THE ENGLISH ELECTRIC TELEGRAPH

CHAPTER XIV.

English Telegraph, and Description of its Electrometer—The Single-Needle Apparatus—Formation of the Alphabet—Single-Needle Instrument and Voltaic Circuit—The Double-Needle Instrument, Alphabet, and Manipulation—The Alarum Apparatus—Combining and Arranging of Circuits.

ENGLISH TELEGRAPH AND DESCRIPTION OF ITS ELECTROMETER.

In preceding parts of this work, I have, with much detail, described the early history of the English Needle Telegraphs, and the principles of philosophy upon which they were respectively founded. I now propose to explain to the reader the organization of the instruments, and the mode of manipulating them as practically operated at the present time.

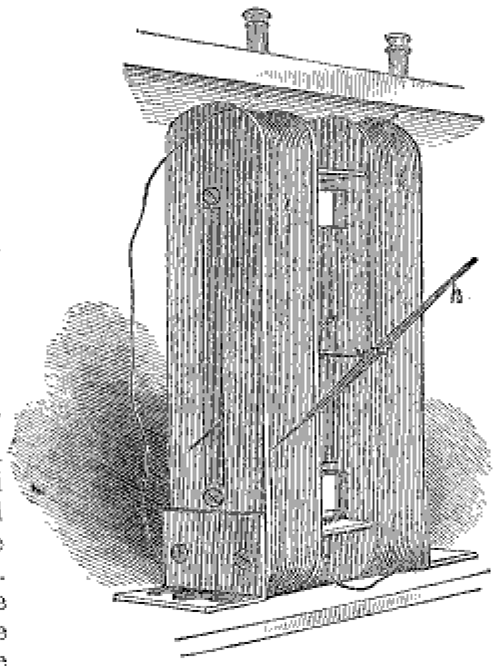
In America, there has not been a just appreciation of the needle telegraph, nor even a moderate idea of the facility and certainty of its operation. In a minority opinion rendered in the Supreme Court of the United States of America, in 1854, it was said that the needle telegraph was an "inefficient contrivance." At that time, I cordially concurred in the opinion of the able jurist; but since then, I have witnessed the operation of the different systems of Europe, and my impressions have undergone some change. In the needle telegraph, the needle vibrates to the right or to the left, and the beats thus made have to be seen, in order to understand the message transmitted.

The American telegraph produces a sound. In many of the offices, the recording apparatus has been abandoned. It is a question yet to be determined in practical telegraphing, which is the most reliable, the sense of *seeing* or that of *hearing*.

In order that the reader may the better understand the subject matter herein considered, I will re-explain the structure of the electrometer, which is the vital part of the telegraph.

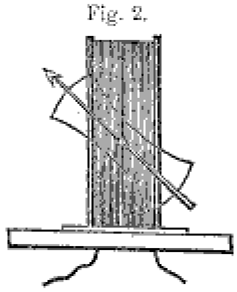
The coils *i k* of the electrometer, fig. 1, are composed of fine copper wire, insulated with silk. The wire is the same as ordinarily used on the relay magnets of the American telegraphs. *h* is the exterior needle, made as the ordinary compass needle. The interior needle in the figure is the same, and their positions of rest are perpendicular, fastened to a common axis. The needles are brought to a vertical position, by placing on the lower end of the interior needle a weight, or the lower end is made the heaviest. When the voltaic current traverses the coils *i k*, the needles move from a perpendicular to the angle seen in fig. 1. Two coils are adopted for convenience in the suspension of the axis bearing the needles. By the transmission of the voltaic current through the coils, the communication is made known by the deflection of the needles. Suppose the current is sent through the coil *i*, from the top to the bottom, or, in other words, from *i* downward, and in the other coil upward to *k*, the needle *h* will be deflected to the right, as seen in fig. 1. If the current be of great intensity, the needle will advance to a horizontal. When the current is sent upward to *i*, and downward from *k*, the needle will be deflected the reverse of the position given in fig. 1. The process of reversing the current is in the act of sending, as will be presently described.

Fig. 1.



