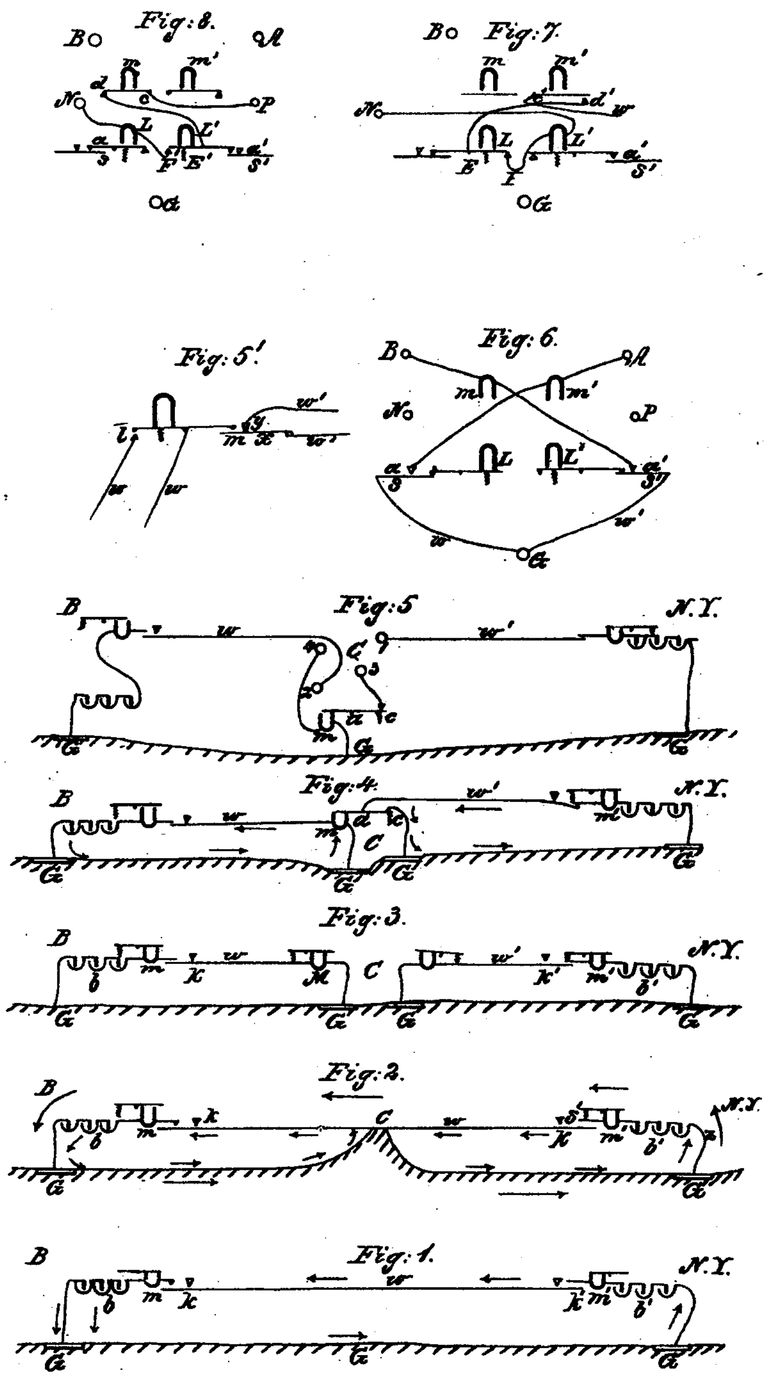
3 Sheets—Sheet 1.

M. G. FARMER.

Telegraphic Repeater.

No. 14,157. Patented Jan. 29, 1856.



3 Sheets—Sheet 2.

M. G. FARMER.

# Telegraphic Repeater.

No. 14,157. Patented Jan. 29, 1856.

Fig: 10.

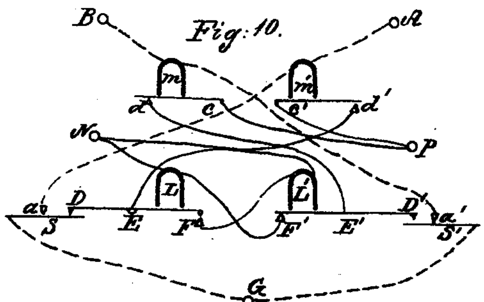


Fig: 9.

