COMMERCIAL PEAT:

ITS USES AND POSSIBILITIES.

The first producer plant in the world making regularly sulphate of ammonia and producer gas from wet peat.

N.B.—Peat may be used containing up to 75 per cent. water. (*See page* 156.)

COMMERCIAL PEAT:

ITS USES AND POSSIBILITIES.

BY

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PREFACE.

When the late Sir Clement Le Neve Foster set before me the project of preparing a book on the subject of Peat, I did not realise how quickly the industry would develop. But the peat resources of the world are so vast, and the commercial possibilities so great, that engineers and scientists, both at home and abroad, are giving close attention to the subject, and a warm welcome was given to the publication of *Peat: Its Use and Manufacture*, under the joint authorship of the late Mr P. R. Björling and myself.

This present volume is designed as a companion to that above mentioned, and presents this important industrial question from a commercial point of view.

To appreciate the seriousness of the problem of utilising the bog-lands, it is only necessary to realise the great surface covered by peat bogs on the Continent of Europe alone. This amounts to 212,700 square miles. The survey of Ireland gives 2,858,150 acres of peat bogs. In Canada more than 30,000,000 acres of land are known to be peat bog, and in the United States 20,000,000 acres. In Newfoundland two-thirds of the surface of the country is said to consist of peat bogs.

The various processes described in this book, evolved by a long course of patient investigation and experience, and the numerous applications for patents, are evidences of a new impetus to the subject. Gas engineers have lately been paying special attention, with most successful results, to the production of gas from peat and the recovery of the valuable by-products, in connection with central electric lighting stations, and their efforts will doubtless go a long way in assisting to solve the problem of the utilisation of peat as a fuel.

The task of sifting and collating the great mass of data placed at my disposal has been a heavy one, and I tender my sincere thanks to the following friends and firms for their encouragement and co-operation, viz. :—Martin Ekenberg, Ph.D.; Herman C. Woltereck, Ph.D.; Dr Eugene Hannel (Canadian Department of Mines); Dr Arthur Heinemann; A. B. Lennox, C.E.; Capt. H. Riall Sankey, R.E. (Ret.), M.I.C.E.; Erik Nyström, M.E. (Canadian Department of Mines); Crossley Bros., Ltd.; Thos. Rigby, A.M.I.M.E.; Candy Filter Co., Ltd.; Sulphate of Ammonia Co., Ltd.; The Power-Gas Corporation, Ltd.; Uskside Engineering Works Co., Ltd.; J. Stevens, M.I.M.E.; Oberbayerische Kokswerk Fabrik, of Beuerberg; Controller of His Majesty's Stationery Office; Director of the Imperial Institute; Secretary of the Department of Agriculture and Technical Instruction for Ireland; Secretary of the Motor Union of Great Britain and Ireland; the Canadian Office, London; United States Geological Survey, Washington; American Consular-Agent W. B. Murphy, Sorau, Germany; A. Heinen; the Swedish Chamber of Commerce, London; and to the Editors of the various Journals quoted.

I desire also to express my appreciation of the care bestowed by the publishers in the production of the work, and for their ready assistance in all questions regarding the arrangement of text, etc.

FREDERICK T. GISSING.

October 1909.

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COMMERCIAL PEAT.

CHAPTER I.

PROCESS FOR THE PRODUCTION OF ALCOHOL FROM PEAT.

THE fuel chiefly employed for motors (to the abundant supply of which the rapid rise of the automobile industry may be said to be largely due) is petrol. The motor industry, which is fast becoming one of the world's greatest industries, is thus dependent upon the supply of a fuel which to all appearance must, according to the present trend of progress, fail in the near future to be equal to the demand.

The Motor Union of Great Britain and Ireland became somewhat alarmed at the serious rise in the price of petrol, and in September 1906 it was suggested that a special Committee should be appointed to fully discuss this important subject.

In July 1907 the official report of the Committee was issued, and through the courtesy of the secretary of the Motor Union the following extracts are taken:—

"The Committee have carefully considered the various substitutes for petrol which have been brought before them, and have unanimously arrived at the conclusion that the main efforts of the Motor Union should be in the direction of encouraging in every way the use and development of a substance, such as alcohol, produced from vegetation.

"Alcohol offers a complete and satisfactory substitute for petrol so far as its properties are concerned, and hence probably the most important recommendation of the Committee is that connected with the production on a large scale of alcohol for the purposes of a fuel. It may be noted that the argument added to all others, but which to many in this country would probably appear the most important of all, is the fact that it would form a home industry, especially if produced from some substance, such as peat, potatoes, or beet, which would place the country in an independent position with regard to foreign supplies, a consideration which, it should be noted, is leading the Governments of France and Germany, particularly the latter, to give every encouragement to the use of alcohol as a fuel.

"The conclusion which impressed itself upon the Committee more and more at each meeting was that a famine in petrol appears to be inevitable in the near future, owing to the fact that the demand is increasing at a rate much greater than the rate of increase of supply. The very important matter of the coming shortage does not appear to be realised by those most concerned. For instance, the Committee have reason to believe that even large commercial undertakings, such as omnibus companies, whilst rapidly increasing the number of their vehicles, have been able to make but little provision for their future supplies of fuel."

During the sittings of the Committee Mr Roger W. Wallace, K.C., gave some particulars of experiments carried out by him, in conjunction with Sir William Ramsay, K.C.B., in the process for the production of alcohol from peat; the latter has prepared a full report of the investigation.[1] He states:—

"One of the principal reasons for the success of the

[1] An article on Sir William Ramsay's Report appeared in the *Automotor Journal*, 20th July 1907.

present process is the fact that the peat can be used wet as it comes from the field, thus eliminating the costly and difficult drying and repeated handling which most other processes demand.

"When brought to the factory the peat is mixed with acidulated water and boiled under a low steam pressure for a little over half an hour, in which time the starchy and gummy matters are converted into sugar. The boiling process is stopped as soon as this purpose is achieved and before the structural cellulose of the fibres has been saccharified, so as to be able to use the cellulose as a combustible to generate steam and power for the driving of the factory. Should the saccharification be allowed to go too far, some of the first formed and easily alterable sugars will be charred. The discovery that the sugars thus destroyed would have yielded more alcohol than those formed from the cellulose is of fundamental importance, and is the result of a minute scientific investigation.

"After the boiling, the peat mass is of a gelatinous consistence, and the excess of acid is reduced by the use of lime or a carbonaceous clay often found at the bottom of peat bogs. The discovery that this clay, besides carbonate of lime, contains phosphoric acid, magnesia, and nitrogen in such proportions as to afford a first-rate nutriment for the yeast employed in the fermentation of the peat wash is specially remarkable, and we are indebted to Professor G. Lagerheim, of Stockholm University, for these researches.

"After neutralisation of the viscid peat wash it is cooled down to 35° C. and fermented by means of a special yeast that has been collected from wild berries often found growing on the bogs.

"When the fermentation is ended the solid parts quickly separate from the liquid, and on sinking collect the yeast cells which have absorbed most of the nitrogen available in the liquid. The clear fermented juice is with advantage used in the boiling vessels instead of water, when it is distilled without any extra cost, and the manufacturer is thus enabled to collect the aromatic elements of the peat during the distillation.

"The solid sediment is passed through a gas generator, and yields the usual dry distillation products—gas for fuel, ammonia water for making sulphate of ammonia, paraffin, creosote, oils, methyl-alcohol, tar, etc."

During the last three years many authorities have drawn attention to the claims of alcohol as a national fuel, to the supply of which there need be no limit, and which is in many ways a better fuel than petrol. It is a fuel which Continental countries have already recognised as essential to the future of many trades and industries, and the only fuel at present in sight.

It has been stated in evidence that the average price at which alcohol can be produced in Germany amounts to 1s. a gallon, including the cost of denaturing and Government supervision. It is also a fact that in this country the actual cost of manufacturing alcohol amounts to 11½d. a gallon (64 overproof, a strength common in industrial spirit—see *Report of Departmental Committee on Industrial Alcohol*). This is produced from beet, potatoes, and molasses. Evidence has been given which tends to show that alcohol may also be produced from sawdust at a very low cost. The lowest figure it is possible to touch in this respect is 3d. per gallon when peat is used. Now, owing to the great strictness of the Excise authorities in England, the cost of denaturing and expenses of supervision bring the total cost of the alcohol up to about 2s. per gallon at the present time, and it is therefore evident that should the Government see their way to take a wider view of the question of alcohol as a fuel for internal combustion engines this price of 2s.

a gallon could be very materially reduced. If this were done, the price could easily be brought to such a figure that it would be a very serious competitor with petrol in this respect alone.

The Government that will recognise this, and will allow untaxed alcohol suitably denatured to be used for light, heat, or power, will be conferring an immense boon and benefiting a very large proportion of the population.

At a cost of 10d. for sulphuric acid, from 25 to 36 gallons of alcohol fit for motor purposes has been extracted from a ton of peat. The method is simple and inexpensive, and the value of the by-products exceeds the cost of production. The new fuel is more efficient in every way. It is safer to handle, and will not overheat the engine, as petrol has a tendency to do. There is undoubtedly an inexhaustible supply of alcohol fuel to be obtained from the vast peat bogs of the world. No special or costly plant is necessary. If sulphuric acid and lime are taken to the peat beds the peat can be treated in works erected on the spot.

The study of peat bogs as able to supply material for conversion into alcohol for driving motors used in home industries has also been attracting attention on the Continent.

After experimenting for over two years, a company in Copenhagen have developed a process for the extraction of alcohol from peat. They state that from one ton of dry peat about 40 gallons of alcohol may be produced, in addition to 66 lbs. of sulphate of ammonia and other valuable by-products. It is claimed that the cost of alcohol made in this way is 4¾d. per gallon, which is considerably below the price at which it can be made from beet or potatoes.

If it is possible to make alcohol from peat cheaply enough to be commercially advantageous as a fuel, and there appears every reasonable prospect of doing so, its industrial value will be assured. Alcohol can be used for many of the purposes for which gasoline and petroleum are now much employed. The production of it in large quantities and at low rates in this country would undoubtedly be a great stimulus to industry. Ireland would probably benefit to the largest extent, as it has the most suitable deposits of peat, but good peat is also to be found in large quantities in England, Scotland, and Wales.

With our peat resources there is a good field for enterprise in this direction and the most should be made of it, as the creation of any fresh industries in this country must eventually prove beneficial to the nation's welfare.

CHAPTER II.

AMMONIA FROM PEAT.

Woltereck Process.

THIS process for the production of ammonia by the moist oxidation of peat consists in passing a mixture of air and water vapour over peat kept at a low degree of heat in specially devised furnaces.

After the peat has undergone the necessary harvesting, it is conveyed to the works and automatically fed into hoppers worked with compressed air, and quickly dropped into the furnaces. Here it is subjected to moist combustion by means of a blast of air charged with water vapour at a regulated temperature. The resulting gases contain paraffin tars, acetic acid, and ammonia. The paraffin tars are removed by the "Woltereck" scrubber, which retains all tarry matter without causing any condensation and consequent loss of ammonia. The acetic acid is next absorbed in the lime tower, where the gases meet hot milk of lime, and combine with it to form acetate of lime, which may afterwards be treated for the recovery of acetic acid or the production of acetone.

The gases pass from the lime tower to the acid towers, where they meet a stream of hot sulphuric acid, which combines with the ammonia to form sulphate of ammonia, the chief object of the process. After the acid is completely neutralised it is drawn off to the crystallising vats. The solution of the sulphate is there further concentrated and allowed to crystallise; and after centrifuging, to remove any adhering liquor, is ready for shipment.

The paraffin tar is drawn off from the scrubber and subjected to distillation to remove the lighter oils.

The acetate solution obtained from the lime tower is evaporated to dryness and distilled with hydrochloric acid to obtain concentrated acetic acid, or can be subjected to dry distillation to produce acetone.

Hitherto sulphate of ammonia has only been obtained as a by-product, mainly from gas-works and coke ovens, etc., and though the supply from these sources is gradually increasing, it is anticipated that such increase cannot possibly be sufficient to meet the growing demands of agriculture. These demands, however, can be fully met by the Woltereck process, which is the only one in commercial operation for the direct production of sulphate of ammonia.

The raw material upon which the Woltereck process depends is peat. The question of the industrial exploitation of peat is one of the most important in the domestic economy of many countries. For the last century it has been brought to the fore, agitated and rejected, forgotten, or subjected to abortive efforts. The quantities of potential fuel contained in the peat bogs, and the growing demands for food stuffs, make the problem of utilising the bog lands a matter of urgent importance.

The great difficulty in the commercial utilisation of peat has always been the large percentage of water it contains, which averages 90 per cent. To eliminate the existing moisture down to 75 per cent. is a comparatively simple matter, but to reduce the moisture sufficiently for the peat to be utilised as fuel has hitherto been a long and expensive process.

The Woltereck process overcomes this difficulty in the treatment of peat. As the result of the working of the

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Fig. 1.—Peat Moor at Carnlough, Co. Antrim.

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FIG. 2.—General View of the Works at Carnlough, Co. Antrim.

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Fig. 3.—Aerial Ropeway, nearly two miles in length, which takes the peat down from the moor terminal to the process plant and automatically feeds the furnaces.

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Fig. 4.—View of the Acid Towers.

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FIG. 5.—Evaporating Shed.

process it has been established that peat containing between 65 per cent. and 80 per cent. of water may be successfully employed. It has been brought to its present stage of efficiency as the result of continuous experiments and the application of the results of such experiments to the industrial requirements of the process, extending over four years.

By this process it has been finally determined on a manufacturing scale that a minimum yield of 5 per cent. of sulphate of ammonia is obtained from the peat, calculated as theoretically dry, and also such by-products as acetic acid and paraffin tar. The chief products of the process, sulphate of ammonia and paraffin tar, have a practically unlimited market, while the market for acetic acid, acetate, and their derivative, acetone, is continually expanding, especially that of the latter, of which enormous quantities are required by the manufacturers of smokeless powder. In addition, the ash of peat is saleable as a cheap fertiliser, since it contains potassium salts, lime, and phosphoric acid in available form.

Fig. 1 shows a view of the peat moor at Carnlough, County Antrim.

Fig. 2 gives a general view of the works at Carnlough.

Fig. 3 illustrates the aerial ropeway, nearly two miles in length, which takes the peat from the moor terminal to the process plant and automatically feeds the furnaces.

Fig. 4 shows the acid towers.

Fig. 5 gives a view of one of the evaporating sheds.

In a valuable technical paper read before section B of the British Association at Dublin in September 1908, Dr Woltereck gave a comparison of the results of a number of experiments which have been made by him determining the quantities of ammonia obtainable by different operations. This paper was also read, in December 1908, before the

Royal Dublin Society, by Prof. Dr H. Ryan, and the following is the official abstract of the paper:—

"Attempts to utilise the nitrogen contents of peat have been made during the last sixty years, but the yield of ammonia obtained by the various processes which have been tried shows that only about one-third of the nitrogen can be thus recovered. Starting from an observation that a mixture of nitrogen and hydrogen passed over reduced iron at a low heat always produced ammonia for some time, the author made further experiments on these lines, and found that the presence of oxygen and water was of importance. This led to the gradual reduction of the quantity of hydrogen, and finally to its complete omission; but the periodical necessity of reducing the iron used for the purposes of moist oxidation led him to employ some carbonaceous material (coke, coal, charcoal, etc.) for this purpose.

"Finally, peat was found to give the most satisfactory and rapid results, and even when it contained up to 80 per cent. of water it could be utilised advantageously.

"In the meantime experiments were made to prove the co-operation of atmospheric nitrogen. Sugar carbon absolutely free from nitrogen was treated by the process and produced an average of 1 per cent. ammonia on the carbon consumed.

"The large plant erected at Carnlough, County Antrim, has finally confirmed the working and results of the process on a commercial scale."

CHAPTER III.

PRODUCTION OF NITRATES FROM PEAT.[1]

In connection with the utilisation of peat bogs some most interesting experiments have been conducted in France by Messrs Müntz and Lainé, on the use of peat in the production of nitrates on an industrial scale, and the results of these researches have been published in a bulletin presented before the French Académie des Sciences.

The uses of nitrates are very varied, the most important ones being their application to agriculture and their entering to a large extent into the manufacture of explosives and war ammunition.

After long and careful experiments, Messrs Müntz and Lainé conclude that, by passing weak solutions of ammonium sulphate over peat beds specially prepared to set up an intensified action of nitrification, the yield of nitrates is one thousand times greater than by the old methods of nitre-beds, in which nitrification was always regarded as a slow and tedious process.

In considering the utilisation of peat for the production of nitrogenous compounds, the fact has not been overlooked that sulphate of ammonia is a by-product of coke ovens and gas producers using peat and soft coal, and that from this source it is comparatively inexpensive.

After having experimented on the active part performed

[1] From the *Summary Report of the Mines Branch, Canadian Department of Mines, for the Fiscal Year 1907-8* (No. 26A, 1908), by permission of Dr Eugene Haanel, Superintendent of Mines.

by organic materials in inducing intensified or forced nitrification, it was thought that peat which enters so largely into the composition of garden soils (garden earth, silico-calcareous earth, clayey earth, and calcareous earth) offered a good base for nitrification.

Investigations were then confined to peat, on which a few experiments had been made as to its adaptability as a nitrifying medium, and the following materials were taken :—

1. A compact peat from Yonne, containing 57·93 per cent. water.

2. A mossy peat from Yonne, containing 68·26 per cent. water.

3. A mossy litter from Holland, containing 59·60 per cent. water.

To these peats had been added 100 oz. of Meudon chalk, 5 oz. phosphate of lime, 1 oz. potassium sulphate, and 50 oz. of garden soil, per 10 pounds of peat. Further, sulphate of ammonium was added, which was renewed as nitrification proceeded.

The results showed a very intense nitrification, manifestly superior to that undergone by the mould alone; by continuing to add ammoniacal salts the enrichment was further increased, and the limit was not reached even then.

The experiments proved that peat constitutes a more active medium for nitrifying beds than soils or even moulds. As its value as a merchantable product is practically *nil*, it could be substituted with great advantage for material usually employed in the making up of nitrifying beds. Therefore, peat offers the best medium for forced (or intensified) nitrification, and it should constitute the basis of nitrifying beds of high yield.

A cubic yard of peat gives by desiccation 590 lbs. of dry matter containing 2 per cent. of nitrogen. Taking a thickness of 40 inches in peat bogs, an area of 2½ acres would contain 165,000 lbs. (about 73 tons) of nitrogen in an inert state.

It is apparent from these results that nitre beds formed of peat yield returns as good as, or even better than, mould; and as there exist practically inexhaustible quantities of this material, its use in the establishment of nitre beds is strongly recommended. Both surface mossy peat and the underlying compact peat are suitable for the purpose, provided that the proportion of earth in this last mentioned material be not too high.

The artificial nitre beds yield calcium nitrate. For the manufacture of explosives it becomes necessary to transform it into nitric acid, which can be done by treatment with sulphuric acid, as in the case of sodium nitrate.

The abstract of the bulletin, which covers sixteen pages of the *Summary Report of the Mines Branch*, is of the greatest value to all concerned in the peat industry. In addition to containing the figures relating to the various experiments carried out, there is also a diagram with description of a plant of eight beds for this continuous nitrification process, and the authors conclude the interesting account of their researches with the following remarks:—

"Peat constitutes a nitrifying medium, or support, superior to all others, either for the installation of intermittent nitre beds or of continuously producing plants. It constitutes a fuel of a very low market price at the bog, and can be utilised to maintain the necessary heat and steam for the plant. Moreover, owing to the high proportion of nitrogen which it contains, and which can be recovered in the form of ammoniacal salts, peat can supply the raw materials necessary for the manufacture of nitrates."

"This manufacture can, therefore, rely wholly for supplies on the exploitation of peat bogs; and to avoid transportation of material which has only a small market value, the nitrifying beds should, if possible, be installed on the bogs themselves."

"An idea might be formed of the potentiality of such deposits by presenting a few figures. A bog with a superficies of 2500 acres and a mean depth of 6 feet, with a content of 2 per cent. in nitrogen, could yield between 800,000 and 900,000 tons of nitrate of sodium, *i.e.* 320 tons to 360 tons an acre respectively. If the area of the peat bogs existing in France be taken into consideration, these figures can safely be multiplied by 300 or 400. This is a reserve of nitrogen which would meet the want of centuries to come."

In the English Patent No. 16,162 (1907) taken out by Messrs A. Müntz and A. G. Girard of Paris for obtaining nitrates from peat the process is described as follows:—Ammoniacal salts are nitrified on peat by treating peat beds with ammoniacal salts or ammonia, such as ammonium humate or ammonium carbonate, which may be obtained by the distillation of peat. The peat beds may be impregnated with a paste of calcium carbonate and phosphate, etc., and are prepared by the addition of nitrifying organisms. The beds are laid on concrete floors and provided with aeration chimneys; rain water and light are excluded by buildings of peat briquettes, etc. Nitrates of soda or potash are produced by treating the resultant nitrate of lime with sulphate of soda or potash. Nitric acid, free from chlorine, is prepared from the nitrate of lime, or soda, of this process.

The question of the utilisation of the extensive peat deposits in Germany for the production of electric power, and, as a by-product, of a nitrogen fertiliser, is again receiving attention.

In December 1903 Professor Adolf Frank, of Charlottenburg,[1] delivered an address before the Central Moor Commission, in which he strongly advocated that the latent resources existing in the moors of Germany should be developed, and thus bring to the extensive and comfortless moors a flourishing and profitable industrial and agricultural business.

"Both on the right and left banks of the Ems river exist large moor beds, of which the Bourtanger Moor, on the left bank, alone has an area of 345,940 acres; while, on the right bank, the Heummlingo Moor is about 370,650 acres in extent; and further north, between the Ems-Hunte Canal and the Ems-Jade Canal, other large moors are to be found, as also in the Oldenburg and the Lower Weser Moor districts.

"During the last two years central stations have been erected at various sites on the banks of the canals draining the moors, and electric power is produced and conducted to surrounding towns within a radius of twenty to thirty miles. Peat fuel is used at all the generating stations.

"Up to the present time Germany has been largely dependent on foreign countries for manures containing nitrogen, but the further development of the question is in obtaining a nitrogen fertiliser from the immense peat beds which are available within the German Empire. This can be done with the greater advantage, because the technique in the manufacture of carbide permits great fluctuations in the supply of power, and offers the possibility of working in such an intermittent way, that if from time to time the power is used for other purposes, the stopping of the individual carbide melting furnaces causes no essential

[1] Professor Adolf Frank, *Electric Power and Nitrogen to be Won from Peat Beds.* Address before the Central Moor Commission, 1903. Translated by American Consular-agent W. B. Murphy, Sorau, Germany.

disturbance to the plant as a whole. The manufacture of carbide operates, to a certain extent, like an accumulator, since it takes up and makes use of all electric power which from time to time remains unemployed.

"With a plant of 10,000 horse-power, 40 tons of carbide can be produced in twenty-four hours, and 100 parts of carbide with 25 parts of nitrogen give 125 parts of manure containing 20 per cent. of nitrogen. It hardly needs to be pointed out that the yearly maximum production of 15,000 tons of manure containing nitrogen, by means of an electric central station of 10,000 h.p., would give German agriculture, which now uses 500,000 tons of Chile saltpetre and 150,000 tons of ammonia sulphate, a very welcome addition to its insufficient supply of manures.

"Taking as a basis the agricultural-chemical experiments carried out since the year 1901, it can already be considered as indisputable that calcium cyanamide (generally called calcareous nitrogen), which is obtained from calcium carbide by admittance of atmospheric nitrogen, constitutes in many cases a useful substitute for the manures containing nitrogen imported from abroad, particularly Chile saltpetre and sulphuric ammonia sulphate. For a successful competition of calcareous nitrogen with Chile saltpetre and ammoniacal salts the only essential condition is the cheapest possible production of calcium carbide, since the other ingredient, air, is everywhere the same. The price of calcium carbide depends essentially upon this, that the electric power, necessary for its production from lime and coal, be not expensive. Instead of paying tribute to foreign countries in ever-increasing amounts, Germany will be able to turn that money over to her own electro-chemical production of manures containing nitrogen, and by this means not only enlarge the circle of consumers of agricultural products, but also bring in a considerable source of revenue. In making use of the natural sources of power existing in the German peat fields for this purpose, energy which can be generated from the vast moors claims first consideration."

CHAPTER IV.

EKENBERG WET-CARBONISING PROCESS FOR CONVERTING PEAT INTO COAL.

THIS process allows mechanical means to be used to expel the bulk of the water, and has been found to work satisfactorily with even large apparatus.

The wet peat is taken from the bog by any of the usual methods, and passed through a specially constructed cutting machine, or disintegrator, which reduces it to a homogeneous pulp. By means of specially designed pumps it is then forced in a continuous stream through the carbonising oven, which is heated to temperatures of between 180° and 230° F. under sufficient pressure to prevent formation of steam; consequently the carbonisation is effected by superheated water, hence the name, "wet-carbonising process." The pressure maintained in the oven is about 200 to 300 lbs. per square inch, and at the corresponding temperature a partial carbonisation takes place and the slimy hydrocellulose is destroyed, which has the effect of so altering the properties of the material that the water can be pressed out. All the valuable volatile constituents of the peat are retained in the product, thus making it a fuel equal to coal.

A particular feature of this treatment is that the original quality of the peat has little or no influence on the finished product, except in yield, so that the age or ripeness of the bog is immaterial. All kinds of peat can be submitted to "wet-carbonising."

From the oven the wet carbonised pulp passes direct to a press, where the bulk of the water is pressed out.

Of the 7 lbs. of water per pound of dry substance contained in the peat from a drained bog, 6 lbs. or more are eliminated, leaving only 8 to 14 per cent. of the water originally in the peat. At this stage the peat is in a condition similar to that of brown coal (lignite), which also contains a like amount of water when taken from the mines. The water remaining after the pressing of the wet-carbonised peat is then evaporated during a final drying by means of the waste heat from the carbonising oven and power plant. The peat is then ready for briquetting, which work is carried out in the ordinary brown coal briquetting presses. The peat briquettes have a black glossy appearance. They have a heating value of about 11,200 to 12,500 B.T.U. per lb., or very nearly equal to that of ordinary coal. On burning, the peat briquettes retain their form until consumed, give a long clear flame, and have proved equal to coal in all instances where it has been tried. They possess the important advantage of containing practically no sulphur, which might injure metals with which the flame comes into contact. When submitted to dry distillation a good-burning coal-gas is given off and a hard coke suitable for metallurgical purposes is left.

In regard to sulphur the peat coal has a distinct advantage, inasmuch as it contains only 0·2 to 0·4 per cent., whereas ordinary coal contains up to 2 per cent. of sulphur.

The briquettes of peat coal can also be used for manufacturing gas for lighting and heating purposes, and are specially adaptable for suction gas motor plants. For producing power-gas no briquetting is necessary, as the pressed carbonised peat is used. As by-products, 4 to 5 per cent. of ammonia sulphate and valuable paraffin tar are obtained.

Fig. 6 illustrates an experimental plant at Stafsjö peat bog, Sweden, for carbonising peat by the Ekenberg wet process.

Fig. 7 shows an Ekenberg recuperative wet-carbonising oven under construction.

Fig. 8 illustrates a powerful peat pulp pump forcing the raw peat pulp through the Ekenberg recuperative wet-carbonising oven.

The fact that Dr Martin Ekenberg's process can be worked all the year round, irrespective of weather conditions, renders it for the first time possible to establish on a firm basis the industry of peat fuel manufacture. The only alternative has been to allow the peat, as taken from the bog, to dry in the air, which is the chief operation in all processes now in use for converting raw peat into fuel. The air drying, however, makes the production entirely dependent on climate and season, and under the most favourable circumstances the air-dried peat retains a considerable proportion of moisture.

By the Ekenberg process the cost of manufacturing the peat briquettes works out at 7s. to 9s. per ton, without reckoning the by-products. About 37 per cent. of the peat in the bog is sacrificed as fuel in the course of manufacture, and the cost of this fuel is included in the figures given. If the conditions of the bog are favourable, the lower figure of 7s. can be calculated as the cost price per ton of briquettes on the waggon at the factory.

In further developing the process, Dr Ekenberg has combined the manufacture with recovery of by-products from the fuel used, principally sulphate of ammonia. The by-products pay a great part of the expenses, thereby considerably reducing the cost of production, so that one ton of

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FIG. 6.—Experimental Plant at Stafsjö Peat-bog, Sweden.
Carbonising peat by the Ekenberg Wet Process.

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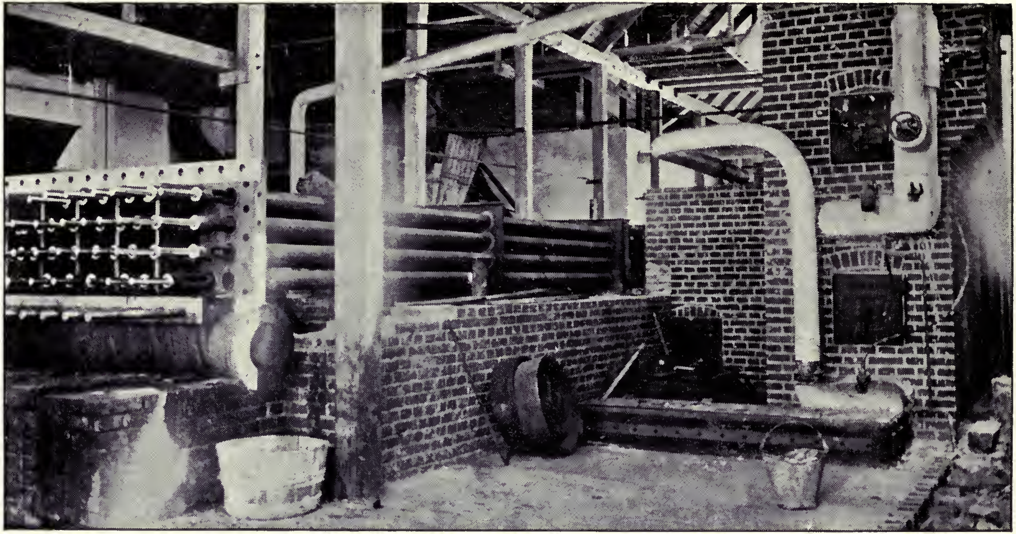

FIG. 7.—Part of the Stafsjö Plant.

An Ekenberg recuperative wet-carbonising oven under construction, showing a block of 52 tubes.

Carbonising capacity, 180 tons of raw peat per day of twenty-four hours.

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Fig. 8.—Part of the Stafsjö Plant.
Powerful peat pulp pump forcing the raw peat pulp through the Ekenberg recuperative wet-carbonising oven.
Pumping capacity, 79,000 gallons per day of twenty-four hours.

briquettes can be produced for 4s. in waggons at the factory. As it is seldom that coal can be brought to the surface and placed in waggons for less than a total cost of 4s. per ton, this recent improvement makes it possible for the briquettes of wet-carbonised peat to come into competition with coal, even in coal-producing countries.

An exceedingly interesting and valuable technical paper, "Fuel from Peat: Researches and experiments with the object of finding a suitable process for converting peat into fuel without air-drying," was read by Dr Ekenberg at the meeting of the Iron and Steel Institute in London in May 1909, and has been reprinted in several of the engineering journals. The paper is well illustrated, and contains plans for a peat briquette factory for fifty tons per twenty-four hours by the Ekenberg process.

CHAPTER V.

THE UTILISATION OF PEAT.

Peat Gas.

THE use of peat has hitherto been much neglected, in all probability owing to the absence of practical implements. Now, however, there seems every chance of peat bogs growing in importance by means of a combination of suction gas plants and electrical works. Peat, which is hard and of uniform consistency, is put into the suction gas generator, and the gas engine is worked as a prime motor for an electric station in the bog districts.

The utilisation of peat for gas making by destructive distillation is being actively pursued by engineers in this country. Though the great peat bogs in the British Isles are still almost untouched, our manufacturers of gas plant and machinery are, nevertheless, alive to the possibilities of peat in the future. Great reliance is placed on the value of the by-products, and mainly on the ammonium sulphate which will be produced in the course of the process of gas making.

During the past year considerable development occurred in connection with the production of gas from peat, and the question of the recovery of the by-products has been brought into the realm of practical utility.

The results of the many experiments carried out have proved, independently of each other, that peat will produce—

1*st*. A gas which is in every way suitable for use in gas engines.

2*nd*. A considerable amount of sulphate of ammonia worth about £12 a ton.

3*rd*. A very good coke which may be used for all kinds of heating purposes.

The Mond Gas Corporation, London, and Messrs Crossley Bros. Ltd., of Openshaw, Manchester, have given considerable attention to this subject. Three special "Mond" gas installations are now either at work or in course of construction, the sizes ranging from 30 to 90 tons of peat gasified per twenty-four hours. These installations are in England, Germany, and Italy. The one in Italy, which is to gasify 90 tons of peat per day, and to recover the sulphate of ammonia from the gas, is intended for the production of power gas for a central electric distributing station of 3000 indicated h.p. This is an entirely unique installation.

In employing peat for gas production in accordance with the process of Dr Caro and Professor Frank of Charlottenburg, the experiments proved conclusively that it was possible to make use of wet turf containing from 50 to 55 per cent. of water, with the simultaneous production of increased volumes of the ammonia sulphate, a most valuable material for use as a manure. It would appear from the report of Dr Caro on the tests carried out on a manufacturing scale at Stockton and Winnington on peat gas production, that it was possible by this means to recover about 70 per cent. of the nitrogen present in the peat in the form of ammonia sulphate. In addition to this, from 1250 to 1500 cubic metres of peat gas, with a thermal value of 1300 to 1350 calories, were obtained under this system.

A second large installation for the use of peat for gas production on the Caro and Frank system has recently been set to work. This undertaking aims at bringing a portion of the extensive peat bogs which spread out over the north-west of Germany into systematic cultivation, with the simultaneous distribution of electrical energy over a wide area for agricultural purposes, as also for the provision of light and power in a number of towns situated within a radius of 50 kilometres (31 miles) round the works. The central generating station is situated on part of the area of the so-called Königsmoor, 25,000 morgen (34,275 acres) in extent, and over this vast uncultivated district it is intended to provide a network of canals attaining to a total length of 40 kilometres (24 miles). These will consist of main and branch canals suitable for extending the cultivation of the territory. The dredging out of the turf will be effected by huge peat-bog ploughs, which will be driven forwards in the line of the future canal by means of electrical energy. The turf thereby excavated will be electrically conveyed to two sets of peat presses, erected at the generating station, and will there be worked up and converted into fuel, after having been sufficiently freed from water. The blocks thus manufactured will serve as the only fuel used for the electric generating plant.

