Sept. 20, 1927. 1,642,710

H. A. AFFEL

PILOT CHANNEL INDICATING SYSTEM

Filed Sept. 18, 1926 2 Sheets-Sheet 1

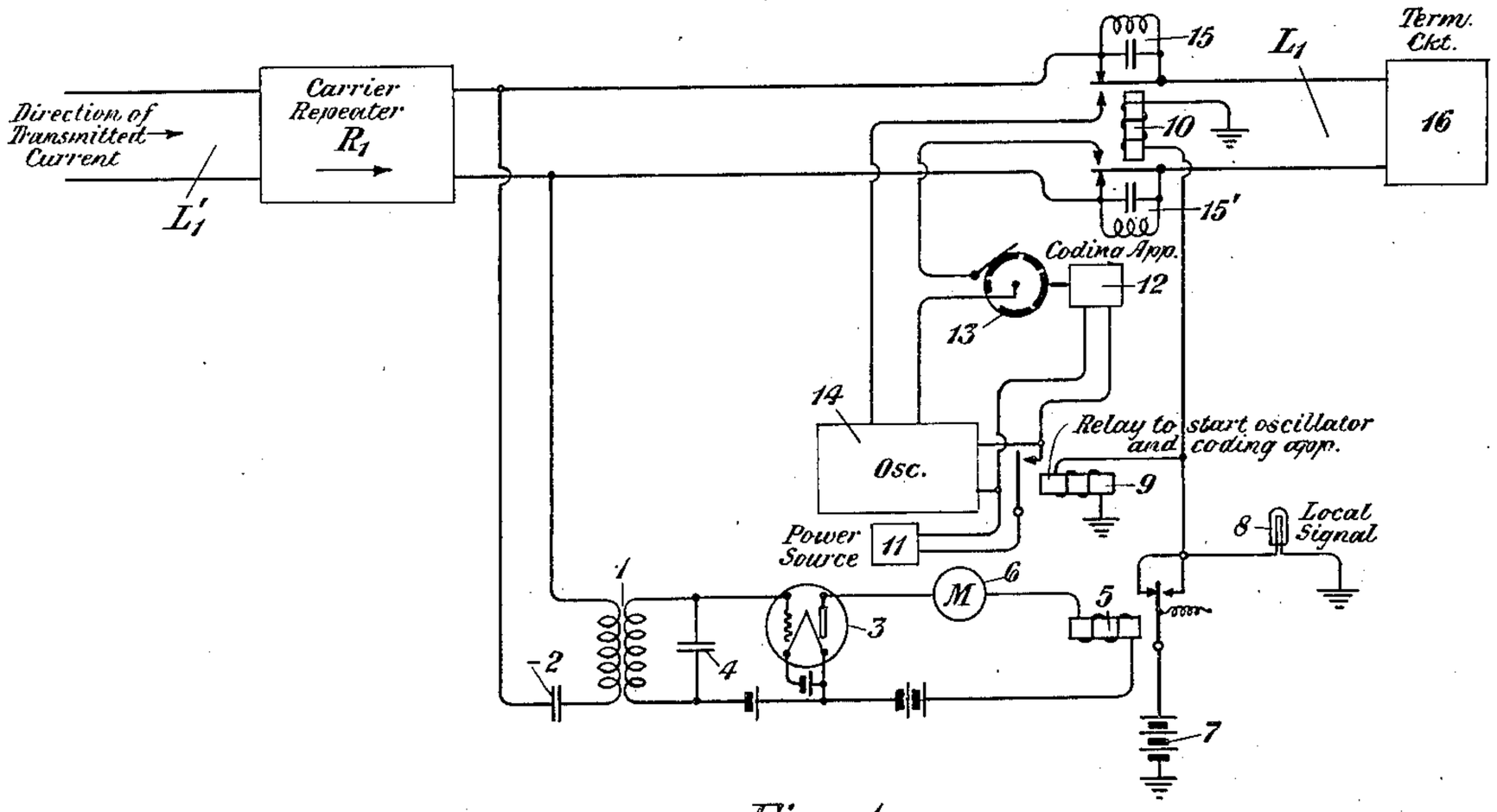

Fig. 1

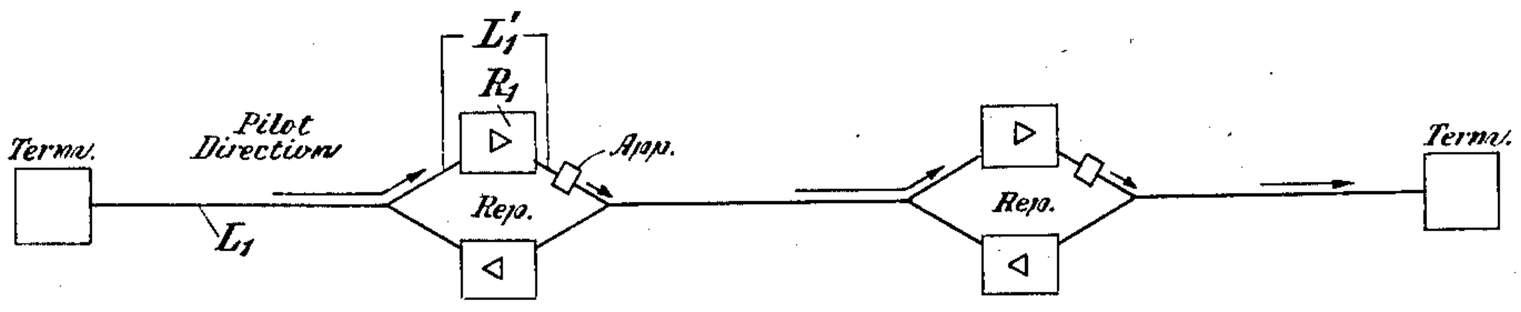

Fig. 2

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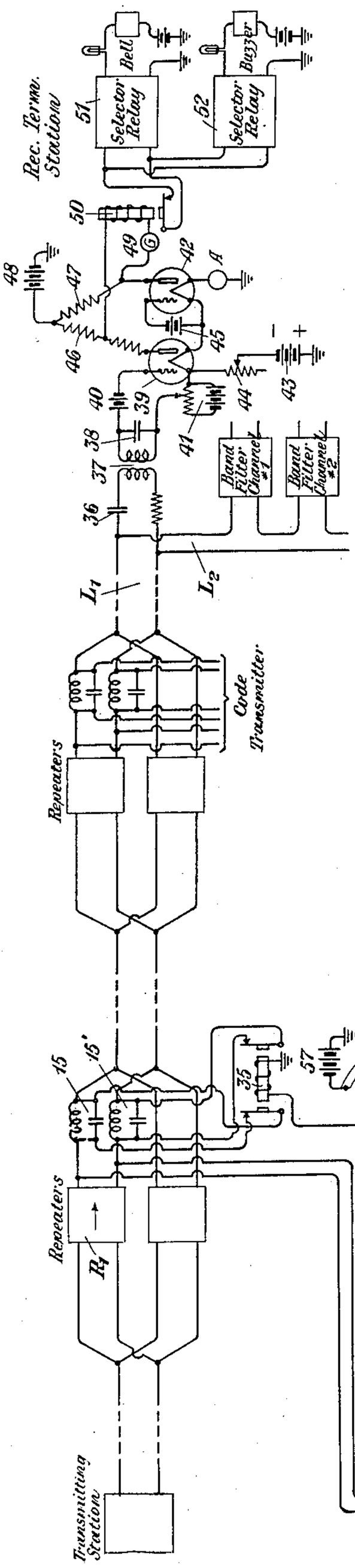

Fig. 3

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Patented Sept. 20, 1927. 1,642,710

UNITED STATES PATENT OFFICE.

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PILOT-CHANNEL-INDICATING SYSTEM.

Application filed September 18, 1926. Serial No. 136,261.

This invention relates to pilot channel alarm arrangements for use in connection with carrier or radio signaling systems, and particularly to means connected with such systems whereby the location of a source of trouble upon the system affecting its transmission characteristics will be automatically made known at one or more places thereon.

In the operation of carrier and radio signaling systems employing one or more repeaters between the terminals thereof, it is customary to transmit a single frequency wave together with the signaling waves, the single frequency wave being known as a pilot channel. The pilot channel serves as an index of line conditions that affect the transmission of signals. The frequency of the pilot channel is so chosen with respect to the frequency of the signaling waves that any variation of line conditions that affect it will, in like manner, affect the signaling channels being transmitted over the line simultaneously with the pilot channel.