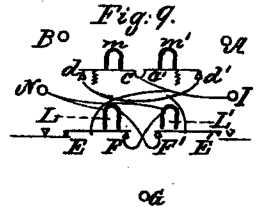


Fig: 14.

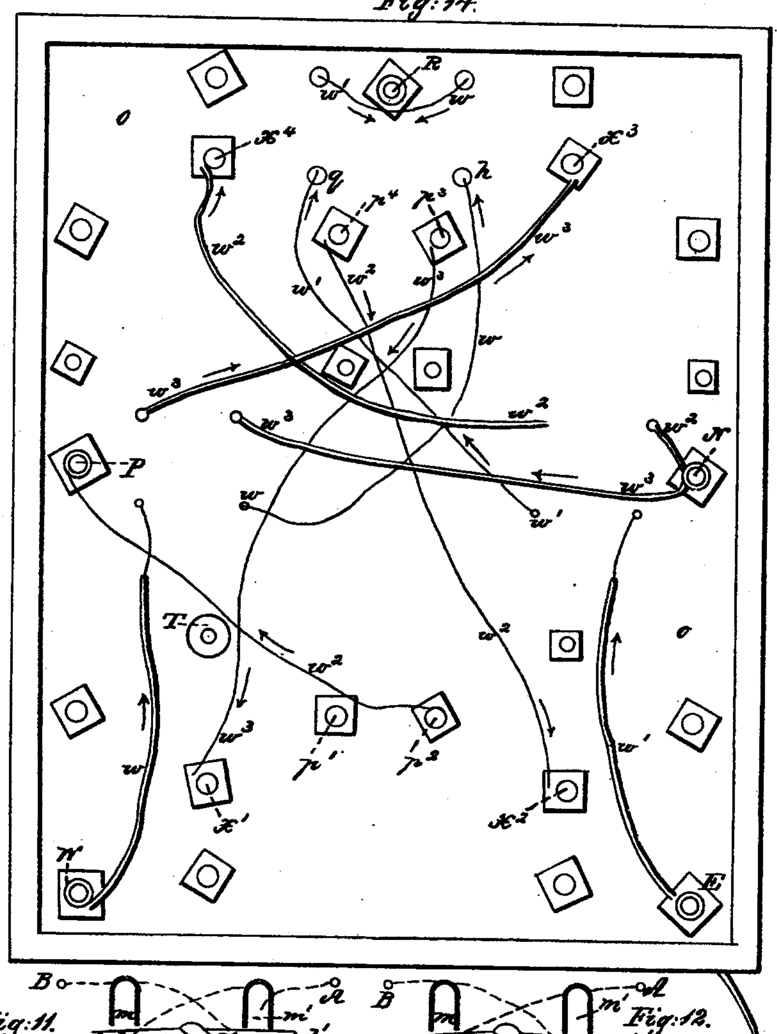


Fig: 11.

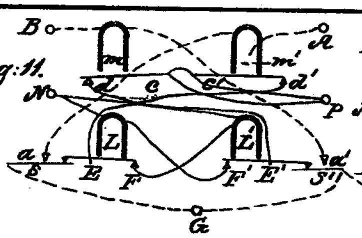
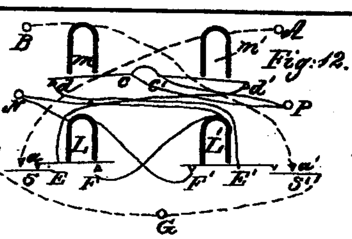


Fig: 12.



3 Sheets—Sheet 3.

M. G. FARMER.

Telegraphic Apparatus.

No. 14,157. Patented Jan. 29, 1856

Fig: 15.

