VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

TELEGRAPHS AND APPARATUS.

BY

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CHAPTER I.

INSTRUMENTS AND SYSTEMS.

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1. RELAYS.—The original relay of Professor Morse was wound with No. 14 copper wire, covered with cotton, and weighed one hundred and eighty pounds. The magnetic effect of this construction, owing to the comparatively few convolutions obtainable with such coarse wire, was very feeble. The French, however, shortly effected a considerable improvement in the construction of the relay by employing a smaller core and winding the same with a fine wire covered with silk. The cores of most of the instruments used in Europe at the present time are about four inches in length and of less than three-eighths of an inch in diameter, and are wound with a fine silk-covered wire, affording a sufficient number of layers or convolutions to give to the spool a diameter of one and one-eighth inches. The spools of the relay are longer, and smaller in diameter, than is the case with the form of this instrument generally in use in the United States.

The advantages derived from the use of cores of such construction may be briefly stated to be as follows:

First. Greater attractive force as a magnet is obtained.

Second. A greater number of convolutions are obtained in proximity to the core.

Third. The winding of the spool, not being attended by any considerable increment to its diameter or thickness, the outer convolutions add less resistance; and as a necessary consequence of the second specification, being nearer to the core, they give greater magnetic effect.

Fourth. Such relays have much lighter armatures than the American.

Fifth. As the result of this difference in construction, the relay is worked by a much less battery-power.

2. It is probable that the firm of Siemens Bros., London, and of Siemens & Halske, Berlin, make by far the greater number of the relays in use in Europe. It has for years been the custom of these makers to mark on the end of the spool of each of their instruments, the resistance of the spool in Siemens units, as also the number of convolutions of silk-covered wire which each contains. The number of convolutions being the measure of the magnetic effect, the intelligent telegrapher is thus

readily enabled to select the relay that is best adapted to the circuit in which it is to be used. For short lines, or for lines having many relays in circuit, instruments with coarser wire and fewer convolutions are the best adapted; for long circuits the finer-wire relays are more suitable.

It is the prevailing opinion among instrument-makers, and many others in the United States, that relays with cores of considerable length do not charge and discharge as rapidly as smaller ones, an opinion which is probably well based. In the sense that a large core is not charged or discharged as soon as a small one, it is true; but the instrument of the size and length to which reference has been made, can be charged and discharged automatically with such rapidity as to produce the Morse characters and writing at a rate of speed fully three times as great as that attainable by the most expert operator—a fact which offers a sufficient answer to the objection above expressed; while the form of the relay is a marked improvement over the relays in use in this country.

3. Siemens' Polarized Relay.—This form of the instrument is an improvement over the ordinary form in working long circuits, inasmuch as it is more sensitive and requires less battery-power. It is operated automatically on the line from London to Teheran, a distance of three thousand eight hundred miles, at a speed asserted to be as much as twice that of the ordinary Morse. In this circuit there are three and sometimes five repeaters. The writer observed that relays of this construction were in use on the longer circuits in all the countries of continental Europe which he had the opportunity of visiting, and the opinion there is universal that they are superior to the ordinary relay. It is worthy of remark that no instruments of this construction are in use in the United States.

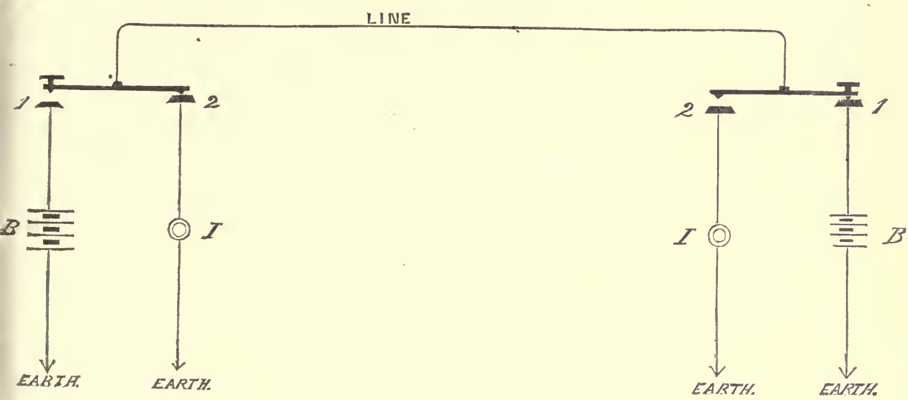
4. Method of connecting up the Morse circuit.—The original method of connecting up the circuit, which was adopted by Professor Morse, and never changed or modified in the United States, was from ground to battery, battery to key, key to relay, relay to line, line to relay, relay to key, key to battery, and battery to ground. These connections form a line of two stations, one at each terminal. The intermediate stations were formed by placing a key and relay in the line. The Germans soon improved upon this method by employing keys made with two insulated anvils, and making the connection thus. Fig. 1, page 7, will suffice to explain the operation of this system.

When the keys are open, they rest upon the back anvil, 2; closing a key sends a current to line and key of the other station, which rests upon the back anvil and sends a current to instrument I. Should one station wish to stop or "break" the other, it is only necessary for the operator to close his key and send a current into the instrument of the other station. The advantages of this method of connection are obviously as follows:

First. The relay is not affected by escape, and requires less adjusting

Second. Operators, while sending messages on a line affected by escape, are frequently governed by the slow response of their instruments to the manipulations of their respective keys, and are apt to imagine that, because their own local does not respond quickly, the instrument at the other terminal is similarly affected in its working. Laboring under this impression, they make dots of too great a length, and their characters at the receiving-station are not sufficiently spaced, and in other respects are badly formed. Lines affected by an escape are much more easily operated with this than with the American method, while on lines not affected by an escape this system has no advantages; moreover, it necessitates the presence of a battery at each sending-station.

FIG. 1.



5. THE MORSE REGISTER.—The original Morse register is now entirely superseded in Europe by the ink-writer. The original apparatus has long been felt to be defective in the following particulars:

First. It required a considerable weight to move the train.

Second. Inequalities in the thickness of the paper, or other causes, are apt to occasion the paper to stop between the rollers, thus producing imperfect characters or omitting them altogether.

Third. The characters of the Morse are only legible when held between the person and the light, or in such a position as to bring a shadow of the impression in view to the eye.

Fourth. The character is very easily erased or obliterated, and, hence, poorly adapted for preservation as a record or proof of correct or incorrect transmission.

6. The defects here enumerated as inherent in the Morse register are completely obviated in the ink-writer as manufactured by Siemens Bros., Digney, and others. The train is moved by a spring of slight tension; the speed of the instrument is uniform, and its operations noiseless; the paper ribbon is but about one-third the width of that used in the embossing-apparatus, and the material itself of lighter body, in consequence of which a roll occupies a comparatively small space, usually

in a drawer beneath the instrument; the characters being in ink are consequently as legible to the operator as printed matter; the strip is preserved to serve as evidence to determine disputed questions concerning correct transmission or reading, and an error is thus easily traced to the operator committing it, and not permitted to rest between two, one of whom is innocent. The cost of this instrument is about double that of the original Morse.

The defects of the American Morse register led to its gradual disuse, and the adoption of the sounder. The register made sufficient tick to be audible, and the operator while using the register soon became so familiar with the ticking as to be able to read the dispatches by ear. Within two or three years after the telegraph was fairly in operation in this country, there were operators who read entirely by sound, but the sound was that of the ordinary register. It was not until some years afterward—about the year 1858—that sounders were made, instruments constructed upon the same principle as the register, with the clock-work and paper omitted. The advantage afforded by the ability to read by sound resides in the fact that the operator is not obliged to direct his eye from his pen while copying the dispatches, a case precisely analogous to that of a person taking a copy with the words read or spoken to him, instead of being obliged to read them for himself.

If the operator is a rapid penman he can even direct his eye from his pen at times and keep pace with the writing of the characters as they are made by the transmitting-operator at the other terminal. This is the more easily done where the characters are in ink, as made by the Morse ink-writer. In Europe, indeed, operators frequently read by sound, but the copy, as printed by the ink-writer, is preserved for reasons before stated. As the magnetic force required to work the pen of the ink-writer is small compared with that required to emboss, it permits of the ink-writer being worked in the direct circuit of the line, and to that end the core of the magnet is wound with fine wire, giving the helices a resistance of five hundred units, or less, according to the length and resistance of the line. This arrangement dispenses with the local battery.

The chief and obvious advantage of the ink-writer over the American sounder consists in the ease of learning to read the printed characters, as compared with the difficulty of learning to read by sound. The printed characters are legible to a beginner as soon as the alphabet is known, a task which a person of average intelligence may accomplish in a day; while to learn to read by the sounder necessitates a familiarity with the tick which cannot be acquired save by the practice of a year. Good sound-operators are expensive; that is they command salaries twice as high as operators who read the printed characters equally well and are otherwise equally qualified.

Another objection may with good cause be urged against the sounder, as employed in this country. It is usually placed in public places, such as hotels, commercial exchanges, railroad-stations, and the like, where the click can best be heard by the public and attract attention. This public situation places it within the power of evil-disposed persons to make improper use of information which they may readily acquire. Operators, for example, who are out of employ, or who are in the employ of rival companies, or who have left the service, can, without difficulty, from the sound of the instrument, read the contents of dispatches and make use of such information to serve their own purposes. There is every reason to believe that this is often systematically practiced. The substitution of ink-writers for the sounders would obviously overcome this grave objection.

7. THE HUGHES PRINTER.—This apparatus is an American invention, and was first brought out in the United States some fifteen years ago. Subsequently the inventor took up his residence in Paris, where, with the assistance of the Digney Frères, his instrument was much improved. They are now manufactured by this celebrated Paris firm, as well as by Siemens Brothers, of London, and Siemens & Halske, of Berlin.

The clock-work of the instrument is driven by a weight, which is wound with the aid of a treadle; in order that the train shall be kept in motion, it is simply necessary that the operator should press the treadle with the foot as often as once in two or three minutes. For the transmission of business between large cities, or commercial centers, requiring the exclusive use of one or more wires, this instrument has great advantages, to wit:

First. The speed of transmission is fully, or even more than, double that of the Morse system, a statement based upon the experience of the telegraph-chiefs at Berlin, Brussels, Vienna, Berne, and Paris. The efficiency of the instrument is therefore vastly greater than that of the Morse, since two operators with one wire can perform as much service, or more, than four operators with two wires worked by the Morse system.

Second. There is less liability of the occurrence of errors in transmitting dispatches, since they can only arise from an incorrect reading of the manuscript of the original, while, with the Morse system, by far the greater number of errors arise from incorrectly interpreting the Morse characters, whether by the sounder or the register; and

Third. The dispatches are delivered in plain Roman characters.

