HISTORY OF THE ENGLISH ELECTRIC TELEGRAPH

CHAPTER XIII.

William Fothergill Cooke and the Telegraph—Möncke's Electrometer Experiments—The English Electric Telegraph invented—Invention of the Alarum—The Mechanical Telegraph—The Escapement Apparatus—Mr. Cooke's Efforts to put his Telegraph in Operation—The Second Mechanical Telegraph—Wheatstone's Permutating Key-Board—Messrs. Cooke and Wheatstone become associated—The Secondary Circuit invented—Mr. Cooke improves his Original Telegraph—All the Improvements combined—Description of the Apparatuses—Improvements patented in 1838—Wheatstone's Mechanical Telegraph—Further Improvements by Mr. Cooke.

WILLIAM FOTHERGILL COOKE AND THE TELEGRAPH.

The English Electric Telegraph, invented by William Fothergill Cooke, will be the subject of consideration in the present chapter.

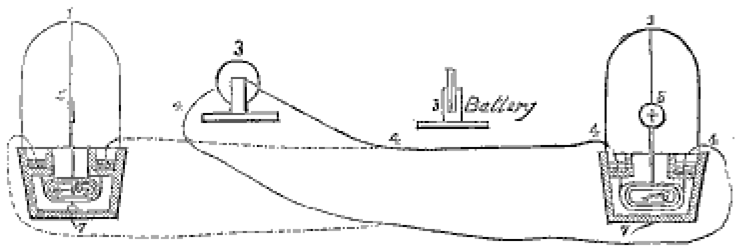
It is not my purpose to discuss the questionable claims of others, in regard to their participation as auxiliaries in the perfection of the above-mentioned telegraph. It *is* my purpose to give the facts with but little comment. The reader can exercise his own judgment in the premises.

In the month of March, 1836, Mr. Cooke was engaged at Heidelberg in the study of anatomy, in connection with the interesting, and by no means unprofitable profession of anatomical modelling; a self-taught pursuit, to which he had been devoting himself with incessant and unabated ardor. On the 6th of March, 1836, he witnessed an electro-telegraphic experiment, exhibited by Professor Möncke of Heidelberg, who had, perhaps, taken his idea from Gaüss. Mr. Cooke was so much struck with the wonderful power of electricity, and so strongly was he impressed with its applicability to the practical transmission of telegraphic intelligence, that, on that very day, he entirely abandoned his former pursuits, and devoted himself henceforth with great ardor, to the practical realization of the electric telegraph.

Professor Möncke's experiment was the only one, at that time, upon the subject of telegraphing, that Mr. Cooke had seen. To him the subject was new and surprisingly novel. The experiment which he saw showed that the electric currents, being conveyed by wires to a distance, could be there caused to deflect magnetic needles, and thereby to give signals. It did not provide any means, however, to practically effect telegraphic purposes. It was but a demonstration of science without a devised appliance in the arts.

MÖNCKE'S ELECTROMETER EXPERIMENTS.

Fig. 1.

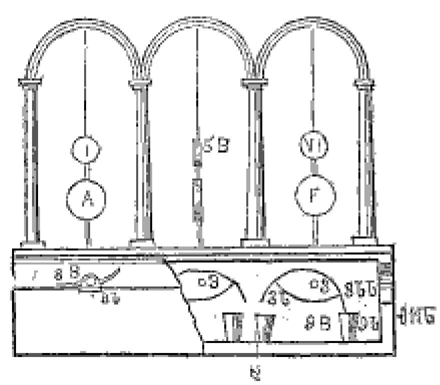


The apparatus exhibited by Professor Möncke, consisted of two instruments for giving signals by a single needle, placed in different rooms, with a battery belonging to each, copper wires being used as the conductor. Fig. 1 represents the apparatus used by Professor Möncke. Numeral 1 is the near and 2 the distant electrometer; 3 is the battery; 4, the conducting or circuit wire; 5, the signal; 6, 6, the electrometers, with magnetic needles, and at 7, 7, are steadying pieces, dipping in a steadying cup of mercury, to support the needle and check oscillation. The signals given, 5, 5, were a cross and a straight line, marked on the opposite sides of a disk of card, fixed on a straw; at the end of which, a magnetic needle was suspended horizontally in an electrometer coil, by a silk thread. The effect of this arrangement was, that if a current was transmitted from either battery when the opposite ends of the wires were in connection with the distant telegraphic apparatus, either the cross would be there exhibited by the motion of the needle one way, or the line by its motion the other way, according to the direction of the current. The apparatus was worked by moving the ends of the wires backward and forward between the battery and the coils.

THE ENGLISH ELECTRIC TELEGRAPH INVENTED.

After Mr. Cooke had witnessed the experiment upon the above described arrangement, he devoted himself to the perfection of a contrivance to effect practically the ends of telegraphing, and within three weeks thereafter, he had, partly at Heidelberg and partly at Frankfort, completed a device for telegraphing, based upon the electrometer form, which, in principle, was the same as the English needle telegraph that has been for many years practically operated in Great Britain. Six wires were used, forming three metallic circuits, and influencing three needles, by which an alphabet of 26 signals was devised. The mechanical and scientific combinations produced a perfect reciprocal telegraphic system, by which a mutual communication could be practically and conveniently carried on between two distant places; the requisite connections and disconnections being formed by pressing the fingers upon the keys, and the signals were exhibited to the person sending them, as well as the person receiving the communication. This important end was effected, by placing a system of keys permanently at each extreme end of the metallic circuit, and by providing each circuit with a cross-piece of metal for completing the continuity of the wires when signals were being received from the opposite terminus. The two signal apparatuses being thus thrown into the course of the electric circuit, every signal was given at both ends concurrently; and the cross-piece was made to restore the circuit for a reply, on the first communication being completed. The system of keys and signal-levers were joined together in the one instrument, so that the pressure upon the key at either station, produced the signal intended at the receiving and sending stations.

Fig. 2.



The apparatus devised by Mr. Cooke to consummate the system of reciprocal telegraphing was simple, and will be understood by studying figures 2, 3, 4, 5, 6, 7, and 8. The whole are parts of the same combination, and the same letters and numerals represents the like parts in the different and respective figures, thus 5 B, represents the same device in fig. 2 that they do in fig. 6.

The apparatuses represented by these figures constituted Mr. Cooke's "reciprocal electrometer communicator."

Fig. 3.

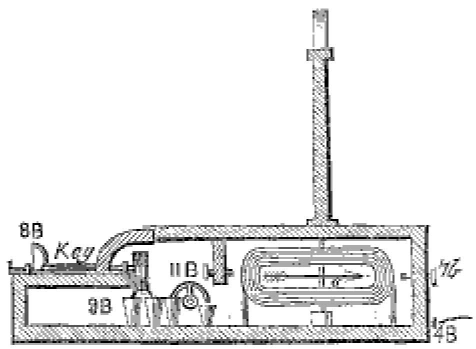
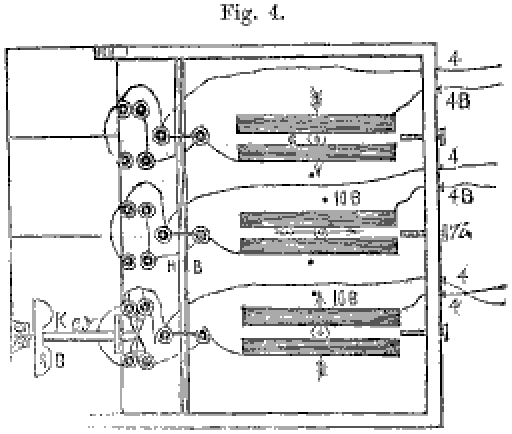


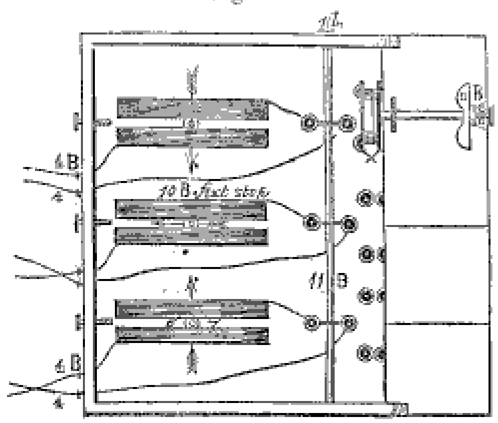
Figure 2 is the near station of the reciprocal telegraph, and fig. 6 the distant station. The battery is represented at the base of fig. 2, and upon a larger scale by fig. 7; 3*b*, 3*bb*, are commutating battery pole bars, for connecting the battery with the conducting or line wires on the pressure of the keys—3*b* is the copper, and 3*bb* the zinc poles of the battery 4, 4B, are the telegraph wires, called by Mr. Cooke, the electrometer or reciprocal telegraph wires, because they were attached to electrometers at each end. 5B is a complete set of 26 simple and compound signals. 7*b* are iron screws for steadying the needles; 8B are communicator keys for uniting the ends of the conducting wires with the poles of the battery, so as to make the current pass in either direction through the conducting wires. The battery seen in fig. 2 is represented in larger scale by fig. 7; and, in fig. 8, a top

Fig. 4.



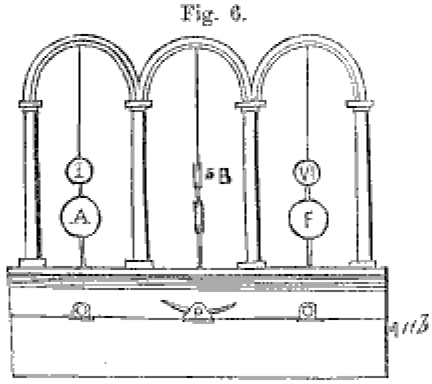
view of it is given. The key 8B, fig. 8, is given on a larger scale with all its parts; the zinc and the copper bars. 9B, 9*b*, represents the current commutator for reversing the direction of the electric current; 9B, is the zinc, and 9*b*, the copper. The line wires and the electrometer as connected with the battery are fully represented in fig. 8. The key represented in fig. 8, is an axle with lever arms, 8B. If the finger presses upon 8B the axle turns, and the connections with the upper cups, fig. 8, are made by the wires attached to the zinc and the copper bars. If the lever on the other side of the axle be pressed, the lower battery, fig. 8, is put into the circuit. If the reader will refer to the keys of the present instruments of the English telegraphs, the same principles will be seen in their organization as represented by fig. 8.

Fig. 5.



In figures 4 and 5, 10B represent fixed stops, or pins, designed to prevent the needles from oscillating too far. 11B is a moveable cross piece, and 11*b* its handle.