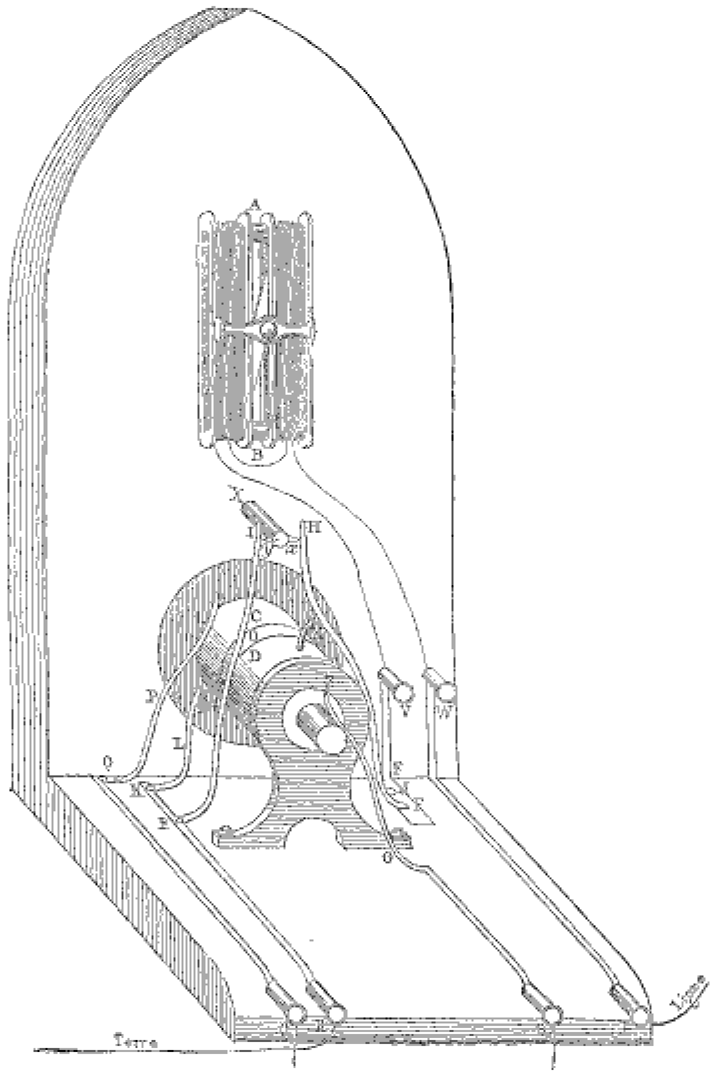
The electrometer needles, represented by fig. 1, are not of the ordinary form adopted for the telegraph instruments. Fig. 2 shows the construction of the interior needle arrangement as sometimes employed. The exterior arrow needle has been thus placed in the figure to show the

Fig. 2.



north and south ends, the arrow head being the former. The interior needle is made larger, so as to retain a greater amount of magnetic force, and to be more sensitive when the electric influence pervades the coils. The exterior needle is sometimes made of wood, or of some light substance; its movement being caused by the deflection of the interior magnetized needle, it has been found most effective, when made of some light material.

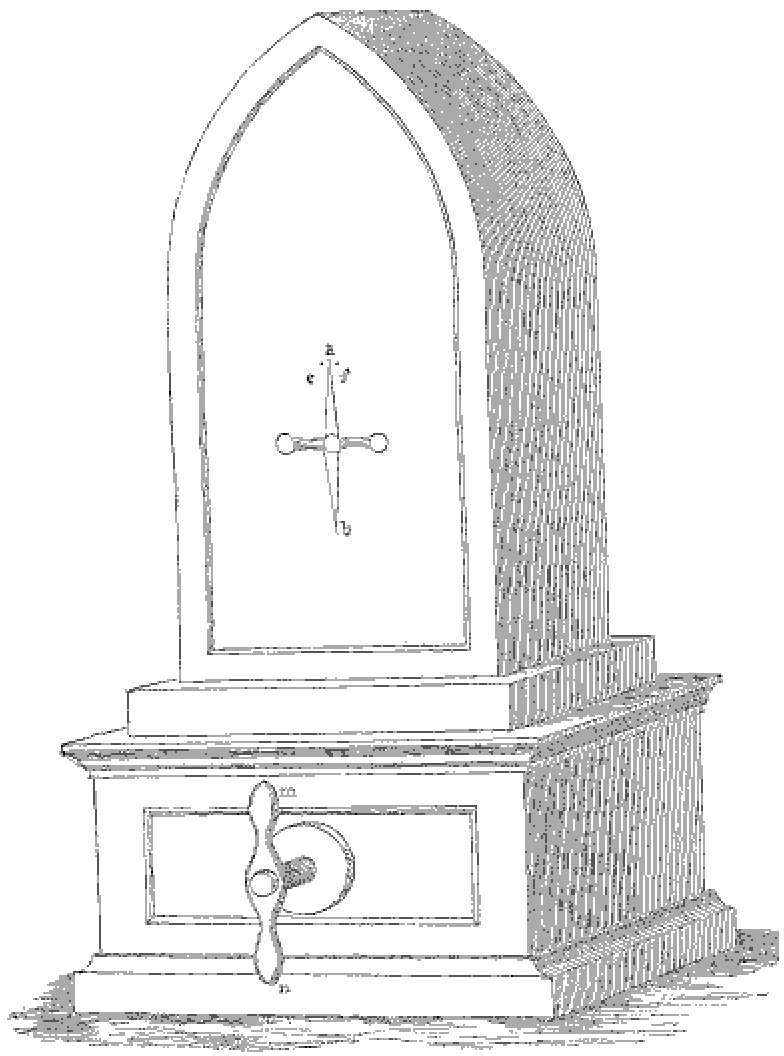
Fig. 3.