As an indication that its merits are duly appreciated, it is only necessary to state that by far the larger portion of the telegraphic business of Germany, Belgium, France, and Switzerland is performed by this instrument.

BELGIAN TELEGRAPHS.

8. BATTERIES.—The batteries employed in Belgium are the Marie-Davy, the Leclanché, (a modified Bunsen,) and the Minotto. This last is the Callaud, with a layer of sand about four inches in depth resting upon the sulphate of copper; the zinc plate rests upon the sand. Of

these several elements, the Leclanché is preferred on account of its economy, for which and other reasons it is believed this form will ultimately supersede all others.

From five to six lines are worked from one battery or set of elements. The wires worked from one battery are those having, as nearly as possible, equal resistances.

9. INSTRUMENTS.—The instruments employed are the Hughes printer and the Morse ink-writer. In the Brussels office there are in use eighty Morse, and fifteen Hughes instruments. The cost of the Hughes instrument is about 1,700 francs; that of the Morse 600 francs. The capacity of the Hughes is stated to be fully double that of the Morse.

10. POSTS.—The kinds of timber employed for posts are the pine, the fir, and the larch. The latter is the most durable, but is expensive. The posts are all injected with sulphate of copper, as a preservative material, by the Boucherie process, which is claimed to afford excellent results. Posts treated by this process, and set in 1850, are still in good condition.

The posts are planted ninety meters distant from each other, and average, therefore, about eighteen to the mile. The same number of posts are employed for a line of one or two wires as for a greater number, though in the latter case higher poles are used. Usually, a set of poles carries from eight to twelve wires. All the poles stationed upon angles or curves are guyed or braced. Those standing in the straight line have a slack guy attached to the post and fastened in the ground, on the side opposite to the track of the railway, in order that in case of accident the poles may not fall across the track and endanger the trains.

11. INSULATORS.—The insulators employed are of porcelain, attached to the post by means of an iron strap, which encircles the insulator, the strap in turn being fastened securely to the post by screw-bolts. There are two sizes of this insulator in use. One of large dimensions for the heavy wire, and the other of smaller size for the lighter wires. The wire is suspended in an iron hook. In the larger insulator, this hook is covered with hard rubber; with both sizes, the strap, screw-bolts, and hook are galvanized. The cost of the large insulator is two francs and seventeen centimes each, that of the smaller size sixty-five centimes.

12. WIRE CONDUCTORS.—There are three sizes of wire employed. For the shorter circuits, which embrace all those not extending beyond the limits of the kingdom, a wire of three millimeters diameter is in use. This wire will weigh about two hundred pounds per English mile, and corresponds very nearly in size to our No. 11. The four-millimeter wire corresponds in size to our No. 8, and is employed for the circuits extending beyond the kingdom. An exception must, however, be made in the case of the longest of these extra Belgian circuits, such as those leading to Paris and Berlin, and designated by the term "international," upon which a wire of five millimeters is used. This

international wire will weigh about five hundred and fifty pounds to the (English) mile, and corresponds very nearly to our No. 6. This wire is manufactured in Belgium, and its quality is most excellent.

13. UNDERGROUND LINES.—In the streets of the large cities, Brussels and Antwerp, no posts are to be seen. Usually seven copper conductors, insulated by gutta-percha and protected by an outer shield of iron wire, are employed. These seven conductors, with their insulated coverings and iron shields, constitute a cable. Two or more of the cables are laid in a brick trough, and the space about them filled out with sand. The wires laid in this manner have remained in perfect preservation, and the plan has proven itself to be eminently practical, involving neither trouble nor expense on the score of deterioration. Any one who is in the least familiar with American telegraphs, cannot fail to be most favorably impressed with the greater strength and permanence manifest in the construction of the Belgian lines, and with the evidences of the skill employed and expense incurred to make them reliable and serviceable. As an indication of the great extent to which the telegraph is used, it will suffice to mention that in the city of Antwerp there were sent and received during the month of April last no less than 44,752 dispatches, representing an amount of business which in this country would be considered very large for any city of twice its size.

The comparison becomes more instructive when it is remembered that the kingdom of Belgium occupies but a small territory, and that by far the greater number of the dispatches are sent for distances so short as to be readily attainable by the mail in a few hours. There is, consequently, less saving of time—that is, less necessity for employing the telegraph as a means of communication—than in a country like ours, where persons are necessitated to hold communication with each other over spaces far more widely separated.

14. AUTOMATIC TELEGRAPH.—During the past six years much attention and inventive skill have been directed, both in Europe and in the United States, to the improvement of processes for telegraphic transmission, the object of these endeavors being to do automatically what has hitherto been done by hand. In all, or nearly all, of these improved processes, perforated paper is substituted as a means of transmission, in place of a Morse key. By any of these improved methods the transmitting capacity of the line is augmented at least threefold, in the same length of time, over that of the ordinary Morse, though it is but fair to state that their employment affords no economy in the number of operators required, the gain in this particular residing in the employment of a lesser number of wires. The same number of words may be transmitted upon one wire as may ordinarily be sent upon three; but to do the work automatically requires the same number of employés upon one wire as upon three wires employing the Morse key.

15. Siemens Brothers exhibited at Vienna their automatic system, consisting of a perforator, a transmitter, and a recorder. In the work of

transmission there are employed two batteries with alternating currents, adapted to the use of their polarized relay. In working at a rapid rate, very sensitive and quick-working recording-instruments are necessary, a requirement which these polarized relays and recorders are especially adapted to meet. The method of alternating currents is a device for either obviating or reducing difficulties due to induction, which always manifest themselves where the attempt is made to operate lines of great length at high speed. The system of Siemens Brothers appears to meet entirely, or at least to a great degree, all the requirements of practice.

16. A noticeable feature in the Prussian department is the system or invention of Gustav Jaite, of Berlin. Connected with all these methods of automatic transmission is the perforator, upon the design of which much skill and ingenuity have been bestowed. The perforator of Jaite is compact in form and portable, and can be operated at great speed, the strips of paper being moved by clock-work. The holes are punched by electro-magnets operated by two keys. By pressing one key, dots will be made so long as it is held down; while by pressing both keys, dashes will be made so long as the pressure is continued. As the paper strip is moved along at a fixed rate of speed, these dots and dashes will appear at regular intervals. It is by pressing these keys in conjunction, or the dot-making key separately, that the letters or characters are formed. This machine appears to possess great advantages, and in practiced hands will doubtless execute a large amount of work.

17. The system of Wheatstone is used to a considerable extent in England in the transmission of dispatches for the press. A paper once perforated answers the purpose of transmitting the same dispatch in any direction. The perforations are made in the London station by means of compressed air. It is really surprising to observe the skill displayed and the speed attained by the operators working these machines.

None of the European automatic processes, however, approach in speed of transmission that of the American system of Little, the record or characters of which are made by the current itself, on chemically prepared paper.

Of the relative advantages or disadvantages of the several processes here enumerated, it would be difficult to venture any opinion, further than that it would be both wise and economical to adopt any of them, rather than to increase the number of wires that already exist between large commercial centers.

18. DOUBLE TRANSMISSION is practiced to a considerable extent in the United States, and to a less extent in England. Theoretically considered, the doubling of the number of operators should also double the amount of work to be obtained upon a wire, as compared with its operation by the ordinary method of transmission; but this result is seldom attained in practice. But even under the supposition that the theoretical limits of

this method of transmission were attained in the practice of the United States, or of England, the performance would no more than equal that reached on the Continent upon one wire by the employment of the Hughes instrument with half the number of operators.

These comments, however, must not be interpreted as applying to the system of double transmission in general, inasmuch as it can be introduced to augment or multiply the transmitting capacity of the Hughes, as well as that of the Morse.

CHAPTER II.

CONSTRUCTION OF LINES AND ADMINISTRATION.

WIRE CONDUCTORS IN EUROPE; BATTERIES; MEASURES OF RESISTANCE; MORSE'S ALPHABET; PRESERVATION OF TIMBER; LINE-CONSTRUCTION; INSULATORS; UNDERGROUND-WIRES; PNEUMATIC TUBES; MONOPOLY OF THE TELEGRAPH; COST OF LINES; BRANCH-LINES; RATES; SYSTEM DESIRABLE.

19. WIRE CONDUCTORS.—The wires employed in Europe for the long circuits, called the "international circuits," and working generally direc from capital to capital, forming thus the transcontinental lines, are of five millimeters diameter. The material of this wire would weigh about five hundred and forty pounds per English mile. On the main routes of travel, more than half of all the wires seen are of this larger size. By agreement between the nationalities, effected some years since, this size of wire was adopted as the "international." For the less important circuits, wire of four millimeters diameter is employed, the weight of which per mile is about three hundred and twenty pounds, a size corresponding very nearly to the American No. 9.

For the branch-lines, that is for the lines leading from the main routes to the towns and villages not situated in the path of railways, there is employed in France, Belgium, and Switzerland a wire of three millimeters. Its weight is about two hundred pounds per English mile. In Germany, there is employed for similar purposes a wire of two and a half millimeters diameter, weighing about one hundred and forty pounds. This smaller size is also used for running in wires to stations, for crossings of the railway-track, &c., uses for which it is specially adapted, being so light that it can be pulled very taut, and the slack taken up without material strain upon the posts. If caught by passing trains the consequences are not so serious as when wires of greater strength are employed.

An erroneous opinion is prevalent among telegraph people in our country that a small wire cannot be used for such purposes without materially diminishing the conductivity of the circuit. It does so, however, only in proportion as it reduces the weight of the wire of that circuit, which forms a portion of the resistance. In a line, for example, of two hundred miles, if all the crossings and running-in wires were of No. 13 wire, the loss in conductivity on that account would be so small as to be practically inappreciable. The smaller wire, again, is more easily spliced and manipulated.

The English practice is to use upon the longer and important circuits a wire of No. 4 gauge, the weight of which, per mile, is about eight hundred pounds; in some instances, however, No. 3 is used, the weight of which is about nine hundred and forty pounds.

20. GALVANIZED WIRE.—It is the opinion of Dr. Militzer, technical counselor of the Austrian telegraphs, that it is inexpedient to galvanize wires; and that the advantages to be derived, as compared with its disadvantages, do not compensate for the increase in cost. In Austria a wire of very superior quality is used, which is made from Styrian iron. In undergoing the process of galvanizing it loses, as does all wire, both in strength and pliability, while its cost is increased about 50 per cent. At a cost no greater than that of the galvanized wire, a wire half again as large, and, consequently, of 50 per cent. greater conductivity, an ungalvanized wire may be used ; or, to put it differently, three ungalvanized wires cost no more than two galvanized wires of equal size. The wires are drawn in long lengths, and the joints are carefully soldered. If the quality of the wire is superior, and it is well annealed, especially when the larger sizes are considered, it is questionable whether the several advantages of greater durability, improved appearance, &c., possessed by the galvanized wire, compensate fully for the increased expense of its manufacture. At all events, the opinion of so eminent an authority as Dr. Militzer is worthy of careful consideration. Austria, finally, is the only country, according to my observation, in which plain or ungalvanized wires were employed. By way of comparison, it may be as well to state that more than half of all the wire used in America is of No. 9 gauge, the weight of which is three hundred and twenty pounds per English mile; a portion of the balance is No. 8, weight, three hundred and eighty pounds per mile; perhaps 3 per cent. is No. 6, weight, about five hundred and forty pounds per mile; and some No. 10, weight, about two hundred and seventy pounds per mile.

