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WAVE SIGNALING SYSTEM

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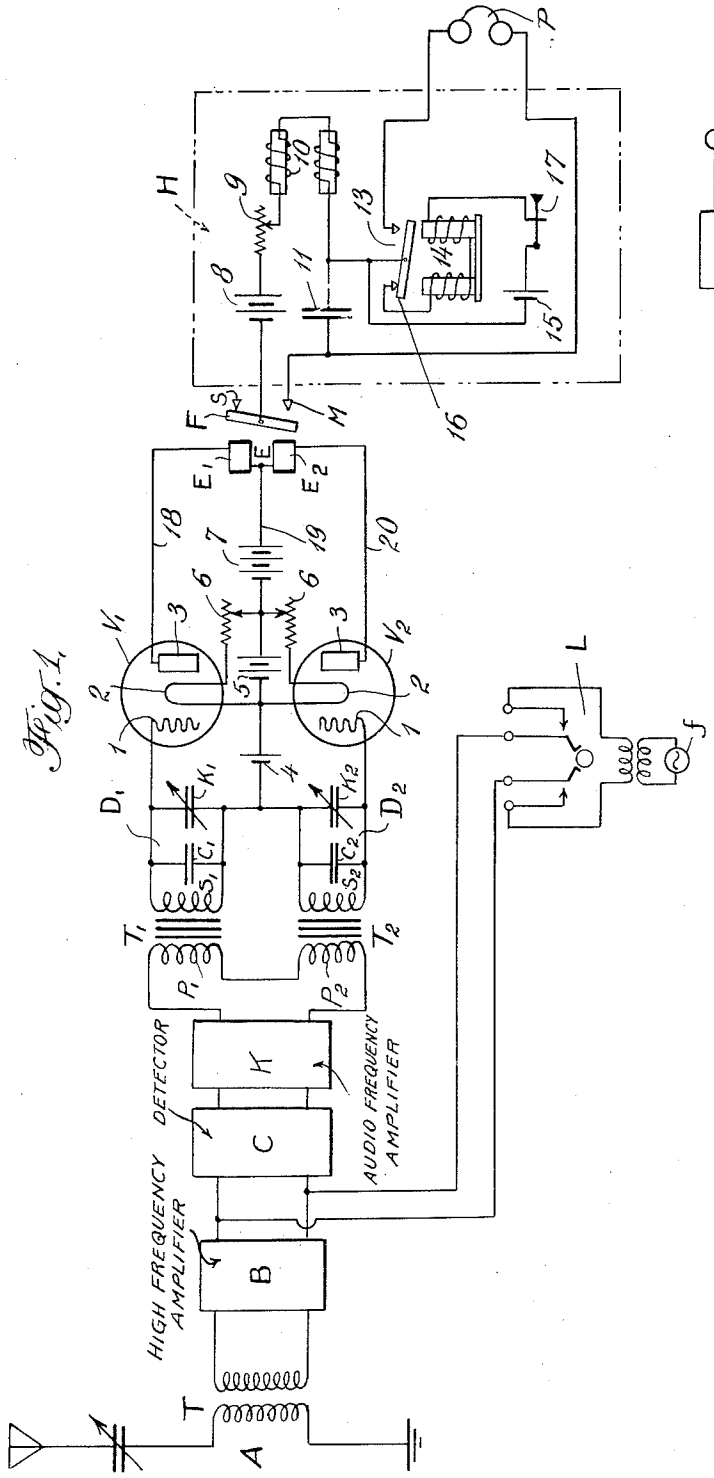


Fig. 1.

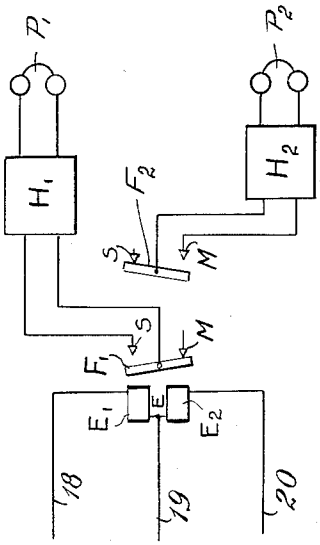


Fig. 2.