DESCRIPTION OF THE SINGLE-NEEDLE APPARATUS.

Having described the electrometer, I now propose to explain its application and its operation in its subserviency to mechanism for telegraphing. The electrometer *a b*, in fig. 3, is a rear view, as will be seen on comparing it with the angular view of fig. 1, and the front view in fig. 2. The cross-bar between *a* and *b* is attached to the frame work. To this cross-bar, made of wood or metal, is attached the moveable axis, to

Fig. 4.



which is fastened the magnetic-needle in the middle of the coils, and the index needle in front of the coils. Between the coils and the index needle is the index face of the instrument. This face hides the mechanism, as seen by fig. 4. Fig. 3 is an open back view of a single needle instrument, and fig. 4 is the front view of the same, with the index needle *a b* in front of the face, through which traverses the axis upon which the needles are fastened.

The instruments vary in size from 10 inches to 20 inches high, and from 6 to 12 inches wide, shaped as the old mantel clock. I will now describe the manipulation of the single needle instrument, figs. 3 and 4.

The cylinder is divided into three parts, of which two, C and D, are copper, the third, O, is ivory, and this ivory section insulates C from D. Two copper points, M N, are fixed upon the cylinder, M, to the copper division, D, and N, to the copper, C; the former above and the latter below on the cylinder. These points communicate with the two poles of the battery by means of the springs Q P and G Z, which press, one upon the cylinder, and the other upon the gudgeon and the two metallic strips, Q Q and G S.

On each side of the cylinder are four springs, connected two and two by the strips K E R, and F J F. Two of these springs placed in front of N, in the ordinary condition, are generally pressing upon the two metallic points, *x y*, fixed at the extremity of a little horizontal copper cylinder, X. The two other springs are in front of N. They are shorter than the preceding strips, and one of them only, K L, is visible in the figure.

The earth wire is attached at R, and connects with the two springs, K L and E I. The line wire is attached at T, and communicates, by means of the electrometer, A B, and the strip, F J F, with the two other springs.

In the receiving position the exterior handle, *m n*, is vertical, as seen in fig. 4. The two points, M N, are also vertical, and do not touch the springs. The current coming from the line at T, after having traversed the electrometer, A B, passes over the spring, F H, and arrives at R by the two points, *x y*, and the two springs, E I. The needle, *a b*, fig. 4, deviates, and by the number and direction of its oscillations indicates the signals transmitted by the corresponding station.

In order to send the current by the zinc pole of the battery, the upper part of the handle, *m n*, is turned toward the left. The point, M, presses against the spring, F H, and separates it from *x*, and the point, N, presses against the spring, K L. The copper pole is then in connection with the earth by means of the springs, K L and Q P, the metallic piece C, the cylinder and the strip, R K, and Q Q. The zinc pole, which connects with the point, N, connects with the line by the spring, H F, the strip F F V, the wire of the electrometer and the strip. W T.

Turning the handle in the opposite direction, the point, M, separates the spring, E I, from *y*, the point, N, presses the spring, the foot of which is at J; the zinc pole is then in connection with the earth and the copper pole with the line. When the current traverses the electrometer, the inclination of the needle is always the same as that of the handle.

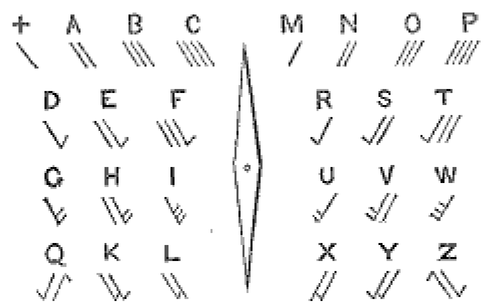
Sometimes an electro-magnet is substituted for the electrometer, as represented in the description of the magnetic telegraph apparatus.

In order to prevent the needle from swinging too far to the right or to the left, small pegs are placed on the face of the instrument, as seen in fig. 4, *e* and *f*, on the sides of the needle.

FORMATION OF THE ALPHABET.

