THE MORSE TELEGRAPH APPARATUSES.

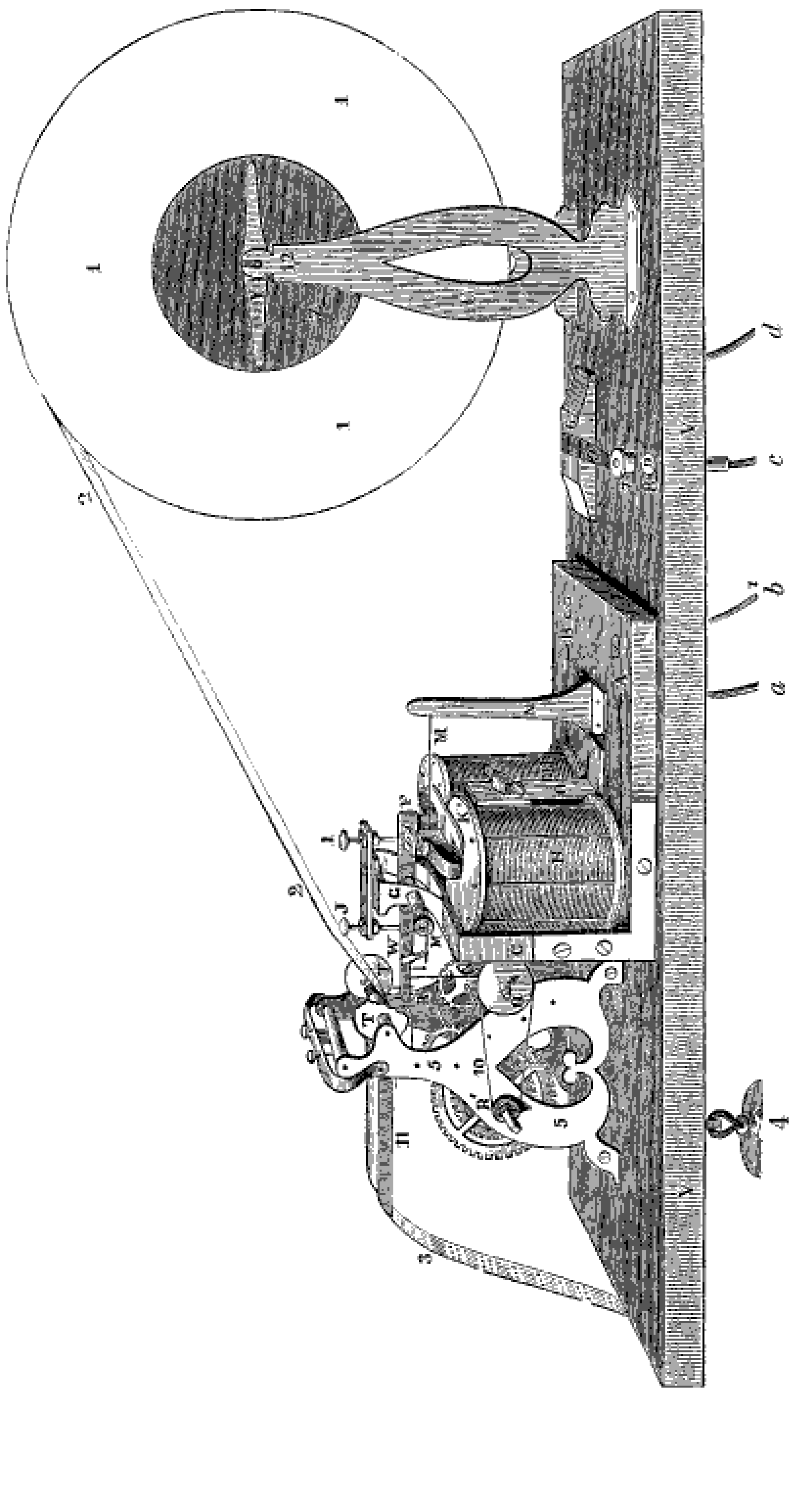
CHAPTER XXXII.

The Early Telegraph Instruments—Modern Lever Key—The Early Circuit Changer—Modern Circuit Closers—Nottebohn's Circuit Changer—Binding Connections—The Electro-Magnet of 1844—The Modern Relay Magnet—The Receiving Register—The Sounder.

THE EARLY TELEGRAPH INSTRUMENTS.

THE present chapter will be devoted to the description of the various parts of the Morse telegraph apparatuses, which have been and are in use for practical telegraphy.

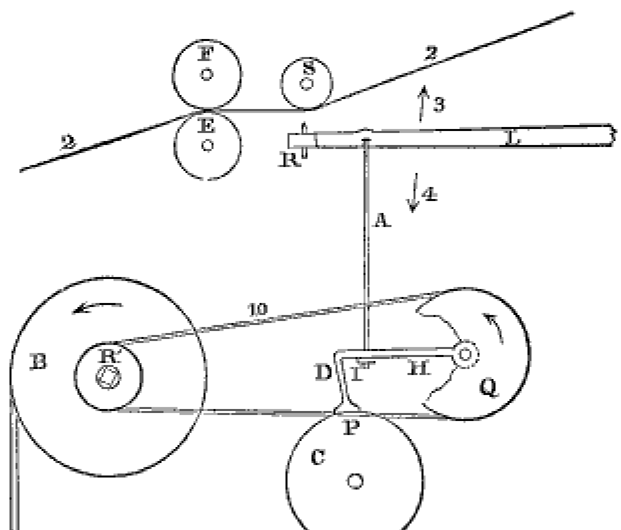
The original patented instruments were soon superseded by mechanism more convenient for the peculiar service. On the experimental line constructed between Baltimore and Washington, the register was similar to that represented by fig. 1, having three pen points to indent the letter into the paper. The perspective view shows the whole instrument. The electro-magnet H H, the pen-lever L, and the armature F, will be better seen on reference to fig. 3, which represents a part of fig. 1. Numerals 1, 1, 1, of fig. 1, represents the reel of paper, with its axle at V, fitted into the brass standard U at 12; 2, 2, is the paper coming from the reel, passing between the rollers E F, as seen in fig. 2; 11 is a metallic trough; and 3 is the paper after it has been marked by the pen points R; 4 is the weight that puts in motion the clockwork revolving wheel B, fig. 2, to which is fastened the pulley R′, with an endless band 10, which puts in motion the wheel Q. Fig. 3 represents the rear part of fig. 1, showing the electro-magnet. The letters *a b*, in figs. 1 and 3, are the line wires, one running to the battery, and the other to the telegraph poles. When the current passes through the coils, H H, the armature F is attracted, and the lever W attached is elevated in the direction of the arrow, causing the small steel points R to puncture the paper passing



between them and the roller T T. In fig. 1 will be seen the key 6, 7, 8, and 9, shown on a large scale by fig. 4. V V is the platform; 8 is a metallic anvil, with its smaller end appearing below, to which is fastened the copper wire *c*; 7 is the metallic hammer attached to the brass spring 9, which is secured to the block 6, and the whole to the platform. The copper wire *d* is fastened to the brass spring 9, and the other end to the line wire; *c* to *b*, and *a* runs to the voltaic battery.

In order to close the circuit between 7 and 8, fig. 4, it was the custom to place between them a metallic wedge. Suppose the distant station is communicating to fig. 1, the current

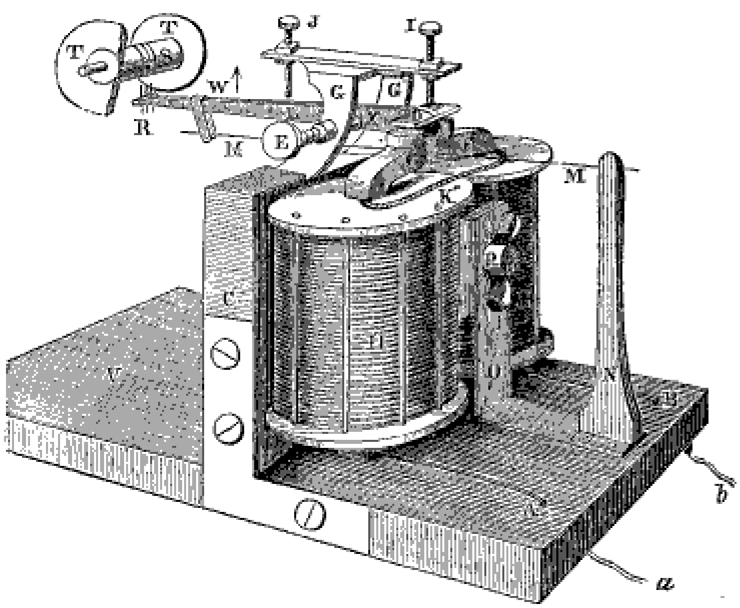
Fig. 2.



would traverse the line, enter by the copper wire *d*, pass through the key lever 9, thence through 7 and the wedge between 7 and 8, thence with the copper wire *c* united to *b*, thence through the magnet coils, thence to *a* and to the battery. Such were the original instruments used on the first line of telegraph constructed in America.

For a long time the mode of making the mark on the paper was the subject of much study, and it finally resulted in the abandonment of all inks, and the adoption of the steel point to indent the paper. The next question of equal solicitude was the mode of opening and closing the voltaic circuit. The original port rule system was not satisfactory, and the later mode—the use of the key and wedge, represented in figs. 1 and 4—was objectionable, as it did not firmly close the circuit.

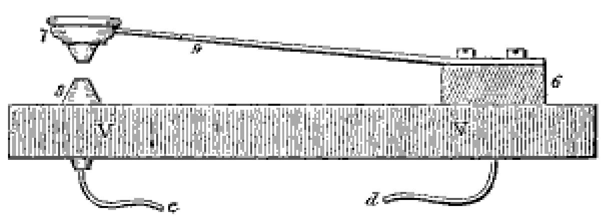
Fig. 3.



It was proposed to use a key-board, represented by figs. 5, 6, and 7.

Figs. 5 and 6 exhibit views of the keyed correspondent, with its clockwork. A′ represents a top view of it, and B′ is a side

Fig. 4.



or front view. 1 1 1 1, of both views, represent the long cylinders of sheet brass, covered with wood or some insulating substance, except at the black lines, which represent the form of the letters, made of brass, appearing at the surface of the cylinder and extending down and soldered to the interior brass cylinder. A cross section of the cylinder is seen at D′, of which the blank ring is the brass cylinder, and the blank openings to the outer circle the metallic forms of the letter J, and the shaded portion of the circle represents the insulating substance, covering the whole surface of the cylinder, except where the letter-forms project from the interior. Every letter and parts of each letter are in metallic connection with the brass cylinder. At each end of the cylinder is a brass head, with its metallic journal, and the journal or arbor turns upon its centre in a brass standard, 17, secured to the vertical frame. To this standard is soldered the copper wire N, connected with the negative pole of the battery. There are together thirty-seven letters and numerals upon the cylinder. and made to correspond

Fig. 5.

