Jan. 25, 1938. F. K. LOW 2,106,356

SIGNALING SYSTEM

Filed April 27, 1935

FIG. 1

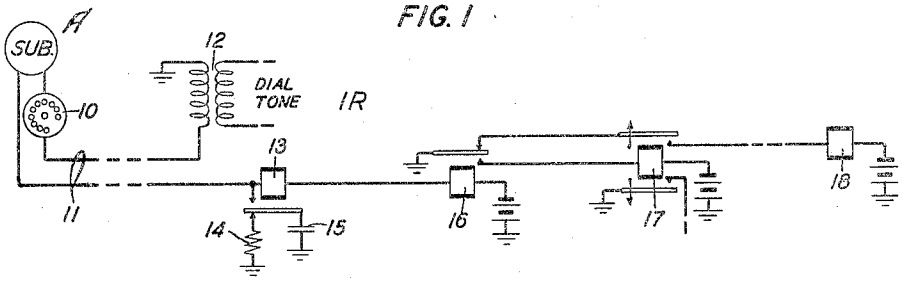


FIG. 2

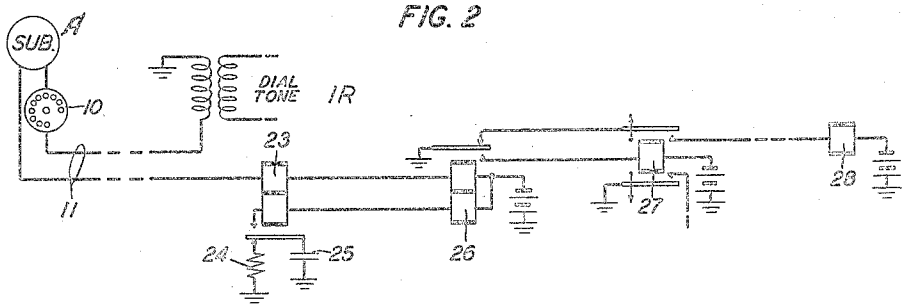
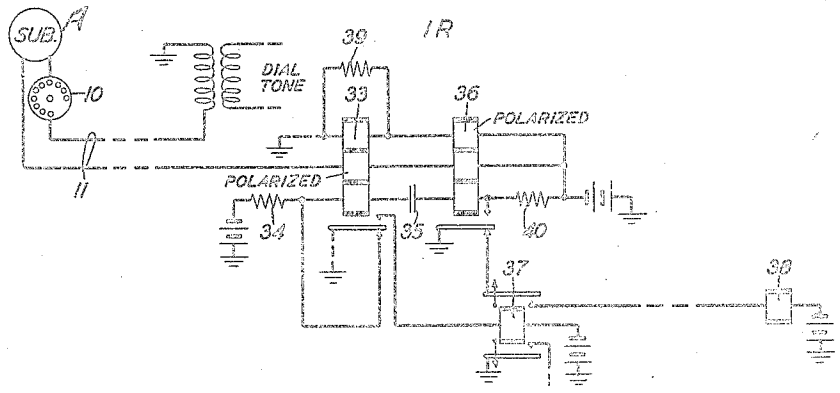


FIG. 3



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Patented Jan. 25, 1938

2,106,356

UNITED STATES PATENT OFFICE

2,106,356

SIGNALING SYSTEM

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Application April 27, 1935, Serial No. 18,504

25 Claims. (Cl. 179—16)

This invention relates to signaling systems and particularly to signaling systems comprising electromagnetic signal-receiving means.

The object of the invention is to provide a more sensitive electromagnetic signal-receiving means and to insure the accurate response of such a signal-receiving means to incoming signals.

In signaling systems in which selective signals are created by the opening and closing of a signaling circuit, a less easily operated and more easily released relay is best suited for response to impulses over lines of low resistance, high capacity and high leakage; and a more easily operated and less easily released relay is best suited for response to impulses over lines of high resistance, low capacity and low leakage. The present invention is an arrangement in which there are two impulse receiving relays, one adapted to release under the more severe release conditions and the other adapted to operate under the more severe operate conditions, the response of either of the relays in advance of the other to the opening or closing of a signaling circuit being effective to aid the response of the other of the two relays and thereby assure satisfactory response to signal impulses under the widest possible limits of line resistance, line capacity and line insulation.

One feature of the invention is a signal-receiving means comprising two relays in combination with a condenser, the operation of one of the relays, which one is more easily operated than the other, rendering effective a circuit including the condenser for aiding the operation of the other of the two relays.

