

Oct. 9, 1934.

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1,976,096

ELECTRICAL SIGNALING SYSTEM

Filed June 29, 1932

2 Sheets-Sheet 1

Fig. 1.

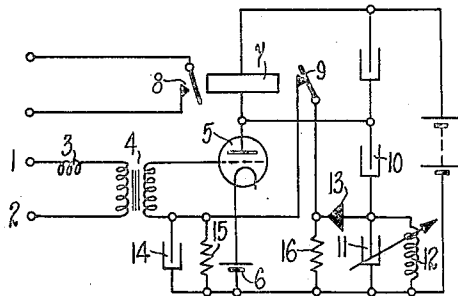


Fig. 2.

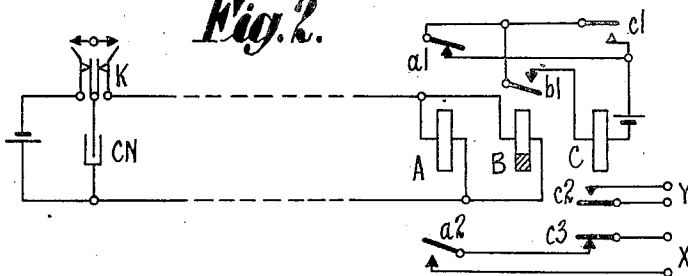
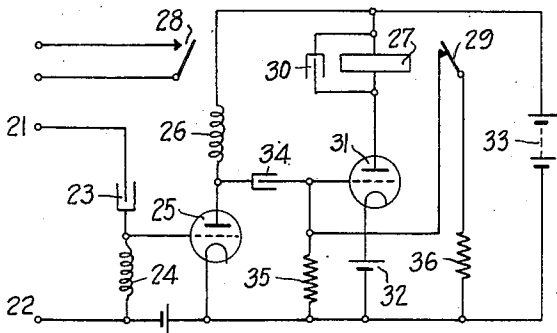


Fig. 3.



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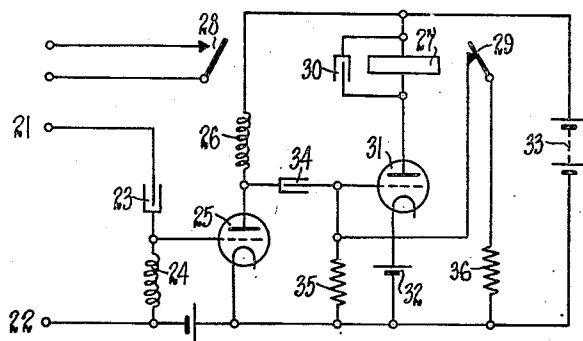
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2 Sheets-Sheet 2

Fig. 3.



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UNITED STATES PATENT OFFICE

1,976,096

ELECTRICAL SIGNALING SYSTEM

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Application June 29, 1932, Serial No. 619,822
In Great Britain July 15, 1931

16 Claims. (Cl. 179-84)

The present invention relates to electrical signaling systems and is more particularly concerned with arrangements for discriminating between signals comprising currents of the same characteristics which differ, however, in the manner in which they cease. Thus, for example, where alternating currents of voice frequency are employed for signaling over circuits used also for the transmission of speech it is an object of the invention to produce signal responding equipment which will operate only when the currents stop abruptly, which is a condition impossible to attain with currents representing ordinary speech.

According to one feature of the invention in an electrical signaling system having signals transmitted in response to cessations of normal current flow in the signaling circuit currents of similar character are arranged to operate receiving equipment differently according as they are stopped suddenly or gradually.

According to another feature of the invention, in a signaling system having signals transmitted in response to variations in the flow of direct current over a line the receiving equipment comprises two relays having different release times and sensitivities connected to the line in such manner that if the current flow stops suddenly the relay which is quicker to release will release first, while if the current falls gradually the relay having the shorter release time which is more sensitive is maintained operated until after the other relay has released.