It is estimated that by means of the large gas engines work to the extent of 600 h.p. hours will be obtained from each ton, while the value of the ammonia recovered is estimated to yield a good interest on the investment.

The plant has been provided by the Siemens-Schuchert works, with the support of the Government, and the above firm has been granted the sole working rights for a period of seventy-five years.

A peat gas plant is being erected near Svedala, Sweden, which will transform power won from peat into electricity, and this electric power will be conducted to neighbouring towns for consumption by municipalities and industrial plants. Of the peat used in experiments, 100 kilos. (220 lbs.) produced 8829 cubic feet of dry gas at 0° C. and 760 mm.

The future of Ireland is intimately connected with the utilisation of peat. It is the one substance which Nature has given bountifully to the "Emerald Isle," from which much power may be obtained. At the moment the question is also of special interest in Ireland, in view of the Central Ireland Electric Power Bill,[1] which has recently been passed by Parliament.

This scheme is for the distribution of electricity generated by engines driven by gas obtained from peat. It differs from all previous methods of utilising peat in that, instead of the costly process of manufacturing peat into artificial fuel, it is applied in its natural state, direct in gas producers, and converted into gas for power purposes.

The process has the following advantages:—

1. The peat can be used wet—about 60 per cent. of moisture being necessary for the requisite slow combustion.

2. The efficiency of the gas producer and gas engine is two to three times that of the steam boiler and steam engine.

3. The value of the by-products, viz., sulphate of ammonia, acetate of lime, tar and tar oils, waggon grease, etc., obtainable from the peat in the process of conversion more than covers the cost of producing the power.

Cheap power is, of course, of enormous efficacy in stimulating manufacture and industrial progress. It has always been lacking in Ireland, but in other countries the value of peat for power purposes has been fully realised and proved.

The object of the undertaking is to generate and supply cheap electric power and cheap gas for power and heating

[1] *Irish Engineering aud Industrial Review*, Sept. 1908. Special number, "Power from Peat." *See* Bibliography.

purposes to local authorities and other large consumers throughout the city and county of Dublin, with portions of Kildare and King's and Queen's Counties traversed by the Grand Canal. This area of country contains the extensive peat bogs known as the "Bog of Allen," which affords a practically inexhaustible supply of peat.

The circumstances that have rendered this undertaking, in the views of the engineers, now feasible, are—first, the advances in chemical knowledge in the recovery of the by-products; second, the advance in size and efficiency of gas engines, and their propulsion by gases of low calorific value; and, third, the advances in electrical transmission of power.

In the Bill it was proposed to erect the generating station alongside the Grand Canal, not far from Robertstown, about twenty-five miles from Dublin. This station would be capable of making 3000 tons of sulphate per annum. The other important by-products were acetate of lime, methyl-alcohol, and tar containing paraffin wax and oils. An excellent waggon grease could be made from the tar, the output of which at Robertstown ought to be about 2000 barrels per annum. The monetary value of these by-products would be about equal to that of the sulphate of ammonia, and the profit would at least cover the cost of getting and drying the peat.

Fig. 9 shows a gas producer made by Messrs Crossley Bros. Ltd. for use with peat, and intended for the recovery of by-products, and fig. 10 is a photograph of the one erected at their works at Openshaw, Manchester.

This firm has been making experiments on the utilisation of peat for some time past. Their calculations and estimates show that the cost of the fuel is more than covered by the sale of the by-products. They have not found any difficulty in working with a peat containing as much as 60 per cent.

of water; it was put direct into the producer, and very

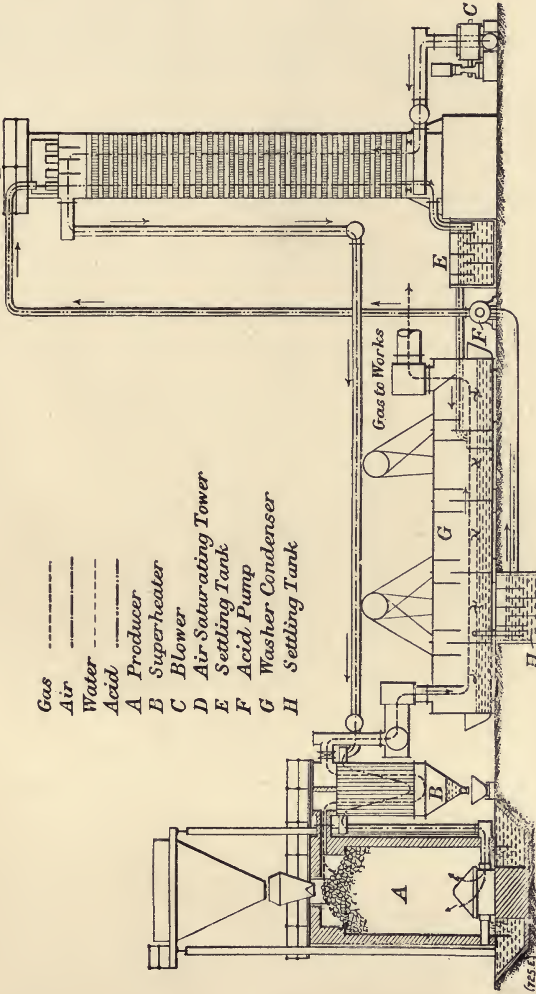

FIG. 9.—Gas Producer made by Messrs Crossley Bros. Ltd., Openshaw, Manchester, for use with Peat, and intended for the recovery of by-products.

(Figs. 9 and 10 are reproduced from *Engineering*, 11th September 1908.)

good gas was obtained. They reckoned that as much as 100 lbs. of ammonium sulphate should be obtained for each

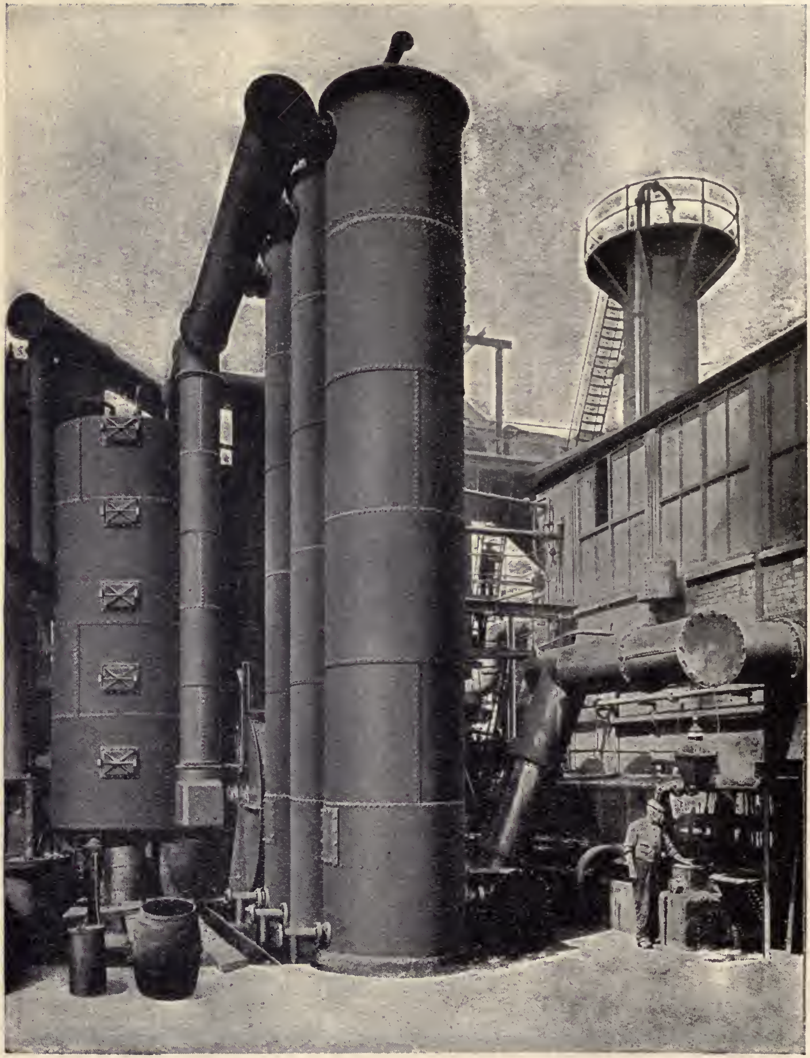

FIG. 10.—Peat Gas Producer erected by Messrs Crossley Bros. Ltd., at Openshaw, Manchester.

ton of Irish peat. An average analysis[1] of the dry gas, as given by Mr Thomas Rigby, A.M.I.M.E., F.C.S. (of Messrs Crossley Bros.) is—

CO	. . . . . .	12
CH_4	. . . . . .	2·8
H	. . . . . .	24
CO_2	. . . . . .	18
N	. . . . . .	43·2
	Total .	100

Lower calorific value, 135·7 B.T.U. per cubic foot.

The recovery of the ammonia as a sulphate requires very intimate contact with dilute sulphuric acid, and this obviously ensures a very perfect washing of the gas, and therefore the principal trouble with large gas engines, which is due to the presence of tar and dust, cannot occur. This is a matter of very great importance.

The amount of sulphate of ammonia obtainable depends on the amount of nitrogen in the peat. It is easy to show that theoretically the maximum yield of sulphate is $\frac{132}{28}$ times the nitrogen present. An analysis by Professor C. Watson Gray gave 1·6 per cent. as the average amount of nitrogen present in the samples taken from the Bog of Allen, and this percentage agrees substantially with other published results. In this case the theoretical yield per ton of dry peat would be 170 lbs., but according to the trials made at Openshaw by Messrs Crossley Brothers Ltd., the actual yield, with peat containing 2·2 per cent. of nitrogen, was 140 lbs. per ton of dry peat, and the proportionate yield for 1·6 per cent. of nitrogen is 102 lbs., which, it will be seen, is 60 per cent. of the theoretical yield. The capacity of the producers for the power scheme

[1] Captain H. Riall Sankey, R.E. (Ret.), M.I.C.E., paper on "The Utilisation of Peat," read before Section G of the British Association at Dublin, 7th September 1908.

under consideration being 65,000 tons of dry peat per annum, the yield of sulphate of ammonia would, in round figures, be 3000 tons per annum. Great care must, however, be taken in selecting the bog, since some analyses show as little as 1 per cent. of nitrogen.

It will be seen from the above that peat, when used in close proximity to the bog, is far more economical as regards fuel cost than any existing steam-driven station, and shows even a considerable advantage over any possible producer gas-driven station using coal.

Apart from the producers, the plant and the various arrangements required for generating electricity and distributing it will be the same as in similar undertakings using coal as fuel, and hence, apart from the cost of fuel, the running expenses, depreciation, repairs and maintenance, etc., can be taken as substantially the same as in similar cases, and there can be little doubt, therefore, as to the probable success of such an undertaking, even if the by-products are not recovered.

When the by-products are recovered the weight of peat required per unit of electricity is increased, and a very safe figure to take, supposing, as before, that the average load on the engines is 70 per cent. of their full load, is that one ton of peat will produce 1000 brake-h.p. per hour. This figure has been experimentally proved by Messrs Crossley Bros. Ltd., and gives a fuel cost of 0·05d. per unit, without crediting the profit on the by-products.

It may be interesting to inquire what number of units of electricity an acre of bog is capable of producing. This quantity, of course, depends on the depth of the bog, but assuming a depth of 20 feet, an acre would contain 24,000 tons of wet, or 90 per cent., peat; and since, as already stated, one ton of dry peat—that is, ten tons of wet peat

—will give 1000 brake-h.p. hours, or, allowing for dynamo losses, 700 units, it will be seen that one acre of bog 20 feet deep is capable of producing 1,680,000 units.

It has been pointed out that cheap power can only be obtained from peat when the power-station is established in close proximity to the peat bog, and therefore an undertaking of this kind would not be a sound commercial proposition unless there was a practical certainty that a market for the electricity produced would be established. It is to be observed that, owing to electric-chemical science, a great many industries have been established in recent years which require a large amount of power, and which depend on the cheapness of this power to enable them to make their products at a remunerative rate. History will undoubtedly repeat itself, and the erection of works, as occurred in the case of the electric water power at Niagara, in many places in Sweden and Norway, and in Italy, will also take place in the neighbourhood of electric-power undertakings using peat fuel and recovering the by-products, for it is fairly obvious that it will be possible under the conditions described above to supply power in bulk at the same price as it is now supplied by water power.

In the discussion which followed on Captain Sankey's paper, Mr W. J. Crossley, M.P.,[1] said: "There had in the past been a pall of failure over Irish undertakings, which he hoped might be raised by the new proposals. When it was first proposed to use as fuel for the producer peat containing 60 per cent. of moisture, they thought it could not be done; but their experiments had shown conclusively that a good and economical gas could thus be obtained, even though they had made use of a plant designed for coke and not quite suitable for the new fuel.

[1] *Engineering*, 11th September 1908.

"He had had made very careful estimates of the results to be expected from sulphate works of various outputs. A plant dealing with 10 tons of dry peat per hour would cost £50,000. Peat containing 2·2 per cent. of N yielded in their original experiments 140 lbs. of sulphate of ammonia per ton of dry peat, a figure which had been checked by Professor Vivian Lewes, who got a slightly higher result. As the apparatus employed was, however, not very suitable, this result must be considered very good. With plant better adapted for the purpose they had got from the same peat 170 lbs. of sulphate per ton of the dried fuel, a figure which was equivalent to a yield of 80 per cent., and he believed that even this result could be bettered. Taking the yield as 140 lbs. per ton, however, and using a plant gasifying 10 tons of peat per hour, costing, as stated, £50,000, he found that, allowing for the writing off of the capital in six years, there could still, on the data taken, be left a profit of £24,000 per annum. In this estimate the net cost per ton of sulphate was £5, 18s., made up as follows:—

	£	*s.*	*d.*
Interest, maintenance, and repairs, per ton .	0	15	0
Labour, including management, ,, .	0	15	0
Collection of peat	2	8	0
Cost of sulphuric acid	2	0	0

"The selling price might be taken as £11, 10s., leaving a profit of £5, 12s. per ton.

"In general, however, Irish peat contained less than 2·2 per cent. of N, the percentage present being more commonly 1·8 to 1·6 per cent. Taking the latter figure, 100 lbs. of sulphate might be expected per ton of dry peat. In that case the labour costs would go up, making the total cost of the sulphate £7, 9s. per ton, leaving a profit of £4, 1s. per ton. In this estimate of cost, that relating to the getting of the peat was a little uncertain, and might be more, though it would certainly not be large enough to reduce the profits below £3 per ton, in which case there would be a profit of £6000 per annum on an outlay of £50,000, without reckoning the value of the gas and of the other by-products to be obtained. As stated, the doubtful point was the cost of winning the peat. Ireland had a damp climate, and this made the item in question very uncertain. With peat containing 3 per cent. of N, he might add, the net cost per ton of sulphate produced would be £4, 19s.; but, as stated, this was high for Ireland, where the contents did not generally exceed 1·8 per cent., and with such there should be a profit of £3, 19s. per ton. From the figures he had just given, it would be seen that Captain Sankey had made out a very good case for his scheme, since the gas would be obtained free, and there would be yet a good profit on the sulphate and other by-products."

In the paper which was read by Mr Rigby before the Engineering and Scientific Association of Ireland, on 26th March 1906, the scheme of utilising peat for gas purposes, at the same time recovering the ammonia by the low temperature process, was for the first time brought under public notice, and this is the scheme which is to be adopted for the Irish Power Scheme. Mr Rigby adds:—

"Peat is an ideal fuel for gas producers, but when used for steam boilers and the like it does not do so well. The conditions of working for gas producers are entirely different to that of an ordinary fire, and from experiments I have actually made I am of opinion that it could be used very satisfactorily for gas power. According to the evidence of P. Dvorkovitz, President of the Petroleum Institute, there are 7,440,000,000 tons of dry peat in Ireland, having a calorific value of 12,000 British thermal units per lb. when perfectly dry. As it is difficult to obtain it dry, it may be assumed that the actual calorific value obtainable in actual work would not be more than 6000 British thermal units per lb. weight, or 2 lbs. of peat are equal to about 1 lb. of bituminous coal. If peat could be obtained close to the actual place of power production it would pay to gasify this in plants from 100 h.p. capacity upwards.

"I have been making lately a great many experiments with this peat, and this, together with evidence I have collected from various sources, proves conclusively that the majority of the peat in Ireland contains a large proportion of nitrogen in its composition. The proportion of nitrogen on the dry fuel varies from about 1 per cent. by weight up to 2 per cent. by weight, the average being about 1½ per cent. It has been proved that this peat can be successfully treated for the recovery of the original nitrogen in the fuel in the form of sulphate of ammonia, and this being the case, if treated on a large scale the by-products obtained from it are very valuable. Indeed, from the figures which have been published it seems to me that it would pay to treat the peat for the recovery of ammonia and other products alone. Peat could be subjected to a simple process of air drying as collected, before being used for gas producer work; and as in practice it is possible to obtain 75 per cent. of the original nitrogen in the fuel in the sulphate of ammonia, a large plant making producer gas with recovery of sulphate of ammonia would be a very remunerative investment. Peat containing about 30 per cent. of moisture is easy to obtain if subjected to air-drying, and the weight of sulphate of ammonia obtained from a ton of such fuel would be approximately 1 cwt. In addition to this there would be produced gas of the equivalent of about 1000 h.p. hours for the same weight of fuel, so that it will be seen that vast possibilities are opened out from the fact that the power could be obtained from this peat for nothing. The land from which the peat is taken would be gradually converted for agricultural purposes. The excellency of sulphate of ammonia as a fertiliser has been placed beyond all doubt by various agricultural authorities, and if the country became a producer of such fertilisers it is only natural to expect that a portion of them, at any rate, could be used on the land from whence they originally sprung, and what are now called 'waste lands' would be great sources of wealth."

Professor Vivian B. Lewes[1] in dealing with the question of sulphate of ammonia from peat, says: "It has been shown by Rigby, Frank Caro, and others, that directly the nitrogen of the peat gets above 1 per cent. a profitable business is to be made by gasifying the peat in a Mond producer of modified construction. Those made by Crossley Bros. answer excellently for the purpose, and differ from the complicated original Mond plant by containing only one tower and one set of pumps, in place of the three towers in the old form of Mond plant. By this process they are able to use a liquor with only a half per cent. of free sulphuric acid for the absorption of the ammonia, in the place of the 3 to 4 per cent. of free sulphuric acid that was used with the old chequerwork tower. In such a plant the peat burns perfectly well whilst still containing 50 to 60 per cent. of moisture, a degree of dryness which can be arrived at in most places by a short period of air drying."

The proprietors of the British Ziegler patents for the manufacture of peat coke, peat charcoal, and the various chemical products from peat, are making arrangements for establishing works in Kildare, and a scheme is now under consideration for mutual co-operation with the proposed Power Company, by which the latter agree to purchase from the Ziegler Company their waste gases, or as much thereof as they can conveniently use, and the Ziegler Com-

[1] Paper on "Sulphate of Ammonia" in *Journal of the Royal Society of Arts*, 7th August 1908.

pany agree to purchase from the Power Company the tar and tar water resulting from gas washing, and also as much extra electricity as they may require for lighting and power. Negotiations are also pending with other companies for power supply.

Comparatively recently a process for smelting metals through the reduction of ores by means of heated reducing gases in a continuous cycle has been patented by Mr A. E. Bourcoud of Bilbao, and in a description of the process it is pointed out that peat-coke is eminently suitable as a fuel for making the reducing gases. The final melting of the metal is intended to be done in the electric furnace. Iron ore is obtainable in Ireland, and probably could be cheaply barged along the Grand Canal to Robertstown. Here, therefore, is another possible industry which might develop to large proportions.

Ziegler Peat Gas Producer.

The peat gas producer shown in fig. 11 has been designed for the production, free of expense, or at least very cheap, of gas for gas motors and for heating purposes, as the recovery of the by-products pay for the peat used. The by-products consist of tar, sulphuric acid, ammonia, and methyl-alcohol.

The first of these gas generators, which has given excellent results, was installed by Mr Fleiss in his steel and iron works at Schlecken, in Eastern Prussia, and is the joint invention of Mr Fleiss, Mr Reddig, and Mr Ziegler.

The producer is cylindrical in form, but it has two contractions which extend all round, thus providing a lower jacketed grate portion of small section, then a wider portion, a narrow belt, or section, and above these a wider portion which extends to the top and is closed in by a feeding hopper for receiving the peat fuel, and a pipe is provided for allowing the gas to escape. After leaving the generator the gas enters the condenser. The tar water afterwards passes through the tar separation tank, where the tar is abstracted, and finally to the distillation chamber, wherein the sulphuric acid, ammonia, and methyl-alcohol are distilled off.

The lower grate portion is square in shape, and in the interior of the jacket there are openings on each side, the

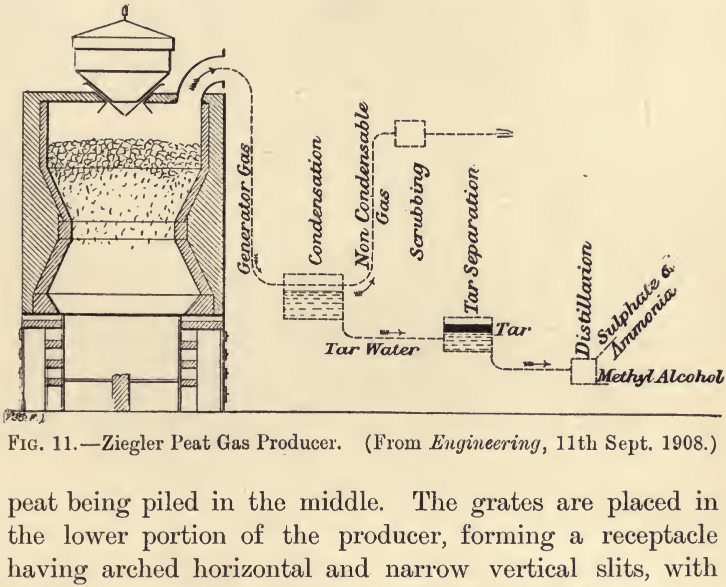

Fig. 11.—Ziegler Peat Gas Producer. (From *Engineering*, 11th Sept. 1908.)

peat being piled in the middle. The grates are placed in the lower portion of the producer, forming a receptacle having arched horizontal and narrow vertical slits, with suitable air chambers, all of which have free access with the interior of the generator. The slits are easily approached through the furnace-doors; the air enters through the grate and is regulated from the ash-pit.

A great advantage in employing this producer is that inferior peat-fuel can be used, as even peat containing a very large percentage of ash, which otherwise could not be made use of, yields good gas.

The purification of the gas has been so completely successful that gas motors after having been at work for several weeks show hardly any signs of being soiled.

The consumption of peat, reckoning 25 per cent. water contents of the air-dried peat, is about one kilogramme (2·2 lbs.) per h.p.-hour.

In the cooling and purification of the gas, valuable tar and gas water is obtained, which is treated for securing ammonia and methyl-alcohol.

The production of the peat is effected in Schlecken by a new process requiring but very few workmen, as the lifting out, transport to the peat machine, and on to the drying ground, is effected by engines and horses, so that apart from the driving power of the gas motors, the wages, and cost of up-keep of the horses for depositing the peat into small heaps, in air-dried state, amounts only to about 2 marks (2s.) per 1000 kilos. (1 ton).

Assuming the heating value of the dry quantity of the turf which can be used for fuel is only 5000 calories, the heating value of the air-dried peat with 25 per cent. contents of water and 8 per cent. of ash may be taken as follows:—

Deduct for water	25 per cent. or $\frac{1}{4}$	of 5000 calories	= 1250	calories.
,, ash	8 per cent. or $\frac{8}{100}$	of 5000 ,,	= 400	,,
		Total .	1650	calories.

This deducted from 5000 calories leaves 3350 calories.

If, furthermore, it is assumed that the grade of efficiency of the generator, having regard to the calories drawn out through separation of the tar and the losses through cooling, is only 75 per cent., there will remain $3350 \div \frac{3}{4} = 2513$ calories. As a large size gas motor, as shown by experience, requires only 2500 calories for the production of one h.p., it is quite evident that one kilogramme (2·2 lbs.) of air-dried peat is amply sufficient to produce one h.-p.

Experiments carried out in America have shown that a high illuminating power gas may be produced from a mixture of peat, petroleum, and water. An emulsion is prepared of these substances, and is forced at a high pressure through a wrought-iron coil heated to redness. The gas produced is capable of taking the place of coal gas for heating and lighting purposes, and some valuable ammoniacal by-products are also secured. The apparatus is not costly, and the process is almost automatic.

The United States Geological Survey have been making practical tests of machine peat as a producer gas fuel. Two kinds of peat were tested, one partly raw and partly machine-treated peat, and the other entirely machine peat. It was found that the raw peat was unsatisfactory in working, and produced a very poor quality of gas. On the other hand, the machine peat, which was obtained from Florida, gave very good results, both as regards reliability and calorific power. The general conclusion is that machine-dried peat can be used more successfully in gas producer plants, and is much better fitted for that than for use in steam boilers.

For a more recent method of making gas from peat, see Appendix.

CHAPTER VI.

PEAT FOR SEWAGE PURPOSES.

THE question of sewage treatment in France has for some time past been engaging the attention of sanitary engineers and the local authorities.

During 1907 [1] Dr Calmette, the Director of the Pasteur Institution at Lille, carried out a series of trials and experiments at La Madeleine, near Lille, an important experimental station, where the principal methods of sewage treatment employed both in France and in other countries were thoroughly investigated.

Dr Calmette's experiments on the employment of peat in bacterium beds leads to the conclusion that this material cannot be advantageously used in beds for the entire treatment of the sewage by bacterial agency. The peat silts up readily and becomes impermeable. In order to use advantageously the properties with which peat is endowed of developing the nitrifying microbes, it is necessary to avoid its use in continuous horizontal layers, and to mix it in small quantities with the materials employed for the construction of the filter beds before they are placed in position.

In connection with the Royal Commission on the Treating and Disposing of Sewage, several experiments have been carried out in order to ascertain whether peat is suitable for the purpose or not.

[1] *The Times* Engineering Supplement, 8th April 1908.

In the Fifth Report of the Commissioners (Blue Book, Cd. 4278, 1908), on page 226, referring to the Interim Report (Cd. 685, 1901), they state the following conclusions arrived at:—

> "No land is entirely useless for purification of sewage, but in the case of stiff clay and peat lands the power to purify sewage seems to depend on the depth of the top soil.
>
> "There are, of course, numerous gradations in the depths of top soil which are met with in Nature, and it is not easy to draw the line between lands which contain a sufficient depth to justify their use, and lands which do not.
>
> "We are, however, forced to conclude that peat and stiff clay lands are generally unsuitable for the purification of sewage, that their use for this purpose is always attended with difficulty, and that where the depth of top soil is very small, say six inches or less, the area of such lands which would be required for efficient purification would in certain cases be so great as to render land treatment impracticable."

In the Supplementary Volume (Blue Book, Cd. 4285, 1908) presented with the Fifth Report, full particulars, with figures, are given of the experiments carried out by Dr W. E. Adeney, Assoc. R.C.Sc.I., F.I.C., Curator and ex-Examiner in Chemistry in the Royal University, Ireland, showing the "Course and Nature of Fermentative Changes in Natural and Polluted Waters and in Artificial Solutions":—

1. Experiments with extract of fresh peat (Table XIV., p. 77).

> (These experiments were made with an extract of fresh peat that was collected from a bog situated on one of the Wicklow mountains, and far removed from

any source of contamination with animal matters. The extract was prepared by boiling the peat in tap water containing a little sodium hydrate. The extract was filtered into a large glass-stoppered jar, which it filled to about two-thirds of its capacity. It was allowed to ferment for nearly six months, the stopper of the jar being taken off from time to time to renew the air. It was then thoroughly mixed with about five times its bulk of tap water and allowed to settle until the following day, when about 6 litres (10½ pints) were decanted off, and the experiments commenced.)

2. Experiments with extract of fresh peat and ammonium chloride (Table XV., p. 78).

(These experiments were made with another portion of the same solution of peat, but it was mixed with a relatively large quantity of ammonium chloride. The results of the experiments prove that peaty matters when mixed with ammonium compounds readily undergo fermentation, but that intermediate combinations may occur between them during the progress of the fermentation.)

And on page 88 of the same book Dr Adeney gives the following conclusions which may be drawn from his experiments:—

That peaty matters when present alone in a water undergo very slow change, but when present with ammonium compounds they readily undergo fermentation together with the ammonium compounds, just as the organic matters which are formed during the first stages of fermentation of animal, vegetable, or artificial organic substances do, during the after-fermentation of ammonium compounds which may have been also formed thereby, or which may have been previously present or added.

That the presence of the above-mentioned fermented organic matters, or peaty matters, appears to determine the nitric fermentation of ammonia, since in their complete absence, similar organisms being present, only nitrous acid is obtained.

That during the intermediate stages of a fermentation of mixed peaty matters and ammonium compounds, various interchanges between the two appear to take place, the character and extent of which apparently depend upon the relative quantities of peaty matters, ammonia, and dissolved oxygen present, and also upon the character of the peaty matters themselves, whether they have been freshly formed, or have undergone any previous fermentative changes.

That in the presence of small quantities of peaty or other fermented organic matters carbon dioxide and ammonia may become "fixed," during fermentation, in appreciable quantities, no doubt from Winogradsky's researches, to form organic matter.

That the formation of one part by weight of nitrous nitrogen during the fermentation of ammonia, in the complete absence of organic matter, is attended by the consumption of about 4·2 parts by weight of oxygen.

That for similar volumes of oxygen consumed the quantity of nitrogen oxidised during the fermentation of ammonia is distinctly greater, in the presence of peaty or other fermented matters during fermentation, than in their absence.

CHAPTER VII.

RECLAMATION AND CULTIVATION OF PEAT LANDS.[1]

The extensive areas of peat lands in various Continental countries has caused considerable attention to be directed to the question of encouraging their development. Much useful work has been done in Germany, Holland, Sweden, Denmark, and Austria, and there are several state experimental stations and moor farms for demonstration purposes. It is to the information thus made available that the progress in the utilisation of peat lands abroad must be largely attributed.

The question as to the best means of converting the peat lands into some profitable use may be considered either from the industrial side—that is, the use of peat for fuel, fibre, fodder, litter, etc.—or agriculturally with a view to the reclamation and cultivation of the soil. Experiments carried out on the Continent have proved that with the aid of artificial manures it is possible to utilise this type of land for growing a variety of crops.

In the first place, all reclaimed land must be thoroughly well drained, thus admitting air and allowing the peat to decompose. The structure of the turf breaks down, and after cultivation the peat turns finally into a black crumbly

[1] Board of Agriculture and Fisheries leaflet No. 203, Feb. 1908. By permission of the Controller of His Majesty's Stationery Office.

mass. Moreover, after draining, the peat contracts and the moor settles, frequently to a very noticeable degree. Drainage is much to be preferred to the "open ditch system," as, apart from the loss of land, drained soil dries and is accessible very much earlier in the spring. Land drained by open ditches becomes frozen not only from above, but also from the sides of the ditches, and drainage can only take place after the ice has melted. Drains, on the other hand, continue to act in winter, especially when the land is deeply covered in snow. The distance apart of the drains is of the greatest importance, and must receive careful consideration in connection with the rainfall and its distribution over the year, as although insufficiently drained land can be improved by laying more pipes, over-drained land can only be put right with great difficulty. The purpose for which the land is to be used must also be considered, as the water-level must be reduced more for tillage than for grass. When the drainage has been carried out, the land must be grubbed, ploughed, and harrowed. Any strongly-built plough may be used, the horses being shod with broad wooden shoes, to which they soon accustom themselves. Disc harrows and strong cultivators are also useful, but if horse implements cannot be used the work must be done by hand.

At the Swedish Experiment Station at Jönköping[1] draining is done by means of open drains which are led into a large main drain. The heather is then cut and removed and some levelling done. Sand is spread two or three inches deep over the levelled ground, and about thirty barrels of lime per acre are also applied. As soon as possible this is worked into the soil by means of cultivators or disc harrows, and it is allowed to rest for a season. The

[1] *Journal of the Department of Agriculture and Technical Instruction for Ireland*, vol. iv. p. 463, March 1906.

ground is then manured in accordance with the results obtained from the experimental plots, and afterwards cropped.

The system of sanding the surface of bog land is much practised in Germany, where it was first introduced by Rimpau on the Cunrau moor. Here the subsoil consists of sand, which is thus available at a very low cost, and it is only where this is the case that the method can be adopted with economic success. Generally speaking, however, experience on the Continent shows that the reclamation of moorland, when properly carried out, proves a very satisfactory undertaking, both from a financial and an economic point of view.

With regard to manure, the method of cultivation and treatment must be varied to suit each individual case. Lime is generally unnecessary, although it is useful in some cases to sweeten the soil and hasten decomposition.

Experiments in Germany have shown that its place, in the earlier years, can well be taken by basic slag, which has been found to be the most useful manure. Superphosphate may also be used, and potash may be supplied in the form of kainit. The land requires manuring annually.

Although the cultivation of field and garden crops is found to be thoroughly satisfactory, experience on the upland moors of Bavaria is not favourable to the laying down of permanent pasture. Grass is found to grow very well for the first two or three years, after which it deteriorates, and the land has to be ploughed up. The crop from rotation grasses and clovers is, however, said to be very good if suitably manured.

Some other crops, such as maize, vines, and hops, have also in individual instances been cultivated on moorland. With regard to the latter crop, its cultivation seems to have met with considerable success in Austria in the neighbourhood of Salzburg,[1] where it has been grown since 1900, and where some 125 acres are now planted with hops. The plantations made in 1901 yielded 8 cwts. per acre in 1903, 13 cwts. in 1904, and 13½ cwts. in 1905, while those planted in 1903 yielded about 6½ cwts. in 1904 and 1905. These figures are stated to compare favourably with the yields obtained in hop-growing districts in Bohemia, and the quality is also quite satisfactory. The success which has attended the cultivation of hops here, if not necessarily applicable to moorland elsewhere, affords an example of the capabilities of such soils when properly cultivated and suitably situated.

The crops most cultivated at the Swedish Experiment Station at Jönköping are peas, beans, rye, oats, mangolds, potatoes, rye grass, and clovers. It is not considered advisable to leave the land in grass more than five or six years.

[1] *Zeitschrift für Moorkultur und Torfverwertung*, vol. iv. No. 1, 1906.

CHAPTER VIII.

PEAT FROM THE FALKLAND ISLANDS.

In the Appendix of *Peat: Its Use and Manufacture,* attention was drawn to the summary of a report by the Director of the Imperial Institute on three samples of peat, sent in 1905 by the Governor of the Falkland Islands, in order that their composition and calorific value could be determined and their suitability for technical use ascertained.

