DESCRIPTION

OF THE

AMERICAN ELECTRO MAGNETIC TELEGRAPH:

NOW IN OPERATION BETWEEN THE CITIES OF

WASHINGTON AND BALTIMORE.

ILLUSTRATED BY FOURTEEN WOOD ENGRAVINGS.

BY ALFRED VAIL,

ASSISTANT SUPERINTENDENT OF ELEC. MAG. TEL. FOR THE U.S.

"The same principle which justified and demanded the transference of the mail on many chief routes, from the horse-drawn coach on common highways to steam impelled vehicles on land and water, is equally potent to warrant the calling of the electro magnetic telegraph — that last and most wondrous birth of this wonder-teeming age — in aid of the post office, in discharge of its great function of rapidly transmitting correspondence and intelligence."

Rep. of Com. of Ways and Means of H.R., 1845.

WASHINGTON:

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1847.

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By Robert D. Keys/NA4G "Boatanchor Bob"

THE
ELECTRO MAGNETIC TELEGRAPH.

THE GALVANIC BATTERY

The galvanic battery, the generator of that subtle fluid, which performs so important a part in the operation of the Electro Magnetic Telegraph, is as various in its forms and arrangement, as the variety of purposes to which it is applied. They all, however, involve the same principle. It is not our design here to describe the various modes of constructing it, but to confine our remarks more immediately to that used for the Telegraph.

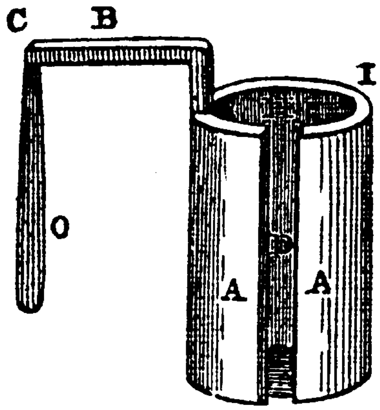
The effects produced by the galvanic fluid upon the metallic bodies, iron and steel, exciting in them the power of attraction or magnetism, its decomposing effects upon liquids, resolving them into their simple elements, its effects upon the animal system, in producing a spasmodic and sudden irritation, are generally known. But of the character of the fluid itself, its own essence or substance, we know nothing. In some of its phenomena, it resembles the electricity of the heavens; both find a conductor in the metals; both exhibit a spark, and both are capable of producing shocks, or when applied, cause the animal system to be sensible to them. Again, in other of its phenomena it is totally unlike it. The galvanic fluid is essentially necessary in producing the electro magnet; while the electricity of the heavens, or as it is generally termed, *machine electricity*, has no such power for practical purposes. The former is more dense, so to speak, and more easily confined to its conductors, while the latter becomes dissipated and lost in the atmosphere long before it has reached the opposite extremity of a long conductor. The former always needs a continuous conductor; while the latter will pass from one metallic conductor to another without that connection. The latter would not subserve the purposes required in the working of the Electro Magnetic Telegraph, and as it is neither essential nor antagonistical, its presence upon the galvanic conductors or wires, at the same time those wires are being used for telegraphic communication, does in no way interrupt or confuse its operation; and its presence is only known from the suddenness of its discharge at long intervals, accompanied by a bright spark, with a loud crack, like that of a coachman's whip.

The most simple mode of developing the galvanic fluid is in the following manner: if a common glass tumbler is two-thirds filled with dilute muriatic acid, and a piece of bright zinc, five inches long and one inch wide, immersed in the liquid, at one of its ends, slight action will be discovered upon it. If a slip of copper be taken, of the same dimensions, and one end immersed in the liquid, but separated from that portion of the zinc immersed, and not permitted to touch it; and the two projecting ends of the zinc and copper, above the liquid be brought in contact, an active decomposition of the muriatic acid will appear.

While the two outer ends are in contact, there is that current formed in the metallic plates, which is termed galvanic. If the contact is broken, the action ceases; if it is again renewed, the action is recommenced. Another very simple experiment, and within the power of everyone to demonstrate for themselves, is that of applying a piece of zinc to the underside of the tongue, and to the upperside, a silver coin, and then by bringing their projecting ends in contact, a sensible and curious effect is experienced upon the tongue. It is a feeble galvanic shock, and is proof of the presence of that fluid termed galvanic.

We will now proceed to describe the battery used for telegraphic purposes; the same in principle, but in arrangement more complicated, and far more powerful, than those in common use. Two distinct acids are employed; two metals and two vessels. Each part will be described separately, and then the whole, as put together ready for use.

Figure 1.



First. A glass tumbler of the ordinary size is used, or about three inches high and two inches and three quarters in diameter.

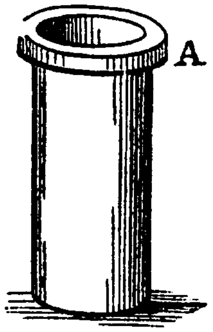
Second. The zinc cylinder, made of the purest zinc, and cast in an iron mould, represented by figure 1. It is three inches high and two inches in diameter. The shell I is three-eighths of an inch in thickness. D is an opening in the cylinder, parallel with its axis, and is of no other use than to aid in the operation of casting them, and facilitating the access of the fluid to the interior. A represents the body of the cylinder. B is a projecting arm, first rising vertically from the shell, and then projecting horizontally one and three-quarters of an inch. To this arm, at C, is soldered a platinum plate of the thickness of tin foil, and hanging vertically from the arm B, as seen at O, and of the form as shown in the figure. This constitutes the zinc cylinder and platinum plate, the two metals used in the battery.

Third. The porous cup. To avoid an erroneous impression in the use of the term porous, it will suffice to state, that it is a cup of the form represented by figure 2, made of the same materials as stone-ware, and baked without being *glazed.*[1] A represents the rim surrounding the top. From the under side of the rim to the bottom, it is three inches long, and one and one-quarter in diameter. The rim projects one-quarter of an inch, and the shell of the cup is one-eighth of an inch thick.

These several parts are placed together thus. The porous cup, figure 2, is set in the hollow of the zinc cylinder, figure 1, represented by H, with the

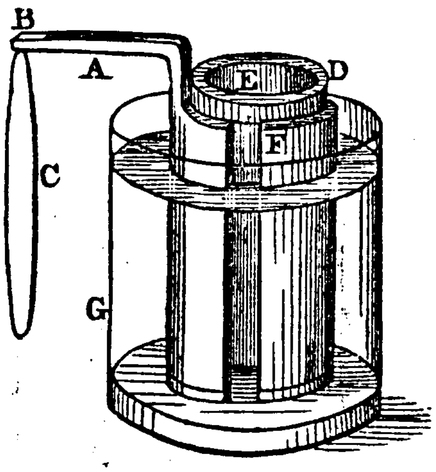
[1] These are made at the American Pottery, in Jersey City, opposite New York.

Figure 2.