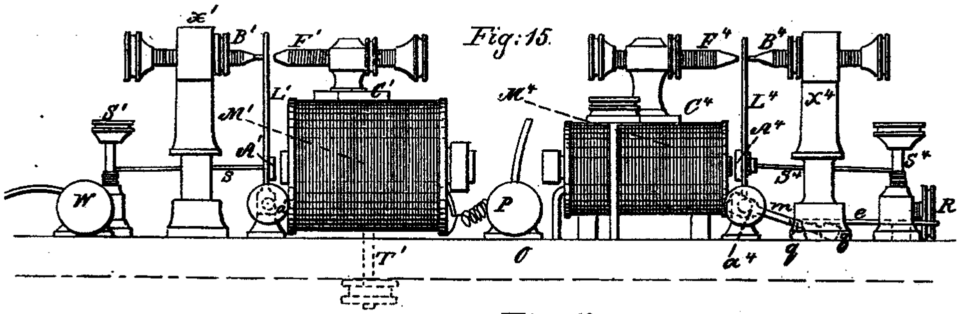
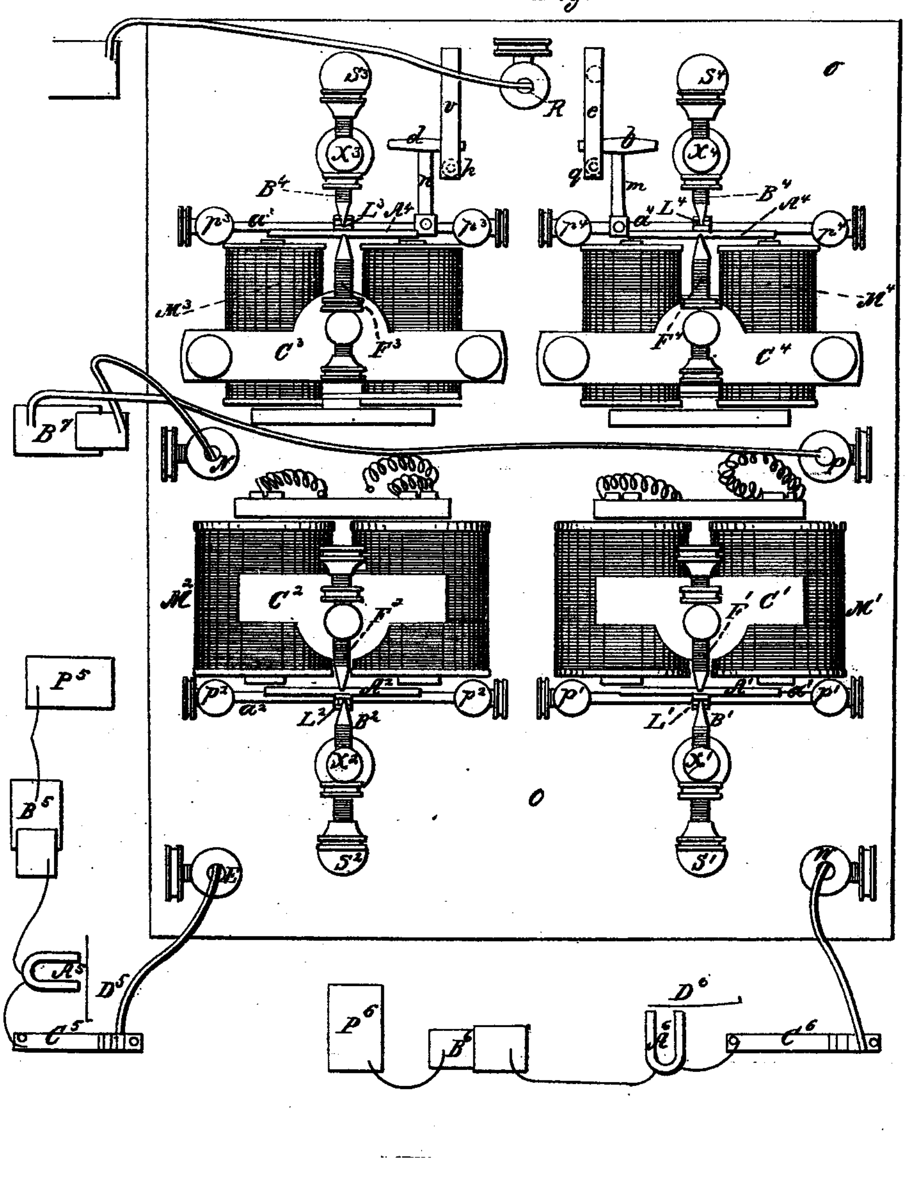


Fig: 13.



