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S. D. FIELD.

TELEGRAPH SYSTEM.

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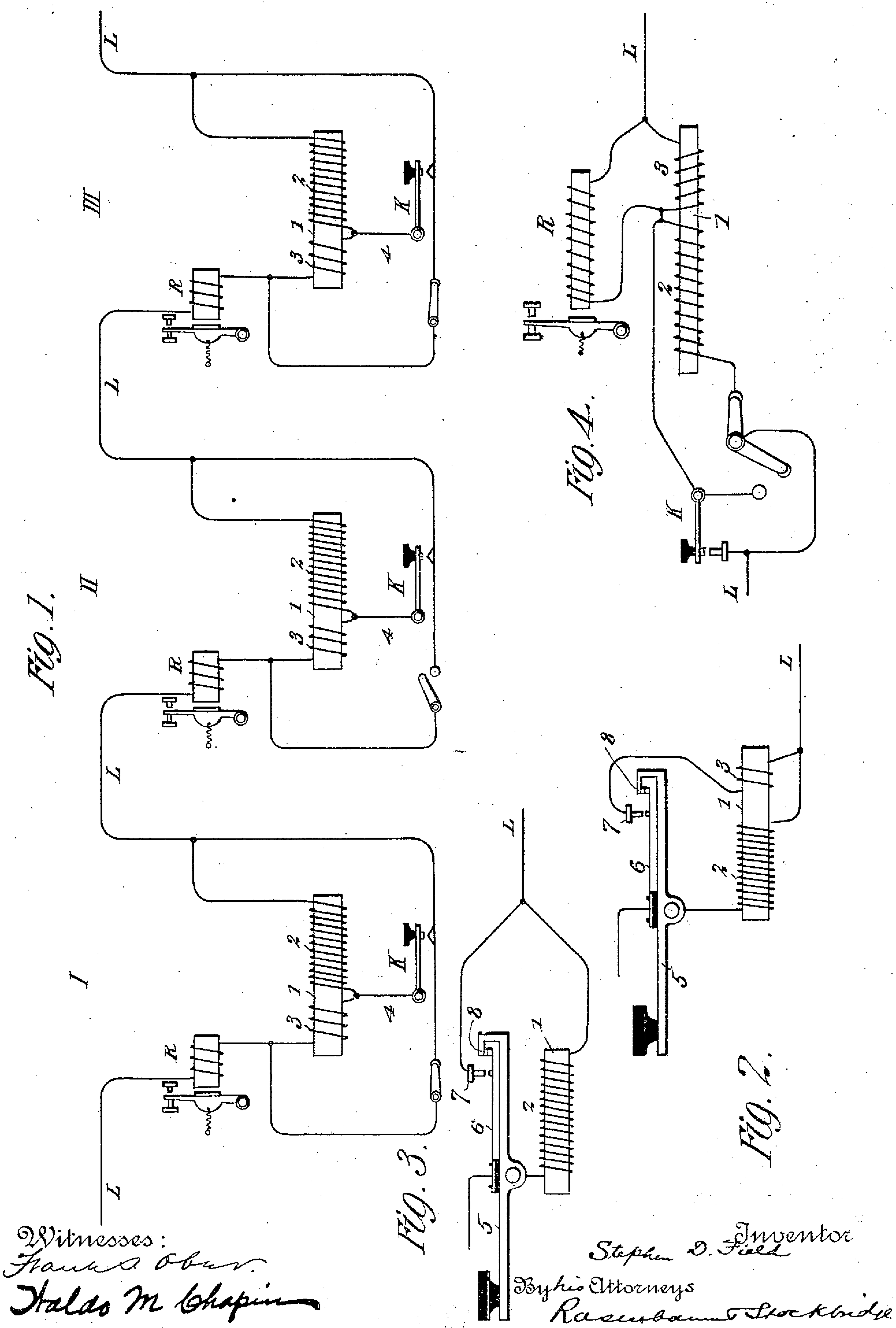

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TELEGRAPH SYSTEM.

No. 889,592. Specification of Letters Patent. Patented June 2, 1908.

Application filed January 24, 1907. Serial No. 353,904.

To all whom it may concern:

Be it known that I, STEPHEN DUDLEY FIELD, a citizen of the United States, residing at Stockbridge, in the county of Berkshire and State of Massachusetts, have invented certain new and useful Improvements in Telegraph Systems, of which the following is a full, clear, and exact description.

My invention relates to telegraph systems, particularly those arranged for simple Morse signaling, in which the relays of the entire line or system are arranged in a single series circuit, which circuit may be interrupted at any station by ordinary keys.

