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TELEPHONE SYSTEM

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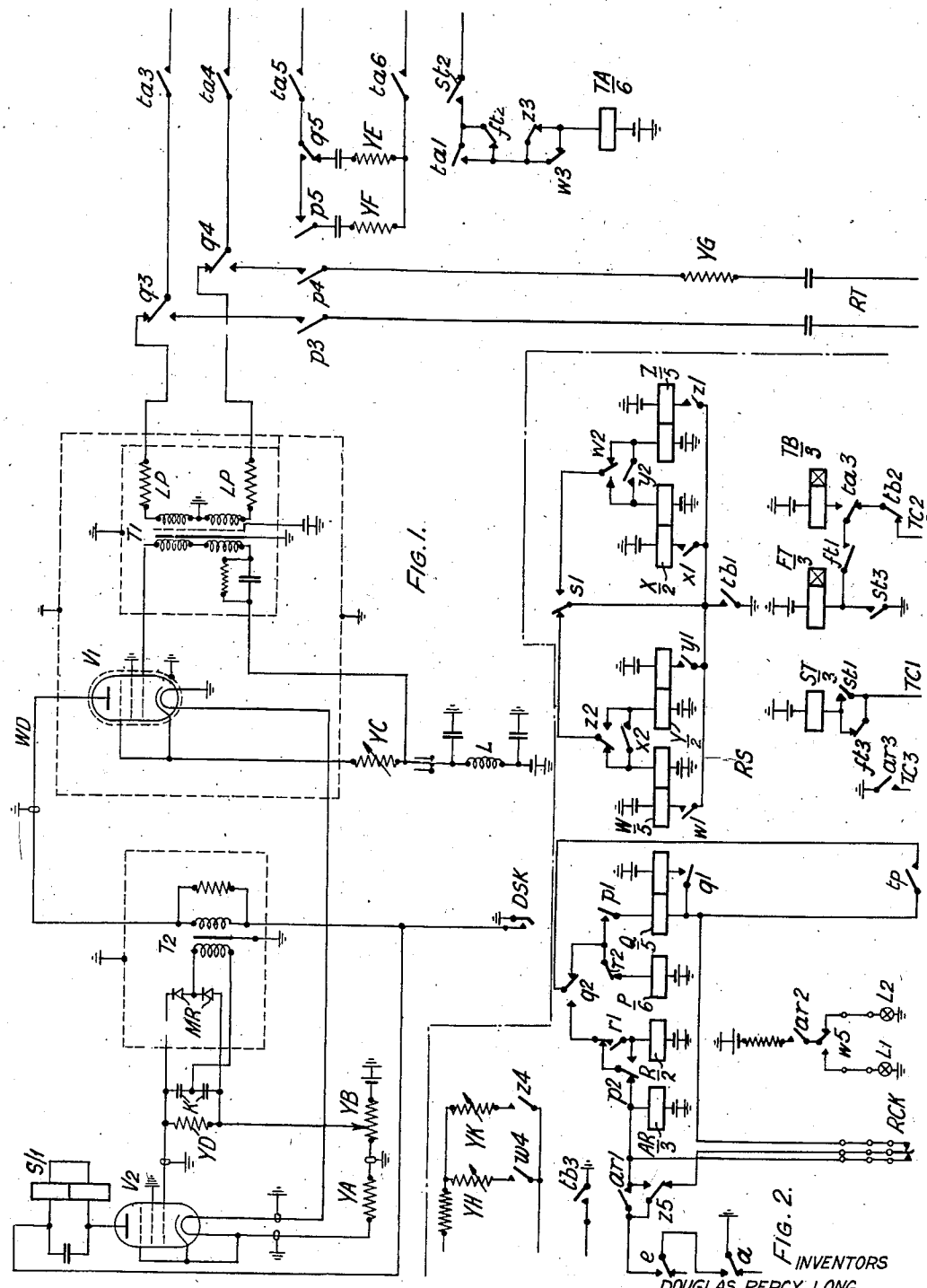


FIG. 1.

FIG. 2.

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TELEPHONE SYSTEM

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The present invention relates to telephone systems, and more particularly to testing arrangements in or for such systems.