Since then, further investigations have taken place, and the *Bulletin of the Imperial Institute,* vol. v. (1907) No. 3, p. 251, contains full particulars of the results of an exhaustive examination of four further samples of peat, sent in 1907, from the extensive deposits in the Falkland Islands, and by permission of the Director of the Imperial Institute the following copy is given :—

Four samples of peat taken from the extensive deposits of this material which occur in the islands were sent to the Imperial Institute by the Governor for examination.

Sample No. 1.—This sample weighed about 10 lbs., and was described as "Brown mossy peat; the first sod obtained after removing the top sod."

The material consisted of the dried and partially-decayed remains of the moss from which the peat is formed. It was very loosely compacted, and could be readily disintegrated. This kind of peat is chiefly utilised as litter for stable use in place of straw. In Europe there has been a constantly increasing demand for material of this type, which, on account of its absorbent and antiseptic properties, forms a cleaner litter and, when spent, is a more valuable manure than straw.

Sample No. 2.—This sample weighed about half a hundredweight, and was described as "Black peat; one or two years old, obtained at a depth of from 2 to 4 feet."

The material consisted of blocks of peat, which were black and dull and contained plant remains still showing structure. It contained a quantity of the soil in which the moss had grown, as is shown by the higher percentage of ash, and would be described as "mud peat."

Sample No. 3.—This sample weighed about 20 lbs., and was described as "Black peat obtained at a depth of 9 feet."

This peat contained more plant remains than No. 2, and this fact may indicate its derivation from a drier locality in which decay has not been so rapid.

Sample No. 4.—This sample of peat from West Point Island was forwarded by the Governor of the Falkland Islands at a later date than the first three samples.

It weighed about 7¼ lbs., was black, tough, and compact, and had a specific gravity of 1·38.

In general physical characters the material somewhat resembled No. 3 of the samples previously submitted, but was rather more compact. The appearance of the peat almost suggested that of lignite.

Results of Examination. — The following are the results of the chemical examination of the four samples:—

[TABLE.

	I.	II.	III.	IV.
	Per cent.	Per cent.	Per cent.	Per cent.
Ash	2·71	6·52	2·72	10·00
Moisture (at 100° C.)	11·13	31·29	37·23	13·55
Volatile matter	57·26	35·39	39·17	49·87
Fixed carbon	28·90	26·80	20·88	26·58
	100·00	100·00	100·00	100·00
	Calories.[1]	Calories.	Calories.	Calories.
Calorific value	4728	4241	4033	4658

The ash was analysed, but the percentages of potash, lime, and phosphoric acid present are too low to make the ash of value as a fertiliser.

Conclusions and Recommendations. — Compared with peat from other sources, Nos. 3 and 4 of the present samples may be said to be of the best quality, whilst No. 2 is of average quality. Analyses of European peat show that the amount of mineral matter (ash) present varies from 1 to 25 per cent., the averages being about 5 per cent. The calorific values, determined by the bomb calorimeter, of the samples (Nos. 2, 3, and 4) which are suitable for fuel were 4241, 4033, and 4658, respectively. The calorific value would be increased by briquetting, since in this process a large proportion of the water would be eliminated.

A noteworthy point about the results of the analysis of the peat from West Point Island (sample No. 4) is the small percentage of moisture present, which is a very satisfactory feature. It will be seen from the above table that samples Nos. 2 and 3 contained over 30 per cent. of moisture when received at the Imperial Institute, whereas

[1] One calorie is the amount of heat required to raise one gramme of water from 0° to 1° C.

sample No. 4 contained only 13·55 per cent. In consequence of the drier condition of the peat from West Point Island its analysis shows higher percentages of volatile matter and fixed carbon than the others, and its calorific value is correspondingly increased; the fuel value of the peat is therefore greater. Sample No. 3 of the earlier specimens, when dried by exposure to the air, finally retained from 12 to 16 per cent. of moisture, and an analysis of a portion containing about 12 per cent. of moisture gave similar results to those obtained for sample No. 4. The low percentage of moisture in sample No. 4 is probably due to its having been exposed to the air before shipment.

As it seemed likely that this peat from the Falkland Islands would yield a compressed fuel of good quality, full information regarding modern methods of compressing and briquetting peat was supplied to the Governor, and as a result proposals have been received from a South American syndicate to work the deposits with a view to producing compressed peat fuel for consumers in the islands and on the South American mainland.

CHAPTER IX.

PEAT COKE.

Ziegler's Peat Coking Process.—The coking plant erected by the Oberbayerische Kokswerke und Fabrik Chemischer Produkte Actien-Gesellschaft, at Beuerberg, near Munich, Germany, under Dr Martin Ziegler's patents, is a thoroughly commercial and satisfactory one in every respect.

The process provides for the employment of the waste non-condensable gases, produced by the dry distillation of the peat itself, for the generation of the necessary heat, the continuous working of the retorts used, and the saving of all valuable by-products.

The peat is taken from the bog in the ordinary way by means of a spade and thrown into the elevator, shown in fig. 12,[1] which feeds the peat into the peat press. The peat press is driven by an electric motor. The peat is air-dried so as to reduce the moisture. It is essential, however, that the peat put into the coking ovens shall not contain more than 25 per cent. of water, otherwise the peat coke would be insufficiently dense and the heat requirements would be too great. When the moisture cannot be brought down to 25 per cent., the peat is not fully coked, but turned into "half-coke," commercial products, and power gas.

In the plant now used at Beuerberg,[2] "each unit consists of two vertical retorts, or kilns, about 40 feet in height with oval cross-sections. The lower half is built of fire-

[1] Reprinted from *Engineering*, 11th Sept. 1908.

[2] *Peat and Lignite*, by E. Nystrom, 1908.

To face p. 52.

Fig. 12.—Electrically-driven Elevator and Peat-Press.

To face p. 53.

FIG. 13 —Coke Cooling in the Trucks, and Coke-sorting Shed.

To face p. 53.

Fig. 14.—Peat Coking Plant at Beuerberg, Germany.

bricks, and the upper one of cast iron with a thin outside lining of fire-bricks. Outside these walls is another fire-brick shell, leaving an air space between, which is, by means of walls, divided into a system of fire-flues. The whole oven is then protected by a wall of ordinary bricks. The retorts usually rest upon a cast-iron foundation, and end in a common hopper provided with two openings for drawing off the peat coke. Each of the retorts is closed on the top by cast-iron covers, and in these latter the feed-boxes are carried. The openings through which the peat is fed and the coke is drawn off are made air-tight. When the oven is first started, it is necessary to use extra fuel until the coking process is well under way. To enable this to be done the oven is provided with two upper and three lower fireboxes. The combustion gases pass through the fire flues and thence to the collecting flue. At a later stage these gases are used either for drying the peat in specially constructed drying chambers, or allowed to escape through the chimney. A hole is provided at the front and rear side of each fire flue for the purpose of watching and taking the temperature. In the lower fire flues the temperature reaches some 1000° C. (1832° F.), and in the upper ones, 600° (1112° F.), 500° (932° F.), and 400° (752° F.) respectively. The highest temperature in the retorts themselves reaches some 600° C. (1112° F.). The heat contained in the gases (200° to 300° C. or 392° F. to 572° F.), resulting from the dry distillation of the peat, and collected through the pipes, is used for drying the ammonium sulphate and acetate of lime, part of the by-products.

"The retorts are charged with peat which (if good coke, especially for metallurgical purposes, is desired) must contain little ash, be well pulped, and not contain more than 20 to 25 per cent. of moisture. At first extra fuel is used, but after forty-eight hours sufficient non-condensable

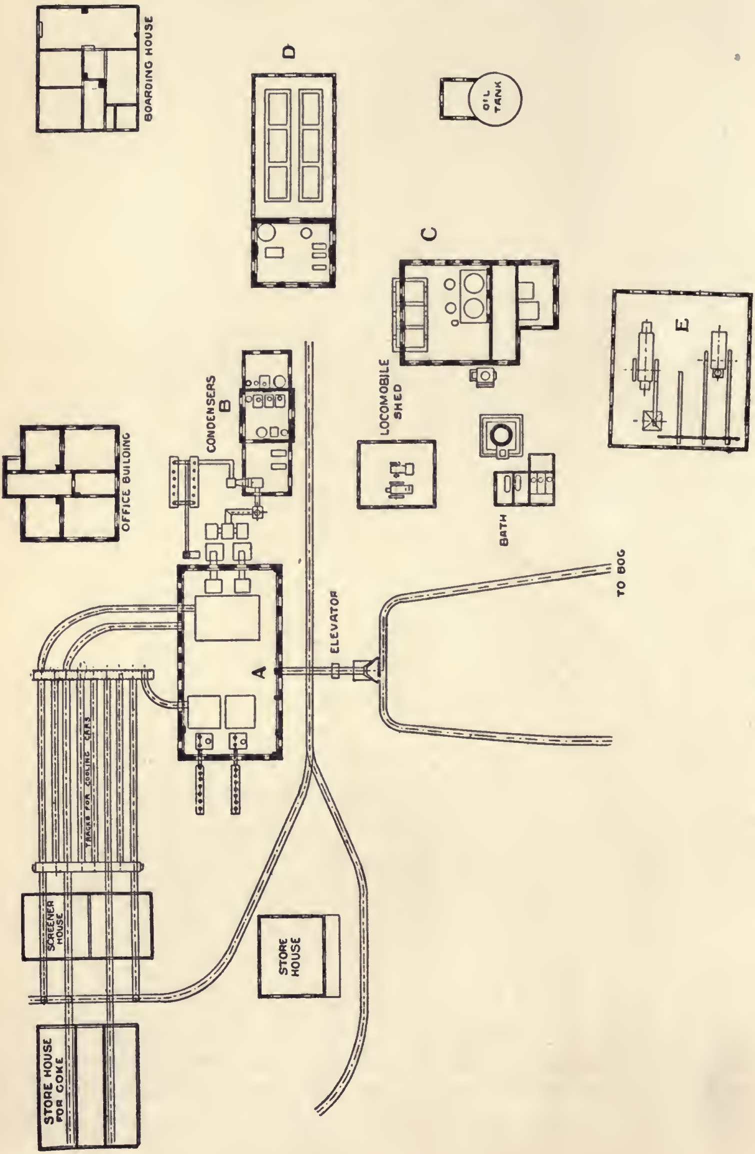

FIG. 15.—Peat Coking Plant at Beuerberg, Germany.
A. Coking ovens. B. Building for tar water distillation. C. Building for tar distillation. D. Paraffin plant.
E. Electric power station.

gases are given off, so that peat firing can be discontinued and the gases ignited. The air necessary for the combustion is previously heated by passing it around the cast-iron hoppers forming the bottom of the retorts, and at the same time cooling off the coke in them.

"When the process is in continuous operation the coke is hourly drawn off from the hoppers into air-tight steel cars (see fig. 13),[1] in which it must be left until thoroughly cooled. After each withdrawal of coke, fresh peat bricks are charged through the feed-boxes. The operation thus becomes a continuous one.

"The water vapour and gases generated are drawn off by an exhaust fan and driven through an air-cooled pipe condenser, where the tar and tar water condense. The non-condensable gases are by means of another fan forced back to the oven, where they are used for heating the retorts. At a plant with a number of ovens more gas is obtained than is required for this purpose, and in such cases the excess is used under the boilers or in gas engines. The gas circuit is provided with safety valves and dampers in order to save the condensing apparatus in case explosions should occur."

The Ziegler oven is also used for the manufacture of so-called "peat half-coke," which is peat not entirely coked, and still containing some of the heavy hydrocarbons.

The peat coke as manufactured in the Ziegler oven using suitable raw material is hard and strong, and compares most favourably with charcoal for metallurgical purposes. It gives good smokeless briquettes for use in marine boilers; they have been used on the German naval torpedo-boats most successfully.

Fig. 14 shows peat coking plant at Beuerberg, Germany, and fig. 15 represents a general plan of the works.

[1] Reproduced from *Engineering*, 11th Sept. 1908.

CHAPTER X.

ZIEGLER PEAT COKING PROCESS AT DARTMOOR.

The West of England Peat Syndicate Limited was formed in June 1908 for the purpose of acquiring, and has now acquired, an option, exercisable within three years, to purchase the latest improved process for the industrial exploitation of peat comprised in the patents known as the "Ziegler Patents" and all improvements thereon, with the right to work and use the same for its own profit during the period of the said option.

These processes have already been successfully worked on the Continent, and have shown fair profits extending over a period of several years, and excellent results, notwithstanding a higher cost and inferior quality of peat as compared with the cost and quality which obtain in this country.

Briefly, the processes under the Ziegler patents are based on simple dry distillation of air-dried raw material (peat), thus dispensing with costly preliminary treatment. This means cheapness and simplicity of process and machinery. The main and by-products are charcoal, peat-fuel, ceresine, tar and its derivatives, acetic acid, ammonia, methyl-alcohol, and gas suitable for lighting and power.

The Syndicate has acquired the lease of about 1150 acres of land at Rattlebrook, Dartmoor, Devon, from H.R.H. the Prince of Wales, K.G., in right of his Duchy of Cornwall, containing an average surface deposit of about 10 to 12 feet of peat, which experts have, on analysis, pronounced eminently suited for treatment by this process. The property is 2000 feet above sea-level, thus presenting the most favourable conditions for air-drying.

The quality of the crude peat is believed to be unique for excellence. It is entirely free from ligneous matter, and can therefore be readily got by machinery. It is eminently suitable for production of the best charcoal and fuel, and contains an average of 7 per cent. of the valuable product known as ozokerite (ceresine).

It is proposed at first to erect a trial plant to demonstrate the practicability of the Ziegler process.

The coke retort has a capacity for three tons of peat daily = one ton of coke. The gas generator will produce daily from 500 to 700 h.p. The tar gained from the peat is to be converted into waggon grease (lubricating fat). The peat, from which the wax is extracted by means of benzol, is either used for gas generating or converted into briquettes.

In addition to the profits arising from the sale of charcoal, waggon grease, wax, and briquettes, further profit will be derived from the installation of a 500-h.p. gas generator, and from the tar water containing sulphate of ammonia, acetate of lime, and methyl-alcohol.

Subsequently it is intended to erect works on a larger scale capable of treating up to 70,000 tons of peat per annum.

CHAPTER XI.

PAPER FROM PEAT.

THE first factory in the United States of America for making paper from peat[1] has been erected near Capac, Mich., and the peat paper is said to be much better for wrapping purposes than that made from wood pulp. It is claimed that one ton of it can be made for £2 as against £5 or £6 for a ton of similar paper from wood pulp. At the present time the great bulk of cheap paper is prepared from wood, which undergoes various mechanical and chemical processes, during which it is converted into "pulp," and finally into paper.

The mill has been built on the edge of a huge swamp. The peat from this is received at one end of the factory, which is 110 feet long, and the paper is delivered at the other. The special drying machine has forty-one huge rollers, and any given point of the web takes only twenty minutes to pass through. The oily bodies contained in the peat make the paper impermeable and safe from the attacks of insects. Furs, etc., wrapped in it are safe from moths and mice. One thing remains to be discovered, namely, a bleaching process which will give white peat paper. At present only dark brown paper can be made.

In August last a letter appeared in *The Times*, from the pen of Mr Angus Cameron, anent the coming scarcity of timber and the enormous amount consumed in paper-mills.

[1] *Paper and Pulp*, October 1908.

Lieut.-Col. Warburton, R.E., in reply said: "Many persons are probably not aware that excellent brown paper is produced from peat, and in all probability it can be bleached. Peat is, in fact, wood put through one process, that of partial disintegration. There are 2,800,000 acres of peat in Ireland, or one-seventh of the surface, averaging 15 feet in depth. As an acre contains 1800 tons of solid peat, and can be bought for from £1 upwards, while a ton of brown wrapping paper cost £8 to £10, some idea may thus be formed of the neglected wealth of Ireland. Probably half the wood used for paper-making is converted into brown paper. The use of peat would arrest the destruction of forests."

The making of peat paper might be made a most important Irish industry, for the bogs which are now the despair of agriculturists would become very remunerative. The same may be said of many other countries containing excellent supplies of peat. Peat has two immense advantages which are not unconnected. The supply is practically inexhaustible and the price is low.

In the early part of last year Mr Charles E. Nelson, of Capac, Michigan, U.S.A., took out an American Patent No. 879,888, 1908, for a "Process of forming paper or board and the like from half-stuff containing peat fibres and the natural gelatinous matter of the peat, in which the half-stuff of the peat fibres and the gelatinous matter of the peat may be produced in any desired manner."

In this process[1] not only are the peat fibres used, but also a considerable amount of the natural gelatinous matter of the peat, and in the finished product the peat fibres give strength and body, while comparatively large quantities of the gelatinous matter are present, adhering to the fibres and binding them together.

[1] *Pulp and Paper Magazine of Canada*, Toronto, May 1908.

The half-stuff containing the peat fibres and gelatinous matter is supplied with a sufficient quantity of water, or other liquid, to float it, and is carried to the stuff-chest. From here it is conducted through the necessary screens to the machine cylinder tanks, where the operation of converting it into paper or board is started. Previous to the actual operation of making the half-stuff into paper or board, the fibres and gelatinous matter are subjected to the action of heat of such temperature that the material may be softened sufficiently to destroy any lumps which it may contain. This softening brings the gelatinous matter into a fluid or soluble condition, and causes it to be uniformly distributed among the peat fibres, and by this means it is evenly distributed throughout the paper board when manufactured, and thus serves to render the finished product water repellent and strong. The heating of the half-stuff prior to the operation of making it into paper board is, preferably, effected in the machine cylinder tanks, although, if desired, the heating may take place in the stuff-chest.

In subjecting the gelatinous matter to the action of heat for the purpose above named, the temperature must not be sufficient to cause coagulation of this matter, which is albuminous in its nature. After the floated half-stuff has been sufficiently heated to reduce any lumps in the gelatinous matter, and to distribute same amongst the peat fibres, both the fibres and a fairly large quantity of the matter are run into paper or board. The finished product of the process contains the peat fibres together with a quantity of the gelatinous matter of peat, which latter acts as an excellent binder for the fibres. If desired, the half-stuff may have mixed with it a small percentage of sulphate or other hard stock. The paper and board produced by this process possesses the desirable qualities of strength and durability, and in addition is insect proof; furthermore, it is damp-resisting, even if not sized, and is also a non-conductor of electricity and a first-rate insulating material.

In several of the Canadian paper-mills experiments have been carried out under the "Esser" patent for making box-boards from peat.

In this process, which was brought out in Austria some years ago and patented in various countries, the peat is taken wet from the bog and delivered into a feeding machine, where the earthy matter is washed away and the sticks and roots are removed. The material is then sent to the beating engine in the mill.

Cardboard and Kraft Paper.—A company has been formed in Sweden, and a factory built, for producing cardboard, and especially that known in the trade as "Kraft" paper (for bags and wrappings) from peat. Several large peat districts in the province of Småland have been acquired, and the company has purchased an American patent.

The price of the manufactured article in America, where this industry is already carried on, amounts to about £6, 5s. per ton. As the quality of the Swedish peat is superior to that of the American peat, and the working expenses are less, it is claimed that the cost of production will be considerably reduced, probably to one-half. The entire process occupies about two hours.

CHAPTER XII.

PEAT DRYERS.

Jones's Peat Dryer.—In principle it consists essentially of the combination of (1) an evaporating cylinder in which the peat is heated by steam or other means; (2) a superposed heating cylinder, in which the peat is heated by the steam rising from the drying material in the evaporating cylinder; and (3) a cooling cylinder, in which the peat is dried and cooled by the action of a current of dry cool air passed through the cylinder.

Lennox Patent Continuous Drying Machine for Drying Peat.—This type of drying machine is illustrated in fig. 16 (sectional elevation) and fig. 17 (plan).

The machine consists of a fixed circular metallic casing of suitable diameter and capacity for the quantity of material to be dried in a given time, and of a revolving inner vertical cylinder concentric with the fixed casing and connected to a central shaft which is driven in any suitable manner.

The casing rests upon a framing, and also forms a bedplate for the central shaft and driving gear. The casing consists of a series of cylinders of uniform depth and diameter superimposed above each other and bolted together, so that the capacity of the machine can be increased by simply adding more cylinders. The cylinders are flanged both top and bottom, and a plate which forms a shelf is placed between each pair of adjoining flanges, and the two flanges

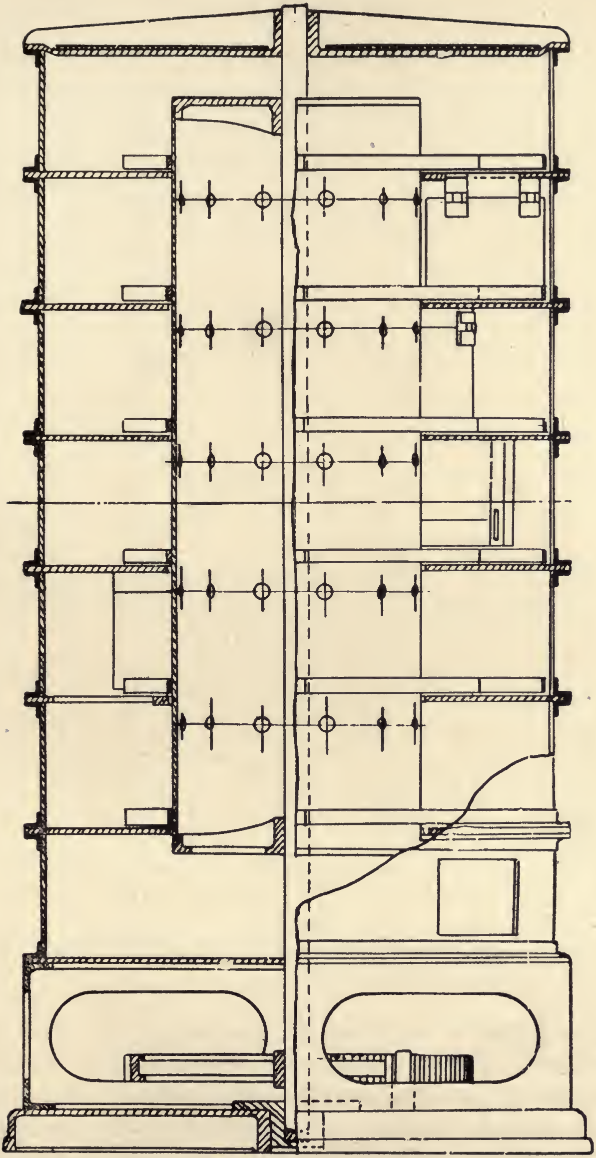

FIG. 16.—Lennox Patent Continuous Drying Machine for Drying Peat. (Sectional Elevation.)

and shelf are bolted together. The middle of the shelf is cut to allow the inner revolving cylinder to pass through, so that the shelves extend from the outer casing to the inner revolving cylinder. The bottom shelf is between the bottom framing and the bottom cylinder, and the top shelf is between the top cylinder and the next below. The inner

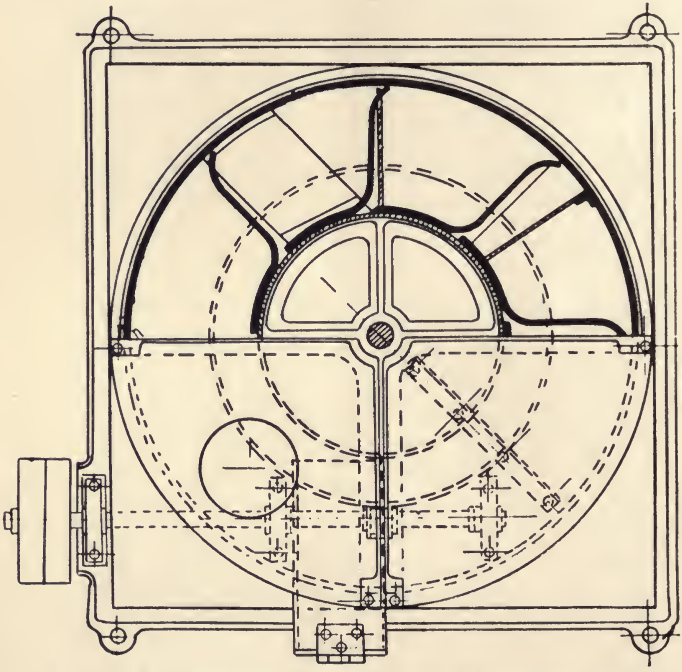

FIG. 17.—Lennox Patent Continuous Drying Machine for Drying Peat. (Plan.)

revolving cylinder is closed at top and open at bottom, and connected to the vertical shaft. In this type of machine the driving gear is arranged at the bottom. Immediately above each shelf a ring of suitable depth is fixed to the inner revolving cylinder, and to this ring is attached a number of scrapers consisting of flat bars on edge, either curved or straight, extending to the outer casing.

The material to be dried is delivered through a hopper

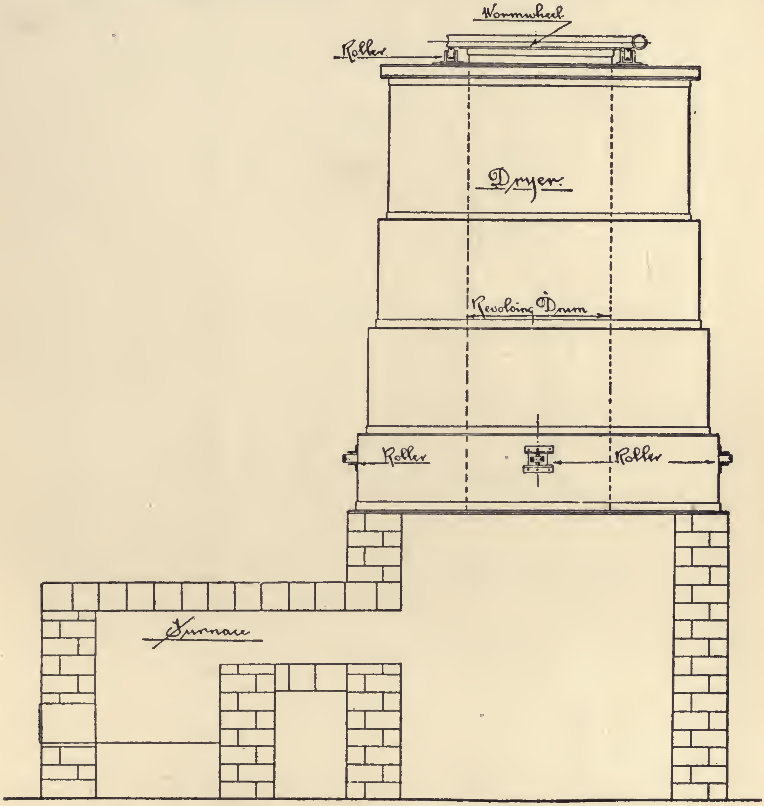

FIG. 18.—Lennox Patent Continuous Drying Machine.
(Elevation, showing Furnace.)

into the top of the casing on the top shelf, and as the vertical shaft revolves the scrapers deliver the peat, after making nearly a complete circuit of the shelf through a hole in the shelf on to the shelf below, where it is again

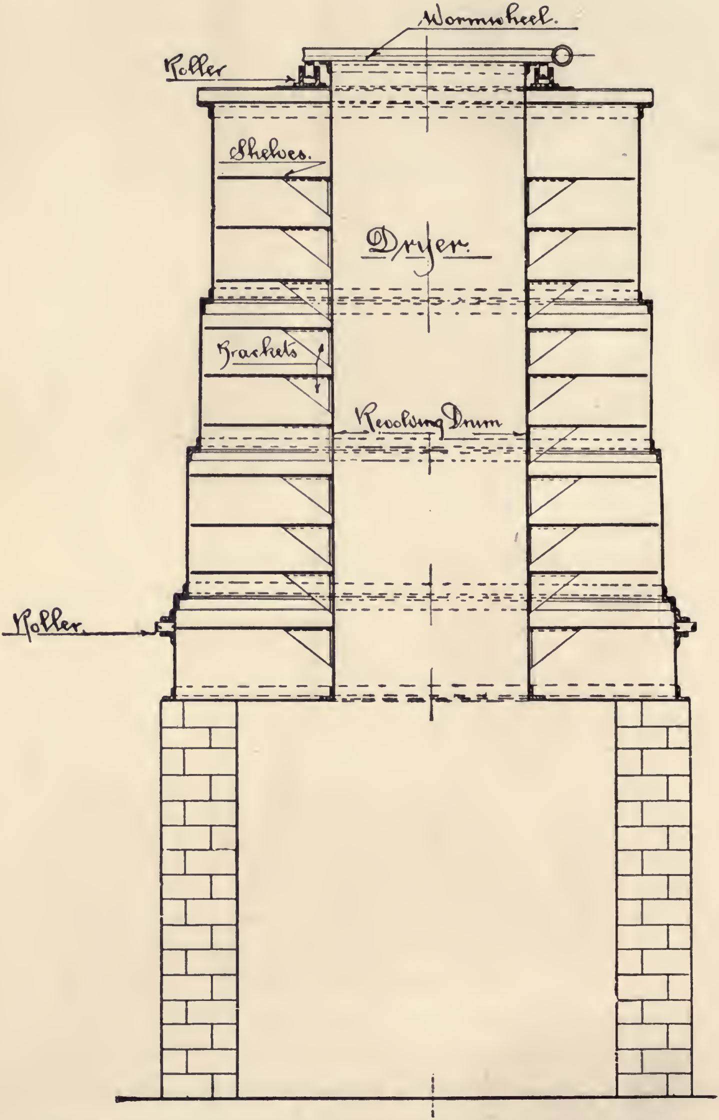

FIG. 19.—Lennox Patent Continuous Drying Machine for Drying Peat.
(Transverse Sectional Elevation.)

carried through nearly a complete circuit of the shelf by the scrapers, and delivered through a hole in this shelf on to the one below, and so on to the bottom shelf, from which it is delivered by a spout into a suitable receptacle. Between each pair of shelves is a fixed partition extending from the upper shelf down to a little above the top of the scrapers above the lower shelf, and placed immediately behind the delivery hole of the upper shelf, and therefore immediately in front of the delivery hole in the lower shelf.

The bottom chamber is in communication with a brick-built furnace, as shown in fig. 18 (elevation) and fig. 19 (transverse sectional elevation), for supplying the necessary heat, such supply being controlled by dampers. The hot air or gas passes round the chamber in an opposite direction to the motion of the scrapers, owing to the position of the partition, to the hole through the shelf above, through which it passes into the second chamber, or next chamber above, and so on through all the chambers, being finally discharged into the atmosphere. In every case the direction of the flow of the hot air or gases between the shelves is opposite to the motion of the scrapers. Openings with doors are provided, opening inwards in the wall of the inner cylinder between each pair of shelves, through which hot air or gas can be admitted direct between any pair of shelves, if desired, in addition to the hot air or gas entering by the ordinary circulation from bottom to top through the chambers. The doors are opened and closed by means of chains or ropes which pass through the top of the inner cylinder. The Patent Dryer shown in figs. 18 and 19 is an improvement on that illustrated in figs. 16 and 17.

Lennox Patent Reversible Current Briquette Dryer.—This consists of a series of vertical chambers built in a double row back to back, each with doors in front.

Under the whole of these chambers is a flue, or passage, connected to a furnace through two air and heat mixing chambers by means of a double or breeches flue fitted with dampers, *i.e.* each leg of the breeches flue goes into an air and heat mixing chamber. There is an opening in the bottom of each air and heat mixing chamber into the flue under the chambers. The air and heat mixing chambers have each an opening into the top of the next drying chamber, as shown by the arrows, and each drying chamber has an opening into the flue underneath, which opening can be closed by doors or dampers. These doors open in opposite directions in each pair of chambers, and each alternate chamber is connected to the next one by an opening in the top of the partition dividing the two chambers. Fig. 20 shows the side elevation, fig. 21 plan, and fig. 22 the end elevation, of this dryer. At the two end chambers the flue turns at right angles into the back row of chambers. On top of the two rows of chambers is fixed a fan of suitable size, the inlet of which is connected to the top of each air and heat mixing chamber by means of a breeches pipe fitted with dampers. This fan is used for exhausting the moisture from the dryer and causing the draught necessary to circulate the heat through the chambers or compartments.

The briquettes are put into the drying compartments on the trays just as they come from the briquette machine. In each compartment there are iron bars, or grids, fixed a suitable distance apart to carry these trays, and the chambers can be built of suitable size to carry any desired number of trays. The trays are stacked on the bars in the chambers in a zigzag form so as to make the heat current take a winding course, and the arrangement of the openings in the top and bottom of the chambers makes the heat current travel up one and down the other, and by the

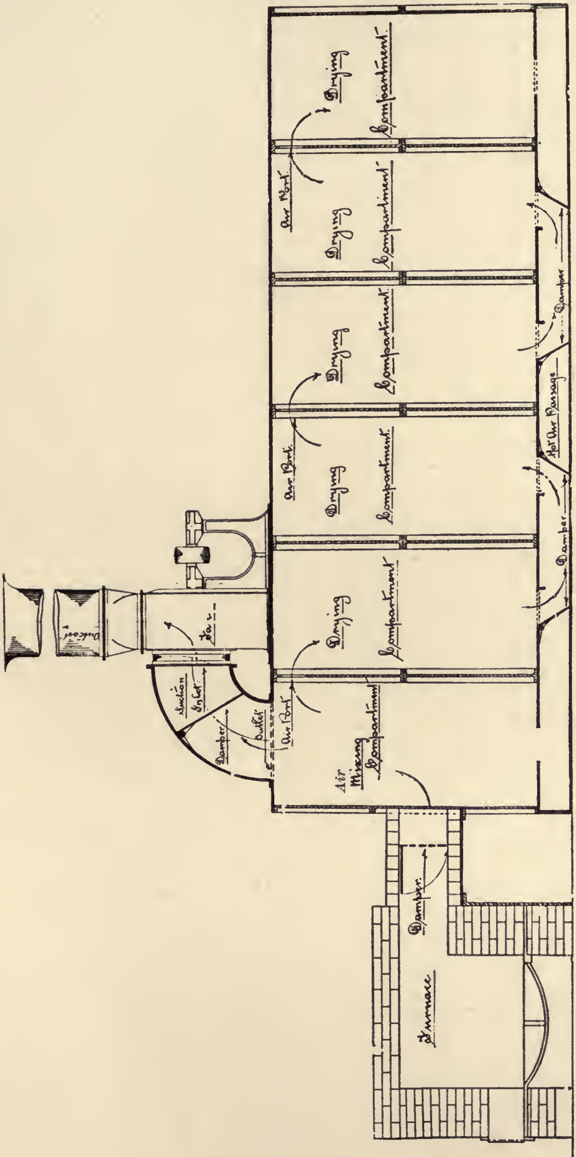

FIG. 20.—Lennox Patent Reversible Current Peat Briquette Dryer. (Side Elevation.)

