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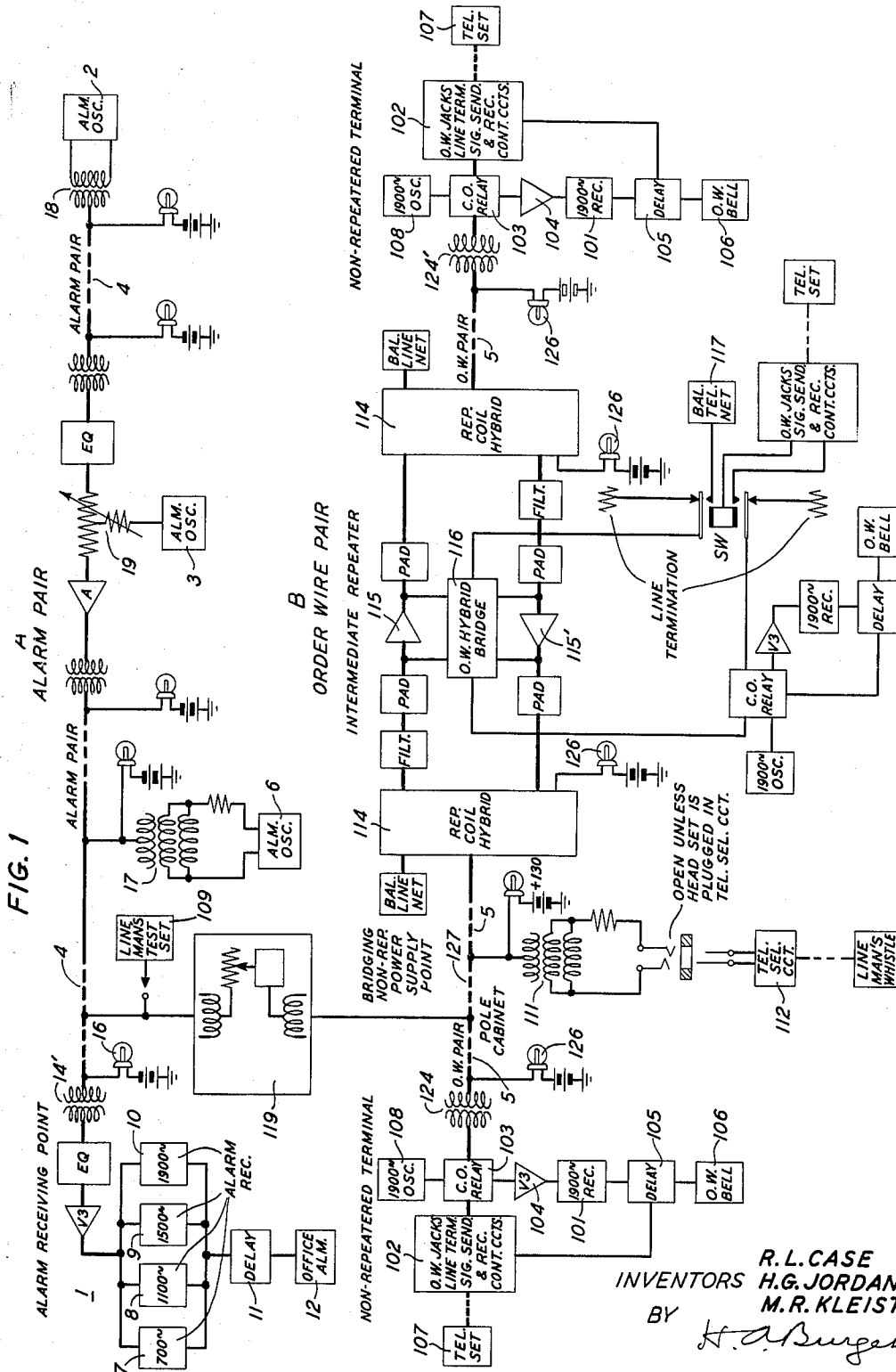
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2,730,579

