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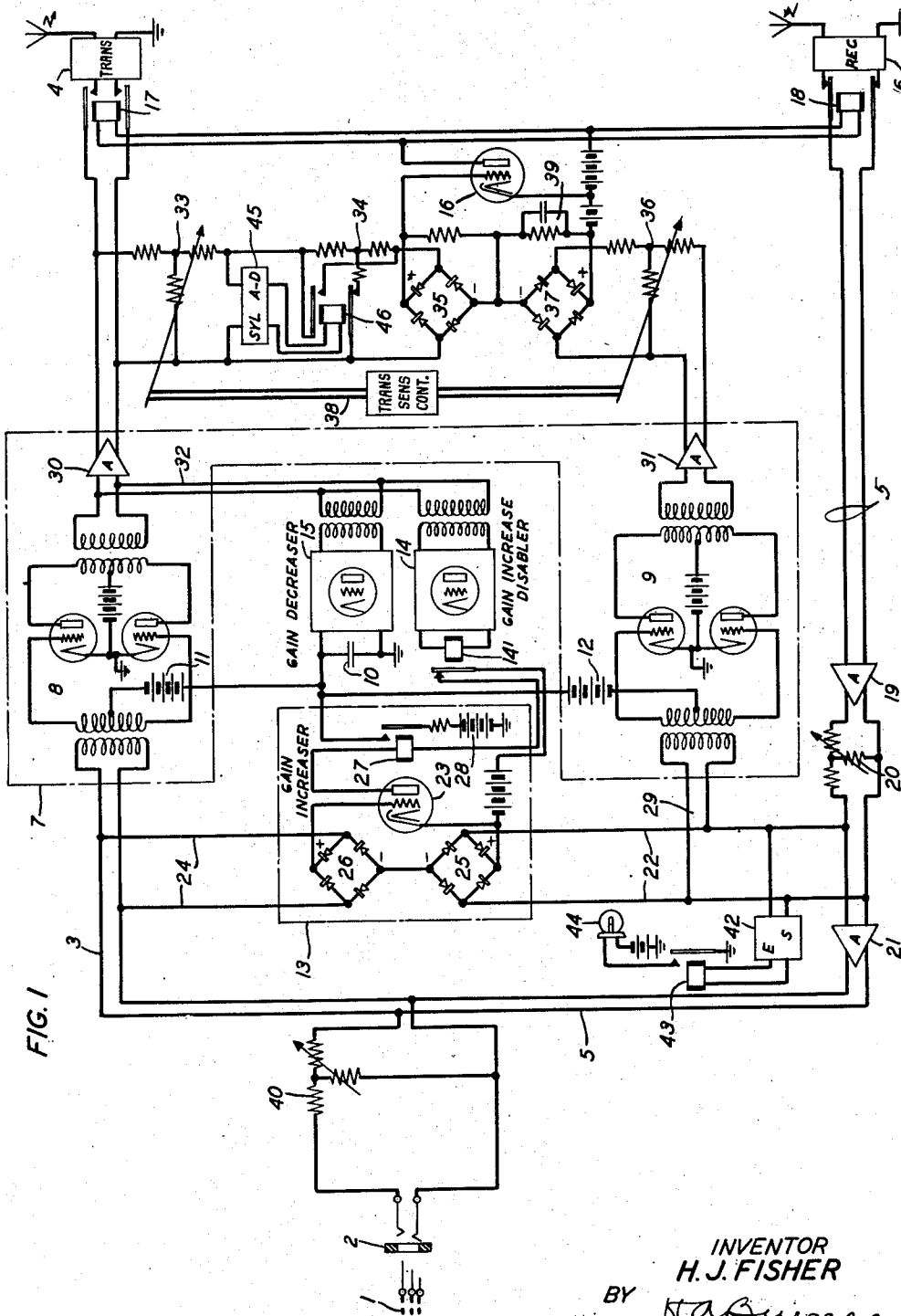
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TWO-WAY SPEECH TRANSMISSION