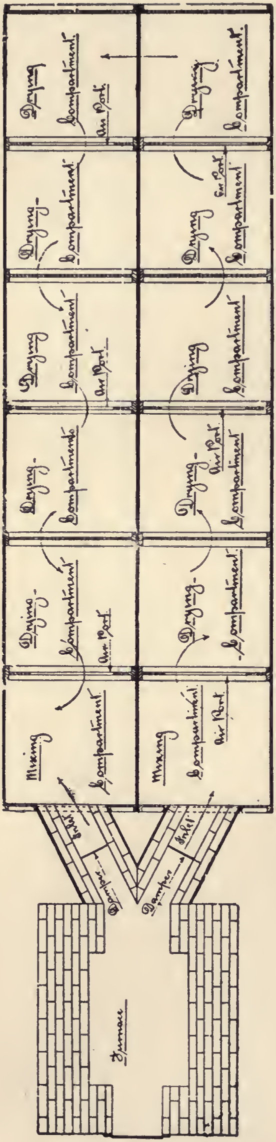

FIG. 21.—Lennox Patent Reversible Current Peat Briquette Dryer. (Plan.)

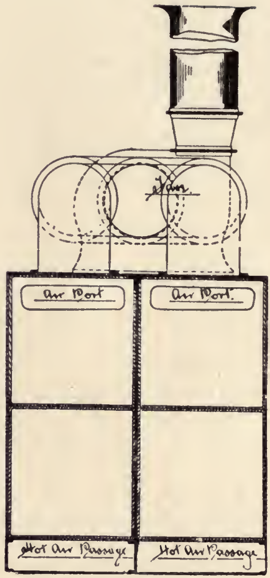

FIG. 22.—Lennox Patent Reversible Current Peat Briquette Dryer. (End Elevation.)

arrangement of the trays the current has to travel a horizontal zigzag or winding course at the same time as an up-and-down course. The advantage of this is that the heat travels under the trays in its upward course and on the top of the wet briquettes in its downward course, and when the current is reversed the heat that has been travelling upwards in a chamber is made to travel downwards in that particular chamber, so that the current can be made to heat the bottom of the tray for so many minutes and then be reversed so as to heat the top of the briquettes, thus giving equal drying. Any two compartments can be shut off and filled or emptied without stopping the dryer, and the drying goes on in the other compartments all the time just the same. This is accomplished by closing the two dampers that are back to back to each other in the two compartments.

The furnace is connected to each air and heat mixing chamber by separate flues in the form of a breeches flue, both legs of which are fitted with dampers. When the heat is drawn through the left-hand furnace flue the damper of the right-hand one is closed, and the inlet of the left-hand flue into the fan is closed and the right hand one is open, so that the heat current travels through all the chambers before it reaches the fan, and has by that time given up its heat to the briquettes and is exhausted through the fan laden with moisture into the atmosphere.

One great advantage obtained in this dryer is that the greatest heat can be turned into any particular pair of chambers that have just been filled with the cold wet peat by closing all the other dampers in front of them, and as soon as the wet briquettes have been heated up the other dampers can be opened and all the chambers worked together. This preliminary heating up of the cold wet peat is necessary to prevent re-condensation of any moisture from the other chambers coming in contact with the cold peat briquettes.

CHAPTER XIII.

PEAT EXCAVATORS.

Heine's System.—In this German process a portable centrifugal pump dredger is employed to excavate the peat from the bog, a rotary cutter being used on the suction pipe so that the peat is reduced to a pulp. This pulp, with about fifteen times its volume of water, is conveyed by means of a pipe line to the briquetting factory. The pump's suction is protected in such a manner that stones and roots cannot enter, and the sand and clay fall to the bottom of the bog.

At the factory the peat pulp is discharged into a vat, from whence it passes to a centrifugal separator which extracts the bulk of water. The peat then passes to a cylinder press, which works on a principle similar to that of a paper-making machine. The peat now becomes a thin sheet which is carried by a belt conveyor to a drying machine, and the moisture is there reduced to 15 or 30 per cent., an amount sufficient for briquetting purposes. The peat, now a hot powder, is automatically fed to the briquetting machine, and is subjected to a pressure of about 13 tons per square inch. The bituminous constituents of the peat act as a cement, and the product is hard, coal-like clean briquettes.

Analyses of these briquettes show, in percentages, carbon 52·5, hydrogen 4·8, oxygen 22·1, ash 9·0, and water 11·6. This corresponds in heating value to 4850 calories per kilogramme ($2\frac{1}{4}$ lbs.) as compared with 5500 calories for ordinary coal and 3000 calories for wood. By carbonising the peat to a greater degree, the heating value may be increased. One metric ton (2200 lbs.) of these briquettes in Germany costs from 5s. to 7s. to produce, according to the size of the plant. A plant for producing fifty tons per day is said to cost about £16,000.

CHAPTER XIV.

PEAT CUTTERS.

Van Breemen's Peat-cutting Machine.[1]—A practical and successful method for the working of the undrained bogs in Holland has been introduced by N. van Breemen, of Haarlem. The bogs are, as a rule, free from roots and stumps of trees, which is a necessary condition.

The machinery, which is placed on a floating iron barge, consists of one or two cutting machines, pulping machine elevators, and locomobile.

The cutting machines are placed in the front of the barge and consist of rectangular frames with sharp edges. The bottom is provided with two large valves, which open up when the frame is pressed down and close by the weight of the peat when it is lifted up. The frame or frames are lowered and raised by means of racks and pinions. The peat lifted up is drawn out of the frame with a rake and falls directly down into the pulping machine, where it is mixed with water. The pulped mass is transported by means of an elevator to a long steel channel supported from the barge. Here it is mixed with more water and run out on the surface of the bog in a trough made by walls of loose boards. The power required to operate the plant is 20 h.p.

The peat porridge run out in the trough has a thickness

[1] *Report to the Canadian Department of Mines on Peat and Lignite.* By E. Nystrom. 1908.

of about two feet, but when left twenty-four hours most of the additional water has run away and the thickness diminished to about half. The mass is then solid enough to retain its shape, and the walls are moved forward.

In order to make it still more compact it is tramped by two men, using square pieces of wood on their feet, and a cup-headed tool. This process is repeated after two, three or more days, depending on weather conditions. When the peat mass is sufficiently dry, it is cut in pieces, which are dried in the usual manner.

With ten men the production of a plant of the above description is, on an average, 82·5 tons of air-dried peat per day of ten hours.

These cutting machines are also used in combination with a Schlickeysen machine for the manufacture of machine-formed peat. In this case the raw peat is dumped into a mixing machine and from there by means of an elevator conveyed to a Schlickeysen machine. No extra water is added, and the pulped peat leaving this machine is placed on pallets in the usual manner and brought to the drying field.

CHAPTER XV.

PEAT MINCING OR DISINTEGRATING MACHINE.

In many processes in which peat is employed it has frequently to be mixed and minced, or disintegrated. A machine largely in use for these operations is one of the Higginbottom-Lennox type, shown in fig. 23.

This apparatus comprises a suitable frame with bearings carrying a shaft on which a number of circular knives or saws are fixed and spaced at suitable distances apart by distance pieces. The circular cutters project into grooves provided on the surface of a drum, which is also mounted in bearings carried by the frame. The drum and cutter shafts are geared together by toothed wheels, so that when one of the shafts is rotated by means of a belt and fast and loose pulleys, the cutters and drum revolve in opposite directions, and the gearing ratio between the cutter shaft and the drum shaft is preferably such that the cutters revolve at a much greater speed than the drum.

The materials to be mixed together and minced, or disintegrated simultaneously, are fed between the cutters and the drum by a hopper divided into compartments by a hinged flap formed with a handle so that that the feed of each separate material can be regulated as desired.

Below the cutters and drum a shoot is arranged for delivering the minced and disintegrated peat, and is provided with a series of fingers to act as scrapers for removing any material from the cutters and drum.

When the machine is employed for mincing or disintegrating peat containing roots, stumps, etc., the drum or cutters

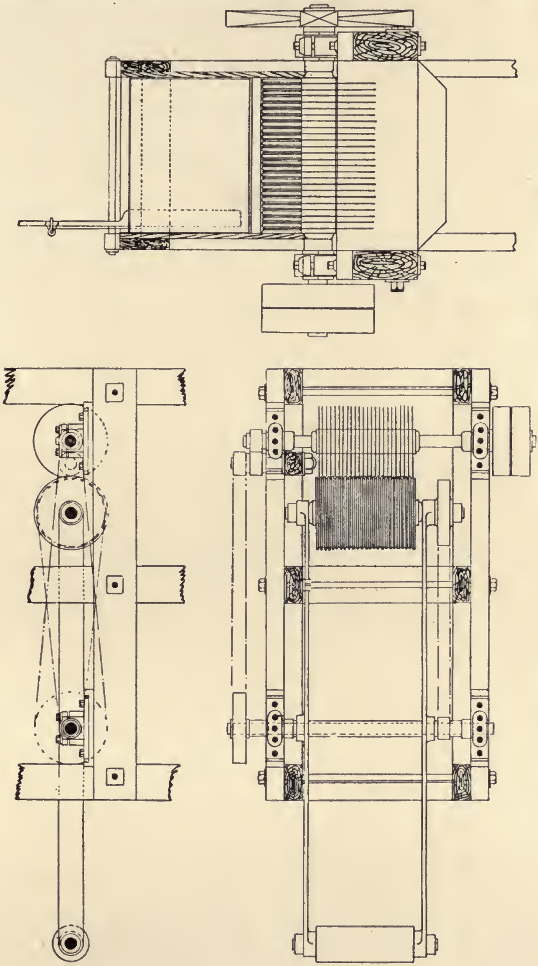

Fig. 23.—Higginbottom-Lennox Patent Peat Mincing or Disintegrating Machine.

are mounted in such a way as to be capable of a certain amount of movement to permit the passage of these obstacles without damage to the cutters. This is effected by mounting the drum between the ends of a pair of arms pivoted on a shaft carried in suitable bearings on the frame and having a balance weight disposed between their other ends. The drum is thus normally kept in the proper position by the adjacent ends of the arms engaging stops on the frame. The drum is driven from the cutter shaft by means of a toothed wheel gearing, with a corresponding wheel mounted on a stud axle carried by the frame, on which is secured a pulley which drives by a belt chain a pulley keyed to the end of the shaft on which the arms are pivoted. At the other end of the shaft another pulley is fixed which drives the drum shaft by means of a belt chain and pulley. Thus when the drum is rotating it is also free to move in a circular path to permit the passage of any roots, stumps, etc., without damage to the cutters.

CHAPTER XVI.

PEAT SQUEEZER.

ONE of the greatest difficulties in the satisfactory treatment of peat has been to extract the high percentage of moisture. Recent processes have, however, largely removed some of this trouble.

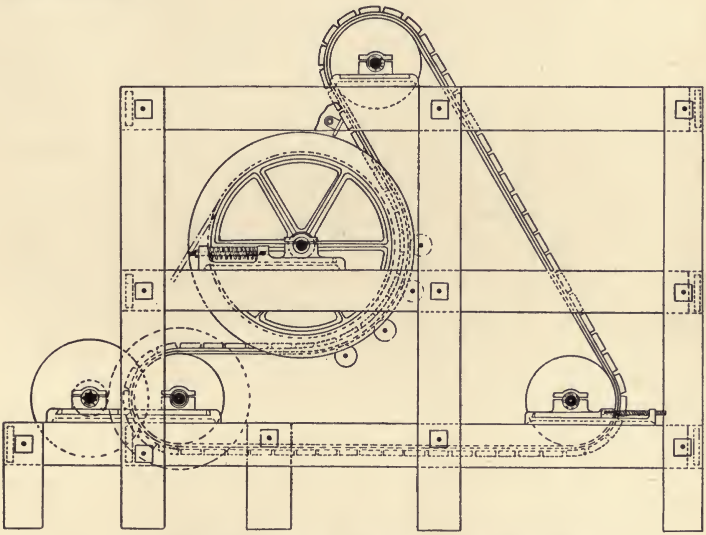

FIG. 24.—Higginbottom-Lennox Patent Peat Squeezer.

A machine that is simple and cheap to construct and efficient in use is that known as the "Higginbottom-Lennox Patent Peat Squeezer," illustrated in fig. 24. This apparatus consists of a wooden frame, upon which bearings are mounted, carrying three pairs of driving pulleys over which passes an endless driving band formed of a sprocket chain carrying wooden boards working in connection with a drum. The drum is arranged is such a manner that the peat is fed on to the band in front of the squeezing drum, through a hopper, and as the band travels the peat is squeezed between it and the drum.

After being squeezed the material is carried on the surface of the drum to a point further round, where it is removed by a scraper and delivered to a shoot. In order to remove any material that may adhere to the band, a scraper is provided near the point where the travelling band leaves the drum. Between the points where the band approaches and leaves the drum, rollers are provided to exert pressure on the back of the band, and the squeezing drum is mounted in adjustable and yielding bearings so that the amount of overlap of the band may be varied as desired, and to permit the passage of an excess of material, or any obstacles in the peat, without damage to the band. By means of pulleys the tension of the band may be regulated or varied. The band is worked by a leather belt running over fast and loose pulleys. To prevent the material being squeezed out between the travelling band and the drum, the latter is provided with extended flanges or edges.

CHAPTER XVII.

PEAT-DRYING OVENS.

Hahnemann Oven.[1]—This oven consists of a cylindrical shaft with the bottom raised. An opening, closed by an iron plate, is left on one side for the removal of the coke, and on the other side is a pipe in communication with the condensing apparatus. The lower part of the shaft is provided with three rows of holes for admittance of the necessary air, and in the centre of the shaft is placed an iron pipe provided with holes at its base, through which the gases can escape. When the shaft is filled with peat, the latter is ignited on top, the shaft opening is then closed by iron plates, and the coking process regulated through the different air-holes.

Lottmann Oven.[1]—In this oven (see fig. 25) a special fuel, which can be of poorer quality, is used for producing the necessary heat. The widest part of the oven or retort is 9 feet 3 inches and the narrower part 7 feet 6 inches. The retort is heated by the gases from the grate (*a*) and the grates (*b*). The gases from the grate (*a*) are drawn through cast-iron pipes (*r*), whereby the interior of the retort is heated, and the gases from the grates (*b*) circulate around the thin walls (*h*), through the channels (*m*), and through the holes (*l*) to the chimney (*g*).

The retort is charged through the door (*t*) and the charg-

[1] *Report to the Canadian Department of Mines on Peat and Lignite.* By E. Nystrom. 1908. Hausding and Larson and Wallgren's *Reports.*

ing holes (*o*), and holds about 700 cubic feet. The gases generated are conveyed to a condensing apparatus. The

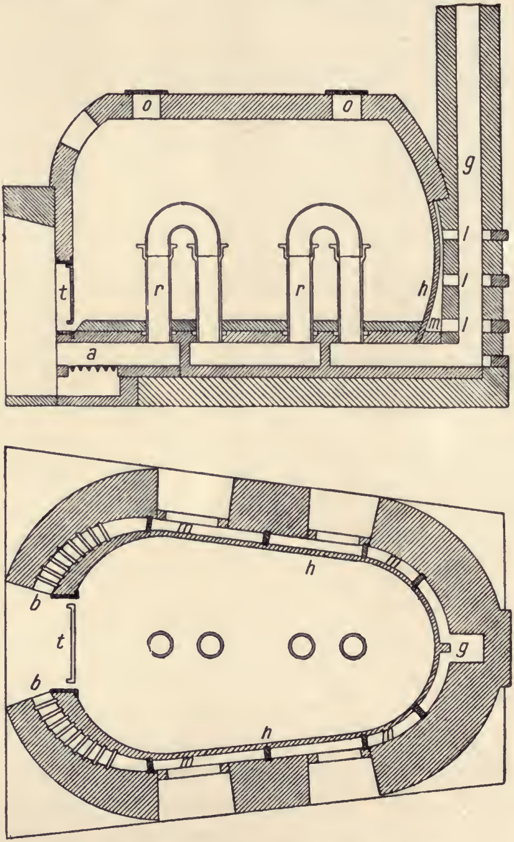

FIG. 25.—The Lottmann Peat Coking Oven.

contents of the retort are coked in fifty to sixty hours, and the coke produced is left to cool for about three days.

Wagenmann Oven.[1]—This oven consists of two cones

[1] *Report to the Canadian Department of Mines on Peat and Lignite.* By E. Nystrom. 1908. Hausding and Larson and Wallgren's *Reports.*

separated by a grate. The upper cone is 6 feet 6 inches high and the lower one 1 foot 6 inches. On one side of the latter is a pipe serving as outlet for tar and gases. The coke is taken out through the opening, which is at the same height as the grate. The cone is filled from above with peat, which is ignited on the top. When the peat is burning the opening is closed and the coking process regulated by air-holes placed in the walls.

CHAPTER XVIII.

HYDRO-EXTRACTOR.

A VERY efficient hydro-extractor, of simple yet novel construction, for the rapid extraction of the water contained in crude peat, has been invented and patented by Mr James Stevens, M.I.M.E., of London.

The peat is removed from the bog and shot into this special machine, and by means of a combination of unique screens and hydraulic power the water in a perfectly clear state is speedily ejected, only the valuable portions of the peat itself being retained.

The semi-dried peat is next discharged from the hydro-extractor, and after passing through a masticator of ordinary construction, is sufficiently solid to be cut into slabs or bricks with any ordinary brickmaking machine. These peat briquettes are then placed on boards and dried off naturally for about fourteen days, they being then fit for commercial purposes.

This hydro-extractor is of the nature of a hydraulic press, built on quite new lines, which will, after it has received the peat, extract from 50 to 60 per cent. of the water in one operation taking but a few minutes, without any of the peat being lost.

CHAPTER XIX.

KORNER'S PEAT PALLET CONVEYOR.[1]

THIS apparatus consists of a number of rolling tables placed on wooden supports. One side of the table has rollers turning in one direction, and the other side has the same turning in the opposite direction. A number of such tables are placed in front of each other until the further side of the drying field is reached. Each section is about 20 feet long, and is easily moved. The rollers for each section are turned in their respective directions by means of a chain running on the top and underneath every second roller. The chain is driven by a pulley, which derives its motion from a bevel gear operated by the shaft placed underneath. This shaft is driven direct from the peat machine, and is supplied with special couplings for each section. These couplings are constructed in such a manner that the different sections of the shaft have about three inches play in a longitudinal direction, and also permit the different sections to make certain angles with each other. The construction is covered by a special patent. The rollers on the table are placed a little inclined in order that the usual pallets carrying the peat bricks may stay on.

The peat is cut in suitable lengths when it leaves the peat machine, and transported by the rollers on one side of the table to the drying field. The empty pallets are placed on the other side of the table, and transported back

[1] *Report to the Canadian Department of Mines on Peat and Lignite.* By E. Nystrom. 1908.

to the plant. The pallets can naturally be taken off at any desired point, as shown in fig. 26. When the drying field furthest from the plant is covered, the sections covering this distance are uncoupled and moved to the next line as shown in the figure.

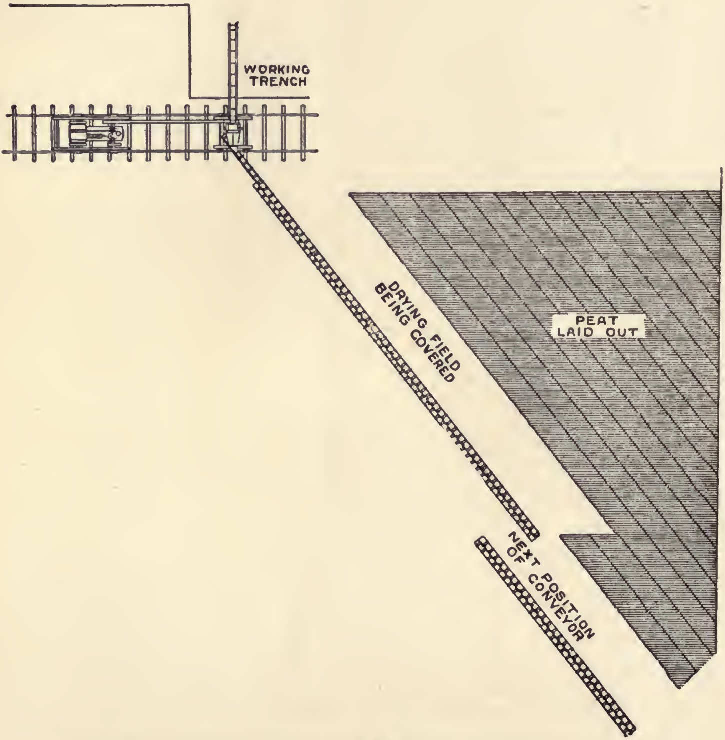

Fig. 26.—Peat Pallet Conveyor and Method of Laying Out for Drying.

This arrangement can be used even where the surface of the bog is fairly uneven, and by its employment tracks and men required for transportation are avoided.

This machinery is manufactured by A. Korner, Eslof, Sweden.

CHAPTER XX.

MANUFACTURED PEAT FUEL.

M'William's System.—This process differs very considerably from those previously tried, and is on the "suction" principle. Over the top of the peat bog, rails are laid about five yards apart on which the "collectors" are run. These are practically electric cars provided with a suction pan. From the side of the car a pipe about two feet in diameter extends, the outer end of same being provided with a shoe, on which a lip is formed, the dry peat dust on the surface of the bog being drawn into the pipe by suction and deposited in the car. As the car travels along, the dust on the surface of the bog is skimmed up at the rate of about fifty tons per day. It is then dried by causing it to travel along a conveyor fitted with an endless screw and surrounded with steam pipes. The dust is afterwards ground to an extremely fine powder, heated to a temperature of 200°, and then compressed into briquettes at a pressure of about eighty tons. In two days the bricks become harder than coal, and nearly the same colour.

Duclos' System.—In this Canadian process the peat is partly dried and pulverised and mixed with some inflammable substance to aid combustion; it is then completely dried and partially carbonised, after which the whole mass is pressed into cakes or briquettes.

The raw peat as taken from the bog is first passed through a rotary disintegrator, and is afterwards mixed with about $5\frac{1}{2}$ per cent. of petroleum, oil, or fatty matter, containing about 2 or 3 per cent. of caustic alkali. This compound is dried by means of a moderate and regulated heat, a double-bottom pan being used for preference, where it is kept in motion in the open air by rakes or stirrers, thus screening the peat resting on the bottom of the pan against the excessive radiation from the fire beneath. Briquettes made in the above manner have been found to be very satisfactory for fuel purposes.

Greeley's System.—In this case the peat is treated chemically to enable the moisture to be freed by pressure. Afterwards it is used for fuel briquettes, insulating electric conductors, as a substitute for wood and other materials for interior decorative work, and other purposes.

The crude peat is first passed between rollers so as to crush the lumps, and is then put into a large vat, or pan. Two or three times its bulk of water is added, together with a solution of sodium carbonate or other chemical. During the boiling of this mixture the peat cells are broken up and the binding elements dissolved. After it has boiled for a time, having been constantly stirred during this period, the mixture is then cooled by gradually adding a cold solution of alum. This neutralises the soda, precipitates the dissolved material, and coagulates the peat mass. The peat is then drained and the residual moisture expressed by pressure.

Fig. 27 shows the general arrangement in elevation, and fig. 28 shows plan of a 50-ton peat briquette-making plant as designed and manufactured by the Uskside Engineering Co., Ltd., of Newport, Mons.

In this plan the peat is received from the waggon and thrown into the pit of the elevator G, by which it is elevated to the first floor of the works. At the same time, the pitch is thrown by a shovel into the pitch-mill I, in which it is roughly ground, and reduced to a size which is

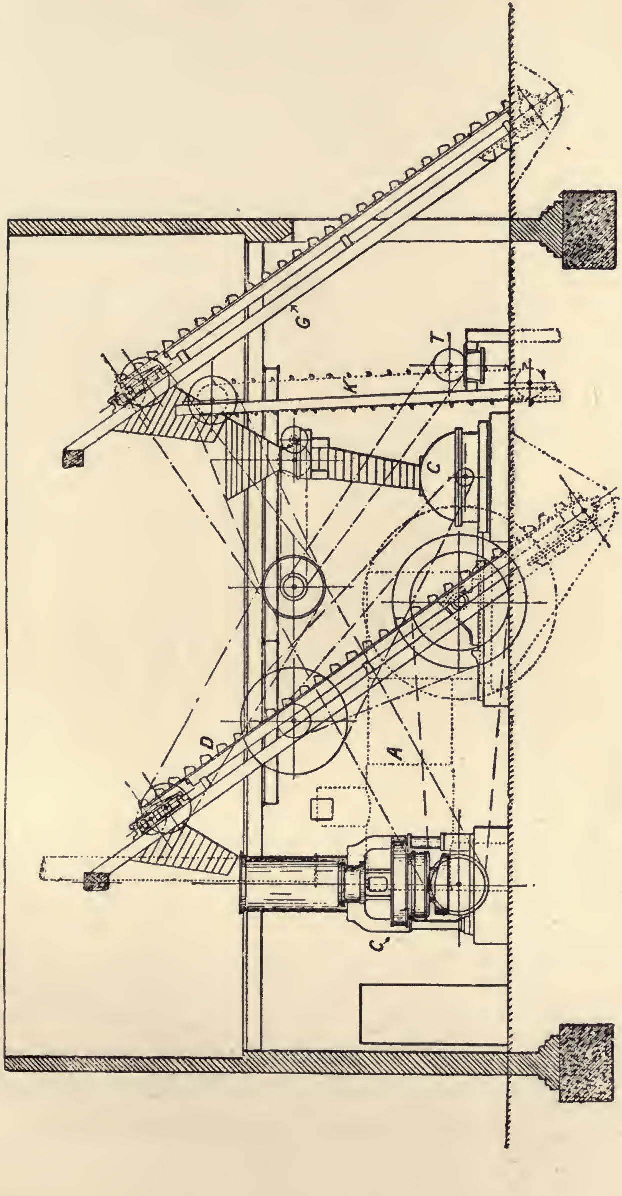

FIG. 27.—Stevens' 50-Ton Peat Briquette-making Plant. (Elevation.)

easily capable of measurement. The roughly-ground pitch is then raised by the elevator H to the first floor, and the peat and pitch are then thrown into separate compartments of the hopper of the distributor F. The distributor is a machine for proportioning the right quantities of peat and

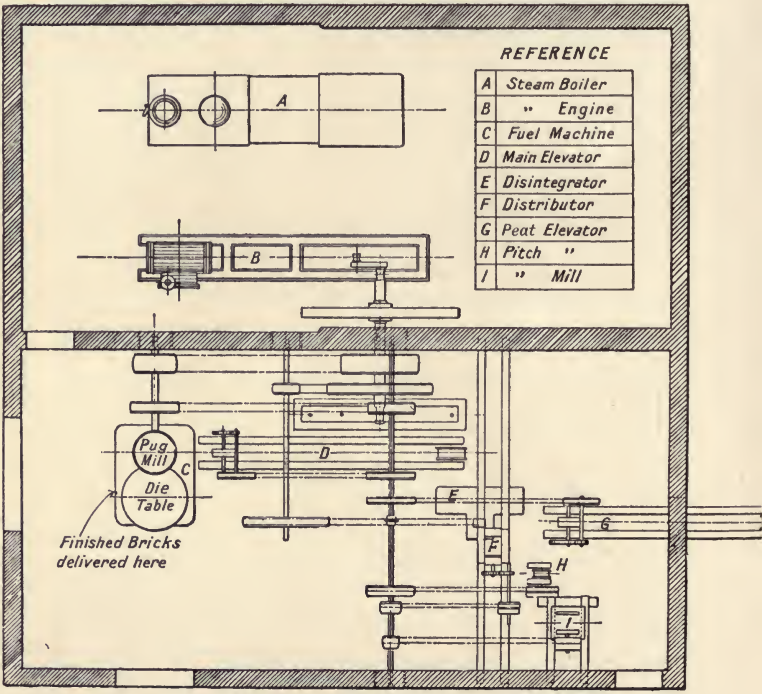

FIG. 28.—Stevens' 50-Ton Peat Briquette-making Plant. (Plan.)

pitch. The material thus measured falls down into the hopper of the disintegrator E, where it is ground and thoroughly mixed together. The peat and pitch being thus ground and mixed, fall down into the hopper of the main elevator D, and are deposited in the pug-mill of the fuel press C. In this pug-mill, by means of the introduction of steam, the pitch is melted during its passage through the pug-mill. From thence it falls into the feeding-pan of the machine, and is then pressed into briquettes, and these can be carried away from the machine either by a shoot, or a belt, or by loading on to trolleys, or by any other means that may be locally advisable.

Fig. 29 shows general view, and fig. 30 section, of Stevens' improved 50-ton fuel press, also manufactured by the same firm. The action of the machine is as follows:—A is the pug-mill in which a set of steel arms are constantly revolving. This pug-mill is fitted with a suitable number of steam jets, the steam from which should be of about 60 to 70 lbs. pressure, and free from water. The peat and pitch which are introduced into the top of this pug-mill are gradually passed down by means of the pug-mill arms, and during their passage the pitch is melted by the steam with which it comes in contact. The mixture of peat and pitch, or paste, as it is sometimes called, then falls into the feeding-pan of the machine. This feeding-pan serves a double purpose; from this pan the paste is forced into the moulds of the die table; but in addition to this, the hot mixture is for a few minutes exposed to the air, which has a beneficial effect upon the paste.

After passing through the feeding-pan B it is forced by the arms in that pan into the moulds marked D, which are cast in the die table of the machine. This die table is usually made with ten moulds, either for making one or two briquettes per stroke, as may be arranged, and is pushed round one mould at a time by means of a strong wrought-iron pushing arm worked off the crankshaft. When the full mould reaches the position shown in the cross section, steam is admitted automatically underneath the piston in the cylinder C; this raises the lever F, and pressing against the pressure plate O, the briquette is thus formed. The table then continues its travel one mould at a time, and the pressing pistons travelling up an inclined plane gradually

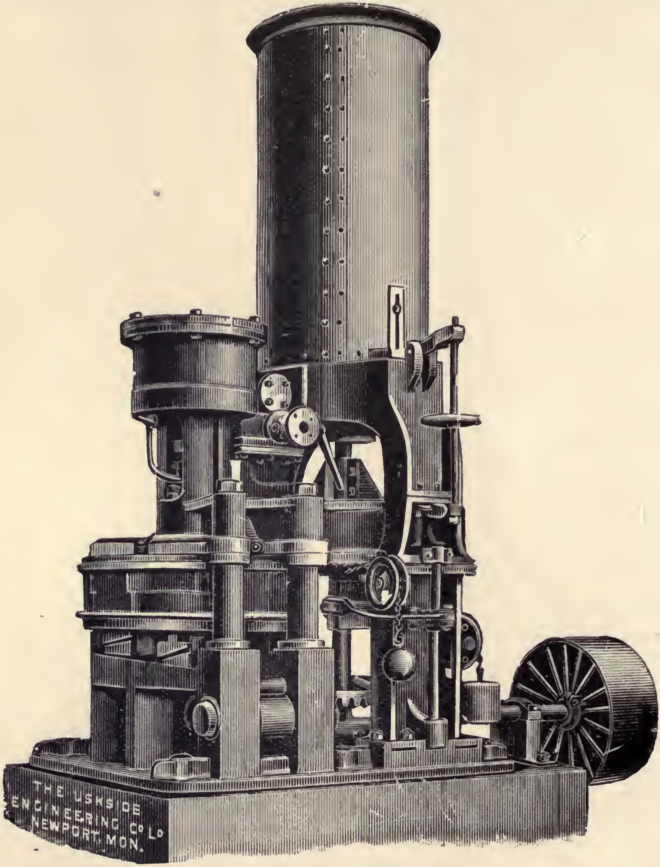

FIG. 29.—General View.

force the briquette to the surface of the table, from whence it is moved on to a shoot or travelling band by a movable arm.

The principal feature in this machine, wherein it differs from many others, is the fact that every mould carries a pressing piston of its own, and consequently no pressing piston enters a mould in order to compress the peat.

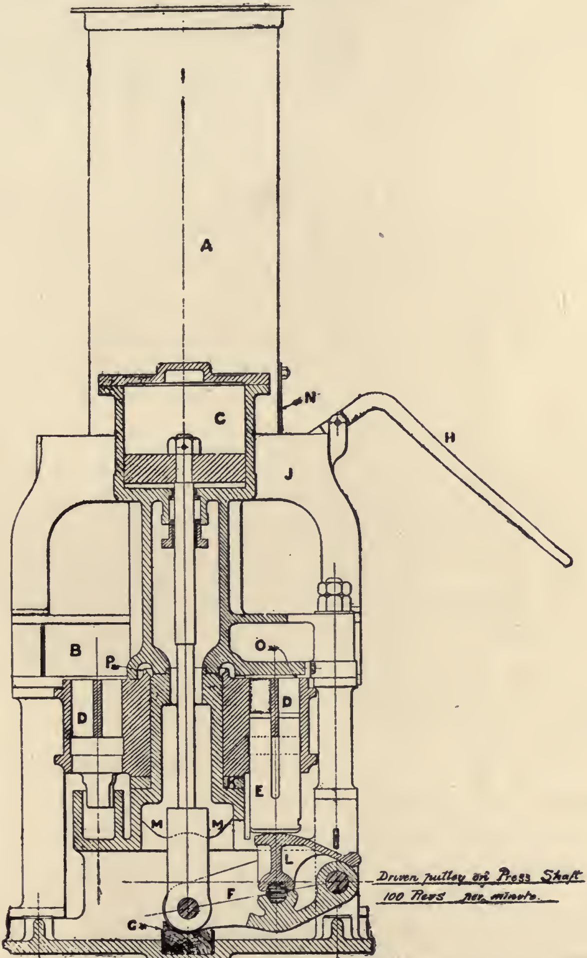

FIG. 30.—Sectional View.

Stevens' Improved 50-ton Peat Fuel Press.

This machine makes five tons per hour of briquettes, measuring $8 \times 6 \times 3\frac{3}{4}$ inches, and weighing about 8 lbs. each; or two briquettes at each stroke, $6 \times 4 \times 3\frac{3}{4}$ inches, and weighing about $3\frac{3}{4}$ lbs. each. The machine has been improved and modified of recent years; it possesses the merit of extreme simplicity and non-liability to break down.