21. GALVANIC BATTERIES.—The Prussian government exhibits at Vienna the Callaud elements, of a pattern very similar to those generally in use in this country. The French exhibit the same. The Callaud, as incidentally remarked, is a modified form of the Daniell. The Austrian government employs another form, known as the Meidinger. The French, likewise, employed at one time the sulphate of mercury element, known as the Marie-Davy, and the peroxide of manganese element, or the Leclanché; but neither of these exclusively.

In one form or another the Daniell element has been employed for telegraphic purposes in all European countries, from the introduction of telegraphy to the present. The several forms in question are the Minotto, in which a layer of sand, about four inches in depth, rests upon the sulphate of copper; the Meidinger and the Callaud, in which the separation of the two solutions is effected by their difference in density, and the Daniell proper, in which the two solutions are separated by a porous cup. For telegraphic purposes the form of battery at present most generally employed is the Callaud, which has been adopted to the exclusion of all others by the governments of Prussia and France.

22. The battery used on the experimental line of Professor Morse, between Baltimore and Washington, was the Grove, which has been used almost exclusively by American Telegraph Companies up to this date. The electro-motive force of the Grove is about twice that of the Daniell, while its resistance is not more than half that of the latter. These properties combined produced an effect, when the Grove element was used for a sounder or Morse register, of manifesting roughly about four times the strength of the Daniell. Had the instruments, in the first place, been adapted to the Daniell, by winding the magnets with a smaller-sized wire, the strength of the Grove would then have shown itself to be approximately only about double that of the Daniell. But while the strength of the latter element is but one-half that of the former, it is found to be ample for all the needs of practice. The cost of the Grove is about double that of the Daniell; that is, one cell of the former will cost as much as two of the latter element; while to obtain the same electro-motive force the expense, which would involve the use of two cups of the one form for one of the other, would be about equal.

The advantages of the Daniell element are:

First. Very decided on the score of economical maintenance; inasmuch as, compared with the Grove, the maintenance of the Daniell, including both labor and materials, does not involve one-fourth the expense of the former.

Second. The Daniell possesses an advantage on the score of constancy. After the Grove is set the strength of the battery runs down very rapidly, so that as a consequence every instrument in the circuit requires adjusting to the diminished force of the current, say as often as once per hour.

Third. There are no disagreeable or unhealthy fumes evolved from the Daniell, a condition unavoidable with the employment of nitric acid in the Grove. Within the experience of the writer four battery-keepers have died in the city of Philadelphia of lung disease, contracted in all probability from this cause.

The improvement effected in the Daniell cell by dispensing with the porous cup is a most advantageous feature, seeing that it accomplishes the more perfect separation of the liquids, and reduces the consumption of material to a minimum. It is an unavoidable feature in all batteries that only a portion of their material is utilized. A Grove when set without closing the circuit soon exhausts itself by local action. The Daniell continues to operate until a complete intermixture has taken place between the several solutions, which shortly takes place through the porous cup, when its action, so far as the instruments are concerned, ceases. Local action then ensues, and the consumption of zinc goes on at a greater rate than before.

23. For an equal amount of work performed, it is probable that not one-

quarter as much zinc is consumed in the Callaud as in the Daniell cell, a difference which is to be ascribed solely to the more perfect separation of the solution in the former. It is true that the internal resistance of the Callaud is greater than that of the Daniell, but this objection is overcome by an improvement known as Lockwood's; a device which consists in permitting a portion of the copper-plate in the form of a spiral wire, to extend upward into the zinc solution. When this spiral is brought to within an inch of the zinc plate, the resistance is reduced to an average of one unit per cell. By reducing the resistance to this point, it permits of many wires being worked from one battery, and the experience of operators has shown that the more such a battery is worked the less will be the tendency of the sulphate of copper solution to rise and become mixed with that of the zinc. It must be premised that the presence of the copper spiral as above indicated, does not in the least detract from the strength of the battery.

Another noteworthy improvement of the Callaud is the device of covering the surface of the liquid with paraffine oil to prevent its evaporation, a function which is performed most effectually. It also serves to prevent the formation of crystals of the zinc-salt from occurring on the surface, and in addition it completely insulates the battery. It has been objected to the use of paraffine oil that it adheres to the zinc when taken out for cleansing or renewal, as well as to the blue-stone, when this is dropped in to replenish the battery. These difficulties are, however, very simply overcome. If the zinc is not permitted to dry, but is immediately rinsed on being removed from the cell, or if the blue-stone is simply wetted with water before being dropped through the oil, no oil will adhere to their surfaces.

This form of battery is peculiarly adapted to the American system of closed circuits, and had it been adopted in the United States when first it came into use in Europe, not only would it have resulted in the saving of hundreds of thousands of dollars, but also in the avoidance of many inconveniences, and the production of much better effects.

24. Measures of resistance.—Breguet, of Paris, exhibits a set of resistances adapted to the French system of measurement, and having the mercury unit as a basis. Ten of these units are equal to one mercury unit; Digney, of Paris, exhibits the same in portable form, as they are employed by the French and Swiss governments in the telegraph service.

The Prussian department has resistance coils representing from one to ten thousand of the mercury units, as manufactured by Siemens & Halske, of Berlin. Siemens Brothers, of London, exhibit the same. There are in use at present two systems of resistance measures, to wit: the British Association, or absolute unit, and the mercury unit, which represents a prism of mercury of one millimeter in cross-section and one meter in length. The B. A. unit represents the resistance through which a unit of work is performed, in a unit of time, by a unit of electromotive force. To establish the exact value of this resistance is a difficult matter, and a subject upon which experts differ from each other; and resistance coils, having this resistance as its representative, or basis, differ very materially from each other. In view of these difficulties, the mercury unit was adopted as the standard of electrical measurement by representatives of the several European governments assembled at Vienna in the year 1868, which decision was affirmed at a similar convention held in Rome about a year ago.

25. THE MORSE ALPHABET.—The alphabet as used in America was, in the early history of the telegraph, improved materially by the Germans. These improvements consisted in doing away with the spaced letters, or those letters formed of dots with unequal spaces between them; and in introducing other changes whereby the characters were made more easily legible, and the liabilities of error in reading were reduced. The original characters of Professor Morse, not used in the European alphabet, are the C, O, R, Y, Z, and the character &.

The changes introduced by the Germans were so manifestly improvements upon the original, that they were soon adopted by all the other countries of Europe, and this modified alphabet is now in universal use except in North America.

About the year 1847, when the telegraph reached Saint Louis, and before railroads had extended into the Western States, an election for United States Senator was held in the State of Missouri. The name of the successful candidate was telegraphed and published in all the Eastern papers as Grier; his real name, however, was Geyer. The names Grier and Geyer appear to be very similar when written in the American Morse characters, inasmuch as there are the same number of dots and dashes and spaces in each, the variation consisting simply in the length of these spaces, and that of very slight degree. When written in the European Morse alphabet, these names have so little resemblance that the reading of the one for the other, by an operator, would be an inexcusable blunder.

In the American alphabet, again, the characters T and L are each a dash, differing only in length, the consequence of which is the frequent mistaking of the one for the other. In the European alphabet they bear no resemblance. It is fair to presume that the errors growing out of the misinterpretation of these characters more than equal those from all other causes combined.

Professor Morse advocated, many years since, the adoption, in this country, of the changes made by the Germans. It can be effected in a day precisely as it was accomplished in Europe. England was the last country to adopt the change, which was effected by the mutual agreement and concerted action of the three telegraph companies at that time controlling the business.

26. PRESERVATION OF TIMBER.—In the mountainous districts of France, Germany, and Switzerland there flourishes a species of evergreen or fir, a tree very straight in its growth, and otherwise well adapted to serve for telegraph-posts, with the one drawback, however, that it decays

very rapidly. This difficulty, however, has been measurably overcome by the preservative process of Boucherie, which consists in injecting the wood with a solution of sulphate of copper. When prepared according to this process, this timber used for telegraph-posts is made to last from fifteen to twenty years. The posts are subjected to this process in the forest directly after cutting and while yet full of sap; the expense of thus treating them varying usually from one to one and a half dollars per post. In many regions of the United States there is a wood of very similar character to that above named, which is known as hemlock or spruce, and which, on account of its perishable nature, has very little value as a timber. It is probable that this species may be found serviceable at some future time, if prepared for such use by Bouchereizing. The wood is more readily and more perfectly protected in proportion as it is porous and rich in sap. After undergoing the preservative process the timber is permitted to season, which proceeds very quickly, when it becomes very light and portable, an advantage, inasmuch as the posts are handled and transported with greater ease. By far the greater number, if not all the posts of the French, German, and Belgian telegraph service are now subjected to this preservative process. There is no timber in those countries which is naturally as durable as the American chestnut, which is quite abundant throughout the Middle and New England States, or as the white cedar of the Northwest. At the present time it is probable that the use of these timbers in their natural state would be more economical than resorting to the process of Boucherie.

27. Modern line construction.—The number of posts per mile usually employed in this country is double the number used in Europe. The greatest number used in England is twenty for ten or more wires. In France it is about sixteen; yet their lines are very substantially built.

If a No. 8 wire is stretched one span at a time, and pulled up to the full strength of two men, and the poles are thirty or more to the mile, such lines will be so tight as to break from contraction in cold weather, provided the line has been strung during the warmer months. On curves and angles this contraction forces the posts out of line; but if the posts are but twenty or less to the mile, two men cannot pull up the span so taut as not to leave sufficient curve or slack in the wire to counteract the strain which it will probably suffer from contraction during the cold season. The breaking-strain of a No. 8 wire is from twelve hundred to eighteen hundred pounds, according to its quality. To bring up the span to within twenty inches of being straight, requires a tension of about four hundred and twenty pounds where the poles are stationed twenty to the mile. The same force will bring up the span to within twenty-four inches of being straight where sixteen poles to the mile are employed. Such a strain will split or detach any ordinary wood-bracket or pin, when the wire is strung one span at a time, and tied or fastened to the common glass insulators. The support of the French insulator is a wrought-iron bracket, weighing three and a half pounds, and has sufficient strength to sustain a tension of one thousand pounds without bending or breaking. This system of a reduced number of posts is not practicable with the common glass insulators of our country. They are of too frail a nature. As used with thirty to forty poles to the mile, a large percentage of them are broken in suspending the wires, so much so that not unfrequently as much as 30 per cent. goes to waste in this manner.