Filed April 16, 1941

2 Sheets-Sheet 1



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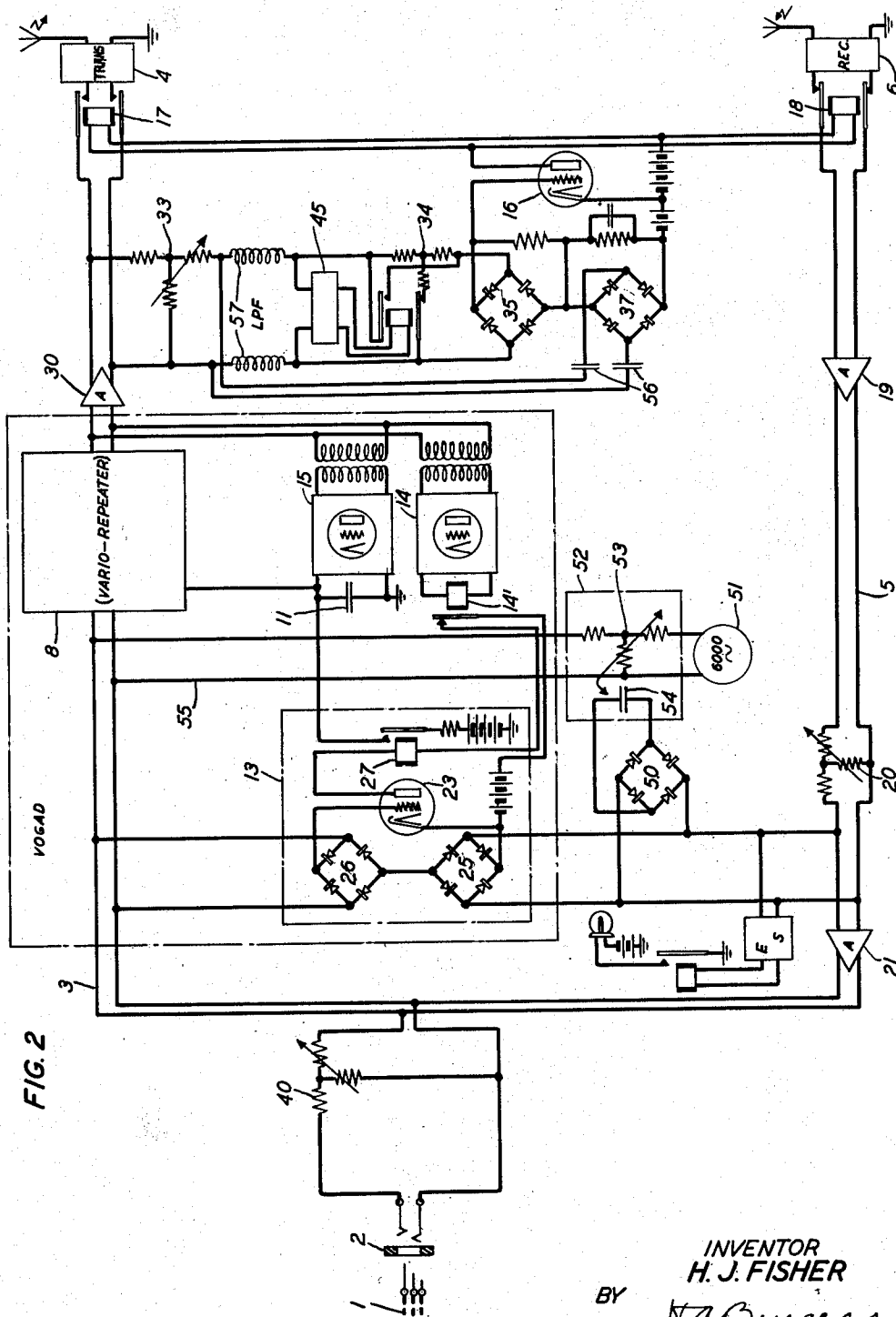
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2 Sheets-Sheet 2



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TWO-WAY SPEECH TRANSMISSION

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7 Claims. (Cl. 178-44)

The present invention relates to the two-way transmission of speech over oppositely directed paths with voice controlled switching in the two paths to provide proper transmission characteristics.

Objects of the invention are to facilitate control of the switching circuits at all times by the near-end talker whether or not the far-end talker has control; to minimize false operation of the switching mechanism by noise or echoes; to remove limitation on sensitivity of the transmitting amplifier-detector in relation to received speech volume (echo margin considerations), and generally to improve operating characteristics of the system.

These and other objects are accomplished in accordance with the present invention by the use of balanced control circuits for balancing the effect of received speech or noise on the operation of the voice controlled circuits. Speech in the transmitting side need only upset the balanced condition to effect operation of the switching circuits.