ORDER WIRE AND ALARM CIRCUITS FOR CARRIER SYSTEMS

Filed Nov. 25, 1950

3 Sheets-Sheet 1



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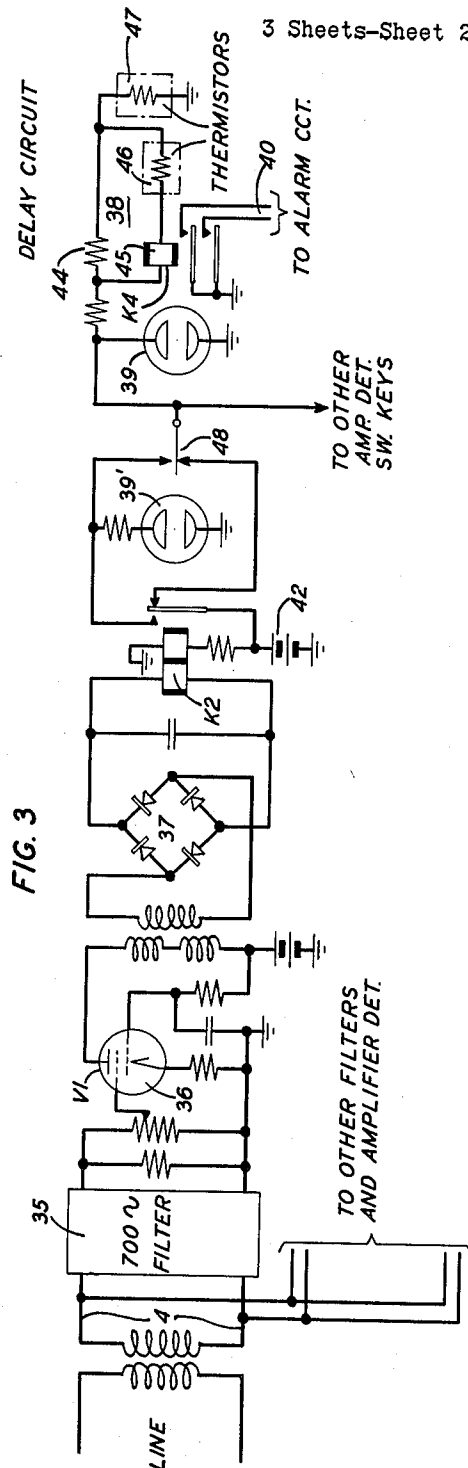
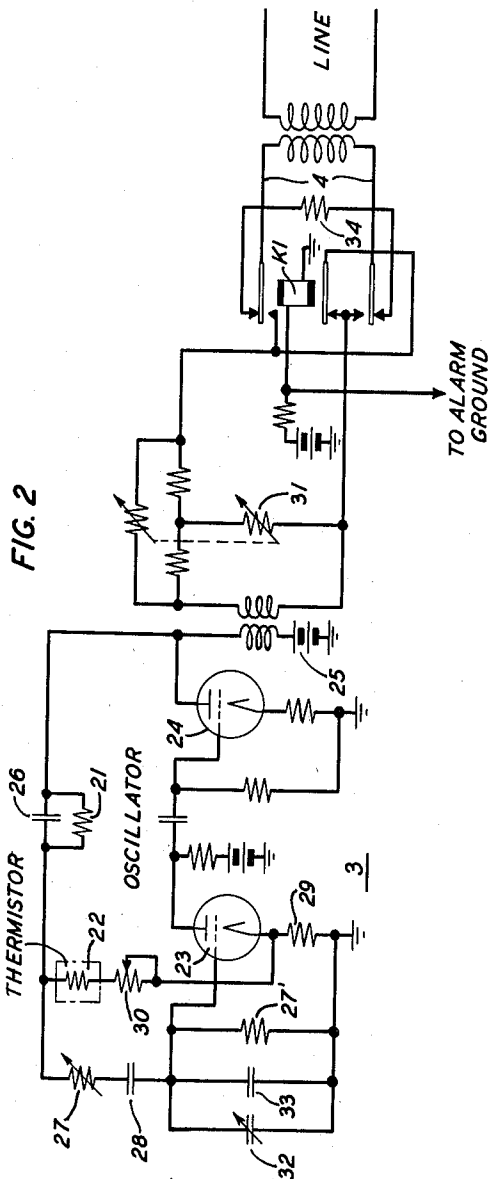
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3 Sheets-Sheet 2



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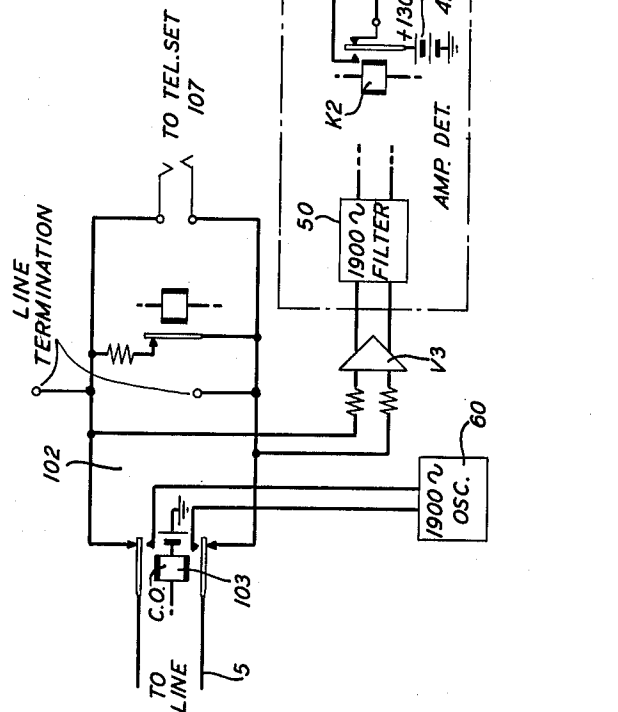
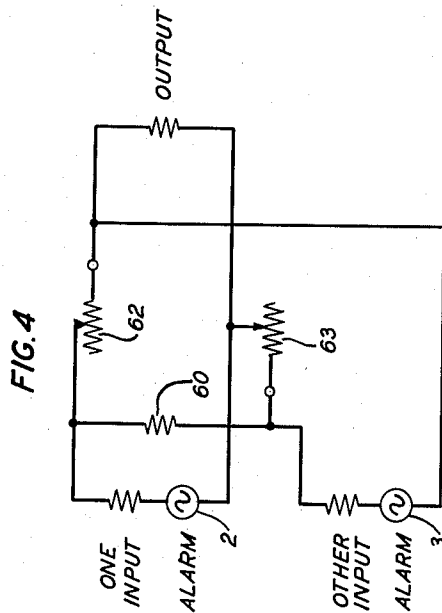
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ORDER WIRE AND ALARM CIRCUITS FOR CARRIER SYSTEMS