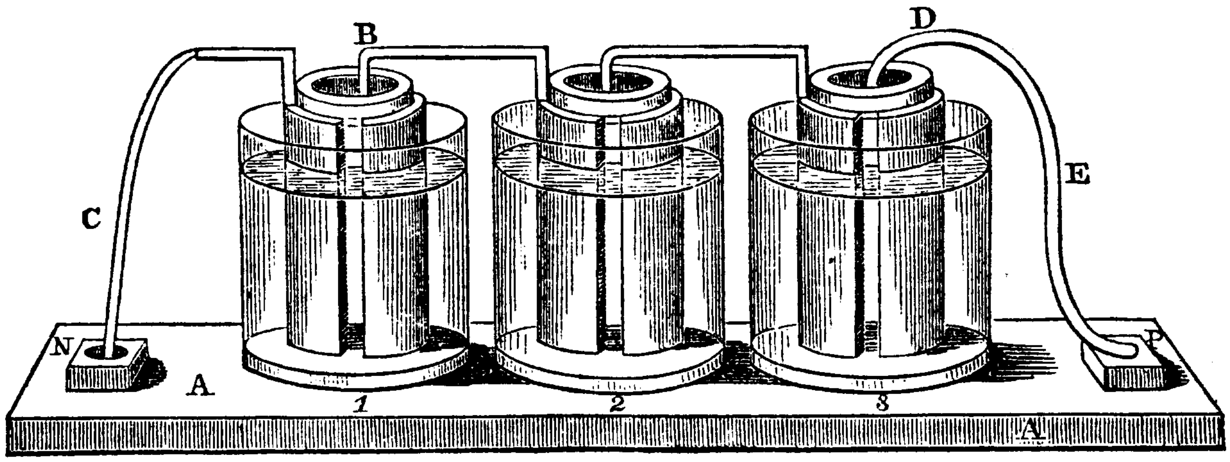
rim of the cup resting upon the top of the zinc at I. The zinc cylinder is then placed in the glass tumbler. The whole is represented in figure 3. D represents the porous cup, F the zinc cylinder, G the glass tumbler, A the projecting arm of the zinc, C the platinum plate, and B the overlapping of the platinum plate upon the zinc arm, where it is soldered to it.

Figure 3.



It is now in a condition to receive the acids, which are two: first, pure nitric acid, and second, sulphuric acid, diluted in the proportion of one part of sulphuric acid to twelve of water. First fill the porous cup with the nitric acid, to within one-quarter of an inch of the top; then fill the glass with the diluted sulphuric acid, till it reaches to a level with the nitric acid in the porous cup. One glass of the battery is now ready for use, and as all the other members of the battery are similarly constructed, (there being as many or few, as circumstances require,) and are to be prepared and filled with their appropriate acids in the same manner, the above description will suffice. There remains, however, some further explanation in regard to the extremities of the series of glasses, that is, the mode of connecting the platinum of the last glass with the wire leading from that end of the series of glasses. Figure 4 represents their arrangement.

Figure 4.



The glasses being all separately supplied with their acids, and otherwise prepared, they are put together upon a table, A A, perfectly dry, and made of hard wood. The first member of the series has soldered to its zinc arm a strip of copper, C, which, extending downward, has its end, previously brightened and amalgamated, immersed in a cup of mercury at N. The cup being permanently secured to the table. Then the second glass is taken, and the platinum, B, at the end of the zinc arm, is gently let fall into the porous cup, so that it shall be in the centre of the cup, and reaching down as far as its length, when the glass rests upon the table. The third glass is then taken and placed in the same manner, and so on to the last. The last glass has, in its porous cup, the platinum plate, D, soldered to a strip of copper, E, which is so constructed as to turn at the top, and admit of the easy introduction of the platinum into the porous cup, while the other end of the copper, previously prepared like the copper of the other end of the battery, terminates in a cup of mercury, P. The cup being capable of adjustment, so as to bring the platinum directly over the porous cup; is, when adjusted, secured permanently to the table. The battery, thus arranged, is ready to be applied.

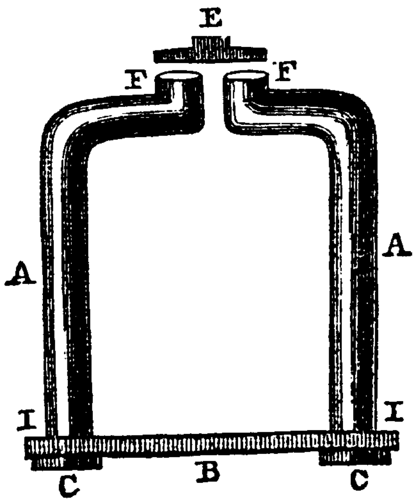
THE WIRE

The wire used in making helices for the magnets, and for connecting the telegraphic stations, is made of copper of the best quality, and annealed. It is covered with cotton thread, so as to conceal every part of the metallic surface; not so much to prevent corrosion or waste from the action of the atmosphere, as to prevent a metallic contact of one wire with another, when placed near each other. After the wire is covered, it is then saturated with shellac, and then, again, with a composition of asphaltum, beeswax, resin and linseed oil. It is now in a condition to be extended upon the poles. That portion of the wire of which the helices are made is only saturated with shellac.

THE ELECTRO MAGNET

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 figure 5, which consists of four parts, viz. A F and A F are the two legs or prongs

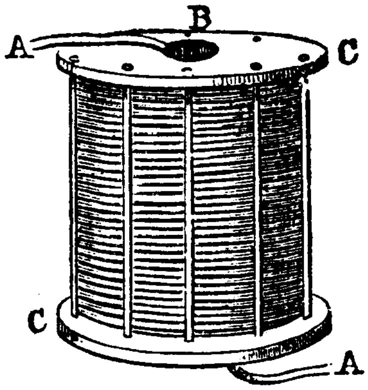
Figure 5.



of the magnet,[2] of a rounded form, and bent at the top, approaching each other towards the centre, where the ends of each prong, without touching, turn up, and 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 permenantly 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 horse-shoe; 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.

[2] The term *magnet*, here, is synonymously used with the iron for the magnet, as the simple iron is not a magnet, except when subjected to the action of the battery through the helices of wire around it. It would confuse the reader, if this distinction be not kept in view. *Permanent magnets* are those which retain their magnetism once they are charged. They are always made of steel, and usually bent in the form of a horse-shoe. Sometimes they are of a single plate of that form, and others are constructed with many plates, side by side, fastened together so as to present a compact magnet of the same form. They are distinguished from *ElectroMagnets* from the fact that the soft iron of the latter depends upon the influence of the galvanic fluid for its magnetism, and retains it only so long as the soft iron is under its influence, while the former, when once submitted to the influence of the galvanic fluid, retain their magnetism permanently.

Figure 6.



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 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 open centre, B, into which the prongs may freely pass. Figure 6 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. The preparation is 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 galvanic 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 most perfect insulation. Two coils are thus prepared for each magnet, one for each prong, A and A, figure 5.

Figure 7.

