THE MAGNETO-ELECTRIC TELEGRAPH.

CHAPTER XIX.

Application of Magneto-Electricity to Telegraphing—Its Advantages—Description of Henley's Apparatus—The Brights' Apparatus—Its Comparative Celerity.

APPLICATION OF MAGNETO-ELECTRICITY TO TELEGRAPHING.

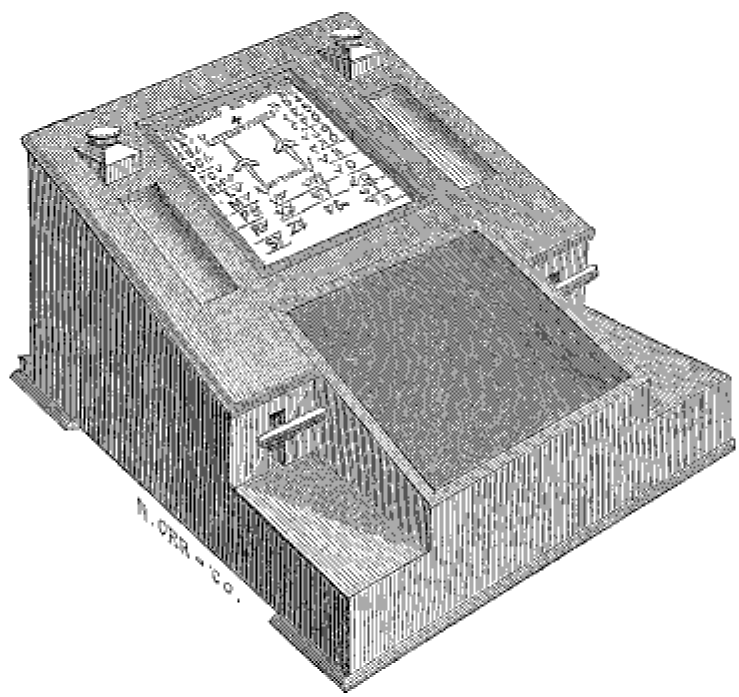
The magneto-electric telegraph is a needle system. It is practically employed on the lines of the Magnetic Company in Great Britain. The Messrs. Bright having tried magneto-electricity, most faithfully, on the lines of their company for several years past, commend it as of superior utility. They informed me, that a pair of magnets, costing at Sheffield 30*s.*, and perhaps 40*s.* to 45*s.* according to finish, will send a strong current on a well-insulated pole line for 200 miles, and on an underground wire above 100 miles. Weak signals had been received on 250 miles underground wires, while on the same lines, a battery of six twelve-cells, was necessary to perform the work, at a cost of £7, 10*s.*, besides the cost of renewals.

A magnet, if the keepers are put on when the instrument is not in use, will retain its magnetism for an indefinite time. They had worked magnets two and three years without remagnetizing them. The experiments made with magneto-electricity by these gentlemen, establish the practicability of its application to telegraphing; in this, however, there is a difference of opinion among scientific telegraphers. Mr. Bakewell, in his late work on electricity, asserts, that electricity generated in this manner is small in quantity, and of comparatively great intensity, therefore more liable to be diverted from this circuit by imperfect insulation; and as another objection to this form of telegraph, he states, that the needle sends signals in one direction only. Two communicating wires are consequently required to obtain the same combination of deflections that can be given with a single wire, when a voltaic current is transmitted. The great advantage, however, of this system is, that it dispenses with the use of voltaic batteries, which are troublesome and expensive; but it remains a question to be determined by practical experience, whether this advantage is sufficient to counterbalance the objections attending the use of magneto-electricity.

The Magnetic Company have several thousand miles of wires, on all of which this system is used, and the brothers Bright, who have been engaged in that company's service for some six years, concur in the opinion of its superiority over the voltaic telegraphs.

It would be unjust, not to fairly consider the opinions of such experts as have expressed their admiration or approval of magneto-electricity for telegraphic purposes. In America, but few trials have been made on the telegraph lines to use this species of electricity, but of these trials reference will be found elsewhere in this book. On the continent of Europe, there are no lines employing it. In Great Britain, it has only been successfully used on the Magnetic Company's lines, as hereinbefore stated. Without further comment, I will give

Fig. 1.



its advantages, and a description of the apparatus as furnished me by Mr. Henley, one of the inventors.

Fig. 1 is a representation of Mr. Henley's instrument, as used in the office for telegraphic service. Before giving a description of this very simple apparatus, I will present the advantages claimed for it by the inventor, which are as follows:

ADVANTAGES OF MAGNETIC OVER VOLTAIC ELECTRICITY.