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3 Sheets-Sheet 3



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ORDER WIRE AND ALARM CIRCUITS FOR CARRIER SYSTEMS

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Application November 25, 1950, Serial No. 197,592

10 Claims. (Cl. 179—175.3)

This invention relates to signaling systems and, more particularly, to order wire and alarm circuits associated with speech transmission systems for the maintenance thereof.

An object of the invention is to provide for the simultaneous transmission of alarm tones from several stations along a speech transmission system and to receive them at a common station, where a particular alarm tone may be identified.

Another object of the invention is to provide a common delay interval in the reception of plural alarm tones to prevent the false operation of the alarm by momentary power failures, lightning disturbances, or other momentary shorts or opens on the line.

A feature of the invention is an alarm receiving station having individual alarm tone filters feeding into a common delay circuit for preventing the false operation of the alarm by momentary power failures, lightning disturbances, or other momentary shorts or opens of the line.

Another feature of the invention is a resistance loss hybrid circuit for applying the alarm tones to a transmission line at spaced points thereof and with controllable levels, whereby the amplitudes of the alarm tones at a spaced point along the line may be equal.

Another feature of the invention is a delay network comprising a pair of thermistors operating in time sequence to prevent false operation of an alarm circuit.

Another feature of the invention is an RC type of alarm oscillator having a thermistor and starting circuit for initiating oscillations, positive feedback for maintaining the oscillations, and negative feedback for stabilizing the oscillator.

In accordance with one embodiment of the invention, an alarm circuit is provided comprising a plurality of tone frequency oscillators providing alarms in the voice frequency band and coupled to a voice frequency transmission medium by variable resistance loss hybrids. At an alarm receiving station, the alarm tones are selectively filtered and detected in separate receivers. A delay circuit common to all the receivers prevents the false operation of the alarm by momentary shorts or opens of the line.

An auxiliary part of the invention comprises an order wire circuit with provision for signaling with a 1900-cycle oscillator or by a special 1900-cycle whistle. A suitable 1900-cycle signaling receiving arrangement is provided somewhat similar to the 1900-cycle alarm tone receiving arrangement with a similar delay circuit having a sufficient delay time to prevent false operation by speech currents, transient disturbances, or other short noise peak currents but at the same time allowing easy operation by the signaling tone.

Referring to the figures of the drawing:

Figs. 1A and 1B show a block schematic of an order wire and alarm system in accordance with the invention;

Fig. 2 shows an alarm tone oscillator coupled to a voice frequency transmission line;

Fig. 3 shows a receiving station for alarm tones and the

2

common delay circuit for preventing false operation of the alarm;

Fig. 4 shows the adjustable resistance hybrid coupling network; and

Fig. 5 shows a receiver for a single tone with a modified form of delay circuit providing an arrangement suitable for signaling on the order wire.

The order wire and alarm circuit of Figs. 1A and 1B are illustratively shown applied to a voice frequency loaded quad for maintaining a multichannel carrier telephone system of the type disclosed in the United States patent application of R. S. Caruthers, Serial No. 176,036, filed July 26, 1950, which issued as United States Patent 2,695,332, November 23, 1954.

Such a multichannel carrier telephone system is suitable for short-haul use on toll and exchange cables. For directional separation of transmissions, it utilizes two conductor pairs, which can be located in a single cable.

In the order wire and alarm system designed for the above-mentioned carrier telephone system, there is provided for this use additionally two pairs of conductors, which are contained in the same single cable as the carrier pairs. The principal purposes of the order wire and alarm system are to supply power for testing the carrier repeaters, to provide an alarm system for indicating trouble at remote points, and to provide circuits for talking and maintenance.

Referring to Fig. 1A, the order wire and alarm system shown therein operates over two pairs, wherein one pair 4 is devoted to the transmission of voice frequency alarm tones, and the other pair 5 is devoted to order wire use. In signaling over the order wire pair 5, a separate oscillator 108 and receiver 101 operate at a frequency of one of the alarm tones, for example, the 1900-cycle tone, and talking over the order wire may take place at either a powered or non-powered repeater point.

The alarm signaling over pair 4 is designed to receive at a desired maintenance point an individual alarm indication from each power supply point. This is accomplished by a plurality of alarm oscillators 2, 3, 6, etc., each one normally applying an audible tone to the line 4 to denote normal operation of the carrier system. Abnormal conditions, such as power supply failure, a blown fuse, or the like, result in "tone off" or the absence of the tone at a remote receiving station 1, which actuates an alarm.

