(Model.)

J. E. FENN.

Duplex Telegraph.

No. 231,904. Patented Sept. 7, 1880.

Fig: 1.

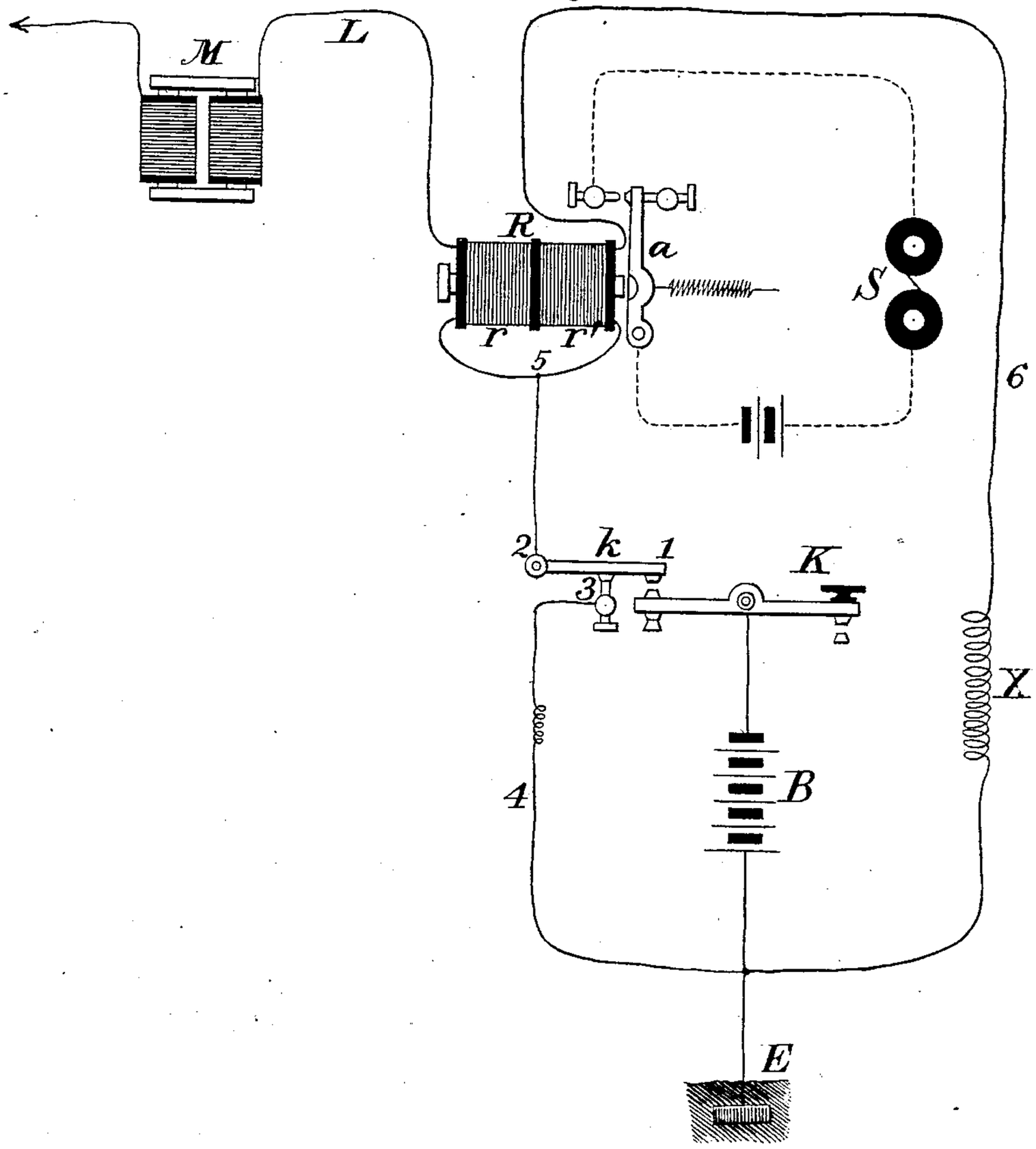
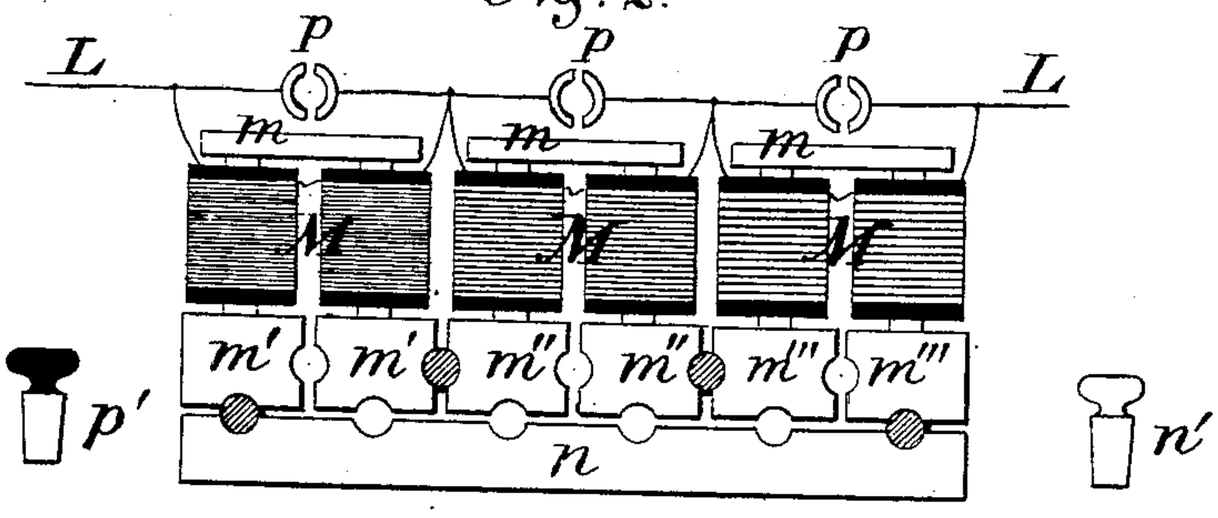