The testing arrangements envisaged find an especially useful application in exchanges such as the so-called trunk exchanges where lines are terminated which are sufficiently valuable to render it important that they should not be treated as engaged for substantial periods with no speech currents passing over them.

In a telephone system, owing to a fault in apparatus or to faulty circuit operation a line may test engaged to apparatus such as a searching selecting switch although the line is not actually being used to provide a conversational circuit between the calling and called parties of a connection or for the setting up of such a circuit. Thus, for example, in the case of a trunk line in which the supervisory signals are transmitted as pulses of speech-frequency current, the line may test engaged at one of its ends because of the fact that a clearing pulse previously sent towards this end has been blocked at the time of its transmission by the untoward presence of other currents on the line, or because such a clearing pulse has not been correctly transmitted.

According to one feature of the present invention, testing arrangements in or for a telephone system comprise testing means adapted to determine whether a line tests free or tests engaged and further testing means adapted to determine whether or not a line which tests engaged is carrying speech-frequency currents.

In carrying out this feature it would normally be arranged that the second-mentioned testing means only effects the giving of a signal or alarm indicating that a line which tests engaged is not carrying speech currents or other speech-frequency currents, and/or only performs some other action appropriate to the finding that such a condition exists on the line, if it has encountered this quiescent condition on the particular line for a sufficient period.

According to another feature of the invention the testing means adapted to determine whether a line which tests engaged is or is not carrying speech-frequency currents is also adapted to distinguish between speech currents and continuous tone currents of speech frequency. This feature may be conveniently carried into effect by arranging that a relay is intermittently operated by speech currents, owing to the fact that such currents fluctuate and lack continuity, and is steadily operated by a continuous tone current of speech frequency, intermittent operation of the relay during a period having a different result from a steady operation for this period. The feature is an important one, as the presence of speech currents on a line which tests engaged is a sign that the line is being usefully employed, while the presence of a continuous tone current for an undue period indicates a faulty or unnecessary holding of the line out of service.

According to yet another feature of the invention the testing arrangements comprise means for transmitting a clearing signal to a line which tests engaged but is not carrying speech-frequency currents. This feature finds an especially useful application in a system in which clearing signals are transmitted as pulses and in which a line may test engaged at one of its ends because of faulty or blocked transmission of a clearing pulse.

In the testing arrangements according to the invention which are specially contemplated, a wave detecting device is associated with an access switch which is adapted to connect the device to any one of the lines to be tested. The access switch is arranged to test the several lines in turn in the manner which is well known in connection with automatic routine testing, but in this case the access switch is arranged to halt on each line which tests engaged, and to connect the wave detecting device thereto. The said device is one capable of determining what the condition of a line to which it is connected is in so far as the presence or absence of speech-frequency currents on the line is concerned, and is adapted to cause the condition of such line to be signalled to indicating or alarm apparatus or to cause the access switch to step on, depending upon which action is appropriate. Actually, an appropriate indication or alarm is given if a line connected to the wave detecting device is found not to be carrying conversational speech currents while the access switch is caused to step on to test a further line if the presence of speech currents is detected. In order that false indications or alarms shall not be given due to temporary conditions, it may be arranged that a period of delay elapses between the connection of the wave detecting device to a line and the giving of an indication or alarm.

The said wave detecting device may comprise or have associated with it auxiliary equipment such as a relay set, a time delay device adapted to measure off a delay period prior to the giving of an indication or alarm, and suitable circuits for interconnecting these items. It may conveniently be arranged that the presence of speech

currents on a line to which the device is connected causes fluctuating operation of a relay forming part of the device, the presence of a continuous tone current of speech-frequency causes steady operation of this relay, and the complete absence of any speech-frequency currents leaves the relay unaffected, the arrangements as a whole being such that in each of these three cases the response or lack of response of the relay brings about appropriate circuit changes in the relay set whereby either the access switch is caused to step on, or is held and the transmission of a signal to the time delay device effected. The holding of the access switch and the transmission of a signal to the time delay device occur in the second and third of the cases mentioned, and the signal may depend on which case is concerned, different signals bringing about the measurement of different delay periods and the giving of different indications or alarms. The relay set may provide for the transmission of a clearing pulse to a line.

