portion of the magnetic oxide, finely pulverizing the tailings and treating with sulphuric acid to make the phosphates soluble and available for plant food.

521,444—June 12, 1894. E. A. UEHLING. *Process of and apparatus for analyzing gases.*

The percentage of a constituent of a gas—say of the waste gas of blast furnaces—is continuously indicated by means of continuous suction through minute inlet and outlet apertures and the abstraction of the constituent from the gas in its passage between said minute apertures, whereby the tension of the gas is varied and is employed as an index of the percentage of said constituent.

522,746—July 10, 1894. E. A. UEHLING AND A. STEINBART. *Process of and apparatus for analyzing gases.*

As an improvement on the process of No. 521,444, the gas is filtered and passed through a number of absorption chambers, each having a minute inlet and outlet chamber, and each abstracting from the gas a constituent, the percentages of which are severally determined by the changes from the normal tensions.

537,941—April 23, 1895. H. F. D. SCHWAHN. *Method of roasting ores and recovering vapors therefrom.*

The ores or minerals ground and mixed with nitrate of sodium or potassium—10 per cent—are roasted and sublimated, steam being injected into the chamber, and the resultant vapors are forced through one or more baths of solutions of nitric acid, hydrochloric acid, a salt of an alkali metal—preferably sodium chloride—in water of about 10° Baumé, causing reactions with the production of chlorides and carbonates of the metallic vapors and sulphates of the alkalis, which are further treated as seems advisable or profitable.

538,785—May 7, 1895. E. E. LUNGWITZ. *Process of smelting ores.*

Ores, containing a volatilizable metallic element, are smelted in a furnace under a maintained pressure higher than the pressure at which the resulting metal or regulus, or one of its constituents, would boil at the temperature obtained in the furnace.

549,596—November 12, 1895. A. ERLENBACH. *Method of utilizing tin of stanniferous materials.*

Stanniferous materials, as tin scrap, stanniferous waste of dyeing and finishing factories, etc., are heated with muriatic acid to turn the tin into solutions of perchloride of tin; the solution is concentrated, and the heating continued to distill off the perchloride of tin, and simultaneously therewith a stream of muriatic acid is introduced into the perchloride of tin.

556,568—March 17, 1896. E. WARZÉE. *Process of precipitating iron from solutions containing iron and zinc.*

Iron is precipitated as ferroso ferric oxide from solutions containing iron and zinc—as the spent electrolytes of galvanic batteries—by adding zinc in excess and blowing in air at a temperature of 90° C. to produce oxidation and agitation.

558,818—April 21, 1896. T. K. KLIMMER. *Process of making alkaline salts of metallic acids.*

For the production of alkaline salts with oxyacids of heavy metals from ores containing the heavy metals combined with oxygen, the ore—such as chrome ore—is mixed with ferric oxide and an excess of alkaline carbonate, calcined in the presence of air, and lixiviated. The residue, dried and ground, is used in a subsequent operation.

582,473—May 11, 1897. J. B. HILLIARD. *Chemical apparatus.*

To prevent gases from intermingling while passing through liquids, inclined, inverted, open channels are used for the gas, with entrance pipes connected with the lower ends of the channels and escape pipes connected with the upper ends.

593,415—November 9, 1897. S. GANELIN. *Method of treating sulfid ores as lead-zinc ores.*

Lead sulphide ores are introduced into a bath of a fused halogen salt capable of being decomposed by the sulphide—as chloride of zinc—effecting a double decomposition and the conversion of the lead sulphide into a halogen salt of lead, and of the base of the halogen salt of the bath into a sulphide.

600,347—March 8, 1898. T. HUNTINGTON AND F. HEBERLEIN. *Process of treating sulfid ores of lead, etc., preparatory to smelting.*

Sulphide ores of lead are oxidized by mixing the ore with an oxide of an alkaline earth metal—as calcium oxide—heating the mixture in the presence of air to a bright red heat (700° C.), then cooling to a dull red heat (500° C.), and finally forcing air through the mass until the lead ore, reduced to an oxide, fuses.