Fig: 2.



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DUPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 231,904, dated September 7, 1880.

Application filed May 20, 1880. (Model.)

To all whom it may concern:

Be it known that I, JOSEPH E. FENN, of Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Duplex Telegraphs, of which the following is a specification.

In transmitting two sets of signals simultaneously in opposite directions over a single telegraph-wire by means of a current which is divided at the home station between the main line and an artificial line of equal or proportional resistance much interference and confusion arises from the false signals which are produced upon the home instrument by the return discharges of static or induced electricity from the line-wire at the instant the home key is connected with the earth, especially when the line is well insulated and of considerable length. The effect of these return discharges upon the relay has been eliminated in several ways, one of which consists in connecting a condenser with the artificial line, so that a return discharge therefrom passes through the opposing or neutralizing coil of the home instrument, and thus counteracts the effect of the discharge from the line. Another method consists in the use of an electro-magnetic coil surrounding a bar of iron and placed in a shunt around the opposing coil of the home instrument, the effect of which is to set up a current in the same direction at the instant the outgoing current ceases to flow, which tends to counteract the action of the return current upon the direct coil of the instrument. This arrangement is much easier to construct, and is less expensive and less liable to get out of order than the condenser; but as heretofore constructed and applied it is not so easily regulated nor so efficient in action as the condenser, especially upon very long lines.

I have discovered that by placing the magnetic coil or coils which inclose the iron directly in the circuit of the main line, instead of in the artificial line or in a shunt connected therewith, as has hitherto been the usual practice, its action is far more efficient than has hitherto been the case, while by means of improvements in the construction of the same the force and duration of the induced current therefrom may be controlled with great facility.