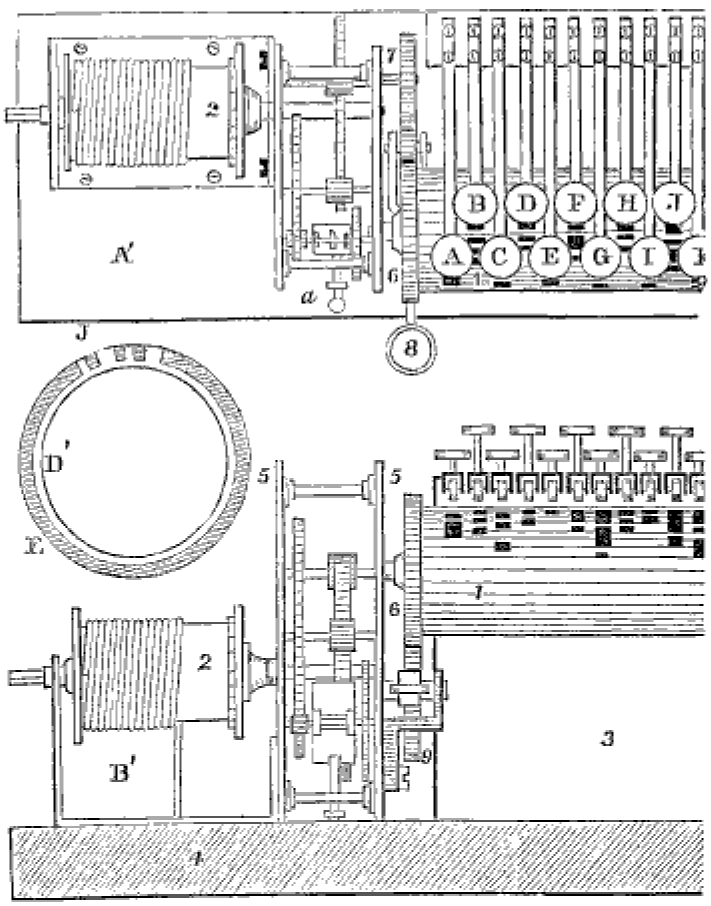
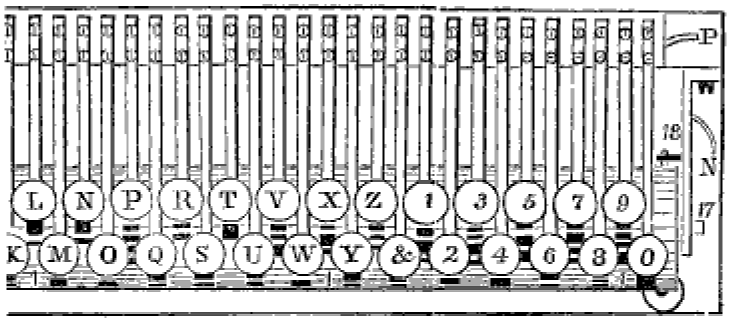


Fig 6.

to the letters of the telegraphic alphabet. To each of these there is a separate key, directly over the letter cylinder. Each key has its button, with its letter A, B, C, D, &c., marked upon it, and beneath the button in a frame of brass is a little friction roller. The key is a slip of thin brass, so as to give it the elasticity of a spring, and is secured at the thicker end by two screws to a brass plate, extending the whole length of the cylinder, so as to embrace the whole number of keys. This plate is also fastened to the vertical mahogany frame. At the right-hand end of the brass plate is soldered a copper wire, leading to the positive pole of the battery, after having made its required circuit through the coils of the magnet, &c. It is

Fig. 5.



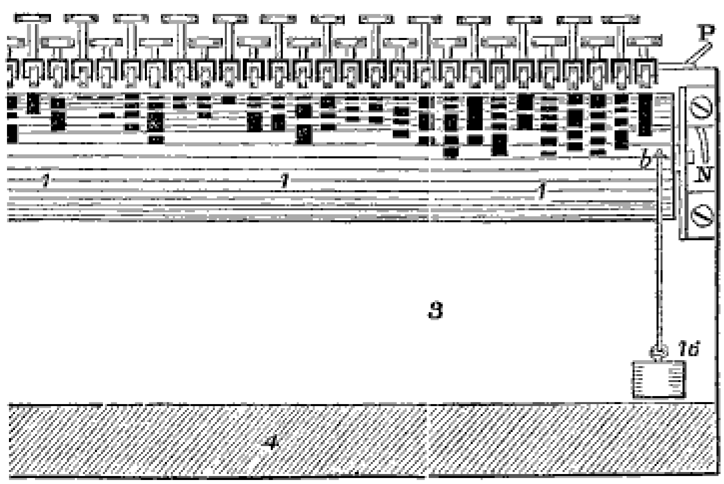


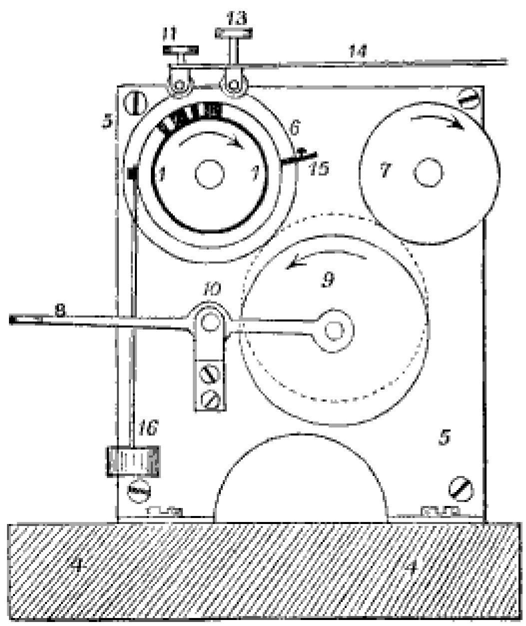
Fig. 6.

clear that if any one of the keys is pressed down upon any portion of a metallic letter, that the circuit is completed: the voltaic fluid will pass to the brass plate to which, P, wire is soldered; thence along the plate to the spring or key; then to the small friction roller beneath the button; then to that portion of any letter with which it is in contact; then to the interior brass cylinder, to the arbor; then to the brass standard, and along the negative wire, soldered to it, to the battery. I have now to explain in what manner the cylinder is made to revolve at the instant any particular key is pressed, so that the metallic form of the letter may pass at a uniform rate under the roller of the key; breaking and connecting the circuit so as to write at the register, with mechanical accuracy, the letter intended.

4 4 is the platform upon which the parts of the instrument are fastened. 3 3 is the vertical wooden back, or support, for the keys and brass standard, 17. 2 is the barrel of the clockwork contained within the frames, 5 5. With the clockwork a fly is connected for regulating its motion, and a stop, *a*, for holding the fly, when the instrument is not in use; 6 is a very fine-tooth wheel, on the end of the letter cylinder; 7 is also a fine-tooth wheel, on a shaft driven by the clock train. In the front view is seen, at 9, another fine-tooth wheel, suspended upon a lever, the end of which lever is seen at 8, fig. 5, A′. 18 is a stop in the standard, 17, to limit the return motion of the cylinder, which also has a pin at 18, at right angles with the former. 16 is a small weight, attached to a cord, and at its other end is fastened to the cylinder at *b*. The relative position of the three fine-tooth wheels, and the lever 8, are better seen in a section of the instrument, fig. 7. The same figures represent the same wheels as in the other views, A′ and B′. 7 is the wheel driven by the weight and train; 6 the wheel, on the end of the cylinder, to which motion is to be communicated; and 9 is the wheel, suspended upon the end of the lever 8, of which 10 is its centre. 1 1 is the brass-lettered cylinder. 11 and 13 the buttons of the two keys, one a little in advance of the other. 14 is the spring, and the two friction rollers of the key may be seen directly under the buttons. 15 is the stop pin. 16 the small weight and cord attached to the cylinder, to bring it back after each operation. 4 4 is the end view of the mahogany platform. The arrows show the direction which the wheels take when the lever is pressed with the thumb of the left-hand at 8, so as to bring wheel 9 up against 7 and 6, connecting the two, as shown by the dotted lines. Wheel 7, communicating its motion to 9, and 9 to 6,

which causes the metallic letters to pass under the rollers in the direction of the arrow. Now, in order to use the instrument, let it be supposed a letter is to be sent. The stop *a*, fig. 5, A′, is removed from the fly, and the clockwork is set in motion by the large weight. Then the thumb of the left hand presses upon the *lever* 8, at the same time *key* R is pressed down by the finger of the right hand, so that the small roller comes in contact with the cylinder. At the instant the roller touches the cylinder, the letter begins to move under the small roller, making and creaking the circuit with mechanical accuracy. When the letter has passed under the small roller, the

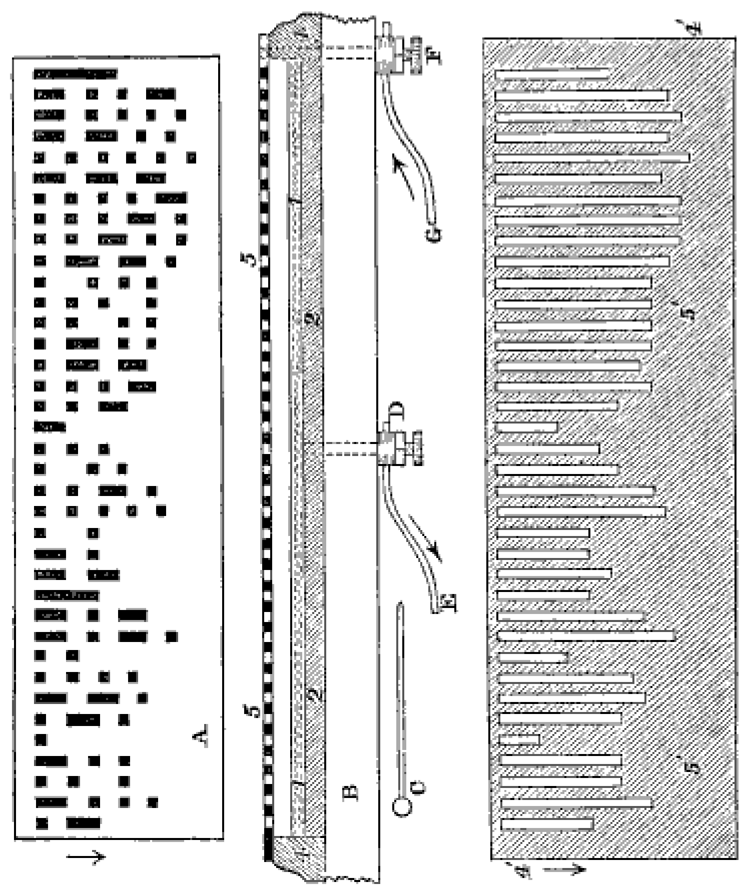
Fig. 7.



thumb is taken off the lever 8, and the finger from the key R. The cylinder is then detached from its geer wheel 9, and the weight, 16, instantly carries it back to its former position, in readiness for the next letter. Then the *lever* 8, and the *key* R are pressed down at the same instant for the next letter, and it is carried under the small roller in the same manner as the first, which, when finished, the wheel 9 is suffered to fall, and the cylinder returns to its natural position again. The same manipulation is repeated for the remaining letters of the word.

