April 16, 1929. H. S. BLACK 1,709,554

VOICE FREQUENCY CALLING SYSTEM

Filed July 20, 1927

FIG. 1.

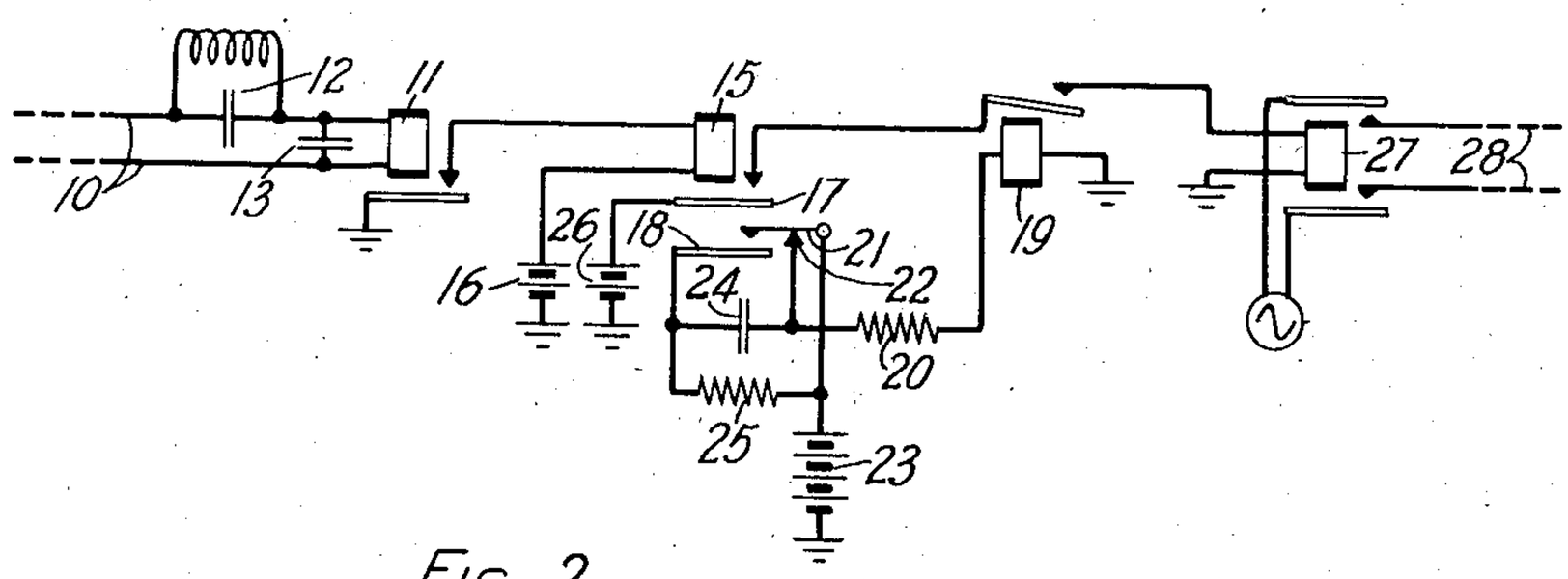

FIG. 2.

