

June 12, 1928.

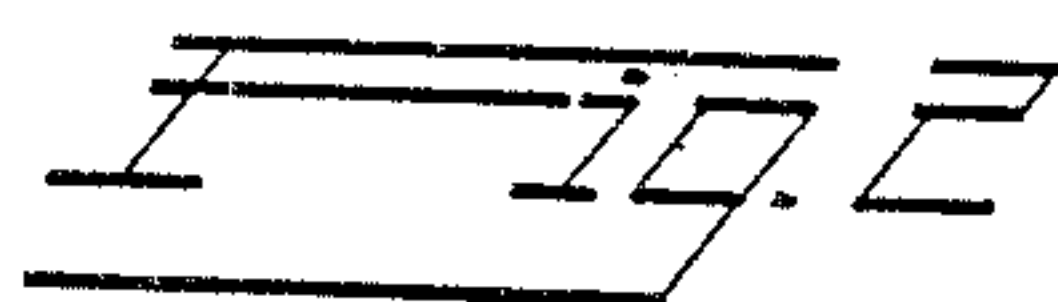
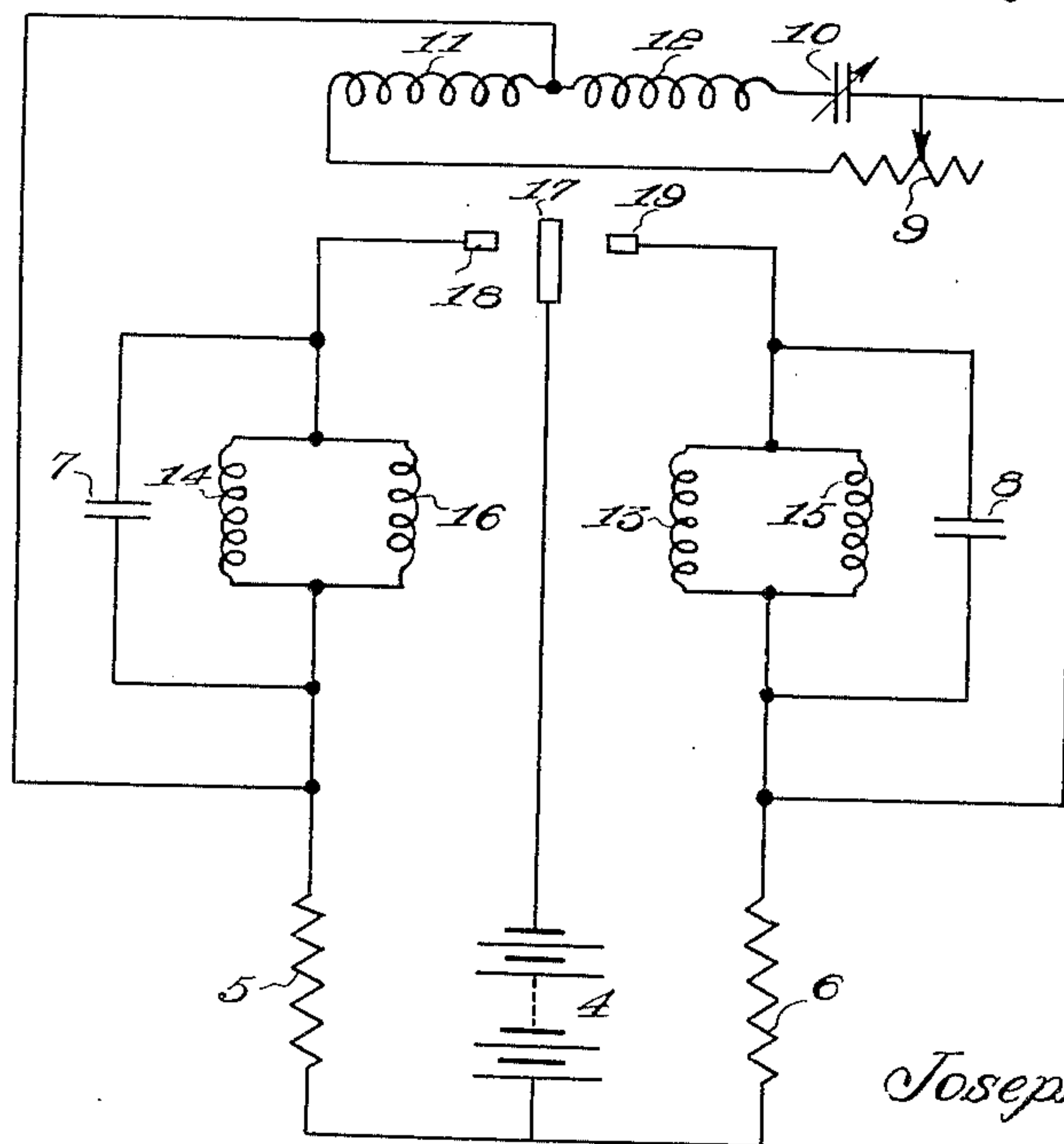
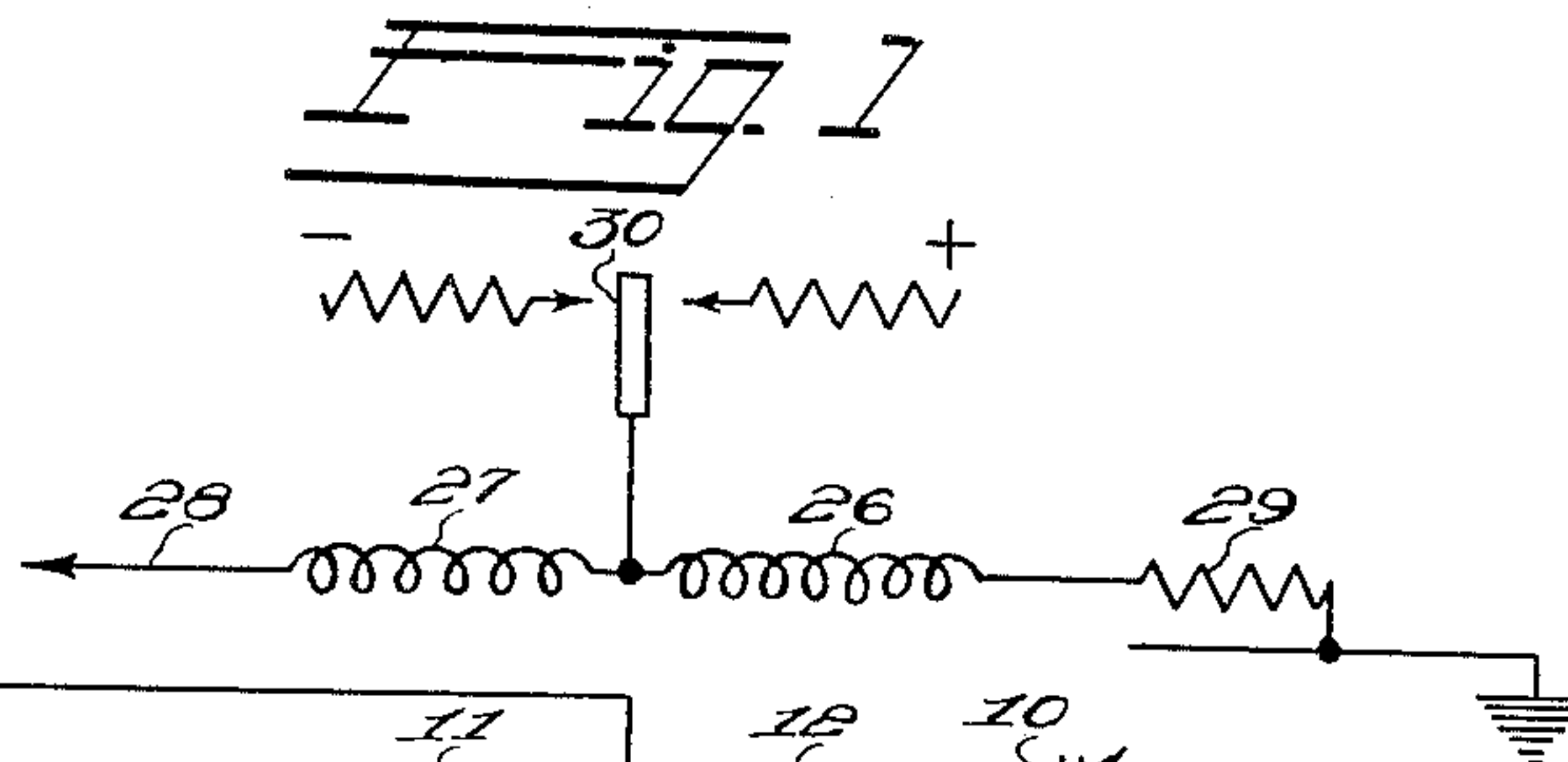