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WAVE SIGNALING SYSTEM

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8 Claims. (Cl. 250—8)

This invention relates primarily to radio telegraph systems, particularly to the receiving portion of such systems.

A primary object of the invention is to provide a radio telegraph receiving system wherein static, atmospheric, or other undesirable electrical disturbances impinging upon the antenna are balanced out, minimized and substantially prevented from affecting the signal indicating device, whereas the desired signaling currents are segregated with high selectivity for suitable operation of the signal indicating element.

A further object is to provide a radio telegraph system of the type specified wherein the components of the disturbing currents which are not completely balanced out and thus eliminated are nevertheless prevented from entering the circuit containing the signal indicating device, whereby the signals therein are at all times clear and distinct being unmasked by the disturbing effects.

The system is characterized in that it requires for signaling purposes the transmission of but a single frequency unmodulated carrier wave or a carrier wave modulated at but a single audio frequency.

Due to the balanced arrangement of the circuit elements, the present invention may be readily adapted to the simultaneous reception of two different sets of signals operating on the same carrier frequency but modulated at slightly different audio-frequencies.

Other features of the system disclosed herein which are deemed novel to the present invention will appear more fully from the subsequent description.

It is quite a general characteristic of radio receiving sets including those intended for the reception of telegraph signals, that static or other atmospheric disturbances as well as those arising from power sources, telephone or telegraph conductors and other electrical circuits, tend to render reception of the desired signals difficult, if not impossible, due to the masking effect produced thereby upon the signal indicating device. This results from the fact that the disturbing currents are in the absence of special precautions amplified along with the signaling currents and to the same degree within the limits of the amplifying equipment, as a consequence of which the relative effects produced upon the signal indicating device are in the same proportion as the relative magnitudes of the signal and disturbing currents flowing in the antenna circuit.

The present invention relates to improvements in and additions to the radio receiver whereby the effects of the disturbing currents are balanced out, while the signal current is selected, amplified and passed on to the signal indicator, where the effects produced are entirely free from disturbances due to the undesired currents.

The invention is accomplished by connecting in sequence, an antenna circuit for picking up the signaling wave which also unavoidably picks up the undesired disturbing currents, a high-frequency amplifier which amplifies the signal and disturbing currents to the same extent, a detector for rendering audible both the signal and the disturbing currents, an audio-frequency amplifier for amplifying the frequencies within the audible range, and a divided circuit arrangement for eliminating the disturbing currents while selecting the signal.

The divided circuit comprises two audio-frequency transformers having their primary windings connected in series to the audio-frequency amplifier output, and having their respective secondary windings sharply tuned to slightly different audio-frequencies by means of suitable capacities in shunt therewith. Each tuned secondary winding is connected to the input of a three-electrode thermionic device individual thereto operating as a current rectifier; the output circuits of the rectifier tubes being in turn connected respectively to the opposite windings of a polarized relay, such for example, as the type known as a British post office relay.

The polar relay windings are differentially connected in the respective vacuum tube output circuits as a result of which current supplied to the relay by one tube tends to operate the armature against one contact while current supplied by the other tube tends to operate the armature against its opposite contact. Thus for equal currents simultaneously supplied by the two tubes the resultant effect on the armature is nil. Preferably the polar relay is so adjusted that the armature is normally biased against one contact, a circuit to operate a signal indicating device being completed through the armature and the opposite or normally open contact of the relay.

The audio-frequency transformers referred to are of special construction in that the secondary windings are of low resistance and are tunable within the audio-frequency range preferably above 1000 cycles, inasmuch as the most serious disturbing currents are for the most part of low audio-frequency. The secondary windings may be such that the inherent capacity between turns is sufficient to tune them to approximately the desired audio-frequency. Or this result may be accom-

plished by connecting suitable fixed capacities in shunt therewith. Supplemental variable capacities are also connected in shunt with the transformer secondaries in order to adjust the tuning in each instance to exactly a desired frequency as explained below.

The respective transformer secondaries are tuned by means of the variable capacities to slightly different audio-frequencies separated by about 200 cycles, as for example 1000 and 1250 cycles. Due to the low resistances of the windings, the tuning is very sharp whereby a very high impedance is obtained at the resonant frequency which falls off at first rapidly and then more slowly for frequencies diverging by increasing amounts from the resonant frequency. Furthermore, owing to the slight difference in resonant frequencies of the two circuits, the resultant impedance-frequency curves substantially coalesce except for the regions in the immediate vicinity of the resonant frequencies.