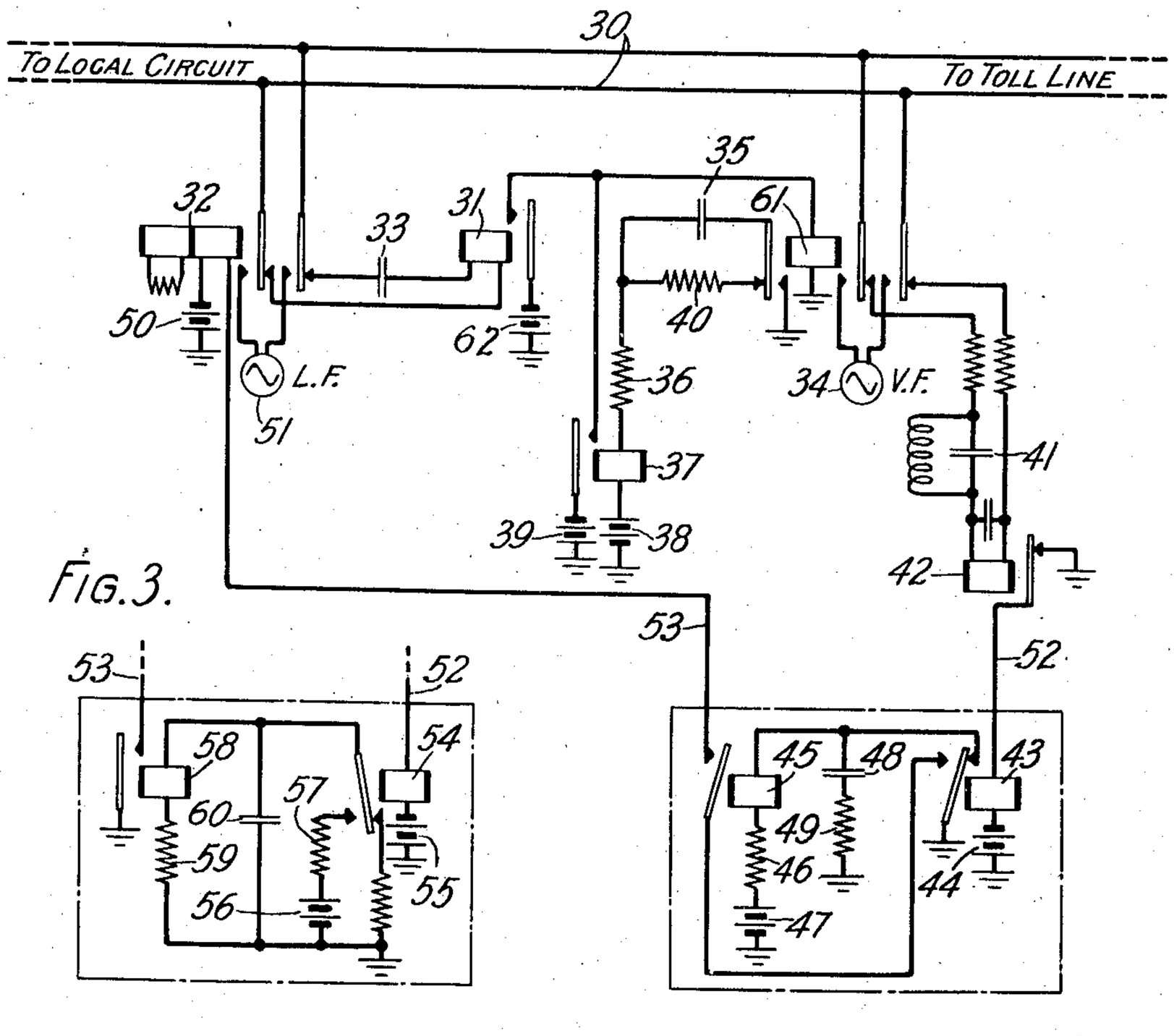

FIG. 3.

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VOICE-FREQUENCY CALLING SYSTEM.

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This invention relates to circuits for differentiating between waves of different durations, and particularly to voice frequency calling or ringing circuits for telephone systems.

An object of the invention is to differentiate between waves of different durations.

In systems, such as carrier telephone systems and those employing voice frequency toll lines and using the lower frequency range for telegraph transmission, it is often desirable to employ voice frequency waves for calling or signaling. It is therefore necessary that the calling apparatus should differentiate between the calling waves and voice waves of the same frequency.

In a specific preferred embodiment of this invention a relay is operated by voice frequency waves in a telephone line to open a direct connection between the battery and the winding of a second relay. However, there is provided in parallel with the direct connection a path comprising a condenser and a resistance in series so that the second relay is maintained in its operated position by the current through the condenser during the charging period, the length of which is determined by the relative values of the capacity and resistance of the circuit. This period is made of such length that if the operating waves are voice waves the first relay will release before the condenser becomes charged and the direct connection to the winding of the second relay will be restored, while if the operating waves are calling waves, which are maintained for a time relatively long compared to the time of a given frequency voice wave, the condenser will become charged and the second relay will release before the first is released. Thus, the second relay will respond to the action of calling waves on the first relay, but not to the action of voice waves.

With the arrangement of this invention the condenser is caused to discharge through a resistance of very low value so that even when the waves impressed on the first relay are interrupted for a very short interval the condenser will completely discharge with the result that when the relay is again operated the process of charging must be entirely repeated. Thus, the circuit is prevented from being operated by a rapid succession of waves of short duration.

In order that the calling current will be impresesed on the line for at least a definite predetermined time independent of the time the operator presses her ringing key, both a main and an auxiliary transmitting relay are provided and a condenser is connected in series with the winding of the auxiliary relay. The action of the operator closes a circuit of the main relay which impresses the calling wave on the line and closes the circuit of the auxiliary relay which makes a parallel operating connection to the circuit of the main relay. This arrangement assures that the main relay will be operated for at least as long as the charging period of the condenser.

The invention is illustrated in the accompanying drawing in which:

Fig. 1 shows diagrammatically one embodiment thereof in the receiving apparatus for a voice frequency calling circuit;

Fig. 2 shows diagrammatically an embodiment in a complete transmitting and receiving arrangement for a voice frequency calling circuit; and

Fig. 3 shows diagrammatically a modification of the circuit of Fig. 2.