It has been objected to the system of a reduced number of posts, that the wires are more liable to be broken by sleet, but this is by no means a necessary consequence. A No. 8 or No. 9 wire of good quality will sustain the necessary tension, say three hundred and fifty to four hundred and fifty pounds, and an additional strain of one thousand pounds without breaking, a strain far greater than that which the sleet is able to bring to bear upon it; but if fifty posts are used to the mile, with wires pulled tight, the sleet will be able to break every span. With sixty posts to the mile, to avoid this very difficulty over the Alleghanies, the writer has seen the wires entirely prostrated by sleet, owing to the tight stretching of the wires. It has likewise been urged that the wires are more liable to be crossed and twisted by high winds, but with a secure fastening at the insulators, such a result does not follow. The weight of the wires keeps them at their proper distance apart; and when moved by the wind they "swing and keep time together."

The illustration (Fig. 2) herewith appended, shows the method

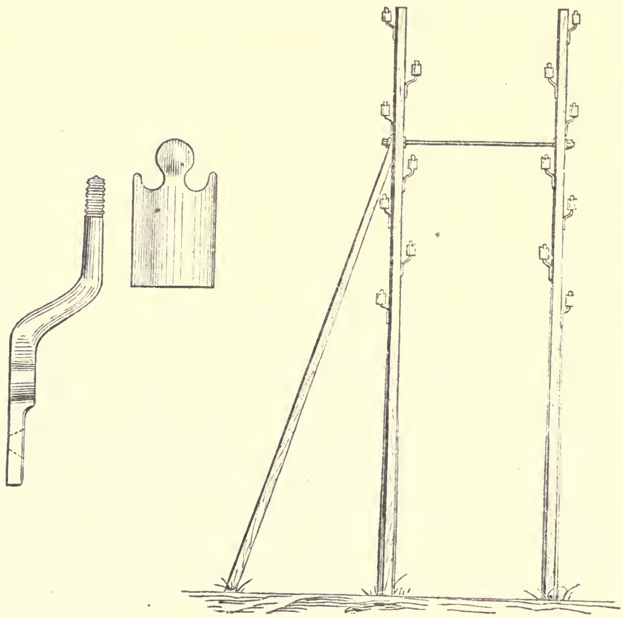


FIG. 2.

adopted by the French in supporting their wires. Two poles are set about seven feet apart, and in a line at right angles to the direction of the wires. These posts are firmly secured to each other by an iron bar, one and a quarter inches in diameter, fastened with screw-nuts. Upon the side bearing against the strain of the wires is placed a third post, in the form of a brace. This brace is omitted where the wires are on the straight line, but is erected when this is otherwise. This arrangement forms an immovable support, capable of safely carrying twenty or more wires.

The illustration (Fig. 3) shows the Austrian method of accomplishing the same purpose. By placing the cross-arms upon each side, and attaching them to the posts with screw-bolts, a structure of great strength is obtained, and at a less cost than upon the French system.

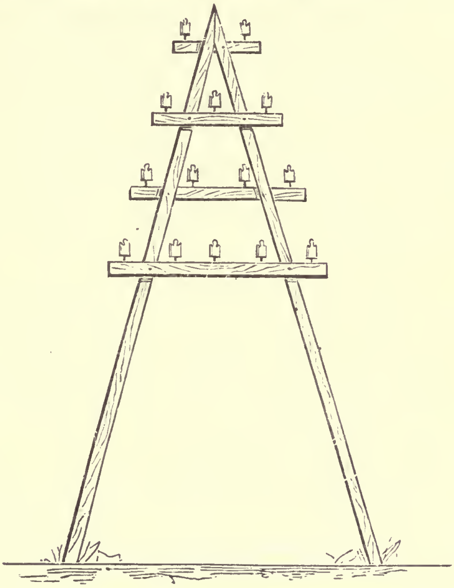


FIG. 3.

28. INSULATORS.—The exhibit of insulators in the Prussian department of the Vienna Exhibition, comprising more than twenty different styles, include in the list the earlier kinds, as well as those at the present time in use by that government. That employed at present was first designed by Colonel Chauvin, formerly director of the Prussian telegraphs. It has a double shed or drip, of greater height than is usually employed, and is placed in an iron bracket of great strength, weighing about three and a half pounds, so formed as to prevent the under surface of the instrument from being wetted by dashing drops of rain.

The first insulators employed on the continent were of glass, and not unlike those in use at the present day in this country. The observation was, however, soon made that the instruments would afford better results when constructed of porcelain. The choice of this material for the above purpose, however, involved the necessity of constant care in selecting the good from among the defective, inasmuch as its quality varies greatly even with pieces from the same burning. The defective pieces are porous, not having received sufficient fusion in the kiln, and consequently are readily permeable to moisture. To detect these defective pieces, for rejection, requires the use of astatic galvanometers. When these precautions are observed, a much better material for insulators than ordinary glass is obtained; besides which, it possesses greater strength, and is susceptible of being molded into forms more suited to the purposes of practice than is glass.

29. The form of instrument known as the Prussian insulator is manufactured largely in France and Belgium. It is used in Germany, France, Italy, Norway, Sweden, and Russia. Those used in Germany are manufactured in Berlin. The French manufacturers make these insulators of the same material as is employed in the manufacture of the French china ware. With this single exception, material quite as good is made in this country at the Trenton, N. J., potteries as is made in Europe; but porcelain has never been used for this purpose with us, and consequently the method of selecting the good from the bad by the use of astatic galvanometers is unknown. As made in France or Prussia, the cost of the Prussian insulator and its iron bracket is about fifty cents each.

The firm of Siemens Brothers, of England, exhibit all the varieties of insulators manufactured in their works, from the early history of the telegraph. Their exhibit includes all or nearly all the forms of this instrument used in England, or manufactured there for export. Among the latter is the Brooks insulator, the invention of the writer, very similar to those made in the United States.

30. While in Europe, in the year 1867, the writer procured sets of insulators of the following nationalities: Würtemberg, Italy, Sweden, Denmark, Russia, Prussia, France, Belgium, Switzerland, Austria, and England. Of the last-named nationality there were three standard kinds, viz: the United Kingdom's, the British and Irish Magnetic Telegraph Company's, and Varley's Double Inverts. These instruments were procured for the purpose of galvanometric measurement and comparison with those of this country, including the form manufactured by the writer. Of these several instruments one hundred and nine separate tests, during the occurrence of rain, have been made and recorded within the past six years, the results of the same having been quite uniform. The following is a summary of these results: The instruments of the French-Prussian pattern gave the best results, exceeding the best of the English insulators in the proportion of four and a half to one; and exceeding the poorest English in the proportion of five to one. Of all the European instruments the English proved to be the poorest, their performance averaging within a fraction of that of the common glass insulators in use in this country. Had the average of two hundred measurements been taken, so as to include the lighter rains, which did not seriously affect the other insulators, the average performance of the English insulators would have been much lower, even below the

American glass insulator, inasmuch as a moderate rain produces a much more serious effect upon them.

31. There is no function in its operation which so seriously affects the economy and efficiency of the telegraph as its insulation. It is by no means uncommon, upon a wet day, for a person to leave a dispatch at the telegraph-office in Philadelphia, directed to New York, and thereupon to take the cars and arrive before the dispatch.

To transact the business between New York and Philadelphia, there are, probably, as many as forty wires. On a fair day, the entire business can be executed upon four wires, with the use of the printing-instruments, with an average delay of less than five minutes to each message. But as a result of their very defective insulation, where they have been exposed to the effects of a few hours' rain, the whole of the wires, worked to their utmost capacity, are insufficient to save the business from hours of delay.

The French, in virtue of the better system of insulation which they have adopted, are able to effect far more upon one wire between Marseilles and Paris, or Lyons and Paris, or Havre and Paris, than the English between London and Liverpool. In equally wet weather, the superiority of the French over the English practice, measured by the amount of work which each is able to perform, will be in the proportion of three to one, at least, and, more probably, in the proportion of five to one. On all the leading routes in France, the Hughes printer is worked, in the rain, at full speed. On corresponding routes in England, it is only possible to work the Morse instrument, and that at a very reduced rate of speed, in spite of the fact that the English have the advantage of larger wires, greater conductivity, and shorter circuit-distances.

32. The French work two wires in all kinds of weather, direct from Paris to Berlin, with the use of the Hughes printer; but are unable to work direct to Vienna, because of the inferior character of the insulation of the Swiss wires, upon which a common glass insulator is in use. The Swiss authorities admit the imperfection of their insulation, and are at present engaged in remedying the evil by introducing the Prussian insulator, as manufactured at the Belgium potteries. The sample specimens of this insulator, shown to the writer in Berne, were somewhat inferior to those manufactured in Prussia.

They are unable to work from Paris to London with the Hughes instrument, on account of the defective character of the English insulation, but can work from Paris to the English side of the channel, where re-transmission is made.

33. In his Handbook of Practical Telegraphy, Mr. Culley gives, as the insulation per mile of a No. 4 wire, in rain, between Dublin and Belfast, while "working well," 91,900 units, and that of a No. 8 wire in the same circuit and under the same circumstances, as 112,000 units. Lines of any length, say, two hundred miles, cannot be worked with such an escape in this country with our American system of closed circuits; yet there are wires in use by our railroad companies of that length, with

three times the resistance of a No. 8 wire, added in the form of relays, working well in rain.

The English endeavor to overcome the effects of bad insulation by the use of larger wires, upon the following principle: If a wire of a given size or weight per foot works up to a certain capacity one hundred miles in the rain, then a wire of twice the size and weight can be worked two hundred miles to the same capacity in rain, making allowance for the increased number of insulators. If the same number of posts were used on the larger wire, that is, half the number per mile, then the larger wire would have exactly equal capacity with the smaller one of half the length. To mitigate the effects of their bad insulation, the English have ground-wires attached to their posts to carry the leaking current to the earth, instead of into the other wires or each other. They also have a separate battery for each wire. This necessitates the employment of forty thousand cells of battery at the central station in London, a sufficient number, used as main batteries, to work all the lines of telegraph in Europe, provided the same were properly insulated.

Theoretically considered, there are fewer cross-currents and disturbances in rain, when working with a separate battery for each wire, than when a number are worked from the same battery, but when the wires are as well insulated as those of the French, this difference is practically inappreciable.