It results from this similarity in impedance frequency characteristics of the two transformer secondary circuits coupled with the fact that the primary windings are series connected to the detector output, that the disturbing currents, the more important of which after detection are as stated within the low audio-frequency range below 1000 cycles, are impressed upon the rectifier tubes in substantially equal amounts at each instant whereby identical current effects are produced in their respective output circuits. And, inasmuch as the polar relay is differentially connected to the two output circuits, the resultant effect produced on the armature thereof is zero.

The series connection of the primary transformer windings ensures that the same instantaneous current will flow in each winding; while the similarity in impedance-frequency characteristics of the tuned circuits at other than the resonant frequencies causes equal instantaneous voltages due to the disturbing currents to be applied thereto. These instantaneous voltages in general, due to the fluctuating character of the disturbing currents, operate by shock excitation to set the tuned circuits into oscillation at their respective natural frequencies. Due to the slight difference in frequency of tuning for the two circuits, however, the resultant voltages impressed upon the tubes are substantially identical at each instant.

As regards the signal frequency, however, which it is to be emphasized is of a sustained character, the effect produced is quite the reverse to that of the disturbing currents. Due to the sharp tuning of the resonant circuits, and to the fact that the impedances thereof decrease rapidly for slight frequency divergences on either side of the resonant frequencies, the signal frequency will produce a far greater effect upon the vacuum tube having the input circuit tuned to that frequency than that produced upon the opposite tube. Thus the rectified signal currents flowing in the respective windings of the relay will differ in magnitude by an amount in general more than sufficient to operate the armature against its normally open contact for each pulse of signaling current received, the arrangement of the circuit elements being such as to insure this effect.

Having thus described the principal features of the invention in general terms, reference will now be had to the drawing for a detailed explanation of a specific embodiment thereof.

In the drawing Figure 1 shows in circuit diagram form a complete radio telegraph receiving system in accordance with the present invention; while Figure 2 shows the manner of modifying the circuit of Figure 1 for the reception and automatic separation of two distinct sets of signals.

Referring to the drawing, A represents an antenna circuit tuned to the frequency of the incoming signal, and coupled by means of a transformer T to a radio-frequency amplifier B, the output of which is connected to a detector or demodulator circuit C which serves to convert the radio-frequency into audio-frequency currents. Connected to the detector output is an audio-frequency amplifier K.

The primary windings P_1 and P_2 of two special transformers T_1 and T_2 are connected in series to the output circuit of the audio-frequency amplifier K. The secondary windings S_1 and S_2 which are of low resistance are tuned by means of the fixed capacities C_1 and C_2 to approximately the desired frequencies for operation of the circuit. These capacities C_1 and C_2 may in whole or in part be physically distinct from the secondary transformer windings, or they may constitute the resultant of the natural capacities inherent between turns of the windings. The variable capacities K_1 and K_2 serve to accurately tune the secondaries S_1 and S_2 to audio-frequencies f_1 and f_2 in general differing in frequency by about 200 cycles. The tuned circuit constituting elements S_1, C_1 and K_1, is designated as D_1, while that constituting elements S_2, C_2 and K_2 is designated D_2.

The circuits D_1 and D_2 are connected between grid 1 and cathode 2 of thermionic tubes V_1 and V_2 respectively, which tubes are adapted by means of the common grid biasing battery 4 to operate as rectifier tubes. The cathodes 2 are heated from the common battery 5, the currents being individually adjustable by means of the separate rheostats 6.

Transformer T_1 is connected in reversed fashion relative to transformer T_2 in order that the instantaneous voltages induced in tuned circuits D_1 and D_2 due to currents in the detector output will be impressed in the same sense between grid and filament of tubes V_1 and V_2 respectively.

The plate electrodes 3 of the tubes V_1 and V_2 are connected respectively through the windings E_1 and E_2 of the polarized relay E, and thence in common through the source of space-current supply 7 to the positive terminal of battery 5. The connections to the polarized relay windings are such that equal currents in the plate circuits of tubes V_1 and V_2 produce balancing effects upon the relay armature F so that no operating effect is produced. The armature F is normally biased against its spacing contact S for maintaining a signal indicating circuit H open at the marking contact M of relay E.