Fig. 6.



The manipulation of the apparatus was very simple and easy. In order that the operation may the better be understood by the reader, I will trece the route of the current and show its action, resulting in the perfect transmission of telegraphic communication. Figures 4 and 5 are two end stations, 100 miles apart, at each of which are the instruments represented in the figures. The line wires are seen to the right of

Fig. 7.

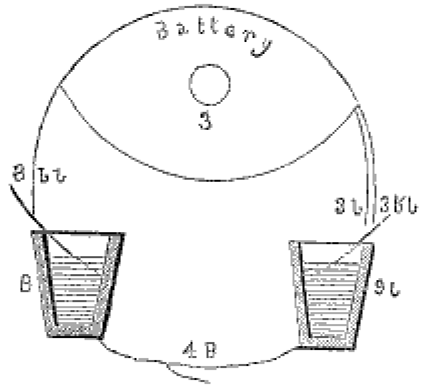
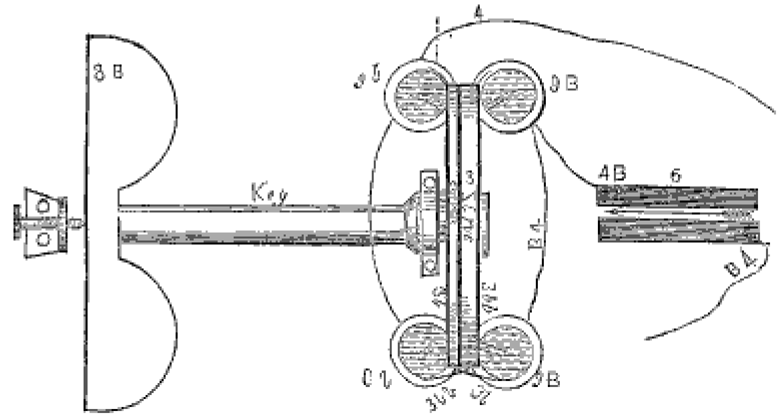


fig. 4, and to the left of fig. 5, marked 4, 4. If the key 8B, fig. 4, is pressed, making the battery current flow over the line, the needle suspended in the coils 10B, will be deflected to the position as seen in the figure, being at right angles to the normal position of the needle, as seen by the middle needle in the same figure. The needle in the terminal station coils, fig. 5, will assume the same position indicated in fig. 4. The electrometer was made in the usual form, and the needle being magnetic, it would move to the right or to the left according to the nature of the current transmitted through the coils, determined by the pressure upon the key, whether upon the right-hand side or upon the left-hand side. The needles of the centre coils are in their normal state. The upper needles are deflected, reverse to those in the lower coils. The position occupied by one may be A, and that by the other B. Two motions, either direction of the needles, another letter and so on, completing the whole combination forming the alphabet.

Besides the arrangement above described, Mr. Cooke invented an apparatus, styled by him a "detector," for discovering any injury done to the conducting wires by water, fracture, or contact. The arrangement was an application of a gauged electrometer.

The foregoing is a fair description of the first electrometer telegraph, invented by Mr. Cooke, between the 9th and 15th

Fig. 8.



of March, 1836. So energetic and successful was Mr. Cooke in the perfection of his telegraph, that within three weeks after he saw the experiment of Möncke, he had the model of his reciprocating telegraphic system in operation.

INVENTION OF THE ALARUM APPARATUS.

Before the end of March, 1836, Mr. Cooke invented the apparatus known as the alarum, which is still extant, in his first mechanical telegraph. The arrangement was of ordinary combination, worked by clock-work mechanism, on the removal of a detent. The invention consisted in placing an electro-magnet in such proximity to an armature of soft iron forming the tail end of a lever detent, that when an electric current passed round the electro-magnet, the magnetism which was, for the moment, excited in it, attracted the tail end of the lever, and by so doing, drew its detent end out of the clock-work; but, on the temporary magnetism ceasing with the cessation of the current, the attraction of the tail-end of the lever ceased also, and the detent-end of it was then replaced in the clock-work by a re-acting spring or balance weight. The principle of removing a detent, by magnetic attraction, and replacing it by mechanical re-action, was not, however, confined to the alarum, but, on the contrary, it was the basis of Mr. Cooke's mechanical telegraphic system, hereinafter described.

THE MECHANICAL TELEGRAPH INVENTED.

In the invention of the mechanical telegraph, Mr. Cooke applied the idea to a musical snuff-box, and in less than six weeks from the time he saw the experiment of Professor

Fig. 9.

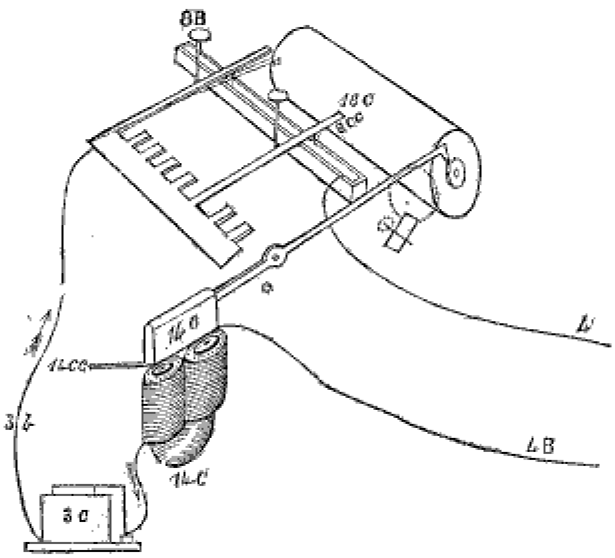
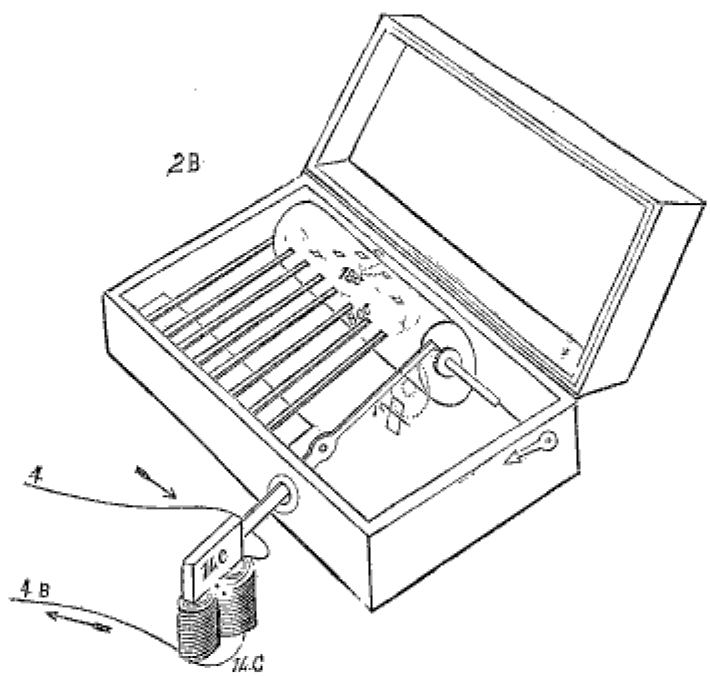


Fig. 10.



Möncke, he had invented his mechanical system. Mr. Cooke considered that the striking advantage held out by the mechanical, in comparison with the electrometer form was, that, whereas the mode of giving signals by combination of magnetic needles, each acted upon directly and separately by an electric current, involved the necessity of using several circuits, and consequently the expense of several wires; on the other hand, if the electric agency could be confined to the office of causing suitable interruptions or divisions in any kind of motion derived from an independent source, the necessity of a plurality of circuits would be avoided, for the diversity of signals would then depend upon the mechanism.

Figures 9 and 10 represent the mechanical telegraph, as devised upon the principles of the musical snuff-box.

The electro-magnets, 14c, of the respective stations, are seen in the figures; 3, the battery; 14*c*, are the armatures of the magnets to which are attached the detent levers; 4 and 4B are the line wires, and the arrows indicate the course of the current. The circuit, as arranged in figs. 9 and 10, is opened and closed by the action of the apparatus of fig. 9. Pressure upon the keys completed the electric circuit; which magnetized the cores of the electro-magnets, the armatures were then attracted, which drew down one end of the detent lever, and elevated the other end, drawing it out of the train of wheels, and allowing the mechanism to move on by its own maintaining power, till the intervention of an appropriate pin, 18*c*, fig. 10, upon the cylinder or barrel, struck up the key, 8*ce*, the circuit was then broken. When broken the magnetism ceased to exist in the cores of the spools, therefore, an end was put to the attraction of the armature end of the detent lever, and the re-acting spring drew the lever, so as to place the detent in its normal position, which put a stop to the mechanism, at the time when the revolving dial was presenting before an opening in the frame of the apparatus at each terminus, the requisite letter, figure, or symbol. The signal to be made was determined by the proportion of a revolution which the barrel was allowed to make without interruption; therefore, although some latitude was allowed for a variation in the speed of the different apparatuses, the successful transmission of intelligence depended, to a certain extent, upon a similarity of timing; any great variation of time would introduce confusion into the signals, and in proportion to every increase in the speed at which the signals were given, the latitude allowed for variations would become actually less, though remaining relatively the same; consequently, in proportion to the increased rapidity of a succession of signals, greater accuracy of mechanism would be required. If the signals could be given by divisions of the mechanical motion similar to the divisions made by the escapement of a clock, the necessity of accurate timing would be altogether avoided, for it would then be only necessary that every intervention of the attractive force of the magnet, should occasion or allow a motion of the armature or pallet of each escapement, without its being necessary that a motion of the pallet should occupy, in each instrument, precisely the same period of time.

Fig. 11.

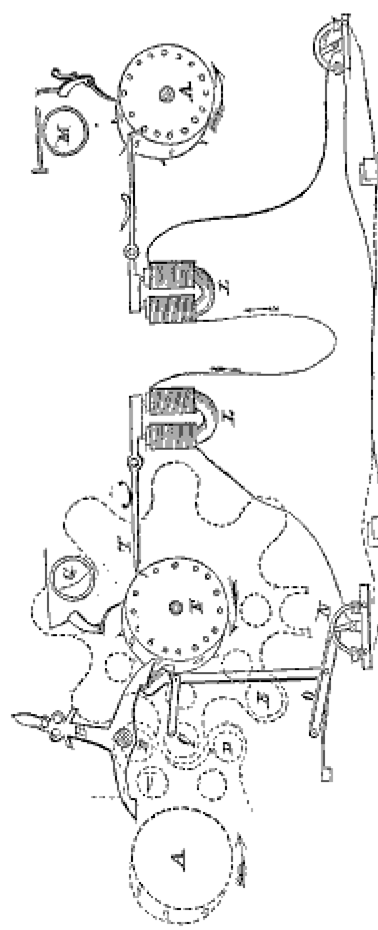


Fig. 11 is an extension of the telegraph, based upon the plan of the musical snuff-box. The engraving is an outline view of the mechanism. The parts in fig. 11 are indicated by different letters from those used in figs. 9 and 10. In the former A A are the cylinders or barrels containing the keys; M is the alarum bell; L L the magnets; B, C, D, and E, are the ends of various cylinders.