602,632—April 19, 1898. G. DE CHALMOT. *Method of obtaining free amorphous silicon.*

Silicon in the presence of copper is reclaimed in a free condition by heating finely pulverized silicon-copper alloy mixed with sulphur in a closed vessel to a temperature between 250° and 300° C. The silicon is set free as an amorphous powder. The amount of sulphur is regulated to form Cu_2S or CuS.

605,379—June 7, 1898. H. S. BLACKMORE. *Retort and method of making same.*

An impervious, noncorrodible retort for manufacture of carbon bisulphide is made of fire clay lined with a glaze of lead sulphide formed by coating it with fusible oxide of lead and then exposing to the action of carbon-bisulphide vapor when at a red heat.

607,497—July 19, 1898. G. M. WESTMAN. *Process of and apparatus for pyritic smelting.*

Hot air from regenerators is forced up through a column of pyritic ore free from carbonaceous fuel; the gases and volatilized products pass off, the oxides are condensed, and the remaining gases, nitrogen and sulphurous acid, produce sulphuric acid, while matte and slag are continuously drawn off from the base of the ore column.

616,821—December 27, 1898. J. BOCK. *Process of and apparatus for obtaining crystals.*

Large individual crystals are obtained from a heated saturated solution by passing it through a long, thin mass of crystals of the substance being crystalized, subjecting it to a gentle and slow disturbance and to a gradual cooling.

624,833—May 9, 1899. E. E. LUNGWITZ. *Process of roasting ores.*

The mass is opened by roasting under super-atmospheric pressure and suddenly removing the external pressure while the blast is shut off, whereby the expansion of the compressed gases within the mass break it open.

634,566—October 10, 1899. F. BALLOU. *Art of smelting ores.*

Water-saturated coke is used in the charge for a stack furnace, resulting in reduction of coke consumption due to the retarding of coke combustion until the charge has sunk to the smelting zone.

ORGANIC.

PROCESSES AND APPARATUS.

49,995—September 19, 1865. J. FRASER. *Improved method of treating oil wells for the removal of paraffine.*

Hot carbonic oxide is used for heating oil wells to redissolve the solid hydrocarbons.

80,835—August 11, 1868. F. RENZ. *Improved process of manufacturing sulphuric ether.*

The vapor from corn mash is passed through sulphuric acid at a temperature of 240° F., forming sulpho-vinic acid, which is washed at a temperature of 195° F. and then passed through sulphuric acid at a temperature of 275° to 300° F., producing sulphuric ether and water, which is then purified by means of an alkali and water baths, and the water condensed, leaving pure sulphuric ether.

136,623—March 11, 1873. W. F. SIMES. *Improvement in preparing camphor.*

Distilled or refined camphor is formed into blocks or tablets by pressure.

164,473—June 15, 1875. I. M. PHELPS. *Improvement in permanent flour of camphor.*

Pulverulent camphor is produced by subliming crude camphor in combination with glycerine. The glycerinated camphor is compressed into blocks.

169,727—November 9, 1875. C. PETERS. *Improvement in reagents for testing the strength of vinegar.*

A mixture of litmus, one-half pound; concentrated liquid ammonia, 1 pound; alcohol, 1 quart; and water enough to make in all 17 quarts, constitutes a blue testing liquid that is turned red by vinegar.

247,793—October 4, 1881. W. H. ATKINSON. *Refining camphor and apparatus therefor.*

Camphor is refined while surrounded by sheet metal or alloy, which can afterwards be stripped from the cake.

511,143—December 19, 1893. W. H. HIGGIN. *Process of making sodium acetate.*

Esparto liquor and other alkaline waste liquors containing sodium acetate are evaporated, the residue carefully heated at about 400° C., but below the heat at which sodium acetate is decomposed, and the charred mass leached.