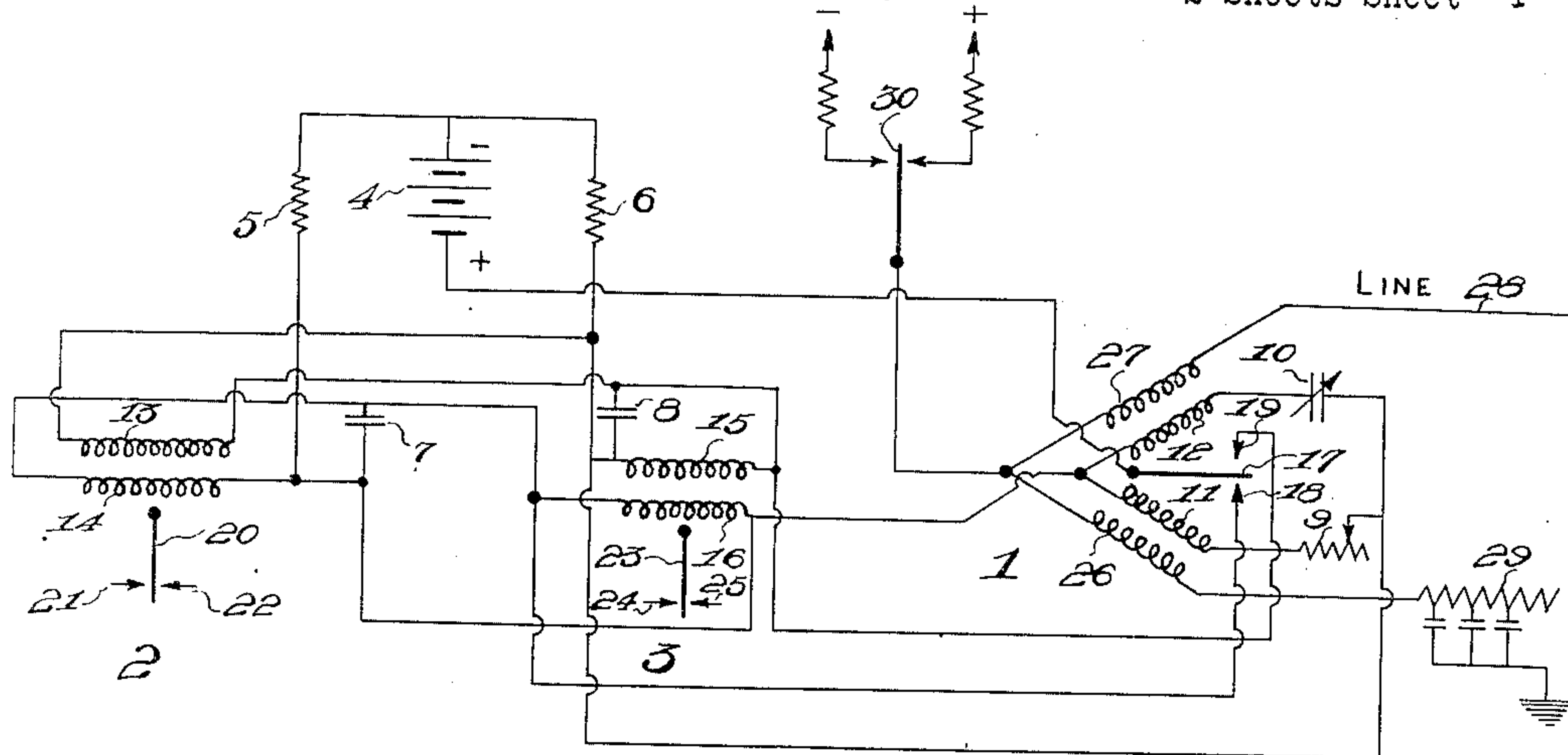
J. W. MILNOR