In one of its aspects the present invention consists of a magnetic inductance which is so associated with the main line as to impress a momentary electromotive force thereon in a direction to assist the line current at the instant of its commencement. In other words, a coil is provided to give assistance or impetus to the current of the line at the instant when it is inclined to be sluggish by reason of the line resistance, inductance and capacity.

In another aspect the present invention consists in an inductance coil at each station of the line separate from the usual relay and which is magnetized when the relay is idle and vice versa, and which has a winding which acts to assist the current at its inception, at the instant when the relay and the inductance of the line are opposing the current.

The invention further consists in the features of construction and combination hereinafter set forth and claimed.

In the drawings: Figure 1 is a diagrammatic view showing several stations of a Morse telegraph system having an arrangement of circuits embodying the present invention; Fig. 2 shows a key having a different arrangement of circuits adapted to secure substantially the same functions; Fig. 3 is a view showing how one of the windings with its corresponding function may be omitted; and Fig. 4 shows another modification.

In order to enable the present invention to be understood, I have shown diagrammatically a simple Morse telegraph system having a plurality of stations each with a relay and a circuit opening key. The ordinary arrangement is to have a battery at one end of the line, which sends a current through all the relays thereof, except when the circuit is interrupted at any station by opening the usual switch and key thereof. In Fig. 1 the circuit is opened at station No. II, and it is evident that the movements of the key at such station transmit signals to the line by alternately completing and opening the circuit thereof. Now in a telegraph line of ordinary length, say 500 miles, the resistance, inductance and capacity factors of the line and the relays thereof are very great, so that the opening and closing of the key at any station, for example, No. II, are not accompanied by instantaneous current flows or interruptions thereof. The current commences to flow only after an appreciable interval of time when the circuit is closed, and persists in its flow an appreciable interval after the circuit is opened. This defect cannot be overcome so long as the line has resistance, inductance and capacity, which it necessarily always has. It can, however, be compensated for by applying to the line an electromotive force which is sufficient to impress an immediate current flow in the line in spite of its inductance and capacity. In other words, if a line has a high inductance and capacity, it will not allow an immediate current flow if no greater force is applied than the central station battery, but no matter how high the inductance and capacity of the line may be, it is plain that a momentary electromotive force can be conceived, which will drive a current through the line in spite of its impedance. This is the thing I aim to obtain by the present invention; that is to say, I aim to secure an electromotive force applied to the line at the instant when the impedance of the line is opposing the initial flow of the current therein, and I aim to provide means by which this suddenly applied electromotive force may be as great as desired without limit, or limited only by the amount of impedance of the line which has to be overcome. I further aim to apply this special electromotive force at the point of the line where it is most needed, that is to say, at the station from which the signals emanate, and at which the circuit is broken and closed. I still further aim to apply an electromotive force upon the line in the opposite direction in order to choke off the current thereof, which tends to persist after the signal has been terminated. I still further aim to obtain these specially applied electromotive forces at any station of the line without the use of an auxiliary battery or current source thereat, making use of the main battery at the central station of the system for all these purposes, and utilizing such battery at the period when it is normally idle, that is, by the ordinary plan of telegraph signaling.

Before taking up the description of the circuits I will consider briefly one principle of electromagnets, of which I take advantage in the performance of my invention. This principle is that the intensity of attraction is proportional to the square of the number of lines of force, and, therefore, to the current strength. In other words, if the current strength is reduced to half its value, the polar attraction of the electromagnet is cut down to one-quarter its former strength. Now in a telegraph line the relays are energized by the line current, and if the latter does not energize them to saturation, as it ordinarily does not, then reducing the line current strength to one-half its value will cut down the polar attraction of the relays to one-quarter their strength, which is not enough to cause them to attract their armatures. This is especially true, since as will later appear, I momentarily absolutely reduce the line current flow to zero before it is allowed to resume its flow at half the normal strength. The relay armatures are accordingly thrown off during the no current interval, and the feeble current which follows is wholly insufficient to energize them enough to attract their armatures.

Reference will now be had to the circuits of a particular station of the line which are arranged in accordance with my invention.

R indicates the usual relay, and K the usual transmitting key, which may have the usual shunting switch, which need not be described. Instead of having the relay R and the key K in a simple series circuit with one another and with the line, I make use of a special device which furnishes the special electromotive forces above referred to at the opening and closing of the key. This device may be made in a great variety of forms, and I do not desire to be limited or restricted to the particular construction shown. The device has these essential characteristics that it has an iron core or mass of fairly heavy construction, either in the form of a bar or ring of horse-shoe, or any other shape, and a winding thereon which is very highly inductive. It may be stated that this device does not give satisfactory results, unless the inductance of the winding is as great or greater than the combined inductance of all the relays of the line together with the inductance of the line itself.