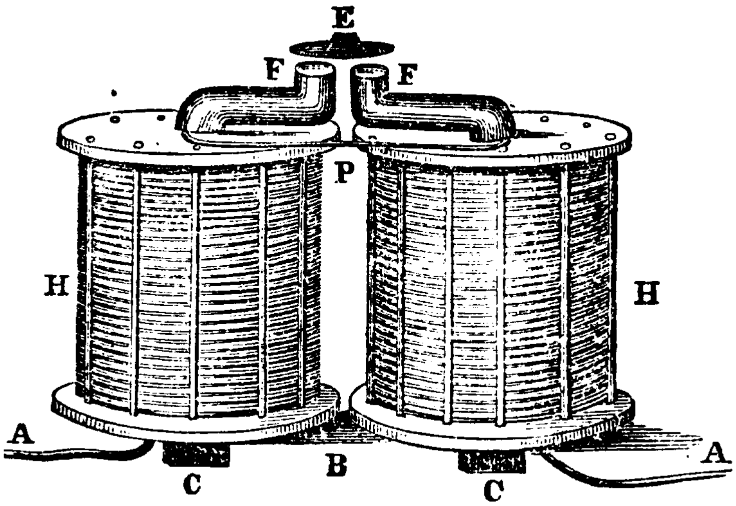
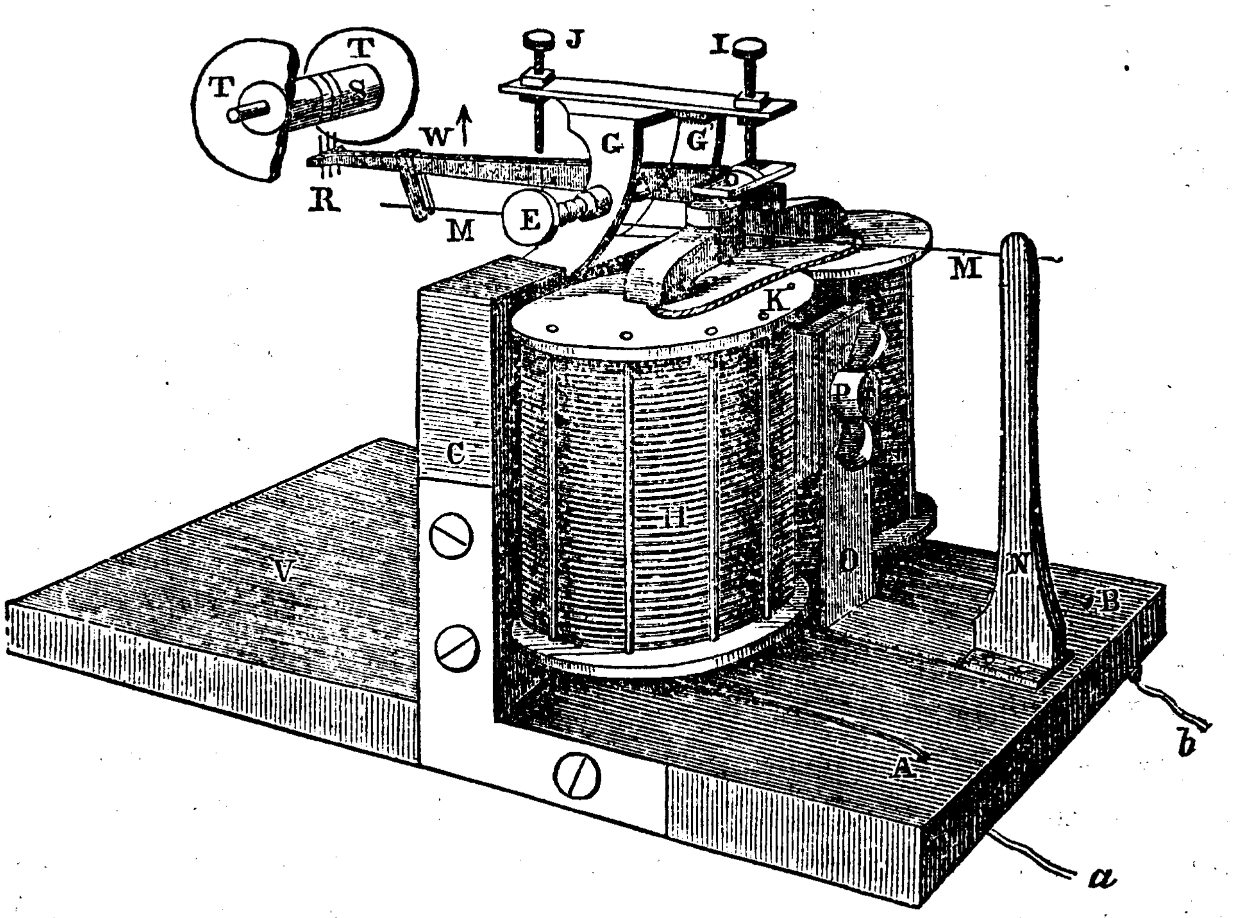


Figure 7 exhibits a view of the magnet; figure 5, with its two coils, H and H, placed upon the prongs. Those parts of the magnet, not concealed by the coils, are lettered as in figure 5, and correspond with its description. P represents the wire connecting the coil H with H, and A and A the ends of the wires leaving the coils.

We now proceed to explain the manner by which the magnet is secured upon a frame, and the arrangement of the armature, E, figure 7, upon a lever, so that the motion peculiar for telegraphic writing may be shown.

Figure 8 exhibits, in perspective, a view of the electro magnet and the pen lever, in a condition to show the effect of the galvanic battery upon the prongs of the magnet, F and F, and the armature, D, and the movement of the pen lever to which the electro magnet is secured. A bolt, upon the end of which is a head or shoulder, passes through the centre of the upright block, C, and between the coils, H and H, and also through the brass brace, O, projecting a little beyond it, with a screw cut upon its end. The thumbnut, P, fitted to it, is then put on, and the whole firmly held by screwing the thumb-nut as far as possible. F and F are the faces of the iron prongs, as shown in figure 7, presenting their flat surface to the armature, D. I, is the pen lever, suspended upon steel points, as it axis, which pass through its side at X, and soldered to it. Each end of this steel centre is tapered so as to form a sharp and delicate point or pivot. E is a screw, passing through the side of the brass standard, G, and presenting at its end a sunken centre, the

Figure 8.



reverse of the steel pivot point at X. There is also another screw, similar to E, passing through the other side of the standard at G', with a sunken centre in its end. By the extremities of these two screws, to which the tapered ends of the steel centre is fitted, the pen lever is suspended, so as delicately to move up and down, as shown by the direction of the arrow. The brass standard, G, is secured to the upright block, C. D is the armature, soldered to the end of the brass pen lever, L, separated from the faces of the magnet, F and F, about the eighth of an inch. W is a yoke, secured to the lever by a screw, and which admits through its lower part the steel wire spring, M M, for the purpose of bringing down the lever when not acted upon by the electro magnet. The spring is secured to a brass standard at the top, represented by N. R represents the three steel points of the pen,[3] which mark upon the paper the telegraphic characters; each of which strike into its own appropriate groove in the steel roller, S. T and T are the flanges of the steel roller, S, and which confine the paper as it passes between the pen points, R, and the steel roller, S, described more fully hereafter. J and I are two screws in the horizontal cross bar attached to the standard, G, and are used for the purpose of adjusting and limiting the pen lever in its movement upward and downward; the one to prevent the pen points from striking too deeply into the paper and tearing it, and the other to prevent the armature from receding too far from the faces of the electro magnet, and beyond its attraction, when it is a magnet. K is the connecting wire of the two coils H and H. A and B show the ends of the wire, one coming from each coil and passing through the stand, and seen below at a and b.

Having explained this arrangement of the electro magnet, the pen lever, and the battery; the effect of the latter upon the former will now be described. Let one of the wires from the coils, figure 8, —a, for instance, be extended so far, that it can conveniently and securely be connected with the mercury cup, N, figure 4, of that pole of the battery. Then take the wire b, figure 8, and extend it also to a convenient length, so as to be freely handled, and connect it with the mercury cup, P, figure 4, of the other pole of the battery. It will be found at the instant the connection is made, that the lever, L, figure 8, will fly up in the direction of the arrow at W. The iron prongs in the centre of the coils, H and H, which were before perfectly free from any attractive power, have now become powerfully magnetic by the inductive influence of the galvanic current flowing the circuitous turns of the wire around the iron, so that now the electro magnet is capable of sustaining twenty or twenty-five pounds weight. This magnetic power concentrated in the faces of the electro magnet, F and F, attracts to it the armature or small iron, D, drawing the pen lever down on that side of its axis, and producing a reverse motion on the other side at L. Now take out the wire b, from the mercury cup, and in an instant its magnetism is gone, and the lever, L, falls by the action of spring, M. If the circuit is closed a second time, the lever again flies up; and if immediately broken, falls. In this manner it will continue to operate in perfect obedience to the closing

[3] One marking point will suffice.

or breaking of the circuit. If the circuit is closed and broken in rapid succession, the lever obeys and exhibits a constant and rapid motion. If the circuit is closed and then broken after a short interval, the lever will remain up the same length of time, the circuit is closed, and falls upon its being broken. Whatever may be the time the circuit is broken, the lever will remain up for the same length of time, and whatever may be the time it continues broken, the lever will remain down for the same time. Suppose the magnet is separated at a distance of one mile from the battery; upon manipulating at the battery, at that distance, in the manner just described, the same vibratory motion is produced in all its vagaries, as when they were removed only a short distance. Separate them 10 miles, and still the same mysterious fluid is obedient to the pleasure of the operator in producing the desired motion of the pen lever. If they were separated at distances of 100 or 1000 or 100,000 miles apart, the lever would doubtless obey the manipulations of the operator, as readily as if only distant a few feet. Here is exhibited the principle uon which Morse's Electro Magnetic Telegraph is based, and which gives to the several portions of the civilized world the power of holding instantaneous communication with each other, with a rapidity far beyond what has ever before been attained. As the above explanation is given only in reference to the power of the electro magnet, when connected with the battery, and to show the movements of the pen lever, we shall speak of the arrangement of the wires for extended lines hereafter.