This machine presses the briquette on one side only. The great advantage in single compression is, as stated above, that every mould can be arranged to carry a compressing piston with it, and the advantage thus gained in simplicity overweighs any advantage which can be gained in other ways.

Lennox Patent Peat Briquetting Machine.—This consists of an endless chain of moulds in the form of troughs fixed to endless sprocket chains driven by sprocket wheels.

In the machine illustrated in the side elevation (fig. 31) there are seventy-four moulds, each mould containing four troughs, 4 inches long $\times$ 4 inches wide $\times$ 4 inches deep, shown in fig. 32 (end elevation), each of which forms one briquette, so that the whole chain of moulds contains 296 troughs; thus one complete revolution of the chain will turn out 296 wet briquettes, which, when dried, form a most convenient size of fuel. On each third or fourth of the moulds there are strikers cast on the outside, which strike the four levers in the feed-box. The feed-box fits close down to the top and sides of the moulds, and has a mouthpiece to prevent the escape of the peat out of the front of the box.

The action of the machine is as follows:—The peat, which has previously been ground to a paste, is fed into the feed-box, and as the chain of moulds travels along under the feed-box the strikers push the levers attached to the feed-plates in the box, and these force the peat into the moulds; when the moulds reach the sprocket wheels at the end they open out as shown, thus breaking the peat into 4-inch

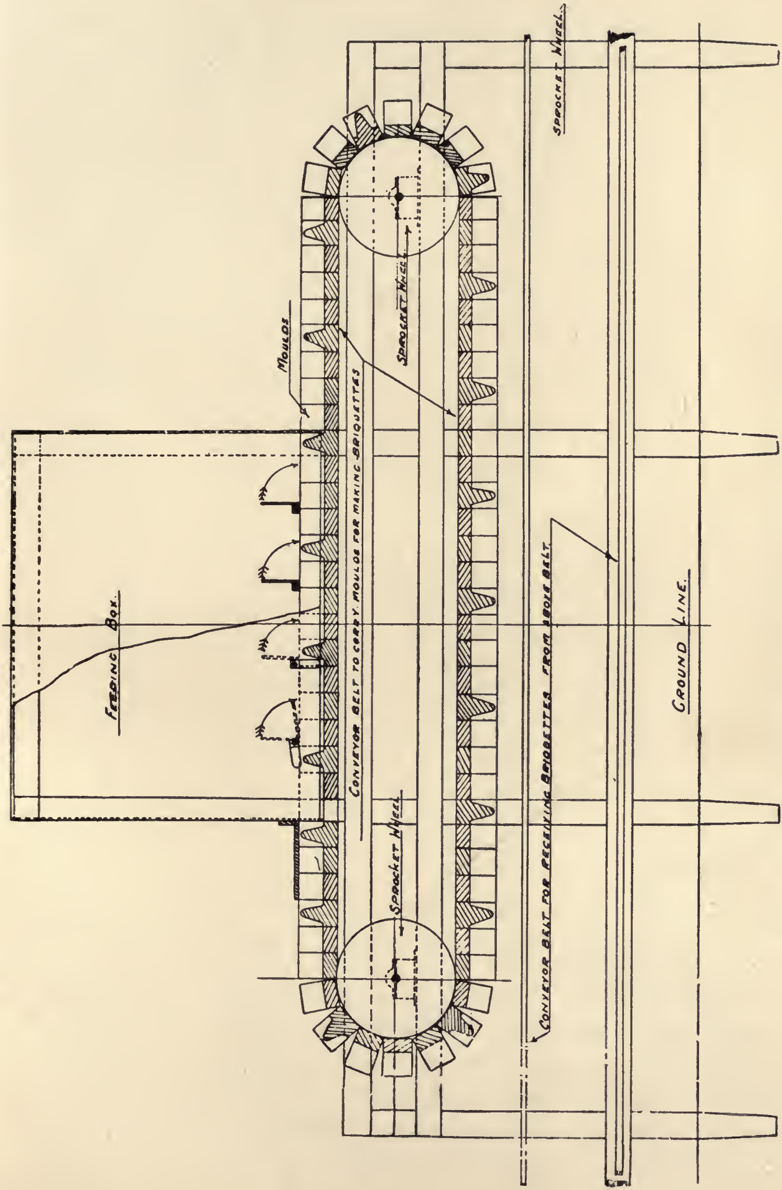

Fig. 31.—Lennox's Patent Peat Briquetting Machine. (Side Elevation.)

cubes. These travel round the wheel, and then move along the under side of an endless band with the troughs upside down, filled with the peat which adheres so closely to the

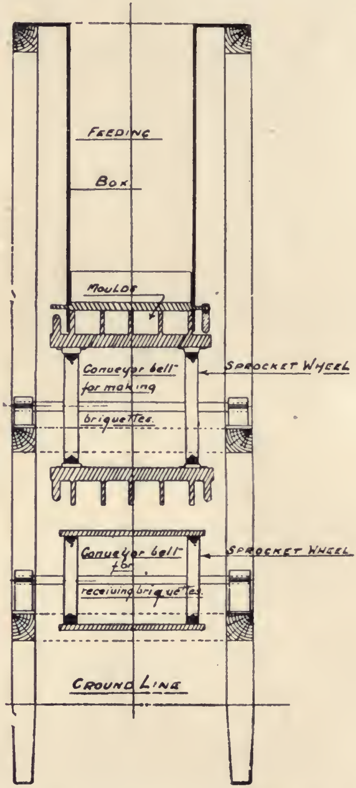

Fig. 32.—Lennox's Patent Peat Briquetting Machine. (End Elevation.)

troughs that it will not fall out. Fixed to the frame of the machine is a comb or set of fingers that fits into the troughs and turns the peat out on to trays on a conveyor band by which they are taken to the dryer. These trays are each large enough to hold twelve briquettes.

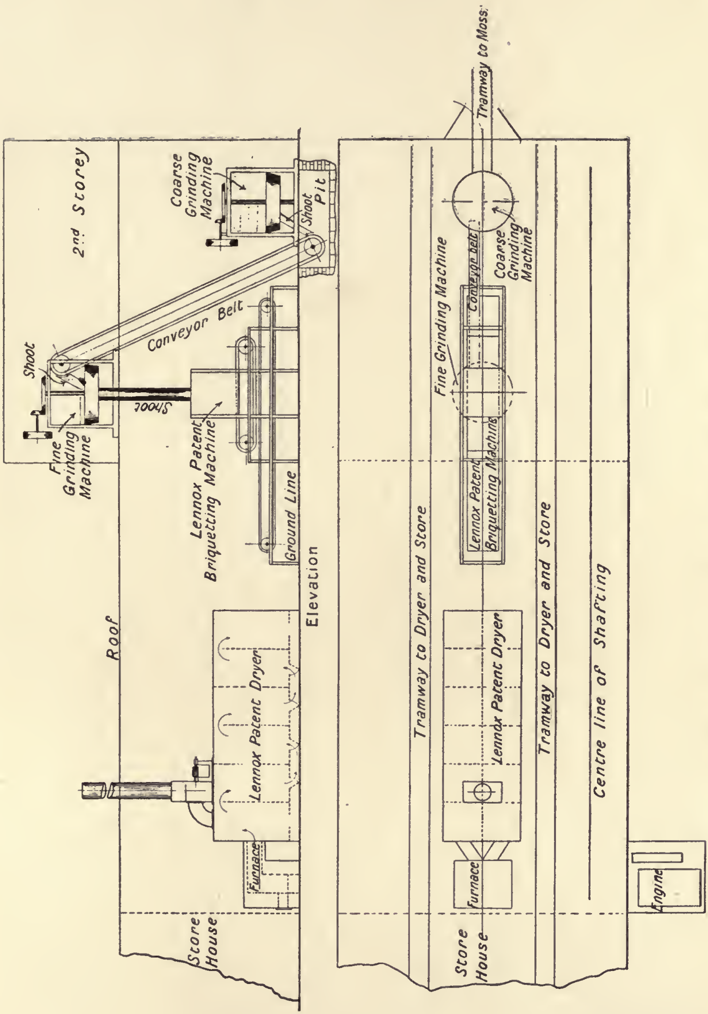

FIG. 33.—Lennox Patent Peat Fuel Plant for 5 to 10 tons per day.

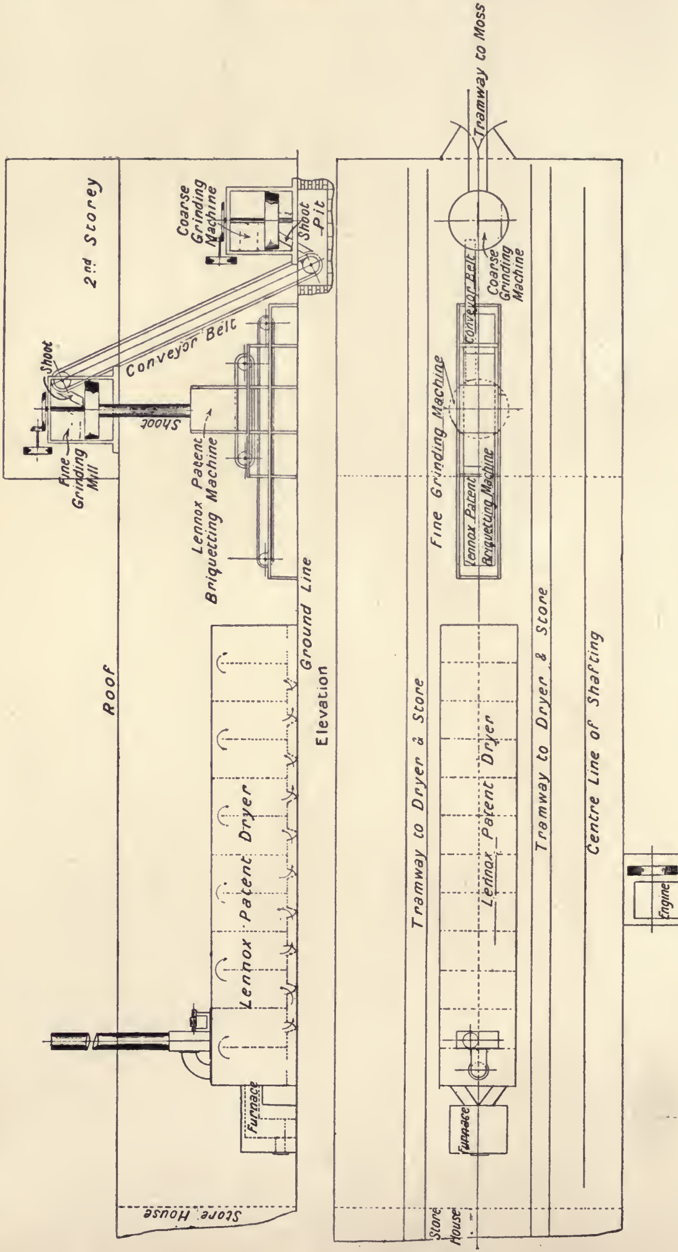

FIG. 34.—Lennox Patent Peat Fuel Plant for 20 to 30 tons per day.

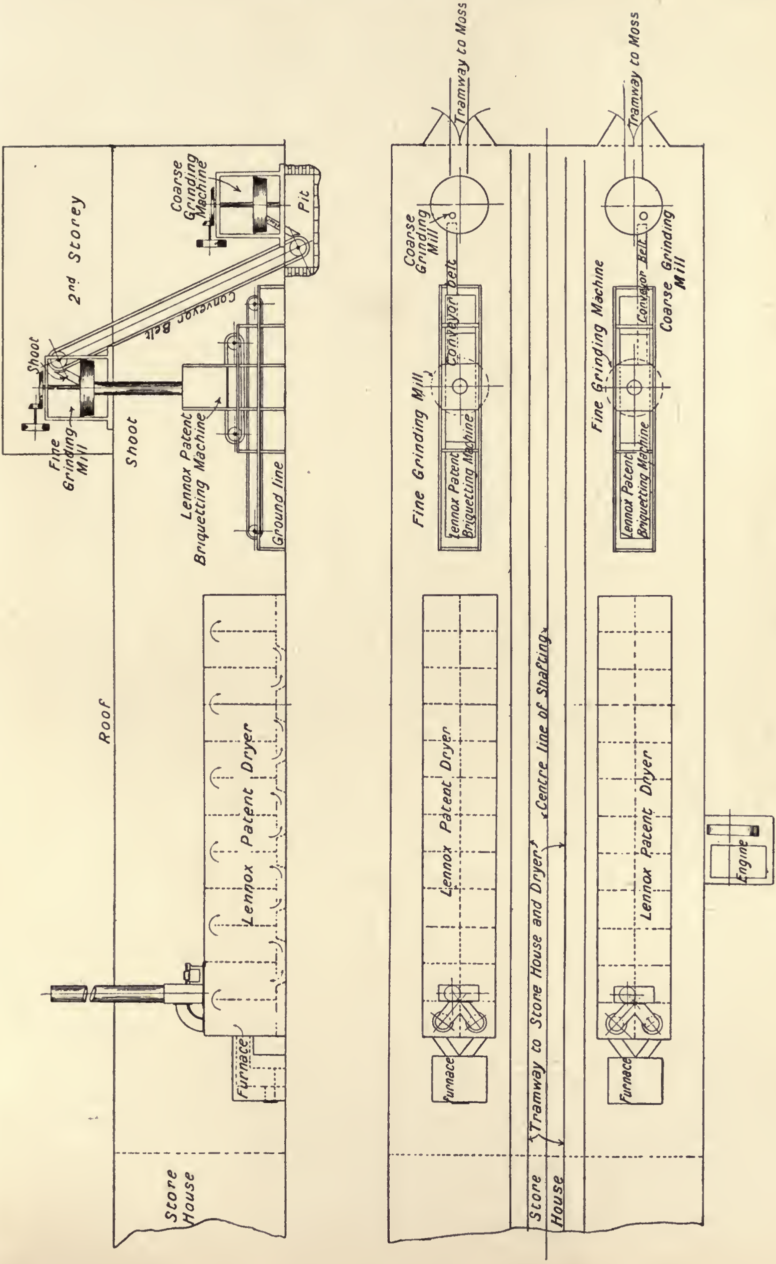

FIG. 35.—Lennox Patent Peat Fuel Plant for 40 to 50 tons per day.

The peat is not touched by hand at all during the operation. It is fed into the briquette machine straight from the pulping and grinding machine, and the moulds or troughs are filled and emptied on to the trays as described. The filled trays are then carried by the conveyor band straight to the dryer. The only labour required is done by two boys, who feed the empty trays on to the conveyor band to be filled with the peat briquettes, and two men, who remove the filled trays from the conveyor belt and put them into the dryer. These briquettes come out of the dryer hard and dense, and make an excellent fuel. This machine will make from 14,000 to 18,000 wet peat briquettes per hour.

Kesson's System.—In this process for the production of peat briquettes the peat is raised from the bog in bogies, or trucks, carried on an endless chain, which is provided with hooks for engaging the bogie spindles. The peat is conveyed to a duplex pulverising and briquetting machine, and thence to a drying machine. The briquettes are afterwards passed through a drying chamber having a series of overlapping horizontal bands moving in alternate directions, and are there subjected to blasts of hot or cold air from a Root's blower.

A large number of processes for the manufacture of peat fuel are described and illustrated on pages 43 to 123 in *Peat: Its Use and Manufacture.*

CHAPTER XXI.

DESTRUCTIVE DISTILLATION OF PEAT.

In the revolving retort for the destructive distillation of peat designed by Herr E. Larsen of Copenhagen, the gases evolved are continually drawn off through a series of valves placed in the periphery of the retort, giving passage to a general collector. The valves close automatically, but are made to open one after the other by the provision of a suitable gear, so that at least one valve is always open in order to allow the gas to pass off.

On pages 143 and 144 of *Peat: Its Use and Manufacture* will be found a list of the by-products obtained during the destructive and fractional distillation of peat, together with results of several tests by air blast and in closed vessels respectively.

CHAPTER XXII.

PEAT MOSS LITTER BALING PRESSES.

THE latest type of peat moss litter baling press made by Herr A. Heinen, Varel, Oldenberg, Germany, is shown in fig. 36.

The press-box is made of best American pitchpine wood and put together with strong beams and planks, which are further strengthened by being shackled with heavy iron fetters. The upper part of the machine is made to open, both in front and behind, so that the press-box is accessible on both sides. On the top the press-box is closed by a strong removable slide. The driving of the cogged racks is effected by a strong winding gear and double shafts fitted with wheel gearing. The machine is driven direct from an engine, by a leather belt. An arrangement is provided so that the winding gear may be disengaged automatically and the machine stopped as soon as the highest pressure is attained. Further, by means of a simple adjusting device the length of the stroke of the pressing-piston can be regulated as desired so as to make bales of different thicknesses and of the highest degree of compactness.

At the actual highest position, the winding gear having been automatically disengaged, the pressing-piston is held in position by a self-acting brake gear, which can be disengaged or held in position by a simple hand lever, according as the pressing-piston is to be moved down or stopped. In this way the pressing-piston may be held in any position.

The machine is worked by two men, who stand upon a wooden platform, fixed half way up the machine, or elevated nearly up to the bottom of the upper side-doors. These two men work the winding-gear and lace the bales with wires. A third workman assists in emptying the press and

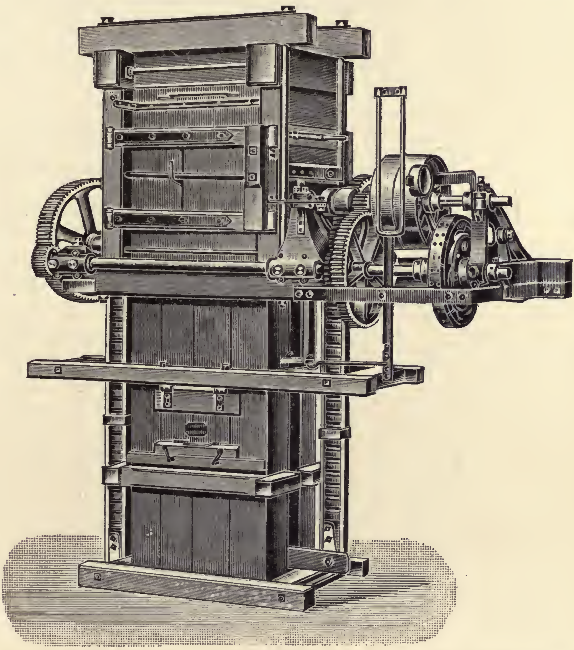

FIG. 36.—Heinen's Peat Moss Litter Baling Press. For Power Plant.

removing the finished bales. The feeding of the machine is effected by any automatic feeding contrivance, or by a simple transporter, which brings the material to be pressed into a large wooden filling-funnel above the press. If the pressing-piston is below, the wooden laths serving for fastening and the lacing of the bales are first placed upon it, and the side doors are closed. The upper slide of the press is now removed and the material is ready for pressing. The winding gear which moves the pressing-piston upwards is put in action until the winding gear disengages itself, and the press is stopped automatically as soon as the highest pressure has been attained. The pressure being over, the upper side-doors are now opened and the wires laced round the bales. At the upper side of the pressing-piston and at the bottom of the slide

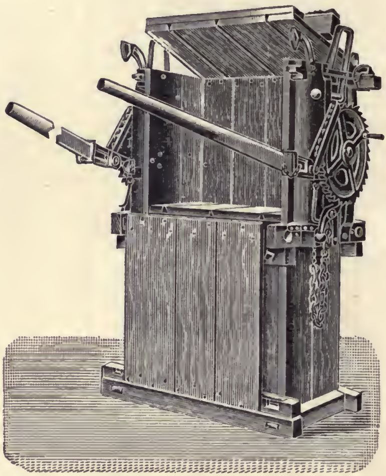

FIG. 37.—Heinen's Peat Moss Litter Hand Baling Press.

there are wire slits for passing the wires through. When the bale is laced, the pressing-piston is slightly lowered, the one movable side-flap released, and the bale pushed out. The presses can be arranged for different sizes of bales.

In Heinen's improved peat moss litter hand baling machine the press-box is made of best American pitchpine wood and strengthened with heavy iron fetters. In the press-box a piston slides up and down, worked at both ends by strong iron chains and ratchets which are put in motion by two hand levers.

The press is worked by two men in the following manner. The upper cover of the press-box and the upper halves of the front and back are opened, as shown in the illustration fig. 36, and the side valves are closed. The upper cover is

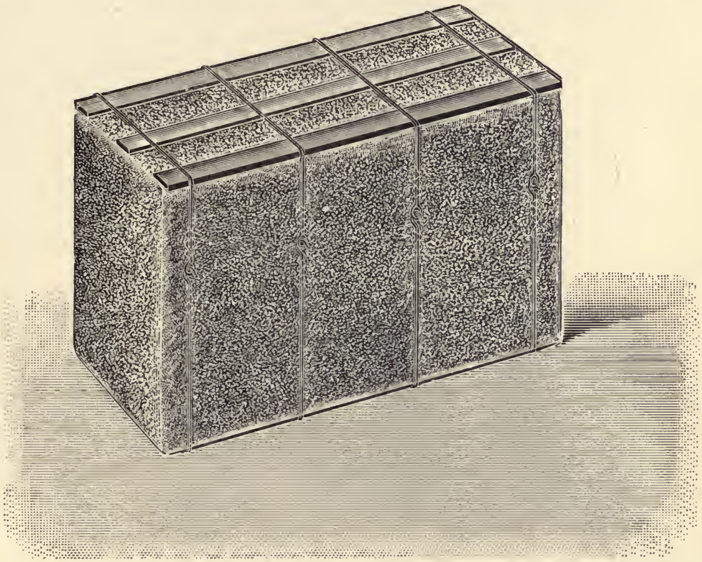

FIG. 38.—Finished Peat Litter Bale.

opened whilst the piston is in its lowest position. After the wooden laths, or the lower half of the linen, serving to wrap the bales in, have been laid upon the pressing-piston, the press-box is filled from the hopper. Then the upper lath, or upper half of the linen, is laid upon it and the cover is closed. The two workmen now move the hand levers up and down until the desired pressure has been attained. The side valves of the press are then opened, by which the bale is accessible on the front and back. On the lower pressing-piston, as well as on the upper cover, there are three slits through which the wires are passed for lacing the bale. This being done, the upper cover is opened and the pressed and firmly laced bale is pushed out.

If the bales are to be provided with linen wrappers, four pieces of linen are taken for each, one lower half, one upper

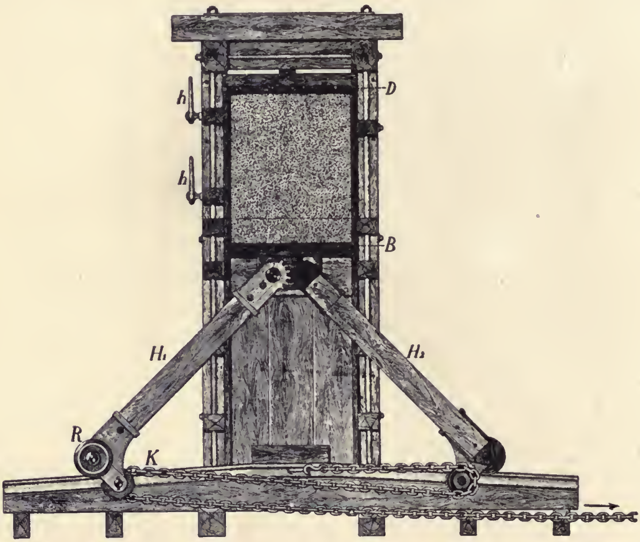

FIG. 39.—Heinen's Peat Baling Press. Patterns P 1 and P 2.

half, and two end pieces. The lower and upper halves are placed in the press-box, together with the wooden laths, the linen being inserted between the laths and the bale. The necessary pressure having been attained, the lower half of the linen is firmly tied together with the upper one and the wire lacing is put round. When this has been done, and the bale has been taken out of the machine, the end laps of linen are attached.

With two workmen engaged, the output of this machine, per day of ten hours, is from thirty to forty bales, or with three workmen, about forty to fifty bales. When finished the bales measure about 33 × 20 × 25 ins., and are neat and compact in appearance.

Using P. 1 Press the finished bales are 33 × 20 × 25 ins.
„ P. 2 Press „ „ „ „ 39 × 20 × 25 ins.

Fig. 40 shows another type of moss litter machine made by Herr A. Heinen. It is adapted for manufacturing moss

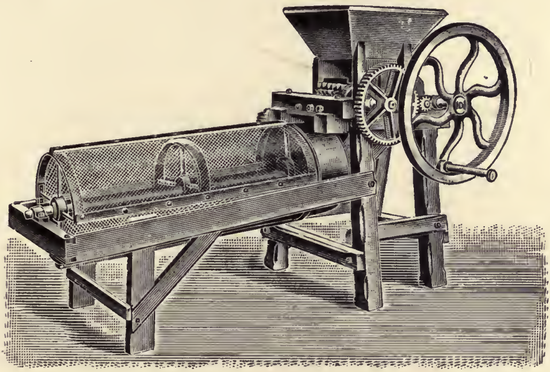

FIG. 40.—Hand Power Moss Litter Machine. Patterns RW 1 and RW 2, with Rotating Sieve.

litter and peat dust from soft moss-peat. The latter must first be cut into square sods, *i.e.* dug, and then dried in the air and sun in the open field.

The machine consists of two toothed rollers which revolve against each other at different speeds and work up the stuff supplied. The latter is reduced to soft woolly litter, and the dust resulting from this process is sifted off by the rotating sieve. The moss litter produced as well as the moss dust are employed for various purposes.

The wooden frame of the machine is strongly bolted together. The cogged wheels and all other pieces of the machines are solidly and firmly constructed. The rollers are adjustable, in order to produce coarse or fine litter. The filling funnel is removable, and every part of the machine is easily accessible for examination.

CHAPTER XXIII.

PEAT MOSS LITTER FACTORY.

FIG. 41 represents the interior of a peat moss litter factory, showing arrangement of Heinen's plant. The moss litter willow, R, which reduces the dry peat squares into small pieces, is erected on the ground floor in order to lessen the weight in the building and framework and to minimise the shaking.

The peat moss material may either be carried on the ground floor by the side of the willow and then be cast into it by hand, or the trucks containing the peat may be carried up an inclined plane to an elevated platform alongside or in front of the willow; this may be easily done by means of a windlass driven from the main shafting. This latter arrangement is most suitable for large factories, and saves a great deal of manual labour.

From the willow R an elevator Z leads into the upper floor of the building and conveys the finished moss litter, worked out from the willow, to the upper part of the building. Here it falls into an inclined funnel-shaped wooden hopper T, which is fitted with a bottom slide K; by this means the moss litter can be passed either to the rotating sieve S or to the grinding mill M; or to both at the same time.

The rotating sieve S, which may also be supplied with a plain shaking sieve, is used for shifting the dust, or mull, which is contained in the moss litter coming out from the

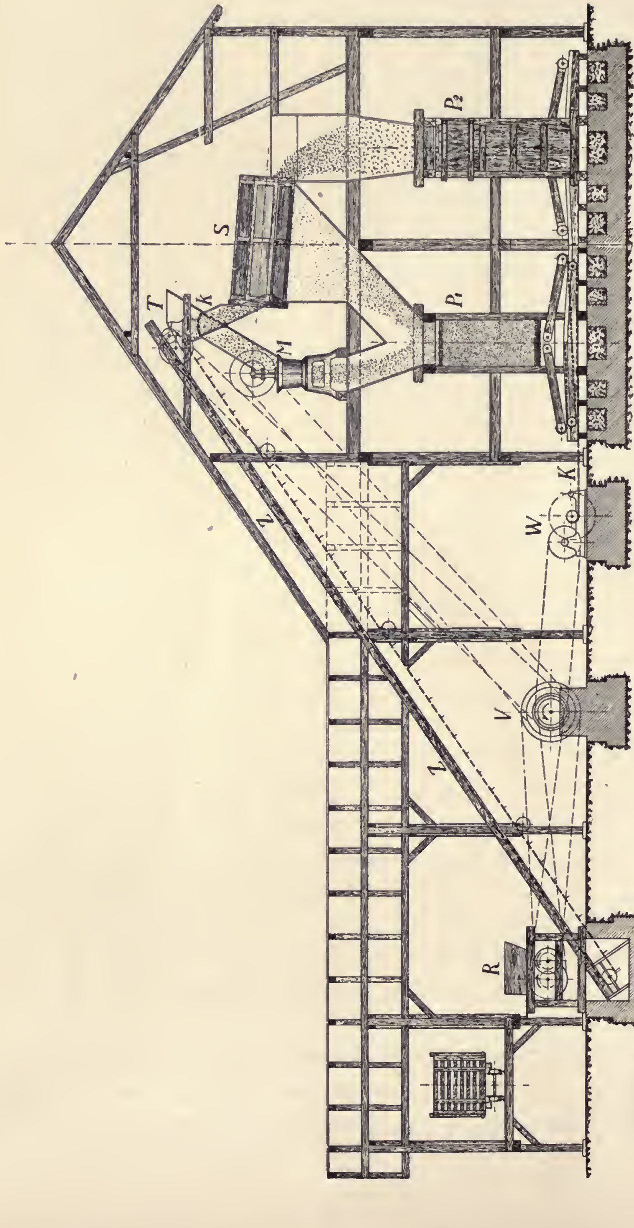

FIG. 41.—Interior of Peat Moss Litter Factory, showing Heinen's Willow for Grinding Moss, Elevator, Rotating Sieve, Peat Grinding Mill, and two Baling Presses.

willow. The quantity of mull generally amounts to one-third to one-fifth of the moss litter itself, according to the quality of it and to the width of the sieve spout. The fine mull coming from the bottom of the grinding mill passes, by means of a lower inclined hopper, into the mull baling press P 1, and the cleaned and finished moss litter, which has been retained by the sifting machine, goes into the moss litter baling press P 2, also by means of a similar hopper.

The peat grinding mill M is fitted up directly below the elevator, and, as before mentioned, the moss litter is conveyed directly to it according to the position of the slider in the upper hopper. The grinding mill may be regulated for any degree of dust, from the finest to the most coarse. If it is necessary to make very fine and uniform mull, it is advisable to fit the mill with a separate flat shaking sieve. The mull coming out from the mill, and also that which falls from the rotating moss-litter sieve, both pass into the mull baling press P 1, by means of the different wooden hoopers.

The mull baling press P 1 and the moss-litter baling press P 2 press the material conveyed to them into tight bales, the process being superintended by two workmen. The remainder of the work is automatically performed, including the feeding of the willow.

The baling presses may be erected in different manners. In factories, for instance, where no mull, or only a little of it, is to be produced, and where the mull grinding mill is not necessary, so that both presses may be used for moss litter, it is advisable to erect the baling presses alongside each other, and not one in front of the other, as shown in the illustration. Both presses can then work alternately. An improvement has, however, been made in this arrangement. In this latter case, the mull, falling out from the

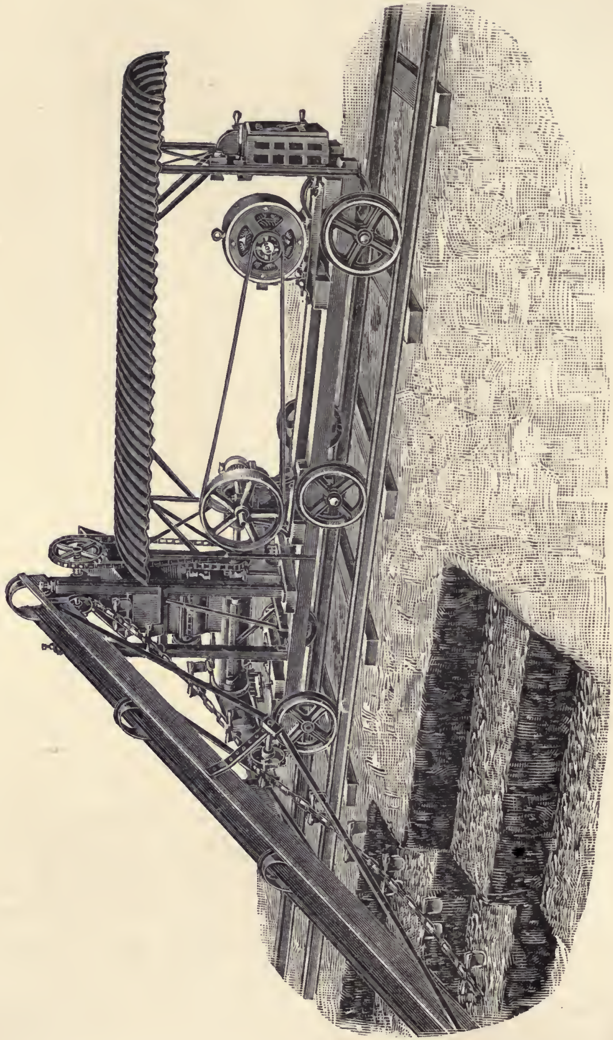

FIG. 42.—Heinen's Peat Machine driven by an Electric Motor.

sieve spout, is a by-product, and is pressed into bales from time to time when a sufficient quantity of it has accumulated.

The driving gears W of the baling presses and the main shafting V, with the pulleys, are erected on the ground floor upon suitable foundations. Only one workman is necessary to attend to the driving gears W of both presses. In small factories the main shafting, with the pulleys, can, if desired, be erected on the framework above.

A very large number of moss litter plants have been erected on the Continent, and this important industry is a most flourishing one.

CHAPTER XXIV.

MOSS LITTER WILLOWS.

FIG. 43 illustrates one of Heinen's double moss litter Willows, pattern R 4, suitable for large and heavily worked moss litter manufactories.

The machines are wholly constructed of iron and steel,

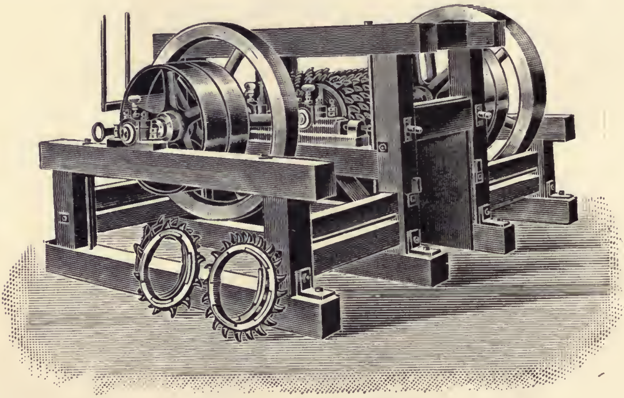

FIG. 43.—Double Moss Litter Willow. Pattern R 4.

and are erected upon a firm and strongly fastened wooden foundation.

On the wooden bed are fitted two large toothed rollers, each of which is provided with a suitable heavy fly-wheel and separate driving gear, with fast and loose pulleys for leather belts. Each roller can be thrown in or out of gear, and each roller shaft is supported by long bearings fitted with automatic ring lubricators of the latest type.