An embodiment of the invention is shown by way of example in the accompanying drawing comprising Figs. 1 and 2. In the drawing WD is a wave detecting device comprising a limiting valve V1, a detector V2, both being pentodes, and coupling arrangements. RS is a relay set comprising control relays ST, TA, TB, FT, signal relays W, X, Y, Z, release control relays P, Q, R and alarm relay AR. Associated with the relay set is an access switch (not shown) which may be of the type commonly used in automatic routiners and which has access to a trunk multiple, and a delay device of which contacts *a* and *e* only are shown.

In making a test on trunk lines, the access switch is started and the control relays are operated in a manner depending on whether a line on which the access switch has come to rest tests free or engaged. If this line tests free, the access switch moves on and tests the next line in the multiple. If the line tests engaged, the control relays connect the wave detecting device to the trunk to determine whether speech frequency current is present in the line or not and if it is, whether it is intermittent e. g. speech, or continuous, e. g. tone. If it is determined that speech frequency current is present, the signal relays, by their operation bring about either the release and advancement of the access switch or the transmission of a signal to the delay device. If no speech frequency current is present on the line, a signal will be transmitted by the signal relays to the delay device and this signal may differ from that transmitted if the speech frequency current found is uninterrupted. The operation of the delay device effects the giving of an indication to that effect and the access switch remains held so long as the engaged condition exists. If the release control relays are connected up by means of key RCK, uninterrupted speech frequency current is applied to the line for a period to simulate a release signal in a speech frequency signalling system with the object of effecting release of the line which may have become faulty.

The wave detecting device WD will now be referred to in more detail. The device becomes connected to a trunk line by the operation of one of the control relays, viz. relay TA, the line being connected to the line transformer T1 over pads LP. The primary winding of the transformer has a centre tapping which is earthed. The secondary winding is connected in the grid circuit of the pentode V1, the circuit including a condenser shunted by a resistance. In the anode circuit of the pentode is connected the primary winding of a transformer T2 with a resistance in shunt therewith, the secondary winding of the transformer being connected to a circuit of the voltage doubler comprising rectifiers MR and condensers K which are shunted by a resistance YD, the circuit being connected in the grid circuit of pentode V2. The grid bias is provided by resistances YB and YA. In the anode circuit of the pentode V2 is connected a relay S of low inertia and inductance shunted by a condenser. The connection to the cathode of pentode V1 includes an inductance L shunted by two condensers in series with their junction point earthed. This is to prevent interference which may be present in the battery supply leads from reaching the device and causing faulty operation. At each pentode the suppressor grid and the cathode are connected together and the screen grid is connected to the positive terminal of the battery (earth) in the usual manner. The pentode V1, and transformers T1 and T2 are each screened and a further screen surrounds the transformer T1 and pentode V1, each screen being earthed. The pentode V1 operates as a limiter valve and the pentode V2 as a direct current rectifier. The anodes of the two pentodes are connected to the positive pole of the battery by throwing key DSK.

When the device is connected to a line in which speech frequency current is present, the grid of pentode V1 which normally has no positive biassing potential, is biassed by the additional grid current due to the flow of speech frequency current through transformer T1 and anode current flows during the positive portions of the grid swing. The anode current thus follows the envelope of the grid signal irrespective of its amplitude. A potential is developed across resistance YC in the cathode circuit and is injected into the grid circuit out of phase with the input signal voltage and therefore the greater the value of resistance YC the lower is the sensitivity of the circuit. The anode current flows through the primary winding of transformer T2 which is shunted by a resistance to flatten the frequency response curve and the induced current in the secondary winding is converted to direct current in the voltage doubler circuit and is then applied to the grid circuit of pentode V2. The D. C. potential overcomes the negative grid bias and anode current flows operating relay S and the only contact of this relay moves from its back to its front position. Any alternating current in the anode circuit flows past relay S through the shunting condenser. The grid circuit of pentode V2 is normally biassed so that anode current is just not flowing and the amount of bias is readily altered by a variation in the amount of resistance of YB included in the grid circuit. The resistances YB and YC enable the receiver to be adjusted so that it will not operate on extraneous noise which may be present on a line.