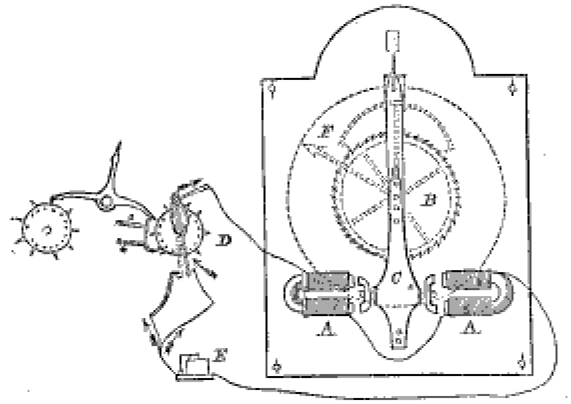
I do not deem it necessary to give a detailed description of the mechanical arrangement of the apparatus, believing that sufficient has been shown to enable the reader to understand the general plan. It is the first mechanical telegraph invented by Mr. Cooke, in March, 1836.

THE ESCAPEMENT APPARATUS.

In July, 1836, Mr. Cooke produced his experimental escapement instrument, represented by figures 12 and 13, based upon the principle of the vibrating pendulum, alternately retained by one of two magnets, on the same conducting wire, actuated by an escapement wheel, the signal being given by an index hand.

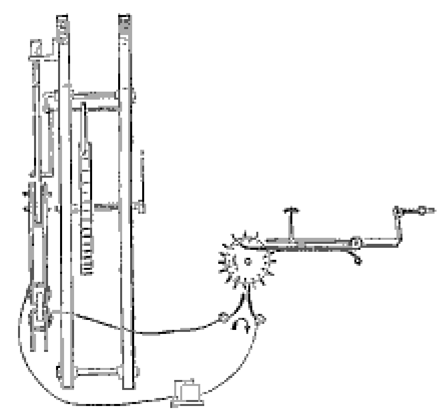
A A are two electro-magnets, alternately detaining the detent, to which are attached the armatures of the magnets; to the right and left of the letter C, is the alternating detent in the form

Fig. 12.



of an anchor escapement, stopping the clock-work by catching the teeth of the scape wheel, B. C is the detent-lever attached to the armatures; F is the revolving hand pointing to the signals.

Fig. 13



nals. Figure 13 is an end view of figure 12, in which are seen the magnets at the left, the scape wheel, B, in the centre, and the index hand is on the right.

MR. COOKE'S EFFORTS TO PUT HIS TELEGRAPH IN OPERATION.

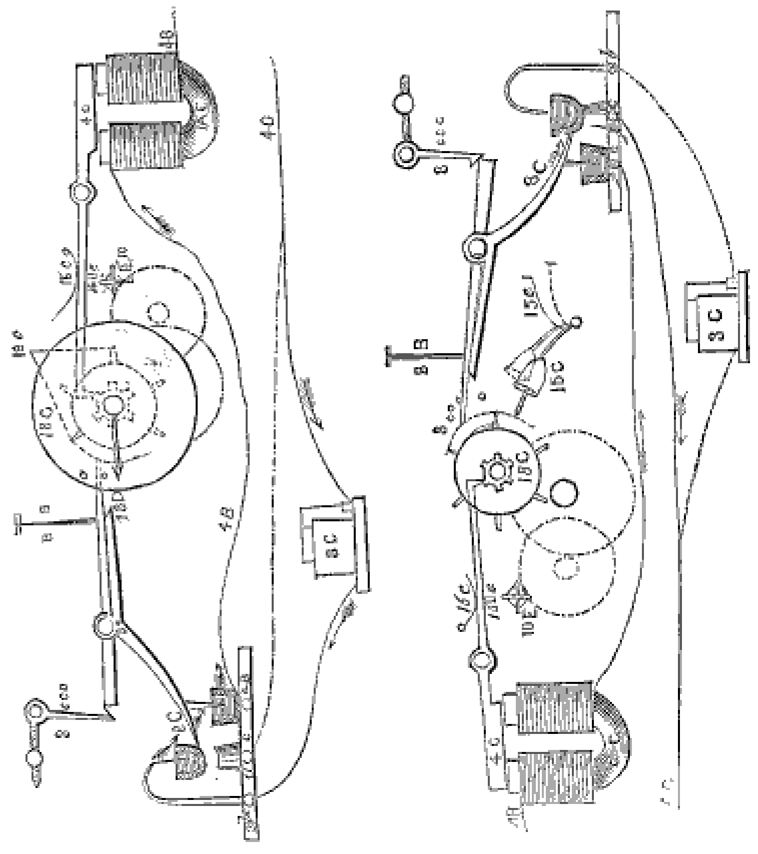
Having thus perfected his various plans of the electric telegraph, Mr. Cooke, in the latter part of 1836, directed his attention toward the application of his invention on the Liverpool and Manchester railway. To this end, he issued a pamphlet, presenting the advantages of his telegraph, its plan of operation and construction, and its utility for the railway service; and particularly having in view the practical adoption of his telegraph in tunnels, for which some mode of conveying signals was required. The directors of the railway company, thought his instrument, which was calculated to give 60 signals, of too complex a nature for the purpose of conveying a few signals along a tunnel, and therefore they proposed to Mr. Cooke, that he should arrange one adapted for their purposes.

With the object of accommodating the wants of the railway service, Mr. Cooke proceeded to devise a system of telegraphing, calculated to give fewer signals and much less complicated. This, however, was done, but upon the principles of the first mechanical telegraphic apparatus.

THE SECOND MECHANICAL TELEGRAPH.

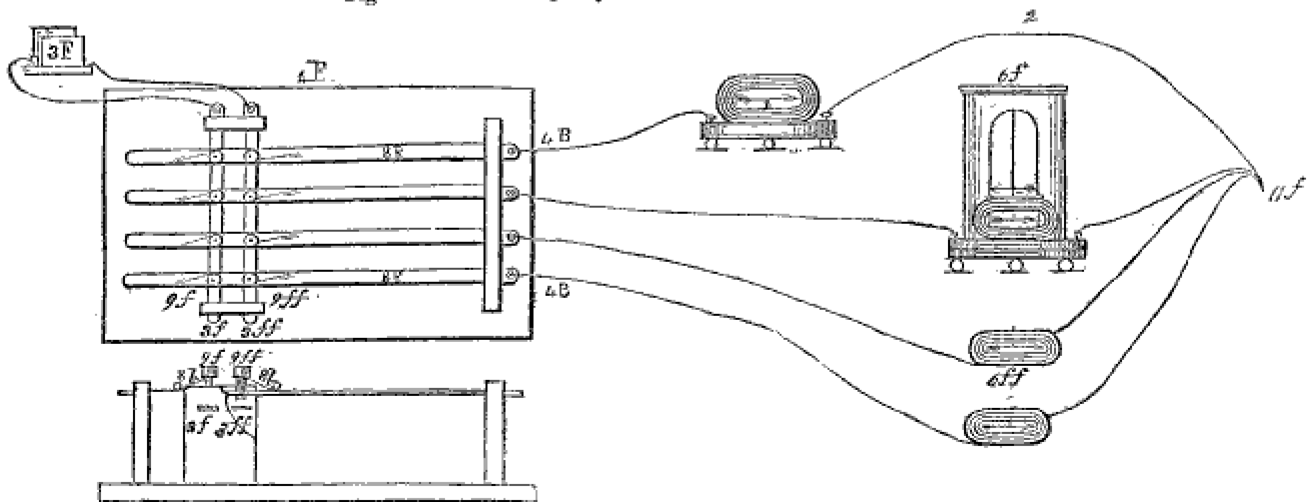
Figures 14 and 15 represent the second mechanical telegraphic apparatus, on which was employed only two wires. It was invented by Mr. Cooke, 10th of February, 1837; two of which he had working together in the following April. The figures represent two different stations; A C are the electro-magnets; 4, the line wire; 3C, the batteries; 4c, the armatures of the electro-magnets, to which are attached the detent levers; 10E, are fan wheels by which the detent arrests the mechanism; 16e, is the detent to catch the fan wheels. The action of the different parts of this apparatus is the same as the like parts of figures 9, 10, and 11. This apparatus was perfectly qualified to perform the intended service at the railway tunnels, but in the meantime a pneumatic apparatus was laid down, which superseded the electric appliance; the former was supposed, by the directors, to be better than any system operated by electricity. It was at a time when there were none of the arts operated through the agency of voltaic force, and the railway company were not disposed to experiment upon that which to them seemed, as the vision of a dream. Mr. Cooke, however, was not to be crushed by this failure, and he proceeded to perfect his knowledge in the science of electro-magnetism, endeavoring to ascertain at what distance an electric current would excite the temporary magnetism required for moving the detent of the mechanism. His experiments were not, to him, satisfactory, and he sought the advice of Prof. Faraday, and then Dr. Roget. This latter gentleman referred him to Professor Wheatstone, of King's College. Mr. Cooke lost no time in making the acquaintance of Prof. Wheatstone, which took place on the 27th day of February, 1837. The two gentlemen discussed the subject of telegraphing, freely, and Prof. Wheatstone exhibited to Mr. Cooke

Fig. 14. Fig 15.



an apparatus which he had been using in his experiments on the effects of electric currents in deflecting magnetic needles. To open and close a circuit, Prof. Wheatstone had arranged two very ingenious contrivances, which he called "permutating key boards."

Fig. 16.—Permutating Key-Board invented by Prof. Wheatstone.



This ingenious contrivance was used by Prof Wheatstone in the latter part of the year 1836, in his room at King's College. About the same time he publicly expressed an opinion that an electric telegraph was possible.

WHEATSTONE'S PERMUTATING KEY-BOARD.