The alarm circuit is designed for four tones spaced 400 cycles apart, for example, 700 cycles, 1100 cycles, 1500 cycles, 1900 cycles, transmitted over the alarm side 4 of the line and applied thereto by the alarm oscillators, respectively, 2, 3, 6, etc., each oscillator being assigned a different frequency for transmission of its alarm indication. The normal operating condition is characterized by steady transmission of tone toward the alarm receiving station 1.

An alarm oscillator 2 of the proper power is applied at the non-repeated terminal at the right of Fig. 1A, the oscillator output impedance 18 terminating the line. At an intermediate repeater point, an alarm oscillator 3 is applied through a variable resistance hybrid attenuator 19 to the input of a line amplifier. This resistance hybrid attenuator is arranged so that when the loss is increased between the alarm oscillator and the amplifier, the loss is simultaneously decreased between the amplifier and the equalizer. By this means, the local alarm tone may be made equal in power at the amplifier input to each of the alarm tones coming in over the line from the right. The purpose of the equalizer is to equalize the line section to the right so that the alarm tones coming in over the line from the right will all be of equal power at the output of the equalizer.

An alarm oscillator 6 is also shown applied to the

3

alarm line at a non-repeated power bridging point. Here, the repeating coil ratio together with the series resistance and oscillator impedance is such that the bridging loss 17 to the through line is small. The local alarm oscillator output is applied at such an output power that its resulting power on the line is the same as that of the other tones at this point. Should the alarm oscillator be removed at this point to indicate an alarm, an alarm equivalent impedance (600 ohms) is connected in place of the oscillator so as to keep the line section loss the same to the other tones as though the local oscillator were present and thus maintain proper release operating margins at the alarm receiving point. This same principle of substituting an equivalent impedance for the oscillator when it is removed from the line is applied to every alarm point.

At the alarm receiving point, the preceding line section is equalized so as to make all the tones of equal amplitude at the amplifier input, the tones are amplified by the V3 amplifier and applied to the alarm receiving circuits in parallel. Each alarm receiving circuit is adjusted by means of a gain control in the input of an individual amplifier so that a fixed input power gives a fixed relay operating current in the amplifier detector output circuit.

The receiving circuit selects a particular tone by a filter, amplifies and detects the tone to hold a relay operated. Thus, at the alarm receiving station 1, receivers 7, 8, 9, and 10 are shown corresponding to each tone. Each individual receiver for a given tone has a different filter at its input designed to pass the particular frequency of its associated alarm oscillator. A delay circuit 11 common to the tone receivers provides a time delay interval in the operation of a polar relay and alarm 12 to preclude false operation by lightning disturbances or other momentary extraneous shorts or opens of the line. An incoming alarm, characterized by absence of tone, releases the relay to actuate alarm 12.

General description of order wire circuits power supply

Direct-current voltage at +130 volts is supplied to the simplex of the order wire pair 5 and at -130 volts to the simplex of the alarm pair 4 at each point along the multichannel carrier telephone route where power is available. The direct-current power is applied to the mid-point of line repeating coils 124, 124' or by repeating coil hybrids 114 according as the point is a line terminal or voice repeater point. At other power supply points, the power is supplied to the simplex of a high inductance bridge repeating coil with the drop side normally open so as to have a negligible effect on the characteristic line impedance. Lamps 126 are used in the simplex leads to provide an adequate degree of protection with minimum resistance.

At non-power supply points, such as pole cabinets 127, the repeater switching set 119, which is used in testing the repeaters of the multichannel carrier systems, derives the necessary power for its operation by a pair bridged across the order wire and alarm pairs. The switching set contains in itself high inductance coils with a simplex tap which are bridged across the alarm and order wire pairs to derive the simplex voltage and at the same time to leave the transmission characteristics of the lines practically unaffected. Thus, the expense of coils at every pole point is eliminated, and the lines are free from shunt bridges unless a switching set is actually being used. Series resistances are provided at the non-power point and may be adjusted to give the proper voltage for the switching set. Due to the nature of the circuit, power comes from more than one point so that all the simplex voltages must be applied before any voltage adjustment is made at a particular non-power point.

Non-repeated terminal

The circuit 102 at the order wire jacks is normally terminated to keep any voice repeaters on the line from

4

singing, the circuit details being shown in greater elaboration in Fig. 5. Assume an incoming ring. The 1900-cycle signaling receiving circuit 101 is bridged across the line on the drop side of the cut-off relay contacts 103. The connection is high impedance so that it causes only a small loss to through transmission, but it has an amplifier 104 in it so as to amplify the incoming 1900 cycles to a suitable value to operate the 1900-cycle alarm receiving circuit which is used for this purpose. The same type delay circuit 105 is used as for the alarm line, but the delay time is reduced to about one second. With one-second delay and the use of 1900 cycles for signaling, it is impossible to talk up or falsely operate the ringer unless a steady note of approximately 1900 cycles is maintained for one second or over. Such a condition is not encountered in maintenance, and even if it were, it would do no harm on order wire use. Operation of the delay circuit 105 operates an annunciator system 106. The circuit can be arranged for a lock-up, in which case the annunciator continues to operate until the call is answered. The circuit can also be arranged for code ringing to respond to ringing spurts and to restore to normal as soon as the distant point has stopped ringing.