Circuit arrangements provide for the connection, by contacts of one of the control relays, TA, of the wave detecting device to the wipers of the access switch which is a stepping switch adapted to be stepped round bank contacts connected to trunk lines and to stop on each contact to allow a test to be made. The access switch is started in any convenient manner in

an access control circuit and a circuit is closed at the same time over wire TC1 and contact *ft3* for relay ST. Relay ST operates, locks itself to wire TC1 over contact *st1*, connects relay TA to the test wiper of the access switch at contact *st2* and closes an operating circuit for the slow operating relay FT at contact *st3*. If the trunk line to which the access switch is now connected is free, no earth will be present on the test bank contact and relay TA will not operate. After an interval relay FT operates and at contact *ft1* extends earth over contacts *st3*, *ta2*, *tb2* to wire TC2. This gives a signal to the access control circuit to cause the access switch to be advanced to the next contacts during which advance relay ST is released and when the contacts are reached, relay ST is re-operated.

If the trunk line to which the access switch is stepped is in an engaged condition, earth will be present on the test bank contact and after the operation of relay ST relay TA will be operated in a circuit including contacts *w3* and *z3* of two of the signal relays, contacts *ft2* and *st2* and the test wiper of the access switch to earth on the test bank contact. Relay TA locks itself to this earth over contact *ta1* and after the operation of relay FT extends earth over contacts *st3*, *ft1* and *ta2* to slow operating relay TB. Relay TB operates, connects earth at contact *tb1* to contact *s1* of relay S in the wave detecting device, disconnects wire TC2 at contact *tb2* and connects an operating earth to the delay device at contact *tb3*. Contacts *ta3* and *ta4* connect the wave detecting device to the access switch trunk line wires and contacts *ta5* and *ta6* connect a termination YE consisting of a resistance and condenser to other wipers of the access switch which may be connected to bank contacts associated with wires connected to a balancing network.

Any one of the following three conditions may now be found on the trunk line wires; (*i*) no current present, (*ii*) intermittent current of speech frequency such as speech itself, (*iii*) persistent current of speech frequency such as that commonly known as tone. When the wave detecting device is connected to the access switch it determines by the non-operation or operation of relay S which of these conditions exists.

If the first condition exists, i. e. no current on the line, relay S will not be operated and consequent on the closure of contact *tb1*, earth over that contact, contacts *s1* and *z2* operates relay W. Relay W locks up over contacts *w1* and *tb1* and opens a point in one circuit for relay TA at contact *w3* but as contact *z3* is still closed, relay TA is not released. Contact *w4* connects a variable resistance YH of 500,000 ohms maximum across a pair of wires leading to the delay device to cause that device to measure off a delay period say of 1 to 3 minutes' duration depending on the value of resistance of YH included in the circuit to the delay device and contact *w5* closes a point in the circuit of the lamp signal L1. At the end of the delay period, earth is connected over contacts *a* and *e* in the delay device, contact *z5*, back contacts of key RCK to relay AR. Relay AR operates and locks to the earth in the delay device over contact *ar1*, completes the circuit for the lamp signal L1 at contact *ar2* and earths wire TC3 at contact *ar3* to give an audible alarm.

If the second condition, i. e. intermittent speech currents which may be assumed to be speech on the trunk line, is found to exist, relay S will be intermittently operated. Depending on whether relay S is operated or not at the moment contact *tb1* closes, relay Z or relay W will be operated. If it be assumed that relay S is unoperated at that moment, relay W will operate and lock up and at contact *w2* prepare a circuit for relay X. When relay S operates, relay X will be operated from earth over contacts *s1* and *w2* and will lock up over contacts *x1* and *tb1* and at contact *x2* will prepare an operating circuit for relay Y. When relay S releases the operating circuit for relay Y is closed over contacts *tb1*, *s1*, *z2* and *x2* and relay Y locks up and prepares at contact *y2* a similar operating circuit for relay Z which is closed over contact *w2* when relay S re-operates. Relay Z thereupon locks up over contacts *z1* and *tb1*. If, at the moment of closure of contact *tb1* relay S is operated, relay Z will operate and a similar cycle of operations will be performed, relays Y, X and W operating in turn. Contacts *w3* and *z3* both being open, relay TA is released and contact *ta2* initiates the release of relay TB. The wave detecting device is disconnected from the access switch at contacts *ta3* and *ta4* and the termination YE is disconnected at contacts *ta5* and *ta6*. After a slight interval, relay TB releases and relays W, X, Y and Z are released at contact *tb1* and earth over contact *st3* is extended to wire TC2 to bring about the stepping of the access switch to the next contacts. As the release of relay TB takes place before the expiry of the shorter delay period provided for and to be mentioned shortly hereinafter, relay AR is not operated and no alarm or lamp signal is given.