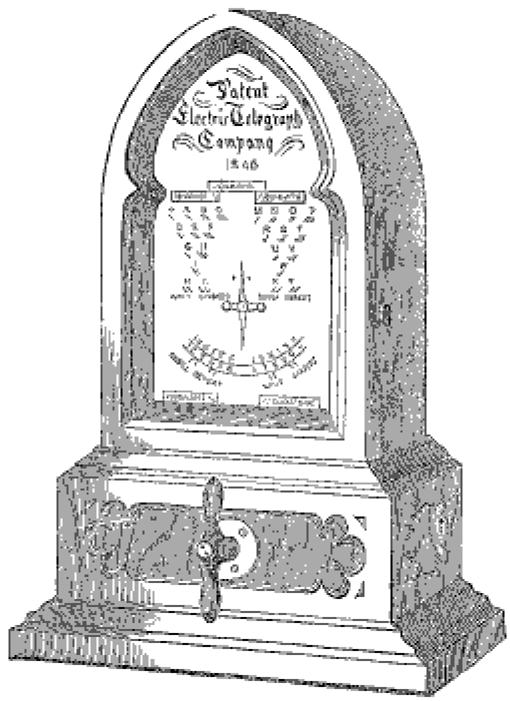
The alphabet is formed of a combination of beats to the right and to the left. I have already mentioned that the deflection of the needle is changed from the right to the left, and *vice versa*, by transmitting the current from the respective poles of the battery. When it is desired to make the letter A,

Fig. 5.



the needle is deflected to the left twice, the letter C four times, and for the letter P, four times to the right. For the letter D, first to the right and then to the left; for the letter R, first to the left and then to the right. The second beat is represented by the long arm of the angle, because if they were equal, the first beat could not be distinguished from the second. When the beat is seen they are of the same force, and the long and short arms are adopted for the book or for writing. In making the letters Q and Z, the short arms are also indicated first. Each of these letters are composed of two deflections each way, thus, V Λ, for Q, and Λ V, for Z. These are the only letters requiring such a combination, and when they are formed, the rule determines which arms are to be short and which long. When figures are to be made, they are preceded by an arbitrary sign. Besides these signals there are compound signals, indicating *wait*, *go on*, *I understand*, *I do not understand*, *repeat*, &c., &c.

Fig. 6.

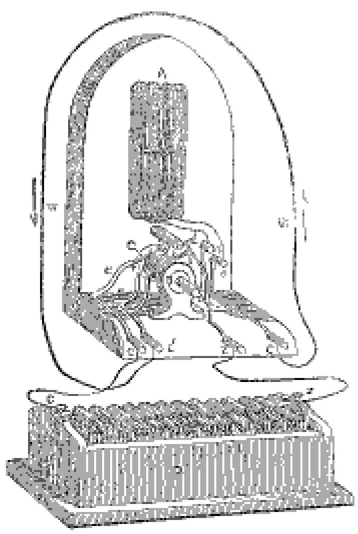


THE SINGLE-NEEDLE INSTRUMENT AND VOLTAIC CIRCUIT.

Fig. 6 is a representation of the single-needle instrument, as now employed in the offices in England. The alphabet upon its face, however, is not on the common instruments, except a few for students. It is the same as fig, 3, except a little more ornamental.

Fig. 7 is a representation of the interior of fig. 6, and the same as represented by fig. 3, and hereinbefore described, with the addition, however, of a voltaic battery and the course of the electric current. I have preferred to describe fig. 3, first, separate from the battery, to prevent confusion; and now that the mechanism of the instrument has been considered, I will repeat, in part, and extend that description to the operation in connection with the voltaic battery.

Fig. 7.



The bobbins or coils A, are made of very fine insulated copper wire, in size about $\frac{1}{100}$ of an inch in diameter, or about No. 36, American gauge. These coils are from two to three inches long, in the form as seen by the different figures. The interior needle is in the rhomboid form, one and an eighth inch long and seven eighths of an inch broad. Sometimes several magnetized short needles are substituted for the one, all firmly secured on either or both sides of a thin ivory disk. The index or exterior needle, seen in fig. 6, is about three inches long. The frame of the coils A is made of copper, wood, ivory, or of any other material. This frame is screwed to a plate of copper, on the sides of the telegraph instrument. The wires surrounding the right hand bobbin or coil is fastened to the screw G, as seen in fig. 7, which, by means of a metallic strap, is connected with the c on the right of the figure, secured on the base of the apparatus. The other end of the wire, on the left hand bobbin or coil, is in contact with another screw, D, supported by a strip of brass, which is fixed to the base; from this brass plate there rises an upright stiff steel spring *d*, which presses strongly against a point attached to an insulated brass rod *r*, screwed against the side of the case; on the opposite side of this rod is another point, against which a second steel spring *d* presses, and this spring is attached to a brass plate E, terminated by the binding-screw E′; this binding-screw E′ is the terminal of the wire from the left hand coil. If C on the right, and E′ on the left, be connected by a wire, W, the current will flow from C, on the right of the figure, through G, into the right-hand coil, out from the left-hand coil to D, thence through *d r d* to E, and to the terminal screw E′, and around the wire circuit W W, back to C on the right of the figure. The battery contact is broken, and the direction of the current reversed, by the action of the spring *d d*, in the following manner:

In fig. 7, B is a box-drum, moveable by a handle H, seen at the base of fig. 6; around either end of this drum are fixed the brass strips, as described in fig. 3. The lettering in figs. 6 and 7 are not the same for the identical parts of the like figures, but the parts in each are fully lettered, so that they may be respectively traced by the reader. In order that the mechanism may be better understood, I have described that of fig. 3, which will serve for the same parts of fig. 7.