In the accompanying drawings, Figure 1 is a drawing of an ordinary differential duplex apparatus to which my improvement has been applied, and Fig. 2 illustrates certain details of construction which form a part of my invention.

The diagram, Fig. 1, represents the arrangement of circuits, batteries, and apparatus in a duplex telegraph at one of the terminal stations of the line, the other terminal station being arranged in precisely the same manner. The receiving, relay, or other instrument R is provided with two separate coils, *r* and *r'*, each of which should have the same number of convolutions, and these two coils are so connected that when the currents of equal strength pass through them simultaneously they will exert an equal and opposite magnetic influence upon the soft-iron cores inclosed in them, and thereby neutralize each other's effect, so that no attraction will be exerted upon the armature.

One pole of the main battery B is connected to the earth at E, and the other to the lever of the key K. The contact-point 3 is connected directly to the earth by the wire 4.

k is a supplementary contact-lever, normally resting upon the stop 3 and pivoted at 2, from which point a wire proceeds to the point 5, where it branches, one branch going through the left-hand coil, *r*, of the relay R, and thence to the line L and distant station, and the other through the right-hand or opposing coil, *r'*, and thence directly back to the earth by the wire 6.

It is obvious that by making the resistance in the respective branches which diverge from the point 5 exactly equal to each other a current can be sent by the depression of the key K to the line from the battery B without affecting the armature of the relay R, provided an artificial resistance is inserted at X which is equal to the resistance of the line added to that of the apparatus at the distant station. The line which branches off at the point 5 and returns by the way of 6 to the earth is termed the "artificial" line, in contradistinction to the actual line L.

When a signal has thus been sent and the key K is again elevated, the contact between the battery and the line is broken at 1, while at the same instant the line is connected di-

rectly to the earth at 3. The result is that a powerful electro-static current or discharge returns from the line, having a polarity or direction opposite to that of the outgoing current transmitted by the key, which return current passes through the coil *r* of the relay to the earth, and, acting on the armature momentarily, gives a false signal, which is technically known as the "kick." This false signal may be prevented in the manner hereinbefore explained—that is, by attaching a condenser of considerable electro-static capacity to the artificial line, and thus producing another and simultaneous return discharge in the opposing or neutralizing coil *r'*, which precisely counteracts the action of the discharge from the line in the first-named coil in its magnetizing action upon the core of the electro-magnet.

I have discovered that the return discharges from the line may also be neutralized in an effective manner by means of my improved device, which I shall now proceed to describe.

M, Fig. 1, represents an electro-magnet constructed in the ordinary manner except that, instead of having one fixed and one movable yoke or armature, (the usual arrangement,) both the armatures are fixed, being in magnetic contact with the ends of the cores, so that it will form a closed magnetic circuit or magnetic ring when excited by the action of the coils.

An electro-magnet, when constructed in this manner, becomes magnetized in the usual manner upon the passage of a current through its coils; but the moment the current ceases or is interrupted the disappearance of the magnetism in the cores produces a powerful magneto-electric current in the same direction, or of the same polarity, as the original exciting-current, and which traverses the line in the same direction. Consequently, if such a device be placed in the circuit of the line L, as shown at M in Fig. 1, it is obvious that the static discharge, in attempting to return from the line through the relay R to the earth at the termination of a transmitted signal will be met by the discharge from the magnet M, of an opposite polarity thereto, which will tend to neutralize or destroy it, and will effectually do so, provided it is of equal strength and of equal duration.

It will be understood, therefore, that in order to effectually neutralize the static discharges it is only necessary that the opposing discharge from the magnet M should occur at precisely the same time and be of equal strength and duration. Now, it is well known that the strength and duration of the static discharge in any given case depends upon numerous conditions, among which may be mentioned the length of the line, the superficial area of the conductor, its distance from the earth and other objects, and the perfection of its insulation, and the latter again depends very much upon the condition of the weather in respect to its moisture or dryness.