According to a further feature of the invention in an electrical signaling system employing voice frequency alternating currents for signaling over a circuit which may be traversed by speech currents the receiving apparatus for responding to signals includes a condenser which is charged due to the receipt of signaling currents and is connected up in such manner that if the currents are interrupted suddenly the absence of the signaling current in conjunction with the charged state of the condenser operates the receiving apparatus while if the currents are interrupted slowly as would occur in the case of speech the condenser has had time to discharge when the signal completely ceases and no operation of the receiving apparatus results.

The invention will be better understood from the following description of three methods of carrying it into effect which should be taken in conjunction with the accompanying drawings comprising Figs. 1, 2 and 3.

Referring first to Fig. 1, it is assumed that an

alternating signal voltage received across terminals 1, 2 is applied through a suitable impedance 3 and a step-up transformer 4 to the grid of an amplifying valve 5, of which the normal grid-cathode potential derived from battery 6 is such that a large current flows in the plate circuit, thereby holding relay 7 operated and the associated contacts 8, 9 open and closed respectively. The amplified alternating current signal is applied through condenser 10 across an impedance, which may if desired be a resonant circuit 11, 12, tuned to the required signal frequency. The alternating voltage received across this impedance is rectified by any suitable rectifier 13, for instance, of the metal oxide type, and applied across a condenser 14 which is shunted by a high resistance 15 in parallel with a relatively low resistance 16. This voltage across condenser 14 increases the negative grid-cathode voltage of valve 5, which causes the anode current to fall, but the presence of the applied signal prevents the anode current from falling sufficiently to cause relay 7 to release since the positive halves at least of the alternating signal voltage applied to the grid will be giving rise to pulses of current in the anode circuit. If the applied signal stops suddenly, however, these pulses will cease but since the condenser 14 is not at once discharged through resistance 16, the anode current falls sufficiently to release relay 7. Contact 8 in the local signal circuit closes, whilst contact 9 opens so that condenser 14 can now discharge only through the high resistance 15, and thus the relay 7 remains released for an appreciable period, for instance 2 seconds, until the condenser 14 has discharged and thereby permitted the anode current to rise again to a value sufficient to operate the relay. If on the other hand the signal stops slowly, the condenser 14 discharges through the low resistance 16 before the anode current has fallen sufficiently to permit relay 7 to release and hence the contact 8 is not closed.

It may be pointed out that if a circuit tuned to the special signal frequency is associated with the rectifier as in the arrangement shown in Fig. 1, the effect of currents of other frequencies which may be present in the received signal will be to increase the anode current without supplying the extra negative grid potential so that these currents will have no tendency to cause the release of relay 7.

It will be understood also that if there are a plurality of different signaling frequencies employed in respect of which signals may be sent simultaneously, the transformer 4 will be pro-

vided with a corresponding number of secondary windings each connected to the grid of the valve in the corresponding receiving equipment. If the number of different frequencies is considerable
 5 however it may be preferable to make use of simple filter circuits instead of the input transformer 4 so that each set of receiving equipment will be supplied with only a relatively small amount of signals of frequencies other than its
 10 operating frequency.

The arrangement illustrated in Fig. 3 shows a somewhat similar circuit which, however, does not make use of a rectifier for obtaining a negative grid cathode potential but instead obtains
 15 similar results by initial amplification of the incoming signal so as to obtain a flow of grid current. The signal voltage applied to terminals 21 and 22 is extended to the series tuned circuit comprising condenser 23 and inductance 24 and is
 20 then amplified by the valve 25 the grid of which is connected to the junction point of condenser 23 and inductance 24. The anode circuit of the valve 25 includes the inductance 26 and is connected to the grid of the valve 31 by way of the
 25 condenser 34, suitable grid bias being provided by the battery 32. As in the previous instance the anode circuit of valve 31 includes a responding relay 27 having contacts 28 and 29 and shunted by the condenser 30 to provide a low
 30 resistance path for the alternating component of the current. Resistance 35 which is comparatively high corresponds to resistance 15 in the previous arrangement whereas resistance 36 which is of much lower value is connected up by
 35 way of contacts 29 which are closed when relay 27 is energized.

