G. E. HINES.

TELEGRAPH SYSTEM.

APPLICATION FILED APR. 13, 1907.

977,008.

Patented Nov. 29, 1910.

2 SHEETS—SHEET 1.

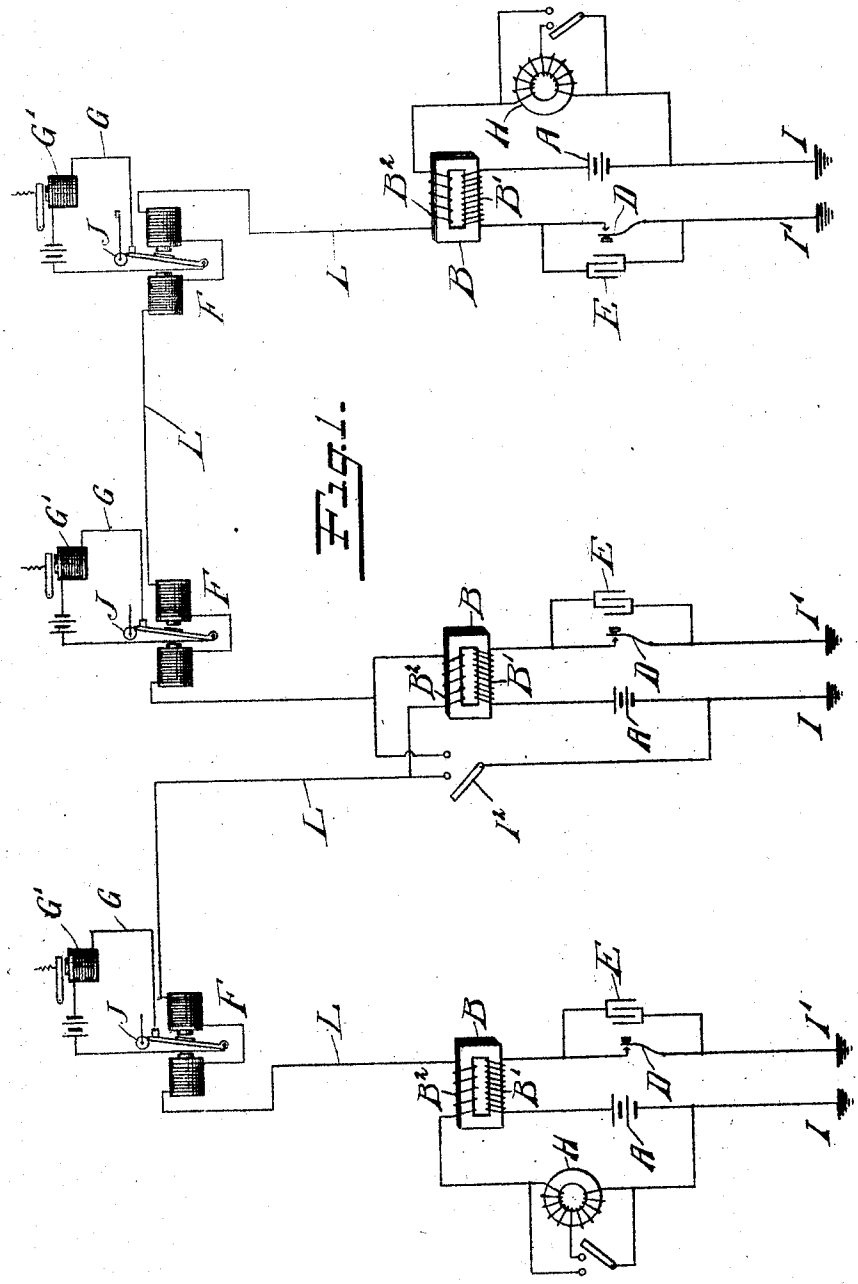

Fig. 1.

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2 SHEETS—SHEET 2.

Fig. 2.