This contrivance was used by Prof. Wheatstone, in his electrical experiments, transmitting different currents over long wires. It was arranged to send a current over any one of the four wires, represented in figure 16. 4F, is the near key-board; 4B, are wires attached to the keys, and extending through the electrometer, 6*f*, and uniting beyond at 11*f*; 6*ff*, were electrometers *designed* to be applied; 3F, is the battery designed to be applied to the several circuits as circumstances required; 3*f*, 3*ff*, are fixed pole bars. The section below, gives an end view of the key-board. At that time, this contrivance was one step toward a telegraph, though in its invention, Prof. Wheatstone, it seems, did not contemplate the invention of a telegraphic apparatus. His mind and experiments were directed toward the advancement of the sciences, leaving to others the application of his discoveries to the useful arts. The principle contemplated, was to give a complete set of signals at a distance, by the motion of two or more horizontal magnetic needles, with permutating keys and commutating pole bars; giving the maximum number of signals by the minimum number of wires required for the electrometer telegraph; thus, the closing of the circuit at the key-board, transmitted a current of electricity, from the voltaic battery, over the wire, and caused the needle of the electrometer to move. It seems, however, that he had not had in view any arrangement for detecting injuries to the wires, of attracting attention at the commencement of the communication, of sending signals alternately backward and forward by the same apparatus, and of exhibiting signals to the operator, as well as to the recipient. But this deficiency in the plans of Prof. Wheatstone, was not surprising. He was in the pursuits of science, expecting no other reward on account of his discoveries, than the consciousness of having advanced science, and the pleasure realized in the discovery of new truths, and the scientific reputation. Such were the sentiments entertained by the philosopher of whom I am now writing.

Mr. Cooke was not so imbued. He was not a discoverer, but an inventor.

MESSRS. COOKE AND WHEATSTONE BECOME ASSOCIATED.

In the short acquaintance which Mr. Cooke had with Professor Wheatstone, he found cause to admire his great learning, and particularly his knowledge of electricity and electro-magnetism, and he urged Prof. Wheatstone to co-operate with him in the advancement of his invented telegraph, confidently believing, that if he had the influence of the scientific recognition of Prof. Wheatstone, his telegraph would command favor. The world at that time was ignorant of the wonderful powers of the electric and magnetic forces for telegraphing. The new art needed the aid of scientific encouragement, and Mr. Cooke believed, that in getting associated with him Prof. Wheatstone, and the influence of his scientific friends, the telegraph would not only be a success in the opinions of scientific gentlemen, but also as a commercial enterprise. Like all high-toned scientific gentlemen, Prof. Wheatstone refused the association, because, as he said, in substance, he preferred to publish the results of his experiments, and then to allow any person to carry them into practical effect, and that, in the position he stood, to associate his name with that of any other person, would diminish the credit which he would obtain by publishing separately the results of his own researches. But, as Mr. Cooke was not seeking scientific reputation, he assured Prof. Wheatstone, that there would be no interference in that respect. In substantiation of the correctness of these statements, reference may be made to the award given by Messrs. Brunel and Daniell, and which award was approved by Messrs. Cooke and Wheatstone; it emphatically says, "Mr. Cooke is entitled to stand alone, as the gentleman to whom this country is indebted, for having practically introduced, and carried out, the electric telegraph as a useful undertaking, promising to be a work of national importance; and Prof. Wheatstone is acknowledged as the scientific man, whose profound and successful researches have already prepared the public to receive it as a project capable of practical application."

In regard to the rapid progress of the telegraph, it was the award of the above-named gentlemen, that to the united labors of the two gentlemen the credit was due.

Mr. Cooke had brought his inventions to England, and to effect success, he needed the scientific assistance of some gentleman, who could inspire the public with confidence in the telegraph, and he never ceased, until he had secured the invaluable co-operation of Prof. Wheatstone, and the two gentlemen embarked in the enterprise, upon agreed terms as to interest and duties, early in May, 1837.

THE SECONDARY CIRCUIT INVENTED.

During the month of April, 1837, Messrs. Cooke and Wheatstone united their labors, to perfect new improvements for the telegraph, and the first achievement was the discharger and

Fig. 17.

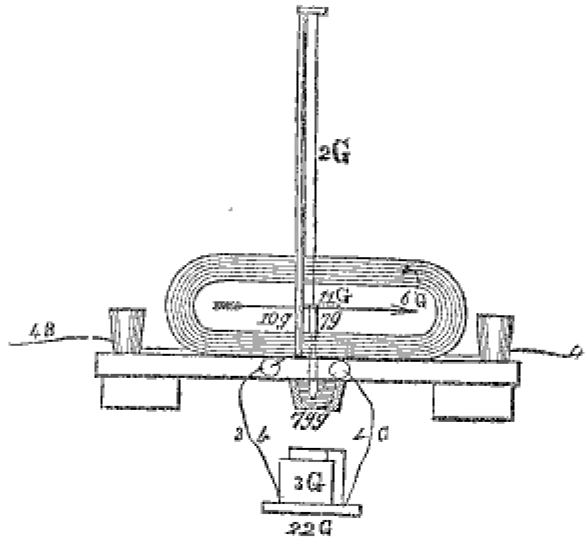
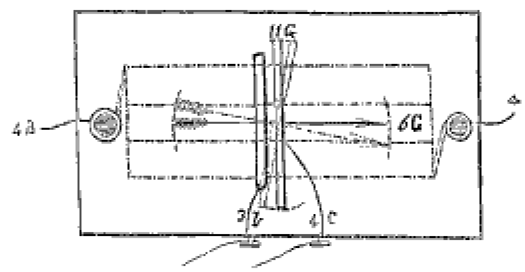


Fig. 18.

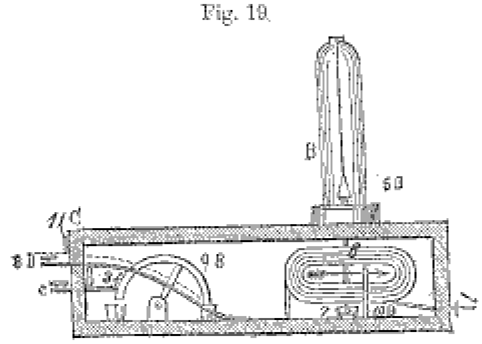


secondary circuit, represented by figs. 17 and 18; to be applied to Mr. Cooke's original alarum, which was subsequently superseded in practice by Mr. Cooke's alarum, described in the second English specification. The principle of this new improvement was the motion imparted to an electrometer needle by a distant battery, being made to complete the circuit of a second battery, which second battery, excited temporary magnetism in an electro-magnet, and by its attraction removed the detent of clock-work mechanism.

The part 2G is of the distant electrometer instrument forming the discharger; 3G is the secondary battery operating with the second circuit; 3*b* is the battery or circuit wire, terminating in the stop 10*g*, and the wire 4*c*, in the cross-piece 11G; so that, when the magnetic needle was moved by an electric current, the cross-piece 11G was brought into connection with stop 10*g*; and completed the circuit of the secondary battery, 3G; 6G is the electrometer needle, carrying the cross-piece, 11G; 7*g* is a connecting and steadying platinum-piece immersed in 7*gg*, which is a mercury cup; 10*g* is a fixed stop, being the termination of battery wire 3*b*; 11G is the moveable cross-piece, here fixed on an axis of a magnetic needle. Fig. 17 is the side view of the apparatus, and fig. 18 is the top view, showing the movement of the needle.

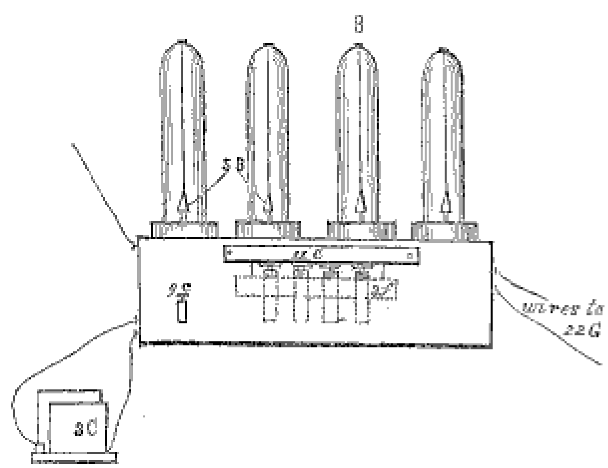
MR. COOKE IMPROVES HIS ORIGINAL TELEGRAPH.

Fig. 19.



In the month of April, 1837, Mr. Cooke, while preparing his application for a patent, made some improvements on his electrometer telegraph of 1836. This new combination included the entire alarum attachment, as practically operated at the present time. It contained the old signal apparatus, slightly varied, and the original cross-piece. It resembled, very much, his original invention, except in the addition of the alarum, which

Fig. 20.



had been adopted in the mechanical instrument, in conjunction with the secondary circuit; this was an important improvement, and it was suggested by the permutating keys and the second mechanical telegraph. The principles of the two were adopted in the use of one common blank wire, which was in

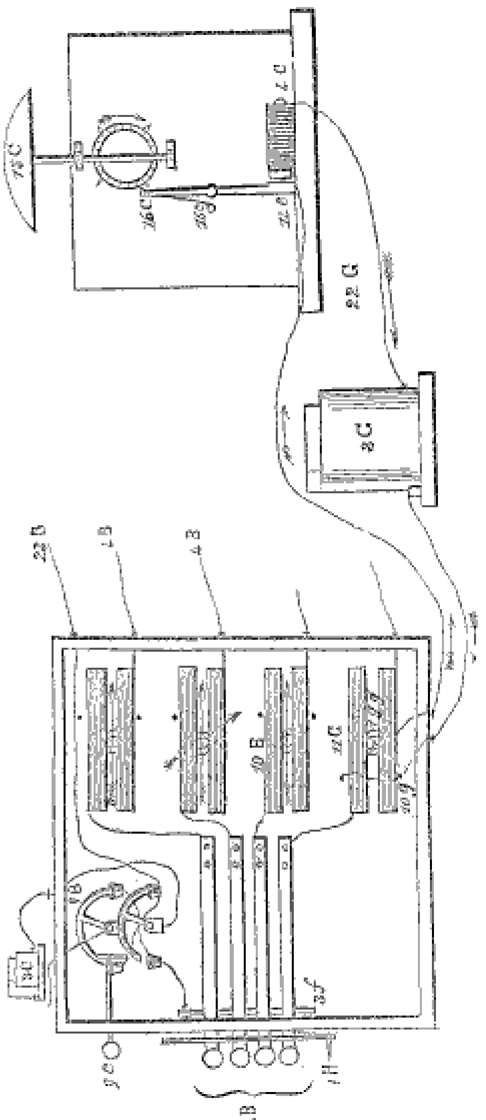


Fig. 21.
The Connection of Prof. Wheatstone's Key-Board and Mr. Cooke's Electrometer Telegraph and Alarum Apparatus.

permanent connection with both terminal batteries. By this combination the movements of single needles were effected, and a distinct class of signals was made, which, subsequently, was found to be highly valuable in practice. Figures 19, 20, and 21, give different views of this later improvement. It is founded upon the principle of the commutation of several electrometer wires with one blank or return wire. Signals given by the motion of one or more needles, were the same as those given in the original invention of 1836. Figure 19 represents a side view, showing the application of the key to the battery. When the key at 8B is pressed, the arc rod *3f* is carried into the mercury cup or other contact arrangement closing the voltaic circuit. Fig. 20 is a front view of the same apparatus, the keys being shown by the dotted lines. Fig. 21 is the top view of figs. 19 and 20 having also the alarum attachment, herein before described. The whole of the mechanical appliances, embraced in this telegraphic organization, have now been described sufficiently to enable the reader to understand the success attained by Mr. Cooke in the invention.