The nature and objects of the invention will be more clearly understood from the following detailed description of the illustrated embodiments shown on the attached drawings in which:

Fig. 1 is a schematic circuit diagram of one terminal of a two-way radio telephone link the distant terminal of which may be similar to that of Fig. 1; and

Fig. 2 is a similar diagram of an alternative form of circuit.

Referring first to Fig. 1, the land line connection represented by plug 1 and jack 2 is arranged by the circuits of this figure for transmitting out over the transmitting side 3 of the four-wire circuit to radio transmitter 4 (when the circuit is in transmitting condition) and for receiving over the receiving side 5 of the four-wire circuit from radio receiver 6 (when the circuit is in receiving condition). The sides 3 and 5 of the four-wire circuit are directly connected together without the interposition of the usual hybrid coil.

A double vario-repeater is shown enclosed in the broken outline 7 including one vario-repeater 8 serially included in the transmitting branch 3 and another vario-repeater 9 included in a control circuit to be controlled by received speech in a manner to be described later on. The gain of these repeaters 8 and 9 is automatically controlled by varying the grid biasing potential in accordance with the charge existing at any

moment on condenser 10 supplemented by the voltage of the respective bias batteries 11 and 12. These amplifiers are so connected to the terminals of condenser 10 that their gains are always maintained at the same values. The gain of amplifiers 8 and 9 is under control of the gain increaser circuit 13, the gain increase disabler circuit 14 and the gain decreaser circuit 15. Circuits 14 and 15 are controlled from the output side of repeater 8 while gain increaser circuit 13 is controlled by waves derived from the input.

The combination of an amplifier, such as 8, with the gain increaser circuit, the gain increase disabler circuit and the gain decreaser circuit is commonly known as a vogad and while the details of the circuit may vary considerably, the general organization illustrated is of a type disclosed in U. S. patent to Bjornson et al. No. 1,936,658 granted November 28, 1933. According to the general mode of operation common to vogads the gain of the vario-repeater is maintained low or at a value corresponding to a net loss when the amplitude of the input waves is so small as to represent noise, cross-talk or other undesired energies of lower amplitude than the weakest speech currents to be transmitted. Incoming waves whose amplitude exceeds the minimum for which the circuit is set and which may correspond to speech waves immediately increase the gain to some positive value to provide a volume level which is automatically maintained constant under various conditions of transmission, such as strong and weak talkers and different lengths of connecting line. Input waves strong enough to operate the gain increaser are rectified at 26 and cause amplifier 23 to energize relay 27 which attracts its armature causing positive voltage from battery 28 to be supplied to the ungrounded terminal of condenser 10, thus lifting the gain of vario-repeaters 8 and 9 to some predetermined positive value. When the output waves from amplifier 8 are of sufficiently high level amplifier-detector 14 connected to branch 32 leading from the amplifier output causes the operation of relay 14' which releases relay 27 to remove battery 28 from across condenser 10. The charge remains on the condenser, however, to hold the gains of the vario-amplifiers at constant value. If the input level increases to a value tending to cause excessive output level, the negative bias on the amplifier-rectifier circuit 15 of the gain decreaser circuit is overcome and some of the charge on condenser 10 is allowed to leak off through the plate impedance of the rectifier, thus reducing the gain

of amplifier 8. This operation ceases as soon as the output waves in branch 32 fall to the proper level.

The function of the other elements of the circuit of Fig. 1 will be described in connection with the following complete description of operation of that circuit.

The operation of the circuit will now be outlined starting with the circuit in receiving condition and assuming incoming speech waves to be present in circuit 5. When the system is in receiving condition relays 17 and 18 are deenergized, thus effectively disconnecting radio transmitter from circuit branch 3 and connecting radio receiver 6 with circuit branch 5. The received waves are amplified at 19 and pass through manual volume adjuster 20 and zero gain amplifier 21 to the terminals of the connecting land line 1. Some of the received waves pass into branch 22 and into rectifier 25 while the portion of the waves passing directly from circuit branch 5 to circuit branch 3 are in part transmitted into branch 24 to rectifier 26. Since amplifier 21 is a zero gain amplifier the received speech waves produce equal effects in branches 22 and 24 and produce equal rectified voltages across rectifiers 25 and 26 which are oppositely poled so as to produce a net effect of zero in the grid circuit of the tube 23. The received speech therefore does not alter the gain setting of the vario-amplifiers 8 and 9.