On moving the drum, by turning the handle H, fig. 4, or in fig. 6, the steel spring *d*, on the right, in fig. 7, will be raised from its connecting point, *r*, the circuit will thus be broken; but by continuing the motion, c, on the left of the figure, will come in contact with the spring below it, and thus there will be a battery-pole at either end of the drum, and signals will thus be made on the dial, and on all the instruments connected with it. The connections are made in such a manner, that when the handle is turned to the right, the needle moves to the right. The exterior or index needle is always placed with its north pole downward, so that, in accordance with the law established by Œrsted, of Copenhagen, looking at the face of the instrument, if the upper part of the needle is seen to be moving toward the right, the spectator may be sure that the current is ascending in that half of the wire which is nearest to him.

DOUBLE-NEEDLE INSTRUMENT—ITS ALPHABET AND MANIPULATION.

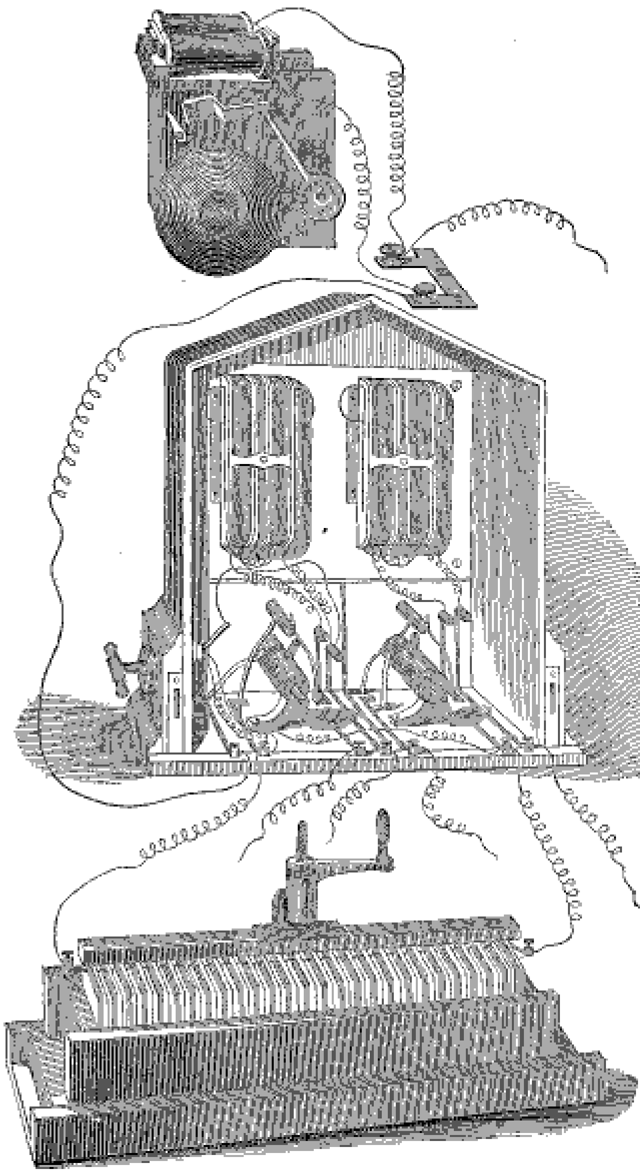
I have now with sufficient detail explained the action of the single-needle telegraph. I will next proceed to describe the double-needle instrument, which is, in fact, a union of two single-needle instruments, with some modification of the mechanism, as will be seen in fig. 8, which is a rear view of the apparatus. Fig. 9 is a front view of the same instrument. Fig. 10 is also a front view of a double-needle apparatus, but without the bell attachment.

Fig. 8 embraces the voltaic battery, the interior of the indicating apparatus, and the alarum attachment. Fig. 9, B, is the front view of the instrument, and A the alarum.

This instrument is in use on nearly all the railway lines in Great Britain, and in the service of the Electric Telegraph Company. Fig. 10 is the front view of a double-needle case, and the dotted lines of the left handle and the left index needle show the extent of the relative motions, in reversed order.

