March 7, 1944. F. FAIRLEY ET AL 2,343,759

ELECTRIC SIGNALING SYSTEM

Filed June 17, 1942 2 Sheets-Sheet 1

FIG. 1.

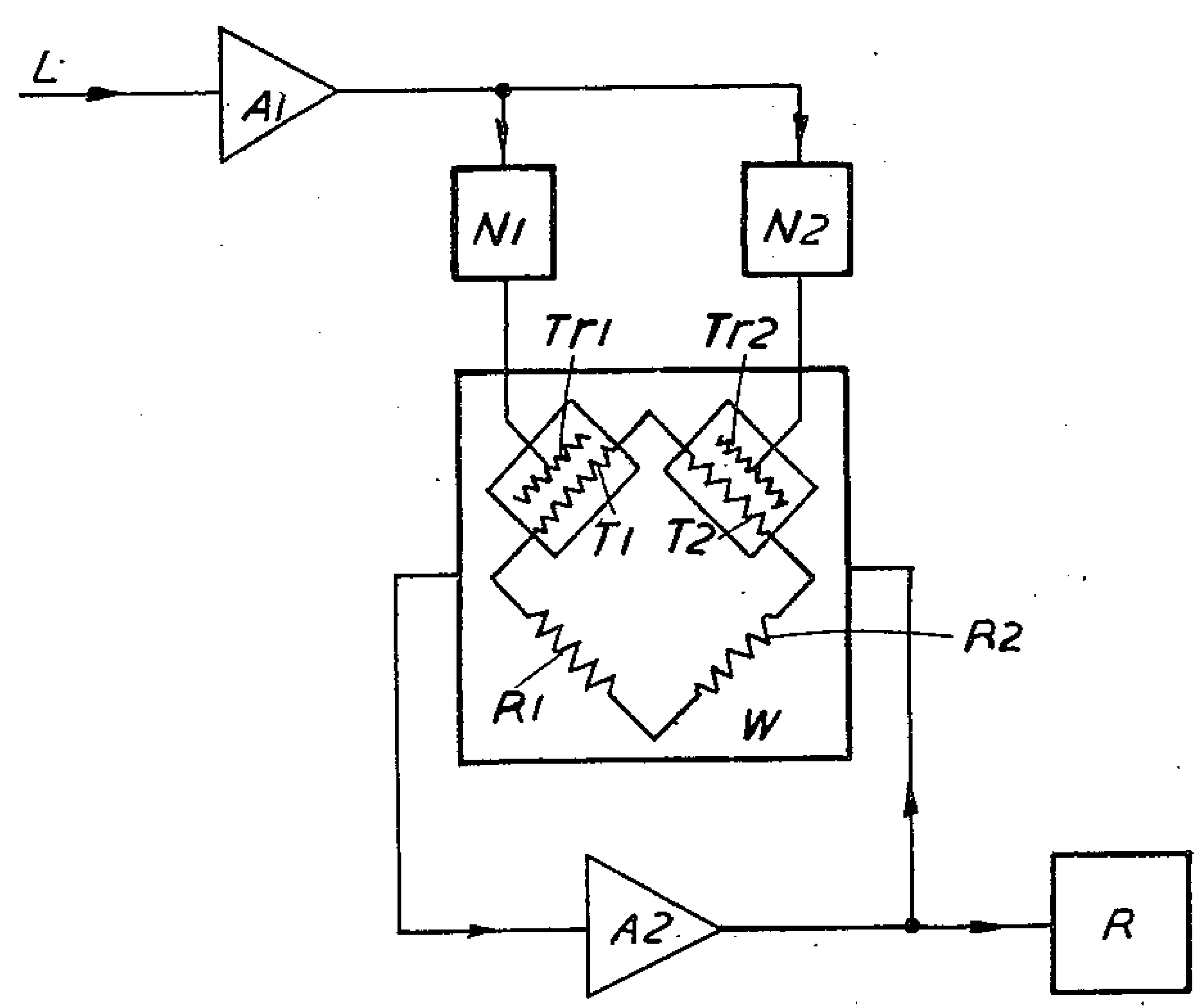

FIG. 3.