Heretofore in order to determine line conditions and to locate a source of trouble it has been customary to select the pilot frequency at each repeater station and also at the receiving terminal station, and to impress it upon suitable circuits whereby its variations from normal would be indicated. Thus each repeater point has been equipped with an alarm circuit which would operate whenever the pilot channel varied in voltage a given amount above or below normal. The repeater attendant would measure the variation and would notify the attendant at the receiving terminal station, to whom is assigned the duty of supervising the operation of the line and of directing the various repeater attendants, to make such adjustments upon the line at such repeater stations as are necessary to bring the transmission back to normal. This requires the repeater attendants to notify the attendant at the terminal station whenever variations occur, and inform him of the magnitude of such variations, all of which introduces a loss of time in effecting the necessary adjustments to bring the transmission to normal.

This invention resides in a method and means whereby abnormal variations of the transmission level of the pilot channel at each repeater point are automatically made known to the attendant at a terminal station.

Other objects of this invention will be apparent from the following description when read in connection with the attached drawing, of which Figure 1 shows schematically a simple form of embodiment of the invention; Fig. 2 shows schematically the manner in which the apparatus is connected into a carrier transmission system; and Fig. 3 shows another form of the invention containing certain refinements not shown in Fig. 1.

In Fig. 1, the line L_1' represents one of the branches at a repeater station as shown in Fig. 2, into which the line L_1 divides. The repeater R_1 is intended to amplify all of the frequencies transmitted in the direction of the arrow which include not only the signaling channels but also the pilot channel. Bridged across the output side of the repeater is a pilot alarm circuit by means of which the attendant at a terminal station may receive automatically an indication of the line condition, which indication will be produced by the pilot channel. The conductors of the pilot alarm circuit which are bridged across the output side of the repeater are connected with the primary winding of the transformer 1, which winding has in series therewith a condenser 2 which together form a circuit tuned to the pilot channel frequency. The secondary winding is connected with the grid of the vacuum tube rectifier 3. This winding has connected across it a condenser 4 which tunes the input circuit of the rectifier to the pilot channel frequency. The output side of the rectifier includes the winding of the relay 5 and a meter 6. The armature of this relay has connected therewith a source of potential 7, which, when the relay is operated, will be connected with a local alarm signal 8 and with the relays 9 and 10. Relay 9 serves to connect a source of power 11 with the motor 12 which drives a commutator 13 by means of which the output of the oscillator 14 will be transmitted over the line L_1 in accordance with a predetermined code. This oscillator may be of any well-known type, so that a detailed explanation of it is unnecessary. Since a desirable form is a vacuum tube type, the relay 9 could

be made to control the closing of the filament circuit in order to put the oscillator in operation whenever relay 9 operates. It will be seen that when relay 10 operates the line L_1 is connected directly with the source of oscillations 14 and with the output of the repeater R_1 through the anti-resonant circuits 15 and 15'. These circuits are made anti-resonant to the frequency produced by the oscillator 14 so that current of that frequency will not feed back into the repeater R_1 or into the circuit of the rectifier 3.

The manner in which this circuit operates is as follows: Let it be assumed that the transmission characteristics of the line L_1 are such that the amplitude of the pilot channel at the output side of the repeater R_1 will be normal. This voltage when impressed upon the grid of the rectifier 3 will cause a current to flow in the plate circuit of the rectifier, which includes the winding of relay 5, which will produce no effect upon the armature of this relay. That is to say, the tension of the biasing spring of this armature is just sufficient to equal the magnetic pull produced by the normal current flowing through the winding of the relay. Consequently, the armature remains at its midposition. If, on the other hand, the amplitude of the carrier frequency became greater or less than normal to a predetermined extent, the armature of relay 5 would move and touch either its right or left-hand contact. This would serve to connect the source of potential 7 with the lamp 8, which would notify the local repeater attendant, and it would also set in operation the apparatus for transmitting a signal to the attendant at the receiving terminal station, apprising him of the change in the transmission characteristics of the system. The current from the source 7 will simultaneously operate the relays 9 and 10. The operation of the former will connect the source of power 11 with the motor 12 of the coding commutator and also will start in operation the oscillator 14. The operation of relay 10 will connect the line L_1 directly with the output of the oscillator 14. so that there will be transmitted over the line L_1 to the receiving terminal 16 at the distant end a series of impulses of the frequency produced by the oscillator 14, arranged in accordance with the code set up by the commutator 13. These coded impulses will be prevented from getting back into the repeater R_1 or to the rectifier 3 by means of the anti-resonant circuits. The receiving terminal would include an alternating current relay that would serve to translate the trains of oscillations of the frequency produced by 14 into direct current impulses which would operate a selecting device, preferably of the type used in train dispatching systems, which type is disclosed in the patent to Field, No. 1,343,256, dated June 15, 1920.