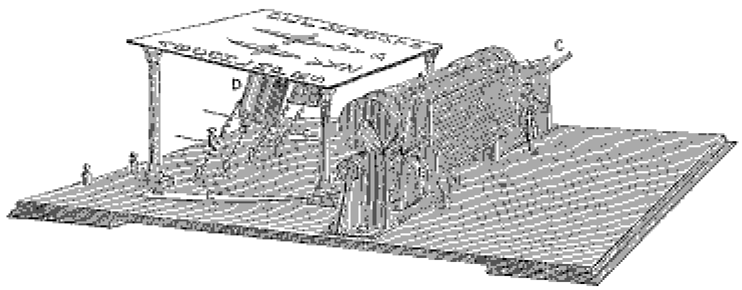
1st. Capability of working without expense, except first cost.

2d. Being always ready for instant use, however long it may have remained inactive.

3d. From its simple construction (being entirely free from all clockwork or complicated movements, and also from all apparatus found in other telegraphs for cutting off or reversing the electric current), it cannot get out of order.

4th. The magnetic needle used for the indications being freely suspended on a vertical axis, without springs or weight of any kind to keep it in the neutral position, and being subjected to the energetic action of an electro-magnet instead of wire coils, moves with a much less electric force than any other telegraph whatever; it, therefore, follows, from the well-known fact of the great diminution of the power of the current in passing through long conductors, that this telegraph will work at a greater distance, or through a greater resistance, than any other, the distance at which any telegraph will work through a given sized wire being in an exact ratio with the electric force required to work such telegraph. There have been many ingenious contrivances made which would work beautifully in a room, but are totally useless when practically tried between distant stations. Another severe test of the capability of a telegraph is a damp state of the atmosphere, especially when the earth is used (as it always is now) as part of the circuit. Every supporting post, when its earthenware insulators become covered with moisture, conveys a great part of the current to the earth, but from experiments tried on the South Devon railway (known to be the worst insulated line in the kingdom), and in the most unfavorable weather, the magneto-electric current from this machine was found to pass the whole distance of the line, and also through a great length of fine wire at each station, without any loss whatever; this arises, not from the electricity being of a different kind, but from its quantity and intensity being so adjusted that the wet posts should offer more resistance than the whole length of the metallic wire. In addition to this apparatus never requiring renewal, a very important fact is the small space required; the magneto-electric telegraph, 18 inches long by 4 inches wide, will transmit a current much farther than twelve 24-cell batteries, occupying a space of 19½ square feet.

Fig. 2.



DESCRIPTION OF HENLEY'S APPARATUS.

Each instrument has two parts, one for producing the current and transmitting it in the required direction, and the other for receiving it from a distant station. The first consists of two compound permanent bar magnets A A, about 10 inches long, placed in a horizontal position parallel with each other, about an inch apart; at each end is suspended, on separate axles, a soft iron armature, on the cylinders of which are wound long coils of fine copper wire covered with cotton, B B. Each pair of coils forming one armature, is connected by one end of the wire of each coil—the other end of each is carried through the axle (but insulated from it) to the base in two spirals. The wires pass under the base, one end of each goes to the electro-magnet of its own dial, and thence to the line and through the distant instrument until it communicates with the earth; the other is led direct to the earth, connections being made by the terminals at the back of the instrument. The other armature and its connections are just the same, and answer the same purpose with the other side of the dial. The armatures are moved by levers, C C, the ends of which pass through the outer case for the convenience of working; their motion is limited by India-rubber stops fixed on the brass casting on which the magnets are placed and the axles suspended. The ends of the magnets are covered with soft iron caps projecting inward so as to bring the poles within about half an inch of each other; these soft iron poles increase the power of the magnets greatly, besides which they will condense the whole power of the magnet at any particular point. The second or receiving part of the instrument consists of a dial mounted on four pillars in an inclined position, this being the best for reading the indications, besides reducing the friction of the needle pivots to one twentieth part. Under the dial two electro-magnets, D D are fixed, one for each needle. It may be mentioned, that electro-magnets have been attempted to be used before for deflecting the needle, by placing one end of the needle between the poles of the magnet, but never succeeded, owing to the residual magnetism left after the battery current had ceased. This was always sufficient to keep the needle deflected, except they made it very heavy at the bottom, or used a strong spring to keep it in the upright position; it then required a strong current to overcome that resistance, and the spring or weight required adjusting according to the strength of the battery, or the state of the weather. In the magneto-electric telegraph two pieces of soft iron are placed on the poles of the electro-magnet of a semicircular shape, which thus forms four poles. (See fig. 3.) Within these is suspended a magnetic needle, the axis of which is prolonged through the dial, carrying an index or pointer. This, as well as the magnetic needle, is limited in its motion by stops on the dial.

Fig. 3.