The operation of the circuit is similar to that previously described; an incoming signal is amplified by valve 25 to a value which causes
 40 grid current to flow and charge condenser 34. If the signal stops suddenly, the anode current falls sharply owing to the negative charge on its grid produced by condenser 34 being no longer counteracted by the positive signal half waves
 45 obtained from the anode circuit of valve 25 and accordingly relay 27 releases. Thereupon the discharge circuit for condenser 34 through the comparatively low resistance 36 is interrupted and discharge can then only take place compara-
 50 tively slowly through resistance 35. Accordingly relay 27 remains de-energized for an appreciable time to close a control circuit at contact 28. On the other hand, if the signal stops slowly, condenser 34 is enabled to discharge through the
 55 comparatively low resistance 36 before the intermittent positive potential due to the signal is removed and hence relay 27 remains operated.

The types of signal receiver just described are suitable for discrimination between tone signals that can stop quickly, and speech signals that may be of the same frequency as the tone signals, but which do not stop quickly. The application of the invention is not confined, however, to this discrimination between tone and speech signals
 60 but it may be used for discriminating between any two alternating current signals having the same frequency, but arranged to stop at substantially different rates. A transmitted signal may be made to stop slowly by incorporating in the
 70 transmitted signal circuit after the signal is stopped a suitable resonant circuit of low decrement.

If a signal consisting of a train of impulses of the correct frequency is transmitted, the receiver
 75 relay releases when the first impulse ceases and

with suitable impulse speed remains released until the next impulse is received. This impulse produces additional relay current, which can be made to cause the relay to operate again. The relay releases once more when the second
 80 impulse ceases. After the final impulse the receiver relay remains released for a longer period and then attains its normal operated state. It is found that impulses up to at least a frequency of 20 per second may be successfully received in
 85 this manner.

Alternatively with a somewhat different adjustment of the relay it may be arranged that the relay remains released through the train of impulses and only re-operates when they cease, when there is sufficient time for the condenser to be substantially completely discharged.

The same principle of securing different effects according as a signal stops suddenly or slowly may be applied to direct current circuits and a simple example of such an application is illustrated in Fig. 2. In this figure it is assumed that current from a suitable battery normally flows over the contacts of the key K to operate the relays A and B at the distant end of the signaling
 100 line. Relay B is provided with a small copper slug to make it slightly slow to release and the adjustment of the two relays is such that relay B requires a larger current to maintain it operated than relay A. The condenser CN which is preferably an electrolytic condenser with a capacity of the order of 500 mf. is normally connected across the battery and is thus fully charged. Relays A and B are also normally operated while
 105 the relay C is normally de-energized.

If now the key K is operated to the right, the current flow over the line will be suddenly reduced to zero and relays A and B will release, relay A before relay B in consequence of the latter's copper slug. In these circumstances no circuit is completed for relay C and the circuit X
 110 to be controlled is closed over contacts c2 and c3. When the key is again restored to normal at the end of the signal period, relays A and B are both again operated and the conditions are restored to normal.

If now key K is operated to the left, the battery will be disconnected from both the condenser and the line and the condenser will discharge over
 125 the line, thereby securing that the time taken for the current to fall to zero may be as much as one second. In these circumstances in view of the fact that relay A will hold on a smaller current than relay B, relay B will be the first to de-energize and consequently a circuit will be completed for relay C which thereupon at armature c1 completes a locking circuit for itself, at armature c2 closes the circuit Y to be controlled and at armature c3 opens a point in the circuit X so
 130 as to prevent this circuit being closed when relay A subsequently falls away. As before, conditions are restored to normal when the key is released. It will be understood that the condenser CN need not be permanently connected across the line as
 140 shown but may be connected up only when a signal is to be sent, thereby permitting satisfactory use of the line for other purposes, e. g. speech.

In the case of direct current working the same principle could readily be applied to produce different effects according as a current was started slowly or suddenly the differences being obtained as in the case just described by the use of a large capacity condenser.