# UNITED STATES PATENT OFFICE.

MOSES G. FARMER, OF SALEM, MASSACHUSETTS.

## IMPROVEMENT IN TELEGRAPHIC REPEATERS.

Specification forming part of Letters Patent No. **14,157**, dated January 29, 1856.

*To all whom it may concern:*

Be it known that I, MOSES G. FARMER, of Salem, in the county of Essex and State of Massachusetts, have invented a new and useful Improvement in Telegraphic Apparatus; and I do hereby declare that the same is fully described and represented in the following specification and the accompanying drawings, letters, figures, and references thereof.

Before proceeding to describe my improved telegraphic apparatus I will endeavor to illustrate the principle on which the invention of it is based.

It is well known to all telegraph-operators that it is almost a practical impossibility to insulate and keep insulated a line of eight or twelve hundred miles in length, or even one of less length, so as to work it with ease and certainty in a single circuit; but there is no difficulty in keeping fifty, one hundred, or two hundred miles thereof in a sufficiently good state of insulation to be always in working order. The telegraph-repeater is an instrument designed to connect such short lines in such a manner as to work together as one long one. In other words, it is a partial remedy for bad insulation, and steps in and does what is practically impossible to effect by any known means of insulation without too great expense.

Suppose Figure 1 of the drawings to represent a line of telegraph connecting two places, such as Boston and New York, B. denoting "Boston" and N. Y. "New York," part at B. and part at N. Y. *b b'* represents a battery of several cells, *k k'* keys for opening and closing the circuit, *m m'* electro-magnets, and G plates buried in the ground. The direction of the current may be represented by the arrows, it passing from N. Y. to B. on the wire *w*, and from B. to N. Y. through the ground G, if the wire *w* is perfectly insulated from the ground through the whole of its length except at the ends. In whatever part of the circuit a break occurs, the magnets *m* and *m'* will lose their magnetism as soon as this current ceases to flow. If, however, the wire is not everywhere insulated from the earth, but makes a slight contact at one or several places between B. and N. Y., the course of the current will be more complicated, as shown in Fig. 2. If the contact at C is slight, only a part of the current will pass to the ground, as indicated by the small arrows. The consequence of this ground-contact at C, or this want of insulation, may be shown as follows: If the circuit is broken by depressing the key *k* at B, the current will cease to flow in that part of the circuit between B. and C., and the magnet *m* will be wholly free from magnetism—that is, if it is good iron—at least no current will be manifest in its coils. But not so with the magnet *m'*. The current from the battery *b'*, though weaker than the whole current, flows through the magnet *m'*, and by the ground-contact C returns to the battery at *z*. The consequence is that the magnet *m'* is charged more or less strongly, according to the resistance which the current from the battery *b'* experiences in passing from the wire *w* at C to the ground. So if an attempt is made at B. to make a signal at N. Y. by breaking the circuit at *k*, it is wholly or partially successful, according to the state of the insulation at C, if the spring *s'* is strained so as nearly to counterpoise the magnetism at *m'*. As soon as the circuit is broken at *k* the magnet at *m'* will lose enough of its magnetism to release its armature, unless the contact at C is sufficient to answer for both currents to pass by the way of the small arrows; but if the contact at C is slight and the spring *s'* is strained tolerably tight, N. Y. will have no great difficulty in getting all the breaks made at B., and vice versa. If the insulation at C is bad, the repeater will be of service in this way: For illustration, suppose that we divide the at ilne C into two parts, each part having its battery and ground-plate, all as seen in Fig. 3. If now we had any mechanism stationed at C by which the working of the magnet M could control the working of the circuit *w'* when a person was operating at *k*, this would accomplish our purpose when transmitting from B. to N. Y. This may be accomplished as shown in Fig. 1. If the circuit *w'* was made complete at C by the contact of the armature-lever *a* with the point *c*, the breaking and closing of the circuit *w'* would be dependent upon the motion of the armature-lever *a*, and of course upon the breaking and closing of the circuit *w*. The circuit *w'* would be dependent upon the circuit *w*, the latter circuit in this case being independent. If, on the other hand, the magnet *m* was shifted into the circuit *w'*, the circuit *w* might be made in like manner dependent and the circuit $w'$ independent. This is Morse's plan of dependent or consecutive circuits. With this arrangement it is possible only to transmit in one direction between B. and N. Y.—viz., from B. to N. Y. with the magnet $m$ in the circuit $w$ and from N. Y. to B. with the magnet $m'$ in the circuit $w'$. It is desirable to place some mechanism at C whereby either circuit may at pleasure be made independent and the other dependent. This may be done very simply as follows, (see Fig. 5:) Suppose a "switch," as it is called, be placed at C, Fig. 5, so that an attendant can at pleasure connect the points 4 and 2 and points 1 and 3. With this connection, $w'$ will be the dependent and $w$ the independent circuit; but if the points 2 and 3 are connected, and at the same time 1 and 4, $w$ will be the dependent and $w'$ the independent circuit. This has been a customary way of working; but it requires the constant attendance of an operator at C to change the connections, according as $w$ or $w'$ is the independent or operating circuit, or, in other words, according to which is the transmitting and which the receiving circuit for the time being. My improved mechanisms, or my improved telegraph-repeater, dispenses with the services of this attendant only so far as it is necessary to keep the armature-springs adjusted. The main principle of my invention is this: It consists in a mechanism which enables the circuit which is first broken to break the other circuit, having first provided against the breaking of the dependent circuit having a similar action upon the independent circuit, or the circuit which is independent for the time being, which means the circuit which is first broken. This is called the "independent circuit for the time being," as this controls the other or dependent circuit for the time that the first is broken.