In fig. 8 is represented the flat correspondent. It somewhat resembles the keyed correspondent, but without keys or clock-work. A represents the arrangement of the letters, presenting a flat surface. Those portions in the figure marked by black lines and dots represent the letters which are made of brass. That portion which is blank represents ivory or some hard insulating substance surrounding the metal of the letters. As in the keyed correspondent, each letter and parts of each letter extend below the ivory, and are soldered to a brass plate, the size of the whole figure A. A sectional view of this is seen at 1 1, which is ivory, and 2 2, the brass plate below. The whole is fastened to a table, B. 5′ and 5′ is a brass plate, called the guide plate, with long openings, represented by the blanks, so

Fig. 12.



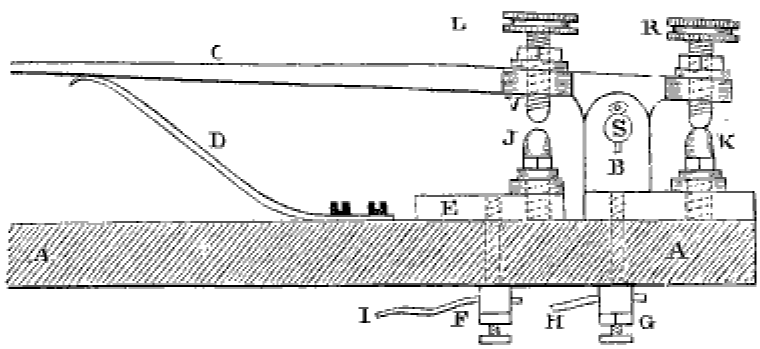
that when the guide plate, 5′ 5′, is put over the form, A, each opening is directly over its appropriate letter, and is a little longer than the length of the letter. 4′ and 4′ is the wooden frame, to which the guide plate is secured. The ends of this frame are seen in the sectional figure at 4 4, and the guide plate at 5 5; the dark portions of which represent the partitions, and the blanks the openings. It will be observed here that the plate 5 5, resting upon the wooden frame 4 4, is completely insulated from the brass letter plate 1 1 and 2 2; the blank space between them showing the separation. It is, however, necessary that the guide plate should be connected with one pole of the battery, and the letter plate with the other pole. For this purpose a brass screw, F, passes up through the table B, and through 4 into the guide plate 5 5. The head of the screw has a small hole through it, for passing in the end of the copper wire G from the battery, and a tightening screw below, by which a perfect connection is made. At D is another screw, passing through the table and into the letter plate 2 2. To the head of this screw is also connected another copper wire, E, extending to one of the poles of the battery.

This instrument, when used, occupies the place of the key or correspondent, in the description heretofore given of the register. The circuit is now supposed to be complete, except between the guide plate 5 5, and the letter plate 2 2. Now, if a metallic rod or pencil, c, be taken, and the small end passed through one of the openings in the shield above the letter, its point will rest upon the ivory; and if it be gently pressed laterally against the side of the opening of the guide plate, at the same time a gentle pressure is given to it upon the ivory, and then drawn in the direction of the arrow 4′, it is obvious that when the metallic current reaches, for instance, the short line of letter B, the circuit will be closed; and the fluid will pass from the battery along the wire to the screw F, then to the guide plate, along the plate to the rod, thence to the metallic short line of letter B, thence to the letter plate below, thence to the screw, from the screw to the wire, and thence to the battery. When the point has passed over the short metallic line, it reaches the ivory, and the circuit is broken.

The next and most important improvement was the manipulating key, represented by fig. 9, which has been in universal use since the first year of the establishment of the experimental line in 1844. This was called the "lever key."

A A is the block or table to which the parts are secured; E represents the anvil block; J the anvil, screwed into the block, both of brass; B is another block, for the stop anvil K, and the standard for the axis of the lever C; L is the hammer, and is screwed into the lever, projecting downward at V, almost in contact with the anvil J; R is another screw of the same kind, but in contact with the anvil K, when the lever C is not pressed upon. Under the head of each of these two screws are tightening screws, which permanently secure the two hammers to any adjusted position required for the easy manipulation of the lever C; D is a spring which sustains the arm of the key up, preventing the hammer L from making contact with the anvil J when not in use; G is a screw connecting with the brass block B, and F a screw connecting with the block E. To these screws the two wires, I and H, of the battery are connected. Now, in order to put it in operation, it is necessary to bring the hammer V in contact with the anvil J for so long a time,

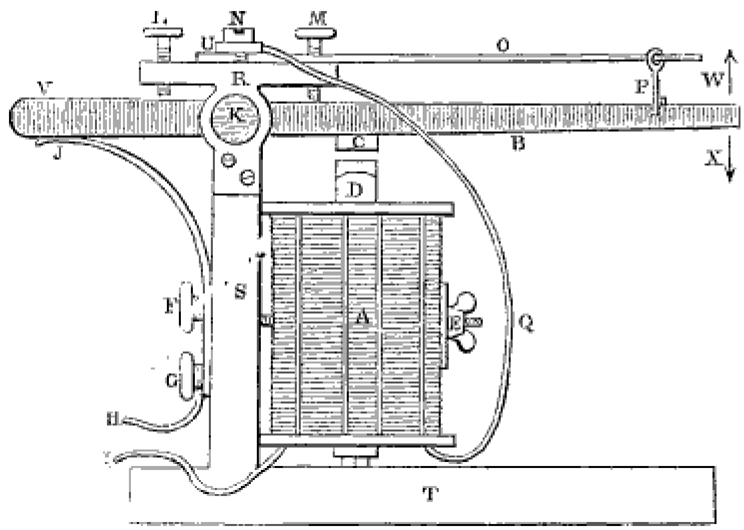
Fig. 9.



and at such regular intervals as are required by the particular letters of the communication. When the key is pressed down, the fluid passes from the battery to the wire H, then to the screw G, then to the block B, then to the lever C, at the axis S, then to its metallic anvil J, then to its screw F, then to the wire I, and so to the battery.

In order to give some idea of the rapidity with which the circuit may be closed and broken, and answered by the motion of the lever, fig. 10 is here introduced to explain its construction and arrangement. The platform is shown at T, and the upright at S, to which the coils of the electro-magnet A are secured by a bolt with its thumb nut E; D a projecting prong of the soft iron, and C the armature attached to the metallic lever B, which has its axis or centre of motion at K, in the same manner as the electro-magnet of the register, R being the standard through which the screws pass; O is the steel spring secured to R, by a plate U upon it, and the screw N; L and M are adjusting screws, for the purpose of confining the motion of the lever B within a certain limit. P is a wire with an eye at the top, through which the end of the steel spring passes, with a hook at the other end passing through the lever. The wire Q from one of the coils is connected with the plate U, at the top of the standard R. As the standard R is of brass, the plate U, the axis of the lever of steel, and the lever B of brass, all of them being metals and conductors of the voltaic fluid, they are made in this arrangement to serve as conductors. I is the wire proceeding from the other coil, and is extended to one pole of the battery. The wire H, coming from the other pole, is soldered to the metallic spring J, which is secured to the up-

Fig. 10.



right S by means of the adjusting thumb screws F and G. This spring is extended to J, where it is in contact with the lever B. We have now a complete circuit. Commencing at I, which is connected with one pole of the battery, thence it goes to the first coil; then to the second; then by Q to U, the plate; then to the standard R; then to the steel screw K; then to the steel axis; and then to the lever to the point J, where it takes the spring to H, the wire running to the mercury cup of the other pole of the battery.

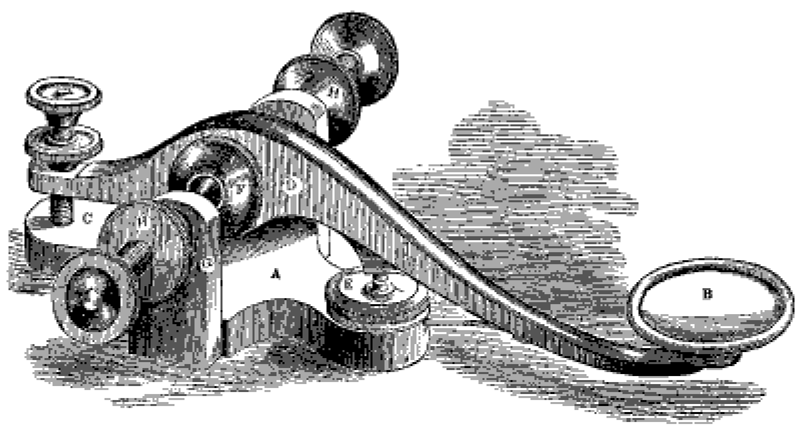
The battery being now in action, the fluid flies its circuit; D becomes a powerful magnet, attracting C to it, which draws the lever down in the direction of the arrow X. But since B and J are a part of the circuit at V, and since, by the downward motion at X, and the upward motion at V, the circuit is broken at J, the consequence is, that the current must cease to pass, and D can no longer be a magnet; the lever at V returns to J, and the current again flows.

Such were the original instruments and plans of the early telegraph in America. I will now present illustrations of some of the more modern apparatuses, with such descriptions of them as may be necessary to enable the reader to understand their respective parts.

MODERN LEVER KEYS.