Received speech which passed directly from branch 5 into branch 3 is transmitted in part through amplifiers 8 and 30 and variable pad 33 to rectifier 35 in the grid circuit of amplifier 16. (Pad 34 is shorted out at this time as will be described.) These waves, if present alone in the circuit, would tend to cause operation of switching relays 17 and 18 by supplying positive voltage to the grid of tube 16. Such action is prevented, however, by passage of a portion of the receiving waves from branch 5 into circuit branch 29 and through amplifiers 9 and 31 and variable pad 36 to rectifier 37 which is poled oppositely to rectifier 35. It will be seen that the received speech goes through equal gains and losses to the two rectifiers 35 and 37 producing no resultant effect on amplifier 16. The received waves are, therefore, ineffective in operating switching relays 17 and 18. With no input voltage from rectifier 35 or 37 the tube 16 is biased to extinction.

When speech is received from line 1 and passes into circuit branch 3, assuming radio speech is also being received in circuit branch 5 as above described, the transmitted speech adds to the received radio speech in branch 3 and upon reaching rectifier 35 overpowers the effect of the received radio speech in rectifier 37, thus causing amplifier 16 to pass current and operate switching relays 17 and 18. Relay 17 connects circuit branch 3 to the radio transmitter 4 and relay 18 disconnects circuit branch 5 from radio receiver 6, thus enabling the talker on line 1 to gain control of the circuit.

When speech is transmitted from line 1 to line branch 3 and no radio speech is incoming in circuit branch 5 the vogad is placed under control of the transmitted speech so as to make gain adjustments, if necessary. Some of the transmitted speech passes through pad 33 to the rectifier 35, thus operating switching relays 17 and 18 to permit transmission out over the radio link. Amplifier 21 in receiving branch 5 operates as a one-way device to prevent back-up of trans-

mitted speech into the receiving side of the circuit.

The variable pads 33 and 36 are sensitivity controls which are operated in unison by means of the handle 38 so as to keep the loss in these pads the same.

Noise protection is afforded by means of syllabic detector 45 which operates relay 46 to shunt out the pad 34 in response to applied speech waves but by not responding to steady noise waves, it leaves pad 34 in the input circuit of the switching relay control to attenuate the noise and prevent false operation of the switches by the noise when speech waves are not being transmitted over circuit branch 3. This syllabic detector may be of the type disclosed in my prior Patent No. 1,939,680 issued December 19, 1933.

Since the tendency of rectifier 37 when operating alone is to oppose operation of the switching relays 17 and 18, it is well to provide a hold-over circuit around this rectifier to insure that its effect is not removed so quickly as to permit premature or false operation of the switching relays by rectifier 35. This is accomplished by the timing circuit 39 comprising resistance and capacity in parallel shunted around the rectifier 37 so that the condenser holds a charge for a time determined by the constants of the timing circuit.

Pad 40 is for the purpose of masking impedance variation in line 1.

To guard against the possibility that radio noise in the receiver might operate echo suppressors in line 1, a duplicate or model of the echo suppressor is bridged across the receiving circuit as shown at 42. When the received noise is sufficient to operate this suppressor, relay 43 lights lamp 44 to notify an attendant that additional loss must be inserted in pad 20 in the receiving side.

It will be observed that the system as herein disclosed removes limitations on received speech volume caused by echo margin considerations, since there are not separate receiving and transmitting amplifier-detectors with separate sensitivity adjustments. Instead, the received radio speech is applied differentially to the same switch-operating circuit, and it can readily be arranged that the speech in the receiving branch is given a slight advantage to insure against false switching.

Referring to Fig. 2, it will be seen that the circuit arrangement is, in general, similar to that of Fig. 1 and similar reference characters have been used to identify like parts. The main difference is that in Fig. 2 a high frequency wave such as 6000 cycles produced in generator 51 is used to obtain the balance that is obtained in Fig. 1 by the speech currents. In Fig. 2 the vario-repeater 9 is omitted from the circuit since the speech waves are not to be directly applied to the rectifier 37 in the relay control circuit. Instead some of the received speech is rectified at 50 and is caused to control the magnitude of the 6000-cycle wave that is transmitted from generator 51 into the vario-repeater 8. This control is indicated by box 52 in the drawing, this box including a vario-loss circuit 53 directly controlled by the rectified output of the rectifier 50. This loss circuit may comprise vacuum tubes, solid element rectifiers such as copper oxide, variable permeability magnetic control or any other suitable means whereby the output of rectifier 50 is enabled to control the amplitude of the 6000-cycle wave. The condenser 54 across

rectifier 50 symbolizes a suitable timing control so that the variations in the loss are made gradually to any extent desired.