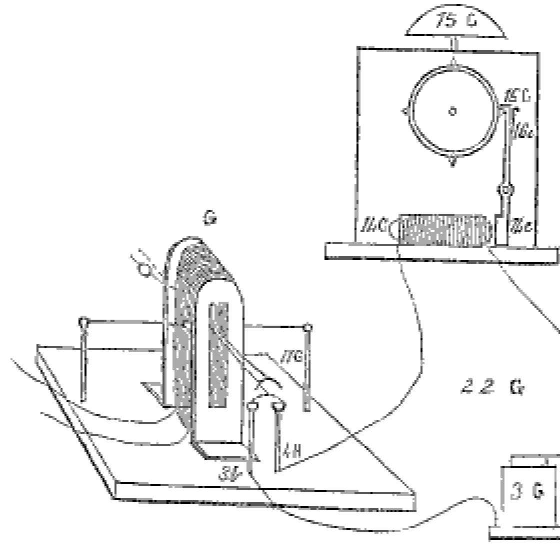
ALL THE IMPROVEMENTS COMBINED.

I have now arrived at the most important invention, that is, the whole combination of improvements, made by Messrs. Cooke and Wheatstone, and for which a patent was obtained, dated June 12th, 1837. The fundamental principle of this telegraph was the same upon which was founded Mr. Cooke's original invention, with the addition of the vertical electrometers and astatic needles, and the invention of the converging vertical diagram, upon which the needles exhibited their relative positions in the formation of signals.

This arrangement contemplated the use of five wires of principal and secondary circuits. The second circuit was designed for alarum purposes.

Before proceeding in the further explanation of the principal circuit—which has already been done sufficient to give the reader an idea of its connection with the second circuit—I will describe the secondary circuit (fig. 22): G is the electrometer, the coils of which are in the main or principal circuit; the to and from wires of which are seen upon the left of the figure; 3b and 4H, are conductors, having at tops mercury cups, into which the fork on the end of the needle descends, whenever a current passes through the electrometer. The connection made between the mercury cups by the fork at the end of the needles, closes the second circuit, in which is placed the voltaic battery 3G; 14c is the electro-magnet, around which the local or

Fig. 22.



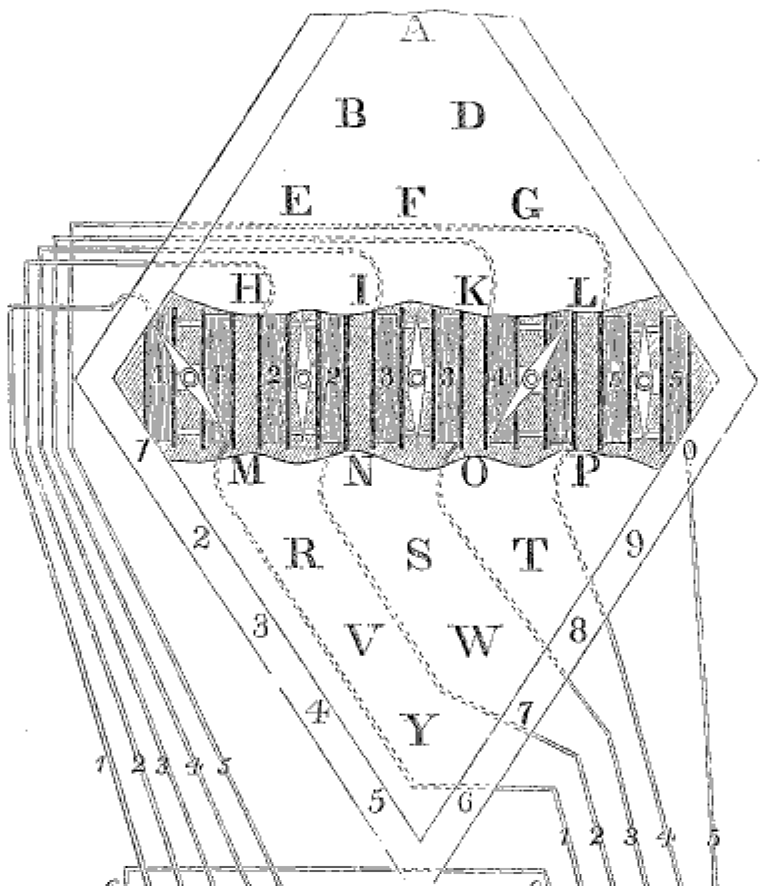
secondary circuit traverses, and magnetizes the soft iron cores or horse-shoe; 14c is the armature and detent rod attached, which catches upon the teeth of the wheel at 16c. When the armature is attracted, the wheel is let revolve, which causes a hammer to strike upon the bell 15c, producing an alarum of any required sound. In this manner, was practically operated a second circuit for the making of intelligible sounds, effected by the aid of a main and a local circuit, the latter being subservient to the will of the operator in the manipulation of the principal or main circuit.

The signal dials were vertical and diamond shaped. The dial was an improvement devised a short time before the application for the first patent. I have, in the foregoing, described all the parts of the telegraph invented and patented by Messrs. Cooke and Wheatstone, respectively, and jointly. With a view to give the reader a better understanding of the system, I herewith present a description, taken from a publication issued in London in 1839, as follows, viz.:

DESCRIPTION OF THE APPARATUSES.

This arrangement requires the service of five electrometers, in every respect constructed similarly to those hereinbefore described. Figure 23 is a representation of the dial, which is also a covering to the case containining, in the interior, the five electrometers and their wires (shown at the opening in the dial board), and numbered, 1, 1; 2, 2; 3, 3; 4, 4, and 5, 5. The coils of the multipliers are secured with their needles to the case, having each exterior needle projecting beyond the dial, so as to be exposed to view. Of the wires from the coils, five are represented as passing out of the side of the case, on the left hand, and are numbered 1, 2, 3, 4, and 5. The other five wires pass out on the right hand, and are numbered in the same manner. The wires of the same number as the electrometer, are those which belong to it, and are continuous. Thus the wire 1, on the left hand, proceeds to the first coil of electrometer 1, then to the second coil, an d then coming off,

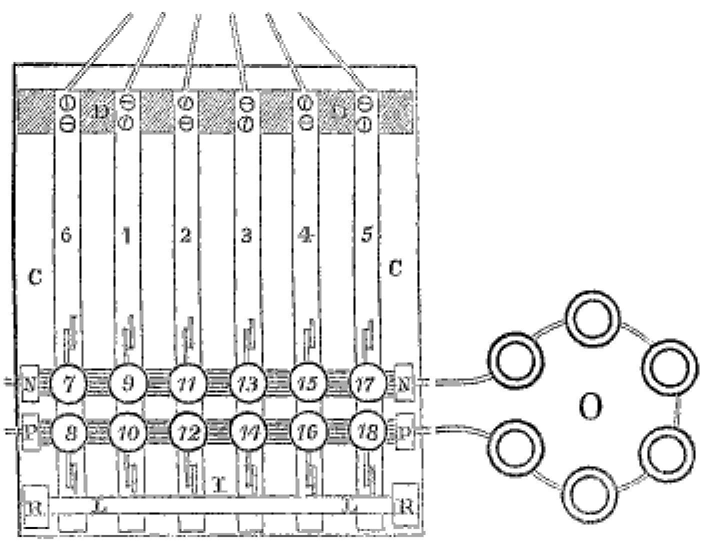
Fig 23.



passes out of the case, and is numbered 1, on the right hand. So of the other wires, thus numbered. The dial has permanently marked upon it at proper distances and angles, twenty of the letters of the alphabet, viz. A, B, D, E, F, G, H, I, K, L, M, N, O, P, R, S, T, V, W, Y. On the margin of the lower half of the dial are marked the numerals, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 0. The letters, C, J, Q, U, X, Z, are not represented on the dial, unless some six of those already there are made to sustain two characters each, of which the specification is silent. Each needle has two motions; one to the right, and the other to the left. For the designation of any of the *letters*, the deflection of two needles are required, but for the *numerals*, one needle only. The letter intended to be noted by the observer, is designated, in the operation of the telegraph, by the *joint deflection* of two needles, pointing by their convergence to the letter. For example, the needles, 1 and 4, cut each other, by the lines of their joint deflection, at the letter V, on the dial, which is the letter intended to be observed at the receiving station. In the same manner any other letter upon the dial may be selected for observation. Suppose the first needle to be vertical, as the needles 2, 3, and 5, then needle 4 being only deflected, points to the numeral 4, as the number designed.

I will now proceed to describe the arrangement of the springs and buttons upon the platform, C C, figure 24 (representing a

Fig. 24.

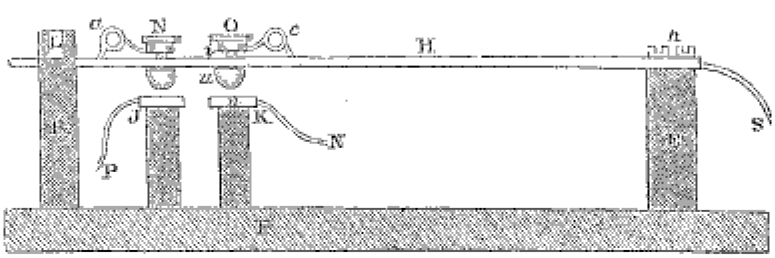


top view), by the operation of which, any two needles may be deflected to designate a letter, or one needle to designate a numeral.