If the third condition, i. e. continuous tone on the line such as the release signal in a system employing speech frequency signals is found to exist, then at the moment of closure of contact *tb1* relay S will be operated and relay Z will accordingly be operated. Relay S remains operated so that the closure of the circuit prepared for relay Y by the closure of contact *z2* will not take place. Relay W will not be operated and relay TA will consequently not be released. Contact *z4* connects a variable resistance YK of 100,000 ohms maximum value to the wires leading to the delay device to cause this device to measure off a shorter delay period than that measured off consequent on the connection of resistance YH, say, a period of 15 to 60 seconds. At the end of this period, relay AR is operated as before described and on the closure of contact *ar2* lamp L2 is lit, contact *w5* being in its unoperated position, and the alarm circuit is closed at contact *ar3*. It will be appreciated that if the tone should go off the line during the delay period due to the release of the trunk line, relay TA will be released consequent on the removal of the busy earth from the test wire.

The release control relays P, Q, R are brought into operation when the key RCK is thrown. This is a key of the locking type and when thrown it connects relay P in a time pulse circuit. Contact *tp* is a contact which is closed for a short time at intervals of 6 seconds and on its first closure after the contacts *a* and *e* of the delay device have been closed under condition (*i*), earth over those contacts, contact *z5*, the front contacts of key RCK and contacts *q2* and *r2* operates relay P. Relay P holds over contacts *r2*, *p1*, left-hand winding of relay Q, the key contacts to earth in the delay device after contact *tp* has opened and relay Q operates and locks up over its right-hand winding and contact *q1*. Contacts *p2* and *q2* prepare an operating circuit for re-

lay R to be completed on the next closure of contact *tp*, contacts *p3*, *p4*, *q3* and *q4* disconnect the wave detecting device and connect up a source of tone current over wires RT to the line wipers of the access switch, a suitable impedance represented by resistance YG and condensers in the leads to the source of tone current being included in the connection, and contacts *p5* and *q5* connect termination YF in place of termination YE to the balance network wires. Tone current is thus applied to the line for a period of not more than 6 seconds and in the case of a trunk line controlled by signals of speech frequency currents this tone simulates a release signal and should result in the trunk becoming released. On the next closure of contact *tp* relay R operates, holds over contacts *r1* and *q2* during the period of closure of contact *tp* and releases relay P at contact *r2*. The tone from the tone source over contacts *p3* and *p4* is disconnected from the line. When contact *tp* opens, relay R releases but relay Q remains held. The next closure of relay *tp* extends earth over contacts *q2*, *r1* and *p2* to relay AR which operates, locks up and closes the alarm and lamp signal circuits. If the trunk has been released meanwhile, relay TA will have been released and the transmission of the tone current terminated consequent on the opening of the circuit to the release control relays following release of relay TB at contact *ta2*.

We claim:

1. In a telephone or like system, lines over which voice frequency current is transmitted at times, a test conductor for each line adapted to be marked variably according to whether that line is engaged or free, means for testing said test conductors of the lines to determine whether they are engaged or free, and means controlled by said last means whenever a tested line tests engaged to also test for the presence of voice frequency current on said line.

2. In a system as claimed in claim 1, means controlled by said first two means in the event a line tests engaged but has no voice frequency current present thereon to give an alarm after an interval.

3. In a system as claimed in claim 1, means controlled by said first two means in the event a line tests engaged and has voice frequency current present thereon to give an alarm after an interval.

4. In a telephone or like system, lines over which voice frequency current is transmitted at times, a test conductor for each line adapted to be marked variably according to whether that line is engaged or free, means for testing said test conductors of the lines to determine whether they are engaged or free, a device controlled by said last means whenever a tested line tests engaged to also test for the presence of voice frequency current on said line, and means in said device for determining whether voice frequency current on said line is continuous or intermittent.