In the drawings, 1 indicates the iron core, and 2 denotes the winding. This winding acts to generate an electromotive force when the key K is opened, which electromotive force opposes the continuing flow of the line current. Immediately after the line current has been choked off and the circuit assumes a state of quiescence, the winding 2 acquires a new and entirely different function. It ceases suddenly to have any function in generating a counter electromotive force, and generates only a magneto motive force to energize the iron core 1. For the purpose of doing this, a feeble line current is allowed to pass during the interval when no signal is being transmitted. This feeble current is not sufficient to energize the relays for the reason above stated, but in view of the high inductance of the winding 2, it is sufficient to energize the iron core 1 to a very high degree of saturation. The winding 2 has no effect to generate an electromotive force to start the current flow when the key K is closed. For this purpose an entirely separate coil 3 is used.

The coil 3 is wound on the same core as the highly inductive winding 2. The direction of the winding 3 is such that the electromotive force generated therein when the magnetism of the core 1 dies out, assists the line current. The key K is made use of to destroy the magnetism of the core 1 at the instant when it is depressed, and the dying-out magnetism of the core generates an electromotive force in the coil 3, which drives a current immediately through the entire line in spite of its inductance, resistance and capacity. The electromotive force generated by the winding 3 depends upon its number of turns, and the energization of the core 1, and it is evident that if the number of turns and the energization are high, that the electromotive force will be correspondingly high. In practice there is no limit to the number of turns which may be used, except the resistance which they would present to the line current, and if fairly coarse wire is used, this may be made low enough, even though a large number of turns in the windings 2 and 3 are used. If the winding 3 has a great many turns of fairly coarse wire, it is evident that it can be made to have very high inductance with only a moderate resistance, that is to say, a resistance sufficient to cut down the line current to half or a third of its value when transmitting a message. With such a high inductance, the magneto motive force acting to magnetize the core 1 becomes very great, and a very large core or magnet may be energized. The larger the magnet or core 1, and the more it is energized, the more powerful is the electromotive force induced in the windings 3 when the key K is depressed. Thus it will be seen that it is easy to make the induced electromotive force sufficient to the needs for any installation, and in practice the adjustment is such as to cause an instantaneous response of the line relays when any key is depressed. There is indeed absolutely no limit to the size that the magnet 1 may be made, except that its magnetic energy must be limited by the electrical energy which can pass through the line during the interval when the key K is open. It is evident that only a certain current, less than necessary to operate the relays can be passed during this interval, and the interval is, of course, only a fraction of a second in some cases. In other words, the magnet core 1 may be made as large as desired, limited only by the fact that its ultimate energy cannot be greater than the energy which passes with the above mentioned current in the above mentioned time. I regard this feature as one of the utmost importance, and as having an important bearing on my invention.

The means by which the magnetism of the core 1 is destroyed whenever the key K is depressed, can be accomplished in different ways, but I prefer the simple arrangement shown in which the winding 2 is simply shunted around the key K. By this means the current flow therein is arrested immediately upon the depression of the key, and there is no magneto motive force to continue the energization of the core 1. But the core 1 has attained a very high degree of magnetic energy, and this energy is instantly transformed into electromotive force impressed on the line through the winding 3. Thus it is possible to attain an electromotive force impressed on the line at the instant when the circuit thereof is closed, and which electromotive force may be made as high as desired, and in practice high enough to overcome the sluggishness of the current flow.

I will now consider the way in which the line current is instantaneously arrested.

As already stated, it is plain that the line current can be instantly arrested if a sufficient counter electromotive force is impressed on it. Now it will be seen that when the key K has been depressed for a second, or appreciable interval, that the core 1 is deenergized, and the winding 2 is, of course, not carrying current. Now if the key K is opened, the only path open to the current is through the winding 2, and since this winding has a very high inductance, it simulates an absolute or dead break in the circuit. In fact, it throws back an electromotive force on the line in the manner of a choke coil, so that for a certain period of time there is absolutely no current flow therein. Accordingly all the relays of the line lose their magnetism and release their armatures with great promptness. But almost immediately afterward, the core 1 being fully energized, the winding 2 ceases to impress such electromotive force on the line, and the current flows feebly through the winding and through the line, but not with sufficient intensity to cause the relays to attract their armatures. The intensity is, however, sufficient to energize the core 1 to a very high degree of saturation, as above stated, and the next depression of the key is accompanied by action of the winding 3, as already described.