The numbers, 6, 1, 2, 3, 4, and 5, represent keys of thin brass, and elastic, and are each fastened to a wooden support, D, D, by means of two screws. These keys are continued under and project beyond, the brass bar, L and L, which is supported by two standards, R and R. Whenever these keys are not pressed upon, they are each in *metallic contact* with the *bar*, R and R. The numbers 7, 8, 9, 10, &c., represent ivory buttons with a metallic stem beneath them, passing through a hole in the spring, or key, and on the lower side of the spring the stem is enlarged, so as to form a kind of hammer, designed to make a metallic contact with the two brass bars, beneath the springs, and represented as supported by the standards N and N, and P and P. Each of the buttons has a small wire spiral spring, to which it is fastened, and the small spring is itself fastened to the larger spring. O represents the voltaic battery, with its poles in connection with the two metallic bars, N and P.

Figure 25 represents a side view of the key arrangement; F is the platform; E the wooden support of the six keys; H is the larger spring, or key, secured to the support by screws, *h*; the spring is observed to project beyond the metallic cross bar, L, after passing beneath it; R is the support of the cross bar L; N and O are two of the ivory buttons, upon their spiral springs, *a* and *c*. Below the button, O, is a shoulder, formed at *i*, upon the stem which passes through the spring, H, and another shoulder is formed by the hammer, *u*, below the spring. It will be observed, that two buttons of the same key are never used at the same time. If the button, O, is to be

Fig. 25



pressed down, the weaker spring, *c*, will permit it to descend until the upper shoulder comes in contact with the larger spring, H, when more pressure is applied, and that spring is brought down, breaking its contact with the metallic cross-bar, L, until the hammer, *u*, comes in contact with the metallic plate, *n*, upon the support, K, and as the plate, *n*, is connected with the N pole of the battery, the connection is formed with it. It will, however, be noticed that the button, N, not being pressed upon, *will not* (though it descends with the larger spring) be brought in contact with the other plate upon the support, J, and connected with the positive pole of the battery. To the end of each spring, a wire, S, is soldered, the purpose of which will be shown hereafter.

Fig. 26.

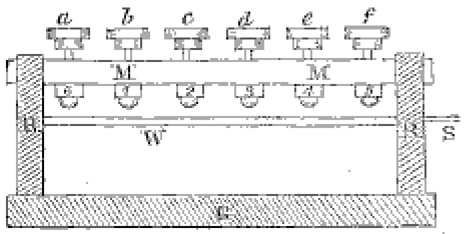


Figure 26 represents an end view of the key arrangement: *a*, *b*, *c*, *d*, *e*, *f*, are the buttons; M and M the metallic cross-bar, beneath which are seen the ends of the six larger springs, 6, 1, 2, 3, 4, and 5; R and R are the supports of the bar, M and M; G is the platform; W is the support of the metallic plates, with which the hammers of the little keys, or buttons, come in contact; S the wire leading to the battery.

Having shown the several parts, I will proceed to describe the arrangements of two termini, as prepared for transmitting intelligence. Figure 27 represents the arrangement of one station, which we may suppose to be PADDINGTON. Figure 28 represents the plan of the other station, which we will suppose to be SLOUGH. The distance between these two places is eighteen miles.

In figure 27, it will be seen, that a wire is soldered to the end of each of the springs 6, 1, 2, 3, 4, and 5, and respectively connected with the five wires of the dial, and the common communicating wire number 6, which does not pass through the dial, nor is connected with any of the electrometers. On the right hand side of the dial, the wires are extended until they are shown as broken. From this point to the opposite one, figure 28, where the wires appear also as interrupted, we may suppose 18 miles to intervene. The wires here proceed to the dial of the Slough station, making their proper connections

PADDINGTON.

Fig. 27.

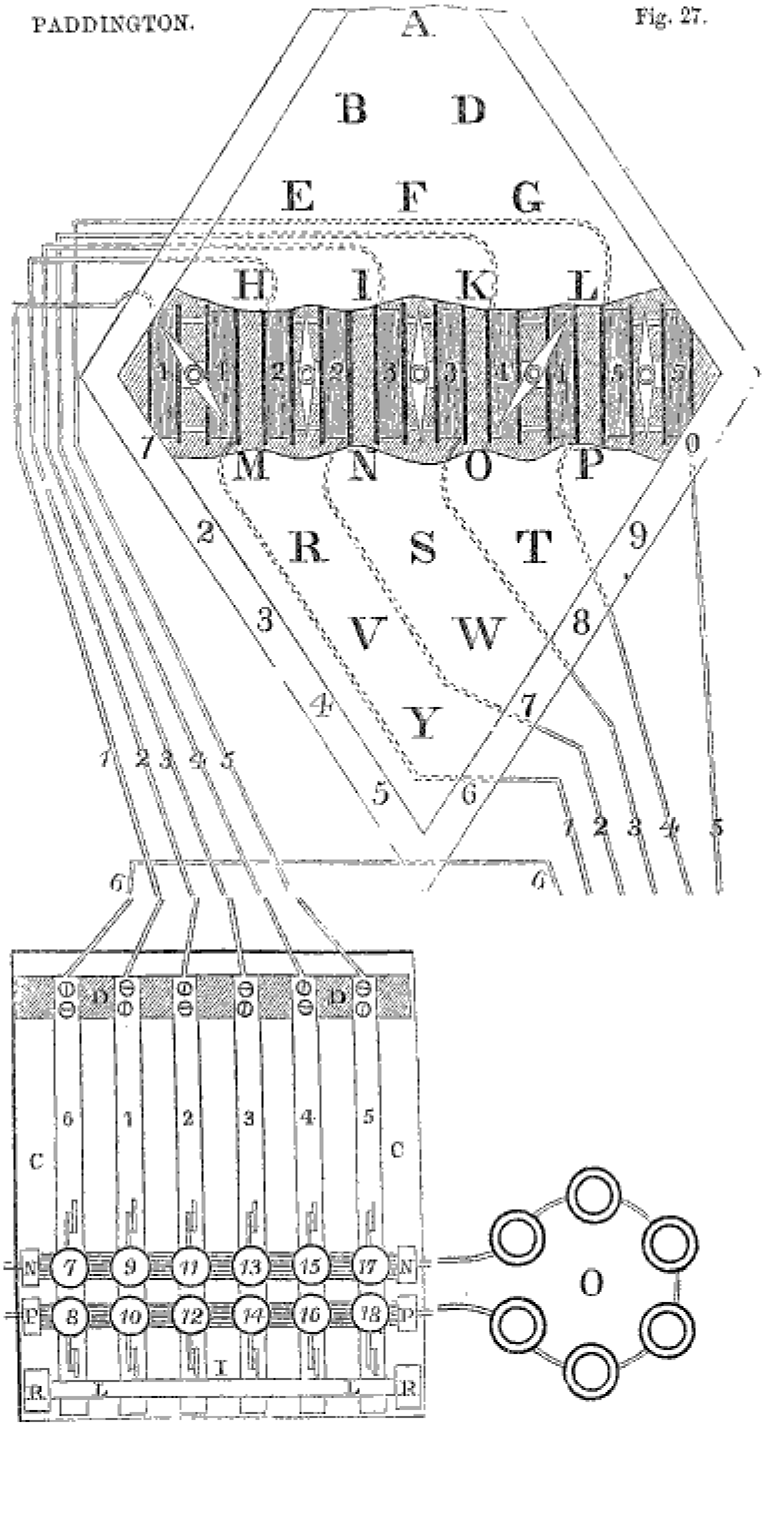
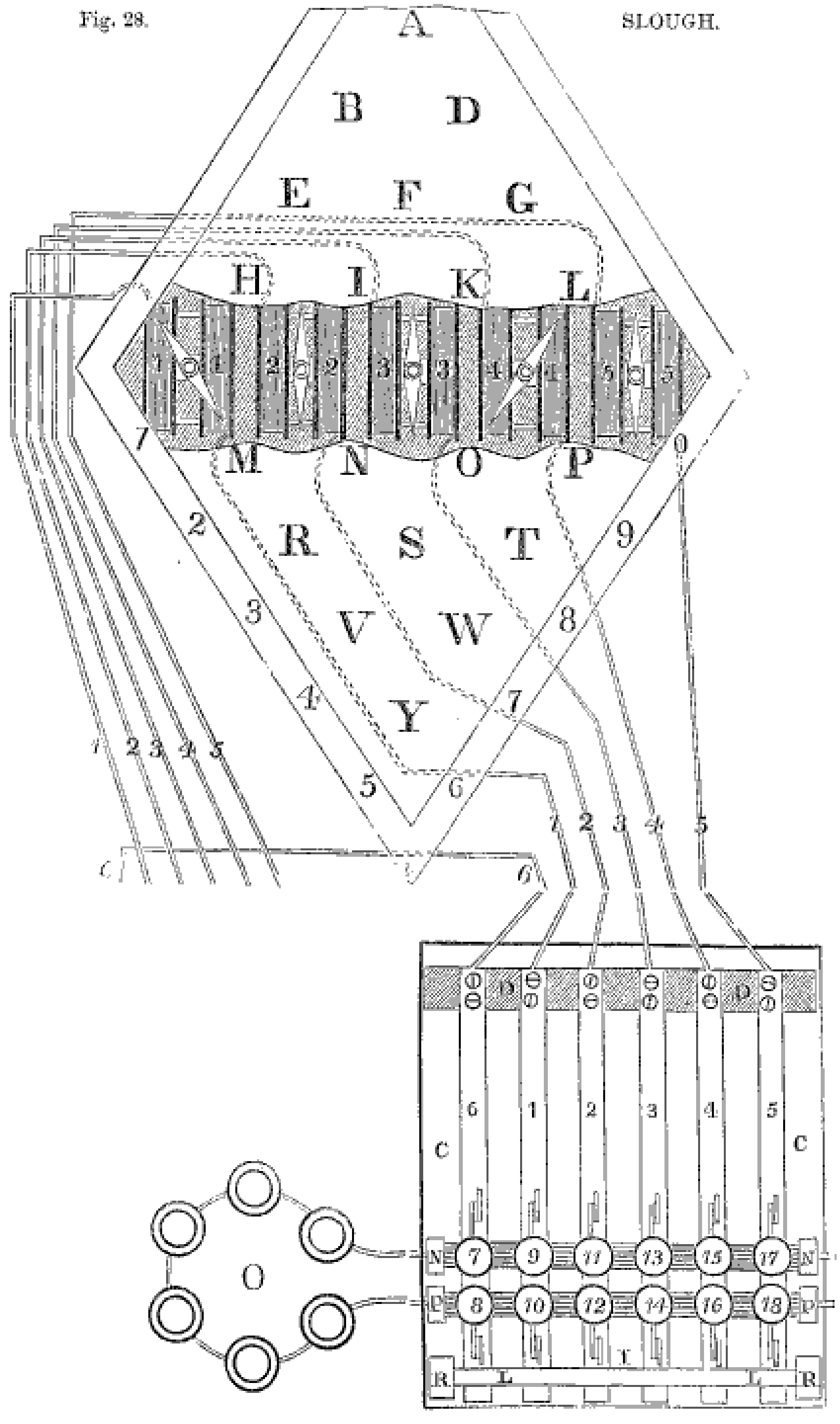


Fig. 28.