The 6000-cycle wave passes through repeaters 8 and 30 and pad 33 along with speech currents present in branch 3. At the output of pad 33 the 6000-cycle wave is separated from the speech waves by means of the high-pass filter 56 (shown as series capacities) and low-pass filter 57 (shown as series inductances) and the two types of currents are thus directed to respective rectifiers 37 and 35 in the input circuit of control tube 16. By proper adjustment of the circuit the relation between the magnitude of the 6000-cycle wave applied to rectifier 37 and the speech waves applied to rectifier 35 as a result of incoming radio speech may be caused to balance out and have no effect on the switching relays 17, 18. The result is similar to that described in the case of Fig. 1.

Waves in the transmitting branch 3 received from the two-wire line upset the balance if radio speech is being received or in the absence of radio speech cause rectifier 35 to operate tube 16 to actuate the switching relays 17 and 18 as in Fig. 1.

What is claimed is:

1. In a four-wire telephone terminal, a transmitting branch and a receiving branch, a vario-repeater in the transmitting branch having a gain increaser circuit, a switching control circuit and switches operated thereby for respectively, when operated, enabling the output of the transmitting branch to transmit and disabling the input of the receiving branch, connections for causing speech waves in said transmitting branch, in absence of speech waves in said receiving branch, to effect operation of said switches, and connections for causing speech waves received over said receiving branch to produce a differential effect on both said gain increaser circuit and said switching control circuit.

2. The combination according to claim 1 in which said differential effect on said switching control circuit produced by speech waves received over said receiving branch is slightly unequal and in the direction to bias said switching control circuit against operation.

3. A control circuit for a two-way radio telephone terminal including a normally disabled signal transmitting circuit and a signal receiving circuit, comprising normally unoperated switching means which when operated enables said transmitting circuit and disables said receiving circuit, one control branch including a wave rectifier connected to said transmitting circuit in front of the disabling point therein, the output of said one control branch being applied to said switching means in such manner as to bias the latter towards operation in proportion to the am-

plitude level of the waves in said transmitting circuit, a second control branch including a second wave rectifier connected to said receiving circuit and supplied with waves therefrom having amplitude variations proportional to those of the waves in said receiving circuit beyond the disabling point therein, the output of said second control branch being applied to said switching means in such manner as to bias the latter against operation in proportion to the amplitude level of the waves in said receiving circuit, and differential means controlled by the waves in the input of said transmitting circuit and the waves in the output of said receiving circuit for adjusting the sensitivity of said one control branch and that of said second control branch so that said switching means will be always operated when outgoing telephone signals are impressed on said transmitting circuit, irrespective of the presence or absence of incoming telephone signals in said receiving circuit, and so that in the absence of outgoing signals and in the presence of signals incoming in said receiving circuit echoes of the latter signals applied to said one control branch will not cause operation of said switching means.

4. The control circuit of claim 3, in which said switching means comprises an electron discharge tube having a cathode, an anode and a control grid, and circuits therefor, said control grid being normally biased to prevent flow of anode current in the anode circuit, and a relay circuit operating in response to flow of anode current in said anode circuit to insert a disabling loss in said receiving circuit and to remove a disabling loss from said transmitting circuit, the output of the rectifier in said one control branch supplying a proportional positive direct current voltage bias to said control grid, and the output of said second rectifier in said second control branch supplying a proportional negative direct current voltage bias to said control grid.

5. The control circuit of claim 3, in which the relative sensitivities of said one and said second control branch are adjusted by a circuit comprising two vogads respectively connected in said transmitting circuit in front of the point of connection of said one control branch thereto, and in the input of said second control branch.

6. The control circuit of claim 3, in which said second control branch is supplied with the received signal waves from said receiving circuit.

7. The control circuit of claim 3, in which said second control branch is supplied with waves of a pilot frequency applied to the input of said transmitting circuit, and the level of said waves of pilot frequency is varied in accordance with the level variations of received signal waves in the output of said receiving circuit.

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