Another feature of the invention is a signal-receiving means comprising two relays in combination with a condenser, the release of one of the relays, which one is less easily held operated than the other, rendering effective a circuit including the condenser for aiding the release of the other of the two relays.

Another feature of the invention is a signal-receiving means comprising two relays in combination with a condenser, one of the relays being more easily operated and more easily held operated than the other, the operation of the more easily operated relay rendering effective a circuit including the condenser for aiding the operation of the other of the two relays and the release of the other of the relays rendering effective a circuit including the condenser for aiding the release of the more easily operated relay.

Another feature of the invention is a signal-receiving means comprising two relays in combination with a condenser, one of the relays being more easily operated and more easily held operated than the other. The operation of the less easily operated relay closes a circuit including the condenser for holding this relay operated for a short interval of time. And the release of the more easily operated relay closes a circuit including the condenser for holding this relay released for a short interval of time.

Another feature of the invention is a signal-receiving means comprising two polarized relays, each having a signal-receiving winding, a biasing winding, and a winding connected in series with a condenser, one of the relays being more easily operated and more easily held operated than the other. The operation of the more easily operated relay renders effective a circuit including the condenser for aiding the operation of the other relay. The operation of the less easily operated relay closes a circuit for holding this relay operated for a short interval of time. The release of the less easily operated relay renders effective a circuit including the condenser for aiding the release of the other relay. And the release of the more easily operated relay closes a circuit including the condenser for holding this relay released for a short interval of time.

A better and more complete understanding of the invention may be obtained by considering the specific embodiments of the invention shown in the drawing which forms a part of this specification. The invention is not, however, limited in its application to these specific arrangements and is, in general, applicable to any signaling system in which selective signals are created by the opening and closing of a signaling circuit.

Referring to the drawing,—

Fig. 1 represents an automatic telephone system comprising a subscriber's station A and impulse receiving means IR having two impulse relays **13** and **16**, each of which has a single winding;

Figs. 2 and 3 also represent automatic telephone systems comprising a subscriber's station A and impulse receiving means IR, each of the impulse relays **23** and **26** of Fig. 2 having two windings and each of the impulse relays **33** and **36** of Fig. 3 having three windings and a polarized magnetic structure.

The apparatus at station A includes a dial **10** or an equivalent impulse sender, and is connected by line **11** to a central office or exchange in which automatic switching equipment is provided for establishing a connection between the line **11** and an idle impulse receiving means IR in response to the removal of the receiver at station

A to originate a call. The impulse receiving means IR may be used to directly control in succession each of a train of selective switches to complete a desired connection or may be used to operate a register which thereafter controls the various switches through which a desired connection is established. Reference may be had to Chapter III of the second edition of "Automatic Telephony" by Smith and Campbell for a description of an automatic telephone system comprising switches of the well-known Strowger type controlled by the dial impulses when dialed. Reference may be had to Patent No. 1,395,977 granted to F. A. Stearn et al. November 1, 1921 for a description of a system comprising switches of the power-driven panel type which are revertively controlled by a register-controller, set in accordance with trains of impulses created by the operation of the dial at any calling subscriber's station to which the register-controller is connected.

The impulse receiving means IR in Fig. 1, comprises two impulse relays 13 and 16, a condenser 15, a resistor 14, a slow-to-release relay 17 and a register or selector 18. Upon connection of the line 11 with the impulse receiving means IR, the windings of relays 13 and 16 are connected in series in a signaling circuit which includes the line 11, dial 10 at station A, and one winding of the dial tone transformer 12. The impulse relays 13 and 16 are operated by the current in this circuit and upon operation of the dial 10 are alternately released and reoperated under the control of the dial contacts. Relay 17 is operated when relay 16 operates, upon connection of the line to the impulse receiving means IR, and being slow in releasing remains operated while the impulses created by the operation of dial 10 are being received by relays 13 and 16. With relay 17 operated, each release of relay 16 is effective to cause a corresponding operation of the impulse register or selector 18.