Plugging the telephone set 107 into the circuit stops the annunciator, removes the line termination 102, and connects the telephone set to the line. Should this terminal desire to ring a remote point, it can be done by operating a ringing key for one second or longer. This operates the cut-off relay 103, disabling the local 1900-cycle receiver so that it will not respond to the ring and at the same time connects the 1900-cycle oscillator 108 to the line, thereby sending out the ringing tone. Releasing the ringing key, of course, restores the cut-off relay to normal, removes the local oscillator, and restores the ringing receiving circuit so that it can again receive a ring.

Non-power supply point

At a non-power supply point, such as a pole cabinet, the order wire line is brought out to a pair of terminals on a small bracket. The lineman's set may then be connected to these terminals in order for the maintenance man to talk at such a point. Maintenance is based on the need for the lineman to call the terminal or maintenance center. The lineman's set has its own batteries for talking purposes. Should the lineman want to call the terminal, he can do so by means of a 1900-cycle whistle designed for that purpose. By blowing into the whistle and holding the whistle near the transmitter, the lineman generates a 1900-cycle tone, sends it along the line to operate the distance 1900-cycle receiving circuit, as previously described. The lineman's set is designed to be high impedance so that it can be bridged across the line without affecting too much any repeaters that may be on this line.

The lineman's whistle is a small fife-type whistle designed to give a note of 1900 cycles. The resonant chamber is a rectangular closed pipe about $\frac{1}{2}$ inch wide by $\frac{1}{4}$ inch deep by 1.64 inches long with a similar shaped mouthpiece $\frac{3}{4}$ inch long arranged to be welded on the resonant chamber at an angle of about 110 degrees to the main axis of the resonant chamber. The orifice at the junction of the mouthpiece and resonant chamber is $\frac{1}{32}$ inch wide. With this arrangement of whistle, the air is blown across the resonant chamber so that condensate does not tend to settle in the resonant chamber, thereby changing the frequency of the tone. The frequency is reasonably close to a pure tone and independent of how hard the whistle is blown until the velocity of the air is high enough to produce a second harmonic. Also, with this design, the volume of sound is sufficient to operate the 1900-cycle receiving circuit at the distant point and not so loud as to be undesirable for use on the order wire pair. The whistle is convenient in size for the lineman and designed

5

with a bottom plate with a hole for carrying it on a string or chain.

Bridging non-repeaterd power supply point

Such points are usually non-attended, and Fig. 1B consequently shows no 1900-cycle oscillator for ringing nor any 1900-cycle receiving circuit for receiving a ring. Such arrangements are available, however, and could be used if desired.

A high inductance repeating coil 111 is bridged across the order wire pair in order to supply the simplex voltage, and the drop side of the coil is left open normally so that the bridge has very little effect on the transmission characteristics of the order wire circuit. To call from such a point, the lineman plugs his telephone set into the circuit. This energizes his telephone set with battery and at the same time connects him across the drop of the repeater coil. This puts a reasonably high impedance across the order wire pair which is sufficiently large to keep any repeaters on the order wire from singing. Removal of the telephone set, of course, opens the circuit again.

The lineman can signal to the distant point by using his whistle just as at the pole cabinet. Transmission from the lineman's set to the distant end and vice versa will be satisfactory. The circuit is also so designed that if there is any repeater on the circuit, the talker's energy at the repeater point will be comparable to the energy that there would be at this point were the talker at the terminal on the same side of the repeater.

Intermediate repeater point

An intermediate point with a voice repeater on the order wire is shown in Fig. 1B. The purpose of such an arrangement is to amplify the incoming speech currents by the proper amount for satisfactory transmission from terminal 110 to terminal 120 and at the same time to give the maintenance man at this point the same transmission as the terminal receives. Also, speech from the man at the intermediate point will arrive at either terminal at the same power as it would were this man at the circuit terminal. The intermediate man can ring either terminal or be signaled by either terminal. When the intermediate attendant is not connected to the order wire hybrid bridge, the bridge is balanced to a high degree by resistance terminations so that the singing point of this repeater is determined primarily by line conditions. When the attendant is talking, a special balancing network to match his telephone set is used so that a reasonably good repeater singing point is obtained.

Signaling is again by means of 1900-cycle tone. A 1900 oscillator is provided for the use of the attendant to signal, and a 1900-cycle receiving circuit is provided for the distant terminal to call him. The operation of this is similar to that described for the circuit terminal. Either terminal or other intermediate points may be signaled, and likewise any point along the route can signal him either by an oscillator or by a whistle.

Details of intermediate repeater

Suppose speech is coming in from the line at the left. It is applied to the repeating coil hybrid, half being dissipated in the pad and amplifier 115 in the lower branch. The useful part of the speech is applied to the filter FLT and a resistance pad of such a value in conjunction with the line loss as to make the circuit level at the junction of the amplifier 115 and order wire bridge about -24 decibels (same level for all other repeaters). Both amplifiers are set at 34-decibel gain. The output pad is of such a value as to give the proper circuit level on the order wire pair at the right, or if this is the last repeater before the terminal, to give the proper over-all circuit net loss at the terminal (usually about 14 decibels). With the amplifier set for 34-decibel gain and the input and output pads as chosen, the order wire hybrid bridge

6

is so designed as to give the intermediate attendant the same transmission as the terminal.