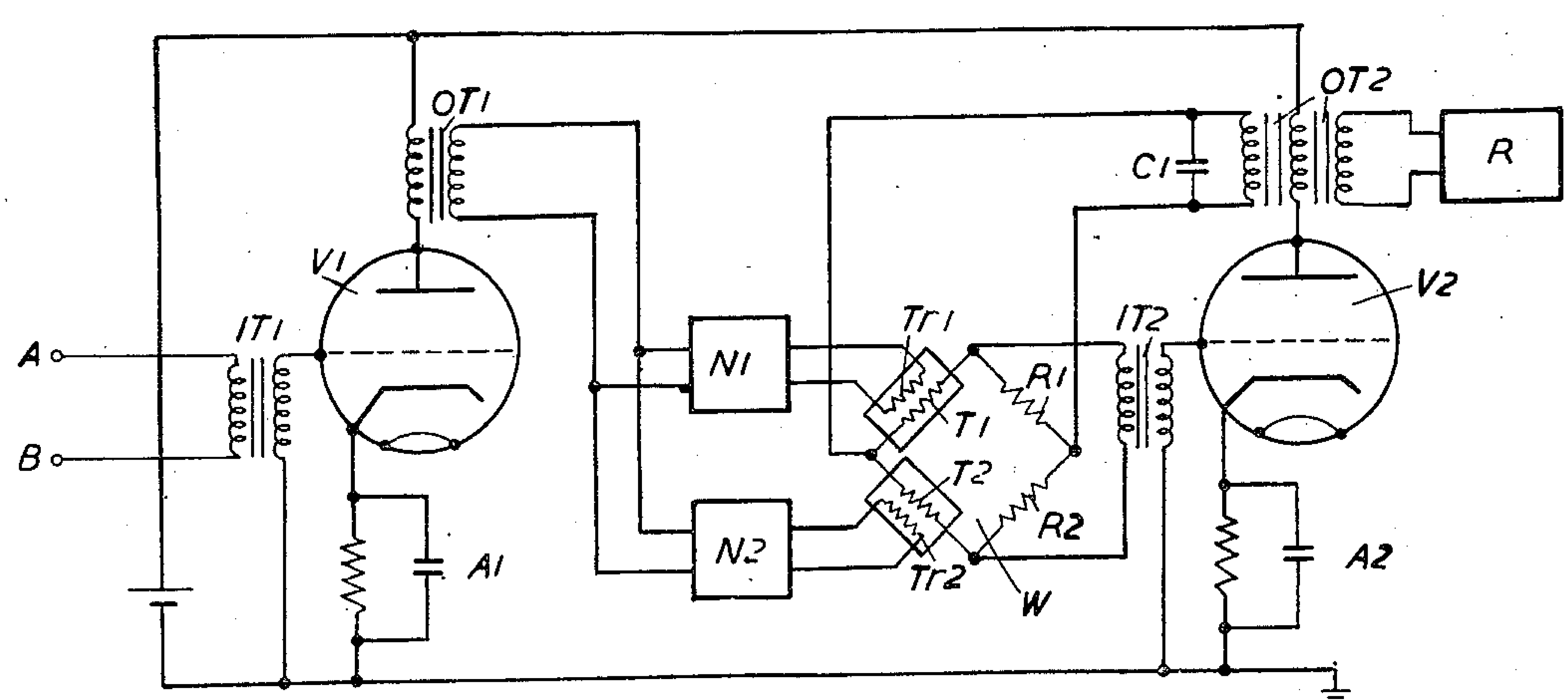

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FIG. 2.