With the above arrangement of circuits it will be noted that the windings 2 are cut out of action when the keys K are depressed by shunting these windings. But shunting these windings through the keys necessarily short circuits them, so that an extra current is able to flow through such closed circuit. This is disadvantageous in that it absorbs the energy of the magnetized core 1, so that not so much energy is available to induce a current in the winding 3. In order to avoid this possible objection, I arrange in some cases to have the winding 2 open circuited rather than shunted to render it inactive. For this purpose a key, constructed as shown in Fig. 2, may be used. The key lever 5 has a spring blade 6 thereon, but insulated from the body of the key. The connection from the relay R goes to the spring 6, and the windings 2 and 3 are respectively connected to the lever 5, and to a contact 7, in the path of the spring 6. 8 denotes an extension on the key lever which is adapted to withdraw the spring 6 from the contact 7, and simultaneously complete connection therefrom to the winding 2. It is evident that the contact at 8 is completed exactly simultaneously with the rupture of the circuit at 7. Conversely the circuit is completed at 7, at the instant that it is ruptured at the point 8. The normal condition when the key is open is to have the circuit completed at 8, through the body of the key 5 and winding 2 to the line L. Since the winding 2 is of high resistance and inductance, a feeble current passes through the line highly energizing the core 1, but not energizing the relays enough to cause them to attract their armatures. When the key is depressed the above circuit, including the winding 2, is broken at the point 8, and a new circuit simultaneously completed at the point 7. The high resistance winding 2 is thus cut out of the line circuit, enabling a strong current to pass through the line, and at the same time it is cut out of action upon the core 1 by being open circuited altogether. The core 1, therefore, deënergizes very rapidly, and an electromotive force in the winding 3, which assists the initial current flow in the line, is produced. This corresponds to the result in the first described form of the invention. Correspondingly when the key 5 is again opened, the winding 2 is thrown into the circuit permanently reducing the current flow by reason of its resistance, and temporarily applying a back electromotive force by reason of its inductance, so that the line current is almost instantly checked.

In Fig. 3 the winding 3 is altogether omitted, but in other respects the connections are somewhat similar to those of Fig. 2. It is evident that the winding 2 has its usual function in opposing the current flow when the key is opened, but in this form of the invention there is no electromotive force applied to the line to assist the current flow when the key is closed.

In some cases, for example, in installations having a comparatively small number of stations, it is sometimes preferable to place the relay in shunt relation to the winding 3 of the inductance device. This arrangement is illustrated in Fig. 4 of the drawing. When the key K is opened, it is evident that the winding 2 is thrown into the line circuit in exactly the same way as in the preceding form of the invention. In like manner when the key K is depressed, the winding 2 is short circuited, and the core 1 deënergized so as to impress an electromotive force on the winding 3. The only difference in the action is that this electromotive force acts directly on the line, except so far as it is shunted by the relay R, instead of having to entirely traverse the relay R, as in the other forms of the invention. By this arrangement an additional advantage is obtained, namely, that the winding 3 forms a magnetic shunt for the home relay, which is well known in the art to be a very efficient means for sharpening up an incoming signal. A condenser may be included between the winding 2 and the usual shunting switch, if desired.

What I claim, is:—

1. In a telegraph system having a plurality of stations all included in the same continuous line circuit, relays and circuit opening keys at the respective stations, and a local inductive shunt at each station and bridged directly across the key thereat, but not including the local relay, and a short-circuiting shunt for bridging the key and the inductive shunt when desired.

2. In a telegraph system having a plurality of stations all included in the same continuous line circuit, relays and circuit opening keys at the respective stations, a local inductive shunt having an iron core bridged directly across the key at each station, but not including the local relay, and an additional winding on said core included in the line circuit both when the local key is opened and closed.

3. In a telegraph system having a plurality of stations all included in the same continuous line circuit, relays and circuit opening keys at the respective stations, a local inductive shunt having an iron core bridged directly across the key at each station but not including the local relay, whereby said inductance is directly in the line circuit when the key is opened, but not when the key is closed, an additional winding on said core included in the line circuit both when the local key is opened and closed, and a short-circuiting shunt for bridging the key, said inductive shunt and said additional winding when desired, but not shunting the local relay.

In witness whereof, I subscribe my signature, in the presence of two witnesses.

STEPHEN DUDLEY FIELD.

Witnesses:
JAMES COAKLEY,
PETER D. GILCHRIST.