In order to provide for these varying conditions, I prefer to make use of a compound magnet made up of a series of single magnets, and to have the coils of the elementary magnets wound with varying numbers of convolutions, so that by putting more or less of them in the circuit of the line at the time, the strength of their combined discharge may be varied at will. It is also necessary to provide a means of varying the duration of the discharge without affecting its strength, and this I effect by taking advantage of the fact that the time occupied in discharging an iron core of its magnetism increases in ratio of its length, and thus, by using cores of varying lengths, or some equivalent device, such as coupling short cores together, and thus causing them to form, in effect, a single long core, I am enabled to produce the required result.

In Fig. 2 I have shown a compound magnet made up of three elementary magnets, although any desirable number of the latter may be used in order to insure a sufficient range of adjustment. The coils of this series of elementary magnets are preferably arranged consecutively in the circuit of the line-wire L, and each single magnet is provided with a peg cut-out, *p*, into which a metallic peg, *p'*, can be inserted, so as to shunt any one or more of the magnets out of circuit.

I prefer, as a matter of convenience in adjustment, to have each of the magnets of a different number of convolutions, as hereinbefore stated, and therefore capable of developing a different strength of discharge-current with the same strength of initial current.

The elementary magnets M M are provided with solid yokes or armatures *m m* at one end, while at the other they terminate in rectangular soft-iron pole-pieces *m' m' m'' m''*, &c., while a soft-iron bar, *n*, is placed near to and parallel with the entire range of pole-pieces, as shown in the figure. Semicircular grooves or channels are formed in the adjacent faces of the several pole-pieces and the bar *n*, so that any two or more of them can be combined together and placed in magnetic connection by the insertion of soft-iron pegs, one of which is shown separately at *n'*. This arrangement renders it possible to vary the duration of the discharge to any extent which may be necessary to meet the varying conditions of actual service. For example, in Fig. 2 all the three elementary magnets M M M are placed in the circuit of the main line L by the withdrawal of the pegs from the cut-outs *p p p*, thus making the strength of the discharge from the combined magnet as great as possible.

The pole-pieces and bar *n* are coupled up by the insertion of iron pegs in such a manner as to make a continuous magnetic circuit, which includes the cores of all the three elementary magnets, so that they, in effect, form a single magnet of great length, and which will for that reason discharge very slowly.

It is obvious that the time of discharge can be shortened by coupling up each magnet in a closed magnetic circuit by itself, which may

be done by placing the pegs so as to connect the two cores directly together.

I do not propose to confine myself to the precise arrangement which I have shown, as this may be modified in various ways without departing from the principle of my invention.

Although I have shown my invention in connection with a differential duplex apparatus, it is equally applicable to a bridge or any other form of duplex apparatus, or to a quadruplex apparatus of any of the well-known forms.

I do not here claim a duplex-telegraph apparatus and a main line, in combination with a bar of soft iron having its ends so connected that it will form a closed magnetic circuit, and a coil or helix enveloping said bar, or a portion thereof, which coil is included in the main circuit at a point between the main line and the receiving-instrument, because I propose to embrace it in a subsequent application.

I claim as my invention—

1. The herein-described art or method of neutralizing the return or static discharge of a telegraph-line at the home station, by interposing an electro-magnet between the receiving-instrument and the line, which is adjustable in respect to the number of active convolutions in its coils, and also adjustable in respect to the magnetic length of the closed magnetic circuit which forms its core.

2. An electro-magnet having its core so arranged as to form a closed magnetic circuit, and provided with shunting devices, whereby the core may be placed under the influence of a greater or less number of active convolutions of the magnetizing-helix, substantially as set forth.

3. An electro-magnet having a core adjustable in respect to its magnetic length, and forming a closed magnetic circuit, substantially as set forth.

4. An electro-magnet provided with shunting devices, whereby the number of active convolutions of the neutralizing helix may be varied, and with a core forming a closed magnetic circuit adjustable in respect to its magnetic length.

Signed by me this 13th day of May, A. D. 1880.

JOSEPH E. FENN.

Witnesses:
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