My invention consists in a combination of two main or primary circuits with two local or secondary circuits, and requires a battery to be placed in each of the main circuits, and one battery for the use of the two local circuits, which two local or secondary circuits are two branches of the local battery. The instrument requires two main circuit or relay magnets and two local or secondary magnets, with armatures, levers, and springs. Each main circuit has its own local-circuit magnet. The armature-lever of the main-circuit magnet opens and closes its local circuit. The armature of each local-circuit magnet has two offices to perform. In the first place, it opens the other local circuit at the point $l$, (see Fig. 5,) and by its further motion opens the other main circuit at the point $m$, which it does by lifting the spring $x$ from the anvil $y$. Each local circuit has two points at which it may be opened or closed—viz., by the motion of its own main-circuit armature, and, secondly, by the motion of the other local armature.

Fig. 6 shows the connections of the main circuits. A represents the screw-cup which receives one main wire. The course of the current is through the main-circuit magnet $m'$ to the anvil $a$, spring $s$, and by wire $w$ to the screw-cup G, which is in connection with the ground. The cup B receives the other main wire, and its course is through the magnet $m$ to the anvil $a'$, spring $s'$, by $w'$ to the ground G. The main circuit B will be opened by the movement of the armature-lever of the local magnet L'. If L' is charged, its armatures will lift the spring $s'$ from the anvil $a'$, and thus break the circuit B at that point. Similarly, the circuit A can be broken at $a$ $s$ by the motions of the armature-lever of the local magnet L.