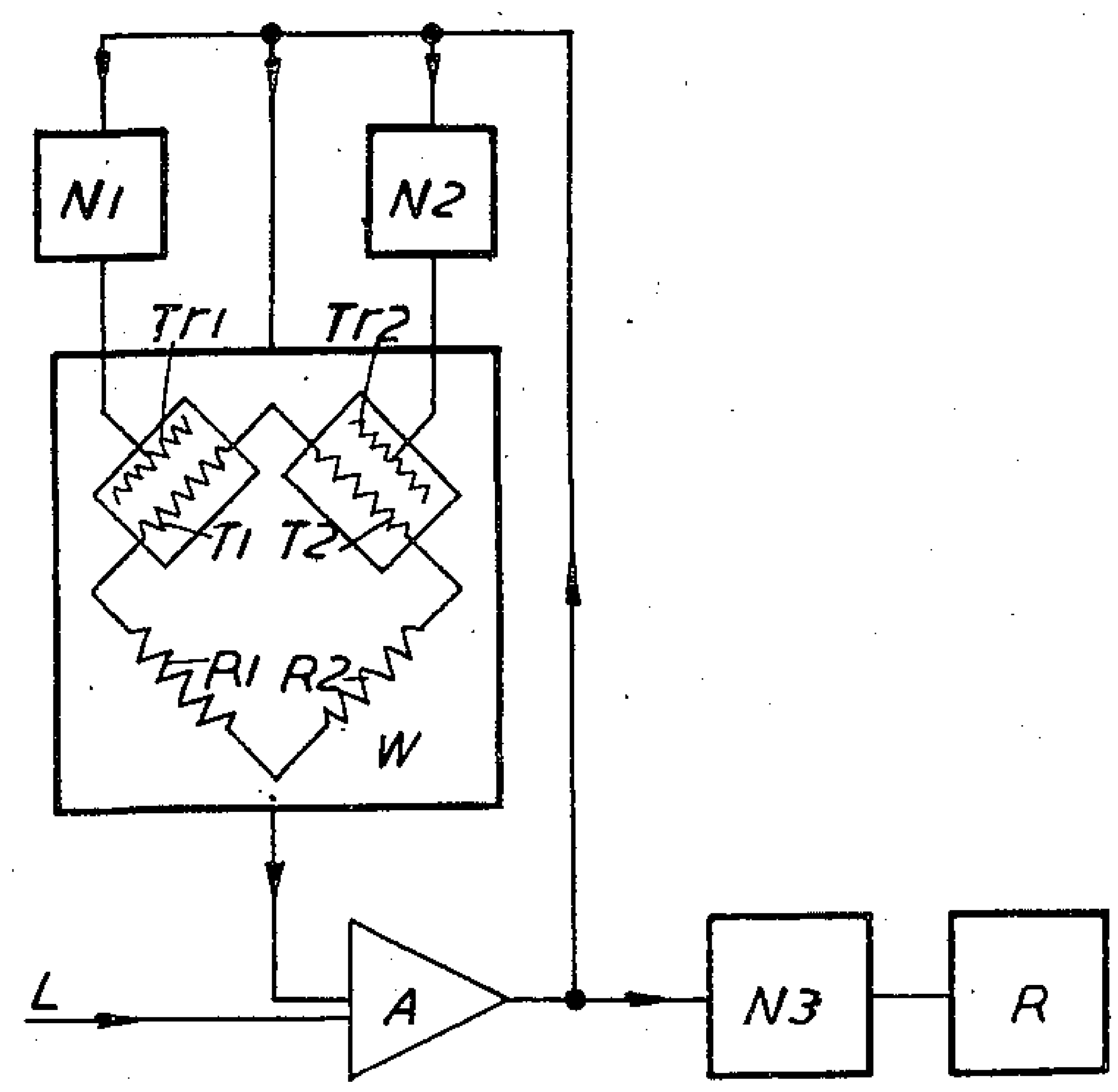
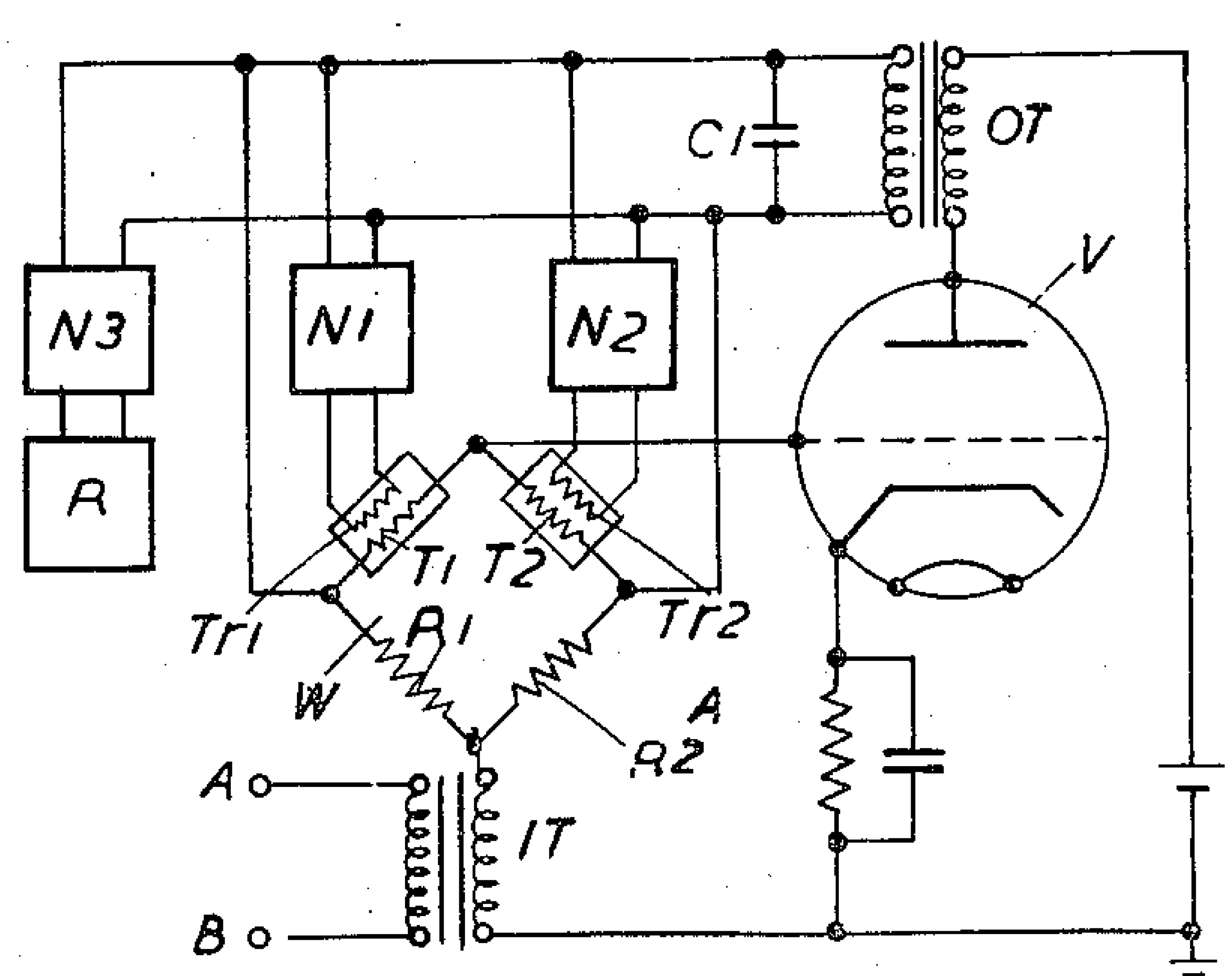


FIG. 4.



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ELECTRIC SIGNALING SYSTEM

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In Great Britain September 15, 1941

12 Claims. (Cl. 179—84)

The present invention concerns selective electric wave receivers and in particular those used for receiving ringing and dialing signals transmitted over telephone communication circuits.