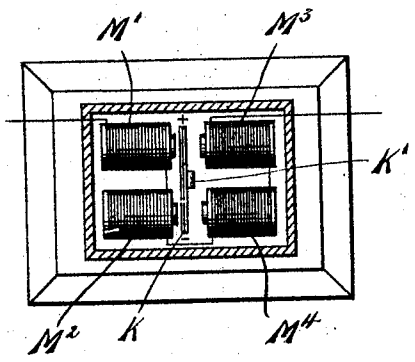
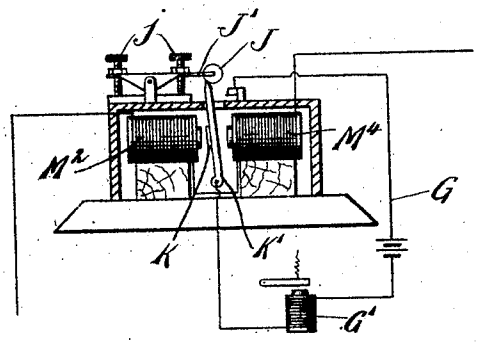


Fig. 3.



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UNITED STATES PATENT OFFICE.

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TELEGRAPH SYSTEM.

977,008. Specification of Letters Patent. **Patented Nov. 29, 1910.**

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To all whom it may concern:

Be it known that I, GEORGE E. HINES, a citizen of the United States, residing at the city, county, and State of New York, 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, and has for its object to transmit over a transmission line to distant stations along the line conductor dynamic currents of definite direction induced by a local or primary current.

Heretofore it has been proposed to impress electromotive forces on a telegraph line by means of induction coils having primary and secondary windings. No practical results, however, have ever been attained, for the reason that the secondary electromotive forces induced upon the make and break of the primary circuit have been impressed during such short periods as to be static in their character, and have thus, instead of producing dynamic currents in the transmission line, produced merely static effects having no definite polarity, which are dissipated in other ways than through dynamic currents. I have discovered that, by the use of a combination of suitable apparatus, currents may be set up in the transmission line such as will magnetize with a definite polarity telegraph apparatus at stations along, and in series with a line conductor. Moreover, the currents impressed upon the transmission line in my system approach the sine wave form, the elements of this wave being made up of a continuous growth of potential energy through an appreciable period of time, and therefore are more easily transmitted and cause less interference with neighboring transmission lines than where an electromotive force from a constant potential source is impressed directly upon the line, as is the practice at the present time. In order to produce these dynamic effects, as distinguished from the static effects, of the apparatus heretofore proposed, I make the primary circuit of the induction apparatus one having a high time constant. The result of this is that when the primary circuit is made, the primary current gradually rises, the magnetism of the induction apparatus gradually rises, and the period of induction upon the secondary is correspondingly extended, resulting in an induced dynamic current of definite direction during the whole of that period. The induction apparatus which I have used in accomplishing this result is a transformer having a closed magnetic circuit, and so wound that the primary circuit has the necessary large time constant. When the primary circuit is closed through a telegraph key, the constant electromotive force of the source is impressed upon the primary circuit and the current rises at a rate determined by the time constant. The magnetism in the core rises at a rate determined by the primary current and the iron losses in the core. I preferably laminate the core so as to eliminate all eddy current losses. A secondary electromotive force is induced in the secondary winding during the whole period of rise of the magnetism of the core, resulting in a secondary current flowing along the line and during this period. Telegraph lines ordinarily have considerable capacity, which varies under varying conditions. I therefore preferably introduce an adjustable self-induction coil in series with the secondary winding, so as to more or less neutralize this capacity. In order to make the fall of the primary current gradual upon the break of the primary circuit at the transmission key, I shunt the transmission key by a condenser. This permits the current within the primary to fall gradually, and incidentally also protects the key from destructive arcing. The decrease of magnetism in the core is determined by the decrease of current in the primary and also by hysteresis of the closed magnetic circuit core, and thereby extends over a considerable period, resulting in an induced secondary current flowing in a definite direction throughout the transmission line throughout that period.

I preferably make the induction coil in series with the secondary of such dimensions as to more than neutralize the capacity of the line, so that the time constant of the secondary circuit assists in causing the induced current on the make as well as on the break to assume more nearly the sine wave form.

I place in series with the line at the transmitting stations, as well as at the receiving stations, relays which control local circuits for operating sounders and other indicating apparatus, the transmitting and relay mechanism being duplicated at each station along

the line. The telegraph or transmitting key is preferably such that the electromotive forces impressed upon the primary are all in the same direction, since a reversal of the electromotive force upon a single operation of the transmitting key is liable to send two impulses in the same direction and of substantially equal strength, instead of one impulse in a given direction of double strength.