1,673,697

RELAY AND RELAYING SYSTEM

Filed Nov. 8, 1926

2 Sheets-Sheet 1



By

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June 12, 1928.

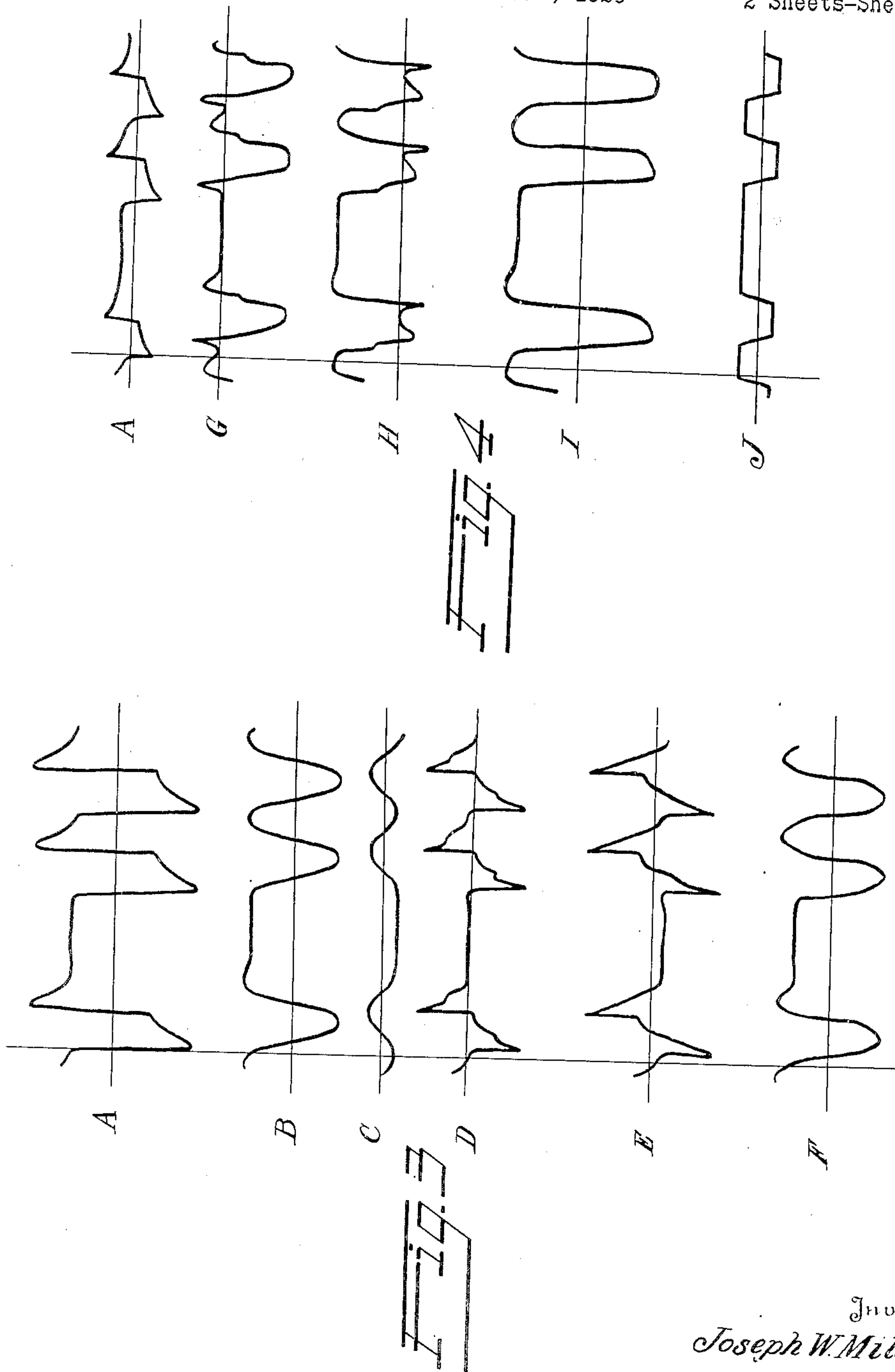
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RELAY AND RELAYING SYSTEM

Filed Nov. 8, 1926

2 Sheets-Sheet 2



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Patented June 12, 1928.