The arrangement shown in Fig. 3 is a modification of that shown in Fig. 1, the principal difference residing in the use of a Wheatstone bridge network having tubes in the arms thereof, which type of circuit is shown in the copending application of Deardorff, Serial No. 138.977, filed Oct. 1, 1926. In this figure the pilot channel alarm circuit is bridged across the output side of the repeater R_1 and it serves to control the sending to the terminal station of a series of impulses arranged in accordance with a code. The alarm circuit, which is bridged across the repeater R_1, is tuned by means of the condenser 2 and the primary winding of the transformer 1 to the frequency of the pilot channel. The secondary winding of this transformer, together with the condenser 4, also constitutes a tuned circuit which is connected with the grid of the tube 3, which constitutes one of the arms of a Wheatstone bridge network. This tube is balanced by another tube 3' which is similar in structure and characteristics to tube 3. The filaments of both tubes are connected in series with each other and with the source of current 17 and the rheostat 18. A potentiometer 19 and source of potential 20 are connected in the grid circuit of the tube 3 which also includes the negative biasing battery 21. The source 53 applies the proper negative bias to the grid of the tube 3'. The equal arms 22 and 23 constitute the ratio arms of the bridge. A source of plate battery 24 is connected with the junction of the arms 22 and 23, which in turn are connected with plates of the tubes 3 and 3', respectively. Bridged across opposite corners is a circuit including a galvanometer 25, a relay 26, and the windings of a contact voltmeter 27. The contacts of this voltmeter are together connected with the source of current 28 which also is connected with the winding of the relay 29. The voltmeter is so designed and adjusted that when the Wheatstone bridge is balanced the armature of the voltmeter will be at its midposition and the current flow from the source 28 through the winding of relay 29 will not be shunted by the armature of the voltmeter 27. Relay 26 is of a sensitive type that releases on zero current. Relay 30 is a time relay which operates whenever relay 26 operates. This time relay serves to control a second time relay 31 which controls the operation of the code-transmitting relay 32. The latter relay is so adjusted that whenever relay 31 operates, the arm 33 will begin to move over the contacts of the code-sending device 34, which is adapted to transmit a series of impulses in accordance with a predetermined code. These impulses will operate relay 35 which opens the shunts

around the anti-resonant circuits 15 and 15'. It is desirable to point out that while the pilot channel current is flowing into the control circuit just described, it is also flowing over the shunt around the anti-resonant circuit and over the line L_1 to the receiving terminal station at the distant end thereof. Whenever relay 35 operates to open the shunt, the anti-resonant circuits become operative, and since these circuits are anti-resonant to the pilot channel frequency, they prevent the transmission of this frequency beyond the point where the anti-resonant circuits are cut in. It will therefore be seen that with the operation of relay 35 in accordance with the code set up upon the device 34, the pilot channel will flow over the line L_1 to the receiving terminal station in a series of impulses representing a code signal controlled by the device 34.