Having now explained the electro magnet and its operation through the agency of the battery, we will proceed to describe those various parts of the register, by which the electro magnet is made subservient to the transmission of intelligence from one distant point to another.

Figure 9 represents, in perspective, the whole of the register, as also the key or correspondent. The electro magnet, H and H, and the pen lever, L, which have just been described under figure 8, need not be recapitulated here. The letters used in figure 8, represent the same parts of the electro magnet in this figure.

The brass frame containing the clock work, or rather wheel work, of the instrument, is seen at 5 and 5. The whole purpose of the clock work is to

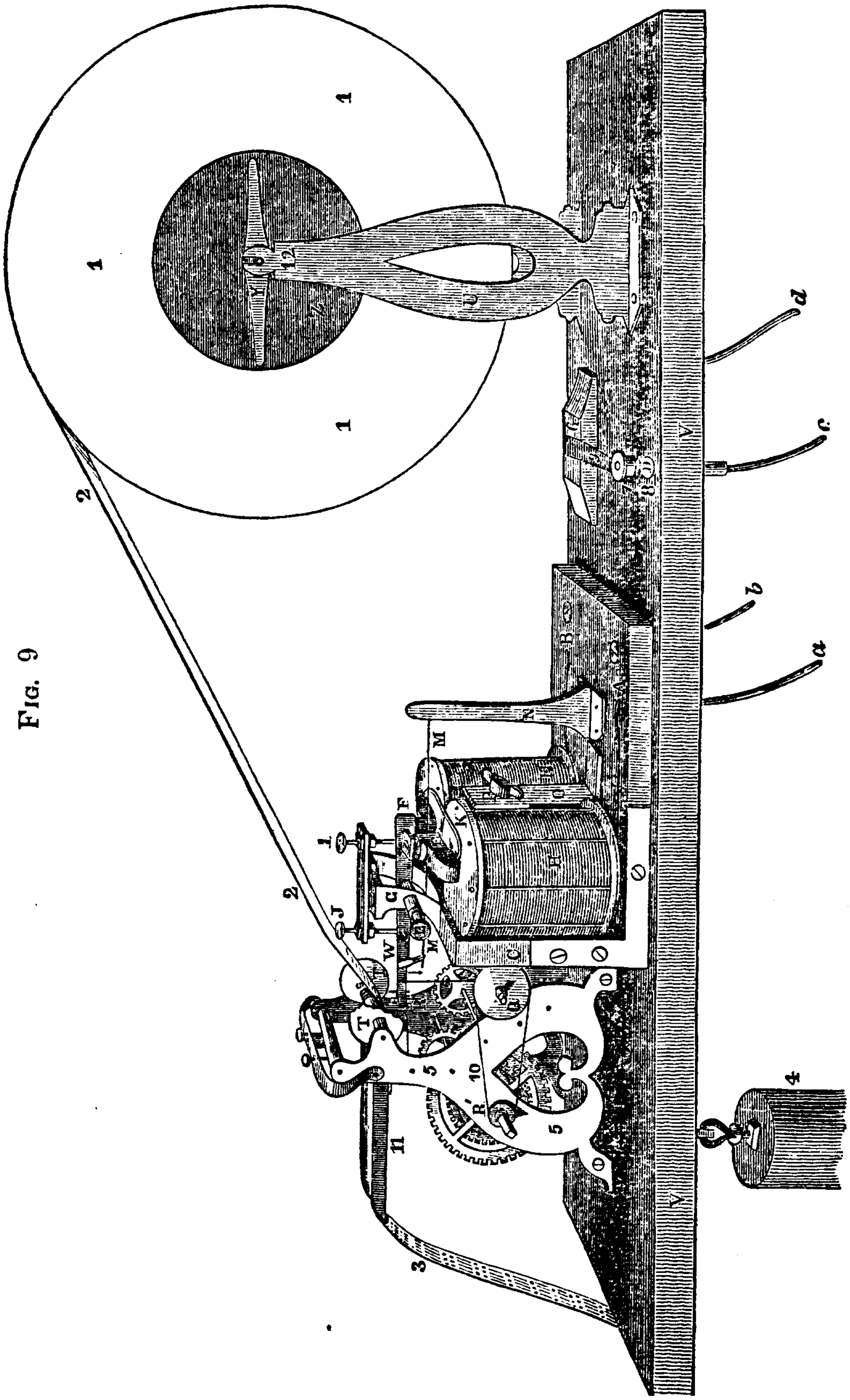


FIG. 9

draw the paper,[4] 2 2, under the steel roller, S, and over the pen, R, at an uniform rate.

There is also an arrangement in connection with the wheel work, by means of which the clock work is put in motion and stopped at the pleasure of the operator at the distant station. How this is done will now be explained. Upon the shaft, R', is a brass barrel, upon which is wound the cord to which the weight, 4, is suspended, and by means of which and the intermediate wheels, the motion produced, is communicated to two rollers (not seen in this figure, see figure 10, E F) in advance of the steel grooved roller, S. These two rollers grasp the paper, 2, 2, 3, between them, and supply it to the pen at a given and uniform rate; the rate being determined by the adjustment of the wings of the fly, connected with the train.