The English, in their telegraph practice, have labored under the disadvantages of bad insulation from the beginning. On this account, the old needle-system was retained in use by them for twenty years, simply because the condition of their wires would admit of no other. Five per cent. of the current leaving the battery will operate the needles at the other terminals; but the speed attained upon the needle-system is no more than half that of the Morse, while the liability to error is twice as great. The condition of the wires in England at this day is improved to the extent of admitting the Morse system of open circuits, but to operate them upon the American system, which is far more economical and convenient, would be impracticable.

34. The extent to which the Hughes printing instrument is used in England and in France, affords a good standard of comparison by which we may judge of the comparative excellence of the insulation of the wires in the two countries.

In the London central station there are employed—

Hughes printers	12
Automatic	40
Ink-recording Morse	240
Duplex	20
Single needle	130
Sounders	12
Bright's bells	6
Total instruments	460

In the central station at Paris, there are employed—

Hughes printers	70
Morse ink-recorders	30
Total instruments	100

The average daily business of Paris proper, not counting repeated messages, but only those originating in Paris to go to other points, and those delivered in that city, amounts to as much as 12,000 dispatches; at times it has reached as high as 15,000.

The average daily business of London, as the writer has been informed, is 15,000 dispatches, but the repeated and local dispatches of the London central station reach upon an average 15,000 dispatches. The statistics of this kind of business at Paris, the writer was unable to obtain, but it is trifling when compared with that of London, since the system of transmission with pneumatic tubes is employed in Paris to a much larger extent than in London.

If the insulation is inferior, the needle system can be operated with the least difficulty; next in order is the open-circuit Morse system to which reference has been made before; while to be able to use the Hughes printer necessitates comparatively perfect insulation. For this reason the Hughes instrument is little used in our own country.

In clear weather, the condition of the wires permits of its employment with all of its advantages, but when the wires are under the effects of rain, these instruments must be placed aside and the Morse substituted, and the dispatches are transmitted at a very reduced rate of speed.

To have two sets of instruments, the one for fair and the other for foul weather, is neither advisable nor economical; so that in this country as well as in England the printing instruments are used but to a very limited extent, and even this limited use is confined to the shortest circuits and the largest wires.

35. Underground wires in cities.—The wires are run under ground in the cities of Berlin, Dresden, Breslau, Dantzig, Stettin, Hamburg, Bremen, Cologne, Frankfort on the Main, Mayence, Carlsruhe, and other large cities and towns of Germany, and in Geneva, Lausanne, Berne, Neufchatel, Zurich, Winterthur, Schaffhausen, Saint Galle, and Lugano, in Switzerland. In nearly all the cities of Europe neither posts nor wires are visible, but the system of underground cables is adopted instead. These cables contain from five to seven conductors each, insulated with gutta-percha, and the whole protected with an armor of iron wires. This system has shown itself in practice to be both economical and reliable. There are now in Paris working lines that have been buried for twenty years, and which have been the cause of little or no expense except their first cost. It is especially worthy of note in this particular that during the reign of the commune, when almost every institution of public utility was destroyed, not an underground wire was disturbed.

There are, probably, five times as many wires in our cities as in European cities of equal size and importance, a condition which is attributable entirely to competition between rival companies, and the consequent multiplication of needless branch offices. One of the most obvious results of this condition of things is that our finest avenues are obstructed, and their appearance marred by unsightly posts and wires. In no part of Europe, not even in the by-ways of the country, do we see such ill-prepared and ill-shaped posts, standing so persistently out of perpendicular, as may be seen in any of our finest thoroughfares. Expensive flagstones and pavements are broken up and injured to make way for these unsightly fixtures, from which, from present indications, there seems to be no relief.

Another disadvantage of this system resides in the fact that the posts so exposed are frequently destroyed by fires, &c., and the working of the wires interrupted when they are most urgently needed.

Wires on mountains are often broken by accumulations of ice and sleet. Our wires to the Pacific have been interrupted from this cause for weeks. In Switzerland the passes of Saint Gothard, the Simplon, and others are crossed by cables laid on the ground, and telegraphic communication effectually preserved by that means. The French accomplish the same object by the use of an iron wire seven millimeters in diameter. This wire is of such size and strength as to withstand any accumulation of ice and sleet.

36. PNEUMATIC TUBES.—The delivery and transmission of dispatches, in the cities of London, Paris, and Berlin is greatly facilitated by the systematized employment of pneumatic tubes in connection with the telegraph. The central telegraph station of Paris is not located in a business mart or thronged center, but is central in position, or equidistant, as regards those business marts. In our own large cities such stations are invariably in or near the business centers or exchanges.

The following details of the operation of the pneumatic system in Paris may be of interest. Within a certain radius of the Paris central station the dispatches are delivered by messengers. Beyond the central station there is a circle or zone reached by pneumatic tubes, embracing eleven stations. Beyond the circumference of the circle reached by the tubes are other radiating points in connection with the central station by local telegraphs. Of the telegraph business of that city probably no less than four-fifths of it is reached or handled with the aid of the pneumatic system. As aids or auxiliaries to the operation of the tubes, the latter system stands in connection with local telegraph lines in much the same manner as the railways employ the telegraph to control and facilitate the movements of trains.

The number of branch offices in Paris, where, next to London, the largest business of any city in the world is transacted, is less than twenty, but for promptness and efficiency the system of working there employed is worthy of highest praise and emulation. As they come from the printing instrument the printed slips are cut, pasted on a sheet, folded, put into an envelope, sent through the tube, a distance of three-quarters of a mile, and placed in the hands of a messenger, all within a space of time averaging not more than four minutes. The chief object which appears to be sought is *dispatch*, and not, as is unfortunately the case in this country, to make or obtain business. When there were but three telegraph offices in Philadelphia, a main office on Third street, with a branch in the Exchange, and one at the Continental Hotel, there was no competition between rival lines or offices; now there are in that city one hundred or more branch offices. The only motive for the establishment of so many branches is the effort to divert business from opposition lines, and the expense necessarily incurred is enormous; and the public are ultimately the bearers of this burden in the form of excessive rates which are charged.

A branch office of some one of the telegraph companies may probably be found, upon an average, within five minutes' walk of any portion of the city of Philadelphia. But as an indication of their inefficiency in meeting the needs of the community, it is not saying too much when it is asserted that, should the sender of a dispatch avail himself of the street-cars, and carry his dispatch in person to the central office, instead of directing himself to the nearest branch office, his message would, as a rule, reach its destination much sooner than if he had adopted the latter alternative.

37. THE MONOPOLY OF THE TELEGRAPH.—The rates of telegraphing in this country have always been high, yet but few of the stockholders, or those who furnished the money to construct the lines, have ever received any return for their investments. In most cases the Morse patent was sold to individuals, who organized companies, received subscriptions to stock, and constructed the lines, deriving personally large profits thereby. Usually about three times the amount of money necessary to build the lines was subscribed by the stockholders, and an equal amount of stock was issued for the patent; so that those organizing the companies not only derived large profits from the construction of the lines, but also held the controlling interest in the stock. By this mode of procedure, a few individual speculators have each succeeded in realizing far greater profits from the Morse patent than were ever realized by its inventor.

As the railway system of the country was developed, the telegraph became indispensable as an auxiliary to its operations. The privilege of the telegraph, however, the railroad owners could only procure by granting exclusive rights to the telegraph company to set the poles and string the wires upon the line of the road. These rights were made perpetual, and were of more avail in securing the monopolizing of the telegraph than the patent itself, since, among other things, lines of telegraph upon highways in this country are expensive to maintain. Again, these exclusive rights have been greatly strengthened by the liberal use of the franking privilege, giving free transmission to the messages of railway officials, legislators, lobbyists, editors, and correspondents of the press. The establishment of the New York Associated Press has as its chief object, so far as the telegraph company is concerned, to silence the criticism and secure the influence of those journals enjoying its advantages, in the matter of preventing governmental interference. By the exclusive transmission of news at reduced rates to that association, the members of the latter possess a monopoly of journalism, to the extent of publishing a daily paper with news from abroad and from all parts of the Union. No journal is permitted to enter the association or to compete with them.

Of the influence of this monopoly, the following instance will give an adequate notion. The last journal to enter this association was the New York World. The value of this arrangement was then fixed by the other journals at $125,000. It is, therefore, to be expected that when such a value is placed upon its privileges, the influence of its participants will be strenuously devoted to the maintenance of the monopoly; and as zealously against the interference of Government in the interests of the people.

The journals constituting the Associated Press sell their news to the press in other parts of the Union, the latter being protected against competition by suitable arrangements with the telegraph company, the result being that no newspaper can obtain their dispatches and enjoy the privilege of the association, except upon payment to its members of such bonus as they may choose to impose. The daily journals outside of New York are thus in turn secured against competition in the early dissemination of news, and their influence in turn will naturally be exerted against any change which would be even remotely liable to affect their interests.

An arrangement of a very similar nature formerly existed in England. The influence of the entire press of that country was exerted to ward off government interference with its perpetuation. The journals of this country have repeatedly reproduced all the criticisms and strictures of the English papers on Mr. Scudamore, and those who were instrumental with him in bringing about cheap telegraphing in that country; yet, among the great class of its citizens who paid for their dispatches before the government took charge of the lines, and who pay for them now, Mr. Scudamore is the most popular man in England.

38. Estimated cost of new telegraph-lines.—The Government has from time to time received estimates of the cost of new lines of telegraph. With reference to these, the writer is convinced that the estimates are, in the main, too high, provided that the best constructed European lines are taken as models. In these estimates, the number of posts specified to the mile is thirty or more. Twenty posts per mile is amply sufficient for any number of wires; more than that number is not only not advantageous, but positively detrimental, entailing in-

creased cost of maintenance. The greater the number of poles, the greater is the number of insulators required; this last item is therefore correspondingly too high by at least 30 per cent; the multiplication of insulators being in turn a positive disadvantage, since every such instrument upon a line is, theoretically, a leak, and hence the fewer the number employed, the less will be the loss of the current.

If the number of wires is no more than two for one set of poles, sixteen poles to the mile is ample. The estimates for poles and insulators are, therefore, for a much larger number than is required by modern and improved construction. The same estimate specifies No. 8 galvanized wire, with improved insulation. No. 11 wire, costing only about half as much as No. 8, will answer every purpose. Excepting the longer circuits, say for three-fourths of the whole number of miles of telegraph specified, the item for wire could be reduced by one-half, or the total estimate for wire by about 30 per cent. The number of miles of wire specified, one hundred and twenty-five thousand, if properly erected, would afford ample facilities for the transaction of any amount of business five times greater than is found to be required at the present day, with existing rates.

39. In Europe there are many more branch lines—lines extending off the line of railways—than in this country. There is a train, called the mail, which leaves nearly all the cities of the Union in the morning. This train makes many stoppages; and at some of the stations a carriage conveys the mail and a few passengers to towns not situated on the line of the road. There is scarcely a post-office of this description where a telegraph station would not be equally desirable, a desideratum which could only be attained by the systematic extension of branch lines.