Referring to Fig. 1 there is shown a line 10 adapted to be connected to a signaling system such as a telephone system over which are transmitted calling currents of the same frequency range as the signaling or voice currents. This line is connected to the winding of an alternating current relay 11 through a filter comprising an anti-resonant circuit 12 in the series arm and a condenser 13 in the shunt arm. This filter acts to attenuate waves of frequencies other than those employed as calling currents. When the relay is operated a connection is made from ground through its armature, winding of relay 15, battery 16 to ground. The relay 15 is provided with two armatures 17 and 18. The armature 18 is arranged in circuit with the winding of a third relay 19 so that whenever the relay 15 is operated for at least a

definite time interval relay 19 will release.

Ordinarily relay 19 is maintained operated through the circuit from ground through winding of relay 19, resistance 20, arm 21 and contact 22 of relay 15, battery 23 to ground. When relay 15 is operated the armature is brought up, breaking the contact between arm 21 and contact 22 and making a contact between the arm 21 and the armature 18 so that the above circuit through the winding of the relay 19 is broken and a circuit is made from ground through winding of relay 19, resistance 20, condenser 24, armature 18, arm 21 and battery 23 to ground. Thus, the relay 19 will remain operated for a definite period of time after the relay 15 is operated. The time required for the current through the condenser to fall below that required to operate a definite relay is determined by the charging period of the condenser 24, which is controlled by the capacity of the condenser, and the resistance of the circuit (primarily the resistance of the element 20). When the relay 15 releases the condenser 24 discharges through the resistance element 25 which may be designed to have a very low resistance as it need only be high enough to prevent the relay contacts from burning while the condenser discharges. If the relay 15 remains operated for a time longer than the charging period of the condenser 24 the relay 19 will release making a connection from ground through battery 26, armature 17, armature of relay 19 and winding of relay 27, causing the operation of the relay 27 and making a connection to the circuit 28 to give an indication that calling signals are being impressed on the line 10.

Thus when waves of short duration such as voice waves are impressed on the relay 11 from line 10, the relay 15 will be operated, but will release before the relay 19 releases. However, when calling currents which persist for a definite period of time longer than the charging time of the condenser 24, are impressed upon the relay 11, the relay 15 will remain operated for a sufficient length of time to cause the release of the relay 19, thus operating relay 27 and giving an indication in the circuit 28. The resistance of the element 25 is made very low so that the condenser 24 will completely discharge even when the operation of relay 15 is interrupted for a very short interval, thus preventing the action of a rapid succession of waves of short duration from building up the condenser charge to such a point that the relay 19 will release.

Referring to Fig. 2, there is shown a line 30 connecting a local circuit to a toll line. Ordinarily low frequency ringing currents impressed upon the local circuit by the operator actuate the relay 31 through the armature of relay 32 and condenser 33. The operation of relay 31 makes a connection from battery 62 through the armature of relay 31, winding of relay 61 to ground, causing the operation of relay 61 and impressing voice frequency calling currents from the source 34 upon the line 30 through the right-hand armatures and contacts of relay 61. The operation of relay 61 also closes a connection from ground through the left-hand armature of relay 61, condenser 35, resistance 36, winding of relay 37 and battery 38 to ground, operating relay 37 and making in parallel with the connection through the armature of relay 31 a holding connection from ground through battery 39, armature of relay 37, winding of relay 61 to ground, so that the relay 33 will be held in the operated position as long as the relay 37 is operated, which in turn will remain operated for the charging period of the condenser 35. Therefore, voice frequency calling current will be impressed on the toll line for a period at least as long as the charging period of the condenser 35. When the relays are released condenser 35 discharges through the resistance 40.

The voice frequency calling current from the source 34 is of a comparatively low level and therefore will produce no undesirable disturbance in the local circuit.

Voice frequency calling signals from the toll line e. g. of 500 cycles are transmitted through the right-hand armatures of relay 61 (when in the released position) and filter network 41 to the winding of relay 42, which is so arranged as to normally complete a circuit from ground through armature of relay 42, winding of relay 43, battery 44 to ground. Relay 43 in turn is arranged so that it is thus normally operated, making a connection from the ground through its armature and right-hand contact, winding of relay 45, resistance 46, battery 47, to ground. However, when the relay 42 is operated by the voice frequency calling currents relay 43 releases opening this circuit through the winding of relay 45. However, the circuit from the ground through battery 47, resistance 46, winding of relay 45, condenser 48, and resistance 49 to ground is not broken, so that the relay 45 will remain operated for the charging period of the condenser 48 in a similar manner as in the circuit arrangement of Fig. 1. However, if the currents which operate the relay 42 persist for a longer time than the charging period of the condenser 48, relay 45 will release, closing a connection from ground through armature and left-hand contact of relay 43, armature of relay 45, winding of relay 32, battery 50 to ground, causing the operation of relay 32 and making a connection from the source of low frequency ringing current 51 through the armatures of relay 32 to the local circuit.