1,673,697

UNITED STATES PATENT OFFICE.

JOSEPH W. MILNOR, OF NEW YORK, N. Y., ASSIGNOR TO THE WESTERN UNION TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

RELAY AND RELAYING SYSTEM.

Application filed November 8, 1926. Serial No. 147,173.

My invention relates to a relay system, and in particular to a system for relaying or repeating telegraphic signals.

Broadly, the object of my invention is to devise a system for relaying telegraphic or other signals at high speed.

One specific object of my invention is to devise a main line relay which will reduce lag in the repetition of signals, which will reduce the detrimental effect of extraneous influences, and which will give improved and sharper signals.

A further object of my invention is to devise an improved form of relay or repeater having a short period of travel, positive operation, and practically no tendency to rebound.

My invention is embodied in a system in which a main line relay, operated in accordance with signals to be repeated, controls one or more local or auxiliary relays which in turn either operate local sounders, recording apparatus, or the like, or repeat the signals into branch circuits or into another line section. The main line relay is of the type employing an "opposing" winding and an "accelerating" winding, in cooperation with a main operating winding, whereby the armature of the relay is operated from one contact to another when the incoming signal is reduced in amplitude below a certain value, and is quickly transferred from one contact to the other by the action of the accelerating winding. The main line relay controls one or more local relays which are provided with two inductively coupled operating windings which cooperate to produce positive and quick operation.

My invention is illustrated in the accompanying drawings in which:

Figure 1 is a circuit diagram illustrating one form of my invention in which a main line relay controls two auxiliary relays;

Figure 2 is a simplified circuit diagram illustrating the connections between a main line relay and the auxiliary relays;

Figure 3 is a series of curves representing various currents which enter into the operation of the main line relay; and

Figure 4 is a series of curves representing various currents which enter into the operation of the auxiliary relays.

Referring to Figure 1, the main line relay is indicated generally at 1, and the two auxiliary relays are indicated generally at

2 and 3. The main line relay is provided with two operating windings 26 and 27 connected in series with each other and with line conductor 28 and balancing network 29. A transmitting key 30 is connected at a point between windings 26 and 27, and is provided with opposing contacts for impressing upon the line signal impulses of opposite polarity in a well known manner. Balancing network 29 is provided for the usual purpose of balancing out the effect of the operation of key 30 upon the main line relay 1, accordingly, it will be understood that transmitting signals from the local station by key 30 does not interfere with reception of signals over line 28 from a distant station. In addition to the main operating winding, relay 1 is provided with two auxiliary windings 11 and 12. The armature 17 of relay 1 is connected to one terminal of a source of direct current 4, the other terminal of source 4 being connected through separate paths to opposing contacts 18 and 19 of relay 1. One of these paths includes a resistance 5, windings 14 and 16 of relays 2 and 3 respectively in parallel with each other and in series with the resistance 5. The other path includes a resistance 6 in series with windings 13 and 15 of relays 2 and 3 respectively connected in parallel with each other. A condenser 7 is also shunted around windings 14 and 16, and a condenser 8 is shunted around windings 13 and 15. Winding 11 of relay 1, which will hereafter be referred to as the "opposing" winding, is connected in a path across contacts 18 and 19 of relay 1 which includes an adjustable resistance 9. Winding 12 of relay 1, which will hereafter be referred to as the "accelerating" winding, is also connected in a path across contacts 18 and 19 which includes a variable condenser 10. It will thus be seen that windings 11 and 12 are in parallel paths connected across contacts 18 and 19, and the windings of auxiliary relays 2 and 3 are connected in common portions of these paths, as is clearly shown in Figure 2. The armatures of the local relays 2 and 3 and their opposing contacts have not been shown in Figure 2 for the sake of clearness of illustration.