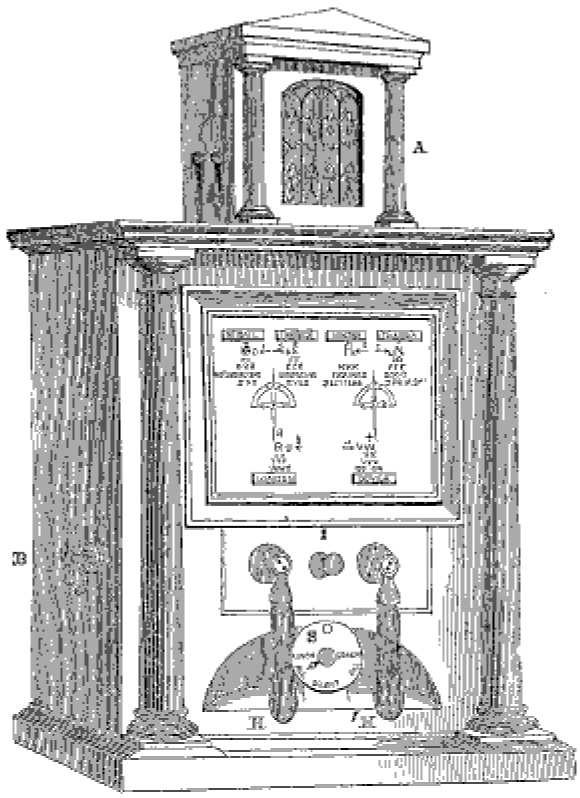
The alarum at A, fig. 9, is worked by the crank at B. The handles, H H′, are the manipulating keys that operate the needles, and S is the silent apparatus. In forming the letters of the double needle apparatus, they are ranged from left to right, as in the ordinary mode of writing, in several lines above and below the points of the needles, the first series, from A to F

Fig. 8.



being above, and the second series, from R to V, below. Each letter is made by one, two, or three movements, in the following order, viz.:

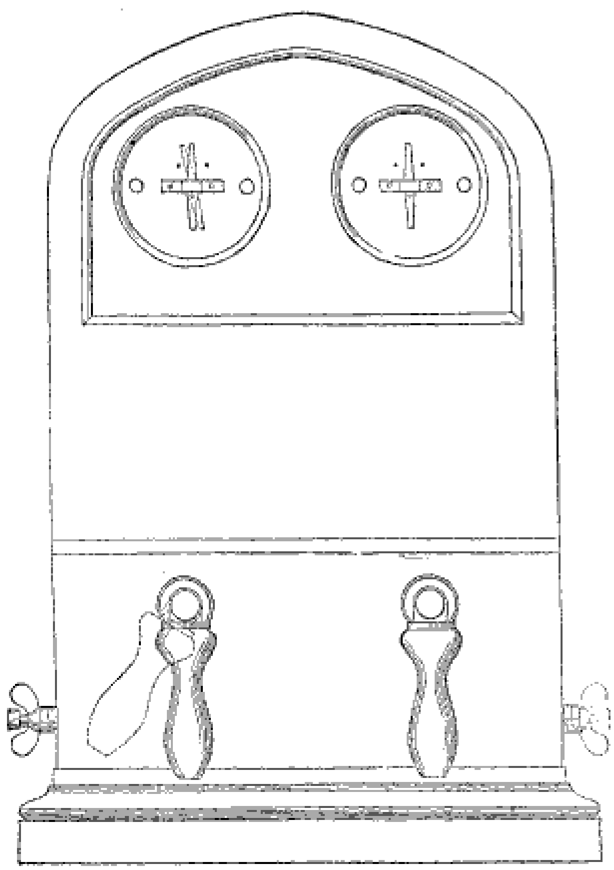
Fig. 9.



A. Two movements toward the left by the left needle.
B. Three movements toward the left by the left needle.
C, and the fig. 1. Two movements of the left, the first to the left, and the second to the right.
D, and the fig. 2. Two movements of the left needle, the first to the right, and the second to the left.
E, and the fig. 3. One movement of the left needle to the right.
F. Two movements of the left needle to the right.
G. Three movements of the left needle to the right.
H, and the fig. 4. One movement to the left by the right hand needle.

I. Two movements to the left by the right needle.
J. Is omitted, and replaced by G.
K. Three movements of the right needle to the left.

Fig. 10.



L, and the fig. 5. Two movements of the right-hand needle, the first to the right, the second to the left.
M, and the fig. 6. Two movements of the right needle, the first to the left, the second to the right.
N, and the fig. 7. One movement of the right needle toward the right.
O. Two movements of the right needle to the right.
P. Three movements of the right needle to the right.
Q. Is omitted, and K substituted for it.

R, and the fig. 8. A single movement of both needles toward the left.

S. Two movements of both needles toward the right.

T. Three movements of both needles toward the left.

U, and the fig. 9. Two movements of both needles, the first to the right, the second to the left.

V, and O. Two movements of both needles, the first to the left, the second to the right.

W. One movement of both needles toward the right.

X. Two movements of both needles toward the right.

Y. Three movements of both needles toward the right.

Z. Is omitted and replaced by S.

The above alphabet is only one of the different combinations in the English telegraph.

The sign of the cross, †, indicates the termination of a word, and is designated by a single movement of the left needle toward the left; the same signal is given when the receiving operator does not understand his correspondent's message.