In voice frequency ringing systems used in communication circuits, difficulty has been encountered in the past in preventing the accidental operation of the ringing receiver during the transmission of speech. The frequency transmitted from the ringing signals is also a component of the speech band, and it frequently happens that the level of the ringing frequency component during conversation momentarily rises sufficiently to operate the ringing receiver, which is permanently bridged across the line. This will cause a false operation of the ringer which is generally termed "talking up."

Various devices have been proposed and used hitherto to avoid this difficulty. Such devices are often complicated, involving guard circuit arrangements with critically adjusted relays for preventing the operation of the ringer while speech is being received, and sometimes employing more than one ringing frequency. Such arrangements are even then not always completely effective in preventing false operation.

One relatively simple arrangement for avoiding false operation of the ringing arrangements by voice currents is described in United States Patent No. 2,117,835. This makes use of a silver sulphide resistance which is also used in carrying out the present invention. The arrangement of the above mentioned patent operates by virtue of the high voltage of the ringing currents which causes the silver sulphide resistance to present negligible impedance to the ringing currents; but at the low speech voltages the impedance is so high that any currents which can reach the ringer are made so small as to be unable to affect it. The present invention is an improvement on this arrangement but operates on an entirely different principle and has a wider application. Discrimination between the voice and ringer currents is obtained in virtue of the different frequency distribution of energy of these currents and does not depend upon nor require a large voltage difference. In the arrangement of this invention, not only do the voice currents fail to operate the ringer, but in addition positive means comes into operation actively to prevent it from responding except when the particular ringing currents are received.

The object of the present invention is to provide a simple and reliable signal receiver in which talking up is effectively prevented without the use of extra frequencies or guard circuits or relays. While its primary application is to ringing or dialing arrangements in connection with transmission systems, it is not limited to such arrangements but is applicable much more broadly to any cases where operation is desired by incoming signal waves having some particular type of frequency distribution of energy, and where operation must not occur when the incoming waves have some other type of distribution.

The invention in its preferred embodiment depends for its effect on an arrangement whereby the incoming signals do not themselves operate the receiver, but cause local oscillations to be generated for this purpose, and then only if the frequency distribution of the incoming energy is substantially of some predetermined form. In the case of particular interest, the incoming energy which is to operate the receiver will be practically of a single frequency, but it might equally well consist of several single frequencies, or bands of frequencies. When the incoming energy has some other distribution, no oscillations can be produced and generally the effect will be further to inhibit any tendency to oscillation.

While talking up on speech is extremely unlikely with the circuit of the invention, it is conceivable that that might happen if the speech should momentarily consist of practically only the ringing frequency at high level. Even in this unlikely event operation of the receiver is prevented by the use of temperature dependent resistance elements such as thermistors or lamps whose response to changes is relatively slow, in a manner to be fully explained below.

In view of the slow response of the thermistors, the circuits of the invention would not receive dialing impulses satisfactorily. Therefore, in order to be able to take advantage of the invention in a dialing receiver so that it shall not be subject to risk of talking up, a prefix signal would be used when dialing which signal would operate the device as described, causing suitable means to function to condition the receiver so as to enable it to receive the impulses for the duration of the dialing, after which it would revert to the "safety" condition.

According to one feature of the invention, a selective electric wave receiver comprises means for comparing the amount of received energy contained within certain ranges of frequencies with the amount of received energy contained within certain other ranges of frequencies; and means to cause the operation of a signal receiving device when the ratio of the first mentioned to the last mentioned amount of energy is greater than a given value; according to another feature a selective electric wave receiver includes means to cause the operation of a signal receiving device on the receipt of signals having a predetermined frequency distribution of energy, and means for preventing operation of the said device when signals having some other frequency distribution of energy are received.

According to the invention, also, the signal receiving device may be operated by local oscillations which are caused to be generated on the receipt of signals having a predetermined frequency distribution of energy, such oscillations being prevented when signals with some other energy distribution are received: and slow acting, thermally operated means may be provided for discriminating between signals having a predetermined energy distribution and those having some other energy distribution.

The invention will be better understood from the following detailed description read in conjunction with the accompanying drawings in which—

Figs. 1 and 2 are block schematic diagrams used for explaining the principles of the invention; and

Figs. 3 and 4 are schematic circuits of preferred embodiments thereof.

In the circuits shown in the above mentioned Figs. 3 and 4, valves are indicated as triodes with indirectly heated cathodes, the heating circuits not being shown in the interests of clearness. The invention is not limited to the use of such valves, and pentodes, or any other convenient types, may be used if preferred. A battery is shown by the conventional symbol to indicate the plate potential source, although this should not be taken to mean that the plate circuits are necessarily supplied in this way, nor that any particular voltage is implied. The arrangements for biasing the control grids are shown in the form of the usual condenser-shunted resistance connected in series with the cathode, but this is likewise not an essential arrangement. It is to be understood that circuits operated in accordance with this invention may be provided with any suitable valves, and that appropriate arrangements may be supplied in any of the well known ways.