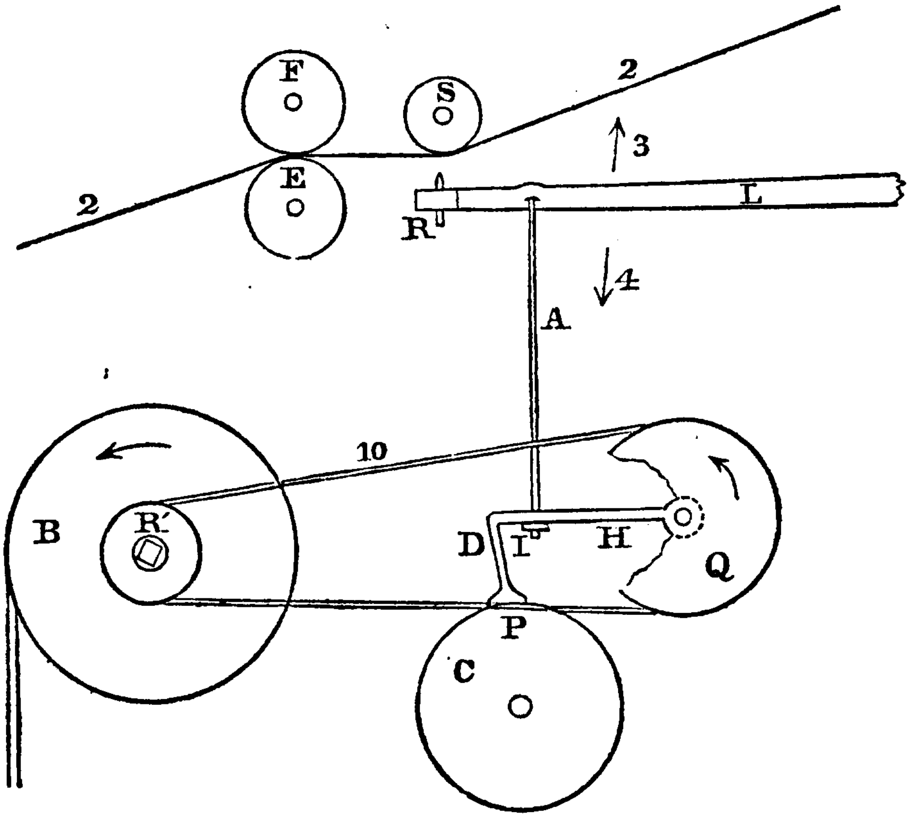
We will now describe, by figure 10, those parts connected with the wheel work, which could not be easily shown in figure 9. F and E represent, in outline, the two rollers which grasp the paper, 2 and 2. The roller E is connected with the train by a cog wheel upon it. F is not so connected; but is pressed hard upon E by means of springs upon the ends of the axle; S represents the grooved steel roller beneath which the paper, 2 and 2, is seen to pass. Directly under the steel roller is one of the steel pen points at R, upon the end of the pen lever; a part of which only is shown. Thus far the description given of the clock work, relates to those parts, by the agency of which the pen is supplied with paper. We now proceed to explain that part connected with the clock and pen lever, by which the clock is set in motion or stopped at the option of the distant operator.

In figure 9, at R', is seen a small pulley upon the barrel shaft of the clock work; at Q, is another pulley, but larger. From the pulley, R', is a cord,[5] or band, 10, proceeding to pulley, Q, and then returning under it to pulley, R', making it continuous. This band communicates the motion of pulley,

[4] The paper used for telegraphic writing is first manufactured by the paper making machine in one long continuous sheet, of any length, about three feet and a half in width, and is compactly rolled up as it is made, upon a wooden cyllinder. It is then put into a lathe and marked off in equal divisions of one and a half inches in width; a knife is applied to one division at a time, and as the roll of paper revolves, the knife cuts through the entire coil until it reaches the wooden centre. This furnishes a coil ready for the register, and is about fifteen inches in diameter. The whole roll of paper furnishes, in this way, about twenty-eight small rolls prepared for use.

[5] The pulley and cord have been dispensed with and two small cog wheels substituted.

Figure 10.



R', to the pulley, Q. In figure 10, these pulleys are represented by the same letters. B represents the barrel; the arrow, the direction in which it revolves when in motion. The arrow at Q shows the direction it takes when motion is communicated to it by R'. Part of the pulley, Q, is broken away in order to show the arm, H, soldered at the middle of the same spindle upon which is the pulley, Q, and directly beneath the pen lever, L. It is bent at D, so as to turn down and strike the wooden friction wheel, C, at the point, P. The friction wheel is secured upone the last spindle of the train at its middle and directly under the lever, L. From the pen lever, L, is seen a small rod of wire, A, passing down through the arm, H, with a screw and nut under it, at I, for the purpose of shortening or lengthening it. It is permitted to work free, both at its connection with the lever and arm. This wire is also extended and passes down through the platform, where it operates upon a hammer for striking a bell, to apprise the operator that a communication is to be sent. The several parts being now explained, their combination action is as follows:

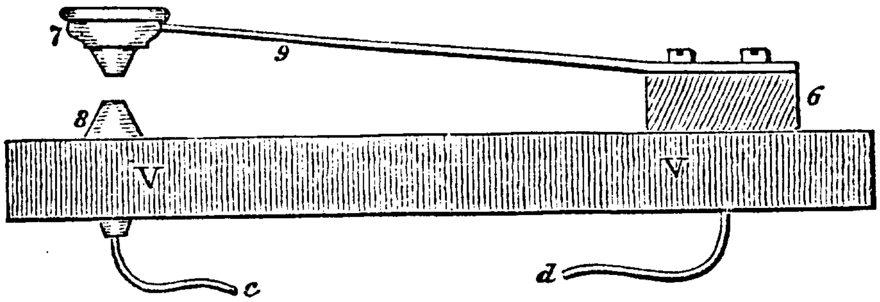
The arm, H and D, is a break, which when brought in contact with the friction wheel, C, prevents the weight of the clock work from acting upon the train, and there is no motion. By the action of the magnet, the pen lever, L, is carried up in the direction of the arrow, 3, and takes with it the connecting rod, A, and also the break, H, D. The break being thus removed from the friction wheel, C, the clock work commences running by the power of the weight. The barrel, B, must consequently turn in the direction of the arrow upon it; this motion is communicated by the band to Q, which revolves in the direction of its arrow; consequently, if the lever, L, is not still held up by the magnet, the break is descending slowly; and when it reaches P, stops the motion of the clock train, unless the pen lever continues in motion, in which case the break, D, is kept up from the friction wheel, thus permitting the clock work to run, until the lever ceases to move, when the break is gradually brought down upon the friction wheel, and the train stops. By this contrivance, the operator at a distance can so control the movement of the paper at the remote register, that when he wishes to write, it shall be put in motion, his pen be supplied with paper, and when he has finished his writing, the register shall stop.

U represents (figure 9) the brass standards, one on each side of the large roll of paper, 1, 1, 1, which it supports. Z is a wooden hub, upon which the roll is placed; and 12, the steel arbor of the hub, and upon which the whole easily revolves as the paper, 2 and 2, is drawn off by the clock work. Y is a brass spring, between the hub and the standard; and keeps the paper stretched between the roll and the pen.

The key or correspondent is represented by 6, 7, 8, 9. Another view of it is more distinctly seen in figure 11. The same letters in each, represent the same thing. V and V is the platform. 8 is a metallic anvil, with its smaller end appearing below, to which is soldered the copper wire c. 7 is the metallic hammer, attached to a brass spring, 9, which is secured to a block, 6, and the whole to the platform, V V, by screws. A copper wire passes through the whole and is soldered to the brass spring at 6. The key or correspondent is used for writing upon the register at the distant station, and both it and the register are usually upon the same table.

Having now explained the Register, Key and Battery, we proceed to describe the arrangement of the conductors or wires connecting distant

Figure 11.



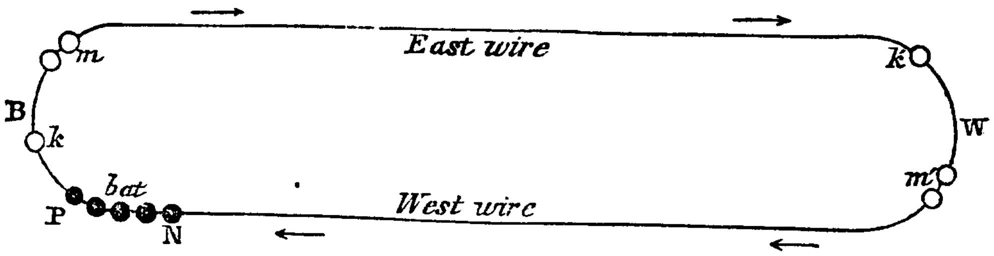
stations, and the mode by which the earth, also, is made a conductor of this subtle fluid.

The term *circuit* used frequently in this work, has reference to the wire, which, commencing at the positive pole of the battery, goes to any distance and returns to the negative pole of the battery. When its going and returning are continuous and unbroken, the circuit is said to be *closed* or *complete.* When it is interrupted, or the wire is disconnected, the circuit is said to be *broken* or *open.*

When a magnet or key or battery is spoken of as being *in the circuit,* it has reference to the use of the wire belonging to the key, magnet, or battery, respectively, as a part of the circuit.