Returning now to a consideration of the input speech at the junction of the order wire bridge and the input of the amplifier 115, a small part of the energy flows into the high impedance order wire bridge 116 and to the telephone set (assuming the attendant is connected), but this energy is very small. Part of the amplified speech at the amplifier output, however, flows into the bridge and, this being much larger in amplitude, reaches both the telephone set and telephone balancing net 117. Very little energy appears as echo in the other direction of the main through circuit either in the input or output of amplifier 115'. Proper poling in the order wire bridge also helps reduce these echo currents.

Transmission from the order wire pair on the right to the intermediate attendant is similar to that just described with the pads being arranged in a corresponding manner and very little echo is obtained on the other side of the circuit due to the order wire bridge.

Now consider that the attendant at the intermediate point starts to talk. His speech current arrives at the order wire whence, in the bridge, it is split and arrives at each of the two amplifier inputs at the same level as the speech would from the distant terminals. The speech is then amplified in each amplifier and passed to each terminal.

In signaling from the intermediate point, operation of the ringing key applies the 1900-cycle tone to the order wire bridge at the same point at his speech arrives, and consequently the ring is transmitted to the distant terminals. A signal from either terminal would be applied to the order wire bridge in the same manner as speech from that terminal and will be applied to the 1900-cycle receiving circuit bridged across the output of the bridge, as shown in the figure.

Oscillator circuit

Fig. 2 shows a specific form of alarm tone oscillator and a variable attenuator for controlling the output power of the oscillator. The oscillators 2, 3, etc., are all identical with the exception of two resistors whose values are changed to obtain a particular frequency required.

The oscillator 3 is a two-stage RC type oscillator stabilized by negative feedback. Its frequency is determined by a selection of various resistance values for resistors 27 and 27'. Capacitors 28, 32, and 33 provide the capacitance portion of the circuit, the major portion of which is supplied by 28 and 33, with 32 acting as a trimmer for making a vernier frequency adjustment for circuit element variations. The oscillator tone is normally applied to the line 4 at a power supply station. When the power fails or for any other alarm condition, the tone is removed from the line to operate the alarm indicator.

The oscillator is provided with a starting circuit comprising resistor 21 connected across capacitor 26 in the voltage feedback path from the plate of amplifying tube 24 to the grid and cathode of tube 23. The direct-current voltage plate battery 25 initially lowers the thermistor resistance sufficiently to enable oscillations to start. Thereafter, the alternating-current oscillations are fed through a one-microfarad condenser 26 whose impedance at the oscillating frequency is effective in shorting out the starting resistor 21. Oscillations are sustained by the positive voltage feedback through variable resistor 27 and condenser 28 to the grid of tube 23. Negative feedback is provided in the feedback path from the plate of tube 24 to the cathode of tube 23 by means of the resistor 29, thermistor 22, and oscillation level control potentiometer 30. The control of the negative feedback by thermistor 22 stabilizes the oscillator output against voltage variations of its power supply.

The amplified oscillations derived from the output of amplifier 24 are applied to conductor pair 4 through an

attenuator 31 to control the power of the tone transmitted to the receiver 1.

Relay (K1) connects the tone to the line when in the operated position. This corresponds to normal conditions. For alarm situations, the 600-ohm termination 34 is connected across the line 4, and the oscillator output is shorted, which results in "tone off." The release of relay (K1) is under control of the alarm ground lead; ground on this lead is supplied by an associated alarm condition. The operation of the oscillator 3 in the alarm application is self-arming because failure of any circuit element results in a cessation of tone applied to the line by the oscillator.

Alarm receiving station (Fig. 3)

The basic function of the receiving station is to discriminate against signals outside a selected tone, to provide high sensitivity to signals of the selected tone, and to rectify the received signal for use in operating a relay to provide a positive indication of the presence or absence of the selected tone at the input of the receiver.

The receiving circuit is the same for all tones except for the particular filter required.

The receiving circuit consists of (1) narrow band filters 35 in parallel for selecting the various individual alarm tone frequencies, namely, 700, 1100, 1500, 1900 cycles, (2) an amplifier V1, (3) a rectifier 37, (4) a common delay circuit 38, lamp 39, and audible alarm circuit connection 40 to indicate trouble.

The circuit may be understood better by following a typical alarm tone through it. Assuming a 700-cycle alarm tone applied to the conductor pair 4, it is selected at the alarm receiving station by filter 35, amplified by tube V1, rectified by a bridge rectifier 37. The rectified tone operates relay K2, lighting neon lamp 39 indicating trouble-free conditions on line 4.

Inasmuch as the K2 relay is thus held operated, no potential from battery 42 is applied from this receiving circuit to operate the neon lamp 39, the common delay circuit 38, and the alarm circuit connection 40.