The lever key, represented by fig. 9, is in principle still in practical use on all the Morse telegraphs on both continents. Fig. 11 represents a key in much use. A C is the brass frame. The lever is suspended between the combination screws H H, passing through the upright pieces, G G, of A C. The axle of the lever D is steel, and it fits into the sockets of the screws H H. To make the key move easy upon its bearings, many operators improperly use oil. At E is an ivory cylinder, which passes through the brass frame A; in the interior of E is a brass piece, upon the top of which is a projecting platina head. This part of the key is called the anvil, and the subtending or hanging nipple to the lever D is called the hammer. The knob B is made of ivory, so as to insulate the finger of the operator. The heaviest part of the lever is behind; its normal position is, as seen in the figure, open at E. The circuit wires are connected under the table on which the key is fastened, so that the

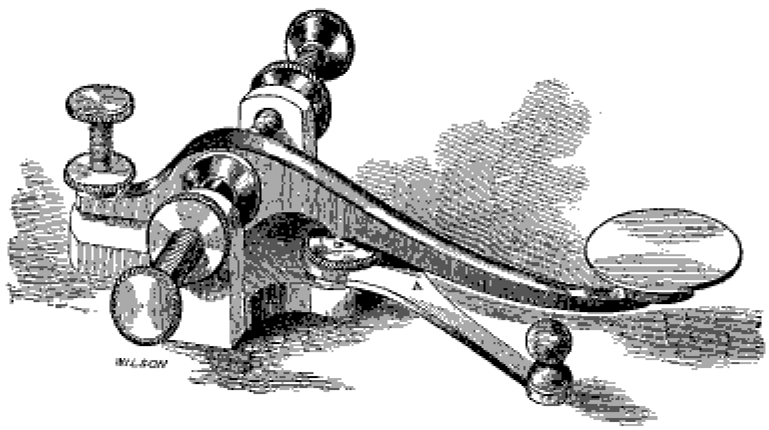
Fig. 11.



current will pass through the brass frame A C G, the screw H H, the axle of the lever at F, with the lever to the hammer and anvil at E, and then with the wire attached beneath. When the operator presses upon B, the lever descends and closes the circuit at E, the weight of the back part of the key elevates the front. This key requires an apparatus known as a "circuit closer," which will shortly be described.

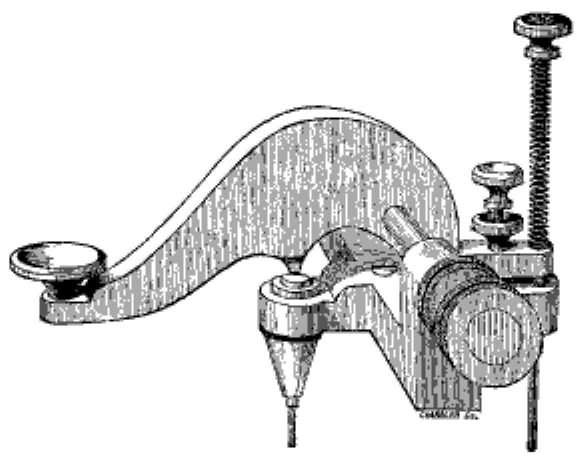
Fig. 12 represents a key with the "circuit closer" attached.

Fig. 12.



A is a small lever, with an ivory knob on its end. In the present position of the lever A the circuit is closed, but to move it to the left at right angles with the key lever the circuit will

Fig. 13.

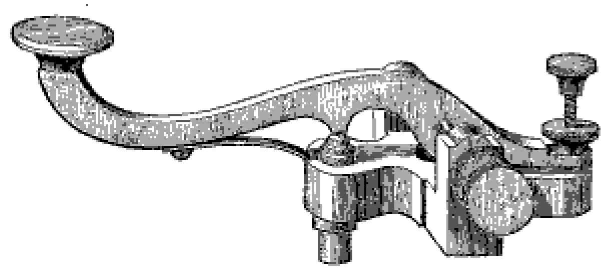


be opened. In swinging the arm to a position at right angles, a brass spring is brought firmly against a pin of steel attached to the anvil.

Fig. 13 is a closed lever key. The front part is heavy, and closes the circuit at the anvil by its own weight. When manipulated, the operator lifts the lever instead of pressing upon it, as with the other forms of keys. In order to make it an "open lever," a spiral spring is placed around the high screw behind; the spiral spring will force down the back part and elevate the front, as seen in the figure.

Fig. 14 represents another form of key, having in front an insulated elevating spring, to raise the lever from a contact at

Fig. 14.



the anvil unless pressed by the finger. The spring projects from the frame and holds up the lever, as seen in the figure. The spring of course is insulated, so as not to form a part of the circuit.

THE EARLY CIRCUIT CHANGERS.

Having explained the lever key, it becomes necessary to describe the different arrangements for opening and closing the circuit, and the plans adopted for the transference of the polarity of the circuits.

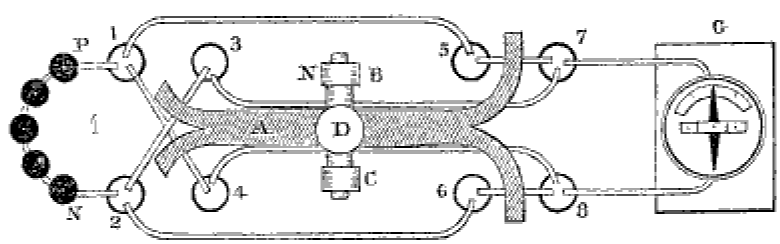
In the early history of the telegraph, it was common to have an arrangement of mercury cups, with bent wires connecting one with the other, according to the necessities of the occasion. These mercury cups were often auger-holes bored into the table or a piece of plank, and the metallic connectors used were the ordinary copper wires.

I introduce here a description of an instrument used for reversing the direction of the voltaic current, and which is applied in the operation of several kinds of electric telegraphs.

The following figures, 15, 16, and 17, are three views of the instrument as it appears when looking down upon it in its three changes. First, that in which the current is broken and the needle vertical; second, in which the circuit is closed and the needle deflected to the right; third, in which the circuit is closed and the needle deflected to the left. Each figure has, in connection with the pole changer, the battery, or any other generator of the electric fluid, represented by N and P, and the electrometer represented by G. In each of the figures, the circles numbered 1, 2, 3, 4, 5, 6, 7, and 8, represent cups filled with mercury let into the wood of the platform, and made permanent. The small parallel lines terminating in these cups represent copper wires or conductors.

A, fig. 15, represents a horizontal lever of wood, or some insulating substance, with its axis supported by two standards, B and C, by which it can easily vibrate. D represents an ivory ball, mounted upon a rod, inserted in the lever, and extending a few inches above it. It serves as a handle, by which to direct the elevation or depression of either end of the lever. Both ends of the lever branch out, presenting two arms each. Through each arm passes a copper wire, insulated from each other. The left-hand branches support the wires which connect the mercury cups 1 and 4, and 2 and 3 together; the right-hand branches support the wires which connect the cups 5 and 7, and 6 and 8, together. The ends of these wires directly over the mercury cups are bent down, so that they may freely enter their respective vessels when required; the other wires are permanently secured to the platform. The

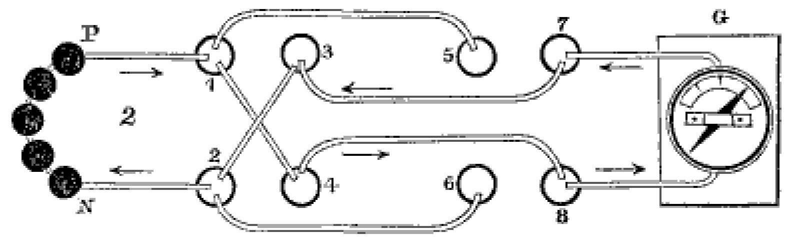
Fig. 15.



position of the lever is now *horizontal*, and the bent ends of the wires, which it carries, are so adjusted, that none of them touch the mercury; consequently, there is no connection formed between the battery and electrometer, and the needle is *vertical*. The ivory ball, it will be observed, is directly over the centre of the axis, and in that position required to break the circuit. Thus, the wires 2 and 3, 1 and 4, 5 and 7, 6 and 8, are each out of the mercury, and the circuit being broken the fluid cannot pass.

Fig. 16 represents those connections which are formed when the left-hand side of the lever is depressed, immersing in the mercury those wires supported by it. The ball and lever are omitted for the better inspection of the wires. Now the circuit is closed, and the current is passing from P of the battery, to the mercury cup, 1; then along the cross wire to 4; to 8; to the coils of the multiplier, deflecting the needle to the *right:* then to 7; to 3; then along the cross wire (which is not in contact with wire 1 and 4) to 2; to the N pole of the battery. The arrows also show the direction of the current. It will be observed that the cups 5 and 7, and 6 and 8 are not now in

Fig. 16.

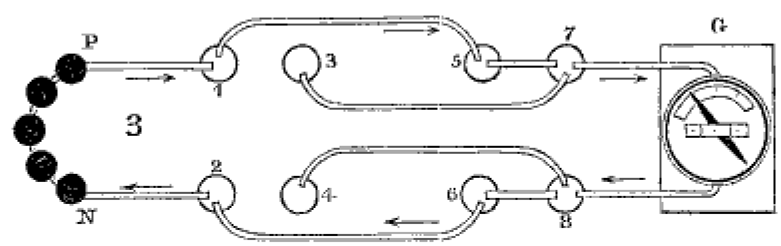


connection, and consequently the current cannot pass along the wires 1 and 5, and 2 and 6.

Now, if the ball D is carried to the right, a new set of wires, fig. 17, are immersed, and those represented in fig. 16, as in connection, are taken out of their cups. The fluid now passes from P of the battery, to the mercury cup 1; to 5; to 7; to the coils of the multiplier, deflecting the needle to the *left;* then it passes to cup 8; to 6; to 2; and then to the N pole of the battery; the arrows representing the direction of the current. It will now be found that the cups, 2 and 3, and 1 and 4, are not in connection; and consequently, the current cannot pass along the wires, 3 and 7, and 4 and 8.

Thus, it will appear, that by carrying the ball D to the left,

Fig. 17.