The signal indicating device H in the present instance comprises battery 8 having one terminal connected to armature F and the other terminal connected in series through variable resistance 9, choke coils 10, and capacity 11 to the marking contact M. A pair of headphones P are connected across the terminals of capacity 11, through the make-and-break contacts 13 of a buzzer 14, the buzzer being continuously vibrated by energization of its windings from battery 15 through make-and-break contacts 16 during closure of switch 17.

Although the buzzer 14 operates continuously to open and close contacts 13, nothing is heard in headphones P so long as the circuit of battery 8 is open at the marking contact M of relay F.

When, however, the circuit through the marking contact M is closed, battery 8 charges condenser 11 during each interval that the buzzer contacts 13 are open. During the remaining intervals, i. e. while contacts 13 are closed, condenser 11 discharges through telephones P, the circuit constants being such that the discharge is of an oscillatory character adapted to produce a clear and suitable tone in the headset.

The operation of the system as a whole is as follows: The signaling as well as the undesired disturbing currents impinging upon the antenna circuit A are amplified in B, detected in C, and further amplified in K at audio frequency to a degree necessary to satisfactorily operate relay E. The modulated disturbing currents due to the substantially similar impedance characteristics of tuned circuits D_1 and D_2 at other than the resonant frequencies cause substantially equal voltages to be impressed upon the input circuits of tubes V_1 and V_2, whereby equal rectified currents flow in opposition through windings E_1 and E_2 respectively of relay E to produce balancing effects on the armature F so that the operative position thereof is not disturbed.

The modulated signaling current, however, which is of frequency f_2 corresponding to the tuning of circuit D_2, causes a maximum voltage to be impressed upon the input circuit of tube V_2, but a much smaller voltage upon the input to tube V_1 due to the difference in frequency of tuning of the elements D_1 and D_2 coupled with the sharp tuning characteristics thereof. In this instance, therefore, a much larger rectified current flows through winding E_2 than through winding E_1 whereby armature F is operated against its marking contact M so long as a sustained signal is being received. During the interval that the relay is thus actuated against its marking contact a clear tone, produced in the manner explained above, is heard in the headphones P.

It was stated that the armature F of relay E normally rests against its spacing contact S. This may be accomplished in a number of ways as, for example, by permanently biasing the relay either mechanically or magnetically; or by normally transmitting a carrier wave continuously from the sending station modulated by a frequency f_1 corresponding to the tuning of circuit D_1 to actuate relay E against its spacing contact, the carrier wave during transmission of a marking signal being modulated by a different frequency f_2 corresponding to the tuning of circuit D_2 to operate relay E against its marking contact.

Or again, by operation of switch L, a source of frequency f may be impressed upon the detector C to heterodyne an unmodulated steadily received signal frequency to a frequency f_1 for normally holding relay E against its spacing contact, the signal frequency being changed slightly at the transmitting station during keying to produce a heterodyne frequency f_2 for operating the polar relay against the marking contact. If desirable, the "autodyne" method of reception may be resorted to wherein the detector C oscillates continuously to supply the modulating frequency f_1 in which case of course the separate heterodyne source may be omitted

Or still again, if the polar relay is mechanically or magnetically biased to spacing, the heterodyne or autodyne frequency f may act upon a single frequency unmodulated signal wave transmitted in accordance with signals to produce a modulated current of frequency f_2 for operating the polar relay E to marking corresponding to the signals received.

Figure 2 shows a portion of the circuit of Figure 1 as modified for the reception and differentiation of two different sets of signals differing slightly in frequency simultaneously received from two different transmitting stations or possibly from a single station adapted to transmit in this fashion. Conductors 18, 19 and 20 correspond to the like numbered conductors of Figure 1, the complete receiving system for the circuit of Figure 2 being identical with that of the circuit of Figure 1 except for the portion shown.