In order to insure the operative response of the register or selector 18 under varying conditions of line resistance, line insulation and impulse frequency, relay 16 is capable of releasing upon opening of the signaling circuit at the dial contacts when connected to a line having the lowest allowable insulation resistance and to insure the closure of its back contact for an interval sufficient to operate the register or selector in response to each dial impulse; and relay 13 is more easily operated than is relay 16 and affords sufficient closure of its front contact when in series with the longest line to which it may be connected. It is the function of the auxiliary impulse relay 13, in combination with condenser 15, to aid the operation of relay 16 and thus insure sufficient and reliable closure of the front contact of relay 16. Condenser 15 is normally connected in a closed circuit through the back contact of relay 13 in series with resistor 14 and is, therefore, not normally charged. Upon operation of relay 13, the condenser is connected in parallel with the line 11, the current through the windings of relays 13 and 16 being thereby increased to charge the condenser. This charging current is effective to aid the operation of relay 16, so that in spite of being adjusted so as to be certain to release when in series with a line of the lowest allowable insulation resistance, it will, nevertheless, be operated upon closure of the signaling circuit over a line of maximum length. This charging current is also effective for a short interval to prevent the release of relay 16 and thus insure that the contacts of this relay remain in their operated position long enough to insure satisfactory operation of the register or selector 18. When relay 13 releases, condenser 15 discharges through resistor 14.

If the current in the signaling circuit is of sufficient strength and duration to afford adequate closure of the front contact of relay 16 without the aid of the condenser charging current, no harm is done by the latter current since the charging of the condenser is concurrent with the dial closure and is effective for no longer a period than a dial closure of sufficient length would be. Under severe release conditions, relay 13 may not release during the time the signaling circuit is open at the dial contacts; but, in such a case, release of relay 16 will be delayed due to these same conditions, and the closure of the front contact of relay 16 will be sufficient without the aid of relay 13 and condenser 15.

If the resistor 14 is low enough in resistance, condenser 15 is fully discharged on the shortest back contact closure of relay 13, which shortest closure occurs at the highest impulse frequency; and, in this case, the maximum condenser charging current will be impressed upon relay 16 at all impulse frequencies, and the effect of the charging current will be more pronounced at high impulse frequencies than at low impulse frequencies. By employing a resistor 14 which permits the condenser to be completely discharged only at the lowest impulse frequency, the strength of the condenser charging current will be automatically regulated so as to have substantially the same relative effect at all impulse frequencies.

The impulse receiving circuit arrangement IR shown in Fig. 2, comprises two impulse relays 23 and 26 (which are similar to relays 13 and 16 of Fig. 1 except that each has two windings), the condenser 25, resistor 24, slow-to-release relay 27, and register or selector 28. The upper winding of each of relays 23 and 26 is connected in series in the signaling circuit over line 11 and the lower winding of each of these relays is connected in series to the front contact of relay 23. Relay 26 is adjusted so as to release under the most severe release condition; and relay 23 is adjusted so as to operate under the most severe operate condition. Condenser 25, normally discharged through resistor 24, is charged upon operation of relay 23, the charging current being effective to aid the operation of relay 26 and hold this relay operated for an interval sufficient to insure operation of the register or selector 28 in response to each dial impulse.

The impulse receiving circuit arrangement IR shown in Fig. 3 comprises the impulse relays 33 and 36, condenser 35, resistors 34 and 40, slow-to-release relay 37, and register or selector 38. Relays 33 and 36 are similar in function to relays 13 and 16 of Fig. 1 and to relays 23 and 26 of Fig. 2. Each of relays 33 and 36 is a polarized relay and has three windings. The upper winding of each of these relays is connected in series in a local circuit to bias the contacts, these biasing windings being the equivalent of biasing springs. The middle windings of the two impulse relays are connected in series in the signaling circuit over line 11, relay 36 being adjusted, by regulation of its biasing winding current, to release under the most severe release condition and relay 33 being adjusted to operate under the most severe operate condition. If the biasing windings of relays 33 and 36 are identical, the desired difference in adjustment

between the two may be secured by connecting a resistor 39 in parallel with the winding of relay 33, as shown in the drawing.