The following is a description of an embodiment of my invention, reference being had to the accompanying drawings, in which Figure 1 is a diagram of a system embodying my invention, and Figs. 2 and 3 are sectional plan and side elevations of the relay used therein.

Referring more particularly to the drawings, A A A represent batteries or other sources of constant potential.

B B B represent transformers, each having a laminated closed magnetic circuit, the primary B′ B′ B′ of which are in series with said sources.

D D D represent telegraph or transmitting keys in series with said primaries and said sources.

E E E are condensers in shunt to the transmitting keys.

F F F are polarized relays of suitable form, which are in series with the transmission line, and G G G are local circuits containing the sounders G′ or other receiving apparatus controlled by said polarized relay. The transmission line L is in series with the secondary B^2 B^2 B^2 of the transformers, and also with the self-induction coils H H. The transmission line at each end is grounded, as at I I. The two terminal stations are the same. The intermediate stations of any desired number are as shown in the center. The line is ordinarily not grounded at this point but means for grounding it on either side of the transformer if desired are provided at I^2.

The relays are provided with jockey wheels to keep the armatures in the positions in which they are thrown by currents from the sources A, it having been found that otherwise stray or earth currents of sufficient strength to move them may pass over the line. The armatures are unretracted inasmuch as they remain in the position to which they are pulled by the electromagnets of the relays.

The relays are more fully shown in Figs. 2 and 3. In these figures K is a polarized armature carried by a pivoted lever K′. M′ M^2 are two magnets wound so as to present poles of opposite polarity to the armature. M^3 M^4 are magnets in series with M′ M^2 and wound so that the pole of M^3 is of opposite polarity to that of M′ and the pole of M^4 is of opposite polarity to that of M^2. J is the jockey wheel bearing against the tip of the lever K′ and held in position by a spring J′ attached to a pivoted block which is adjusted by set screws j' j' so as to be in proper position to engage the lever K′ but not to hold it too firmly.

In the operation of the system, when any primary circuit is closed through its telegraph key, the primary current by reason of the time constant of the primary circuit, rises slowly, and the magnetism in the closed core of the transformer rises through a considerable period determined by the rise of the primary current and the hysteresis of the core. A secondary current is induced in the secondary coil which is transmitted along the line, having a duration corresponding to the rise of the magnetism of the closed core, and magnetizes the relays by a current of given direction. The polarized armatures of the relays are by this current caused to move so as to complete the local circuits containing the receiving apparatus. When the primary current is broken by another movement of the telegraph key, another current flowing in the opposite direction to that before produced is induced in the secondary circuit and flows along the transmission line. This current continues during a period determined by the gradual fall of the magnetism in the transformer core, and is of such duration as to cause the armatures and the polarized relays to move in the other direction and to open the local circuits controlled by the relays. The relays are preferably such as described, having polarized armatures which are moved in both directions by the dynamic currents. The presence of the relays in series with the line introduces some self-induction therein and assists in overcoming the capacity of the line, and also reduces the tendency of the line circuit to reduce the time constant of the primary circuit. Where cables or a few stations only are employed I preferably use high potential primary circuits and step down transformers as shown, since I am thereby able to more easily obtain a higher time constant in the primaries.

As before stated, the currents upon the transmission line not only persist during a considerable period and flow in a definite direction, but approximate at least the sine wave form, so as to be more readily transmitted and not interfere seriously with the working of other transmission lines by reason of their static induction, and this gradual rise and fall and duration are principally due to the high time constant in the primary, at the make, the capacity in the primary on the break. The self induction of the line circuit and the hysteresis of the closed iron core also assist in attaining this necessary effect.

What I claim is,—

1. The combination of a main line conductor continually grounded at each end so

as to provide a closed electric circuit, closed magnetic circuit transformers having secondary windings in series with said conductor and a key-controlled primary circuit in series with a source of constant current, relays having movable polarized armatures and also in series with said conductor, and jockeys restraining said armatures against movement due to the action of stray currents.

2. The combination of a main line conductor grounded at each end, closed magnetic circuit transformers having secondary windings in series with said conductor and a key-controlled primary circuit in series with a source of constant current, relays having movable polarized armatures also in series with said conductor, jockeys restraining said armatures against movement due to the action of stray currents, and an adjustable self induction device also in series with said conductor.

GEORGE E. HINES.

Witnesses:
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