In describing the operation of my invention it will be assumed that a current flowing from left to right in any of the windings

in either of the local or main line relays tends to move the armature of that relay to the left hand contact, and vice versa. The left hand contact is known as the "spacing" contact, while the right hand contact is known as the "marking" contact. The operation of my invention may be understood by reference to Figure 3, curve A of which represents signals impressed upon the distant end of the telegraph line; curve B represents the signals received in coils 26 and 27 of relay 1; curve C represents the current which flows in "opposing" coil 11 of relay 1; curve D represents the current which flows in "accelerating" coil 12 of relay 1; curve E represents the sum of the currents flowing in coils 11 and 12 of relay 1; and curve F represents the net effective current operating relay 1. A time reference line at the left of all curves is drawn at the point where the transmitted current passes through zero. In curve A of Figure 3 the negative current pulses below the zero line are marking signals, and the positive current pulses above the zero line are spacing signals. It will be assumed that a spacing signal is being received and that armature 17 of relay 1 is being held against spacing contact 18. Current will be supplied to opposing winding 11 by battery 4 through resistance 6, resistance 9, winding 11, windings 14 and 16 of auxiliary relays 2 and 3 in parallel, contact 18, and armature 17. This current is in such direction as to oppose the current flowing through coil 26 and 27, and tends to move armature 17 towards contact 19. As the line current flowing in windings 26 and 27 falls to a value, the magnetic effect of which is slightly less than the magnetic effect of the opposing current flowing in winding 11, the armature 17 of the main line relay starts to move away from contact 18. When armature 17 breaks its contact with stop 18 the accelerating condenser 10 discharges through the accelerating winding 12 in series with resistances 5 and 6, thereby causing a current to flow through accelerating winding 12. The direction of current in winding 12 is such that it acts upon armature 17 to carry it quickly across to contact 19. The current in the opposing winding 11 falls to zero during the time in which armature 18 travels from one contact to the other. When the armature strikes the marking contact 19 the accelerating condenser takes a sudden charge thereby causing a current to flow through the accelerating winding 12 in such a direction as to hold the armature firmly on the marking contact stop. It will thus be seen that the action of accelerating winding 12 is such as to reduce the tendency for rebound of the armature. If the windings of the opposing and accelerating circuits each contain half the number of turns of the main line windings,

the relative magnetic effects of the currents in the line circuit and the effective current in the auxiliary circuits will bear the relation shown in curves B and E. This particular ratio of turns in the main line and auxiliary windings, however, is not essential to the operation of the circuit. The net result of all the currents acting on the main line relay is shown in curve F.

By comparing curve F with curve B, the incoming signals, it will be noted that the resultant current approaches and crosses the zero line more sharply than the incoming current, which reduces the detrimental action of extraneous currents such as telegraph and other line induction. Also, the initial resultant current rises to a higher value than the incoming current, which promotes quick armature travel and affords a strong force to hold the armature at its contact and minimize rebound. Finally, the steady state value of the resultant current is lower than the steady state value of the line current, which is of assistance in preparing for transition to the following signal:

The action of the local or auxiliary relays may be understood by reference to Figure 4. Curve A represents the transmitted signals and corresponds to curve A of Figure 3. Curves G and H show the marking and spacing pulses flowing through the windings of each local relay and will be considered together. The action of both local relays is the same, and only that of relay 2 will be described. When relay 1 breaks contact at 18 a steady current through the spacing coil 14 of local relay 2 falls quite sharply towards zero, as shown in curve H. As soon as this current starts to fall, condenser 7 discharges through winding 14 in such a direction as to hold armature 20 on the spacing contact 21. When the armature of relay 1 strikes the marking contact 19, current in coil 13 of relay 2 builds up, as shown in curve G. It will be noted from curve G that a short spacing kick precedes the actual marking signal pulse. This short kick is the result of a voltage induced in winding 13 by the rapidly falling current in winding 14, due to a transformer action in the relay. This kick is in such a direction as to hold the armature 20 on spacing contact 21, i. e., to slightly delay the signal. After the spacing signal pulse in winding 14 has fallen to zero, a small marking pulse flows through this winding as a result of an oscillation between the inductance of the winding 14 and the capacity of condenser 7, as is shown in curve H. This pulse is in such a direction as to aid the marking signal building up in winding 13 at this time. The net effect of the current in windings 13 and 14 is shown in curve I. The transition from spacing current to marking current, or vice versa, is sharp. The benefits here derived are: short

travel time of the local relay armatures; the initial value of the pulses is somewhat higher than the steady state value, thereby affording a large holding force to reduce the contact rebound; and the lowered steady state value prepares the relay for the following signal. All these advantages in the local relays are gained by the particular arrangement of the local relay windings in the circuit and by the shunt condensers 7 and 8. Curve J shows the repeated signals from one of the local relay armatures.