The rollers are composed of single toothed steel rings which are tightly connected with each other and fastened on a common axle. Each steel ring is interchangeable, which is of considerable advantage in case of any defect; moreover, by this arrangement it is also possible to re-sharpen the teeth at any time.

The roller bearings are adjustable, and screws are provided for regulating same so that coarse or fine litter may be produced as desired. A special feature claimed for these machines is the entire absence of any cogged wheels, thus avoiding the risk of breakages.

The filling funnels, or hoppers, are removable. The machines are well and substantially made throughout, are compact, durable, very reliable, and give most excellent results.

CHAPTER XXV.

PEAT MULL GRINDING MILLS.

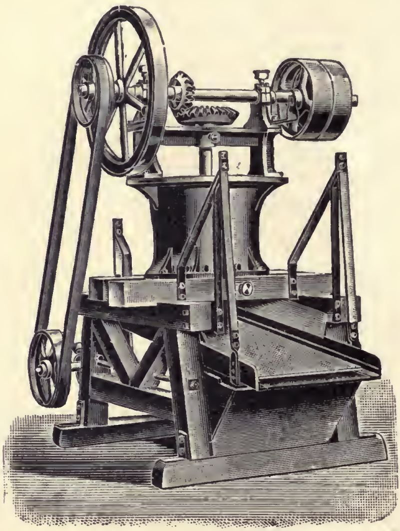

FIG. 44.—Heinen's Peat Mull Grinding Machine. Patterns MS 1, 2, and 3 (with Sieve).

Daily capacity for ten hours.

MS 1 machine $2\frac{1}{2}$ tons, MS 2 machine 5 tons, and MS 3 machine $7\frac{1}{2}$ tons of fine mull.

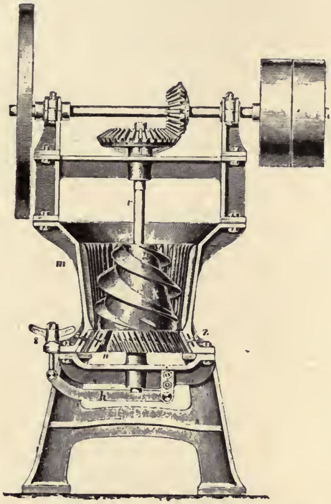

FIG. 45.—Section of Heinen's Peat Mull Grinding Machine. Patterns M 1, 2 and 3.

Daily capacity for ten hours.

M 1 machine 5 tons, M 2 machine 10 tons, M 3 machine 15 tons of coarse mull.

The use of peat mull, or powder, as a disinfectant is largely on the increase in Germany and other Continental countries. It is much used for fruit packing, its antiseptic and non-oxidising qualities rendering it a valuable material for this purpose. Peat mull, owing to its being a non-conductor, can be packed round ice in the cellars, and it will be found that the loss through melting will be reduced to a minimum.

CHAPTER XXVI.

PEAT TEARING AND MIXING MACHINE.

A TYPE of machine largely used in Germany is represented in fig. 46, side elevation; fig. 47, side section; and fig. 48, end section. Fixed in the feeding hopper of the machine, as

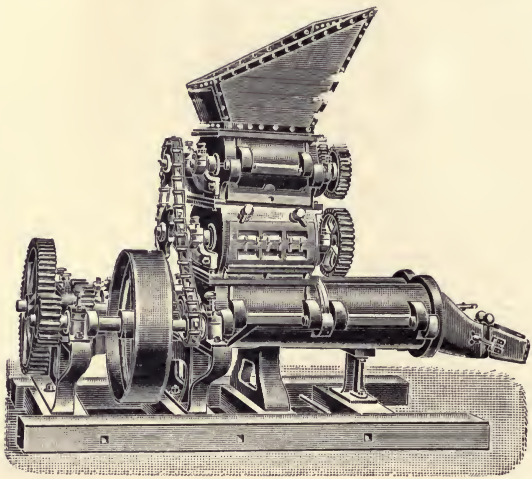

FIG. 46.—Heinen's Peat Tearing and Mixing Machine. (Side Elevation.)

will be noticed in fig. 47, are two steel shafts *a* and *b*, each fitted with wings, which mix and tear the raw peat material. Beneath these shafts are fixed two more shafts, *c* and *d*, each being provided with steel knives which pass between the fixed knives *g* (fig. 48), inserted through the sides.

The purpose of this series of knives is to cut and pulp the peat before it enters the lower part of the machine, where it is again mixed and kneaded by the screws *e* and *f* during its movement towards the mouthpiece of the machine. The two shafts *a* and *b* are made in two parts and afterwards joined together, and the two lower shafts, *c* and *d*, are

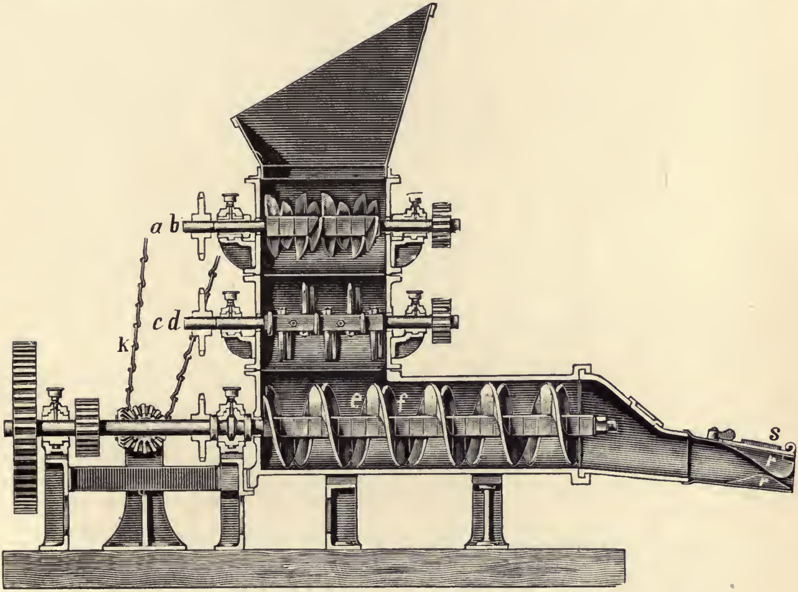

Fig. 47.—Heinen's Peat Tearing and Mixing Machine. (Side Section.)

accessible by means of the movable side plates in which the fixed knives are secured. The lower part of the machine is also easy of access for examination or repairs, and by simply removing the bolts *m m* (fig. 48) the upper portions and the cover can be lifted up. The knives *r* (fig. 47) in the mouthpiece may be raised by the handle *s*, when this part requires cleaning or inspection. One of the leading features in this machine is that either pair of shafts, with their corresponding knives, can be removed, or replaced, independently, so that if desired at any time the machine can be worked with only one pair of knives.

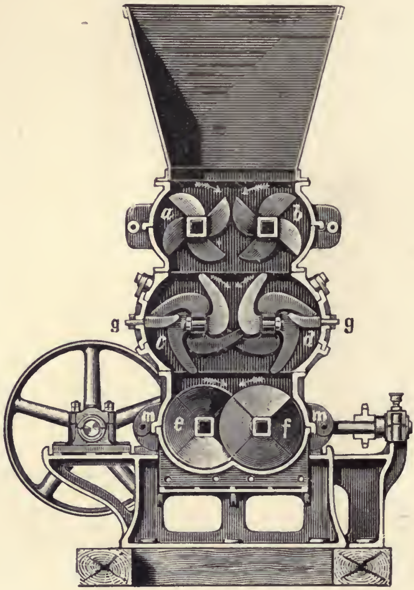

FIG. 48.—Heinen's Peat Tearing and Mixing Machine. No. T 2, W. (End section.)

CHAPTER XXVII.

"LENNOX" PEAT PLANT.

"Lennox" Processes and Patents for the Manufacture of Peat Litter, Peat Dust, Peat Fuel, and Peat Charcoal.—This plant has been designed after twelve years' careful and continuous experiment, and has the advantage of being low in first cost and in cost of working. There are no complicated parts to get out of order, and all the machinery is constructed to stand heavy wear and tear. The wet peat can be supplied either in the hand-dug form or it may be raised by a floating steam dredger, shown in fig. 49, effecting a great saving in comparison with the ordinary hand-digging.

The cost of digging the peat by means of this dredger does not exceed three-halfpence per ton of wet peat, and the capacity of the machine is from thirty to fifty tons per hour. The peat is tipped from the dredger into bogies and conveyed to the works, where it is put through a large slicing machine and sliced into pieces of suitable size.

If it is to be made into moss litter and peat dust, it falls from the slicing machine into an elevator, and is carried to the top of a large patent dryer, shown in fig. 50, where it falls through a hopper into the dryer. This dryer is continuous in its action, and turns out the dry peat in one continual stream.

This machine can be built to any suitable capacity, and the following advantages are claimed for it:—

It will dry the material either quickly or slowly, as may

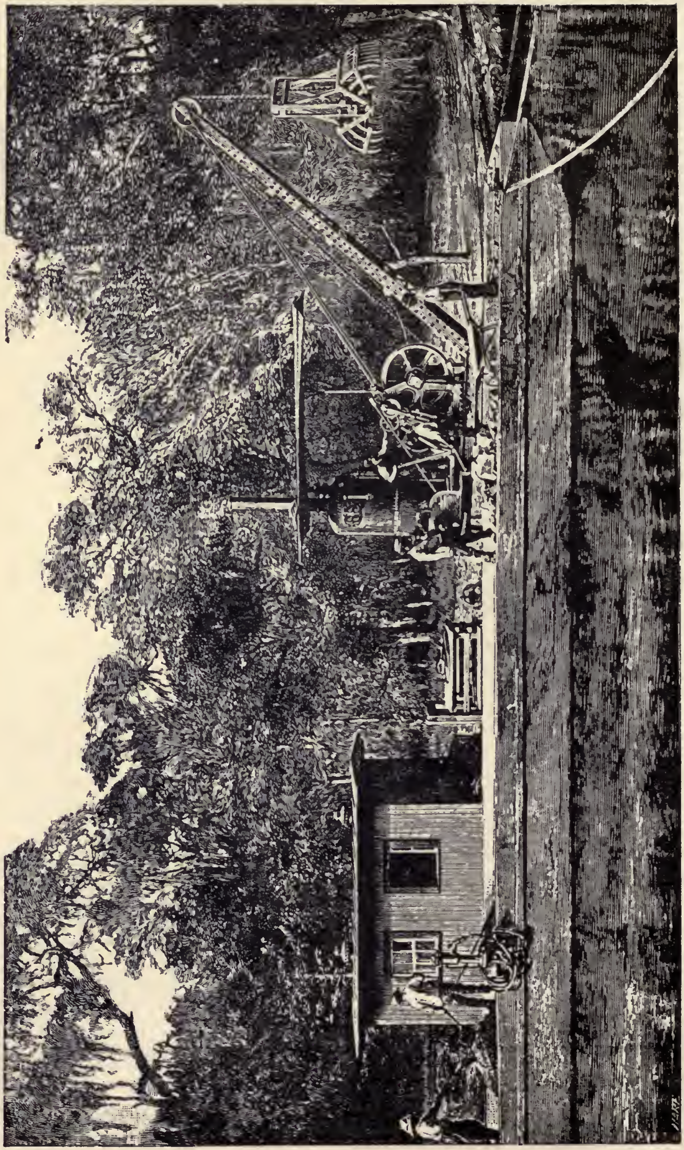

FIG. 49.—Floating Steam Peat Dredger.

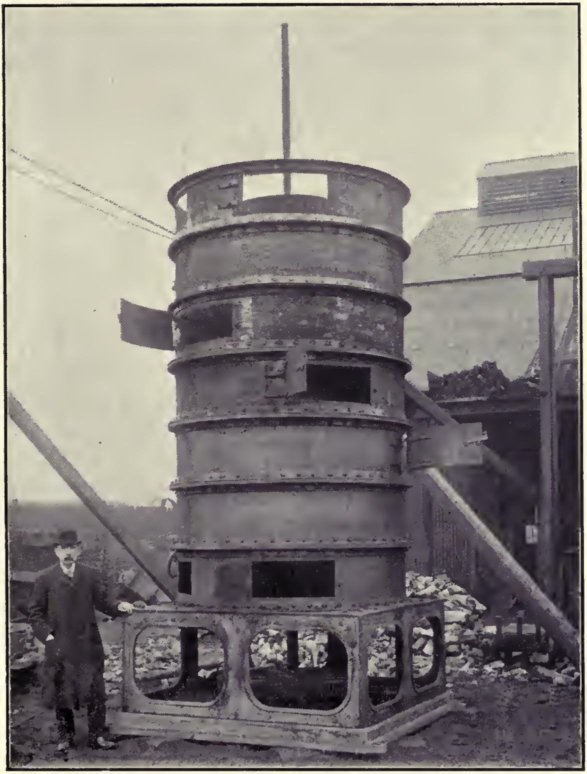

FIG. 50.—Lennox's Patent Continuous Automatic Peat-drying Machine.

be required, at any desired temperature. It is entirely automatic in its action. It uses either waste heat from the boiler or furnace flues, or direct furnace gases, or hot air. It has a low cost of installation, of labour, and of driving power. It automatically spreads the wet material evenly over the drying shelves to any desired thickness, for either quick or slow drying. There is automatic turning and mixing of the material in its progress through the machine. Temperature can be controlled to suit the material to be dried and the rapidity with which the drying is required to be done. The hot air, or gas, travels under the shelves and over the top of wet material, so that the material is heated both from the top and the bottom at the same time.

The construction and action of the dryer are as follows:—

The machine consists of a fixed circular metallic casing of suitable capacity and diameter for the quantity of material to be dried in a given time; of a revolving inner vertical cylinder concentric with the fixed casing and connected to a central shaft, which is driven in any suitable manner; and of a number of horizontal shelves extending from the inner cylinder to the fixed casing, the shelves being fixed to the inner cylinder and revolving with it. This inner vertical cylinder, which is closed at the top and open at the bottom, is suspended from a turntable actuated by power through suitable gearing, and travels on a path carried on the top of the fixed casing (see fig. 19). All the shelves, excepting the bottom one, which is solid and a certain distance above the bottom of the casing, have two openings extending from the outer edge to the inner cylinder. The shelves are spaced a suitable distance apart. The material is delivered on the top shelf, which is at a fixed distance below the top of the casing, and as the shelf revolves the material passes under a spreader, consisting of a bar adjustably fixed to the casing and extending from the casing to the inner cylinder. When the shelf has made nearly a complete revolution the material is stopped by a scraper and precipitated through one of the holes in the shelf on to the shelf below immediately behind a hole in this shelf. It then passes under another adjustable spreader, and, making almost a complete revolution on the second shelf, is precipitated through a hole in this shelf by another scraper to the third shelf, and so on to the bottom shelf, from which it is delivered by a scraper through a hole in the casing to a spout, or shoot, thence into any receptacle. The holes in one shelf are in advance of the holes in the shelf immediately above, and the spreader for one shelf is approximately below or in advance of the scraper for the shelf above. The scraper consists of a bar fixed to the casing, and is radial, or tangential to the inner cylinder, or curved, to suit the particular material being treated. As the shelves cannot be made to fit so closely against the casing as to prevent a certain amount of material falling from top to bottom past the edges of the shelves, the casing is made of several diameters increasing from top to bottom, so that at certain stages the diameters of the shelves are also increased to suit, and any leakage from one shelf only drops to the next larger shelf instead of to the bottom. The edge of the bottom shelf runs against horizontal rollers carried on the outside of, and projecting slightly through, the casing, and prevents any side movement of the bottom of the inner cylinder. The bottom of the inner cylinder and the space below the bottom shelf are in communication with some suitable furnace for supplying the heat, the supply being controlled by a damper. Suitable holes are provided in the wall or inner cylinder between each pair of shelves, and permit the hot air or gases to pass into the spaces between the shelves, and, after circulating through the machine, to be discharged into the atmosphere.

The time taken to dry the wet peat varies from half an hour to one hour, according to the amount of moisture in the peat, and also the density of the peat.

After the dry peat has left the drying machine it is passed through a screen, where it is separated into various grades, such as peat dust, peat meal, granulated peat, and peat litter. The dust and meal are then filled into bags and the litter is taken to a baling press and pressed into bales of 2 cwt. each, ready for the market. The cost of the dust and litter ready for the market does not exceed 7s. 6d. per ton.

When the wet peat is to be made into fuel it is put through a pulping machine and made into a fine paste, which is fed into a patent briquette machine, illustrated in figs. 31 and 32, and described on page 94.

This machine consists of an endless band of moulds which on the level form a series of troughs of any suitable size according to the weight of briquettes required. These moulds pass under a feed-box, where they are automatically filled with the wet peat. After leaving the feed-box the filled moulds pass over the sprocket or cant wheels carrying the endless band of moulds, and these open at the joints and break the peat into blocks the size of the moulds. After the chain of filled moulds have passed round the wheel they travel along face downwards where the peat blocks are turned out of the moulds by scrapers on to pallets travelling along on a conveyor band under the mould boxes. Upon leaving the machine, the pallets filled with the wet briquettes are put in a patent dryer specially constructed to dry them evenly throughout without being touched or handled, and they come out hard and dense and make a splendid fuel. This machine will produce from 16,000 to 18,000 wet peat briquettes per hour. They are 4-inch cubes when wet from the machine, but dry down to 2-inch cubes. This size has been specially selected for making charcoal, and also for use in suction gas plants. The cost of this fuel ready for the market is 8s. per ton, and the selling price from 12s. to 16s. per ton.

If required for making charcoal, the briquettes are put into retorts and carbonised and the by-products recovered, the gas given off in the charring being used to heat the retorts, and the waste heat from the gas after being burnt is used as the heating medium in the dryers, the whole operation being continuous and very economical.

A very great improvement in the method of air-drying of peat has been effected by the invention of the "Lennox" patent interlocking portable tramways and gantries, shown in fig. 51.

These form a huge network on the moss so that they cannot sink into the soft peat, and they will carry hundreds of tons of wet peat sods to be dried. Four men can lay several hundreds of yards of the tramways and gantries in a day.

The wet peat is stacked on pallets, six tiers high, at the working face of the moss as quickly as it is dug by hand, and these tiers of pallets when filled with peat sods are lifted by a patent lifting and lowering bogie, supplied with the interlocking tramways (see figs. 52 and 53), and conveyed to the gantries, where they are lowered on to them and left to dry. They do not require any further attention until the peat is dry, when it is lifted again by the lifting bogie and taken to the works to be baled.

By this system the peat dries quicker, being clear of the wet moss. There is no necessity to handle the sods after they are put on the pallets. All the spreading, turning, pyramiding, gathering, and walling of the peat sods is done

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Fig. 51.—The New Method of Drying on "Lennox" Patent Interlocking Portable Tramways and Gantries.

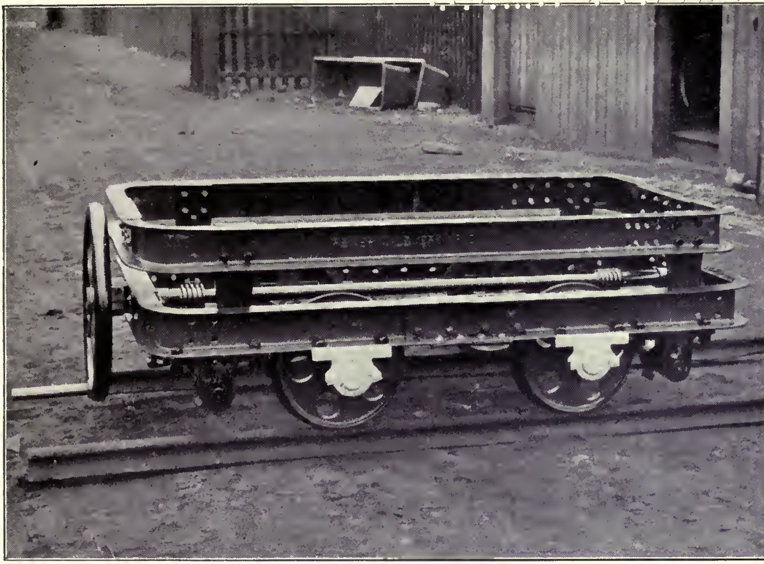

FIG. 52.—"Lennox" Patent Lifting Bogie with top raised.

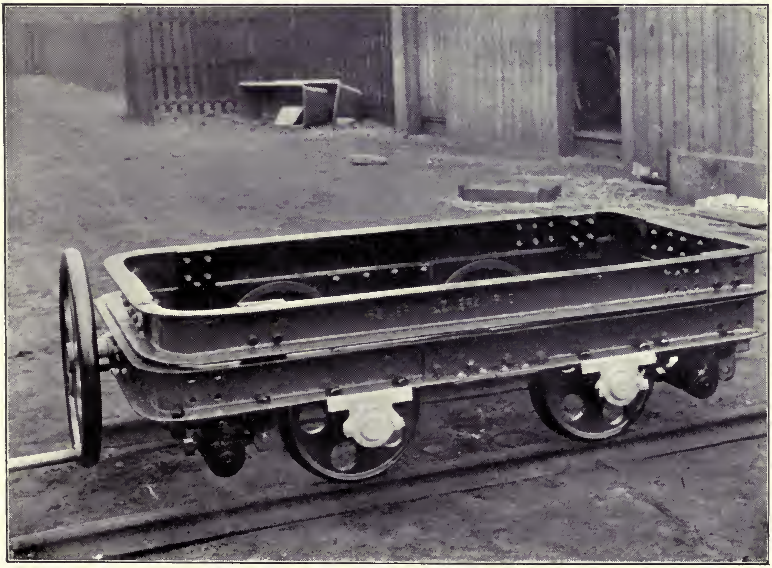

FIG. 53.—"Lennox" Patent Lifting Bogie with top lowered.

To face p. 126.

FIG. 54.—The Old Method of Drying by spreading the Peat out on the moss.

away with, effecting a very great saving; and four times the amount of peat can be dried per acre as compared with the existing method of spreading the peat sods on the moss to dry.

Fig. 54 shows the old system of drying the peat. In this case the peat has to be spread out on the moss and turned frequently to enable it to dry; it has afterwards to be gathered into small heaps, and these again built into stacks, all of which operations entail a large amount of labour and expense, in addition to which a very large area of moss is required to dry a few hundred tons. By the new method of drying on the patent portable gantries, shown in fig. 51, all this extra outlay is avoided, only one-fourth the area of ground is required compared with the old method, and not one-fourth the labour, thus effecting considerable saving in the cost of the treatment of peat. Another great advantage is that these portable tramways and gantries can be made by any local joiner or carpenter at a small cost.

CHAPTER XXVIII.

THE CANDY FILTER.

For the purification of peaty waters required either for dietetic or boiler feeding purposes, the Candy Filter Co., of London, have designed a special automatic compressed air and oxidising filter for neutralising the peaty acids, without

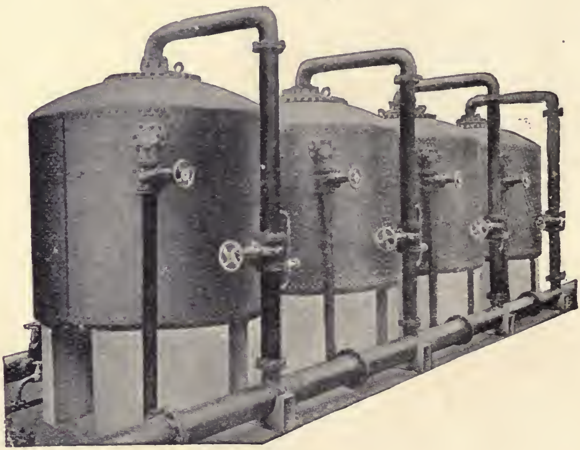

Fig. 55.

the daily addition to the water of chemicals such as lime, chalk, etc.

This type of filter, which is illustrated in fig. 55, contains in addition to selected and graded sand and gravel and the oxidising materials polarite and oxidium, a compartment holding a specially prepared acid-destroying substance (the invention and exclusive property of the Candy Filter Co.). It has been found that not only can a water be rendered non-plumbo-solvent by the process carried on in the filter, but that practically any desired degree of hardness can be imparted to a water. The value of this will at once be recognised by those having to deal with soft peaty waters.

Briefly described, the Candy patent automatic compressed air and oxidising filter enables all the results of the best kind of sand filtration to be obtained, while giving the special advantages which this filter alone possesses of automatically compressing the atmospheric air into the water, saturating it with dissolved oxygen previous to purifying it by the powerful oxidising materials polarite or oxidium contained in the filter. After this purification and filtration process has been carried on, when the water under treatment is of a peaty character, it then passes through the special compartment charged with acid-destroying material, and is rendered non-plumbo-solvent, or as hard as may be desired.

The Candy filter is not a mechanical filter or strainer, but a perfect natural method of effecting purification of peaty water by oxidation, Nature's own way. The filters are cleansed by a reversal of the flow of water for a few minutes. The quantity of water used for washing is extremely small, averaging about one-fifth of one per cent. of the water filtered. The filtering medium is practically indestructible, and effects a material reduction in the objectionably brown colour of peaty water, and gives a high degree of bacterial purity. The filters are suitable for dealing with either large or small volumes of water, and are extremely economical both in capital outlay as well as working expenses, being practically automatic in their working and cleansing. They are very largely used, not only in England, but in various parts of the world.

CHAPTER XXIX.

PEAT DEPOSITS.

BRITISH ISLES.

Ireland.

In the Bog of Allen the peat has an average depth of 16 to 25 feet, but occasionally it is 47 feet deep. The Irish bogs yield an immense quantity of peat, and contain numerous remains of skeletons of men and animals, and relics of human habitation and occupancy.

Extensive tracts of deep wet bog, or morasses, are found in Longford, Roscommon, and other counties, and give a peculiarly dreary and desolate aspect to the scenery. Notwithstanding the large quantity of water in these bogs, they give out nothing injurious to health, owing to the presence of tannin.

Tullymore Bog, three miles from Donegal town, contains excellent peat.

Knockboy Hill slopes down to the south, west, and east, the slope being of an undulating character, thus producing various smaller hills, until it finally runs out into bog up to 8 or 10 feet deep, if not more, on the south and east boundaries.

The Wicklow mountain chain rises to an elevation of 3039 feet in Lugnaquilla, and forms the most elevated tract of mountain land in Ireland. From near Dublin to a point south of Lugnaquilla the upper portions of the range are covered with peat to varying depths. A large area of the Slieve Aughty Mountains, in Galway, also contains good peat.

A large portion of the mountain land in Ireland is covered with wet peat, and the hills of Antrim, the Sperrin mountains in Londonderry, the Donegal highlands, and the mountain ranges of Mayo, Galway, Leitrim, and Sligo, all possess large areas of peaty land.

The question of afforestation has been engaging the attention of the Departmental Committee on Irish Forestry for some considerable time. After a careful survey of the various bogs it would seem there is some difficulty in growing large trees in bogs of any depth unless the surface is specially prepared and made suitable by draining and the addition of a clay soil, or by adding an artificial manure in the form of kainit, or basic slag.

All bogs contain an acid which is detrimental to the growth of trees, and this must be overcome before any plants which strike deep in the soil can hope to thrive.

By reclamation, many of the turf bogs might possibly be made suitable for pasture and field crops, and prove profitable in agriculture. The fact, however, must not be overlooked that in years to come compressed turf may be as valuable in Ireland for railway locomotives as it now is in various parts of Sweden, Germany, France, and Canada; therefore in countries like Great Britain and Ireland, which are adequately supplied with coal and peat, the question of the production of firewood is of secondary importance.

Isle of Man.

An important scheme for the reclamation of waste land has been prepared in the Isle of Man, probably the greatest of its kind that has ever been devised on the island, by Mr J. Curphey.

The proposal is to reclaim some 4000 acres of waste and bog land on the Baullaugh Curraghs, and to create two hundred small holdings, or allotments. The soil is very suitable for the cultivation of fruit and vegetables.

Thames Deposit.

Peat beds occur here and there in this deposit, notably in the vicinity of the Victoria Docks, where trunks of large trees have been discovered, thus giving evidence of the existence of woodlands at a former period on this site when it probably stood at a higher position above sea-level than it now occupies.

Peaty layers are occasionally met with in the Woolwich beds.

FRANCE.

West of a ridge called the Sillon de Bretagne, running north-west from Nantes to Pont Château, is a vast region of turf bog, "La Grande Brière," in which lacustrine shells and deposits have been found.

La Rochelle.

It is proposed to manufacture fuel from peat under a new patented process in the peat district on the borders of the Charente-Inférieure and Deux-Sèvres departments. The fuel produced experimentally is said to be of good quality. Other industrial uses of peat are contemplated.

SWEDEN.

During recent years the Swedish railways have been making many trials with British coal, Swedish coal and peat, separately and mixed, with a view to ascertaining the most economical form of fuel. It is calculated that economically combustible peat can be delivered at Swedish railway stations at about 9 kronor (10s.) per ton. The valuable by-products to be obtained from the peat greatly increase the chances of economical working of peat fields.

Sweden possesses the largest supply of peat in the world of any country except Russia.

In the early part of 1907 the attention of the Swedish Chamber of Commerce in London was drawn to the possibilities of creating an export trade from Sweden in moss litter and peat dust with the United Kingdom, and an interesting article upon the subject appeared in the Chamber's first annual report (1907).

The article[1] states: "The matter was thoroughly investigated, but no satisfactory arrangements with the Swedish houses were, however, arrived at, the Swedish exporters insisting on stipulating their own terms, etc., and not being willing to comply with the trade customs prevailing on this side.

"Moss litter is chiefly used in England by the large omnibus companies and railway companies in their stables, and it is also largely employed at the military stations. Some exporters of fruit from the Channel Islands use peat dust as a packing material; but it is anticipated, however, that farmers will soon better understand the great value of moss litter for agricultural purposes.

"There seems thus to be prospects of an increased import of moss litter into this country, but the imports from the Netherlands, Germany, Belgium, and other foreign countries, even under the present undeveloped conditions, are considerable.

"According to the Board of Trade returns, the export from Sweden to the United Kingdom of peat moss litter

[1] "Prospects of an Import from Sweden of Moss Litter." Swedish Chamber of Commerce in London *Annual Report*, 1907.

was in 1906, nine tons, value £20; and in 1907, 419 tons, value £507, Sweden's share of the total import being 0·02 and 0·51 per cent. respectively.

"The figures for 1908 are not yet available, but from the consular reports this newly developed export trade has greatly increased.

"There ought to be a good future for Swedish moss litter in the United Kingdom, on account of its superior absorbing power.

"Analyses of Swedish moss litter from two factories have shown that one sample, water free, from the county of Blekinge (Mörrum) has absorbed 19·7 times its own weight in water. Another sample, containing 20 per cent. of water, from the same place, has absorbed 15·8 times its own weight in water. An analysis from the county of Scania (Bjerrum) of the samples taken from the various parts shows that the average absorbing power of a water-free sample is 17·4 times its own weight in water.

"The dimensions of moss litter bales made by the factories in Sweden are, as a rule, 100 × 75 × 50 centimetres (3 feet 4 inches × 2 feet 6 inches × 1 foot 8 inches), and the weight of the bales varies from 65–70 (146–158 lbs.) and 85-99 kilogrammes (190–225 lbs.)."

At the request of the Swedish Riksdag, renewed experiments are to be undertaken in order to investigate the question of coal and peat used as fuel on railways, and new trials are now (August 1909) to be made. Between Elmhut and Alfresta there will be run a special train, consisting of fifty waggons, loaded with coal and peat. This train will be run for a fortnight between the two places, using alternately as fuel English steam coal, peat and steam coal in different proportions, and peat only. There will also be used different types of locomotives. The results of these experiments are looked forward to with great interest, especially by those who are connected with the peat industry.

An account of peat fuel trials carried out on English, French, Swedish, and Canadian railways will be found on pages 126–132 of *Peat: Its Use and Manufacture.*

Wisby, Gothland.

The Wisby Cement Company has during this year erected a second cement factory. Both the factories obtain their power from three peat-gas machines, of together 1000 horse-power, costing 230,000 kronor. The new factory is worked by electric transmission of power. The Company possesses a peat bog at Martebo, and has procured new machinery for digging up the peat.

According to the latest statistics, the total peat bogs in Sweden would be capable of producing 10,000 millions of tons of air-dried peat suitable for fuel. This quantity, as compared with the present import of coal, would be sufficient for a period of 1500 years. More exact examination of the geological character of the peat bogs will soon be started by the Swedish Geological Society.

NORWAY.

A company has been formed in the Island of Froien, on the coast outside Trondhjem, for the production of peat fuel, with a calculated output of 3000 tons per annum. This fuel will be placed on the Trondhjem market, at a price somewhat lower than the local price of coke, and which it is also claimed will possess greater heating power.

AUSTRIA.

The swampy plains in Bohemia yield an enormous amount of peat.

GERMANY.

Helleweger Bog, between Bremen and Hamburg, has a depth up to 25 feet.

The depth of the Augustendorfer Bog ranges from 20 to 26 feet, and in its composition resembles the deeper bogs found in County Galway.

Burgrittensen Bog varies in depth from about 18 inches to 4 feet, and in some portions probably a little more.

Schleswig-Holstein,

the most northerly province of the German Empire, has 486 square miles of moors and bogs. There are no fewer than 1085 separate bogs, of which a very large proportion yield peat for use as firing. The bogs are rapidly decreasing, many being now cut-away bogs. The depth of the bogs varies from 10 to 30 feet.

The manner of producing peat[1] for use as an article of commerce in Schleswig-Holstein includes two methods—1st, the Back Torf; and 2nd, the Press Torf.

The first mode is chiefly adopted by the peasants for the manufacture of peat for their own use, and may be described as the hand-made system. It was introduced from Holland some time prior to the year 1803 by Herr Goopmans.

The second method may be divided as follows:—Manufacture of peat for fuel; manufacture of Torf-streu, or peat-moss litter, for use in stables, and Torf Mull, or fine turf dust, made up in large packages for disinfecting purposes, for preserving of meat, fish, and fruit, and for filling up walls and ceilings, stalls, and ice-houses.

[1] "The Peat Industry in the Province of Schleswig-Holstein." J. Tissington Tatlow, *Journal of Department of Agriculture and Technical Instruction for Ireland*, June 1902.

Hanover.