Figs. 1 and 2 are block schematic circuit diagrams which will be used to explain the principles involved. Fig. 1 represents the circuit of a signaling receiver suitable, for instance, for receiving the ringing currents in a telephone transmission system employing voice frequency ringing. The ringing currents are applied from the line L, and after passing through the receiver, cause the operation of a relay system of some suitable known type indicated at R.

The signals are applied to an amplifier A1 and the relay system R is operated from an amplifier A2 which is provided with a feed back path through a Wheatstone bridge network W. This network has four branches of which two comprise the constant resistances R1 and R2 and the other two comprise resistances T1 and T2 which are variable with the temperature. T1 and T2 are respectively provided with electrically insulated heater coils operated from the amplifier A1. One pair of diagonal terminals of the network W is connected to the input of amplifier A2 and the other pair of diagonal terminals is connected to the output thereof. The network W accordingly provides a feedback path for the amplifier.

The resistances T1 and T2 are preferably composed of material (such for instance as silver sulphide) whose resistance varies with the temperature and may be mounted in containing envelopes Tr1 and Tr2 with the corresponding heater coils as indicated in Fig. 1. In this form they may constitute elements known as thermistors of the indirectly heated type, of which the resistance depends mainly on the current flowing through the heater coil and practically not at all on the current flowing through the resistance element itself. Such thermistors have a negative temperature coefficient of resistance.

The heaters are each connected through a corresponding network N1 or N2 to the output of amplifier A1. Any currents arriving from L will be amplified and will flow through the heaters of Tr1 and Tr2 after being attenuated in the networks N1 and N2. The input circuits of these networks are shown in Fig. 1 connected in parallel. They could equally well be connected in series if preferred.

Now let it be assumed that there are no signals coming in from the line and that the values of the resistances R1, R2 and T1, T2 in the Wheatstone bridge network are so chosen that the feedback produced in the circuit of amplifier A2 is negative. It will then be quiescent. Now assume that a ringing signal comes in, consisting, for example, of a single frequency applied continuously, and suppose also that it passes through the network N1 substantially without attenuation, but that it is blocked by network N2. The heater of Tr1 will then receive a current and will heat the corresponding resistance T1, but Tr2 will be practically unaffected. The result will be to decrease the resistance of T1. Now assume that when the temperature of Tr1 has become constant, the resistance T1 has so changed the condition of the bridge network that the feedback has become positive. The amplifier A2 may then be caused to generate oscillations at a suitable frequency determined, for example, by a tuned circuit appropriately located in the amplifier, which oscillations can be used to operate the relays in R by a suitable rectifying circuit (not shown) located in R. Thus the effect of applying ringing current to the input of amplifier A1 is to cause (indirectly) the operation of the relays in R as desired. When the ringing current is removed the thermistor Tr1 will cool down and in a short time the feedback will again become negative and the oscillations operating R will cease. It is preferable, though not strictly necessary, that the feedback introduced by the Wheatstone bridge network should be negative when no signals are being received: it may however be zero, or even positive so long as the amount of feedback is insufficient for there to be any risk of the amplifier oscillating.

In general, the ringing receiver will be bridged across the line so that it will be subjected to the ordinary speech transmission currents as well as to the ringing currents. These speech currents cover a band of frequencies perhaps 2700 cycles wide or more with a certain average type of energy distribution. The ringing frequency will of course occur, but the energy associated therewith will generally be small compared with the total energy in the band. In Fig. 1 if the network N2 were so designed that it allows substantially the whole band to pass except the ringing frequency, and if N1 were so designed that it blocks substantially the whole band except the ringing frequency, then heater of Tr1 will receive a very small amount of energy due to the ringing frequency component of the speech band, but that of Tr2 will receive a large amount of energy due to nearly the whole band. The result will be that the resistance of T1 will be slightly reduced but that of T2 will be reduced much more. The effect can be made to change the bridge network in such a manner that the feedback produced becomes more negative than before, so that the amplifier A2 is taken further away from the oscillating condition and so remains quiescent, the relay system R being unaffected. The speech currents have thus operated to prevent the response of the relay system R.

The networks N1 and N2 could for example be respectively complementaary narrow band pass and band elimination filters, the narrow band being central round the ringing frequency.

The thermistors Tr1 and Tr2 are relatively slow to operate and their temperature is chiefly determined by the instantaneous energy in the corresponding heater integrated over a period of time, which is controllable by suitable design, and which can be made long compared with the period or duration of any of the frequencies in the speech wave. Thus even if the speech energy should consist momentarily of only the ringing frequency at an abnormally high level (a condition which in many voice frequency ringing systems causes false ringing), its effect on the thermistor Tr1 will be negligible as it will not have had time to respond. On this account the system of the invention is entirely proof against talking up.

In order to make clear the working of the invention, a particular (though not unlikely) series of circumstances has been assumed in the above explanation. The invention is however of a much broader nature, and is not necessarily applicable only to ringing systems. As an example of another possible arrangement, a dialing system might be operated over the line, employing two voice frequencies simultaneously applied thereto, and the network N1 and N2 might then consist of band pass and band elimination filters having two bands corresponding to the two frequencies. It might also be assumed that the voice frequency circuit is used sometimes for picture transmission, in which case the energy distribution in the band would be quite different from that for ordinary speech. This is therefore another case in which the receiver must operate when it receives energy having one kind of distribution and must not operate when it receives energy of another kind of distribution; stated in this way the broadest aspect of the invention is expressed.