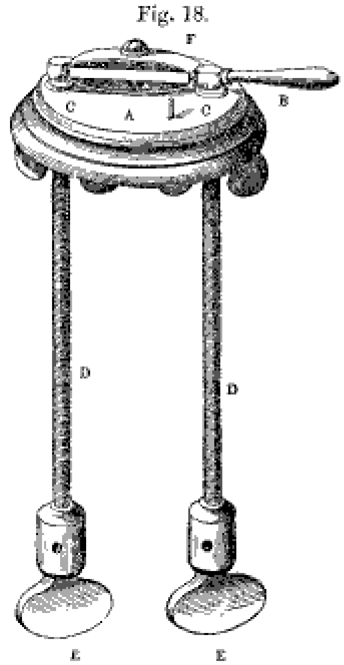


the needle is deflected to the *right;* then, by carrying the ball to the right, the needle is deflected to the *left;* and when the ball is brought to the vertical position, the needle is *vertical.* These three changes enter into the plans of several electric telegraphs, which are to be hereafter described.

MODERN CIRCUIT CLOSERS.

In later years, the mercury cups have been abandoned, and metallic connectors are used in their stead. Fig. 18 represents a circuit closer, that accompanies the keys represented by fig. 11. The base A is made of wood; between A and C is a brass pin serving as a stop to the lever B. The lever moves around a fulcrum at the centre; C C are the top ends of the elongated screws, D D, the lower ends of which are attached to the circuit wires; these screws pass through the table board. The line wires enter the holes as seen in the larger ends of the screws, and the binding screws E hold the wires with a good metallic contact; F is a spring which causes the lever to press upon the upper ends of D D. This is the normal position of the circuit closer. The key is open and the current passes from the wire into the long screw D at E, thence through the lever from C to C, thence down D to the line wire. If the operator desires to manipulate with his key, it is necessary to move the lever B from C, to the pin by which the circuit is broken, and then upon pressing the lever of the key, the circuit is again closed. Whenever the operator has finished manipulating, it is necessary to close the circuit by placing the lever arm of fig. 18 in its present position.

Fig. 18.



Figs. 19, 20, 21, and 22, are circuit closers of different forms, but constructed upon the same principle as fig. 18.

Like arrangements are used for the transference of circuits from one apparatus to another. There are a variety of arrangements for effecting this end. Figs. 23 and 24 are in common use in America. On the Western Union lines, Mr. Anson Stager has applied a very ingenious circuit changer, having metallic straps across a board, and a hinge lever to transfer

Fig. 19.

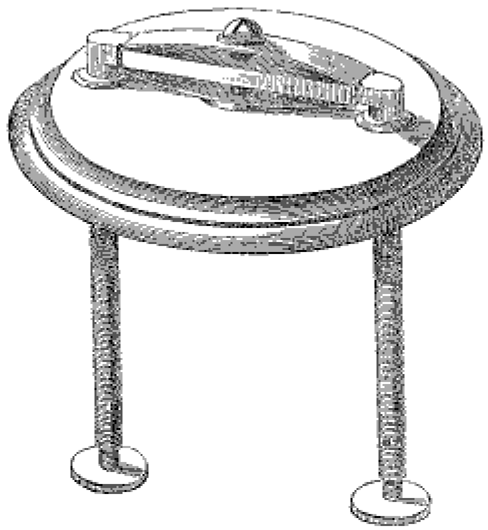


Fig. 20.

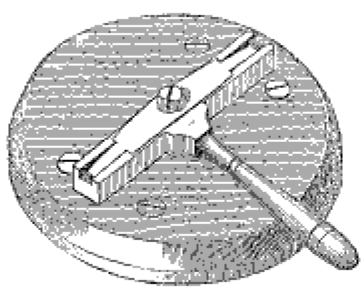


Fig. 21.

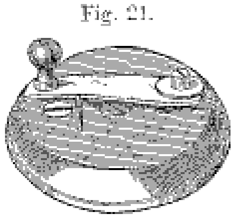
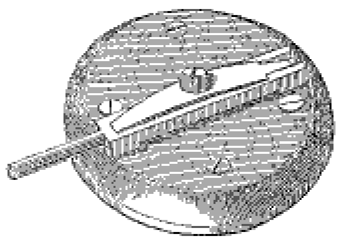


Fig. 22.



the current from one place to another. It is a compound "switch board," and is fastened upon the wall, so that any operator in

Fig. 23.

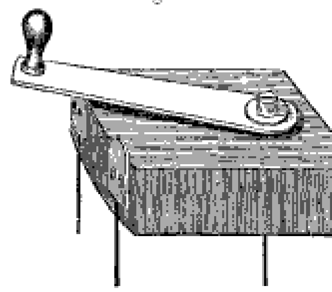
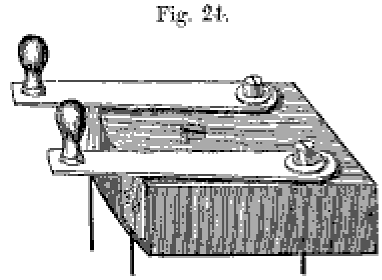


Fig. 24.

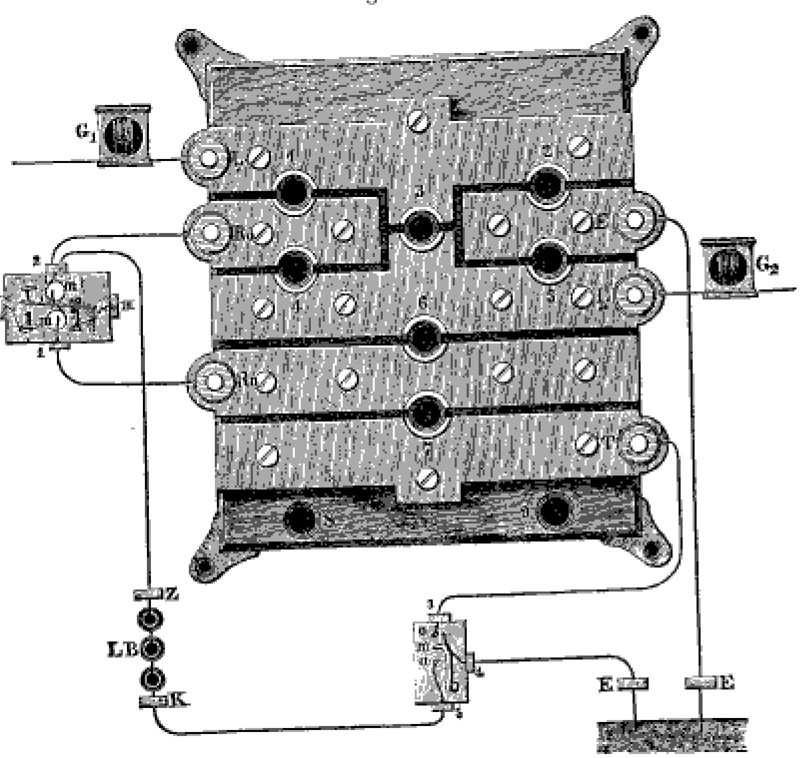


the room can see from his place the arranged circuits. Fig. 23 is a single, and fig. 24 is a double switch.

NOTTEBOHN'S CIRCUIT CHANGER.

An ingenious contrivance was gotten up by Mr. Nottebohn,

Fig. 25.



director-general of the Prussian telegraphs, for the purpose of changing the circuits. Fig. 25 represents the circuit changer used on the Prussian lines. It consists of six brass pieces, or plates, insulated by means of ivory, and situated upon a square piece of plank. Between the plates are seven holes, numbered from 1 to 7. By means of the metallic plug, fig. 25*a*, placed in one of the holes, between two plates, a metallic connection is established. For example, if the metallic plug is placed in hole number 3, a connection is made between the upper plate and the plate 4, 6, L̤. The holes 8 and 9 in the plank are merely to contain the plugs when not in use. By means of the bolt L̤ the line wire coming from one side is fastened—for example, from Berlin through L̤ to the side going to Minden—and at E the wire leading to the earth is fastened. Letters G^1 and G^2 are vertical electrometers; R *o* is connected with the apparatus by means of numeral 2; and R *u* by means of numeral 1; and by means of bolt 3 with L̤. The copper end of the battery K is connected with the earth, and the zinc end with the instrument. In the writing apparatus, the wire of the local battery proceeds from bolts III and IV. E E are the earth plates. The board containing these circuit connections is fastened to the wall at some convenient place, and thence run the wires to the different apparatuses.

Fig. 25*a*.

BINDING CONNECTIONS.

The wires in the stations are often changed and disconnected from the apparatus, battery, or other parts. To facilitate the handling of the wires, screw-standards, such as fig. 26 and 26*a*, are attached to the instruments. The wire enters

Fig 26.

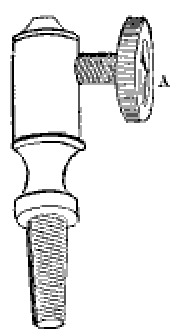
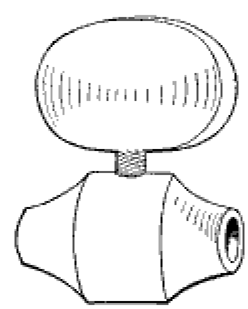


Fig. 27.



a hole, and the screw A, to the right, binds the wire fast. Figs. 27 and 28 are for uniting two ends of the wire together.

Fig. 26a.

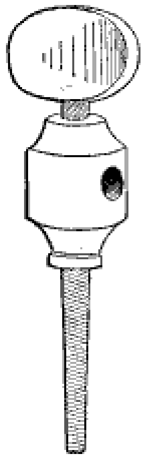
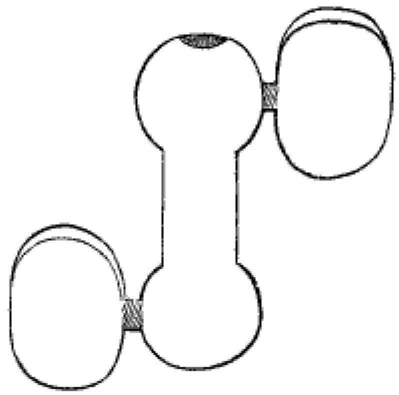


Fig. 28.



Figs. 29 and 30 are for making the connection between the wires and the arms of the battery.

Fig. 29.

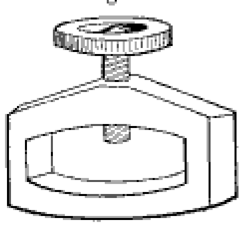
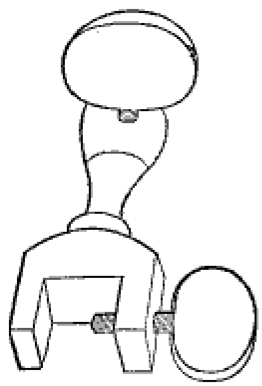


Fig. 30.