The letter E is the signal for "*yes*" and "*understand.*"

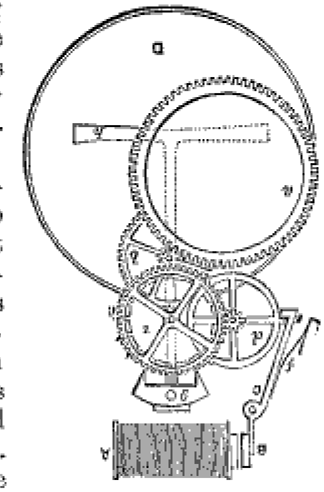
The signal E, however, is repeated twice, that is, two movements of the left needle toward the right.

The words "wait," "go on," seen on the right and left side of the bottom of the dial face, are of much importance in the transmission of messages. Suppose London wishes to correspond with Dover. The operator sends signal indicating Dover as the office desired. If the operator at Dover is engaged, and cannot receive the message from London, he sends the letters R R, which means "*wait.*" When he is ready to receive the dispatch from London, he sends the letters W W, which indicate the arbitrary term, "*go on.*" The correspondence then proceeds. Suppose London wishes to send a message to Tonbridge, Ryegate, Ashford, or any other office. The arbitrary signal indicating each station, is made; thus, for London the letter R is the signal, for Tonbridge, the letter E, for Dover, W, and so on. London signals Tonbridge, and the alarum attachment being in circuit, the bell is sounded, which calls the attention of the operator, who immediately repairs to his instruments, and reads the signal calls being made by London, the operator at Tonbridge responds by sending the signals R and E, which means that he is present, and the signal, "go on," is also sent if he is ready to receive the message. London then proceeds, first by ringing the bell, and then in the sending of the words by signaling each letter. If Tonbridge does not understand he sends the signal of the cross, †, and if he understands, he sends the signal E. When the message is finished, London deflects his left hand needle twice to the left. Tunbridge returns the signal as a finish.

The numerals are indicated by the formation of the letters, preceded by the signals H and the cross, †. These signals mean that figures are to be sent, and not letters. These figures are given by the deflections representing the letters C, D, E, H, L, M, N, R, U and V. The W is used as a space mark between the figures, thus, for $123 00 is sent C D E W V V. The dollar, sterling, franc, shilling, penny, and other terms, have arbitrary signals.

DESCRIPTION OF THE ALARUM APPARATUS.

Fig. 11.



The mechanism of the alarum apparatus is arranged at the upper part of the instrument. They are all based upon the same principles in science and art, but some differ immaterially from others in mechanism.

Fig. 11 represents the mechanism of the alarum. A is the electro magnet. B is the armature of soft iron, susceptible of attraction whenever the electric current traverses the coils or bobbins A. The armature is prevented from coming in contact with the electro-magnets by stop pins of copper, insulated with ivory, inserted in its face. The armature is mounted on the lever arm, C, which carries at its lower end a short projecting piece, *e*, which, catching in a stop on the circumference of the wheel, *d*, prevents it from moving. When the current ceases to traverse the helices or coils, the armature is drawn back to its normal position by the small spring, *f*. The principal pieces of the clock-work are shown in the figure, namely the cog-wheel, *b*, is connected by a pinion with the cog-wheel, *a*, which works *i*, and this again gives motion to *d*, which carries the stop. The anchor escapement, *g*, works on the wheel, *i*, and on the axis of the same wheel is placed the double-headed hammer, *h*. On completing the battery circuit, the armature, B, is attracted by the electro magnet, the long arm of the lever, C, moves to the left, and the wheel, *d*, being then set at liberty, the mainspring in the barrel, or the weight suspended therefrom, which is kept constantly wound up, sets it in motion, and the hammer is instantly put into rapid vibration, striking alternately the opposite sides of the bell, D; the ringing is kept up as long as the circuit is closed, but the moment it is broken, the armature is detached by the spring, *f*, and the catch is again pressed into its place on the wheel, *d*. It is not the voltaic current that rings the bell, but the mainspring in the barrel, or the weight thereto attached. All that the electric current does is to disengage the catch. Any size bell can be rung by an arrangement of this kind. This is verified by the ringing of the church bells in Boston, to give the alarm of fire. A central station transmits the electric current through a wire extending to the bells of some dozen churches. An electro magnet at or near each bell, disengages a catch, and the mechanism is put in motion, and the bell is rung a given time, and the hammer strikes the bell a given number of times to indicate the section of the city in which the fire is located.

The bell arrangement herein described is common to all electric telegraphs. I have described it, because I deemed it necessary to enable the reader to understand its application to the needle telegraph.