In order to appreciate how the receiver of the invention will be designed to fulfill the requirements just stated, let E1 and E2 be the energy received respectively by the heaters of Tr1 and Tr2 integrated over the appropriate time. The tendency for oscillation of the amplifier A2 will be determined by the ratio T1/T2 which is in turn a function of E1/E2. The values of E1 and E2 are determined by the networks N1 and N2 and by the energy distribution of the band of frequencies applied to the input terminals. In order that the receiver shall operate for a distribution D1 and shall not operate for a distribution D2, the ratio T1/T2 must change in a manner tending to make the feedback positive when D1 is applied, and must change in the opposite manner when D2 is applied. Knowing the nature of D1 and D2 it will be possible by well known means to design the networks N1 and N2. In many cases such as those described above, N1 and N2 can be relatively simple filters.

An important difference between the method of the present invention and that of the United States Patent No. 2,117,835 referred to above, may be seen in the fact that the circuit of the invention may be designed so that if the incoming currents contain any additional currents outside the predetermined frequency or band of frequencies, the relay device R is still prevented from operating by the presence of these outside frequencies although the predetermined frequency, or band, is there also. In the arrangement of Patent No. 2,117,835 the relays will always operate when the predetermined frequency is present with sufficient voltage, irrespective of what other frequencies are also there; it is accordingly unable to detect the presence of extra frequencies.

By a modification of the arrangement of Fig. 1 a proportion of the output of the amplifier A2 may be fed back to the input of amplifier A1. If the oscillation frequency of A2 be chosen so that it will be passed by the network N1, and excluded by N2 then the arrangement may be made to lock itself when once operated. Thus if the ringing current be applied long enough to start the oscillations of amplifier A2 those oscillations will be fed through the amplifier A1 to the heater of Tr1 and can be made to maintain its temperature at or near the temperature produced by the incoming ringing currents, so that the feedback is kept positive. The relays in R will then remain operated until the arrangement is broken down by independent means (such as by momentarily cutting either of the feedback connections). The feedback connection between the amplifiers A2 and A1 may be made in any convenient way.

More generally, the oscillating frequency and the networks N1 and N2 may be so chosen and designed that when some of the energy of the oscillations is fed back in the manner just described, and after ringing current has been applied, the ratio T1/T2 is so modified that the feedback produced by the network W either is made more positive, or is unaltered, or is made less positive, than it otherwise would have been if the applied currents acted alone. In the first case the arrangement may lock itself permanently in operation; in the last case it may be made to operate intermittently while the ringing currents are applied, by suitable choice of the conditions, this being possible as a result of the relatively slow response of the thermistors. In the latter case, also, all operation ceases a short time after removal of the ringing currents. In the case when the arrangements are such that the feedback introduced by W is not affected by the oscillations, the time of the release of the relay system R will be prolonged due to the energy of the oscillations which will continue to flow with diminishing amplitude in the bridge, after removal of the ringing current.

In Fig. 2 is shown another arrangement employing only one amplifier A. The incoming signals are applied from the line L to the input of this amplifier which is provided with a feedback path through a Wheatstone bridge network W similar to that described in connection with Fig. 1. The heaters of the thermistors Tr1 and Tr2 and in this case connected through the networks

N1 and N2 to the output of the amplifier A, and in this case an additional network N3 is interposed between the amplifier output and the relay system R. This network is necessary to ensure that the relay system R shall be operated by the locally generated oscillations and not directly by the incoming signal.

With this arrangement, feedback is produced, as before, through the network W, which will be so adjusted that initially this feedback is negative, (or at least insufficiently positive for oscillations to occur). If single frequency ringing currents be received, they will be amplified by the amplifier A and will thereafter reach the input circuits of the networks N1, N2 and N3. If N2 and N3 be designated to exclude the ringing current and N1 to pass it, then as in the case of Fig. 1 the heater of Tr1 will receive energy and that of Tr2 will receive practically none. Arrangements are made so that the corresponding reduction of the resistance T1 causes the feedback to become positive thereby initiating oscillations, the frequency of which is chosen so that they can pass the network N3 and operate the relay system R. If it be assumed that the oscillations are also excluded by N1 and N2 then the circuit behaves as in the case of Fig. 1 without the additional coupling between the amplifiers A1 and A2.

The networks N1 and N2 will preferably be designed as before so that N1 substantially excludes the band of speech frequencies and N2 passes it, and so that the ratio T1/T2 changes to make the feedback more negative when speech currents are being received.

With this circuit, the network N3 should preferably be designed substantially to exclude the speech currents in order that the relay system R may not be in any danger of being operated directly by them. A convenient though not essential arrangement would be to choose the frequency of oscillation so that it lies outside the band of speech and ringing frequencies. N3 could then, for example, be a relatively simple low pass or high pass filter.