THE ELECTRO-MAGNET OF 1844.

The next telegraphic apparatus which I propose to describe is the electro-magnet of 1844. It is one of the most important parts of the system, and one that every operator should well understand. There are two kinds, the register magnet and the relay magnet. The name of the latter is not strictly proper, but in its understood sense it means an electro-magnet that is placed in the main circuit for the purpose of putting into action another, a local or secondary circuit. In the understood sense, as a telegraphic technicality, I use the term relay magnet.

The magnet first used on the American telegraph in 1844 was as represented by figs. 31 and 32, and was thus described by Mr. Vail :

" The electro-magnet is the basis upon which the whole invention rests in its present construction ; without it, it would entirely fail. As it is of so much importance, a detailed account will be given of the construction of the electro-magnet, as used for telegraphic purposes. A bar of soft iron, of the purest and best quality, is taken and made into the form presented in fig. 31, which consists of four parts—viz., A F and A F are the two legs or prongs of the magnet, of a rounded form, and bent at the top, approaching each other toward the centre, where the ends of each prong, without touching, turn up and

Fig. 31.

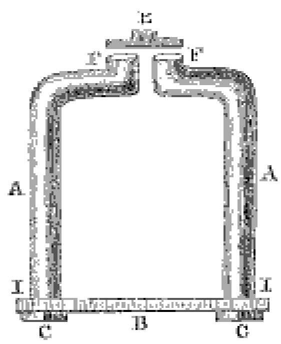
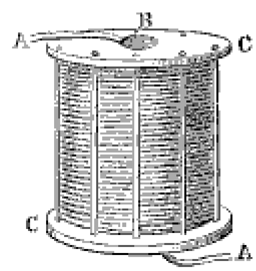


Fig. 32.



present flat, smooth, and clean surfaces, level with each other, at F F. The other end of these prongs or legs is turned smaller than the body, on the end of which is a screw and nut, C C. These ends pass through a plate of iron, B, of the same quality, at I and I, until they rest upon the plate at the shoulder produced by turning them smaller. They are then both permanently secured to the plate B by the nuts C C, and the whole becomes as one piece. This arrangement is made for the purpose of putting on the coils or taking them off with facility. The form most common for electro-magnets is that of the horseshoe ; and is simply a bar of iron bent in that form. E represents a small flat plate of soft iron, sufficiently large to cover the faces of the two prongs F and F, presenting on its under side a surface clean and smooth, and parallel with the faces, F and F.

The coils or helices of wire which surround the prongs A A, necessary to complete the electro-magnet, consist of many turns of wire, first running side by side, covering the form upon which the spiral is made, until the desired length of the coil is obtained; the wire is then turned back, and wound upon the first spiral, covering it, until the other end of the coil is reached, where the winding began; then again mounting upon the second spiral, covers it, and in the same manner it is wound back and forth, until the required size of the coil is attained.

The coil is wound upon a form of the size (or a little larger) of the legs of the magnet, and when the coil is completed, the form is taken out, leaving an opening in the centre, B, into which the prongs may freely pass. Fig. 32 represents a coil constructed in the manner described. A and A are the two ends of wire which are brought out from the coils. The one proceeds from the centre of the coil, and the other from the outside. C and C are circular wooden heads, on each end of the coil, and fastened to it by binding wire, running from one head to the other around the coil. The wire used in constructing it, as heretofore mentioned, is covered in the same manner as bonnet wire, and saturated or varnished with gum shellac. This preparation is considered necessary, in order to prevent a metallic contact of the wires with each other. Such a contact of some of the wires with others encircling the iron prong would either weaken or altogether destroy the effect intended by their many turns. If the wires were bare instead of being covered, the electric fluid, when applied to the two ends, A and A, instead of passing through the whole length of the wire in the coil as its conductor, would pass laterally through it as a mass of copper, in the shortest direction it could take. For this reason they require a careful and more perfect insulation. Two coils are thus prepared for each magnet, one for each prong A and A, fig. 31."

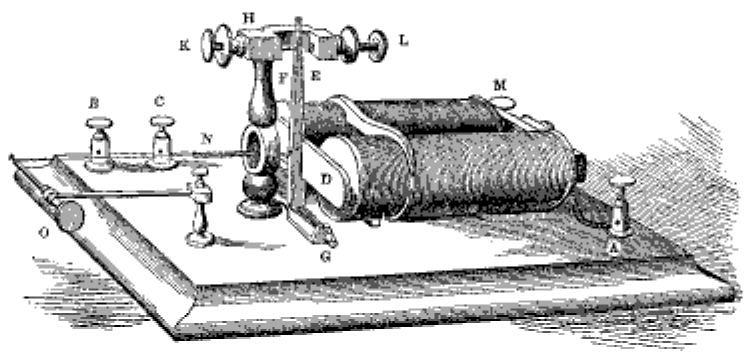
Such was the construction of the magnets in 1844. The wire was large, and one pair of coils weighed 185 pounds. Since then the ingenious spirit of the age has reduced the size and weight; the usual weight does not exceed from one to two pounds; the wire is very fine, and well covered or insulated with silk. The mechanism has very much changed; so much so, in fact, that the telegrapher unacquainted with the facts in the case, would not suppose the magnets above described ever belonged to the telegraph.

THE MODERN RELAY MAGNET.

The modern relay magnets are of many forms of construction. I will describe one of them in detail. Fig. 33 represents the magnet as it sets upon the table, with its wooden base, having at each corner binding posts. The line wire enters the hole in the post A, and is bound by the screw in its top. To the post A is soldered the copper wire leading to the spools or coils of the magnet. One end of the insulated wire that surrounds the coils is joined to the wire that leads to the post A; the other end of the spool wire is in the same manner connected with the post M. The current from the line wire enters the station and follows the conductor to the post A, thence through the magnet coils, thence to post M, and thence to the battery.

The local circuit is united to the posts B and C; the lower

Fig. 33.



end of post B is connected by a wire beneath the base to the metallic frame G; the other local post, C, is connected by a wire underneath to the metallic standard H; the armature D is attached to a brass upright lever, on the side of which, near E, is fixed a piece of platina; K is an adjusting screw, with an insulating point, F, made of ivory; L is another adjusting screw, with a platina point E. The upright lever attached to the armature D does not touch the brass arm H. Suppose a current is transmitted over the line wire; it traverses the coils and produces magnetism in the cores of the spools. The armature D is then attracted toward the magnet, and the upright lever is brought into contact with the platina point E, which closes the local circuit. The current from the local battery will then flow with the copper wire conductor to the post B, thence to the metallic axle frame G, thence up the lever of the armature, thence with the screw E, thence with the brass work H, thence underneath the board to post C, and from there through the register magnets to the other end of the battery. This completes the local voltaic circuit. If the circuit be broken at E, the local battery fails to act. Every time the current is transmitted over the line by the contact of a key at a distant station, the current flows through the relay magnet t the local circuit is then closed, and the local battery curren

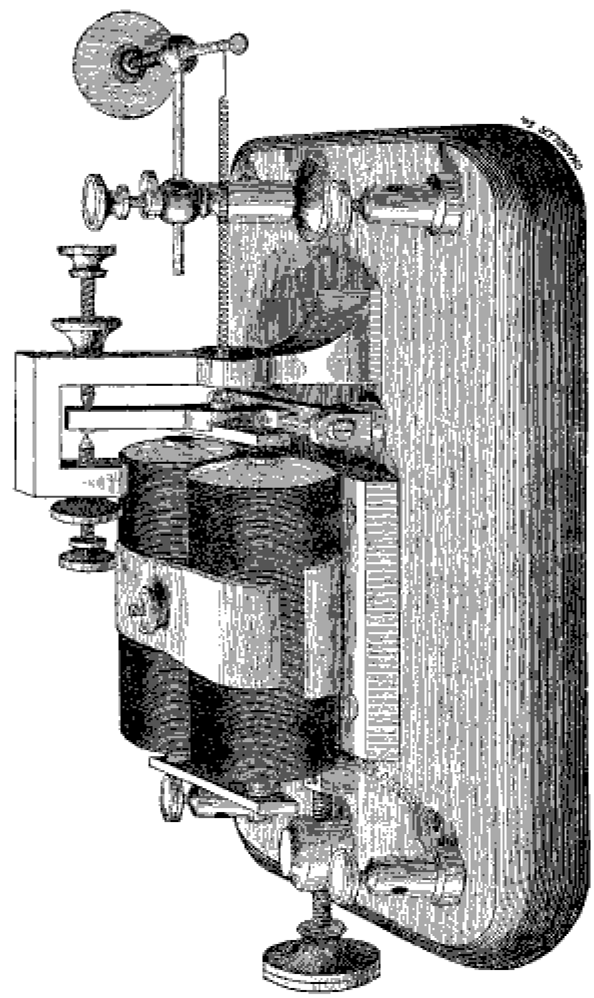


Fig. 4.

passes through the register magnets, which causes the pen lever to mark upon the paper. If the magnetism in the cores be too strong, the armature D is drawn farther from their ends by the adjusting screw O, to the end of which is attached a silk thread or cord. This cord is tied to one end of a spiral spring, N, the other end being fastened to the armature lever. These explanations are, I presume, sufficient to enable the reader to understand the application of the relay magnet in the telegraph apparatus.