Referring to Figure 2, the polar relay E is provided with two independently operable armatures F_1 and F_2. Each of armatures F_1 and F_2 is pivoted to operate between a pair of associated contacts S and M, individual thereto. Contacts S are, in each instance, so arranged that a preponderance of rectified signaling current flowing in winding E_1 tends to operate both armatures against their respective contacts M. Contacts M, on the other hand, are so arranged that a preponderance of rectified signaling current flowing in winding E_2 tends to operate both armatures against their respective contacts S. Armature F_1 is normally biased mechanically, magnetically or otherwise, against its contact M, whereas armature F_2 is similarly normally biased against its contact S. Armature F_1 controls a circuit H_1, similar to circuit H of Figure 1 for actuating headphones P_1 in accordance with received signals. Armature F_2 likewise controls a circuit H_2 to actuate headphones P_2.

Assume now that two sets of signals differing slightly in frequency are simultaneously being received, one set of signals comprising a carrier wave modulated at frequency f_1 corresponding to the tuning of resonant circuit D_1, while the other set comprises a carrier wave modulated at frequency f_2 corresponding to the tuning of resonant circuit D_2.

The signals of frequency f_1 after being received and demodulated by detector C, are selected by resonant network D_1 and substantially repressed by network D_2 to produce a preponderance of rectified current in winding E_1 of polar relay E which, as stated, tends to operate both armatures F_1 and F_2 against their respective contacts M. It will be noted, however, that inasmuch as armature F_1 is already on its contact M, it is not affected by said signal. On the other hand, armature F_2 being normally on its contact S is operated in accordance with the received signal of frequency f_1.

In the same fashion the signals received from the other transmitting station which are modulated at frequency f_2 are selected by resonant circuit D_2 to produce a preponderance of rectified current in winding E_2 of the polar relay E, with resultant tendency to operate armatures F_1 and F_2 against their respective contacts S. Armatures F_2 being normally biased against its contact S, is not affected, whereas armature F_1 being normally biased against its contact M is operated in accordance with the received signals of frequency f_2.

It therefore results that with the circuit arrangement shown in Figure 2 signals of frequencies f_1 and f_2 simultaneously received are automatically differentiated in the circuit, the signals of frequency f_1 being heard only in headphones P_1, while signals of frequency f_2 are heard only in the headphones P_2. The static or other inter-

fering currents are, of course, eliminated from both headphones P_1 and P_2, since such currents produce balancing effects on the armatures of the polar relay.

The single relay E of Figure 2 equipped with two armatures may, of course, be replaced by two relays each similar to that of Figure 1.

I claim:

1. A radio telegraph receiving system adapted to minimize the effects of static or other undesirable electrical disturbances comprising, means for receiving and detecting high-frequency disturbing and signaling currents to produce currents of audio-frequency, means for amplifying said currents of audio-frequency, a divided circuit comprising a pair of transformers having their primary windings serially connected to said amplifier output, the secondary winding of one said transformer being sharply tuned by capacitive means in shunt therewith to said signal frequency, the secondary winding of the other said transformer being similarly tuned by other capacitive means to a slightly different frequency, current rectifying means individual to said transformer secondaries, and signal indicating means differentially associated with the output sections of said rectifying means respectively, whereby the resulting disturbing currents are substantially balanced out and said signal current is rendered effective to operate said indicating means.

2. A radio telegraph receiving system adapted to minimize the effects of static or other undesirable electrical disturbances comprising, means for receiving and detecting high frequency disturbing and signal currents to produce currents of audio-frequency, means for amplifying said currents of audio-frequency, a divided circuit comprising a pair of audio-frequency transformers having their primary windings serially connected in opposition to said amplifier output, the secondary winding of one said transformer being sharply tuned by capacitive means in shunt therewith to said signal frequency, the secondary winding of the other said transformer being similarly tuned to a slightly different frequency, current rectifying means individual to said tuned transformer secondaries, a polar relay having its windings differentially connected in the output sections of said rectifying means respectively, whereby the resulting disturbing currents are substantially balanced out whereas the signal current is rendered effective to operate said relay, and signal indicating means controlled by said relay.

3. A radio telegraph receiving system as set forth in claim 2 wherein said signal indicating means comprises a condenser chargeable through an inductance from a potential source, an acoustical element connected across said condenser through contacts of an independently and continuously operable buzzer element, whereby said condenser is alternately charged and discharged in oscillatotry fashion through said acoustical element to produce a clear tone therein in accordance with said signal current.