Fig. 7 shows the operation of one of the local circuits. When the main circuits A and B are both closed their armatures are drawn away from their back-stops, and of course the local circuits are both open. If now the main circuit A be opened at some distant station, its armature $c'$ will go back and make contact with the point $d'$. The current from the local battery will pass from P to $c'$ by the wire $w''$, from $c'$ to $d'$, thence to the local armature E, thence to the back-stop F, with which it is in contact, thence to the magnet L' and to the battery at N. The magnet L' becomes charged and attracts its armature to it. This breaks the main circuit B at the point $a'$ $s'$. It should be observed that this magnet L' would not have become charged unless the armature of L had been resting on its back-stop F, so that unless this local circuit is closed in the two places F and $d'$ at the same time its magnet L' does not become charged. The other local circuit is similarly arranged, as shown in Fig. 8, and both are combined in Fig. 9. Fig. 10 shows them with the main circuits added in dotted lines. If now the main circuit A be broken anywhere, the armature C' will fly back against the stop $d'$ and close the local circuit represented by the red lines, changing the magnet L'. Its armature E moves and breaks the other local circuit at F. The other end, D', of the armature lifts $s'$ from the anvil $a'$, thus breaking the other main circuit, B, (represented by the blue dotted lines,) between $a'$ and $s'$, the magnet $m$ becomes discharged, its armature $c$ flies back and closes its local circuit at $d$; but this local circuit being also broken at the point F', (by the previous movement of the armature E',) the local magnet L does not become charged, and of course its armature does not move. Therefore the main circuit A remains entire at $a$ $s$, also the local circuit of the magnet L' remains entire at the point F. If the circuit A be now closed again, its armature $c$ is now attracted, and its movement breaks the local circuit at the point $d'$, the magnet L' is discharged, its armature flies back, restoring the main circuit B at $a'$ $s'$ and the local circuit L at F'. Similarly if the main circuit B were first broken, it would close its own local circuit L at $d$, break the other local circuit at F and the other main current at $a$ $s$. Thus, whichever main circuit is first broken, it closes its own local circuit first, breaks the other local circuit next, and lastly breaks the other main circuit by lifting the spring from the anvil. Fig. 11 shows the main circuit A as broken first, or as the independent circuit, and Fig. 12 shows the circuit B as the independent or leading or transmitting circuit.

The object of my invention is so to connect two independent lines of telegraph using the closed-circuit system that the working of either one of the lines shall work the other. By "closed circuit" I mean a continued circuit of conductors including a battery. By "open circuit" I mean a continuous circuit of conductors not including a battery. By "broken circuit" I mean a circuit of conductors, either without or with a battery, but not continuous.

I am aware that repeaters have been used for working both ways on the open-circuit system, but am not aware that they have ever before been used to work both ways on the closed-circuit system without the assistance of an attendant to change the connections according to the change of direction in transmission.

To construct my apparatus I procure a suitable platform, $o$, and attach to it four electro-magnets, $M'$ $M^2$ $M^3$ $M^4$, with their armatures, stops, springs, adjusting-screws, and the necessary screw-caps, &c., as hereinafter described. The construction and operation of these magnets, &c., are well known, and therefore need not be described.

Of the drawings, Fig. 13 represents a top view of my apparatus. Fig. 14 is an underside view of it. Fig. 15 is a side elevation of it.

In said figures, W represents a screw-cup which receives one of the independent main lines, (west, for instance,) in which circuit the magnet $M'$ is embraced, being connected with W by the wire $w$. The other main line enters the cup E and embraces the magnet $M^2$. Each of the main lines has a battery in some portion of its circuit exterior to the repeater, and the currents should flow in such manner that if the two lines were united the currents would unite in direction.

$M^4$ is the magnet embraced in the local circuit, which is opened and closed by the motion of the armature of the magnet $M'$. In like manner $M^3$ is the local magnet, operated by the armatures of the main magnet $M^2$.

N and P are screw-cups which receive the poles of the local battery.

R is a screw-cup for receiving the ground-wire for main lines.

The wire on the magnets $M'$ and $M^2$ should be suitably firm for long circuits. That on $M^3$ and $M^4$ should be adapted to short circuits. The bar $C'$, by means of the screw $T'$, confines the magnet $M'$ to the platform O. The point of the screw $F'$ is called the "front stop." Each magnet has two screws. As to those of the magnet $M'$, the point of the screw $B'$ is called the "back-stop," and is supported by the post $X'$.

$S'$ is the adjusting-screw to draw back the armature $A'$, to which it is attached by the india-rubber cord or spring $s'$, each armature having a like spring and screw.

$P'$ $P'$ are posts supporting the axis $a'$, to which the armature $A'$ is attached by the lever $L'$.

Similar explanations apply to the other magnets with their fixtures, the letters being numbered to correspond with the magnets.

To the axes $a^3$ $a^4$ are firmly attached arms $n$ and $m$, to which are affixed cross-bars $d$ and $b$ of some insulating substance, the use of which arms is to lift the springs $v$ $e$ from the anvils $h$ $q$, on which the springs naturally rest, forming metallic connections.