There are three modes of arranging the wires, so as to communicate between two distant stations. Two of these modes are *inferior,* as they furnish but one circuit for the termini, and consequently obliging one station to wait, when the other is transmitting, both stations not being able to telegraph at the same time. These two modes are called the *dependent circuits.* The first mode is, where two wires are used, of which figure 12 is a diagram. B represents Baltimore, and W Washington; m is the magnet or register; k the key, and bat the battery, all at the Baltimore station; m' is the magnet or register; k' the key at the Washington station. The lines, represent the wires upon the poles, connecting the two stations, and are called the east and west wires. In this arrangement of the wires and also in the second, the key (which has been explained in a preceding figure, 11, and shown at 6 and 7 to be open) must be closed at both stations, in order to complete the circuit, except at the time when a comunication is being

Figure 12.

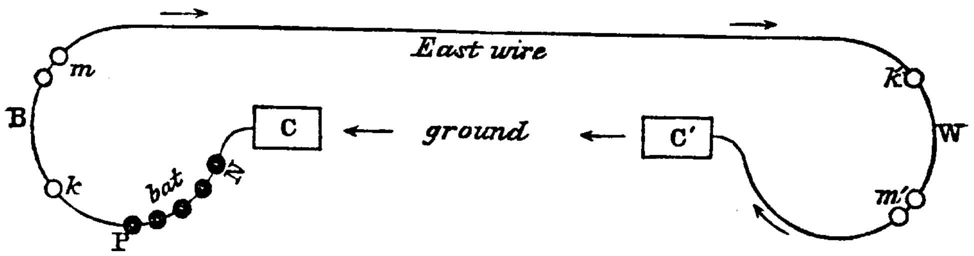


transmitted.[6] For the purpose of closing the circuit at the key, a metallic wedge is used, which is put in between the anvil 8 and the hammer 7, and establishes the circuit. Supposing the battery is in action, and B has a communication for W: he opens his key, by removing the wedge, and sends his message. The galvanic fluid leaves the point, P, of the battery, and goes to k, to m, along the east wire to k', to m', and back by the west wire to N pole of the battery. In the same manner it proceeds along the wires, if W is writing to B. In this arrangement, the direction of the galvanic current is the same, whether B or W is communicating, unless the poles of the battery are reversed.

The second mode has but one wire and the ground, represented by figure 13. The use of the ground as a conductor of the galvanic fluid, between two distant points, is to many a mystery. But of the fact there is no question. The above diagram exhibits the manner which the east wire and ground were used from the first operation of the Telegraph, until the close of the session of Congress, June, 1844. In this diagram, we will minutely follow the course of the galvanic current. B represents Baltimore, and W Washington; C represents a sheet of copper, five feet long and two and a half feet wide, to which a wire is soldered and connects with the N pole of the battery. This sheet of copper lies in the water at the bottom of the dock, near the depot of the Baltimore and Ohio Rail Road, Pratt street. From P of the battery, the wire proceeds to k, the key, then to m, the magnet or register, then it is the *east wire* to k', the key at W, then to m', the magnet or register, then to the *copper sheet*, C', buried beneath the brick pavement in the dry dust of the cellar of the capitol. The direction of the current is from P of the battery to k, to m, and along the east wire to k', to m' and

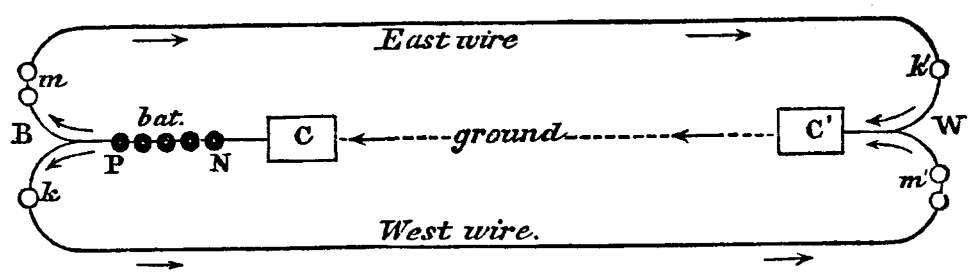
[6] At this time the key is opened at the station from which the communication is to be sent.

Figure 13.



to C', where it is lost in the earth; but reappears at the copper plate, C, at B, and thence to the N pole of the battery, having completed its circuit. It is, therefore, certain, that one-half of the circuit is through the earth. From B to W the east wire is the conductor; and from W to B the ground is the conductor. In this arrangement, the west wire is thrown out, and is no part of the circuit; while the earth has been made a substitute for it.

Figure 14.



The last diagram, as has been stated, exhibits the plan of the wire and ground, as used for telegraphic purposes, from its first operation, until the adjournment of Congress in 1844, being prevented from completing the arrangement of the third mode from the throng of visitors, that pressed to see its operation. After the close of the session, the following arrangement of the wires was made, as shown in the diagram, figure 14, by means of which, both stations could transmit at the same time, with one battery for both, and the keys were not required to be closed. It is called the two *independent circuits*. Here the west wire is used for transmitting from B to W; and the east wire from W to B. The copper plates at B and W remain as they are described in the second plan. *Bat*, the battery, at B is used in common for both circuits. It is simply necessary here to designate the course which the fluid takes when both lines are in operation, viz. B transmitting to W; and W to B. In the former case, the current is from P of the battery to k, then the *west wire*, then to m', at W, then to C', thence through the ground to C at B, and then to the N, or negative pole of the battery, as shown by the arrows. In the latter case, the current is from P of the battery to m, then the *east wire*, then to k', at W, thence to C', thence through the ground to C at B, thence to the N, or north pole of the battery, as shown by the arrows. This arrangement, by which one battery is made efficient for both circuits at the same time, where two were formerly used, was devised by Mr. Vail, assistant superintendent, in the spring of 1844, and has contributed much to diminish the care and expense in maintaining that part of the apparatus of the telegraph. One battery being now used instead of two. By the above diagram, it will be perceived that the *ground* is common to both circuits, as well as the *battery*, and also the wire from the N pole of the battery, to the copper plate, C; and from the copper plate, C', to the junction of the two wires near the two arrows. For the purposes of telegraphic communication they answer as well as though there were four wires and two batteries. Instead of using the ground between C and C', a wire might be substituted, extending from the N pole of the battery to the junction of the wires at the two arrows at W. The arrangement of the wires, battery, keys, magnets or registers at both stations, with the ground, as shown in figure 14, is the plan now used for telegraphic operations between B and W; and has many decided advantages over the arrangements of figures 12 and 13. First. In both of those arrangements, the circuit is obliged to be kept closed, when neither station is at work; and the battery is only in action when the circuit is closed, it follows that the battery will not keep in action as long as when the circuit is allowed to remain open, as in the use of the third plan, figure 14. Second. There is an advantage in dispensing with the use of the metallic wedge, which is liable to be forgotten by the operator. Third. The attendant may occasionally leave the room, and is not required to be in constant waiting, as the clock work is put in motion and stopped by the operator at the other end, and the message written without his presence. But in the first and second arrangement, the apparatus for putting in motion and stopping the clock work, is entirely useless. The attendant being obliged to put it in motion and stop it himself.