While I have illustrated one form of my invention in which a main line relay controls two local or auxiliary relays, it will be understood that a greater number of relays may be controlled by the line relay, or that instead of operating local relays, the main line relay may operate local apparatus such as printers, correcting circuits, etc. And also, while I have illustrated my invention as applied to a differential, polar duplex telegraph system, it will readily be understood that my invention is not limited in use to such a system, and is adaptable to any system of telegraph signal transmission, whether simplex or any of the various forms of duplex systems.

I claim:

1. A relay comprising a polarized armature, a main winding for operating said armature between opposing contacts, an auxiliary winding normally tending to operate the armature to the opposing contact, a second auxiliary winding for accelerating the movement of the armature from one contact to the other, said auxiliary coils being connected in parallel paths across said opposing contacts, and means including said armature for energizing said auxiliary windings.

2. A relay comprising a polarized armature, a main winding for operating said armature between opposing contacts, an auxiliary winding normally tending to operate the armature to the opposing contact, a second auxiliary winding for accelerating the movement of the armature from one contact to the other, said auxiliary coils being connected in parallel paths across said opposing contacts, a third path connected across said contacts including a resistance, and a source of current connected between said armature and a point in said third path intermediate the terminals of said resistance.

3. A relay comprising a polarized armature, a main winding for operating said armature between opposing contacts, an auxiliary winding normally tending to operate the armature to the opposing contact, a second auxiliary winding for accelerating the movement of the armature from one contact to the other, said auxiliary coils be-

ing connected in parallel paths across said opposing contacts, a third path connected across said contacts including a resistance, and a source of current connected between said armature and a point in said third path intermediate the terminals of said resistance, and relay windings connected in said third path on each side of said point of connections.

4. In a relay system, the combination of a relay comprising a polarized armature provided with opposing contacts, a winding for operating said armature between said contacts, a circuit connection between said contacts including a resistance, a source of current connected between said armature and a point in said circuit connection intermediate the terminals of said resistance, a second relay comprising an armature and two operating windings, said windings being connected in said circuit connection on opposite sides of the point of connection of said source.

5. In a relay system, the combination of a relay comprising a polarized armature provided with opposing contacts, a winding for operating said armature between said contacts, a circuit connection between said contacts including a resistance, a source of current connected between said armature and a point in said circuit connection intermediate the terminals of said resistance, a second relay comprising an armature and two operating windings, said windings being connected in said circuit connection on opposite sides of the point of connection of said source, and a condenser in shunt to each of said second relay windings.

6. In a relay system the combination of a relay comprising a polarized armature provided with an operating winding and opposing contacts, a second relay comprising an armature provided with two operating windings, a source of current, a circuit connection between the armature of said first relay and one of its contacts including said source and one of the operating windings of the second relay, and a circuit connection between the armature of the first relay and the other contact including said source and the other winding of the second relay.

7. In a relay system the combination of a relay comprising a polarized armature provided with an operating winding and opposing contacts, a second relay comprising an armature provided with two operating windings, a source of current, a circuit connection between the armature of said first relay and one of its contacts including said source and one of the operating windings of the second relay, a circuit connection between the armature of the first relay and the other contact including said source and

the other winding of the second relay, and a condenser in shunt to each of said second relay windings.

8. In a relay system the combination of a relay provided with an armature, an operating winding, and opposing contacts, means to energize said winding, and means operative upon breaking the energizing circuit of said winding to at first hold the armature upon the engaged contact and to later repel the armature from the engaged contact.