Fig. 3 shows a modification of the boxed in portion of the circuit of Fig. 2, the corresponding connections to the remainder of

the circuit being numbered 52 and 53 respectively in each figure. In this arrangement the relay 54 is normally maintained operated by the connection from ground through the armature of relay 42, connection 52, winding of relay 54, battery 55 to ground. However, when the relay 42 is operated this connection is broken and the relay 54 releases, closing a connection from battery 56 through resistance 57, left-hand contact and armature of relay 54, winding of relay 58, and resistance 59. However, since the winding of relay 58 and resistance 59 are shunted by condenser 60 relay 58 will not operate immediately. This parallel circuit has practically the same time constant as would a circuit of infinite inductance in that at first the current practically all passes through the condenser 60 with no current through the relay while as the condenser begins to charge, the relay current builds up slowly. After a definite predetemined interval sufficient current will flow through the winding of relay 58 to cause its operation, closing the circuit from ground through the armature of relay 58, connection 53, winding of relay 32 and battery 50 to ground. This interval is so determined, by proportioning the impedances of the elements of the circuit, that the relay 58 will not be operated by ordinary signaling currents but only by the voice frequency calling currents which persist for a definite period.

The invention may advantageously be used on telephone toll lines or carrier and radio systems, a feature being that ringing currents of low strength or amplitude may be used, comparable to the strength of the telephone currents themselves. These low strength currents are readily transmitted by the vacuum tube repeaters of a toll line and by the repeaters and terminal circuits of a carrier or radio channel. It is to be understood that the sending circuits illustrated in the drawings may be connected either to voice frequency lines or to carrier or radio channel apparatus for modulating carrier waves, and similarly the receiving circuits may be actuated directly by waves from a telephone transmission line or by waves resulting from detection of modulated waves sent over a carrier or radio channel. The claims are intended to apply both to transmission at the signaling frequency level and to transmission by means of a carrier wave as in rado or carrier systems.

What is claimed is:

1. In combination, a line adapted for transmitting waves of short duration and waves of relatively long duration both of the same frequency range, a relay connected thereto and responsive to waves of said frequency range, a source of energy, a second relay connected to said source and controlled by said first relay, and a condenser in circuit with said second relay to prevent actuation of said second relay during the transmission of said waves of short duration.

2. In combination, a line adapted to transmit waves of short duration and waves of relative long duration both of the same frequency range, a relay responsive to waves of said frequency range, a second relay controlled by said first relay, and means for preventing the actuation of said second relay except by waves which persist uninterrupted for at least a definite period, said means comprising a condenser connected in circuit with the winding of said second relay by the operation of said first relay and a path of low resistance through which said condenser discharges upon the interruption of the operation of said first relay.

3. In combination, a line adapted to transmit waves of short duration and waves of relatively long duration both of the same frequency range, a relay responsive to waves of said frequency range, a second relay to be operated only by said waves of long duration, a source of current, a normally closed contact connecting said source to the winding of said second relay and opened by the action of said first relay, connections including a series condenser for supplying current to the winding of said second relay whereby on the opening of said contact said second relay will remain operated for the charging period of said condenser.

4. In combination, a telephone line, means for transmitting voice frequency calling signals thereover, a relay responsive to said signals, an armature and associated contact for said relay, a second relay having a winding, an armature and an associate contact, connections for normally supplying operating current to the winding of said second relay whereby after the response of said first relay to waves in said line, the second relay is held operated for the charging time of said condenser, to prevent said second relay from being responsive to waves of short duration.

5. In combination, a line, a source of waves, a main relay for connecting said source to the line, means for operating said relay, an auxiliary relay for maintaining the operation of said main relay, a winding for said auxiliary relay, a source of direct current, a condenser, and means actuated by said main relay for connecting said direct current source to the winding of said auxiliary relay in series with said condenser whereby said auxiliary relay is maintained operated for the charging period of said condenser, to maintain the operation of said main relay for a period of time at least as long as the charging period of the condenser.

6. In combination, a line adapted for transmitting waves of short duration and waves of relatively long duration both of the same frequency range, a relay connected thereto and responsive to waves of said frequency

range, a source of energy, a second relay connected to said source, a condenser connected in circuit with said second relay, and means controlled by said first relay to control said second relay and start charging of said condenser and to render actuation of said second relay dependent upon substantially complete charging of said condenser and prevent actuation of said second relay during the transmission of said waves of short duration.

In witness whereof I hereunto subscribe my name this 18th day of July, A. D., 1927.

HAROLD S. BLACK.