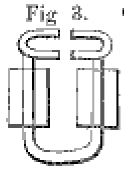
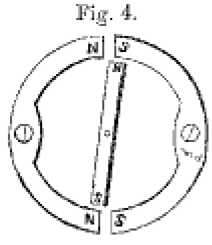
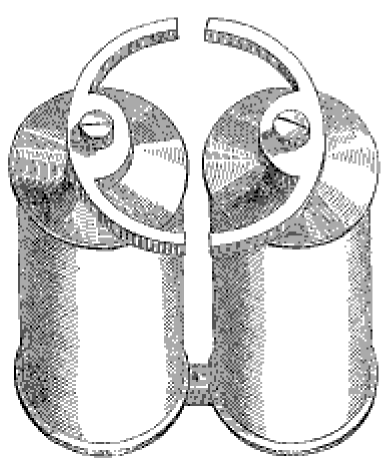


Fig. 4.



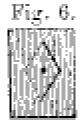
Figs. 4 and 5 represent the magnetic needle, and the horns of the magnet. On pressing down the lever, the ends of the armature change place with respect to the poles of the magnet. This produces a current of electricity in the armature, and through the circuit, which, passing round the wire on the electro-magnet, causes it to become magnetic. As shown in the diagram, fig. 4, there are then four distinct forces acting on the needle to deflect it in the position shown; the two south poles of the electro magnet attracting one end of the needle, and repelling the other, and the two north poles the same with the other end. While the handle is kept down, although no electricity is passing, the needle is kept deflected by the residual magnetism in the horns. On allowing the lever to return by the force of the spring on the base, the ends of the armatures and magnets again change places,

Fig. 5.



and a current of electricity is produced in the opposite direction, which entirely neutralizes the residual magnetism, and then reverses the poles of the electro-magnet, bringing the needle to the opposite side; but in the single-needle telegraph, the armature takes a midway position between the poles, which has the effect of neutralizing the residual magnetism only. Fig. 5 represents the electro-magnets, with the horns attached.

Fig. 6.



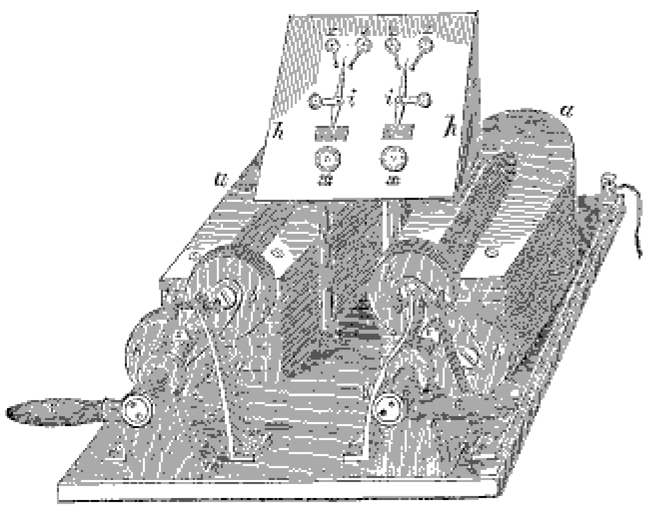
In the ordinary needle telegraph, a diamond-shaped needle is suspended within coils of wire. (See fig. 6.) On the passing of an electric current the needle has a tendency to move at right angles to the wire. When a flash of lightning strikes the wires, the needle cannot move quickly enough, but the poles move, that is to say, the polarity of the needle is placed at right angles to its former position; consequently, on the passing of the battery current, it has a tendency to remain stationary; in this way 200 or 300 miles of telegraph are rendered inoperative in a single night. On inspecting the magneto-electric telegraph, it will be obvious this cannot occur—the lightning in passing through the instrument will not act primarily on the needle, but secondarily by the electro-magnet; this becoming magnetic will deflect the needle if the current is passed in one direction, and if in the other will have a tendency to retain it in its ordinary position; and if any change occurs, it would be by the needle becoming stronger. Should the telegraph remain a long time out of action, the horns of the electro-magnet form keepers to the needle, and maintain its power; and, likewise, by the arrangement of armatures and permanent bar magnets, the latter will always retain their power; the poles are brought so near together, that the armature before leaving one magnet is on the other. This arrangement gives three advantages: the magnets always have the protection of a soft iron keeper, and the two currents produced by leaving one magnet and approaching the other, are combined in one, doubling the strength and duration of the current; and it is evident, if the magnets were farther apart, when the armature was quite free of both poles, it would alter the magnetic character of the other armature, and thus produce a current in it, and move the wrong needle.