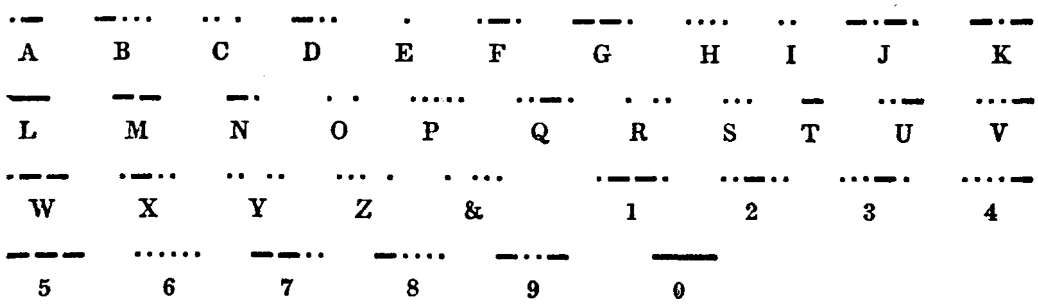
We will now proceed to describe the modus operandi of transmitting intelligence from one station to another; the arrangement being as in figure 14; k is the key of the operator at Baltimore, and m' represents his register, or writing desk, at Washington; k' is the key of the operator at Washington, and m his register, or writing desk, at Baltimore. Each has the entire control of his respective register, excepting, only, that each operator winds up the other's instrument, and keeps it supplied with paper. It will also be borne in mind, that each circuit is complete, and every where continuous, except at the keys, which are open. If, then, the hammer is brought in sudden contact with the anvil, and permitted as quickly as possible to break its contact by the action of the spring, and resume its former position, the galvanic fluid, generated at the battery, flies its round upon the circuit, no matter how quick that contact has been made and broken. It has made the iron of the electro magnet a magnet; which has attracted it to the armature of the pen lever; the pen lever, by its steel pen points, has indented the paper, and the pen lever has, also, by the connecting wire with the break, taken it from the friction wheel; this has released the clock work, which through the agency of the weight, has commenced running, and the two rollers have supplied the pen with paper. But, as only one touch of the key has been made, the clock work soon stops again, if no other touches are made, by the action of the break upon the friction wheel.

This shows the whole operation of the Telegraph, in making a single dot by a single touch of the key. In order now to explain more fully the operation of the steel pen points upon the paper, which is in contact with the grooved roller, let there be made four touches at the key; this will be sufficient to start the clock work, and allow the paper to have attained a uniform rate; then let six touches be made at the key. The contact has been made six times and broken six times. Each time it is closed, the electro magnet, as heretofore explained, attracts to it, with considerable force, the armature of the pen lever, carrying up the steel pen points against the paper, 2, under the steel roller, S. The three points of the pen, falling into the three corresponding grooves of the roller, carry the paper with them and indent it,[7] at each contact. There then appear upon the paper, as it passes out from under the rollers, six indentations, as if it had been pressed upon by a blunted point, such as the end of a knitting needle would be supposed to make, when pressed upon paper, placed over a shallow hole, but in such a manner as not to pass through the paper, but raising the surface, as in the printing for the blind. These indentations of the paper are the marking of the pen, but varied in the manner now to be described.

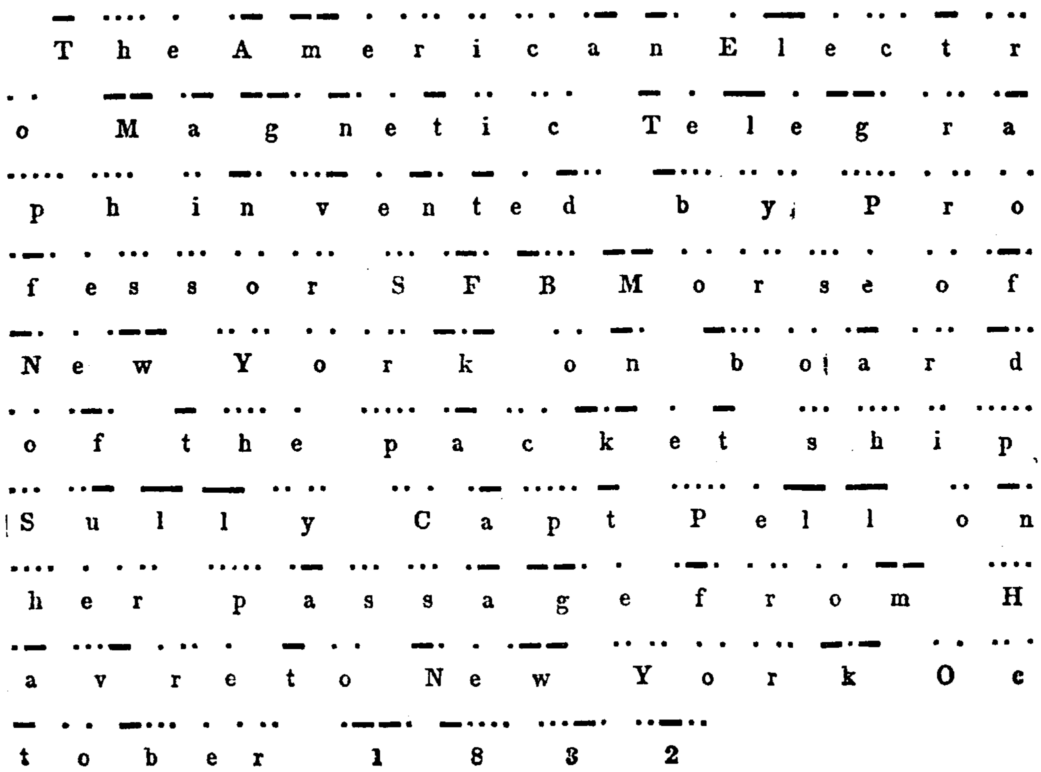
By examining the telegraphic alphabet, the characters will be found to be made up of dots: short and long lines — and short and long spaces. A single touch of the key, answers to a single dot on the paper of the register; which represents the letter, E. One touch of the key prolonged, that is, the contact at the key continued for about the time required to make two dots, produces a short line, and represents T. A single touch for about the time required to make four dots, is a long line, and represents L. A single touch for about the time required to make six dots, is a still longer line and represents the 0 of the numerals. If the use of the key be suspended for about the time reqired to make three dots, it is a short space, used between the letters. If suspended for the time required to make six dots, it is a long space, used between words, and a longer space is that used between sentences. These are the elements which enter into the construction of the telegraphic characters, as used in transmitting intelligence. The alphabet is represented by the following combination of these elements.

[7] The first working model of the Telegraph was furnished with a lead pencil, for writing its characters upon paper. This was found to require too much attention, as it needed frequent sharpening, and in other respects was found inferior to a pen of peculiar construction, which was afterwards substituted. This pen was supplied with ink from a reservoir attached to it. It answered well, so long as care was taken to keep up a proper supply of ink, which, from the characters of the letters, and sometimes the rapid, and at others the slow rate of writing, was found to be difficult and troublesome. And then again, if the pen ceased writing for a little time, the ink evaporated and left a sediment in the pen, requiring it to be cleaned, before it was again in writing order. These difficulties turned the attention of the inventor to other modes of writing, differing from the previous two modes. A variety of experiments were made, and among them, one upon the principle of the manifold letter writers; and which answered the purpose very well, for a short time. This plan was also found objectionable, and after much time and expense expended upon it, it was thrown aside for the present mode of marking the telegraphic letter. This mode has been found to answer in every respect all that could be desired. It produces an impression upon the paper, not to be mistaken. It is clean, and the points making the impression being of the very hardest steel, do not wear, and renders the writing apparatus always ready for use.