At the receiving terminal station the line L_1 is connected with a plurality of branches. One of these branches is tuned by the condenser 36 and the primary winding of the transformer 37 to be resonant to the pilot frequency. Another branch L_2 comprises a plurality of band filters by means of which the carrier channels are separated and led into their respective terminal circuits. This latter feature forms no part of this invention and therefore will not be described in detail. The terminal circuit for the pilot channel resembles somewhat the circuit at the repeater station. Thus the secondary of the transformer 37 and the condenser 38 constitute a circuit tuned to the pilot frequency which is connected with the grid of the tube 39. This input circuit also includes the negative biasing battery 40 and the potentiometer 41. The corresponding arm of the bridge includes the vacuum tube 42. The filaments of both tubes are in series with the battery 43 and the rheostat 44. The negative bias upon the grid of the tube 42 is supplied by the battery 45. The arms 46 and 47 are connected with the plates of the tubes 39 and 42, and the junction of these arms is connected with the source of plate voltage 48. Bridged across opposite corners of the arms is a circuit including the galvanometer 49 and a relay 50. This relay opens and closes its contact whenever an impulse of current impressed upon the grid of the tube 39 causes variations in the plate current of that tube. This relay controls a plurality of selector relays, such as 51 and 52, which preferably are of the type, used in train dispatching systems, that is disclosed in the patent to Field, No. 1,343,256, dated June 15, 1920. Each of these selectors would, when operated, control a signal device which may be different in order that the attendant would know by the character of the signal which selector had operated. The number of selector relays employed would, of course, be equal to the number of code-transmitting devices employed at the repeater points along the line.

The manner in which the system operates in order to carry out the invention is as follows: Let it be assumed that the system is normal, so that the magnitude of the pilot channel current at the output side of the repeater R_1 is normal. This current will flow over the line L_1 to the receiving terminal station and also into the branch at the repeater station R_1, and into similar branches at other repeaters. The current flowing into this branch will impress a voltage upon the grid of the tube 3, which will cause current of a known amount to flow from the plate to the filament of this tube. This current is supplied by the source 24. At the same time current from this source flows through the plate circuit of the tube 3'. By adjusting the voltage of the biasing battery 53 connected with the tube 3' the bridge may be balanced for the normal voltage impressed upon tube 3 by the pilot channel. Consequently no current will flow in the circuit including the galvanometer 25 and the relays in series therewith. The pilot channel current that flows through the repeater R_1 and the subsequent repeaters connected with the line L_1 will likewise be impressed at the terminal station upon the tube 39. This Wheatstone bridge circuit is similar to that just described in connection with the repeater station R_1 in that for the normal pilot voltage impressed upon the tube 39 no current will flow in the circuit that includes the galvanometer 49 and the relay 50. Consequently no signal is given at the terminal station.

Let us assume that the pilot channel frequency voltage has increased to a predetermined value due to changes in line conditions. This voltage, when impressed upon the grid of the tube 3, will cause a space current to flow between the plate and the filament of this tube that is greater than normal. This flow of current will unbalance the bridge and will cause current to flow through the galvanometer 25, the relay 26, and the contact voltmeter 27. Relay 26 will be energized, which will in turn cause the operation of relay 30. The contact voltmeter will likewise be energized to such an extent that its armature will touch one of its contacts and thus will shunt a portion of the current that normally would flow through the winding of relay 29. This will allow relay 29 to release, thus establishing a circuit from the battery 54, one of the contacts of relay 30, and the winding of relay 31, energizing the latter. Current will thereupon flow from the battery 55 through the winding of relay 32 to ground through the contact of relay 31. This will cause the arm 33 of the code-transmitting device 34

to move over the contacts of the device, thereby opening and closing the circuit from the source 57 through the winding of the relay 35. As the latter relay is energized or de-energized, it will open or close the shunt around the anti-resonant circuits. The effect of this is to open or close the line circuit L_1 for the pilot frequency. Accordingly, as relay 35 operates there will be transmitted over the line L_1 to the receiving terminal station, a series of impulses each representing a train of waves of the pilot frequency and of a magnitude greater than normal, the trains being separated by spaces in accordance with the code set up upon the device 34. These impulses will impress a voltage upon the grid of the tube 39 at the terminal station, which will cause current to flow from the plate to the filament of that tube, that is greater than normal. This will upset the balance of the Wheatstone bridge and cause impulses of direct current to flow through the circuit, including the galvanometer 49 and the relay 50. Each impulse of direct current corresponds to a train of waves of the pilot frequency and of amplitude greater than normal impressed upon the grid of the tube 39. Relay 50 will accordingly open and close its contact at the beginning and the end of each direct current impulse. This will cause the selectors 51 and 52 to be stepped around, but only that selector will be operated which is adjusted to respond to the group of impulses representing the code sent out by the pilot channel transmitting device at the repeater R_1. The manner in which these selectors operate is clearly described in the patent to Field, heretofore referred to. Upon the operation of the selector, which will be assumed to be 51, the lamp and the bell connected with that selector will be energized. The attendant at the terminal station will thereupon know that the variation in the line conditions that caused the increase in the amplitude of the pilot channel voltage lies beyond the repeater R^1. He will thereupon call the repeater attendant at R_1 and also at the distant transmitting station and cause them to effect such adjustment as to bring the transmission back to the desired level.