Now suppose the power at the distant point sending the 700-cycle tone fails. The 700 cycle normally sent from that point drops off so that there is now no 700-cycle tone at the alarm receiving station. Under these circumstances, the K2 relay releases, the neon lamp 39 is extinguished, indicating which tone has failed. Battery voltage 42 is applied to lamp 39, lighting it to indicate the failure of the 700-cycle tone. The battery voltage at 42 is also applied to a delay circuit network 38 comprising the parallel combination of an 8000-ohm resistor 44 and an alarm relay 45 in series with a thermistor 46 and also to thermistor 47 connected to ground.

Initially, both thermistors 46 and 47 have high resistance when cold, and these resistances are slowly reduced in sequence as the thermistor is heated, thus giving a delay of about five seconds. The thermistor 47 reduces its resistance first, then thermistor 46 is activated sufficiently to permit the alarm relay 45 to operate and connect an audible alarm 40.

This delay of five seconds is introduced antecedent to the operation of alarm circuit 40 in order to prevent lighting disturbances or other momentary shorts or opens of the line from activating the alarm. There is no delay to the operation of neon lamp 39. Hence, it will flash in response to intermittent trouble and will stay lighted when the alarm sounds to indicate trouble in the carrier system. The extinguished lamp 39 indicates which point along the line is in trouble.

The switch key 48 may be operated to cut off the audible alarm by breaking the connection between the receiving circuit and the delay circuit. When the alarm tone is restored, an alarm indication is again received, and restoring the switch key 48 to normal will then cut off the audible alarm.

Fig. 4 shows the unbalanced, adjustable resistance hy-

brid circuit employed in Fig. 1 for coupling a tone oscillator 3 to the line in a manner to equalize the incoming alarm tone powers with the power of a particular alarm tone applied at a particular station on the alarm line.

The resistance hybrid circuit is a network of a fixed resistor 60 and adjustable potentiometers 62, 63 arranged in the form of a network with two inputs and an output. The two potentiometers 62, 63 are geared together and controlled by a single shaft.

For any setting, the value of resistance R1 and R2 introduced, respectively, by each potentiometer 62, 63 into the hybrid circuit is such that $\sqrt{R1R2}=600$ ohms which represents the line termination value. Adding loss to one input circuit concomitantly removes loss from the other input and vice versa. In this manner, the power of the tone being applied at a particular station may be made equal to the power of the tones from the remote stations.

Order wire circuit (Fig. 5)

Fig. 5 shows an order wire circuit and, more particularly, the signal receiving portion and the modified delay circuit for preventing false operation.

About one second delay is provided between receipt of tone and operation of the audible signal in order to provide discrimination between talking on the order wire and steady tone. This time discrimination in combination with the filter discrimination at the receiving circuit provides a means of signaling with a single steady 1900-cycle frequency of one second duration or longer. Syllabic volume changes in voice transmission, except for steady tones in the 1900-cycle range, will not operate the alarm relay and hence will not actuate the audible calling-in signal.

The order wire circuit in Fig. 5 uses a separate 1900-cycle oscillator 60 corresponding to the 1900-cycle oscillator shown in Fig. 2 as a source of signaling at main offices. When the attendant rings, the operation of the ringing key operates cut-off relay 103, which connects oscillator 60 to the line 5 for signaling. The telephone set 107 plugged into jack 63 is used for communication on a calling-in basis to the stations in the maintenance section of line.

The 1900-cycle signaling tone coming in on line 5 is applied through a 1900-cycle filter 50 to the amplifier and detector (indicated by dotted lines and label), whence the rectified tone operates the K2 relay, thereby applying battery voltage to the lead S. This battery voltage operates the relay K3.

Relay K3 operated removes the grounding shunt from the C4 condenser, applies a positive 130 v. potential to main anode 4 of a cold discharge tube V1, and applies positive 130-volt charging potential through resistors R3, or resistors R3 and R4, to capacitor C4.

The values of R3, R4, and C4 determine the time interval required to raise control anode 1 to its firing potential. With both R3 and R4 in the circuit, this interval is about five seconds; when R4 is strapped out, the interval is about one second. When enough time has elapsed to charge C4 to the firing potential of the control gap of cold discharge tube V1, this gap fires between electrodes 1, 4, which in turn fires the main gap 2, 4. The main gap then provides a conducting path for 130-volt battery through R6 through relay K4 to ground.

Relay K4 then operates, and in the case of the alarm use, it supplies ground for the bell circuit 51 and ground to the visual alarm circuit 52. In the case of 1900-cycle signaling, it supplies ground for the bell circuit 51 and battery in circuit 52 for operating the order wire relay circuits shown in block 102 of Fig. 1.

When the ringing current is removed from the line, the K2 relay releases, causing the K3 relay to release, which extinguishes tube V1. When the tube V1 is extinguished and becomes non-conducting, it causes relay K4 to release and the lamp and audible signal go off.

Upon removal of battery voltage of battery 42, even momentarily, from the "S" lead (or the A lead in the case of the alarm circuit), the K3 relay releases and discharges condenser C4 through a small resistor R2. Consequently, when relay K3 is again operated, a new timing interval is started for operating relay K4.

Condensers C2 and C3 provide a by-pass for high frequency surges of office noise which might falsely fire discharge tube V1 prematurely before condenser C4 is charged to its normal firing value.