The course of the main circuit W is to the main magnet $M'$ by the wire $w$, thence by wire $w$ to anvil $h$ and spring $v$, to ground R. The main circuit E proceeds by wire $w'$ to magnet $M^2$, thence by wire $w'$ to anvil $q$ and spring $e$, to ground screw-cup R. One local circuit proceeds from N by wire $w^2$ to magnet $M^3$, thence to post $X^4$. From post $X^4$ it proceeds to stop $B^4$, bar $L^4$, rod $a^4$, post $p^4$, by wire $w^2$ to post $X^2$. From thence its course would be through $B^2$, $L^2$, $a^2$, $p^2$, $p'$, and P. The other local circuit proceeds from N by wire $w^3$ to magnet $M^4$, thence by wire $w^3$ to $X^3$ $B^3$ $L^3$ $a^3$ $p^3$, thence to $X'$, $L'$, $a'$, and $p'$, and by wire $w^2$ to cup P.

Suppose now the main circuit of W to be whole, with a battery in some portion of it exterior to the instrument, with the platina pole toward the cup W, the circuit embraces $M'$, anvil $h$, spring $v$, and reaches R by wire $w$. Similarly the other main circuit, E, embraces the magnet $M^2$, anvil $q$, and spring $e$, reaching R by wire $w'$. Suppose a local battery connected with the cups P and N. If now the main circuit W be broken, the magnet $M'$ will be discharged, its armature-lever $L'$ brought into contact with $B'$ by the contractile force of the spring $s'$. The current from the local battery now passes from N by wire $w^3$ to magnet $M^4$, post $X^3$, lever $L^3$, post $p^3$, thence to $X'$ $L'$ $a'$ $p'$ to P. $M^4$ becomes charged and its armature attracted, and by its motion it lifts up the spring $e$ from its anvil $q$, thus breaking the main circuit through E at $q$. The local circuit $w^2$ is also broken at $L^4$ $B^4$. The magnet $M^2$ is of course discharged and its armature-lever drawn back against $B^2$, thus closing the local circuit $w^2$ at $B^2$; but, it still being broken at $B^4$, the magnet $M^3$ does not become charged, and of course does not break the circuit through W at $h$ $v$. Whenever the main circuit W is again closed the several parts resume their former position. If, on the contrary, the main circuit E be first broken, its local circuit $w^2$ is closed at $B^2$, the magnet $M^3$ is charged, and by the motion of its armature breaks the local circuit $w^3$ at $B^3$. It also breaks the main circuit $w$ through W at $h$. Thus, whichever main circuit be first broken, it first closes its own local circuit and next breaks the other local circuit and also the other main circuit.

In Fig. 13 I have also shown the local battery at $B^7$, with its connections with the screw-cups N and P. The remainder of the main circuits connected with the screw-cups E W is also represented. $P^5$ and $P^6$ are the ground-plates of such circuits, $B^5$ and $B^6$ their batteries, $A^5$ and $A^6$ their electro-magnets, $D^5$ $D^6$ the armature-levers thereof, and $C^5$ $C^6$ the operating-keys.

I am aware that a telegraphic repeater operating upon the same general principle as mine has been invented at an earlier date by Elisha Wilson, of New Haven, Connecticut. In his machine, however, the local circuits are both closed when the main circuits are both closed, while in mine the local circuits are similarly both open when the main circuits are both closed. The same work which in Wilson's machine is done by the closing of the local circuit is done in mine by the opening of the local circuit, and vice versa. The general plan, therefore, in which my machine agrees with Wilson's I do not claim; neither do I claim simply substituting the breaking of the circuit for the closing to do the same work; but

What I do claim is—

That modified combination of parts by which in the self-acting telegraphic repeater, as described, the breaking instead of the closing of the local circuit is made to close the main circuit, and by which throughout the breaking of the local circuit is made a substitute for the closing.

In testimony whereof I have hereto set my signature this 12th day of February, A. D. 1853.

MOSES G. FARMER.

Witnesses:
G. H. BURNHAM,
R. H. SHAPLEIGH.