Extensive operations have been carried out during the past year for the reclamation and cultivation of the vast peat bogs of Königsmoor and Marcardsmoor, situated in the Leer district, East Friesland, Hanover, which extend over an area of nearly 25,000 acres. The network of canals in connection with the same reaches a total length of nearly twenty-five miles. At the junction of the main canal with the high road from Leer to Wittmund a generating station for electricity for lighting and power purposes has been erected by the Hanseatic Siemens-Schuckert Company and the Augsburg and Nürnberg machine factory. From this centre the current is distributed over a wide circle some thirty miles in diameter. The fuel used is peat, and there is an ample supply of peat in the district to meet future requirements. The ploughs and other machinery employed in this great reclamation work are thus driven by means of power generated from the products of the bogs and at a very much cheaper rate than if coal or other means of providing generation had to be depended on; and further, the by-products, chiefly sulphate of ammonia, are recovered and are saleable. Agriculture has great need of artificial fertilisers, and the proposals to obtain them from the soil itself are not only of great interest to the country at large, but deserve the most careful consideration. If artificial manures continue to rise in price, it is more than possible that our peat lands will be drawn upon extensively for sulphate of ammonia. The station has been erected for the purpose of supplying current for light and power in Aurich, Emden, Leer, Wilhelmshaven, and several other towns.

The German-Hanoverian Peat Utilisation Co. was formed in March last, in Berlin, with the co-operation of the Deutsche Bank, the company for electrical enterprise and of chemical and other undertakings. The share capital amounts to £100,000, and the object is the production of gas from peat and its employment in the driving of gas engines and dynamos, the process of gasifying the peat being based on patent rights.

HOLLAND.

There are peat deposits in North Brabant, Limburg, Drenthe, Friesland, Overyssel, and in Groningen to the north-east, and the industry gives employment to a very large number of people in digging and exporting. Cut out in neat blocks, the peat is dried, and loaded on the Tjalks (barges), and distributed over the country by its network of canals. Good-sized blocks are sold at the rate of ten for five cents (one penny).

To a great extent the success and profitable working of the Dutch moors and bogs, and the flourishing condition of the turf industry, is due to the ready means of transit which, owing to the excellent system of intersected canals, is reduced to a minimum.

UNITED STATES.

The area of the peat lands is estimated at 20,000,000 acres.

The reclamation of bog and swamp lands for agricultural purposes and reafforestation is receiving much attention, and several large drainage projects are at present under consideration.

Peat deposits occur in the Eastern Dakotas, Minnesota, Wisconsin, Michigan, Northern Iowa, Illinois, Indiana, Ohio, New York, New England States, New Jersey, Maine, portions of Virginia, North and South Carolina, Georgia, and Florida.

Maine.

In the Maine States there is a large quantity of peat of good quality, and the average depth is about 10 feet.

Quite recently a survey, extending over an area of 25 square miles, has been carried out under the United States Geological Survey, by Messrs Edson S. Bastian and Charles A. Davis, and their joint report (Bulletin No. 376) is an interesting and exhaustive one. It contains photographs of the most important peat bogs, analyses, calorific values, etc., and they add, in summarising, that "Peat resources as great as, or greater than, those of Southern Maine, are to be found in the forest lake districts of the northern part of the State, and it is probable that the deposits tested form only one-tenth to one-fifth of the total peat resources of the State."

In the southern and eastern parts of the State peat deposits of good quality are most abundant in Androscoggin, Kenebec, and Penobscot counties, and especially in the Washington County.

Peat is also found in Aroostook, Cumberland, Hancock, Knox, Oxford, Piscataquis, Somerset, and York, and on the coast south-west of Portland are numerous broad expanses of salt marshes in which are found peat of considerable thickness. There are also deposits in Wayne County and Monroe County.

As peat bogs exist in the district of Astoria, a dryer has been set to work, and it is proposed to manufacture peat fuel and put same on the market.

In Franklin County the peat beds are from 8 to 9 feet deep, and of average quality.

It is stated by the Federal peat experts of the United States Geological Survey who have been studying the peat deposits for some time, that millions of dollars worth of peat fuel lies undeveloped in the swamps and bogs of the United States. It is estimated that its value, on a basis of 3 dollars (12s. 3d.) per ton, roughly guessed at by the experts, is more than 38,000,000 dollars.

Mexico.

Surveys of the peat bogs not far from the Lake of Tezcuco have shown that these deposits have more than 8,000,000 tons available for fuel purposes.

CANADA.

Owing to the increasing population and industrial activity in Canada demanding every year a larger amount of fuel, the growing scarcity of wood in the settled parts of the country—caused by the number of pulp and paper mills which have sprung up in recent years, thus increasing the value of forests for this purpose—and the increasing price of both coal and wood, the question of utilising the large areas of peat bogs has become one of extreme importance.

In 1906[1] a petition was signed by a large number of influential residents in the different sections of the Dominion asking for a thorough investigation of the peat deposits in the country by the Mines Branch, "with a view to obtaining such reliable information as to situation, extent, capability of drainage and best methods of working available bogs; together with the quality, character, calorific value, etc., of the peat contained in them, as may aid in the intelligent development of this valuable resource." The petition was addressed to the Minister of the Interior, and afterwards transferred for action to the Minister of Mines.

In May 1907 the Director of Mines recommended that

[1] *Summary Report of the Mines Branch for the Fiscal Year 1907–8.* Canadian Department of Mines, Mines Branch, No. 26A, 1908.

Mr Erik Nyström, an engineer on the staff of the Mines Branch, be appointed to investigate the peat industry of Europe. This was confirmed, and the instructions given to Mr Nyström were: "You are to proceed at the earliest moment to Sweden, Norway, Finland, Denmark, Germany, Holland, and Ireland for the purpose of studying and reporting upon the peat industries in these countries." And later on it is stated that "this examination is undertaken in the interest of the peat industry of Canada." For that great country is known to contain nearly 40,000 square miles of peat bog; it is most probable that the area is very greatly under-estimated.

The official report[1] issued on this subject is an exceedingly valuable and interesting volume, covering 262 pages, and is very fully illustrated. The report makes frequent quotations from *Peat: Its Use and Manufacture.*

For a long time peat fuel and other peat products have been used in several European countries for domestic and industrial purposes, with the most satisfactory results.

In a paper, "Notes on the Mineral Fuel Supply of Canada," read before the Royal Society of Canada in 1907, Dr Ells states that peat occurs in large quantities in Ontario, Quebec, and Manitoba, and in some places a successful industry in the manufacture of compressed peat fuel is being carried on. In all three provinces the prospects for the development of the industry are good, as peat is abundant and accessible.

Excellent peat is found in Prince Edward Island, but this has not yet been exploited, as coal can be carried cheaply across the Northumberland Straits from Pictou and Inverness.

In many parts of the province of Quebec there are extensive peat-bogs, particularly in the area between St

[1] *Peat and Lignite.* By Erik Nyström, M.E., Ottawa, Canada, 1908.

John's and Farnham, where there appears to be a good prospect for the manufacture of compressed peat.

Peat deposits are also to be found in Eastern Canada.

[1] The importance of the peat fuel industry to the central portion of Canada, where coal fuel is non-existent and its importation so comparatively costly, requires no demonstration. A bulletin has recently been issued by the Mines Branch of the Department of Mines, Ottawa, entitled, "The Investigation of the Peat Bogs and Peat Industry of Canada during the season of 1908–9." This bulletin, compiled by Mr Erik Nyström and Mr S. A. Anrep, comprises twenty-five pages of text, and includes six large scale maps of the following peat bogs:—(1) Mer Bleue, near Ottawa; (2) the Alfred Peat Bog, about forty miles from Ottawa; (3) the Welland Peat Bog, about six miles north of Welland; (4) the Newington Bog, on the New York and Ottawa Railway, and about forty miles from Ottawa; (5) the Perth Bog, a mile and a half from Perth; (6) the Victoria Road Bog, about a mile from Victoria Road Station, on the Midland division of the Grand Trunk Railway. The bulletin contains a descriptive report of each bog, showing the location, area, and structure, and giving an estimate of the available supply of peat fuel, with records of analyses, calorific values, etc. A fuel-testing plant is now being erected at Ottawa, in which the value of peat for the production of power-gas will be demonstrated. The Department proposes to carry on a thorough investigation of this subject. During the year 1908 only one small peat plant was in operation during part of the season, and only a few hundred tons of peat fuel were obtainable by local consumers. This fact is stated to be due to the failures of the peat companies formerly started, to lack of knowledge of the properties of peat, and to the employment of im-

[1] *The Times Engineering Supplement*, 4th August 1909.

practicable methods, or unsuitable bogs. The plant operated last season by Dr J. M'William is situated about two miles from Dorchester Station, near London, Ontario. The method employed is briefly as follows:—The surface of the bog is harrowed by means of a common harrow, drawn by a horse, and the peat is exposed to the air and sun, and left until partly air-dried. When sufficiently dried, the upper layer is collected by means of a suction fan, mounted on an electrically drawn car, moving on rails laid down on the bog and deposited in a special car moving on the same rails. The collector travels backwards and forwards and collects the peat from the area which can be reached by the suction pipe of the fan. This pipe is connected with the fan by means of a flexible joint, and can be swung out at a greater or less distance from the track on which the car travels, thereby covering a considerable area from one track. The loaded car is brought to the plant, where the peat is deposited in a storage shed. From the shed it is conveyed to a drier, and subsequently to the briquetting press. The power for the plant is supplied by a 100 horse-power boiler, furnishing the steam for a 75 horse-power engine which drives the dynamo. The M'William system is described on page 87 of this book, but as the above remarks furnish one or two more details, it has been thought of interest to insert them.

NEWFOUNDLAND.

Sir Edward Morris, the Premier of Newfoundland, at the conclusion of his recent visit (August 1909) in connection with the question of naval defence, has spent the little leisure he has had in the prosecution of his schemes for the economic development of his colony's products. Amongst other things, he is turning his attention to the utilisation of the great peat resources of his colony. Newfoundland has extensive peat bogs, and tests are to be made with the new process for extracting the moisture and converting the peat into good serviceable fuel. By the Ekenberg process, which is in successful use on the Continent—and a plant for working the process is in course of installation in England—peat bogs become valuable. The peat is excavated, fuel, charcoal, and fertilisers are manufactured therefrom, and the remaining bog-bottom is recovered for agricultural purposes. In addition, the valuable by-products would be obtained from the peat. The question of producing gas from the Newfoundland peat bogs will also be fully considered, especially in view of the successful experiments and results in England, on the Continent, and in Canada and America.

INDIA.[1]

Extensive beds of peat are found and worked in Cashmere, at Nilgri, the United Provinces, Nepal, Assam (in Fenchgung), and in Burma considerable deposits are met with in the higher valleys of the Irrawaddy and Salwin rivers.

Attempts have been made to utilise the Nilgri deposits for several industrial purposes in the hill-station of Otakamund. Southern India is suffering much from the lack of coal mines to develop mining and other industries. The deposit of peat, however, will partially supply the fuel demand of the hill regions.

The peat deposit is situated at about 6000 feet altitude in a manner that goes to prove the limitation of the course of peat to temperate and cold regions. An elevation of 6000 feet virtually brings the country into a condition comparable with the temperate zone.

[1] Sarat C. Rudra, "The Mineral Resources of British India," in *Transactions of American Institute of Mining Engineers*, vol. xxxiv., 1904.

APPENDICES.

APPENDIX I.

THE ASTOR VIBRATORY PEAT-GAS PRODUCER.[1]

THE economic utilisation of the enormous peat bogs found throughout the temperate zone has been a problem baffling scientists and engineers for a great many years. Attempts at reclaiming the peat bogs to make arable farm land have met with partial success in Norway and Sweden. Peat has been successfully used as a fuel, but, due to the large amount of water contained in the peat, it is necessary to dry it for a long time before it can be burned.

Inasmuch as the solid portions are almost entirely carbonaceous, it is better adapted in some respects for the manufacture of producer gas than is bituminous coal. Ordinary peat is of a very porous and loose texture, and a great deal of gas is occluded among its fibres. It has such poor heat-conducting qualities that when heated in a producer a portion of the peat will be completely burned without heating other portions to any material extent.

The vibratory disintegrator which has been invented by Colonel John Jacob Astor, New York, and which, according to *The Scientific American*, it is believed will solve the problem of the commercial manufacture of producer gas from peat, utilises the expansive force of the air and gases within the very porous peat to disrupt and disintegrate the latter, and to permit the peat to be thoroughly and

[1] The above description appeared in *The Practical Engineer*, 9th July 1909, and is reproduced by the courtesy of the Editor.

uniformly heated. The gas generated may be supplied to an ordinary internal-combustion engine D, the engine muffler C being placed inside the gas producer (*see* fig. 56).

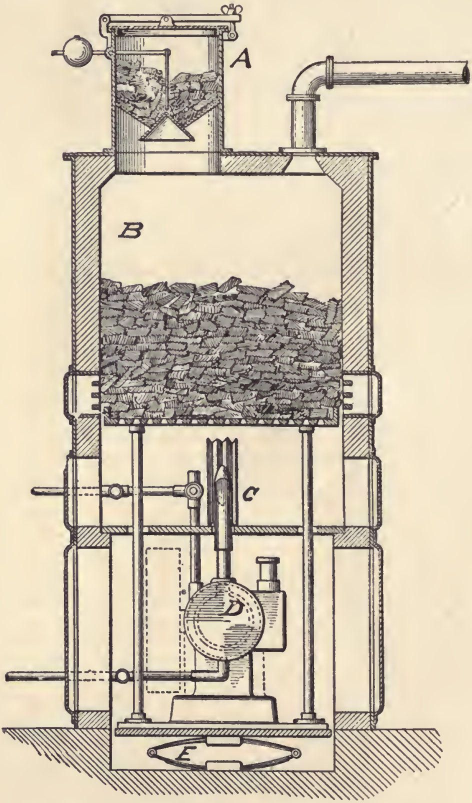

FIG. 56.—Astor Vibratory Peat-gas Producer.

The sides of this muffler are thin, so as to permit them to be distended and drawn inwardly upon variations in the pressure within the muffler. The edges of the muffler may be fluted, corrugated, or accordion pleated, to facilitate this relative movement of the opposite sides, and one end of the muffler is connected to the exhaust pipe. The gas escaping from the engine cylinder after each explosion in the latter tends to expand the muffler, and as the exhaust gas escapes from the muffler, the sides will again contract. These vibrations of the side walls of the muffler cause the successive compression and expansion of the gas within the gas producer, and likewise the gas included in the pores and interstices of the peat. As a result, the cells and pores contained in the peat are disrupted, and the peat is broken up and disintegrated.

To further aid in breaking up and disintegrating the peat and permitting of its uniform heating, the peat chamber B of the producer is supported from the engine frame or brass E, so that the jarring and vibrating of the engine frame is transmitted to the peat.

Any suitable form of gas engine may be employed, but preferably one running at comparatively slow speed, so that the successive charges of exhaust gas will have time to produce the desired expansion in the muffler. Preferably an air-cooled engine is employed, and the air utilised in cooling the engine cylinder is delivered in part or in whole to the base of the producer.

As peat can be obtained by the farmers in many sections of this country for the mere trouble of digging the same, it is evident that producer gas could be manufactured at a very low cost. This would permit the farmers to drive various kinds of farm machinery by gas engines, to illuminate and heat their homes, and give them a very valuable fertiliser for their impoverished soil as a by-product in the peat residue.

A peat-fuel producer-gas plant is now being erected at Rhinecliff, on the Hudson, in which the vibratory disintegrator will be given a practical test. The plant, of about 150 h.p., is to run a stone crusher; and if the peat yields its gas, as it is confidently believed it will, it will mean an engineering advance that may have very far-reaching results.

It is understood that Colonel Astor intends to allow the public the full benefit of his invention.

APPENDIX II.

Distillation of Peat.

Herr Zechmeister's patent system for distilling peat consists in first distilling the material at a temperature not exceeding approximately 160° C. (320° F.), as long as the material continues to evolve acid vapours, and thereupon raising the temperature to approximately 300° C. (572° F.) at most, and maintaining it until the tar vapours are separated. These operations can take place in a single or separate retort for the purpose of obtaining the solid final product, forming a valuable heating material with practically smokeless combustion or supplying power gas without further distilling.

APPENDIX III.

Peat Coke.

The main feature of Aarts' patent process consists in continuously charging the peat or other raw material into the top end of a retort which is surrounded with spirally arranged heating channels, and is heated in such a manner as to graduate the temperature from the hottest zone towards both ends of the retort. In this manner the peat introduced at one end traverses the temperate zones, increasing in heat until it reaches the hottest temperature zone, where complete distillation and gasification takes place, after which the material gradually passes through cooler and cooler zones. The opposite end of the retort is provided with a water seal so that the hot coke is delivered into the water and cooled by producing superheated steam, the coke being removed in a cooled condition.

APPENDIX IV.

Peat Half-stuff, Paper, and Boards.

In the process patented by Herr L. Franz, of Admont, Styria, Austria, the peat is passed through a hopper into a press with a revolving screw. This screw forces the peat through a nozzle, from which it issues in the form of an endless rope, which is cut up by a knife revolving in the front of the orifice into discs. These discs are fed into a revolving endless screw fitted with cutters which, with the aid of water, break up the peat discs into single fibres. The peat substance is fed into the centrifugal drum from above, and is expelled from the drum by the centrifugal action through the slot apertures, against an annular screen. The peat fibres pass through the screen and are caught in a channel outside the screen. The peat fibres are then passed on to a washing machine, in which they are cleansed of more minute impurities and earthy substances. This washing machine consists of a rotary sieve drum, supported on rollers, and having arranged in its interior a helical conveyor and pipe for supplying a water jet. The peat passes into one end of the drum in the form of a thin paste, and is carried by the helical conveyor to the other end of the drum. It is then subjected to treatment in a fibre-comminuting machine until the fibre is worked up to half-stuff. It is then mixed with half-stuff made of waste paper, wood cellulose, or other material, to make paper pulp ready for the paper machine.

Peat Paper and Boards.

The Callender patent process for the treatment of peat moss for the manufacture of paper or boards is as follows:—

A given quantity of peat moss is saturated in a volume of water equal to about ten times its own weight, and when thoroughly mixed a small quantity of bromine is added diluted with water. The bromine attacks the gummy substances surrounding the fibres and renders them more soluble in any alkaline solution. The mass is thoroughly agitated, and a small quantity of alkali, preferably soda ash, is added, and the whole mixture is subjected to heat, with or without pressure. This heat, or boiling and pressure, is continued for five hours, the result being that most of the gummy substances have been dissolved and are either clinging to the fibres or in solution. Good results are obtained by using 8 lbs. of bromine to the ton of peat, and about 100 lbs. of soda ash to the same quantity of peat. It is sometimes advantageous to use a caustic alkali and also to heat under pressure, but nearly the same results are obtainable by heating or boiling in an open vessel.

The gummy mass which has been dissolved is then drained and washed from the fibres, so as to leave the fibres more or less clean and free from gummy substances. The fibres so cleaned are soft and pliable and well fitted for the manufacture of paper, either alone or in combination with some other substance. They can also be bleached or coloured in the usual manner. If a very clean fibre is needed, the fibre may be put through all, or part, of the above treatment more than once. In place of using bromine, some other equivalent medium may be employed, such as iodine, which will enter into combination with the gummy substances on the peat and render them more easily soluble. The bromine may be made more fluid and soluble by the addition of a little common salt.

In the process for the treatment of peat fibres for paper making patented in 1902 by Mr James Doull, C.E., London, the peat is first washed to free it from all sand and dirt, etc.

The moss is then passed into a tank and soaked for a length of time varying from four to eight hours in a weak solution of 2 per cent. sulphide or sulphate of soda, or it may be a cream of lime or alkali. The resultant mass is then soaked for four hours in another open tank in a 2 per cent. solution of an acid, muriatic, sulphuric, or oxalic. The soaking is done in open tanks at the ordinary temperature, without boiling, though in cold weather a gentle heat may be employed.

In order that the solution may be effective, the material after each soaking is compressed between rollers so as to open the fibre for the action of the reagents while pressing the solution into the fibres. The action of these weak solutions in the tanks is aided by agitation with rakes, or stirrers.

If the longer fibres are required to be separated from the shorter, a sorting or sizing machine is used, together with an ordinary combing machine.

For the final removal of moisture, or as preparation for combing and treatment of the fibre, a current of heated air is employed, driven by fan or otherwise through the chambers containing the material.

Blotting-paper from Peat.[1]

Excellent blotting-paper is made from this material. This class of paper is not expected to be too strong, but it should be highly absorbent, and peat-made paper is pre-eminently absorbent. Colour is no objection when the peat is used in this way. White blotting-paper cannot of course be made from peat until a suitable bleaching process can be found. Experiments in this direction are being carried out, and there is no doubt this difficulty will be successfully overcome before very long.

Many blotting-papers are made from other raw material than peat [2] and are dyed to the colour naturally possessed by peat papers, so that in the manufacture of such papers from peat there is a double saving from the employment of a cheaper fibre and from the ability to dispense with the expenditure of dyes and dyeing process. At the same time peat blotting-paper is easily dyed to any dark colour that may be desired.

The question of making paper from Irish peat has again been under consideration. A company has been formed to work the process introduced by Herr O. B. Beck, of Hamburg and America. Suitable peat lands have been found by Herr Beck near Athy, Co. Kildare. Arrangements have been entered into for the lease of these lands and works will be erected. The Swedish peat expert Herr Folke Svenson has reported very favourably upon the quality of the Irish peat to be used by the company, and in reference to the manufactured product, specially alludes to its indestructible, waterproof, odourless, and sanitary advantages.

[1] *Pulp and Paper Magazine of Canada*, January 1909.
[2] *Paper Making.* London, March 1909.

The "Beck" process is successful in America. It has been carried to such an extent that paper of almost every variety of weight and quality can be made from the peat fibres, while the strength, toughness and durability of each is equal to that of paper made from any kind of vegetable pulp.

By the further employment of this material in paper-making a large portion of the peat resources of Ireland could be turned to account and converted into valuable properties, and a flourishing industry would provide work for numbers of persons. It seems a pity that Ireland with her vast peat bogs should not participate in the many advantages which would undoubtedly accrue from their utilisation.

APPENDIX V.

Use of Peat in Scotch Distilleries.

During the sittings of the Royal Commission on Whisky and other Potable Spirits, evidence was given as to the use of peat as an essential fuel in the kilning of the malts used in making Highland whisky, the flavour of the peat permeating the spirit.

In the Appendix in Blue Book Cd. 4181, 1908, vol. i., an extract is given of the paper (reprinted from the *Journal of the Society of Chemical Industry*, 15th June 1905, No. 11, vol. xxiv.) by Philip Schidrowitz, Ph.D., F.C.S., and Frederick Kaye, A.R.C.Sc., on "The Chemistry of Whisky" (Part 11), and the following is a copy of the portion referring to the effect of the use of peat in some of the Scotch distilleries:—

"*The Highland Malts* are produced (if we except a few distilleries on the islands in the west and north) in the district on the mainland lying north of an imaginary line drawn through Dundee on the east and Greenock on the west. The malt is cured either with peat alone, or with a mixture of peat and coke. *The Lowland Malts* are made south of the imaginary line alluded to. Less peat is used in the preparation of the malt, and occasionally, we believe, peat is dispensed with altogether, especially of late years, owing to the growing taste for a spirit with a less pronounced peaty flavour. *The Campbeltowns* are distilled at the southern end of the Kintyre peninsula.

"The *Islays* are made in the island of that name. More peat is used in the preparation of these whiskies than in any of the other classes. We have laid some stress on the amount of peat used, as it is one of the few specific points in manufacture of which we have fairly definite knowledge. It must, however, not be assumed that the use of peat alone is responsible for all the characteristics of Scotch whisky, for the Lowland malts in the preparation of which little and sometimes no peat is employed, and the grain whiskies which are made without peat, yet unmistakably possess those broad characteristics of flavour which are associated with the article in question. The differences between the various classes and individuals of the same class are largely dependent, no doubt, on the nature of the barley and other raw materials of a starchy nature employed, on the water, the methods of malting and distilling, the shape and manner of working the stills, etc."

Various processes have from time to time been employed for the extraction of alcohol itself from peat.

On p. 150 of *Peat: Its Use and Manufacture*, a process is described and results of yields given.

In his investigations of the subject it is stated[1] that Sir William Ramsay, the eminent scientist, has extracted six gallons of whisky from one ton of peat.

APPENDIX VI.

The "Lennox" Patent Horizontal Revolving Peat Dryer.

Fig. 57 illustrates the latest design, patented in May last, of the "Lennox" Horizontal Revolving Peat Dryer.

The revolving part consists of four or more square or rectangular horizontal or slightly inclined boxes of suitable

[1] Mr David Sherlock at the discussion on Capt. H. Riall Sankey's paper on "The Utilisation of Peat," at meeting of Section G of the British Association at Dublin, 7th September 1908.

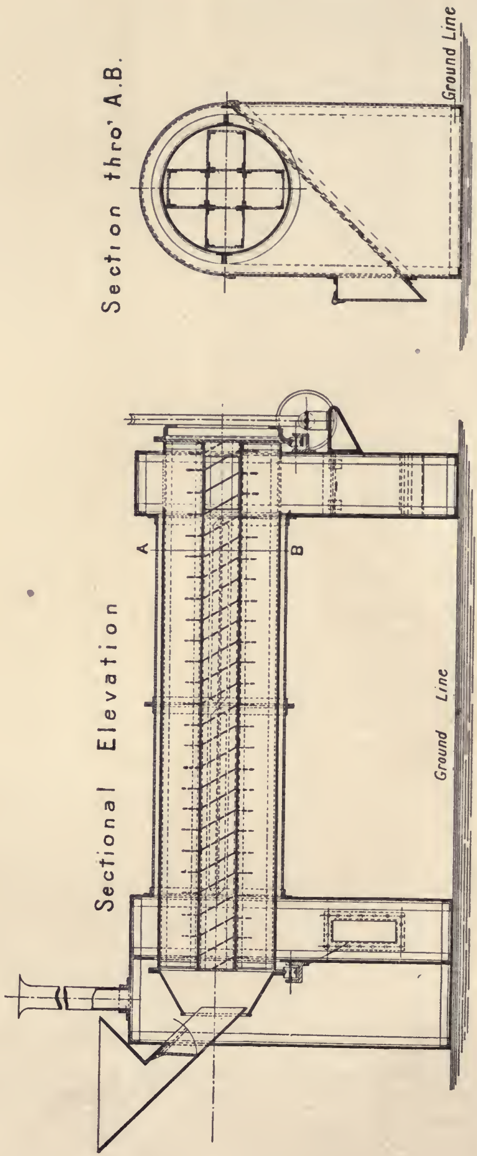

FIG. 57.—The "Lennox" Patent Horizontal Revolving Peat Dryer.

and equal length, open at one end and closed at the other. The material to be dried is introduced at the open end and delivered at the closed end. The boxes are arranged equally around a common centre, so that if four boxes are used, the backs of the boxes will form a complete or incomplete square. At the open, or receiving, end, the spaces between the boxes are closed by a plate. This plate and the plate which closes the other, or delivery, end of the boxes are circular, of larger diameter than the distance across the outside of the boxes, and are flanged, or have angle bars on their outer edge. These flanges bear on rollers suitably carried on the casing. The back of each box is provided with gills of suitable height and distance apart, and inclined to the sides, to convey the material along the box as the machine revolves. The boxes are revolved by any suitable power through a worm supported from the casing and a worm wheel attached to the delivery end of the boxes. A truncated hollow cone whose large diameter is less than the distance across the outside of the boxes is fixed on the receiving end of the boxes with the larger diameter adjoining the boxes, and the material to be dried is delivered from a hopper into the cone, and thus into the boxes. In the hopper is a door which opens when the material is being fed into the cone, bnt normally remains closed.

A cylindrical casing encircles the boxes, and is supported by and forms part of a hollow pedestal at each end, the said pedestals forming chambers. The boxes project a short distance through these chambers, and revolve on rollers suitably carried on the outside of the chambers. Hot air or gas from any suitable source is admitted into the receiving end chamber below the boxes, and the material after drying is discharged out of the boxes into the delivery end chamber, and thence through a door into any suitable receptacle. For this purpose the front of that part of each box which passes through the delivery end chamber is open. A plate, or ring, encircles, and is fixed to, the boxes at the outside of each chamber to prevent heat escaping from the chambers. An additional chamber is built against the receiving chamber and contains the cone and the bottom of the hopper, and on the top of this chamber is a chimney. In the machine above described the hot air or gas is admitted into the receiving end chamber, and passes along the spaces between the boxes to the delivery end, where it passes into the boxes and comes in direct contact with the damp material, then through the boxes to the receiving end, and out through the cone to the chimney on the top of the additional chamber.

When drying materials which are not suitable for this direct contact of the hot air or gas, the latter after circulating round the outside passes into the atmosphere by a chimney on the casing near the delivery end chamber. In this case a plate, or ring, is fixed round the boxes to prevent the passage of the hot air or gas into the delivery end chamber. If preferred, the hot air may be admitted at the delivery end, and the chimney placed near the receiving end, of the casing.

APPENDIX VII.

Mond Peat-gas Plant.

The frontispiece of this book shows the first producer plant in the world making regularly sulphate of ammonia and producer gas from wet peat containing up to 75 per cent. of water.

The Power-Gas Corporation, Stockton-on-Tees, first turned their attention to the question of utilising peat for the production of power and the recovery of by-products in the year 1905. Since that date hundreds of samples of peat have been examined from all parts of the world, and many trials on a very large commercial scale have been carried out, peats having been obtained in bulk from Ireland, Sweden, Germany, Italy, and other countries.

To utilise dry peat has never presented difficulties to them, but since peat contains 90 per cent. moisture, and (in spite of more than fifty years' investigations by eminent scientists) as no apparatus has been devised for economically drying it, it was realised years ago that any process, to be really successful, must deal with peat in a comparatively wet state, so that it may be produced during the greater part of the year.

Peat containing 60 to 75 per cent. of water can be utilised by their process, and such peat can be produced by a brief period of air-drying in most countries at all seasons except the depth of winter.

The success which has attended their efforts is obvious from the fact that three large installations are either already in operation or nearly completed: one in England, one in Italy for the Societa per l'Utillazione dei Combustibili Italiani of Pontedera—this plant is to gasify about 100 tons of peat per day; this is a special plant for the recovery of by-products from peat, and to supply gas for a central electricity station,—and a third in Germany for the German Mond Gas and By-Products Co., Mont Cenis; this plant is to gasify 20 tons of peat per day. In the last-mentioned plant large practical trials of peat have been successfully carried out by the officials of the Power-Gas Corporation for the German Government, and on the basis of these trials a large sum of money has been raised, and a company formed to build a central electric distribution station, driven by peat gas produced by the Power-Gas Corporation process.

Briefly, the process consists of gasifying the peat in specially designed producers (built to deal with wet peat) by means of a superheated mixture of air and steam. The gas produced is treated for the recovery of by-products, cooled and purified, and then used in gas engines for the production of power. A portion of the gas produced is used in the process itself for steam raising, etc.

The most valuable by-product is sulphate of ammonia, which has a value of from £11 to £12 per ton, and which costs from £3 to £4 to manufacture.

The yield of sulphate of ammonia depends entirely on the quality of the peat and the amount of nitrogen contained therein, and varies from 70 to 215 lbs. per ton of dry peat gasified (this latter expression is merely used as a standard of computation, the peat, in fact, being utilised in wet condition). So great are the profits obtainable that it is often possible, while taking no credit whatever for the value of the power gas, to obtain as much as 100 per cent. profit from sulphate of ammonia alone, after making proper allowance for the cost of digging the peat, bringing it to the plant, and for labour, stores, capital, shares, etc. Indeed with peats comparatively poor in nitrogen it is possible in many cases to produce the gas for nothing, the cost of power being then merely that of operating the gas engines, together with capital charges on the same.

In addition to sulphate of ammonia, it is possible to recover other by-products such as acetate of soda or lime, acetone, wood spirit, and tar, all of which are valuable products, and in plants of large size fruitful sources of revenue.

The tar produced is of quite a different character to coal tar, but can be separated into paraffin wax, lubricating oils, creosote, diesel oil, pitch, etc., which make its treatment quite profitable.

RESULTS OBTAINED.

Fuel used.	German Peat.	Italian Peat.	English Peat.
Moisture content of fuel	40 to 60%	15%	57·5%
Nitrogen content of fuel	1·0%	1·58%	2·3%
Quantity of gas produced per ton of theoretically dry peat	85,000 c. ft.	60,000 c. ft.	90,000 c. ft.
Heat value of gas produced	150 B.T.U. per c. ft.	166 B.T.U. per c. ft.	134 B.T.U. per c. ft.
Sulphate of ammonia produced per ton theoretically dry peat	70 lbs.	115 lbs.	215 lbs.

The fuel to be gasified is delivered by means of an elevator or other means into a cast-iron charging hopper immediately above the gas producer, and thence into a cylindrical bell within the producer itself. The charging apparatus is operated from a platform fitted above the producer body, whence also the fuel bed may be observed, and, if necessary, stirred. The casing continues down to a water lute at the base, into which the ashes descend. These are removed from time to time without in any way interfering with the continuous working of the producer. The blast is delivered by a Root's blower and distributed through the grate into the mass of incandescent fuel.

Where the circumstances warrant the use of an ammonia recovery plant, the hot gas from the producer is passed first through a tubular recuperator, where it gives up some of its sensible heat to the incoming air and steam; it then enters the mechanical washer, a rectangular chamber in which the gas is brought into intimate contact with water, the water being sprayed up by quickly revolving dashers. In this apparatus the gas is freed from dust and part of its tar, while its temperature is again considerably reduced. The gas is then taken from the mechanical washer through an apparatus in which the ammonia contained in the gas is fixed by weak sulphuric acid, and forms a solution of sulphate of ammonia which is withdrawn periodically, and either sold in the form of liquor for redistillation or converted by evaporation into solid sulphate of ammonia of good quality which finds a ready sale. The gas having now given up its ammonia, is next passed through the gas cooler, where it is subjected to a further cooling and cleansing by means of a finely divided spray of cold water. It is then ready for use in furnaces, but if required for power it is further treated in additional cleaning apparatus.

A special apparatus is provided whereby the bulk of the heat given up in cooling the gas is recovered and returned for the purpose of heating and saturating the air blast required for the producer. This is achieved by continuously employing the water in circulation as the heat-carrying agent between the hot gas in one vessel and the cold air in another. By this arrangement a continuous cyclical exchange of heat takes place, and a large proportion of the steam required for the producer-blast is recovered. This forms a distinctive feature in the economy of the process.

Bituminous fuels vary very considerably in their behaviour in gas producers, but the Mond Producer has a wider application than any other in the case of refractory and highly caking fuels. With a little intelligent observation the conditions required for the gasification of any fuel can be ascertained and established permanently. One of the main factors to be observed is the quantity of steam in the blast, which has a most important effect on the mechanical working of the producer and on the quality of the gas. By the use of a proper quantity of steam the formation of clinker is practically avoided, and the producer is prevented from becoming too hot, while its capacity, in regard to rate of gasification, is greatly increased.

