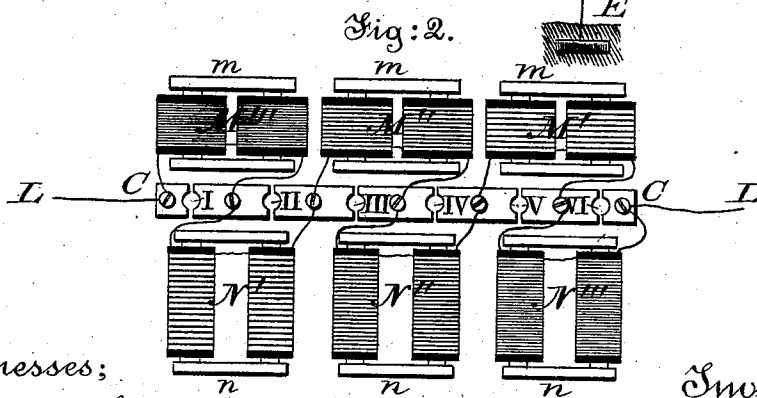
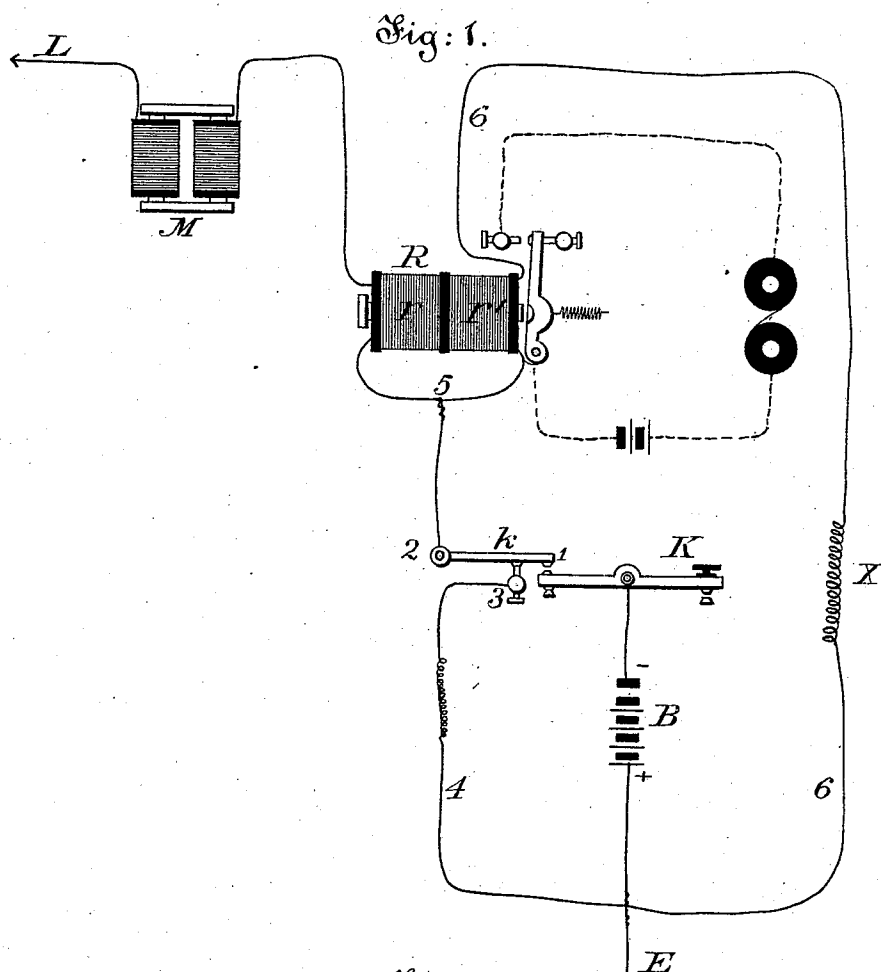


J. E. FENN.  
Duplex Telegraph.

**Patented Jan. 4, 1881.**



Witnesses;

Wilton, Cal.  
Mrs. F. Lockwood French,

Inventor,  
Joseph E. Senn,  
by his attorney,  
Frank L. Pope

# UNITED STATES PATENT OFFICE.

JOSEPH E. FENN, OF ELIZABETH, N. J., ASSIGNOR TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y.

## DUPLEX TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 236,321, dated January 4, 1881.

Application filed October 23, 1880. (No model.)