For a line of one wire, twelve poles to the mile is all that would be required, a No. 11 wire (weight per mile two hundred pounds) is best adapted, and the cost of such a line will not be half as great as for one constructed with No. 8 wire and thirty-three poles to the mile, the kind of line for which estimates have been made.

In most of the European countries, such minor stations are maintained for the convenience of citizens, just as there and in this country minor post-offices are maintained. Telegraph stations, at such points, should, with equal propriety and utility, be erected and maintained in this country. Should the Government, through its agents, propose to furnish the wire and instruments for such branch lines, the citizens would, without doubt, in most cases, be glad to provide the poles and labor and supply the operator. The receipts from such minor stations might be appropriated to the citizens of the place to go toward providing a fund for the maintenance of the poles, a portion of the same going to the person in charge of the instrument. Upon such terms, some person could readily be found wherever there was a postal station who would be willing to take charge of the instrument. Again, as the instrument most suitable for such stations is the ink-writer, the difficulty of finding an operator will be materially lessened, or altogether obviated, since any person of average intelligence can learn to operate and to read from that instrument readily in a day by earnest application; a fact which when appreciated would, beyond question, make such a post very desirable, for an accomplishment of this kind would be sought by many, with the object of making such knowledge of future benefit rather than of immediate profit. As its share, the Government could appropriate the receipts from the return business, which could constitute a fund from which to repay the outlay for wires and instruments. It is by the systematic development of a system similar in its tenor to that above suggested, that France and Germany are covered with a veritable net-work of wires, by which the telegraph is brought *in fact* within the reach and means of the people of every portion of the territory of those countries. In this country there are thousands of postal stations that could be reached in this manner without cost to the Government.

Again, so far as the item of labor is concerned, the trunk lines can be built and maintained by the railway companies for less than one-half the money that the telegraph companies expend for this purpose. This the railroad company should do, and be paid for it, the same as for carrying the mails, or performing any other service for the Government.

40. The foregoing suggestions are the outgrowth of many years' experience with the telegraphic system, as practiced at home and abroad, and, though crude and imperfect, the writer is convinced that they must form the basis of that system which aims to bring the telegraph veritably within the reach of the people at the least public cost. The writer entered the telegraph service in this country in the year 1845; first in the construction of the line between Baltimore and New York, and afterward in the construction of the line between Philadelphia and Pittsburgh. The line between Washington and New York was known as that of the "Magnetic Telegraph Company." For one hundred dollars paid in, two shares, of one hundred dollars each, were issued to the subscribers to stock. An equal amount of stock was issued to the patentees, so that for every one hundred dollars paid in there were four hundred dollars of stock issued.

At first two wires on one set of poles were the extent of its facilities, but the profits of the company soon enabled it to increase the number of its wires, as well as to pay its stockholders dividends of 12 per cent. on its capital stock. The stock of the company was subsequently very much increased.

For the line between Philadelphia and Pittsburgh, three shares of stock were issued for one paid in, and the stock was subsequently doubled, so that six shares were issued for one paid. This stock paid from 12 to 15 per cent. on its face when absorbed by the present Western Union Telegraph Company. The original rates upon which these dividends were declared were:

From Philadelphia to Washington, 30 and 2; now 40 and 3.
Baltimore, 25 and 2; now 30 and 2.
Wilmington, 10 and 1; now 25 and 2.
New York, 25 and 2; now 30 and 2.
Lancaster, 20 and 1; now 25 and 2.
Harrisburg, 25 and 2; now 35 and 3.
Pittsburgh, 40 and 3; now 40 and 3.
Cincinnati, 80 and 6; now 100 and 7.

To nearly every point from Philadelphia, as may be drawn from the foregoing, the rates of transmitting telegraphic messages have been raised; besides which, an extra charge is now made for delivery of the dispatches, which, formerly, were delivered free of charge. From the years 1845 to 1866, the writer was in the service of the telegraph in this country, either in the capacity of manager, director, or superintendent, save for the year 1851, when employed in Mexico in the construction of a line from Vera Cruz to the city of Mexico. Since 1866, he has twice visited Europe, and has given the subject much attention.

41. It is the profound conviction of the writer, and one which is shared by every independent observer who has given the subject careful attention, that we are far in the rear of all civilized nations in the matter of making the telegraphic service a popular medium of communication, and this, too, in face of the fact that almost every valuable invention and improvement connected with the telegraph is of American origin. There is no country in which the telegraph could be made so invaluable in serving public necessity and convenience as in the United States, where those having business or other relations requiring correspondence are so widely separated from each other.

Finally, the writer may be pardoned for venturing a few words concerning the rates or charges for telegraphing in this country.

Take as an example a wire or circuit worked one thousand miles, on which circuit there are way-stations. If a dispatch is sent from one station to the next or nearest station, or less than fifty miles, the minimum charge for ten words is 25 cents, which only occurs where there is no extra charge for delivery and when the message is delivered within a short distance of the receiving-station.

It costs the telegraph company just as much to send this dispatch as to send one the entire length of the circuit, and while it is being sent over this short distance the balance of the line is idle or waiting; but, on the other hand, if a message is sent the entire circuit, the charge is one dollar or more, the actual cost of transmission being the same in both cases.

Take another example, in which the message is sent from one circuit to a parallel circuit, or from one circuit on to another, or where the dispatch requires re-transmission. The distance in such a case may be less than fifty miles, and the charges only 25 cents, yet the labor involved and the time during which the wires are occupied in its transmission are double that of the case in which one dollar or more is charged.

It is obvious, therefore, that the theory upon which the telegraph company proceeds in its charges, is to measure the necessities or object gained by those sending dispatches, and not the labor and expense involved in their transmission. A letter is sent from one part of the Union to another—from Maine to Oregon—for 3 cents, but if the cost of transmitting letters be compared with that of transmitting telegraphic dispatches, there would be vastly more justice in regulating the charge for carrying letters by distance than in the case of the telegraph. If we were to compare the average distance that dispatches are sent in Canada with their average distance in this country, it would be found that this is greater in Canada than with us, inasmuch as the large cities and towns of the former country in which the bulk of the telegraphic business is transacted are farther apart than in this country. Canada, however, has a uniform charge of 25 cents for telegraphic messages, and the telegraph company makes dividends to its stockholders of 10 per cent. on a capital much in excess of what would build lines of modern and improved construction having three times their capacity.

42. A proper telegraphic system would require wires extending from one extremity of the country to the other, but it is only a very small percentage of the whole number of dispatches that would require this long transmission.

With the improved construction of lines that will not be reduced in their efficiency by unfavorable weather, and that will admit of the use of printing-instruments, and by the adoption of the automatic processes for those circuits having the greatest amount of business, the writer can see no good reason to justify a charge greater than 25 cents for twenty words, and then pay a fair rate of interest on the capital expended in constructing the lines. If worked, then, with the simple object of defraying running expenses, a uniform charge of 20 cents would be ample.

APPENDIX.

CATALOGUE OF TELEGRAPH EXHIBITS AT THE VIENNA EXHIBITION.

UNIVERSAL EXHIBITION AT VIENNA, 1873.

CATALOGUE OF THE APPARATUS EXHIBITED BY THE IMPERIAL-GERMAN TELEGRAPHIC BUREAU.

General number.	Group number.	
		A.—HISTORICAL SECTION.
1	II	The electro-chemical telegraphic apparatus of Sömmering; the first practically developed in Germany; constructed in 1809.
2	II	Drawing of an apparatus invented by the Russian Councelor Schilling, in Cannstadt, in the year 1832; the first needle-telegraph.
3	III	The electro-magnetic-telegraph apparatus constructed by Gauss and Weber, in Göttingen, and used from 1832–1838. Belonging to this—
3*a*	III	The signal-sender, (by induced currents;)
3*b*	III	The signal-receiver, (bar-magnet, with multiplier and mirror;) and
3*c*	III	Telescope for reading off the deflection of the magnet.
4	II	The electro-magnetic telegraphic apparatus of Steinheil, Munich, 1837.
5*a*	III	Sending-apparatus of the dial-telegraph, constructed by Leonhard, in Berlin, 1845; in use between Berlin and Potsdam, 1847.
5*b*	III	Receiving-apparatus of the same.
6*a*	III	Electro-magnetic dial and printing telegraphic apparatus, made by
6*b*	III	Siemens, of Berlin; patented in Prussia, 1846.
7	III	Signal-apparatus for railroads by Siemens, 1847. (Exhibited in London, 1851.)
8	I	Circuit-closer of Siemens, 1847.
9	III	First gutta-percha press for the manufacture of insulated conductors with gutta-percha covering without seam. Model constructed by Siemens and assigned to Fonrobert and Bruckner. The numerous under-ground telegraph-lines built in Germany and Russia between the years 1847–1851 were prepared by machines constructed upon this model, as are also all the modern submarine cables.
10	I	Plate lightning-arrester; first used by Siemens in 1848, between Eisenach and Frankfort-on-the-Main.
11	III	Trough-battery of Siemens, 1849.
12	III	Dial-apparatus of Kremer, Nordhausen, 1849.
13	I	Call-bell for intermediate stations, by Kremer, Nordhausen, 1849.
14	III	Electro-magnetic needle-telegraph of Siemens, 1849. (Exhibited in London, 1851.)
15	II	Embosser of Siemens, 1849, (one of the earliest instruments constructed upon the system invented in America by Morse.)
16	I	Relays of the oldest construction, 1849.
17*a*	III	Double-pointed embosser, by Siemens, 1850. (Exhibited in London in 1851.)
17*b*	I	Polarized relay belonging to this, (oldest form, without steel magnet, the magnetic induction of the core and keeper produced by a branch current from the local battery.)

Apparatus exhibited by the Imperial-German telegraphic bureau—Continued.