SLOUGH.



with their respective, electrometers, and thence they are continued and soldered to their springs of the key arrangement, with the exception of wire number 6, which passes direct to the key 6, without going through the dial case. In both figures, is represented the battery, O, consisting of six cups The wire from one pole of the battery is connected with the N metallic plate, the other wire with the P metallic plate. While none of the buttons are pressed down, the battery is *not* in action, and it will also be observed, that the circuits are all *complete*. The action of the keys, then, is this, by a single operation to break the circuit formed with the cross-bar, L L, and, at the same time, bring *into* the circuit, the battery, O.

The following numbers, representing the buttons, are those necessary to be pressed down, in order to signal the letters and numerals on the dial:

Letters.

For A,	buttons	10	and	17.	For M,	buttons	9	and	12.
" B,	"	10	"	15.	" N,	"	11	"	14.
" D,	"	12	"	17.	" O,	"	13	"	16.
" E,	"	10	"	13.	" P,	"	15	"	18.
" F,	"	12	"	15.	" R,	"	9	"	14.
" G,	"	14	"	17.	" S,	"	11	"	16.
" H,	"	10	"	11.	" T,	"	13	"	18.
" I,	"	12	"	13.	" V,	"	9	"	16.
" K,	"	14	"	15.	" W,	"	11	"	18.
" L,	"	16	"	17.	" Y,	"	9	"	18.

Numerals.

For 1,	buttons	7	and	10.	For 6,	buttons	8	and	9.
" 2,	"	7	"	12.	" 7,	"	8	"	11.
" 3,	"	7	"	14.	" 8,	"	8	"	13.
" 4,	"	7	"	16.	" 9,	"	8	"	15.
" 5,	"	7	"	18.	" 0,	"	8	"	17.

The direction of the current, when the letter V is to be signalled, is this: pressing down the buttons, 9 and 16, at the Paddington station, the fluid leaves the battery, O, along the wire to the cross bar, P; then to the hammer of the button, 16; then to the spring, 4; then along wire 4, to the electrometer, 4, and through it, deflecting the lower half of the needle to the left; then along the extended wire, 4, to the dial, and electrometer, 4, of the Slough station, deflecting the lower half of that needle to the left; then to wire, 4, leaving the dial, to key, 4; then to the cross-bar, L and L; and along the cross bar to key, 1; then to wire, 1; then to electrometer, 1; and through it, deflecting the lower half of the needle to the right; thence it proceeds along the extended wire, 1, to the Paddington station; entering the dial to the electrometer, 1, deflecting the lower half of the needle to the right; then along wire, 1, to the key, 1; then to button 9; then to the cross-bar, N, beneath; and then to the negative pole of the battery, O. It will be observed, that the needles of both stations, thus deflected, point to the same letter V.

If a numeral is be signaled, it is obvious, that but one electrometer is needed. We will, therefore, suppose that the needle, 1, is vertical.

Let the buttons, 7 and 16, be pressed down, at the Paddington station. The current then leaves the positive pole of the battery, O, to the cross-bar, P; then to the key, 4; then along wire, 4, to electrometer, 4, deflecting the lower half of the needle to the left; thence to the Slough station to electrometer, 4, deflecting the lower half of the needle to the left; then to wire, 4; then to key, 4; then to the cross-bar, L and L, and along it to key, 6; then to wire, 6, and along the extended wire to the Paddington station, to key, 6; then to the cross-bar beneath the button, 7; then to the negative pole of the battery, O. The needles, 4 and 4, of both stations, are simultaneously deflected, so as to point to the figure, 4, on the margin of the dial.

In this manner the circuits required for each letter and numeral may be traced out. Now, suppose the message to be sent from the Paddington station to the Slough station, is this, "WE HAVE MET THE ENEMY AND THEY ARE OURS." The operator at Paddington presses down the buttons, 11 and 18, for signalizing upon the dial of the Slough station, the letter W. The operator there, and who is supposed to be constantly on the watch, observes the two needles pointing at W. He writes it down, or calls it out aloud, to another, who records it, taking, according to a calculation given in a recent account, two seconds at least, for each signal. Then the buttons, 10 and 13, are pressed down, and the needles are observed to point at E; and so for the remaining letters of the sentence, U excepted, which has no letter on the dial.

IMPROVEMENTS PATENTED IN 1838.

The second English patent was sealed 18th of April, 1838, for an improvement, with the power of communicating from intermediate points in either direction; but when not working, the alarum belonging to it could be sounded from either terminus to demand attention. The patent embraced mile-post arrangements for the connection of portable telegraph, and for proving the wires. Spare wires were arranged, by means of which, faulty wires could be restored at several places without

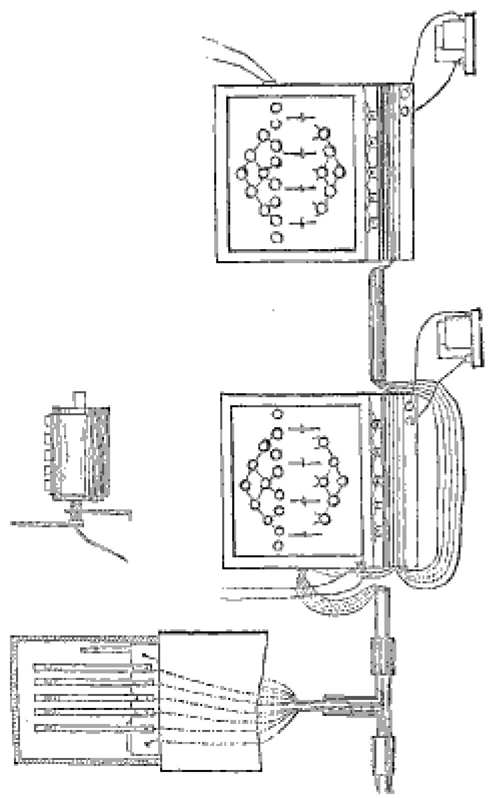


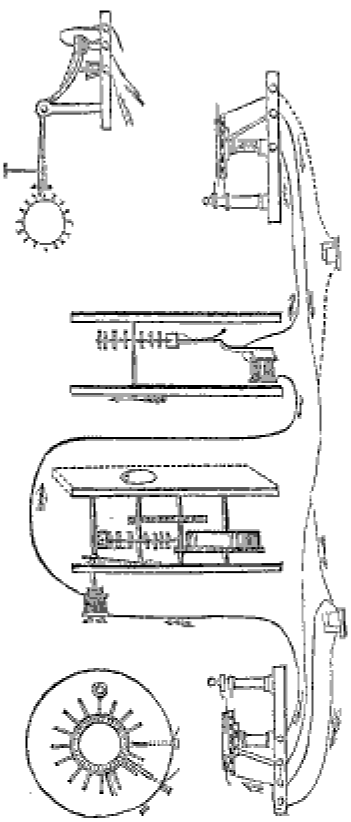
Fig. 29.
A diagram of the apparatus, atented in 1838, for communicating both directions at an intermediate station.

disturbing the general line. Iron tubing and fittings were specified, for the protection of the conducting wires, and admitting of their being carried under ground. Besides these, there were other valuable improvements invented by M. Cooke, having in view the perfection of his telegraphic system, not only in regard to the manipulating instruments of the station, but also relative to the mode of constructing the lines, and for maintaining a continuous means of electric communication.

At the date of this patent, but little was known in regard to the difficulties to be encountered, and to avoid all kinds of hindrances, the telegrapher had to devise many ingenious contrivances.

WHEATSTONE'S MECHANICAL TELEGRAPH.

Fig. 30.



Wheatstone's mechanical telegraphic apparatus, invented in 1839, was considered an improvement on Cooke's mechanical telegraph, invented in 1836, though never put in general use.

The next important improvement was the mechanical telegraph, invented by Prof. Wheatstone, in the autumn of 1839. It was an escapement apparatus, with one magnet and two wires, founded upon the principle of giving signals by a revolving dial fixed on the arbor of an escapement wheel, which was moved by a maintaining power on the removing of an alternating escapement detent, by the alternate attractive force of a magnet, and the reaction of a spring. Also, moved by the alternate attractive force of a magnet and reaction of a spring, without maintaining power, adapted for domestic use. Also, a capstan communicator, effecting by a revolving motion, the breaking and renewal of the current, corresponding with the alternating movement of the escapement. Also, an alarum detent, removed by the blow of a hammer transmitted to detent, when required, by a magnetic needle interposed by an electric current between the hammer and detent; and, also, the substitution of the magneto-electric machine for the voltaic battery. Such were the principles embraced in this patent. Fig. 30 is a skeleton view of the apparatus. Figures 31, 32, and 33, are more detailed representations of the ingenious device, and with a little study, the reader will fully comprehend the mechanism, and the application of the science to the art in the premises.

Fig. 31.