The "Mersey" Patent Semi-bituminous Gas Producer Plant for use with Peat.

This plant, as its name implies, is designed by the Power-Gas Corporation, Ltd., for the purpose of gasifying fuel of a semi-bituminous nature, such as wood, peat, collie coal, brown coal, lignite, etc., and other fuels of a similar character. In many cases these fuels may be obtained at the required site at a very low rate, whereas, owing to distance, the cost of anthracite, coke, or charcoal (the combustibles suitable for the ordinary suction producer) is prohibitive.

Although this gas producer is quite a new type on the market, it is constituted of parts which the above-named company, who control the valuable patents and processes of Dr Ludwig Mond, F.R.S., have used for many years in conjunction with their other highly successful patent plants installed and in operation in all parts of the world.

As will be seen in the illustration, the plant consists substantially of a special generator, stoking valve, vaporiser, washer, or scrubber, combined tar extractor and exhauster, and filter; the arrangement being such that but little space is occupied.

Peat containing 30 to 40 per cent. of moisture has been successfully used in this plant, and the consumption has been 3 lbs. per h.p. hour.

To power users this plant is of especial interest, as it will produce approximately five times the power as when the fuels are burned for direct steam raising, or, in other words, the plant will only consume one-fifth the fuel to produce the same output. Where gas is required for heating purposes, etc., this plant is also worth close consideration on account of great economy and a higher efficiency being shown over the ordinary type of producer.

The outstanding results from this type of producer are:—clean gas, simplicity of working, reliability, freedom from breakdown, highest possible efficiency, with a moderate initial outlay and negligible running costs.

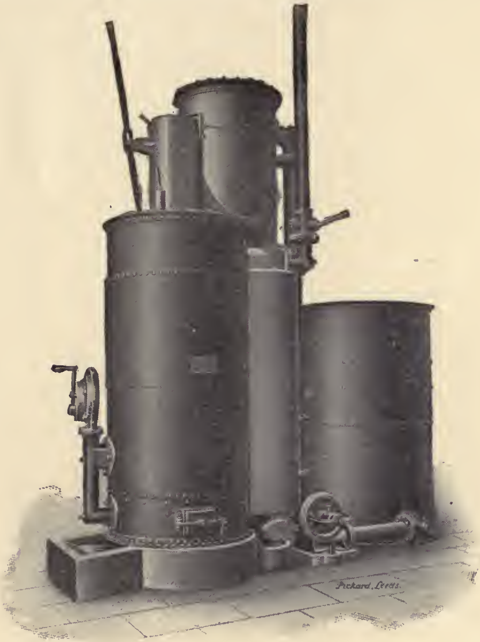

FIG. 58.—The "Mersey" Patent Semi-bituminous Gas Producer Plant for use with Peat.

The construction of this plant necessitates comparatively little in the way of attention. The labour requisite is unskilled, and is required only intermittently on the small and medium sizes. Such portions of the plant as may require cleaning are easily accessible, but to a great extent automatically clean themselves in the working.

The plant is started by means of a hand fan, and good gas can be generated on plants approximately up to 150 h.p. in about ten minutes, assuming that the fire is alight from the previous run.

This gas-producer plant is so designed that it will run continuously day and night without variation in working; and, further, a notable advantage of this type is that, by a patent arrangement, the ash and clinker may be removed whilst gas is being generated and the engine in operation, the quality and making of the gas not being interfered with in the slightest degree.

BIBLIOGRAPHY.

[For further Bibliography refer to pp. 156–160 in *Peat: Its Use and Manufacture.*]

"Alcohol from Peat." Article on Sir William Ramsay's Report, *The Automotor Journal*, 20th July 1907.

"Anleitung zur Durchführung moorstatischer Erhebung," *Zeitschrift für Moorkultur und Torfverwertung*, pt. i. vol. iv. 1906.

Anrep, S. A., see **Nyström, E.**

"'Astor' Vibratory Peat-gas Producer." Illustrated article in *The Practical Engineer*, July 9, 1909.

Bailey, The Rt. Hon. W. F., C.B., Woods, Forests, Turf-bogs, and Foreshores of Ireland. 1880.

Bastian, E. S., and **Davis, C. A.**, "Peat Deposits of Maine," United States Geological Survey, Washington, *Bulletin* No. 376, 1909. Contains Photographs of the most important Peat Bogs, Analyses, Calorific Values, etc.

"Bayerns Moore und ihre Kultur." Fühling's *Landv. Zeitung*, 15th June 1906.

Bersch, Dr Wilhelm, "Die Praxis der Moorkultur," *Zeitschrift für Moorkultur und Torfverwertung*, pt. i. vol. lv , No. 3. 1906.

"Beuerberg Peat Works, Germany." Illustrated descriptive Article in *Engineering*, 15th November 1907.

Björling, P. R., and **F. T. Gissing,** Peat: its Use and Manufacture. London, 1907.

Bowack, Douglas, see **Remington, J. S.**

"Canadian Process of Briquetting Peat," *Bulletin* No. 5. (Issued by the Legislative Assembly of Ontario.) 1903.

Dal, A., "The Utilisation of the Peat Fields of Europe," *American Engineering Magazine*, vol. xxiv. November 1902.

Davis, C. A., see **Bastian, E. S.**

Dixon, B., see **Remington, J. S.**

Ekenberg, Dr Martin, Ph.D., "Fuel from Peat." Researches and experiments with the object of finding a suitable process for converting peat into fuel without air-drying. *Iron and Steel Institute*, May 1909. (This paper was reprinted in *Engineering*, 29th May 1909.)

Ells, Dr, "Notes on the Mineral Fuel Supply of Canada, including Peat." (Paper read before the Royal Society of Canada.) 1907.

Farrer, Reginald, Alpine and Bog Plants. London, 1908.
Felitzen, C. von, Gödslingsförsok utförda of Svenska Mosskulturföreningen, 1880–1886. Göteborg, 1887.
,, ,, *Ibid.*, 1887–1899. Göteborg, 1901.
Frank, Prof. Adolf (Charlottenburg), *Verein zur Förderung der Moorkultur im deutschen Reich*, No. 14. 1905.
,, ,, ,, "Uses of Power generated from the German Peat Moors." (Paper read before the Central Moor Commission.) December 1903.
"Fuel from Peat.—Ekenberg Wet-carbonising Process," *The Practical Engineer*, 11th, 18th, and 25th June, and 2nd July 1909; *Engineering Review*, July 1909.
Gissing, F. T., Commercial Peat: its Uses and Possibilities. London, 1909. See Björling, P. R.
Grist, E., M.A., "Geology of the Thames Valley." (Peat reference. Paper read before the Home Counties Archæological Society. June 1908.)
Grossmann, J., M.A., Ph.D., F.I.C., Ammonia Recovery from Peat: Ammonia and its Compounds. London, 1906.
Haanel, B. F., B.Sc., "Peat and Lignite Fuels. Investigations of Gas Producer Systems" (*Summary Report of the Mines Branch*, 1907–8, Canadian Department of Mines).
"Half-stuff from Peat," *Pulp and Paper Magazine of Canada.* Toronto, May 1908.
Hausding, A., Handbuch der Torfgewinnung und Torfverwertung mit des Berücksicht der erforderlichen Maschinen und Geräte, etc. Berlin, 1904.
"Hop Cultivation on Peat Land at Salzburg, Austria," *Zeitschrift für Moorkultur und Torfverwertung*, vol. iv. No. 1. 1906.
"Illustrated Description of Ekenberg Wet-carbonising Process for Converting Peat into Coal," *The Graphic*, 16th January 1908.
Irish Engineering and Industrial Review. September 1908. Special Number. "Power from Peat." Being a full report of the Parliamentary Proceedings on the Central Ireland Electric Power Bill before the Select Committees of the House of Commons and the House of Lords, giving the evidence of experts as to the power obtainable from peat and its valuable by-products.
"Irish Peat Question," *Forest and Bog Journal*, Dublin. May 1904.
Kilroe, J., Ireland: Industrial and Agricultural. 1902.
Kinahan, G. H., M.R.I.A., Geology of Ireland. 1878.
,, ,, ,, "Irish Soils, including the Peat." (Papers contributed to the *Farmer's Gazette*.) 1902.

Larsson, Alfred, Report to the Swedish Department of Agriculture of Experiments carried out by the Ekenberg Wet-carbonising Process for converting Peat into Fuel. 1905.

,, ,, *Törfbriketter—Teknisk Tidskrift.* 1907.

Larsson, Alfred, and **A. Möllerberg,** Report of Results of Tests of the Ekenberg Wet-carbonising Process for converting Peat into Fuel, made at the Stafsjö Peat Works, Sweden, on the 17th, 18th, and 20th October, and the 2nd November 1905. Granefors, 11th December 1905.

Lewes, Prof. Vivian B., F.I.C., F.C.S., "Sulphate of Ammonia," with reference to Peat. (Paper in *Journal of the Royal Society of Arts.*) 7th August 1908.

,, ,, "Fuel and its Future." (Peat reference. *Cantor Lectures,* Royal Society of Arts, 9th, 16th, 23rd, and 30th March 1908.)

Lewis, F. J., F.L.S., F.C.S., "Sequence of Plant Remains in the British Peat Mosses." (Article in "Science Progress" in the *Twentieth Century.*)

,, ,, "The History of the Scottish Peat Mosses and their Relation to the Glacial Period." (Paper read before Liverpool Geological Association, 4th February 1907.)

,, ,, "The Plant Remains in the Scottish Peat Mosses," *Transactions of the Royal Society of Edinburgh,* xlvi. 2, 8th July 1908.

,, ,, "The Changes in the Vegetation of British Peat Mosses since the Pleistocene Period," *Proceedings of Liverpool Geological Association,* No. 3, New Series. November 1908.

Lomas, J., F.G.S., "Report on a Marine Peat from the Union Dock, Liverpool." (Read before Sec. C, British Association, 6th August 1907; and Liverpool Geological Society, 10th December 1907.)

Lough, Arthur S., "The Manufacture of Peat Fuel in Ireland and How to Improve It," *Journal of Department of Agriculture and Technical Instruction for Ireland,* March 1904.

Lynn, R. J., "Ireland's Fortune in Peat," *World's Work and Play,* July 1905.

Maddocks, W. H., see **Radcliffe, L. G.**

"Making Paper from Peat," *Paper and Pulp.* October 1908.

"Manufacture of Peat Fuel in Ireland and How to Improve It," *Forest and Bog Journal,* Dublin, May 1904.

Massenbach, G. von, Praktische Anleitung zur Rimpauschen Moordammkultur. Berlin, 1904.

Meddelanden fran Kungl. Landtbrukstyrelsen, No. 7. 1904. (Tests of Different Peat Machinery carried out by the Swedish Government in 1903.)

"Method of Reclamation of Peat Land practised at the Swedish Experiment Station at Jönköping," *Journal of Irish Department of Agriculture,* vol. iv., March 1904.

Möllerberg, A., see **Larsson** and **Möllerberg.**

Moore, E. V., A.M.Can. Soc., C.E., "Some Notes on the Development of the Peat Fuel Industry and its Possibilities," *Transactions of Canadian Society of Civil Engineers,* vol. xxii. part 1, Paper No. 261. 1908.

Mosebladet. July 1907. (Calorific Value of Samples of Danish Peat, with its Percentage of Moisture Calories.)

Müntz and **Lainé,** "Notes on Production of Nitrates from Peat" (*Summary Report of Mines Branch*, 1907–8, Canadian Department of Mines).

New Source of Coal Fuel, *The Times,* 18th May 1909. (Dealing with Dr M. Ekenberg's paper on "Fuel from Peat," read before the Iron and Steel Institute on 14th May 1909.)

Nyström, Erik, M.E., Peat and Lignite: their Manufacture and Uses in Europe. Ontario, 1908.

Nyström, E., and **Anrep, S. A.,** "The Investigation of the Peat Bogs and Peat Industry of Canada during the season of 1908–9," *Bulletin,* issued August 1909, by the Mines Branch of the Department of Mines, Ottawa. Comprises twenty-five pages of text, and six large scale maps of peat bogs, descriptive report of each bog, showing location, area, and structure, and giving an estimate of the available supply of peat fuel, with records of analyses, calorific values, etc.

Orwell, Frank, "Converting Peat into Coal," illustrated Article on Dr Martin Ekenberg's Wet-Carbonising Process, *World's Work.* August 1908.

"Paper from Peat," *Pulp and Paper Magazine, Canada.* January 1909.

"Paper from Peat," *Paper-Making* (London), March 1909.

"Paper from Peat," *Paper Trade Journal* (London), 22nd April 1909.

"Peat as Central Station Fuel," *Electrical Review,* 8th January and 12th March 1909.

"Peat Deposits of Maine"; deals with Bastin and Davis's Survey of Peat Deposits in Maine, U.S.A., *The Engineer,* 8th October 1909.

"Peat Exhibits at Vienna Exhibition, 1900," *Nature,* 31st May 1900.

"Peat Fuel," *Forest and Bog Journal,* Dublin, January 1905.

"Peat in Germany," *Cassier's Magazine,* June 1903.

"Peat Harvesting and Utilisation," *Machinery Market,* 14th February 1904.

"Peat Industry in Canada"; deals with Nyström and Anrep's "Investigation of the Peat Bogs and Peat Industry of Canada during the season of 1908–9," *Engineering,* 17th September 1909.

"Peat Industry in Sweden," *Nature*, 18th April 1901.

Peat Industry in Europe (Om bränntorfindustrien i Europa). *Report* by Alfred Larsson and Ernst Wallgren, Swedish Government Commission. 1902.

"Peat in the Falkland Islands," *Bulletin of the Imperial Institute*, vol. v. (1907), No. 3.

Philipp, Herbert, "Peat and the Production of Power," *Proceedings of the New York Section of American Peat Society*: Electro-chemical and Metallurgical Industry. March 1909.

Prospects of an Import from Sweden of Moss Litter, Swedish Chamber of Commerce, London, *Annual Report*. 1907.

Radcliffe, L. G., and **W. H. Maddocks,** "The Constants of Bog-Butter found in Peat in Ireland." (Paper read before Manchester Section of Society of Chemical Industry.) January 1907.

Ramsay, Sir William, "Process for the Production of Alcohol from Peat, Article on Report," *Automotor Journal*, 20th July 1907.

Reeves, A., and **A. S. Lough,** Report to the Department of Agriculture and Technical Instruction on the making of Turf by Machinery and the Reclamation of Bogs at Helenaveen, Holland, and at Jönköping and Ljungby, Sweden, *Departmental Journal*, March 1904.

Remington, J. S., Douglas Bowack, and **Bedford Dixon,** "Peat as a Paper-making Material," *Pulp and Paper Magazine of Canada*. May 1909.

Reid, Mrs E. M., "On a Method of Disintegrating Peat and other Deposits containing Fossil Seeds." (Paper read before the Linnean Society of London, 6th February 1908.)

"Report on Peat Moss Deposits in the Cross Fell, Caithness, and Isle of Man Districts," Section K, British Association. 2nd August 1906.

"Report on Plant Remains in the Peat Deposits of Teesdale and Stainmoor (Cumberland and Westmorland) and the Western portion of Iceland." (Read before Sec. K, British Association, 1st August 1907.)

Richardson, Ralph, Peat as a Substitute for Coal. 1901.

Rigby, T., A.M.I.M.E., F.C.S., "Power Gas Plants, with Special Reference to Use of Peat." (Paper read before Engineering and Scientific Association of Ireland, 26th March 1906.)

Rowan, F. J., "Ammonia Recovery in connection with Gas Producers." (Peat reference. Paper read before the West of Scotland Iron and Steel Institute. January 1908.)

Rudra, Sarat C., "Mineral Resources (including Peat deposits) of British India," *Transactions of American Institute of Mining Engineers*, vol. xxxiv. 1904.

Ryan, Prof. H., M.A., D.Sc., "Report upon the Irish Peat Industries, Part I." *Transactions of the Dublin Royal Society*, 6th July 1908.

Sankey, Capt. H. Riall, R.E., M.I.C.E., "The Utilisation of Peat for making Gas or Charcoal." (Paper read before the British Association, Dublin.) 1908.

Sankey, Lieut.-Gen. Sir R. H., R.E. (retired), "Utilisation of the Peat Bogs of Ireland for the Generation and Distribution of Electrical Energy." (Paper read at the Industrial Conference, Cork Exhibition.) 1902.

Schorr, R., "Peat Fuel Briquetting," *Transactions of American Institute of Mining Engineers*, vol. xxxv. 1905.

Smith, W. G., D.Sc., "Marsh and Bog Plants." (Paper read before Doncaster Scientific Society, 8th April 1908.)

Svenska Mosskulturföreningen Tidskrift. May 1905. (Chemical Composition of the Dry Peat Substance from Bogs in Different Localities.)

Swedish Peat Culture Society's *Journal*, "Areas of Peat Bogs," No. 4. 1902.

Talbot, Frederick A., "Transforming Peat into Coal"; deals with the Ekenberg Wet-carbonising Process, *Chambers's Journal*, August 1909.

,, ,, "Fertiliser from Peat." Illustrated descriptive Article on Woltereck Process for obtaining sulphate of ammonia from Peat, *World's Work*, October 1909.

Tatlow, J. Tissington, "Bog Reclamation and Peat Industries Abroad." (Paper read at the Industrial Conference, Cork Exhibition, 1902.)

,, ,, "The Peat Industry in the Province of Schleswig-Holstein," *Journal of Department of Agriculture and Technical Instruction for Ireland.* June 1902.

Thaulow, J. G., Engineer to the Norwegian Government, Report on Peat Fuel in Europe and America. June 1902.

Thenius, G., Die technische Verwertung des Torfes und seiner Destillations-Produkte, Wien. 1904.

Tolf, Direktor, Bog Cotton Peat, Tidskrift. 1901. Heft. i.

Tomlinson, Thomas, B.A.I., M.I.C.E., M.I.E.E., "Peat Fuel." Paper read before the Institution of Civil Engineers of Ireland. December 1908.

,, ,, "New Source of Peat Fuel." Article dealing with the Ekenberg process of peat utilisation, *Electrical Review*, 28th May 1909.

,, ,, "A Review of the Peat Question: its Position and Prospects," *The Irish Builder and Engineer*, 7th August 1909.

,, ,, "The Ekenberg Wet-carbonising Process for Conversion of Peat into Coal," *The Irish Builder and Engineer*, 15th May 1909.

Travis, W. G., "On Plant Remains in Peat in the Shirdley Hill Sand at Aintree, Liverpool." (Paper read before Liverpool Botanical Society, 11th May 1908.)

Tunzelmann, G. W. de, B.Sc., "The Direct Manufacture of Sulphate of Ammonia from Peat." Article on the Woltereck Process, *The Times* Engineering Supplement, 29th January 1908.

"Turf-making by Machinery," illustrated Description of Experiments in Cavan, Ireland, *Anglo-Celt*, June 1903.

"Utilisation of Peat," *Department of Agriculture and Technical Instruction for Ireland Journal*, vol. viii., August 1900 to May 1901.

"Utilisation of Peat," *Engineering*, 17th May 1907.

"Utilisation of Peat," *The Engineer*, 4th September 1908.

"Utilisation of Peat Land on the Continent," *Board of Agriculture Journal*, vol. xiv. No. 3. June 1907.

Utilisation of Peat Lands, *Board of Agriculture and Fisheries Leaflet*, No. 203. April 1908.

Wallace, Roger W., K.C., "Process for the Production of Alcohol from Peat," *Report of the Fuels Committee of the Motor Union of Great Britain and Ireland*, 1907.

,, ,, "The Alcohol Problem," Articles in *The Car Illustrated*, of 5th, 12th, 19th, and 25th June, 3rd and 10th July 1907, giving Description of a New and Remarkable Process for the Manufacture of Alcohol from Peat.

Wells, J. Walter, Report on Thirty-six Samples of Peat from Different Peat Bogs in Ontario, Belleville, Ontario. 1902.

,, ,, Report on Peat and Peat-Gas from Actual Trials at the Provincial Assay Offices, Belleville, Ontario. 1901–1902.

Woltereck, H. C., Ph.D., Paper on "The Production of Ammonia from Atmospheric Nitrogen by Means of Peat," read before British Association at Dublin, September 1908; and before Royal Dublin Society, December 1908.

Zeitschrift für Moorkultur und Torfverwertung, Wien. 1903.

PATENTS.

[For further List of Patents refer to pp. 161–165 in *Peat: Its Use and Manufacture.*]

Year.	Patent No.	Name.	Address.	Subject of Patent.
1900	4,338	Lennox, A. B. .	Newcastle-on-Tyne	Drying peat and similar material.
	15,849	,, ,,	,, ,,	,, ,,
1901	4,830	Tucker, A. E. .	Birmingham. .	Peat fuel.
		Cory, C. . .	Swansea . .	,, ,,
	7,051	Trainer, Dr E. .	Bochum, Prussia .	Peat briquettes.
	11,519	Jousset, C. . .	London . .	Peat fuel.
		M'Kay, W. R. .	London . .	,, ,,
	20,001	Stöckman, L. .	Göttingen . .	Process for increasing heat value of fuel, including peat.
	20,472	Gaston de Velna .	Paris . . .	Manufacture of peat coke.
	23,904	Blunden, O. G. .	Putney. . .	Peat briquettes.
		Malden, W. J. .	Uckfield . .	,, ,,
		Malden, A. . .	London . .	,, ,,
1902	9,408	Doull, Jas. C. E. .	London . .	Treatment of peat moss for production of fibre for spinning, paper-making, and other purposes.
	16,027	Stoclet, V. . .	Brussels . .	Peat fuel.
	19,067	Lennox, A. B. .	Newcastle-on-Tyne	Lifting bogie for peat drying.
		Higginbottom, A. H.	,, ,,	,, ,,
	20,574	Lennox, A. B. .	Newcastle-on-Tyne	Drying peat.
		Higginbottom, A. H.	,, ,,	,, ,,
	20,670	Köneman, W. A. .	Chicago . .	Peat fuel.
	22,381	Zechmeister, L. .	Munich . .	Process for distilling peat.
	25,785	Heydebrand und der Lasa, F. C.	New York . .	Peat fuel.

Year.	Patent No.	Name.	Address.	Subject of Patent.
		Note.		
1902	6,844	Hülsberg & Co. .	Charlottenburg .	Should read "impregnation of peat," and not "peat wood."
1903	8,287	Brunk, R. . .	Dortmund . .	Distillation of peat.
	10,834	Ekenberg, Dr M. .	Stockholm . .	Improved method of, and apparatus for, heating substances containing liquid or moisture.
	14,014	Cory, C. . .	Swansea . .	Peat briquettes.
	22,272	Laurenius, C. E. .	Göteborg . .	Charing or coking peat.
		Note.		
1903	20,420	Ekenberg, Dr M. .	Stockholm . .	Should read "peat fuel," not "artificial wood."
	21,968	Horing, Dr P., and Mjöen, Dr J. A.		Names should read as now written.
1904	5,170	Higginbottom, A. H., and Lennox, A. B.	Newcastle-on-Tyne	Expressing moisture from peat.
	5,171	,, ,,	,, ,,	,, ,,
	15,351	Lennox, A. B. .	Newcastle-on-Tyne	Drying apparatus for peat.
	16,504	Woltereck, H. C. .	London . .	Production of ammonia from peat.
	19,737	Hülsberg & Co. .	Charlottenburg .	Impregnation of peat.
	27,446	Lennox, A. B. .	Newcastle-on-Tyne	Lifting bogie for peat.
1905	3,154	Woltman, H. H. .	Berkeley, California	Peat briquettes.
	6,780	Leadbeater, J. W..	Leeds . . .	Peat fuel.
	8,187	Aarts, J. G. . .	Dongen, Holland .	Distillation of peat.
	10,866	Grayson, P. . .	London . .	Peat fuel.
	10,927	Augier, A. . .	Paris . . .	Carbonising peat.
	13,914	Connell, J. T. .	Edinburgh . .	Peat fuel.
		Haldane, F. F. .	,,	,, ,,
		Thomson, J. . .	,,	,, ,,
	15,818	Le Maitre, R. A. .	Ixelles, Belgium .	Coking peat.
	19,498	Wood, W. J. .	St Helens . .	Peat fire lighter.
	19,539	Heyden, W. van der	Paris . . .	Peat briquettes.
	21,644	Engle, A. . .	Metz, U.S A. .	Peat fuel.
		Cahill, T. . .	Stuart, U.S.A.	,, ,,
1906	968	Wielandt, W. .	Zwischenahn, Oldenburg	Coking peat.
		Torf Koks Co. .	Berlin.	,, ,,
	1,397	Stauber, E. . .	Königsberg . .	Coking and carbonising peat.

Year	Patent No.	Name.	Address.	Subject of Patent.
1906	5,435	Marriott, T. . .	Kingston-on-Thames	Peat fuel.
	5,503	Oberbayerische Kokswerke und Fabrik Chemischer - Produkte Akt. Ges.	Beuerberg, Bavaria	Coking peat.
	7,357	Vivian, A. W. H. .	London . .	Peat briquettes.
	11,621	Stevens, Jas. .	London . .	Hydro-extractor for the rapid extraction of the water contained in crude peat.
	11,925	American Chemical Eduction Co.	New York . .	Coking peat.
	11,926	,, ,,	,,	,, ,,
	28,576	Buss, J. . .	Munich . .	Peat briquettes.
		Fohr, C. . .	Schloss Wallenburg	,, ,,
	28,963	Woltereck, H. C. .	London . .	Production of ammonia from peat.
	28,964	,, ,,	,,	. ,, ,,
1907	2,226	Verey, J. C. . .	Kilberry, Kildare .	Improvements in or relating to the manufacture of peat blocks or peat fuel, and the apparatus therefor.
		Downes, L. . .	London	
	4,030	Clement, H. M., and National Peat Industries, Ltd.	London . .	Improvements in and relating to method and apparatus for recovering peat fibre from raw peat.
	4,911	Vilar, H. E. L. F. J. S. de	Paris . . .	Peat gas producer.
	5,128	Pradel, G. J. L. .	Aubervilliers, France	Improvements in and relating to treatment of peat.
	5,195	Drawbaugh, D. .	Camphill . .	Peat fuel.
		Gamble, B. E. .	Bowmansdale, Penn., U.S.A.	
	6,620	Booth, A. T. .	London . .	Extracting moisture from peat.
	9,136	Hassmann, A. V.	Elkhart . .	Peat fuel.
		Pinterbaugh, W. F.	Indiana, U.S.A.	,, ,,
	12,087	Black, J.	Newcastle-on-Tyne	Machine for drying peat.
		Lennox, A. H.	,, ,,	,, ,,
		Lennox, H.	,, ,,	,, ,,
		Lennox, A. B.	,, ,,	,, ,,
	13,016	Hemmerling, Josef	Dresden . .	Manufacturing dry peat fibre or peat dust.

Year.	Patent No.	Name.	Address.	Subject of Patent.
1907	24,295	Black, J. . .	Newcastle-on-Tyne	Machine for drying peat.
		Lennox, A. H.	,, ,,	,, ,,
		Lennox, H.	,, ,,	,, ,,
		Lennox, A. B.	,, ,,	,, ,,
1908	1,455	Black, J. . .	Newcastle-on-Tyne	Peat-drying machine.
		Lennox, H.	,, ,,	,, ,,
		Lennox, A. H.	,, ,,	,, ,,
		Lennox, A. B.	,, ,,	,, ,,
	8,779	Dokkenwadel, F. G.	Coshocton, Ohio, U.S.A.	Treatment of peat for use as a fertiliser.
	9,911	Greeley, C. U. .	Bangor, Maine, U.S.A.	Treatment of peat.
	12,087	Black, J. . .	Newcastle-on-Tyne	Apparatus for drying peat.
		Lennox, H.	,, ,,	,, ,,
		Lennox, A. H.	,, ,,	,, ,,
		Lennox, A. B.	,, ,,	,, ,,
	13,425	Hengerer, K. .	Stuttgart . .	Artificial or peat wood.
	13,994	Franz, L. . .	Admont, Styria, Austria	Peat half-stuff.
	14,678	Cowper-Coles, S. O.	London . .	Peat fuel.
	15,646	American Peat Machinery Co.	Portland, Maine, U.S.A.	Disintegrating and compressing peat.
	16,162	Müntz, A. . .	Paris . . .	Nitrates from peat.
		Girard, A. C.	,,	,, ,,
	16,978	Griffin, W. T. .	New Jersey, N.Y.	Drying peat.
		Tucker, B. W. .	New York. . .	,, ,,
	22,033	Zindler, Adolf .	Berlin . . .	Peat briquettes.
	23,392	A. Kesson . .	Lynedoch, Prestwick, Ayr, N.B.	Peat briquettes.
	American 879,888	Nelson, Chas. E. .	Capac, Michigan, U.S.A.	Process of forming paper or board and the like from half-stuff containing peat fibres and the natural gelatinous matter of the peat.

APPLICATIONS FOR PATENTS.

Year.	No. of Application.	Name.	Address.	Subject.
1908				
Jan. 22	907	Suchowaik, V. .	London . .	Peat fuel.
Jan. 24	1,653	Millar, J. . .	Glasgow . .	Improvements in the treatment of peat in order to prepare it for use as a fuel, and for other purposes.
Feb. 26	3,738	Michalowski, C. von	London . .	Process and apparatus for drying and removing moisture from peat and other similar material.
Apr. 25	9,039	Garforth, J. . .	Addingham, Leeds	Baling press for peat.
May 21	11,047	Jabs, A. . .	Zurich . . .	Gas from peat.
Aug. 22	17,692	Booth, A. T. .	London . .	Improved method and means for extracting moisture from peat and fibrous or other material.
Aug. 27	17,978	Crossley, W. J. . Rigby, Thos. .	Manchester . . ,, . .	Improvements in gas producer plants primarily designed for the recovery of ammonia from peat, etc. (See application No. 11,890 of 20th May 1909.)
Sep. 11	19,149	Von Mentzer, G. A.	London . .	Baling press for peat.
Nov. 24	25,299	Bradley, W. H. .	United States .	Improvements in or relating to the handling and treatment of peat and in apparatus therefor.
Dec. 4	26,286	Andreas Hendune .	London .	Improvements in peat compressing machines.
Dec. 22	27,905	Woltereck, H. C., and Sulphate of Ammonia Co., Ltd.	London . .	Improvements in the process of producing ammonia from peat.
Dec. 24	28,179	Marshall, F. D. .	London . .	Improvements in the manufacture of artificial fuel, particularly peat briquettes.
1909				
Jan. 15	1,034	Tirlicien, J. G. . Buronfasse, A. A. .	London . . ,,	Apparatus for the treatment of and moulding of peat and plastic matters.

Year.	No. of Application.	Name.	Address.	Subject.
1909				
Jan. 18	1,247	Zailer, V. . .	London . .	Improvements in peat products for fuel purposes, and process of manufacturing the same.
Jan. 29	2,209	Bull, E. R. . .	London . .	Improvements in or relating to turf cutters.
Feb. 2	2,531	Black, J. . . Lennox, A. H. . Lennox, H. . . Lennox, A. B. .	Newcastle on-Tyne ,, ,, ,, ,, ,, ,,	Improvements in continuous drying machines for drying peat.
Feb. 25	4,701	Schlicht, P. . .	London . .	Improvements in or relating to processes for use in de-hydrating peat and the like, and in apparatus therefor.
Mar. 3	5,157	Crossley, K. I. . Rigby, T. . .	Openshaw . . Manchester . .	Improvements in apparatus combined with gas engines for the treatment of fuels (peat) containing excessive quantities of moisture.
Mar. 30	7,572	Clarkson, P. . Behrmann, E. .	Glasgow . . ,,	Process for the manufacture of briquettes from peat bog, and apparatus connected therewith.
Apr. 8	8,540	Bradley, W. H. .	Maine, U.S.A. .	Improvements in or relating to peat preparing and excavating apparatus.
Apr. 8	8,541	Bradley, W. H. .	Maine, U.S.A. .	Peat drying apparatus.
Apr. 15	8,901	Epstein, G. J. .	London . .	Improvements in or relating to the treatment of vegetation (peat), and arrangements therefor.
Apr. 23	9,691	Lynn, A. H. .	Bromley, Kent .	Improved process for dehydrating peat.
Apr. 27	9,934	Epstein, G. J. .	London . .	Improvements in or relating to the treatment or utilisation of peat or the like, and arrangements therefor.
Apr. 27	9,968	Beck, O. P. . .	London . .	Improvements in apparatus for making half-stuff from peat, turf, or other fibrous material.
May 18	11,657	Henslow, T. G. W.	Chippenham .	Turf-cutting gauge.

Year.	No. of Application.	Name.	Address.	Subject.
1909 May 20	11,890	Crossley, W. J. . Rigby, Thos. .	Manchester . . ,,	Improvements in gas producer plants primarily designed for the recovery of ammonia from peat, etc. (Supplementary to application No. 17,978, 27th August 1908.)
May 21	12,010	Ekenberg, M. .	London . .	Improvements relating to the briquetting of carbonised peat and the like.
May 26	12,464	Lennox, A. B. .	Newcastle-on-Tyne	Improved machine for moulding or pressing peat and the like into blocks.
May 26	12,465	Lennox, A. B. .	Newcastle-on-Tyne	Improved machine or apparatus for drying peat briquettes.
July 22	17,074	Lynn, A. H. .	London . .	Production of gas and ammonia from peat.
July 22	17,139	Roux, H. M. .	London . .	Process for converting peat into charcoal.
July 28	17,570	Crombie, W. A. E.	London . .	Distillation of peat.
July 31	17,855	Egoroff, P. . . Remmer, A. . .	London . ,, . .	Peat half-stuff. ,, ,,
Aug. 13	18,652	Crombie, W. A. E.	London . .	Treatment of peat fuel and collection of by-products.
Aug. 23	19,395	Zohrab, E. F. S. . Massey, J. D. .	London . . ,, . .	Treatment of peat. ,, ,,
Aug. 31	19,959	Koppers, H. . .	London . .	Process for obtaining by-products in the dry distillation or gasification of fuel, including peat.
Sep. 11	20,784	Howard, H. M. . Bradbury, J. E. A.	Derby . . . ,, . . .	Baling press for peat. ,, ,,
Sep. 16	21,158	Wielandt, W. .	London . .	Excavating and dredging machines for peat.
Sep. 24	21,768	Zohrab, E. F. S. . Evans, T. H. .	Glasgow . . ,, . .	Smelting ores in conjunction with lignite or densified peat and the charcoal obtained therefrom.

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