What I claim as new and desire to secure by Letters Patent is:

1. In an electrical signaling system, a signaling circuit, means for transmitting signals in response to cessation of normal current flow in said signaling circuit, and receiving equipment operated differently by currents of similar character in accordance with the sudden or gradual change of the current flow.

2. In an electrical signaling system, a line, means for transmitting signals in response to variations in the flow of direct current over said line, a receiving equipment including two relays each having different release times and sensitivities, each of said relays connected to said line, the first of said relays having the quicker release time is released before the second relay in case the current flow stops suddenly and the said first relay is maintained operated until after the second relay is released in case the flow of current falls gradually.

3. In an electrical signaling system wherein voice frequency alternating signaling currents and speech currents are transmitted over a signaling circuit, a receiving apparatus, a condenser in said receiving apparatus charged in response to the receipt of said currents, means responsive to the sudden interruption of said signaling currents and the charged state of said condenser for operating said receiving apparatus, said receiving apparatus non-operative at the time the current flow ceases in case the said condenser is discharged by the gradual fall of current flow during speech transmission.

4. In an electrical signaling system wherein alternating signaling currents within the voice frequency range and currents of other frequencies are transmitted over a signaling circuit, a receiving apparatus including a condenser, a thermionic valve, a relay and an anode circuit, said thermionic valve including a suitable grid bias to effect the normal operation of said relay in the anode circuit, a circuit tuned to the signaling frequency connecting the anode to the grid circuit, circuit arrangements whereby the currents of any frequency increases the anode current while in consequence to the connections of the tuning circuit the currents of signaling frequency charges said condenser to increase the negative of the grid to reduce the anode circuit, said relay released to operate said receiving apparatus only in response to the sudden cessation of said currents of signaling frequency.

5. In an electrical signaling system wherein voice frequency alternating signaling currents are transmitted over a signaling circuit, a responding equipment including a thermionic valve and a direct current relay, said relay connected in the anode circuit of said valve, a condenser included in the grid circuit of said valve, means for charging said condenser in response to signal-

ing current incoming over said signaling circuit, and a discharge circuit provided for said condenser over a circuit including a low resistance and a normally closed contact on said relay.

6. In an electrical signaling system as claimed in claim 2 including a third relay, two circuits controlled by said third relay for signaling purposes, and a circuit for controlling the operation of said third relay controlled jointly by said two relays.

7. In an electrical signaling system as claimed in claim 2, means including a charged condenser connected to the line for gradually reducing the flow of signal current.

8. In an electrical signaling system as claimed in claim 2, means including a charged condenser connected to the line for gradually reducing the flow of signal current, and means responsive to said last means for transmitting a signal.

9. In an electrical signaling system as claimed in claim 3 including a valve for first amplifying the incoming signal and for charging the said condenser by the flow of grid current due to the heavy input.

10. In an electrical signaling system as claimed in claim 4 including a rectifier and means for charging said condenser by potential supplied from the anode circuit by way of said rectifier.

11. In an electrical signaling system as claimed in claim 5 including a rectifier, a circuit tuned to a particular signaling frequency, and means for operating said responding equipment only in response to said particular frequency by the association of said tuned circuit with said rectifier.

12. In an electrical signaling system as claimed in claim 3 including a high resistance shunt permanently connected to said condenser.

13. In an electrical signaling system as claimed in claim 4 including a high resistance shunt permanently connected to said condenser for maintaining said relay released until said condenser has discharged through said high resistance.

14. In an electrical signaling system as claimed in claim 4 including circuit arrangements whereby said relay is adjusted to reoperate in response to a further signal and also reoperate after a predetermined interval in case no signal is received to enable a train of impulses to be repeated in case the interval between signals is less than the said predetermined interval.

15. In an electrical signaling system as claimed in claim 5 having a grid bias voltage to produce a considerable plate current when no signaling current flows over said signaling current.

16. In an electrical signaling system as claimed in claim 5 including a plurality of further similar responding equipments, and a filter circuit for each equipment corresponding to a particular frequency for feeding the correct frequency signals to the corresponding responding equipment.

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