ALPHABET



Suppose the following sentence is to be transmitted from Washington to Baltimore:



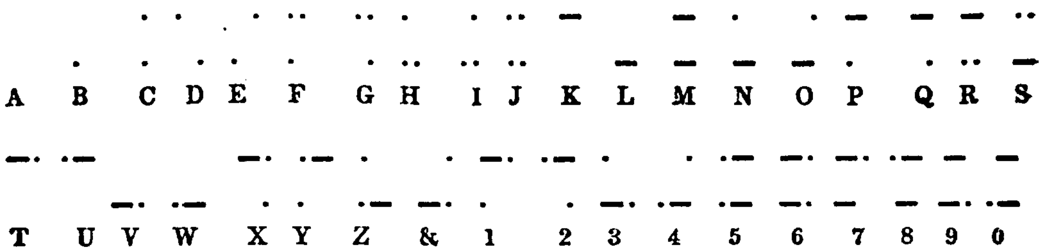
It is evident, as the attendant at Baltimore has no agency in the transmission of this message from Washington, his presence, even, is not absolutely required in the telegraph room at Baltimore, nor is it necessary, previously, to as the question, *are you there?* The operator at Washington transmits it to Baltimore, whether the attendant is there or not, and the telegraphic characters are distinctly recorded upon the paper of the Baltimore Register. If he omits a letter at the key, in Washington, it is omitted on the paper in Baltimore. If he has added at the key in Washington, it is also upon the paper in Baltimore, nothing more or less is marked upon it.

From the peculiarity of the motion obtained at the pen lever by the action of the battery upon the electro magnet, it is evident that a few elements only are presented upon which to base the telegraphic characters. The motion of the lever, to which is attached the steel pen points, is vibratory; but capable of being so controlled as to cause it to retain either of its positions (that is, up or down) as long, and at such intervals, and in as quick succession as the operator may choose. Therefore, every sort of combination which dots, lines and spaces, in any succession, and of any length can make, are here as much at the pleasure of the telegraphic manipulator, as the English alphabet is with the letter writer. So that if from this countless variety, twenty-six of the most simple, to represent letters, and ten to represent the numerals, shall be taken, we come at once into possession of the means of representing words and sentences, by new, but intelligible characters, and through them, can be conveyed as clearly, and as concisely, as if they were given *viva voce*, or written in Roman characters. Such is the alphabet given above. This conventional alphabet was originated on board the packet Sully, by Prof. Morse, the very first elements of the invention, and arose from the necessity of the case; the motion produced by the magnet being limited to a single action.

During the period of thirteen years, many plans have been devised by the inventor to bring the telegraphic alphabet to its simplest form. The plan of using the common letters of the alphabet, twenty-six in number, with twenty-six wires, one wire to each letter, has received its due share of his time and thoughts. Other modes of using the common letters of the alphabet, with a single wire, has also been under his consideration. Plans of using two, three, four, five and six wires to one registering machine, have, in their turn, received proportionate study and deliberation. But these, and many other plans, after much care and many experiments, have been discarded; he being satisfied that they do not possess that essential element, *simplicity*, which belongs to his original first thought, and the one which he has adopted. A detailed account of these various plans with fewer or more wires, might be given here, but it will suffice merely to present the alphabet adapted to a register, using 2, 3, 4, 5, or 6 wires, with a separate pen to each wire, capable of working together, or in any succession. It is obvious that every additional pen will give an additional element to increase the combination, and were there any real advantage in such an arrangement it would have been adopted long since.

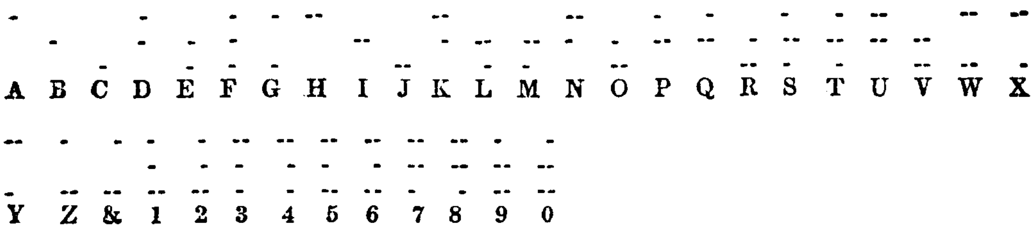
No. 1.

Alphabet for two pens, operating together or in succession.



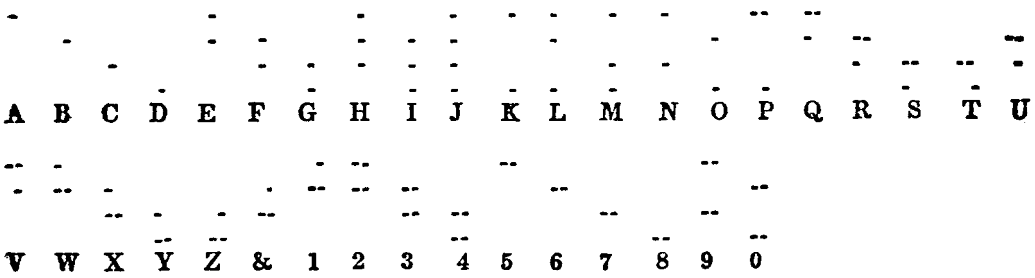
No. 2.

Alphabet for three pens, operating together or in succession.



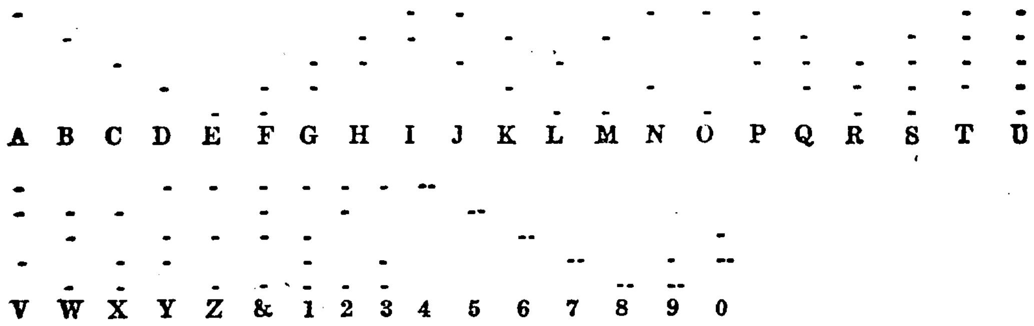
No. 3.

Alphabet for four pens, operating together or in succession.



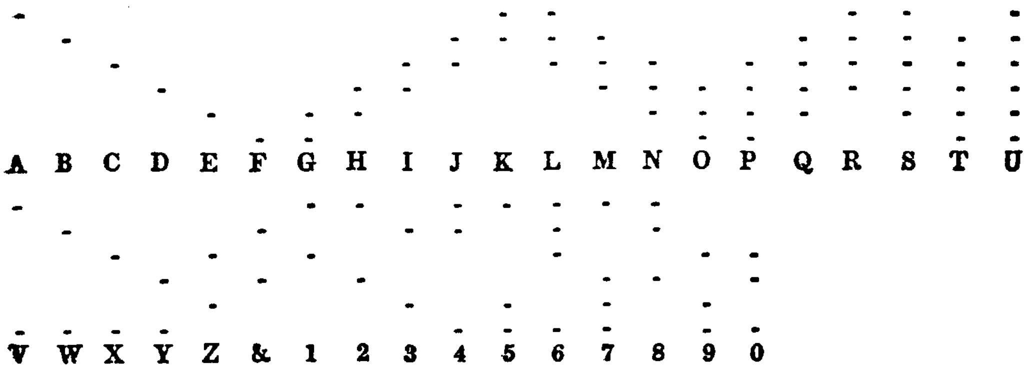
No. 4.

Alphabet for five pens, operating together or in succession.



No. 5.

Alphabet for six pens, operating together or in succession.



Specimen of the Telegraphic Language.

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