From the description of the English needle telegraph, the reader will see that it is not an "inefficient contrivance," but really an ingenious piece of mechanism, blending principles of science and art peculiarly simple, and at the same time wonderfully utilitarian. It is a perfect system, and has proved to be eminently practicable. A month's study and practice renders an operator capable of managing an instrument. Expertness follows practice and close application in the perfection of manipulation. An operator can send some 150 letters per minute, but the rapidity of the signals would be difficult to be understood. An expert can receive at the rate of 100 letters per minute. The usual rate is as fast as the receiver can conveniently write them.

COMBINING AND ARRANGING OF ELECTRIC CIRCUITS.

The arrangement of the wires on the English telegraph lines are apparently complicated, but in reality their connections are under the most perfect organization. To enable the reader to understand something more of the details of the English system, I have selected a few examples to illustrate the respective points referred to.

The North Kent Line, from London to Rochester, has a through group of five chief stations on one pair of wires; and two shorter groups, of six and seven stations respectively, on a second pair. They are all double-needle instruments, with alarums on one of the needle wires. The branches to Tunbridge Wells, to Maidstone, to Ramsgate, to Deal, and to Margate have each a pair of wires for double-needle instruments at their stations, and a third wire for the alarum. At Tunbridge, the switchmen have single-needle instruments and alarums on one and the same wire. All stations are furnished with an earth-wire, and all groups must terminate in the earth.

The silent apparatus is an application of the earth-wire, as at Tunbridge, Ashford, and Folkestone, on the main line; and at Lewisham, Woolwich, and Gravesend, on the North Kent line. Take Tunbridge, for an example: wires 1 and 2 pursue an uninterrupted course from London to Dover, and include the Tunbridge instrument in their course; hence, if London makes a signal for Dover, or Dover for London, it must, of course, be visible at Tunbridge; and if Tunbridge makes a signal for London, it must be seen at Dover; because the circuit begins with the London earth-plate, and is continued by the unbroken wire to the Dover earth-plate; and, although not required at Dover, the current in this case must go there to get to the earth and complete the circuit. But if provided with a means of getting to the earth at Tunbridge, the long and unnecessary journey will be saved, and it will at once enter the earth at the nearest spot: if, therefore, when talking from Tunbridge with London, two small wires are carried from Tunbridge earth to the line-wires on the Dover side of the Tunbridge instrument, the line is cut short, and the signals are compelled to go only in the direction required, namely, up toward London: by putting the earth-wire on the other side of the Tunbridge instrument, signals are passed down the line only. The little arrangement, called the *silent apparatus*, is provided for performing this operation readily. Its face is seen at the lower part of the instrument, fig. 9, with an index, showing its position for either operation. Four springs, two from the wires on the London side of the instrument, and two from those on the Dover side, are resting on a boxwood cylinder ready for use. A slip of brass, in connection with the earth-wire, is inlaid in the wood; and by turning the cylinder in one direction, the slip of brass is brought into contact with the springs on the London side, and by turning it in the other, with those on the Dover side; thus connecting the up or the down wires respectively with the earth. This operation possesses a double advantage: by reducing the distance one half, it enables the station to work with less battery power; and by confining the signals to one half of the wires, it leaves the other half at liberty to other stations, and so on, while Tunbridge talks to London, Ashford may talk on the continuation of the same wires to Dover. The name of this apparatus is derived from another adjustment with which it is provided: by pointing the index to the word "silent." is moved a brass slip into metal connection with the springs from either side of one of the electrometers, and another brass slip with those of the other electrometer; a short circuit is then made, and causes the sending station signals to appear on its own instrument only, and allow signals to pass on between other stations without entering its instrument; in fact, just as if the wires did not enter the Tunbridge station at all. The silent apparatus on the North Kent line is the same in principle, but different in construction.

By the above arrangement, all the line is provided with instruments, and no part is overcrowded; and an examination of the plan will show that when a station is not in direct communication with a group, it can hand its message on to a station that is; for instance, London gets a message to Penshurst by forwarding it *viâ* either Ryegate or Tunbridge.

Turn-plates.—Under common circumstances, the branch lines of telegraphs terminate at the junction stations—as the Deal branch at Minster, the Ramsgate at Ashford, the Maidstone at Tunbridge, the North Kent at London. But there are contrivances for turning on the branch wires at pleasure to the wires of the main line, somewhat as trains are turned by switches from one line of rails to another. The turn-plate is a cylinder of boxwood, inlaid with certain slips of brass, and mounted for protection withinside a small mahogany box; several steel springs press on either side of the cylinder, and are connected with terminals on the outside of the box; the wires are connected to these terminals. The slips of brass are so arranged that in one position of the cylinder the springs are connected into one set of pairs of springs, and by giving it a quarter of a revolution, they become connected into another set of pairs. In one case the two springs from the branch wires are connected respectively with springs from the earth-wire at the junction station, while the main line is open through from end to end; in the other case, the two springs from the branch wires become connected respectively with the two wires that lead up the line, while the two wires from down the line become connected with the earth at the junction station.