By a modification of Fig. 2, the variable resistances T1 and T2 are of self heated type, and are shunted respectively by discriminating networks M1 and M2, the networks N1 and N2 shown in Fig. 2 being removed. T1 and T2 may for example be directly heated thermistors: that is, they may consist of silver sulphide resistance elements not provided with heating coils, but designed to be heated by the current flowing through them. T1 and T2 might also consist of other types of element whose resistance depends upon the current flowing through them, such as lamps, and may have a positive or a negative temperature coefficient of resistance. The networks M1 and M2 will be two terminal impedances designed to shunt the elements T1 and T2 in a selective manner. All the other elements will be shown in Fig. 2 and operate in the same way. Thus if it be assumed, as before, that single frequency ringing currents are used, then (the bridge network W having been adjusted to produce negative feedback initially when no currents are being received), M1 and M2 might be designed so that the ringing current passes through T1, but substantially none of it through T2, thereby making the feedback positive; and so that the speech currents flow through T2 but practically none through T1 making the feedback more negative; oscillations for operating R being produced in the first case but not in the second. Network N3 as in the case of Fig. 2 should preferably exclude the speech currents from R to prevent it from being directly operated by the speech currents.

The operation of the circuit of Fig. 2 and the modification thereof have been explained for clearness in terms of a particular case of a line transmitting ordinary speech and using a single frequency ringing system. As in the case of Fig. 1, these circuits are not limited to such a particular system, but may be designed to discriminate between two systems of currents comprising bands of frequency with different energy distributions D1 and D2, by proper design of the discriminating networks, according to the principles explained above in connection with Fig. 1. It will also be noted that the oscillations can be made to affect the resistances of the elements T1 and T2 of the bridge W, either directly, or through the heaters, provided that their frequency and the discriminating networks are so chosen and designed that a proportion of the energy of the oscillations is allowed to flow through one or both thermistors.

Thus, as in the case of the modification of Fig. 1 in which feedback is provided between the amplifiers A1 and A2, the oscillations may be made to affect the bridge so that the feedback tends to be made more positive, or less positive, or is unaffected. In the first case the circuit may be made to lock in operation after application of the ringing currents, and in the second case intermittent operation can be made to occur during the period of application of the ringing currents.

Figs. 3 and 4 show the circuits of two preferred embodiments of the invention according to Figs. 1 and 2 respectively, in which corresponding elements are given the same designations; and as the operation of such elements has already been fully explained they will not be again described in detail.

In Fig. 3, the amplifier A1 comprises a thermionic valve V1 provided with input and output transformers IT1 and OT1 respectively. Incoming signals are applied from the line to the input terminals A, B connected to the primary winding of the transformer IT1, and the secondary winding of the transformer OT1 is connected to the networks N1 and N2. The amplifier A2 likewise comprises a thermionic valve V2 with input and output transformers IT2 and OT2 respectively. The diagonals of the Wheatstone bridge network are connected respectively to the primary winding of the transformer IT2 and to a secondary winding of OT2. The relay system R is connected to another secondary winding of OT2.

A condenser C1 is shown connected across the first mentioned secondary winding of OT2 for the purpose of providing a tuned circuit for fixing the oscillation frequency of the valve V2. Alternatively, C1 could be connected across the primary winding of IT2; and any other convenient arrangement might obviously be used instead.

Feedback between the valves V1 and V2 for obtaining locked or intermittent operation could be obtained, for example, by providing OT2 and IT1 each with an extra winding and connecting them together.

Fig. 4 shows the circuit of another preferred embodiment, according to Fig. 2. The amplifier A comprises a thermionic valve V provided with input and output transformers IT and OT respectively. Incoming signals are applied from the line to input terminals A and B connected to the primary winding of IT. One pair of diagonal terminals of the Wheatstone bridge network W is connected to the control grid circuit of the valve V in series with the secondary winding of IT. The other pair of diagonal terminals is connected to the secondary winding of OT in parallel with the input circuits of the networks N1, N2 and N3. Feedback is thus directly obtained between the plate and grid circuit of the valve. The circuit operates exactly as explained in connection with Fig. 2. Alternative arrangements may be obtained by interchanging the positions of the bridge W and the secondary winding of the input transformer IT so that the latter is directly connected to the control grid of the valve and the former is connected to ground; also the connections between the bridge W and the control grid circuit may be made through an additional input transformer the secondary winding of which is connected in series with that of IT: other like arrangements are clearly possible.

The circuit of Fig. 4 may also be modified in accordance with the modified arrangement of Fig. 2 whereby the networks N1 and N2 are omitted, and directly heated thermistors (or lamps) shunted by impedance networks M1 and M2 are used, exactly as previously described.

Although the invention has been explained in terms of specific embodiments, it is not intended to be limited thereto; and various other arrangements in accordance with the principles explained will occur to those skilled in the art.

What is claimed is:

1. A selective electric wave receiver comprising filter networks of unlike frequency outputs, output connections from the respective filter networks to the opposite branches of a Wheatstone bridge network including resistances having negative temperature coefficient of resistance, and a signal receiving device connected to the output side of the bridge network and said receiving device being operative when the ratio of energy of one branch circuit to the other is greater than a given value.

2. A selective electric wave receiver comprising filter networks of unlike frequency output, output connections from the respective filter networks to the opposite branches of a Wheatstone bridge network including thermistor resistances having negative temperature coefficient of resistance, an amplifier connected to the opposite branches of the bridge network to establish a feedback circuit thereto and a signal receiving device connected to the output side of the amplifier and said receiving device being operative when the ratio of energy of one branch circuit to the other is greater than a given value.