Neon light 55 provides a visual indication which comes on as soon as the K2 relay operates in case of signaling (or releases in case of alarm use). This light is provided primarily to indicate an alarm failure and serves no major purpose when used for signaling. Also, short interruptions of the alarm line will show as flashes on the neon light 55 and provide an indication of the nature of the disturbance.

For the application of the receiving circuit to the order wire line, the calling-in signal is operated on a tone-normally-off basis. That is, the application of tone to the receiving circuit operates the signal. Because only 1900 cycles per second tone is transmitted over the order wire pair, interference from other tones on the pair is no consideration. However, false operation by speech and noise as well as cross-talk from tones on other pairs in the cable must be safe-guarded. In this application, components of speech in the 1900 cycles per second band operate the K2 relay intermittently, but the insertion of the delay circuit, strapped for one second delay, between the K2 relay and the audible alarm circuit provides discrimination against voice current in the band passed by the input filter. The one-second delay is a compromise value intended to provide as much discrimination as possible against talk-up without introducing excessive hazard of missing one or more rings in code ringing spurts shorter than the duration required to activate the delay circuit.

Although the order wire and alarm circuits have been described in connection with a particular short haul multichannel carrier system, it should be understood that it may be applied more generally to voice frequency telephone systems, to other types of carrier telephone systems, or to spur routes of microwave radio relay link systems and the like.

What is claimed is:

1. An alarm signaling system comprising a transmission line, a plurality of single frequency tone oscillators coupled thereto at spaced stations along said line, means for maintaining the level of said tones constant at a common receiving station along said line, a plurality of receivers at said station, each receiver having a narrow band filter therein and a detector selective to a tone, an alarm indicator and a common delay circuit between said receivers and indicator for preventing false operation of said indicator by extraneous currents of short duration with respect to the delay interval.

2. An alarm signaling system comprising a transmission line, a plurality of single frequency oscillators providing tones in the voice frequency band, connected thereto at spaced stations along said lines, adjustable resistance networks providing variable loss in said line connecting said oscillators to said line to provide constant amplitude level of said tones at a common receiving point along the line, a plurality of frequency selective receivers at said receiving point, each corresponding to an alarm tone in frequency, an alarm indicator and a common delay circuit for all said receivers between said indicator and receivers comprising a network of thermistors operating in sequence over a delay time interval whereby to prevent false operation of said indicator by noise and normal speech frequencies.

3. An order wire and alarm system comprising a quad, one conductor pair thereof being provided with alarm tone transmitters, and receivers, a common delay circuit for said corresponding receivers adapted to be operated

when a tone is removed from said pair, the other pair of the quad being an order wire line provided with a tone transmitter identical in frequency with one of said alarm tones, a receiver and delay circuit therefor, said delay circuit having a different time delay than said common delay circuit and being actuated by application of tone from said order wire.

4. The circuit of claim 1, and means for operatively connecting said delay circuit to a receiver when the corresponding oscillator tone is removed from said line.

5. The circuit of claim 2, and an alarm relay in series with one of said thermistors adapted to be operated after the other thermistor is activated.

6. The circuit of claim 5, and a switching means between a receiver and delay circuit.

7. An order wire and alarm system comprising an alarm pair and an order wire pair, a power supply connected between said pairs, the alarm pair being provided with alarm tone oscillators of different frequency located at stations spaced therealong, a variable resistance bridged T network for coupling certain of said oscillators to the alarm pair whereby the amplitudes of alarm tones at intermediate points may be equal, a plurality of frequency selective receivers in parallel for separating said tones, a common delay circuit having thermistors of different time constant connected to said receivers and energized when a tone is removed from said alarm pair, said order wire pair being provided with a tone oscillator identical in frequency with one of said alarm tones, a receiver and delay circuit therefor, said delay circuit having a different time delay than said common delay circuit and being actuated by application of tone from said order wire.

8. An alarm signaling system comprising a transmission line, a plurality of oscillators connected to said line at spaced points thereon, each oscillator providing oscillations of single frequency, adjustable resistance networks coupling said oscillators to said line, said resistance networks simultaneously varying the loss in said line and the output of each corresponding oscillator in inverse relation, and means for connecting a resistance termination to said line when the oscillator is disconnected therefrom.

9. An order wire circuit signaling system comprising a steady tone oscillator having its frequency in the voice band, a line, an adjustable bridged T network coupling said oscillator to said line for simultaneously varying the loss in said line and the output of said oscillator inversely to each other, a receiver comprising a narrow filter for passing said frequency, an alarm, a delay circuit to prevent false operation of said alarm by speech components, and means for shorting said oscillator and connecting a termination to said line in response to an alarm condition.

10. An alarm signaling system comprising a line, a plurality of single frequency tone oscillators connected thereto at spaced points, a variable network bridged across the line for maintaining the level of all applied tones constant at any intermediate point of application of said tones, a plurality of receivers connected to said line, each receiver having a narrow band filter therein and a detector selective to a corresponding tone, an alarm indicator, means for connecting a terminating resistance to said line when said oscillator is disconnected in response to a local alarm condition, and a common delay circuit for preventing false operation of said indicator by extraneous voltages of short duration with respect to the delay time.

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