The lower windings of relays 33 and 36 are so connected in series with condenser 35 and resistors 34 and 40 that condenser 35 aids the energization of relay 36 upon the closing of the signaling circuit over line 11 and aids the de-energization of relay 33 upon opening of the signaling circuit over line 11. Upon connection of a calling line to the impulse receiving means, ground is connected to the armature of relay 33 and the biasing circuit through the upper windings of relays 33 and 36 is closed. Relays 33 and 36 are both operated due to the energization of their middle windings in series with line 11. The operation of relay 33 causes the operation of the slow-to-release relay 37; and, with relay 36 operated, condenser 35 is charged in a circuit from negative battery through resistor 34, lower winding of relay 33, condenser 35, lower winding of relay 36, and through the front contact of relay 36 to ground. Whatever effect condenser 35 has at this time is of no importance, and relays 33 and 36 remain operated until the dial is operated. At the first opening of the signaling circuit at the contacts of dial 10, relay 36 begins to release, the opening of the front contacts of relay 36 rendering effective a circuit for discharging condenser 35; this circuit is traced from negative battery through resistor 34, lower winding of relay 33, condenser 35, lower winding of relay 36, and through resistor 40 to negative battery. The current in this circuit is in a direction which aids the complete release of relay 36 and also aids the release of relay 33. When relay 33 closes its back contact, a circuit is closed from ground thereat through the lower winding of relay 33, condenser 35, lower winding of relay 36, resistor 40 to negative battery and the condenser discharge current through the lower windings of relays 33 and 36 is thereby continued in the same direction to charge condenser 35 in the opposite direction; this current is effective to insure that relays 33 and 36 remain released long enough for the operation of register 38. When the signaling circuit is again closed at the dial contacts, at the end of the first impulse, relay 33 is the first to break its back contact, the aforementioned circuit for discharging condenser 35 thereby again becoming effective, the discharge current through the lower windings of relays 33 and 36 now being in a direction to aid the complete operation of relay 33 and the operation of relay 36. As soon as relay 36 closes its front contact, the current through the lower windings of relays 33 and 36 continues in the same direction to again charge condenser 35 in the direction that it was charged prior to the first dial impulse. This charging current is effective to insure that relays 33 and 36 remain operated long enough to hold relay 37 operated and long enough for the release of the register magnet.

This cycle of operations is repeated in response to each dial impulse, the condenser 35 being charged first in one direction and then in another, the current which aids the release and re-operation of the impulse relays resulting from a change in potential equal to twice the battery voltage. Thus a very efficient impulse receiving circuit is obtained, the condenser being effective to aid the release of the impulse relays upon the opening of the signaling circuit and insure that they remain released for a definite interval of time, and to aid the operation of the impulse relays upon the closing of the signaling circuit and insure that they remain operated for a definite minimum interval of time. This arrangement is not only a sensitive impulse receiving arrangement but also one which is adapted to correct for too short an opening of the impulse circuit and to correct for too short a closing of the impulse circuit between succeeding impulses of a train.

What is claimed is:

1. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being more easily operated than said second relay, and a circuit adapted to aid the operation of said second relay.

2. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being more easily held operated than said second relay, and a circuit adapted to aid the release of said first relay.

3. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being more easily operated than said second relay, and a condenser adapted to aid the operation of said second relay.

4. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being more easily held operated than said second relay, and a condenser adapted to aid the release of said first relay.

5. In a signaling system, a line, a signal sender, a signal receiving relay, a signaling circuit comprising said line and sender and a winding of said relay, the closing of said circuit being effective to cause the operation of said relay, and circuit means not included in said signaling circuit but rendered effective in response to the closing of said signaling circuit for aiding the operation of said relay.

6. In a signaling system, a line, a signal sender, a signal receiving relay, a signaling circuit comprising said line and sender and a winding of said relay, the opening of said circuit being effective to cause the release of said relay, and circuit means not included in said signaling circuit but rendered effective in response to the opening of said signaling circuit for aiding the release of said relay.

7. In a signaling system, a line, a signal sender, a signal receiving relay, a signaling circuit comprising said line and sender and a winding of said relay, and means comprising a condenser for aiding the operation of said relay in response to the closing of said circuit.

8. In a signaling system, a line, a signal sender, a signal receiving relay, a signaling circuit comprising said line and sender and a winding of said relay, and means comprising a condenser for aiding the release of said relay in response to the opening of said circuit.

9. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and one winding of each of said relays, said first relay being operable by a smaller current in said circuit than

that required for operating said second relay, a condenser, a circuit including said condenser and another winding of each of said relays effective upon release of said first relay to charge said condenser in one direction, and another circuit including said condenser and said other windings of said relays effective upon operation of said second relay to charge said condenser in the other direction.

10. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and one winding of each of said relays, said first relay being operable by a smaller current in said circuit than that required for operating said second relay, a condenser, a circuit including said condenser and another winding of each of said relays and normally closed contacts of said first relay, and another circuit including said condenser and said other winding of each of said relays and normally open contacts of said second relay.

11. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being more easily operated and more easily held operated than said second relay, and a circuit for aiding the operation of said second relay and for aiding the release of said first relay.

12. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being more easily operated and more easily held operated than said second relay, a condenser, and a circuit including said condenser for aiding the operation of said second relay and for aiding the release of said first relay.

13. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being more easily operated and more easily held operated than said second relay, and a circuit rendered effective by the operation of said first relay for aiding the operation of said second relay and rendered effective by the release of said second relay for aiding the release of said first relay.

14. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being more easily operated and more easily held operated than said second relay, a condenser, and a circuit including said condenser for aiding the operation of said second relay in response to the closing of said signaling circuit and for aiding the release of said first relay in response to the opening of said signaling circuit.

15. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit including said line and sender and a winding of each of said relays, said first relay being more easily operated and more easily held operated than said second relay, a circuit closed by the operation of said second relay in response to the closing of said signaling circuit for preventing the release of said second relay for a short interval of time, and a circuit closed by the release of said first relay in response to the opening of said signaling circuit for preventing the reoperation of said first relay for a short interval of time.

16. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit including said line and sender and a winding of each of said relays, a condenser, a circuit including said condenser closed by the operation of said second relay for holding said second relay operated for a short interval of time, and a circuit including said condenser closed by the release of said first relay for holding said first relay released for a short interval of time.

17. In a signaling system, a line, a signal sender, a signal receiving relay, a signaling circuit including said line and sender and a winding of said relay, a condenser, a circuit including said condenser rendered effective in response to the closing of said signaling circuit for aiding the operation of said relay, and a circuit including said condenser closed by the operation of said relay for holding said relay operated for a short interval of time.

18. In a signaling system, a line, a signal sender, a signal receiving relay, a signaling circuit including said line and sender and a winding of said relay, a condenser, a circuit including said condenser rendered effective in response to the opening of said signaling circuit for aiding the release of said relay, and a circuit including said condenser closed by the release of said relay for holding said relay released for a short interval of time.

19. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being operable by a smaller current in said circuit than that required for operating said second relay, a condenser, a circuit including said condenser and a winding of each of said relays rendered effective by the operation of said first relay, and another circuit including said condenser and said windings closed by the release of said first relay.

20. In a signaling system, a line, a signal sender, two polarized signal receiving relays, one of said relays being more easily operated and more easily held operated than the other, a signaling circuit including said line and sender and one winding of each of said relays, a circuit including a second winding of each of said relays for biasing each of said relays, a condenser, a circuit including said condenser and a third winding of each of said relays rendered effective by the operation of said one of the relays in response to the closing of said signaling circuit for aiding the operation of the other of the relays and rendered effective by the release of said other of the relays in response to the opening of said signaling circuit for aiding the release of said one of the relays, a circuit including said condenser and said third winding of each of said relays closed by the operation of said other of the relays for holding said other of the relays operated for a short interval of time, a circuit including said condenser and said third winding of each of said relays closed by the release of said one of the relays for holding said one of the relays released for a short interval of time, and a register controlled by said signal receiving relays to register the impulses created by the operation of said signal sender.

21. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and one winding of each of said relays, said first relay being operable by a smaller current in said circuit

than that required for operating said second relay, a condenser, a circuit including said condenser and another winding of each of said relays effective upon release of said first relay to charge said condenser in one direction, another circuit including said condenser and said other windings of said relays effective upon operation of said second relay to charge said condenser in the other direction, and a third circuit including said condenser and said other windings.

22. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and one winding of each of said relays, said first relay beng operable by a smaller current in said circuit than that required for operating said second relay, a condenser, a circuit including said condenser and another winding of each of said relays and normally closed contacts of said first relay, another circuit including said condenser and said other winding of each of said relays and normally open contacts of said second relay, and a third circuit including said condenser and said other windings of the relays.

23. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit including said line and sender and a winding of each of said relays, said first relay being more easily operated and more easily held operated than said second relay, a circuit rendered effective by the operation of said first relay for aiding the operation of said second relay and rendered effective by the release of said second relay for aiding the release of said first relay, a circuit closed by the operation of said second relay in response to the closing of said signaling circuit for preventing the release of said second relay for a short interval of time, and a circuit closed by the release of said first relay in response to the opening of said signaling circuit for preventing the reoperation of said first relay for a short interval of time.

24. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit including said line and sender and a winding of each of said relays, a condenser, a circuit including said condenser rendered effective by the operation of said first relay for aiding the operation of said second relay and rendered effective by the release of said second relay for aiding the release of said first relay, a circuit including said condenser closed by the operation of said second relay for holding said second relay operated for a short interval of time, and a circuit including said condenser closed by the release of said first relay for holding said first relay released for a short interval of time.

25. In a signaling system, a line, a signal sender, a first relay, a second relay, a signaling circuit comprising said line and sender and a winding of each of said relays, said first relay being operable by a smaller current in said circuit than that required for operating said second relay, a condenser, a circuit including said condenser and a winding of each of said relays rendered effective by the release of said second relay, and another circuit including said condenser and said windings closed by the operation of said second relay.

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