General number.	Group number.	
17*c*	III	Transmitting-key of the same.
18	I	Intermediate call-bell of Siemens, 1850. (Exhibited in London, 1851.)
19	III	Magneto-electrical machine with twenty-eight pairs of plates, employed by Siemens with signal-apparatus in 1850. (Exhibited in London, 1851.)
20	I	Relays used in Hanover, 1850.
21	III	Siemens's blast-igniter, 1850.
22	I	Old key used in 1850.
23	I	Wire-coil lightning-arrester by Siemens, 1850–1853.
24	I	Wire lightning-arrester with metal ground-plate, by Siemens, 1850–1853.
25	I	Point lightning-arrester, by Siemens, 1850–1853.
26	I	Ball-and-point lightning-arrester, by Siemens, 1850–1853.
27	I	Box-relay, by Siemens, 1851.
28	I	Vacuum lightning-arrester, by Siemens, 1852.
29	I	Polarized relay, with double-point embosser, by Siemens, 1852.
30*a*	III	Hand-perforator for rapid writing, constructed by Siemens, 1823. (Exhibited at the Industrial Exhibition at Munich until May 30, 1854.) The Warschaw, Petersburg, and other Russian lines, built by Siemens and Halske, were first furnished with apparatus upon this system.
30*b*	III	Sending-apparatus for the same.
30*c*	III	Receiving-apparatus for the same, (a Morse, with swinging-magnets.)
30*d*	I	Relay of the same, (with magnets.)
31	III	A one-German-mile resistance, by Siemens, 1854.
32	I	Polarized relay for induced currents, with two steel magnets, a straight electro-magnet, and swinging core, (without keeper,) by Siemens, 1854.
33	I	Polarized relay for induced currents, with two straight electro-magnets and steel keeper, by Siemens, 1854.
34	I	Plug-switch, for intermediate stations, used in 1854.
35	II	Original ink-writer, by John, Prague, 1854.
36	I	Relay, with swinging magnets and double windings, to be used with the double transmitter of Frischen and Siemens, patented in Prussia in 1854, with resistance-scale graduated for miles of copper wire of 1''' diameter, as they have been supplied by Siemens since 1848.
37	1	Polarized relay, with a horseshoe-magnet and steel keeper, by Siemens, 1855. (A construction much used to-day.)
38	I	Polarized relay, with steel keeper, by Siemens, 1855.
39	III	Double-induction machine, by Siemens, 1855; designed to produce induced currents (secondary currents) with fewer elements.
40*a*	III	Induction-coil made by Siemens, 1855, in the first experiments to produce Morse characters, with the aid of polarized relays, by employing short intermitting currents of equal duration.
40*b*	I	Induction-key. (Same.)
41	II	Morse apparatus, constructed by Frischen, 1856.
42	I	Alarm, with relay for currents of definite direction, by Borggreve, 1857, constructed for small stations, (in connection with post-office.)
43	I	Switch for intermediate stations, by Nottebohm; in use until 1857.
44	I	Switch for intermediate stations, by Nottebohm; in use until 1857.
45	I	Line-switch, by Nottebohm; in use until 1857.
46	III	Crank rheostat, with resistance of 1-50 German miles of iron wire of 2.1 lines diameter, 1857.
47	I	Commutator, by Nottebohm; in use until 1857.
48	I	Lightning-arrester, terminated by pillars, by Nottebohm; in use until 1857.
49	I	Lightning-arrester, with blades for stations with one line; in use since 1857.
50	I	Lightning-arrester, with blades for stations with two lines; in use since 1857.
51	I	Relay with horizontal magnets, by Nottebohm; in use until 1857.
52	I	Relay, by Borggreve, 1857.

Apparatus exhibited by the Imperial-German telegraphic bureau—Continued.

General number.	Group number.	
53	I	Switch for intermediate stations, by Borggreve, which, with some trifling modifications, is still in use.
54	I	Switch for intermediate stations, by Borggreve, 1857; still in use.
55	II	Submarine-telegraphic system, constructed by Siemens in 1857 for the Red Sea cable.
56	I	Galvanoscope cut-off.
57	I	Crank-switch; still in use for various purposes.
58	I	Plug-switch; still in use for various purposes.
59	I	Plug-switch; still in use for various purposes.
60	I	Return-current discharger for submarine lines, by Siemens, 1857; first used in the Red Sea.
61	I	Relay with double-wound helices, for double transmission, by Borggreve, 1862.
62	I	Switch for intermediate stations, with apparatus and alarm, constructed by Borggreve in 1862, for the purpose of changing the direction of the current, for calling or for correspondence.
63	II	Writing-apparatus, constructed by Siemens, in which a small color-wheel, movable upon a universal joint, enters an open reservoir, the surface of which can be raised or lowered; patented in England, 1862.
64	II	Embosser of Lewert, Berlin, 1865.
65	II	Color-writer of Lewert, Berlin, 1865.
66	II	Graphite resistances, to regulate the resistance at intermediate stations; in use since 1865. They consist of graphite powder pressed into glass tubes, and are furnished of different sizes, from 500 to 2,500 Siemens units.
67	III	Automatic Morse type-register, by Siemens, 1865.
68	I	Switch for testing, by Elsasser, 1866.
69	I	Key for alternating currents; in use until 1866.
70	I	Lightning-arrester, by Elsasser, 1866.
71	I	Line-switch, such as have been in use since 1866.
72	II	Color-writer of Lewert, Berlin, 1868.
73	II	Polarized quick-writing apparatus, using color, with variable velocity, by Siemens, 1868.
74	I	Relay with movable core, 1868.
75	I	Key, with battery-commutator; in use until 1869.
76	I	Key, used from 1869 to 1871.
77	I	Plate lightning-arrester, by Elsasser; in use since 1869.
78	I	Galvanoscope, (after Varley, 1857;) introduced in 1857.
79	I	Polarized relay, with two horseshoe electro-magnets, two steel magnets, and two keepers, for use on lines with commutated currents by Siemens, 1869; constructed for the Indo-European line.
80	I	Galvanoscope, Siemens, 1869.
81	I	Key, used since 1871.
82	I	Galvanoscope, such as have been in use since 1871.
83	....	Map showing the German telegraph line in 1854.
84	....	Map showing the German telegraph line in 1860.
85	....	Map showing the German telegraph line in 1866.
86	....	Map showing the German telegraph line in 1872.
87	....	Graphical representation of the development of telegraphic communication and means of communication in Germany from 1854 to 1872.
88	....	Special chart of normal connections of telegraph-lines, 1872.
		B.—TELEGRAPHIC APPARATUS NOW IN PRACTICAL OPERATION, AND THEIR SWITCHES.
89	IV	Switch of a line for two end stations and one intermediate station The writing-apparatus are switched in the circuit directly without relay and local battery.
90	IV	Switch of a line on open circuit for two end stations and one intermediate station. The writing-apparatus are switched directly on the line; transmitting arrangement by Maron.

Apparatus exhibited by the Imperial-German telegraphic bureau—Continued.

General number.	Group number.	
91	V	Switch of a line provided with Hughes's apparatus for two end stations and one intermediate station. The transmission is accomplished partly by means of the Hughes apparatus, after the directions of Jaite, and by the use of the automatic commutator designed by him, and partly after the directions of Maron, by means of two polarized relays, with the use of branch currents.
92	VI	Line provided with the automatic rapid-writer of Siemens, (key-perforator, sender, and receiver).
93*a*	....	Two battery-boxes for small stations, with Meïdinger elements; attached to the wall at Tables I and XIII.
93*b*	....	
		C.—APPARATUS AND IMPLEMENTS FOR PURPOSES OF CIRCUIT-TESTING.
94	VII	Case and apparatus for the examination of under-ground lines (old).
95	VII	Testing-galvanometer, (needle suspended from a fiber of silk), with stand, (old).
96	VII	Testing-galvanometer, with tree-screw.
97	VII	Differential galvanometer, with tree-screw.
98	VII	Pocket-galvanometer.
99	VII	A variety of apparatus for testing-purposes.
		D.—LINE-CONSTRUCTIONS (ERECTED IN THE GARDEN.)
100	....	Pole furnished with iron line-wires, and armed with three porcelain insulators, with brass boxes in rubber packing-rings, of which— I. One main-line insulator is placed on top of pole on straight fork-bracket. II. Two branch-line insulators are on ſ-shaped fork-brackets.
101	....	Pole furnished with the simple porcelain insulators used on the first iron line-wire, of which one main-line insulator is on top of pole and two branch-line insulators on ſ-shaped brackets on the same level. (Mark: Porcelain insulators, 1851–1855.) At the lower part of this pole there are attached two porcelain bells, with cast-iron caps, such as were used in 1853. (Marked, Porcelain bells, with cast-iron cups, 1853.)
101	....	Pole armed with the so-called cast-iron insulators, with porcelain ring; in use from 1855 to 1857. (*a*) One main-line insulator on top of pole. (*b*) Two branch-line insulators on ſ-shaped brackets.
103	....	An arrangement of iron insulators as they were used and mounted 1855–1857. Two poles erected two or three feet from each other, and bound together at the top with brace; both poles are armed. One for the main-line, with cast-iron insulators, with porcelain fitting, upon the top of the pole. Two for the branch lines, with similar cast-iron insulators on ſ-shaped supports.
104	....	Disengaging apparatus, 1857. A strong column provided with brackets for main and branch line.
105	....	Pole furnished with Borggreve's insulator, (1857.) (*a*) For the main line, on top of poles, with straight supports. (*b*) For the branch lines, upon screw-supports. At the lower part of this pole there is a so-called "commission insulator," on ſ-shaped support, 1858. (This form of insulator was proposed by a commission charged with the task of determining the most practical form, &c., of insulators).
106	....	Pole furnished with the double bell first proposed by Chauvin; first used in 1858, and generally introduced in 1862. The pole is braced. At the lower part of pole there is— 1. double bell, with straight support, on cast-iron brackets; and, 2. One on wrought-iron angle-support.

Apparatus exhibited by the Imperial-German telegraphic bureau—Continued.

General number.	Group number.	
107	....	Testing-station, (still in use,) with double brackets of malleable cast iron.
108	....	Cast-iron strengthening-column, with three insulators, (until 1862.)
109	....	Wooden strengthening-column of modern construction, with ebonite tubes and double bells for three lines.
110	....	Double poles of modern construction.
111	....	Double standard of the form at present used.
112	....	Disengaging-pole armed with three double bells.
113	....	A station arrangement as furnished in 1866–1867.
114	....	The same, with ebonite tubes and double bells, of the construction employed to-day.
115	....	Arrangement for a tunnel-line.
116	....	Various samples of wire-connections, &c.
117	VIII	E.—EXHIBITION OF THE ROYAL BAVARIAN TELEGRAPHIC COMMISSION (AS PER SPECIAL ANNOUNCEMENT.)
118	IX	F. A map with nineteen plate-drawings, showing the arrangement of the Royal Würtemberg Telegraphic Commission.
		G.—EXHIBITION OF VARIOUS MECHANICS AND MANUFACTURERS.
119	X	*Lewert in Berlin:* (*a*) Two complete sets of apparatus for private telegraphic stations for use with battery on open circuit; the writing-apparatus with self-releaser. (*b*) A differential galvanometer. (*c*) Three pocket elements.
120	XI	*Gwilt in Berlin:* A line provided with Jaite's apparatus for two end-stations and one intermediate station.
121		The same: Two complete sets of apparatus for railroad telegraph-stations.
122	XII	*Nagle in Berlin:* One Morse. One Wheatstone's dial-apparatus. One railroad signal-apparatus. One complete Morse apparatus, with relay. Two Meidinger elements of different construction. Two insulators with supports.
123	XII	*Vogel in Berlin:* Several specimens of wire for winding electro-magnets and rheostats and office-wire.
124	XII	*Stock Company for Telegraphy in Berlin (formerly H. Shombürg):* The apparatus of Schneider. Three elements. Several insulators and porous cups.
125	XIII	*Wiesenthal & Co., in Aachen:* Three complete Morse apparatus, two with relays, one with polarized register, without relay. Three single Morse apparatus of different construction. One lightning-arrester. One railroad signal-apparatus, with bell-house and induction-apparatus belonging to it.
126	....	*Schönemann, of Munich:* House and hotel telegraph, on the wall over Table VII.
127	....	*Felton & Guilleaume, of Cologne:* Several specimens of cable, on the wall over Table VIII.