The signals are indicated on the dial by the separate or combined motions of the two needles, for instance, A, B, and C, are separately indicated by one, two, and three motions of the left needle; D, E, and F, by similar motions of the right needle; G, one left and one right; H, one left and two right; I, K, by the reversed motions of the needles; for the remainder of the letters, the simultaneous motions of both needles are used in addition to one or more of either needle; marks are placed on the dial near each letter, to indicate what motions are required for it; two marks meeting at the bottom like the letter v, signifies the simultaneous motion of both needles.

DESCRIPTION OF THE BRIGHTS' APPARATUS.

The Magnetic Telegraph Company, under the able administration of the distinguished telegraph electricians, the brothers Bright, have on its lines an instrument operated by magneto-electricity, invented by those gentlemen. In principle it is the needle telegraph, worked by the inductive influence exercised by magnets upon electro-magnetic coils, when placed in propinquity to the poles of the permanent magnets. Fig. 7 represents this apparatus.

Fig. 7.



This instrument is placed upon an ordinary table, before which the operator sits; letters *a a* represent the compound horseshoe magnets, formed of steel, and screwed to *g*. Those which I have frequently seen in England and Scotland, in the offices of this company, have magnets about 15 inches from the poles to the back or bend, about 5 inches in height, made of 12 plates, and in breadth about $1\frac{1}{2}$ inches; *b b* and *b′ b′* are induction coils attached to the axles moved by the handles *c c*. The operator placing his hands on *c c*, by depressing and elevating them, a current of electricity is generated. One of the wires terminating each pair of the inductive coils, is connected to an insulated *cam;* the other end of each pair of coils is conducted directly to the earth: *c c*, the metallic *cams*, are insulated from the axles to which they are attached by ivory plates; *f f* are two springs connected with the line wires, and resting against the screws of the bearings *g g*, which are bridge pieces, in connection with the indicating portion of the instrument: *h h* is the outside of the dial plate, and *i i* are the indicating needles moved by the magnetic needles inside on the same axles; *x x* are thumb screws, by which the regulators are adjusted; *z z z z* are adjusting pins between which the needles beat.

The internal arrangement is much the same as given in the description of Mr. Henley's machine, and, in fact, fig. 5 is a drawing of an electro-magnet given me by the brothers Bright, on one of my visits to Liverpool.

The spring *f*, when at rest, is in contact with the bridge piece *g*, and the line wire is in direct communication with the indicatiug dial face. The electric or magnetic current from other stations of the line pass from the line wire through the indicating coils, and thence to the earth, which on passing through the coils produces the desired indication, or movement of the needles. When the handle is depressed, then the metallic "cam" attached to the axle presses upon the spring, and moves it away from the bearing *g*, at which time the current of magneto-electricity produced in the induction coils, by the changing of their position, as regards the pole of the permanent magnet, passes to the line wire, and this movement deflects the needle from "zero" at other stations.

When the depressing motion of the handle ceases, and it begins to ascend, a different current is induced, which also flows through the line wire, bringing the needles of the other stations back to zero, from which they had been taken as just above described; but at the same time the apparatus of the operating station is not changed, because the connection between the spring *f* and the bearing *g*, remain incomplete. When the spring *f* is brought into contact with the bridge piece *g*, on the cam *c*, which sets it at liberty, the line wire, in which a portion of the lost current has been fixed, as in trasmission, seeks to gain its equilibrium, and the recoil current passes through the indicating part of the apparatus, and holds the needle at zero, in the proper position to be actuated by currents from the other stations.

ITS CELERITY COMPARED WITH OTHER NEEDLE SYSTEMS.

In the arrangement of the dial of this apparatus, the brothers Bright have improved its operation by placing the adjusting pins z z, between which the needles vibrate. In other needle systems, the needles move to the right or to the left with unequal force, and on their restoration to zero, they swing beyond as a pendulum, causing error or delay in transmission by the waiting for the needle to rest at zero. These pins not only aid in celerity of communication, but they produce a sound. The needles beat against the pins, and a sound is produced sufficiently distinct to be read by the operator. In practical telegraphing, therefore, these pins prove very great auxiliaries in communicating dispatches. The operator need not depend upon the eye to see the movement of the needles. The pins may be made to produce different sounds, and those sounds can be as distinct as the beats or movements of other systems producing intelligible sounds.

The brothers Bright informed me that they found in practice the apparatus as arranged by them much more reliable than the needle system not having the stop pins. The movement of the needles, and their *dead beat*, that is, the absence of all vibration and oscillation, tended to prevent mistakes. In the ordinary galvanic needle systems, which have not the stop pins, the needles sway to and fro, after each beat, occasioning more or less confusion between letters, which are formed by the combination of "*beats*." Such are the advantages claimed for the magneto-electric telegraphs.