3. A selective electric wave receiver comprising a plurality of filter devices of unlike frequency output, output connections from the respective filter devices to the opposite branches of a Wheatstone bridge network including slow acting thermistor resistances having negative temperature coefficient of resistance, an amplifier connected to the opposite branches of the bridge network to establish a feedback circuit thereto and a signal receiving device connected to the output side of the amplifier.

4. A selective electric wave receiver comprising an amplifier, filter networks of unlike frequency characteristics connected to the output of said amplifier, output connections from the respective filter networks to the opposite branches of a Wheatstone bridge network including thermistor resistances having negative temperature coefficient of resistance, a second amplifier connected to the opposite branches of the bridge network to establish a feedback circuit thereto and a signal receiving device connected to the output side of the second amplifier and said receiving device being operative when the ratio of energy of one branch circuit to the other is greater than a given value.

5. A selective electric wave receiver comprising an amplifier, filter networks of unlike frequency output, output connections from the respective filter networks to the opposite branches of a Wheatstone bridge network including indirectly heated thermistor resistances having negative temperature coefficient of resistance, a second amplifier connected to the opposite branches of the bridge network to establish a feedback circuit thereto and a signal receiving device connected to the output side of the second amplifier and said receiving device being operative when the ratio of energy of one branch circuit to the other is greater than a given value.

6. A selective electric wave receiver comprising an amplifier, filter networks of unlike frequency output connected to the output of the amplifier, output connections from the respective filter networks to the opposite branches of a Wheatstone bridge network including directly heated thermistor resistances having negative temperature coefficient of resistance, an amplifier connected to the opposite branches of the bridge network to establish a feedback circuit thereto and a signal receiving device connected to the output side of the amplifier and said receiving device being operative when the ratio of energy of one branch circuit to the other is greater than a given value.

7. A selective electric wave receiver comprising an amplifier, a pair of filter networks of unlike frequency output connected to the output of the amplifier, a Wheatstone bridge network including thermistor resistances having negative temperature coefficient of resistance, output connections from the respective filter networks to heater coils of the thermistor resistance, an amplifier connected to the opposite branches of the network to establish a feedback circuit thereto and a signal receiving device connected to the output side of the second amplifier.

8. A selective electric wave receiver comprising an amplifier, filter networks of unlike frequency output connected to the output of the said amplifier, a Wheatstone bridge network including thermistor resistances having negative temperature coefficient of resistance, output connections from the respective filter networks to heater coils of the thermistor resistance, a second amplifier connected to the opposite branches of the bridge network to establish a feedback circuit thereto, said second amplifier having frequency oscillation range corresponding to the frequency output of one of the filter networks and a signal receiving device connected to the output side of the second amplifier and responsive to the operative when the ratio of energy of one branch circuit to the other is greater than a given value.

9. A selective electric wave receiver comprising a thermionic valve amplifier having associated input and output transformers, filter networks of unlike frequency output connected to the secondary of said output transformer, a Wheatstone bridge network including thermistor resistances having negative temperature coefficient of resistance, a second thermionic valve amplifier having associated therewith input and output transformers, the latter having its primary winding

connected in series with the plate circuit of the first thermionic valve and having a secondary winding connected to the first pair of diagonals of the bridge network and said latter input transformer having a primary winding connected to the input of the receiver and having a secondary winding connected to the control grid circuit of said second valve and in series with the second pair of diagonals of the bridge network, and a signal receiving device connected to another secondary of the latter output transformer.

10. A selective electric wave receiver comprising a thermionic valve amplifier having associated input and output transformers, filter networks of unlike frequency output connected to the secondary of said output transformer, a Wheatstone bridge network including thermistor resistances having negative temperature coefficient of resistance, a second thermionic valve amplifier having associated input and output transformers, connections from the diagonals of the bridge network respectively to the primary of the latter input transformer and to the secondary of the latter output transformer and a signal receiving device connected to another secondary of the latter output transformer.

11. A selective electric wave receiver comprising a thermionic valve amplifier having associated input and output transformers, filter networks of unlike frequency output connected to the secondary of said output transformer, a Wheatstone bridge network including thermistor resistances having negative temperature coefficient of resistance, a second thermionic valve amplifier having associated input and output transformers, the latter having its primary connected in series with the plate circuit of the first thermionic valve, connections from the diagonals of the bridge network respectively to the primary of the latter input transformer and to the secondary of the latter output transformer and a signal receiving device connected to another secondary of the latter output transformer.

12. A selective electric wave receiver comprising a thermionic valve amplifier having associated input and output transformers, filter networks of unlike frequency output connected to the secondary of said output transformer, a Wheatstone bridge network including thermistor resistances having negative temperature coefficient of resistance, a second thermionic valve amplifier having associated input and output transformers the latter having its primary connected in series with the plate circuit of the first thermionic valve, and having a secondary winding connected to the first pair of diagonals of the bridge network, a condenser shunting the latter secondary and said latter input transformer having a secondary winding connected to the control grid circuit of said second valve, connections from the other diagonals of the bridge network to the primary of the latter input transformer and a signal receiving device connected to a secondary of the latter output transformer.

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