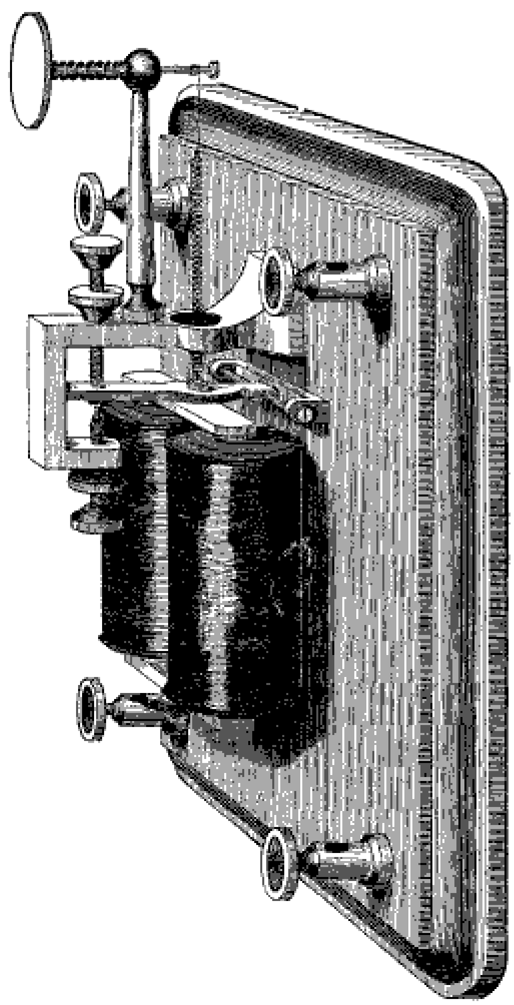


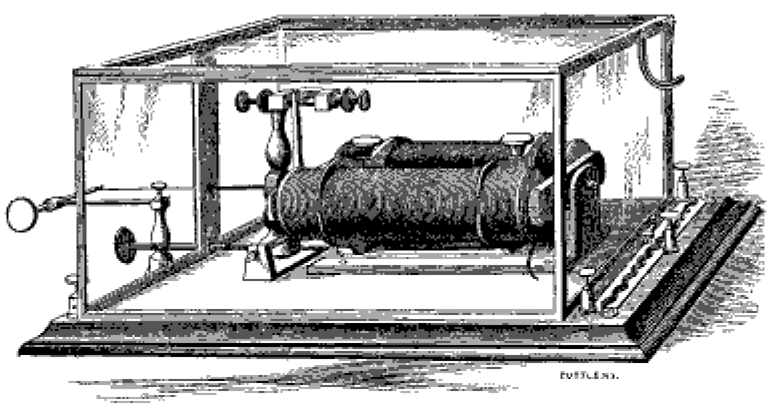
Fig. 25.

Fig. 34 represents a relay magnet with adjustable coils. By turning the screw at the left of the engraving, the spools or helices can be drawn from the armature or placed closer to it, as circumstances require. It is best for the armature lever to be poised on its axle, and when the adjusting screws are all arranged, it is easier to remove the coils backward or forward by the one screw, than to readjust the armature lever by the three screws L K and O, as seen in fig. 33. This valuable improvement was invented by Mr. Thomas Hall, of Boston, who has been engaged in the manufacture of telegraphic apparatuses since the commencement of the enterprise. By his ingenious mechanical skill many very valuable improvements have been made, and the telegrapher has realized many advantages in the service by the application of Mr. Hall's contrivances in the different departments of the art.

Fig. 35 is another form of a relay magnet, manufactured by the same gentleman. The line wire is connected to the various parts beneath the base board.

Fig. 36 is another improved relay magnet, gotten up by

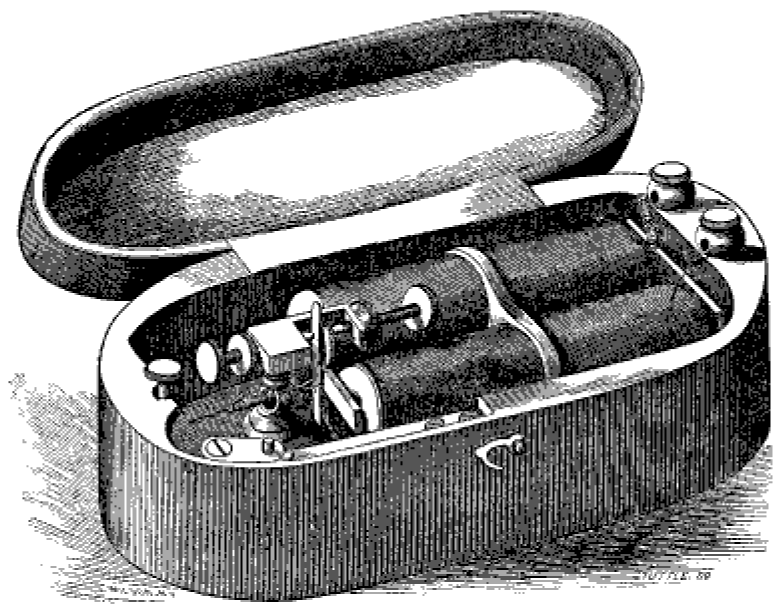
Fig. 36.



those energetic telegraphers, Messrs. Chester and Brothers. The coils of this magnet are covered with a glass case, set in a brass frame with hinged top. The coils are moveable by an adjusting screw outside of the glass. At one end of the board is attached a paratonnerre, with the earth wire connected to the centre post. The line wire is fastened to the posts at each end of the paratonnerre. If the lightning enters the station, it passes from the inner to the outer brass plate between the two posts in preference to traversing the coils. If the wire from one end of the brass plate is not connected with the earth, and both ends lead on to other stations on each side, the plus lightning will pass over to the exterior or right-hand brass plate and follow the earth wire from the centre post, seen in the figure. This excellent combination is worthy of the highest appreciation.

Fig. 37 is a pocket relay magnet; it is small, and weighs about one pound. The coils are fitted in a little case, and all the arrangements for wire connections are perfect. On the side is attached a small key, so that an operator can manipulate

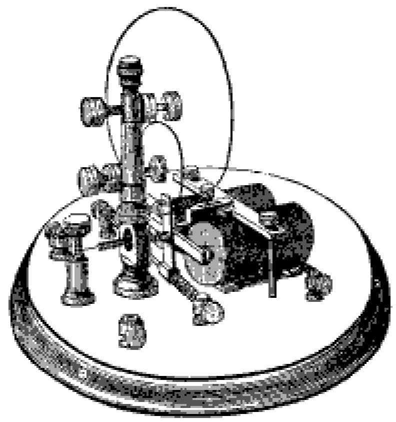
Fig. 37.



with it as perfectly as with the larger keys of the station. The binding posts at the right hand end receive the line wires. The current traverses the coils, and the armature lever makes the telegraphic sound, and the expert operator is thus enabled to transmit and receive information with the same perfection, common at the stations. Repairers find this miniature magnet of great value.

Fig. 38 represents what has been commonly known in America as the Bain sounder. It is the ordinary relay magnet, with one or more glass disks attached to it as seen in the figure. It was used as a call magnet on the lines not having the patented authority to work the Morse system. The Bain lines applied this magnet, so that the stations could hear the "call" when wanted by a distant station. The armature

Fig. 38.



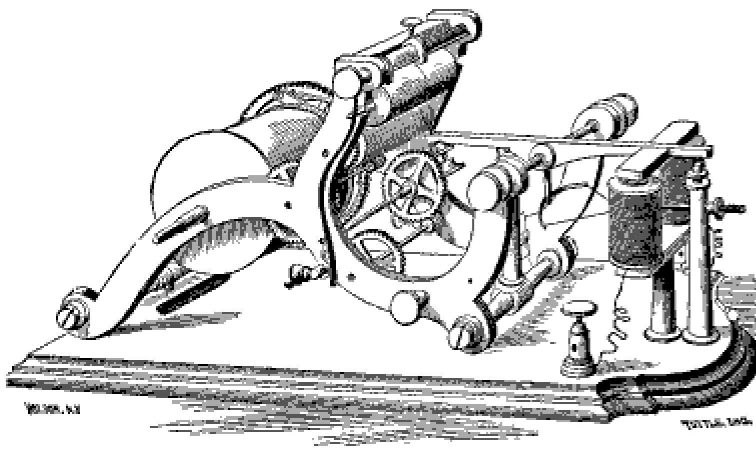
striking upon the glass disk, a distinct and intelligible sound was made.

THE RECEIVING REGISTER.

The next apparatus to be described is the register, an instrument of simple construction, and perfectly effective in the recording of the dispatch. The register herein before described was a complete success. Subsequent improvements have added to the exactness of the mechanism, and rendered it as reliable and durable in its service as possible to be attained in the art.

Fig. 39 represents an improved register, exhibiting the clock-work and magnets. The pen-lever is seen in the figure with the steel point projecting upward; the magnets are fastened to the upright standard. The wire from the local battery connects with the front standard, and it is then carried, as seen in the figure, to the front coil; after surrounding it and the rear spool, it is united with the rear standard. The wire surrounding these magnets is not so fine as the wire used for the relay magnets. The local battery circuit commences with the platina end of the battery, and runs to the relay magnet, and passes through the connections at that instrument as before described; thence it comes to the register, and through the coils; it then runs to the zinc end of the battery, which completes the local circuit. Whenever the relay magnet, fig. 34, attracts the armature, the local circuit is closed at E, and the local current traverses the coils of the register magnet, fig. 39, which generates magnetism in the cores, the armature is then attracted down, which elevates the other end of the lever, and the pen point is thus caused to puncture the ribbon paper,

Fig. 39.



as seen in fig. 40. The clockwork being in motion, the paper is drawn through by the grooved rollers, and thus a clear piece of paper is continually presented for indentation by the pen point. The clockwork is wound up by the key, seen in the figure, and it is set in motion or stopped by the stop slide, the handle of which is seen at the centre and under the mechanism.

Fig. 40.

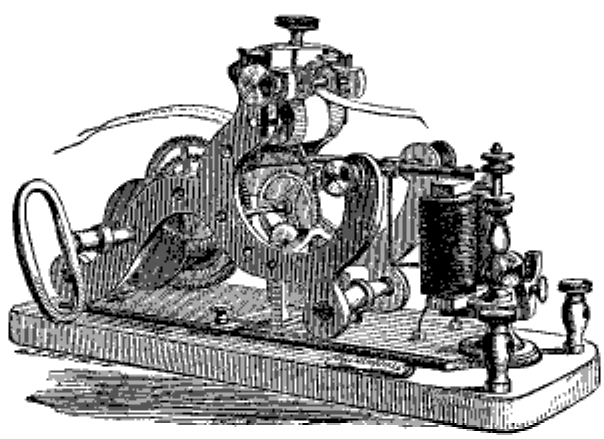


Fig. 41 represents an improved register, manufactured by the Messrs. Chester. It is one of beautiful finish and perfection of mechanism. The base is of pure Italian marble, highly