5. In a telephone or like system, lines over which voice frequency current is transmitted at times, a test conductor for each line adapted to be marked variably according to whether that line is engaged or free, means for testing said test conductors of the lines to determine whether they are engaged or free, a device controlled by said last means whenever a tested line tests engaged to also test for the presence of voice frequency current on said line, means in said device for determining whether the voice frequency current on said line, if any is present, is intermittent or continuous, means controlled by said first means and by said device to give an alarm after an interval in the event said line tests engaged if it either has no voice frequency current thereon or has continuous voice frequency current thereon, said last means effective to give no alarm in the event said line tests engaged if it has intermittent voice frequency current thereon.

6. In a telephone or like system, lines over which voice frequency current is transmitted at times, a test conductor for each line adapted to be marked variably according to whether that line is engaged or free, means for testing said test conductors of the lines to determine whether they are engaged or free, a device controlled by said last means whenever a tested line tests engaged to also test for the presence of voice frequency current on said line, means in said device for determining whether the voice frequency current on said line, if any is present, is intermittent or continuous, means controlled by said first means and by said device to give an alarm after a certain interval in the event said line tests engaged if it has no voice frequency current thereon and to give an alarm after a different interval in the event said line tests engaged if it has continuous voice frequency current thereon, said last means effective to give no alarm in the event said line tests engaged if it has intermittent voice frequency current thereon.

7. In a telephone or like system, lines over which voice frequency current is transmitted at times, a test conductor for each line adapted to be marked variably according to whether that line is engaged or free, means for testing said test conductors of the lines to determine whether they are engaged or free, a device controlled by said last means whenever a tested line tests engaged to also test for the presence of voice frequency current on said line, means in said device for determining whether the voice frequency current on said line, if any is present, is intermittent or continuous, means controlled conjointly by said first means and by said device to give a certain alarm in the event said line tests engaged if it has no voice frequency current thereon and to give a different alarm in the event said line tests engaged if it has continuous voice frequency current thereon, said last means effective to give no alarm in the event said line tests engaged if it has intermittent voice frequency current thereon.

8. In a telephone or like system, lines over which voice frequency current is transmitted at times, a test conductor for each line adapted to be marked variably according to whether that line is engaged or free, means for testing said test conductors of the lines to determine whether they are engaged or free, a device controlled by said last means whenever a tested line tests engaged to also test for the presence of voice frequency current on said line, a source of voice frequency current associated with said device, and means in said device operated if said last test indicates that no voice frequency current is present upon said line to connect said source to said line.

9. In a telephone or like system, lines over which voice frequency current is transmitted at times, a test conductor for each line adapted to be marked variably according to whether that line is engaged or free, means for testing said test conductors of the lines to determine whether they are engaged or free, a device controlled by said last means whenever a tested line tests

engaged to also test for the presence of voice frequency current on said line, a source of voice frequency current associated with said device, means in said device operated if said last test indicates that no voice frequency current is present upon said line to connect said source to said line for an interval, and means operated at the end of said interval if said line still tests engaged to give an alarm.

10. In a telephone system or the like, lines, testing equipment, means for associating said equipment with each of said lines in turn to test for a certain condition thereon, a wave detecting device in said equipment, and means in said equipment operated whenever one of said lines is found to have said certain condition thereon then to connect said device to that line to determine whether or not current of speech frequency is present on said line.

11. In a system as claimed in claim 10, wherein said wave detecting device includes thermionic valves, means for controlling the sensitivity of said valves to said current of speech frequency.

12. In a telephone system or the like, a line, testing equipment, a wave detecting device in said equipment, means for connecting said equipment to said line to test same, and means in said equipment effective if said test indicates that a particular condition is present on said line then to connect said device to said line to determine whether or not current of speech frequency is present on said line.

13. In a system as claimed in claim 12, means in said device for distinguishing between different kinds of current of speech frequency on said line if such current is present thereon.

14. In a telephone or like system, a line upon which different kinds of audio frequency current are impressed at times, testing equipment, a wave detecting device in said equipment, means for connecting said equipment to said line to test same, means in said equipment operated if it is determined by said test that a particular condition is present on said line then to connect said device to said line to test for the presence of audio frequency current on said line, and means controlled by said device for producing a certain action if one kind of audio frequency current is found to be present on said line and for producing a different action if another kind of audio frequency current is found to be present on said line.

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