CATALOGUE OF APPARATUS EXHIBITED BY SIEMENS & HALSKE, BERLIN.

No.	
	A.—Measuring-instruments.
1	Mirror-galvanometer, with a periodic swinging needle
2	Universal galvanometer for the measurement of resistance and electro-motive forces.
3	Complete ship-galvanometer, with astatic needle, with protecting case.
4	Sine and tangent Boussole, with protecting-case.
5	Sine Boussole and differential galvanometer in leather fitting.
6	Tangent Boussole.
7	Battery-tester.
8	Universal resistance.
9	Resistance-scale from 0.1 to 10,000 Siemens's units.
10	Resistance-scale from 0.1 to 5,000 Siemens's units.
11	Resistance-scale from 0.1 to 100 Siemens's units.
12	Siemens's units in German-silver wire.
13	Complete magneto-electrical distance-measurer, for stationary erection at torpedo-works, &c., consisting of the observing-instrument with inductor and of the observing-instrument with indicator.
14	Complete portable bridge for measuring resistance up to one million Siemens's units.
15	Complete magneto-electrical apparatus for indicating the height of water-column, showing the height of water at any time and distance; consisting of inductor, with float and chain, dial-apparatus, and automatic alarm.
16	Water-meter for tube 150 millimeters wide, combined with—
17	Water-meter for 20 millimeters.
18	Water-meter for 12 millimeters.
19	Water-meter for 25 millimeters.
20	Water-meter for 40 millimeters.
21	Water-meter for 60 millimeters.
22	Similar apparatus for alcohol.
23	Complete electrical apparatus for measuring the velocity of the ball in the tube of gun, consisting of a measuring-apparatus, a gun, a battery of Leyden jars, and a volta inductor, together with battery for charging the same.
24	A periodic Boussole.
	B.—Telegraphic apparatus.
	I.—*Lightning-arresters.*
25–29	Lightning-arresters of various constructions.
30	Large plate lightning-arrester, at the same time a cut-off.
31	Same, medium size, and cut-off.
32	Same, small, and cut-off.
33	Combined lightning-arrester, with automatic cut-off, in glass protecting-case.
	II.—*Galvanoscopes.*
34	Hair-needle galvanoscope, for the indication of very short currents.
35	Galvanoscope in cast-iron case.
36	Galvanoscope in polished mahogany box.
37	Traveling galvanoscope.
38	Pocket-galvanoscope, with case.
39	Central galvanoscope.
	III.—*Relays.*
40	Box-relay.
41	Polarized relay.
42	Iron relay.
43	Relay with horizontal magnet.
44	Submarine relay.

Apparatus exhibited by Siemens & Halske, Berlin—Continued.

No.	
45	Core-armature relay.
56	Shortening relay for increasing the rapidity of communication, after v. Hefner-Alteneck.
	IV.—*Telegraph-keys.*
47	Key for commutated current, with contact-springs (submarine apparatus).
48	Noiseless key.
49	Cast-iron key.
50	Magneto-induction key.
	V.—*Plug-switches.*
51–53	Various plug-switches.
	VI.—*Crank-switches.*
54–58	Various crank-switches.
	VII.—*Writing-apparatus.*
59	Small so-called box (Morse.)
60	Large box (Morse,) with double magnet.
61	Normal color-writer.
62	Normal embosser.
63	Cast-iron embosser.
64	Submarine writing-apparatus.
	C.—COMPLETE TELEGRAPHIC ARRANGEMENT.
	I.—*Army-telegraphs.*
65	Complete apparatus for army use, with all belonging to it, packed in compact form.
	II.—*Telegraphs for railroad service.*
66	Complete railroad telegraph-station, with table-embosser, key, galvanoscope, and lightning-arrester.
67	Complete railroad-telegraph station, furnished with table, color-writer, key, galvanoscope, and lightning-arrester.
68	Complete railroad-telegraph, double station, with suitable table for receiving the batteries, and upon it, color-writer, key, relay, galvanoscope, and lightning-arrester.
69	Complete telegraphic apparatus, with color-writer, transmitting-apparatus, galvanoscope, and lightning-arrester.
70	Complete guard-station apparatus, with color-writer, key, galvanoscope, and switch, in protecting-case.
71	Complete railroad-guard-house telegraph, with (dry) color-writer.
72	Complete railroad-guard-house telegraph, writing with liquid ink.
73	Complete railroad-guard-house telegraph, with self-releasing action and alarm.
	III.—*Transportable telegraphs.*
74	Transportable color-writing telegraph.
75	Complete transportable color-writer, with key and galvanoscope in case.
76	Complete transportable ink-writer, with switching-arrangement.
	IV.—*Apparatus for instruction.*
77	Writing-apparatus for instruction and practice; may be used without battery.

Apparatus exhibited by Siemens & Halske, Berlin—Continued.

No.	
	D.—FIRE-TELEGRAPH APPARATUS.
78, 79	Automatic fire-alarm.
80	Completely-furnished fire-alarm, intermediate station.
81	Completely-furnished fire-alarm, central station.
	E.—PRINTING-TELEGRAPH APPARATUS.
82	Complete type-printing apparatus, after Hughes.
	F.—AUTOMATIC TELEGRAPHIC SYSTEM OF THE INDO-EUROPEAN TELEGRAPH-LINE.
83	Station-table, with polarized rapid-writing apparatus, commutating-key, hair-needle, galvanoscope, two switches, and resistance.
84	Rapid-writing apparatus for dispatches on perforated paper.
85	Punch-key for perforating the dispatch-paper.
86	Cylindrical perforating-apparatus.
	G.—MAGNETO-ELECTRIC DIAL APPARATUS.
87	Complete magneto-electrical dial apparatus in case.
88	Magneto-electrical dial apparatus, with alarm.
89	Magneto-electric dial apparatus (transportable) for military use, in suitable packing.
89*a*	Small magnet-dial.
	H.—APPARATUS FOR SIGNALING AND CONTROLLING RAILROAD-TRAINS.
90	Complete train-signal apparatus for attachment in the interior of the coaches.
91	Train-controlling apparatus, registering the running and stopping time of the trains, with watch in case, and—
92	A paper-strip numbering-apparatus.
	I.—RAILROAD-SIGNALS.
	I.—*Alarm for battery-current.*
93	Alarm with automatic interruption and automatic off-switching upon supports.
94	Alarm with automatic interruption for placing on table.
95	Same, large size, upon supports.
96	Same, in mahogany case.
97	Rattling-alarm, with clock-work.
	II.—*Call-bell for induction-current for the use of magneto-inductors.*
98	A cast-iron suspended induction-alarm, with two small bells, for outdoor use.
99	Same, with two large bells, for outdoor use.
100	Same, variously attachable.
101	Standing induction-alarm, with large bells.
102	Same, with small bells.
103	Same, with disk.
	III.—*Signal-bells for indoor use.*
104	Small house-signal bell, in case on brackets.
	IV.—*Railroad-station signal-bells.*
105	Station-bell, with two bells in iron protecting-case, with roof.
106	Same, with two bells on cast-iron bracket, zinc protecting-case.
107	Same, with a bell, in wooden cover.
108	Same, with two bells on cast-iron bracket for vibrating cut-off switch, in zinc case.

Apparatus exhibited by Siemens & Halske, Berlin—Continued.

No.	
	V.—*Signal-apparatus.*
109	Complete railroad signal-column (by Hefner-Alteneck).
110	Same, with vibrating cut-off switch and warning-signal (by Hefner-Alteneck).
111	Complete iron guard-house, with a bell and signal-disk.
112	Complete iron guard-house, with two bells and vibrating cut-off switch and warning-signal arrangement.
	VI.—*Magneto-inductors for signal-bells.*
113	A magneto-inductor, with eighteen magnets for direct currents, with four keys for four wires.
114	Same, with twelve magnets for direct currents, with three keys.
115	Same, with twelve magnets for commutated currents, with two keys.
116	Same, with six magnets for commutated currents, with two keys.
117	Same, with six magnets for direct currents, with one key.
118	Same, with four magnets for direct currents, with one key.
119	Same, with twelve magnets in desk, with two keys.
120	Complete mine-inductor, with key-button.
121	Magneto-electric-bell signal-sender.
	K.—Railroad block-signal system.
122	Five electric block-signal apparatus, forming a continuous line, two apparatus as depot-apparatus, two as depot protecting-apparatus, and an intermediate apparatus.
123	Complete track control-apparatus, with track-switch apparatus; block-signal apparatus, with imitated semaphores, also with track-rails and rail-levers, (system of Frischen.)
123*a*	Electric block-apparatus for arriving trains.
124	Complete depot protecting-apparatus, consisting of a block-signal apparatus with commutated current-arrester and a block-signal apparatus, with arresting-lever for depot use, (the system of Frischen.)
	L.—Dynamo-electric machines and electric illuminating-devices.
125–126	Dynamo-electric blast-exploder, for sparks.
127–128	Same, for heating.
129	Dynamo-electric machines, for the generation of strong direct currents, (system of Hefner-Alteneck.)
130	Same, small.
131	Same, small.
132	Automatic electric lamp, for commutated currents, with parabolic mirror upon universal joint and triangular support.
132*a*	Same, for direct and commutated currents, (by Hefner-Alteneck.)
133–134	Two combined dynamo-electric-light machines, mounted upon a locomotive for service with this:
135	Electric hand-lamp, with Fresnel lens system, the last furnished by Messrs. L. A. Veitmeyer & Co., Berlin; L. Soutter & Co., Paris.
	M.—Cable.
136	Collection of sample of telegraphic cables, from the manufactory at Woolwich.
	N.—Line-apparatus.
137	Various insulators.
138	Various iron telegraph-posts.
	O.—Clock-work.
139	A complete representation of the manufacture of Morse registers, from the factory at Berlin.

Apparatus exhibited by Siemens & Halske, Berlin.—Continued.

No.	
	P.—BATTERIES.
140–142	Various batteries.
	Q.—LATEST CONSTRUCTIONS.
143	Chain rapid-sending apparatus, together with receiver.
144	Box type-sender for Morse's rapid writer (by Hefner-Alteneck).
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