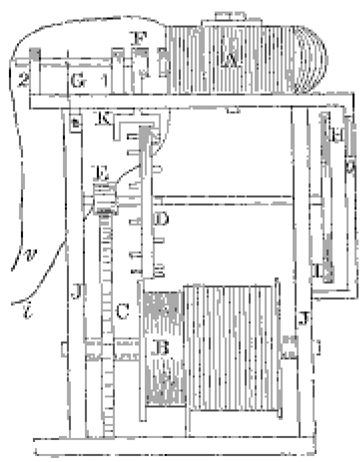
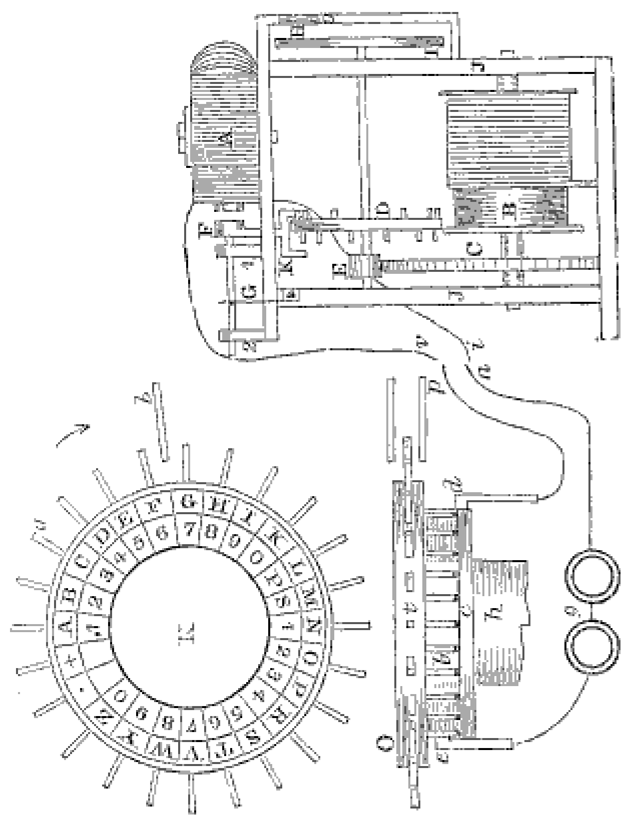


Figure 31, represents a side elevation of the dial and clock work of the *receiving station*. A represents an edge view of the electro magnet, from which proceed the two wires, *v* and *i*. J and J is the brass frame containing the wheel work, C and E; the pin wheel, D; the dial plate, I; and the barrel B, which is driven by a weight and cord. In the side of the wheel D, are pins projecting from the rim, parallel with the axis, and are equal in number to the divisions, or letters, upon the dial, I. They are, however, placed alternately on each side of the rim. F is the armature of the magnet, fastened upon a horizontal rod, sliding freely through the stan lards 1 and 2. G represents a spring, fastened to the frame, J, and which carries back the armature, F, when the magnet has ceased to attract it. From the armature there extends downward an arm, K, which, as it approaches the pin wheel, D, presents two arms, or pallets, one on each side of the wheel. These pallets are so arranged with regard to the pins, that if one pallet releases a pin on one side of the wheel, the same movement will cause the other pallet on the other side, to arrest the motion of the wheel by its striking against the next alternate pin. H and I is an edge view of the circular dial, enclosed in a case, with a single opening at O, so that only one letter at a time can be seen.

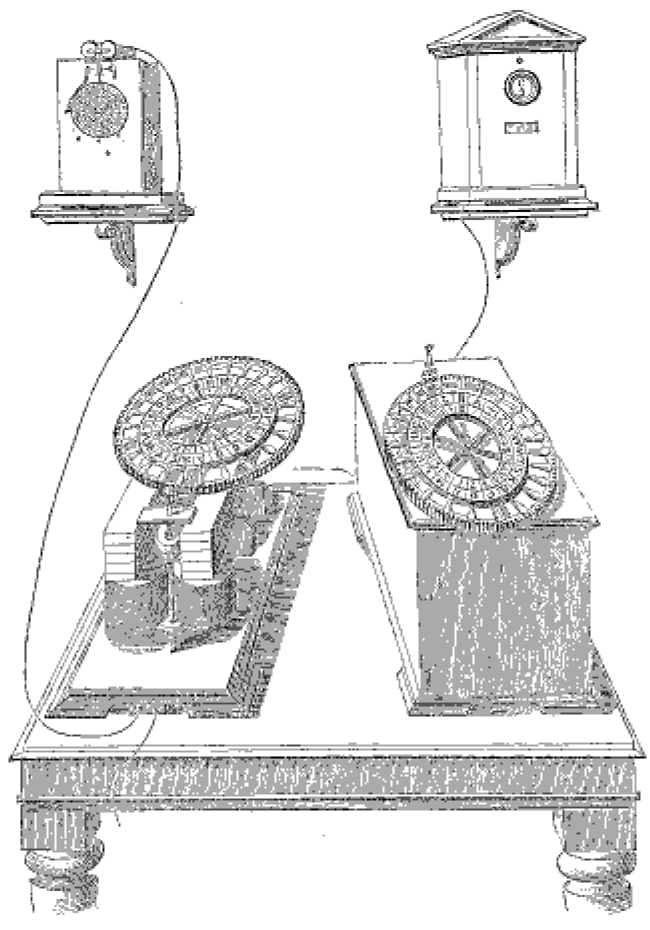
Figure 32, represents the two instruments: O the *transmitting* iustrument, and the right hand figure the *receiving* instrument. The wires, v and i, are respectively connected with p and n. It will be observed, that the armature, F, is not attracted, and that the right hand pallet is checking the pin wheel, so that the dial is stationary. If, however, the disk, t, is turned so that the circuit is completed, by the contact of the spring, c, with one of the ribs, instantly the armature isat-

Fig. 32.



tracted by the electro-magnet, which will carry the right-hand pallet away from the pin wheel, and which will then move by the action of the weight upon the barrel B, until it is checked by the left-hand pallet, which had advanced to the wheel at the same time the other receded. This single operation has moved the disk one division, and the armature is still attracted. Now let the disk, *o*, be turned until the spring, *e*, has been passed by the rib, and is in contact with the ivory only, instantly the current ceases; the armature, F, recedes from the magnet by the action of the spring, G; this has taken the left-hand pallet from the pin wheel, which is permitted to move until the next pin strikes against the right-hand pallet. This has now

Fig. 33.



brought another letter in front of the aperture at H. Thus it will be seen, that the design of this instrument is to bring into view, at the aperture such letters as are required in transmitting a message.

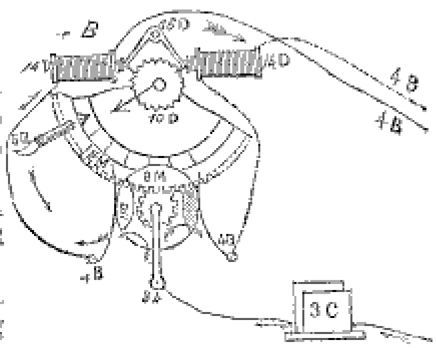
Suppose letter A is at the point, *b*, of the *disk;* and letter A of the *dial* is opposite the opening; the instrument is now ready to transmit, and let the letter I, be the first of the message. The operator gently turns the disk round in the direction of the arrow, so that each time the circuit is broken, a new letter appears at the dial, and each time it is closed by the operation of the pallets, in checking and releasing the pin wheel. This is the operation until the letter I, has reached the point, *b*, when a short pause is made.

Figure 33 represents the instrument in its case, and also as exposed. The permanent and electro-magnets are seen in the left-hand figure. When the disk was revolved, a current of electricity was generated, and the effect was produced at the distant station as herein before described.

FURTHER IMPROVEMENTS BY MR. COOKE.

The next and last improvement, was that invented by Mr. Cooke, in the month of November, 1839.

Fig. 34.



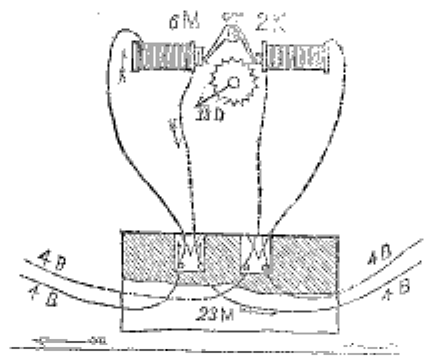
Figures 34, 35, and 36, represent the escapement telegraph, with three wires, as invented by Mr. Cooke. The three figures are of the same arrangement, and the wires 4 B in each figure are intended to unite.

The principles on which this invention was founded were, viz.:

1st. Giving signals on a fixed dial by a revolving index-hand, fixed on the arbor of an escapement-wheel, moved by a maintaining power, on being stopped by the retentive attraction of one of the two electro-magnets, acting upon the alternating escapement detent.

2d. Portable telegraph, requiring no battery to be carried with it, and adapted for working in both directions at the same time.

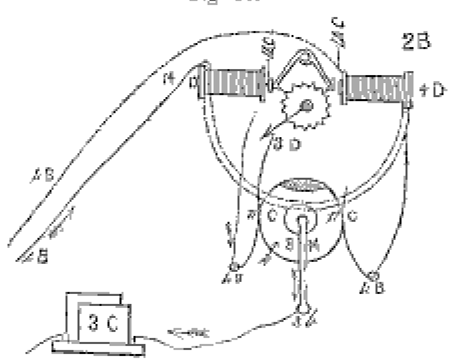
Fig. 35.



3d. The application of a constant current of electricity for telegraphing.

4th. Self-acting telegraph, the hand being fixed to the arbor of the escapement; adapted for tunnels, crossings, and approaches to stations: enabling a train to give notice of its own approach in any direction; also, adapted to give more signals when required, by a hand fixed on a second wheel.

Fig. 36.



5th. Air pressure apparatus, for keeping the inner surface of the tube under constant pressure, and, by adapting the degree of pressure to circumstances, enabling the tube to be carried safely under water. A barometrical detector will indicate, even during dry weather, any unsoundness of the tubing, which hitherto has been indicated only by the interruption of the signals caused by the admission of wet. A portable detector can be applied, at each providing box. The air pressure apparatus may, also, be used for forcing dry air through the tube, to remove any dampness that might exist.

In figures 34, B M, and 36, 8M, are the connecting wheels of the communicator, by which the telegraph wires are brought into connection with the pole bar 3; the batteries are 3C; 11C are self-acting cross-pieces, and the same pieces of metal, as B M, and 8M; 18M, in fig. 34, is a revolving communicator, concentric with the signals, and fulfilling all the conditions, whether applied to terminal, intermediate, or portable telegraphs, and capable of working the portable without a distinct battery; 14D, are the electro-magnets; 10D, 13D, 3D, are the index hands, and 4B, the conducting wires between the respective stations.

The different telegraphs, and parts thereof, were, from time to time improved, and to this day, the ingenious mechanic is devoting his mind toward the perfection of the general combination. Notwithstanding the instruments have undergone some change in their peculiar construction, yet, in principle, they remain the same, and perhaps ever will. Mr. Cooke can enter the operating room, and there find his Heidelberg apparatus, though dressed in fine rosewood or mahogany. The plain and simple mantle he placed upon it has been laid aside, and the mechanic has ornamented it with beautiful tesselated work. The original electrometer telegraph will be found within its decorated casing, and perhaps will for all time, conferring honor and well-earned fame upon the inventor. The annals of England are studded with the names of men who have performed deeds great upon the battle-field, of those who have, by their pen, given to the world light and knowledge, to illumine the pathway of men through life; but the crowning glory is due to William Fothergill Cooke, who has, by the invention of the English telegraph, added to his nation's renown increased lustre, and to the galaxy of her illustrious men, the most brilliant star.