Fig. 41

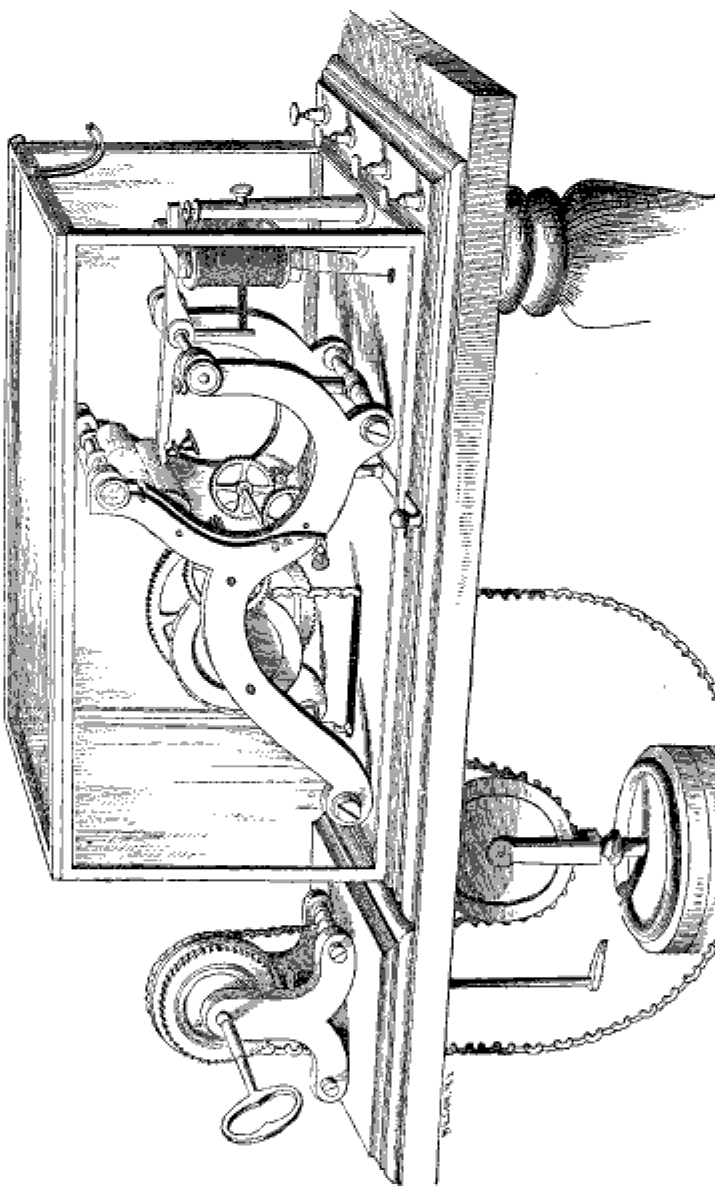
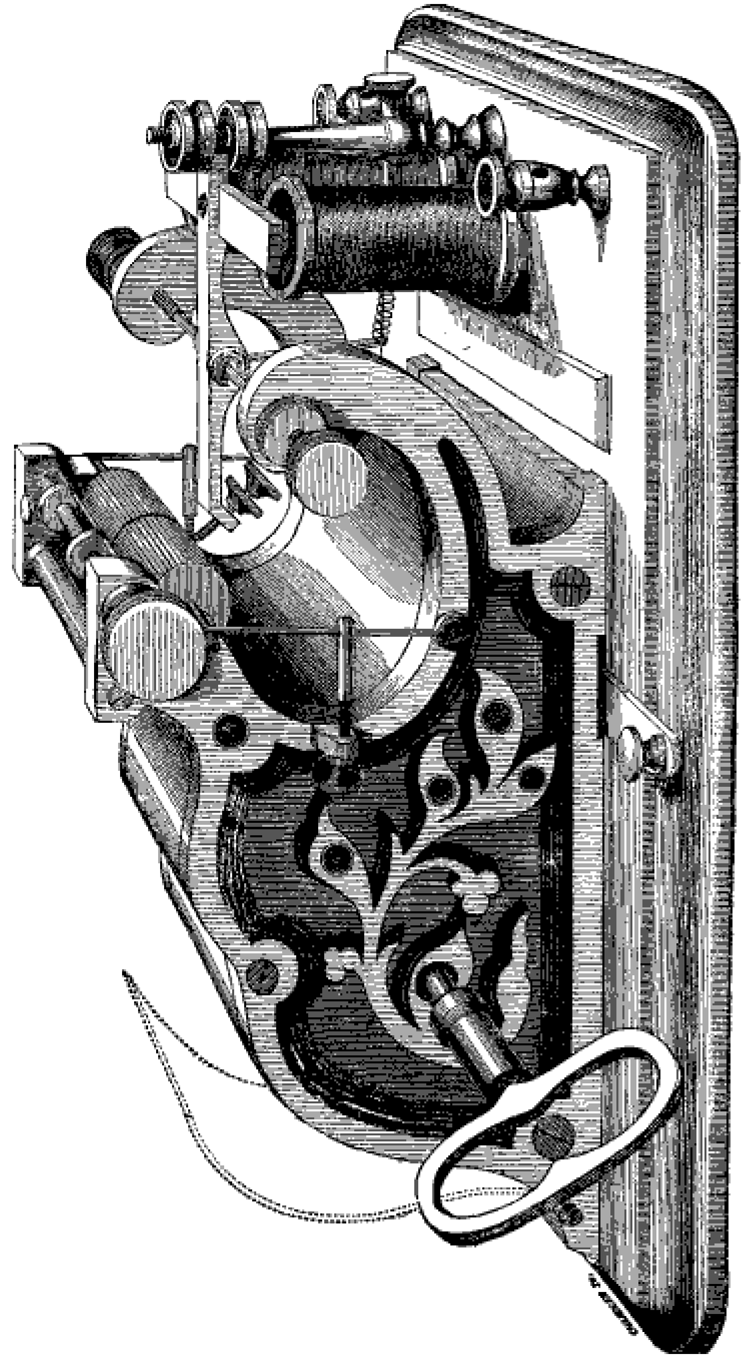


Fig. 42.



polished. It is encased in glass, with an opening at the top with a hinge.

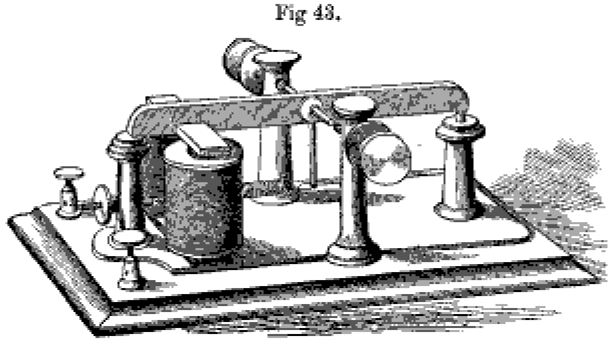
The arrangement for winding up this register is on the outside of the glass case, which can be done while the clockwork is running. The pen-lever is also arranged to open and close another main circuit serving the purposes of a "repeater." The wire connections are made outside with the binding posts, as seen in the figure.

Fig. 42 is a closed register, manufactured by Mr. Thomas Hall. The clock-work is enclosed in a brass or iron case. In front is a hinged opening, which, when open, occupies the position indicated by the dotted lines to the left. This register has been extensively used on railway telegraph lines, and it has given universal satisfaction. The clock-work once put in order remains so for a very long time, and the wheels are thus enabled to move with the desired celerity. It has all the necessary and improved appliances for adjusting and regulating the different parts, and the whole embraces everything necessary to render it useful and economical.

THE TELEGRAPHIC SOUNDER.

Fig. 43 represents a sounder, as now successfully used in many of the American telegraph stations. The register, with all its clock-work, marking on paper, and accompaniments, has been laid aside at the leading stations, and this simple apparatus has taken its place. The coils are the same as those

Fig 43.

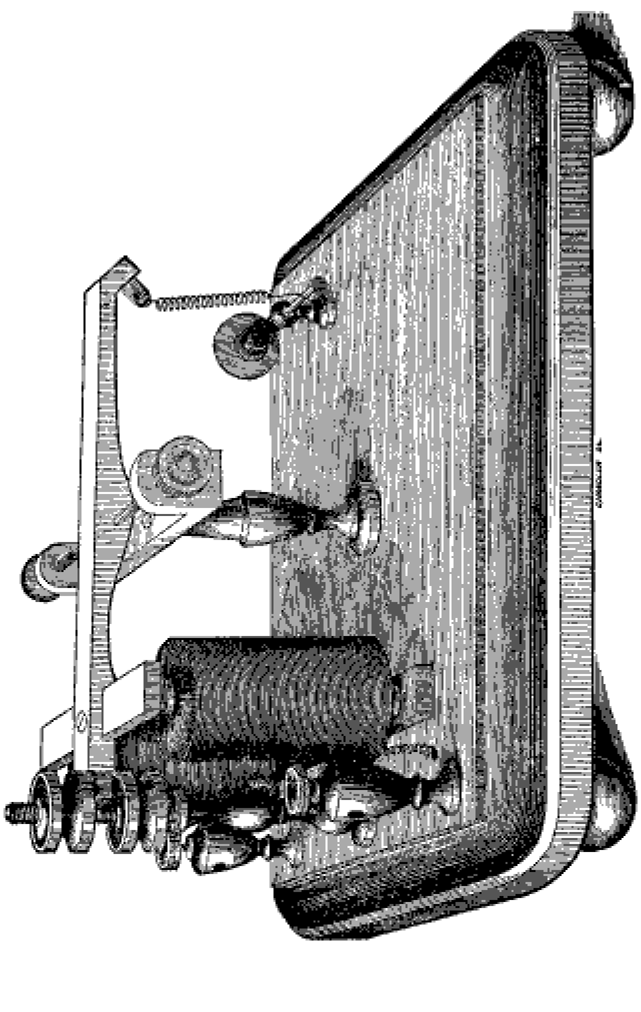


used in the register; the lever is made substantial, and the local current causes the magnet cores to attract the armature with great strength, and thus a good clear sound is made, by which the operator in any part of the room can hear and understand what is communicated by any other station on the whole line.

Fig. 44 is another form of the sounder; the lever is adjusted at the end by the spiral spring, seen in the figure. Some operators prefer one mode of construction, and others choose a different kind; some prefer a heavy sound, others can hear more distinctly a lighter tone. The sense of hearing is not the same with all operators, and it is but natural that there should be a difference in choice as to the sounder.

Of all the mysterious agencies of the electric telegraph, there is nothing else so marvellous as the receiving intelligence by sound. The apparatus speaks a language, a telegraphic language, as distinct in tone and articulation as belong to any

Fig. 44.



tongue. The sound that makes the letter, is as defined in the one as it is in the other. An operator sits in his room, perhaps some ten feet from his apparatus, and he hears a conversation held between two others, hundreds of miles distant, and perhaps the parties conversing are equally as far apart. He hears every word; he laughs with them in their merriment, or perhaps sympathizes with them in their bereavements. The lightning speaks, and holds converse with man! What can be more sublime!