*To all whom it may concern:*

Be it known that I, JOSEPH E. FENN, a citizen of the United States, residing at Elizabeth, in the county of Union and State of New Jersey, have invented certain new and useful Improvements in Duplex Telegraphs; and I do hereby declare the following to be a full, clear, and exact description thereof, reference being had to the accompanying drawings.

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 of 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.

In Letters Patent of the United States No. 231,904, granted to me September 7, 1880, I have described and shown a method of neutralizing the return or static discharge of the 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.

The subject-matter of my present application relates to certain modifications and im-

provements in the apparatus described in my said prior Letters Patent, whereby the adjustment of the same to the varying conditions of the line may be more conveniently and readily effected.

The particular combination of devices herein claimed will be set forth in detail at the end of this specification.

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 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.

$\lambda$  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 line and the battery is broken at 1, while at the same instant the line is connected directly 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 of the relay to the earth, and, acting on the armature momentarily, gives a false signal, which is technically known as the "kick." I make use of the apparatus hereinafter described for the purpose of preventing or neutralizing this false signal.

In Fig. 1 of the drawings, M 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 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 series of independent single magnets, and to have the coils of the said magnets wound with varying num-

bers of convolutions, so that by putting more or less of them in the circuit of the line at one 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 detached and independent cores of varying length, but having a like number of convolutions in their respective coils, I am enabled to produce the required result.

In Fig. 2 I have shown a series of three detached and independent cores,  $m m m$ , each of which has its poles connected together so as to form a closed magnetic circuit. These three cores are of the same, or substantially the same, magnetic length and time of discharge. The respective helices or coils of these electro-magnets  $M'$ ,  $M''$ , and  $M'''$  have varying numbers of convolutions. For example,  $M'$  may have one thousand,  $M''$  two thousand, and  $M'''$  four thousand, convolutions, and as the magnetic intensity in any given core is in proportion to the number of convolutions surrounding it, it is evident that with the same strength of current the magnetic intensity developed in the three cores would be in the proportion of one, two, and four. A second series of similar independent cores,  $n n n$ , is also provided, of much greater magnetic length than the series just described; but the corresponding series of helices  $N'$ ,  $N''$ , and  $N'''$  are graduated in the same manner as the first series in respect to the number of convolutions composing them. For example, the number of convolutions in the helix  $N'$  is approximately equal to the number in the helix  $M'$ , and  $N''$ , in like manner, is made equal to  $M''$ . All the helices in both series are connected together in succession in the main circuit, but are so arranged in relation to the commutator C C that any particular one, or any required combination of separate sets of helices may be thrown into or out of the circuit. Thus, if metallic pegs are inserted at I, II, III, IV, V, and VI, all the helices are cut out of the circuit. The withdrawal of a peg from I throws the helix  $M'$  into circuit, and in like manner the helix  $N'$  may be put in circuit by withdrawing the peg from II.

The advantage of my present arrangement consists in the facility with which it may be adjusted to meet any required conditions. For example, if it is desired to maintain a discharge of given intensity, but to vary its duration, different electro-magnets may be employed which have the same number of convolutions in their helices, but have cores of different lengths and times of discharge—as, for example,  $M'$  and  $N'$ . So, in like manner, if it is desired to maintain the same duration of discharge and to vary the intensity of it, this may be done by making use of different elements of the series,  $M'$ ,  $M''$ , and  $M'''$ , for ex-

ample, all of which have the same length of core, but differ in respect to the number of convolutions in their respective helices. In this way by selecting the proper elements any desired combination may be made up, by means of which the intensity and duration of the discharge may be varied to suit the requirements of any particular case.

I do not propose to 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 claim as my invention—

1. The combination, substantially as hereinbefore set forth, of a duplex telegraph apparatus and a main line, 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.

2. The combination, substantially as hereinbefore set forth, of two or more detached and independent cores or bars, of soft iron, of equal, or substantially equal, magnetic length, and each forming a closed magnetic circuit surrounded by a series of helices having unlike numbers of convolutions, respectively, and a commutator, whereby the helices surrounding any one or more of said independent cores or bars may be included in or cut out of a circuit.

3. The combination, substantially as hereinbefore set forth, of two or more detached and independent cores or bars, of soft iron, of different magnetic lengths, surrounded by a series of helices having an equal, or substantially equal, number of convolutions, and a commutator, whereby the helices surrounding any one of said independent cores or bars may be included in or cut out of the circuit.

In testimony whereof I have hereunto subscribed my name this 26th day of October, A. D. 1880.

JOSEPH E. FENN.

Witnesses:

NELSON ZABRISKIE,  
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