4. A radio telegraph receiving system adapted to simultaneously receive two different sets of signals transmitted on the same carrier frequency but modulated at slightly different audio frequencies while minimizing the effects of static or other undesirable electrical disturbances comprising, means for receiving and detecting said signaling and disturbing currents to produce corresponding currents of audio-frequency, means for amplifying said currents of audio-frequency, a divided circuit connected to said amplifier output, one portion of which is sharply tuned to one said signal frequency, the other portion being similarly sharply tuned to the other said signal frequency, current rectifying means in each said portion, polarized relay means, a pair of independently operable armatures associated with the relay means, said relay means being differentially associated respectively with the output sections of said rectifying means whereby the effects of said disturbing currents are substantially balanced out whereas said signaling currents are rendered effective to operate said pair of armatures whereby one said armature responds to signals of one said frequency only and the other said armature responds to signals of the other said frequency only, and signal indicating means individual to and controlled by said armatures respectively.

5. A radio telegraph receiving system adapted to receive a carrier wave modulated in accordance with signals at a single audio-frequency and adapted further to minimize the effects of static or other undesirable electrical disturbances comprising, means for receiving, detecting and amplifying at audio-frequency said disturbing currents along with the signaling current, a divided circuit comprising a pair of audio-frequency transformers having their primary windings serially connected in opposition to said amplifier output, and having secondary windings respectively of low resistance, the secondary winding of one said transformer being sharply tuned by capacitive means in shunt therewith to said signal frequency, the secondary winding of the other said transformer being similarly tuned to a slightly different frequency, current rectifying means individual to said tuned secondaries, a polar relay differentially connected in the output sections of said rectifying means respectively, whereby the resulting disturbing currents produce substantially balancing effects on said relay whereas the signal current is rendered effective to operate said relay, and signal indicating means controlled by said relay.

6. A radio telegraph receiving system adapted to receive unmodulated radio frequency signal currents of single frequency, and adapted further to minimize the effects of static or other undesirable electrical disturbances comprising, means for receiving disturbing currents along with said signals, a local source of single frequency current and detecting means for rendering said signaling and disturbing currents audible, means for amplifying said currents of audio-frequency, a divided circuit comprising a pair of audio-frequency transformers having their primary windings serially connected to said amplifier output, the secondary winding of one said transformer being sharply tuned by capacitive means in shunt therewith to the signal frequency, the secondary winding of the other transformer being similarly tuned to a slightly different frequency, current rectifying means individual to said tuned transformer secondaries, a polar relay having its windings differentially connected in the output sections of said rectifying means respectively, whereby the resulting disturbing currents produce substantially balancing effects on said relay whereas the signal current is rendered effective to operate said relay, and signal indicating means controlled by said relay.

7. A radio telegraph receiving system adapted to receive a carrier frequency modulated at two

slightly separated audio-frequencies in accordance with marking and spacing signals, and adapted further to minimize the effects of static or other undesirable electrical disturbances comprising, means for receiving, detecting and amplifying at audio-frequency the disturbing currents along with the signaling currents, a divided circuit comprising a pair of audio freqency transformers having their primary windings serially connected to said amplifier output, the secondary windings being of low resistance, one said secondary sharply tuned by capacitive means in shunt therewith to the audio-frequency corresponding to said spacing signal, the other said secondary being similarly sharply tuned to the audio frequency corresponding to said marking signal, current rectifying means individual to said tuned transformer secondaries, a polar relay having its windings differentially connected in the output sections of said rectifying means respectively, whereby the resulting disturbing currents produce substantially balancing effects upon said relay whereas said spacing signals are effective to operate said relay against one contact and said marking signals are effective to operate said relay against its other contact in accordance with said signals.

8. A radio telegraph receiving system adapted to minimize the effects of static or other undesirable electrical disturbances comprising, means for receiving and detecting high-frequency disturbing and signaling currents to produce currents of audio-frequency, a divided circuit comprising a pair of transformers having their primary windings serially connected to said detector output, the secondary winding of one said transformer being sharply tuned by capacitive means in shunt therewith to said signal frequency, the secondary winding of the other transformer being similarly tuned by other capacitive means to a slightly different frequency, current rectifying means individual to said transformer secondaries, and signal indicating means differentially associated with the output sections of said rectifying means respectively, whereby the resulting disturbing currents are substantially balanced out and said signal current is rendered effective to operate said indicating means.

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