In like manner, if the amplitude of the pilot channel voltage dropped to a predetermined extent below normal, the pilot channel code-transmitting device at the repeater station would function and transmit a signal to the receiving terminal station. It will be seen that the contact voltmeter 27 at the repeater station has two contacts, one of which touches the armature whenever the pilot channel voltage goes upward a predetermined amount, and the other when it goes down a predetermined amount. The effect upon the subsequent apparatus is the same regardless of the character of the change of the voltage.

While this invention has been disclosed as embodied in particular forms, it is capable of embodiment in other and different forms without departing from the spirit and scope of the appended claims.

What is claimed is:

1. In a carrier signaling system, the method which consists in transmitting over a line an alternating current constituting a pilot channel, selecting part of the pilot channel current at a point between the terminals of the line and effectively interrupting in accordance with a predetermined code the flow of pilot current over the said line whenever the said current exceeds a fixed limit, receiving the code interrupted current at another point upon said line more remote from the transmitting end than the said selecting station, and operating an alarm responsive only to the code transmitted from a particular station.

2. In a carrier signaling system, the method which consists in transmitting over a line an alternating current constituting a pilot channel, effectively interrupting in accordance with a predetermined code the flow of current over the said line whenever the said pilot current exceeds a fixed limit, and selectively operating at another point on said line an alarm responsive to the particular code of interrupted pilot current.

3. In a carrier signaling system, the method which consists in transmitting over a line an alternating current constituting a pilot channel, effectively interrupting in accordance with a predetermined code the flow of pilot current over the said line when the said current at the point of interruption exceeds a fixed limit, the code of interruption produced at one point being different from that produced at another point, and selectively operating by the said interrupted current an alarm at a supervisory station connected with the said line, the particular alarm operated depending upon the code of interruption of the current.

4. In a carrier signaling system, the combination with a line of a source of alternating current constituting a pilot channel connected with said line, a supervisory station connected with said line and a code transmitting station connected with the said line between the said source and the said supervisory station, the said code transmitting station having means to interrupt the flow of pilot current over the said line in accordance with a predetermined code when the current at that station exceeds a fixed limit, the said receiving station having an alarm signal responsive only to the said code-interrupted pilot current.

5. In a carrier signaling system, the combination with a transmission circuit of a

source of alternating current connected therewith constituting a pilot channel, code transmitting means connected with the said transmission circuit comprising means responsive to predetermined variations from normal of the pilot current, a code transmitting device controlled by the said current-responsive means, and means controlled by the code transmitting means to interrupt the transmission of the pilot current over the said line in accordance with the predetermined code, and an alarm signaling means connected with the said transmission circuit responsive to the impulses of the pilot current.

6. In a carrier signaling system, the combination with a transmission circuit of a source of alternating current connected therewith constituting a pilot channel, code transmitting means connected with said transmission circuit comprising means responsive to predetermined variations from normal of the pilot current, a code transmitting device controlled by said current-responsive means, and means controlled by the code transmitting means to interrupt the transmission of the pilot current in accordance with the predetermined code, and a receiving circuit connected with the said transmission circuit comprising means to select the pilot current, and means responsive to the impulses of said current to actuate an alarm signal.

7. In a carrier signaling system, the method which consists in transmitting over a line an alternating current constituting a pilot channel, selecting part of the pilot channel current at a point between the terminals of the line and effectively modulating the pilot current over the said line whenever the said current exceeds a fixed limit, receiving the modulated current at another point upon said line more remote from the transmitting end than the said selecting station, and operating an alarm responsive only to the modulated current from a particular station.

8. In a carrier signaling system in which a pilot channel and a signaling channel are simultaneously transmitted, the method of determining the level at any point which consists in selecting a part of the pilot channel current and using it to modulate the remainder of the pilot current being transmitted over said system whenever said current exceeds a fixed level.

In testimony whereof, I have signed my name to this specification this 17th day of September, 1926.

HERMAN A. AFFEL.