9. In a relay system the combination of a relay provided with an armature, an operating winding, and opposing contacts, means to energize said winding, a condenser connected in shunt to said winding and operating, upon opening the energizing circuit of said winding, to at first hold the armature upon the engaged contact and to later repel the armature from the engaged contact.

10. In a relay system the combination of a relay provided with an armature, two operating windings, and opposing contacts, a source of current, a switch element and circuit connections for alternately energizing said windings from said source, and a condenser connected in shunt with each of said windings.

11. In a relay system the combination of a relay provided with an armature, two operating windings and opposing contacts, a source of current, a switch element and circuit connections for alternately energizing said windings from said source to transfer said armature from one contact to another, and means operative upon opening said circuit connections to at first hold the armature upon the engaged contact and to later transfer the armature to the opposite contact.

12. In a relay the combination of a polarized armature, an operating winding and an energizing circuit for holding said armature against a contact, a condenser in shunt to said winding, said condenser and coil being so proportioned that upon opening the energizing circuit a complete oscillation of current flows in the local circuit including said winding and condenser.

13. A relay comprising a polarized armature, a main winding for operating the armature between opposing contacts, an auxiliary winding for accelerating the movement of the armature from one contact to the other, a circuit connection between the contacts including the auxiliary winding, and means including the armature for energizing the auxiliary winding.

14. In a relay system, the combination of a relay comprising a polarized armature provided with opposing contacts, a winding for operating said armature between said contacts, a second relay comprising an armature provided with two operating windings, a circuit connection from one of said contacts

including one of the operating windings of the second relay and a circuit connection from the other of said contacts including the other operating winding of the second relay.

15. In a relay system, the combination of a relay comprising a polarized armature provided with opposing contacts, a winding for operating said armature between said contacts, a second relay comprising an armature provided with two operating windings, a circuit connection from one of said contacts including one of the operating windings of the second relay, a circuit connection from the other of said contacts including the other operating winding of the second relay, and a condenser in shunt to each of said second relay windings.

16. A relay comprising a polarized armature, a main winding for operating said armature between opposing contacts, an auxiliary winding for accelerating the movement of the armature from one contact to the other, a circuit between the opposing contacts including the auxiliary winding, a second circuit between the contacts including two resistances, relay windings common to the two circuits, and a source of current connected between the armature and a point in the second circuit between the two resistances.

17. In a relay system, the combination of a relay comprising a polarized armature provided with opposing contacts, a winding for operating the armature between the contacts, an auxiliary winding for accelerating the movement of the armature from one contact to the other, a circuit between the contacts including the auxiliary winding, a second circuit between the contacts including two resistances, a source of current connected between said armature and a point in the second circuit between two resistances, relay windings common to said two circuits, and a condenser in shunt to each of said relay windings.

18. In a relay system, the combination of a relay comprising a polarized armature provided with opposing contacts, a winding for operating said armature between said contacts, an auxiliary winding for accelerating the movement of the armature from one contact to another, said auxiliary winding being connected in a circuit between the opposing contacts, a second relay comprising an armature provided with two operating windings, a circuit connection from one of the opposing contacts including one of the operating windings of the second relay, a circuit connection from the other of the opposing contacts including the other of the operating windings of the second relay, and a condenser in shunt to each of the operating windings of the second relay.

19. In a relay system, the combination of

a relay comprising a polarized armature provided with opposing contacts, a winding for operating the armature between said contacts, an auxiliary winding for accelerating
5 the movement of the armature from one contact to the other, a second relay comprising an armature provided with two operating windings, a circuit between the said opposing contacts including the auxiliary wind-
10 ing, a second circuit between the opposing contacts including resistance, the two circuits including in common the operating winding of the second relay, and means including the armature of the first relay for
15 energizing the said two circuits.

20. In a relay system the combination of

a main relay comprising a polarized armature provided with an operating winding and opposing contacts, a plurality of local
relays each comprising an armature pro- 20
vided with two operating windings, a source of current, a circuit connection between the armature of said main relay and one of its
contacts including said source and one of
the operating windings of each of said local 25
relays, and a circuit connection between the armature of the main relay and the other contact including said source and the other
winding of each of said local relays.

In testimony whereof I affix my signature.

JOSEPH W. MILNOR.