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REMOTE CONTROL SYSTEM

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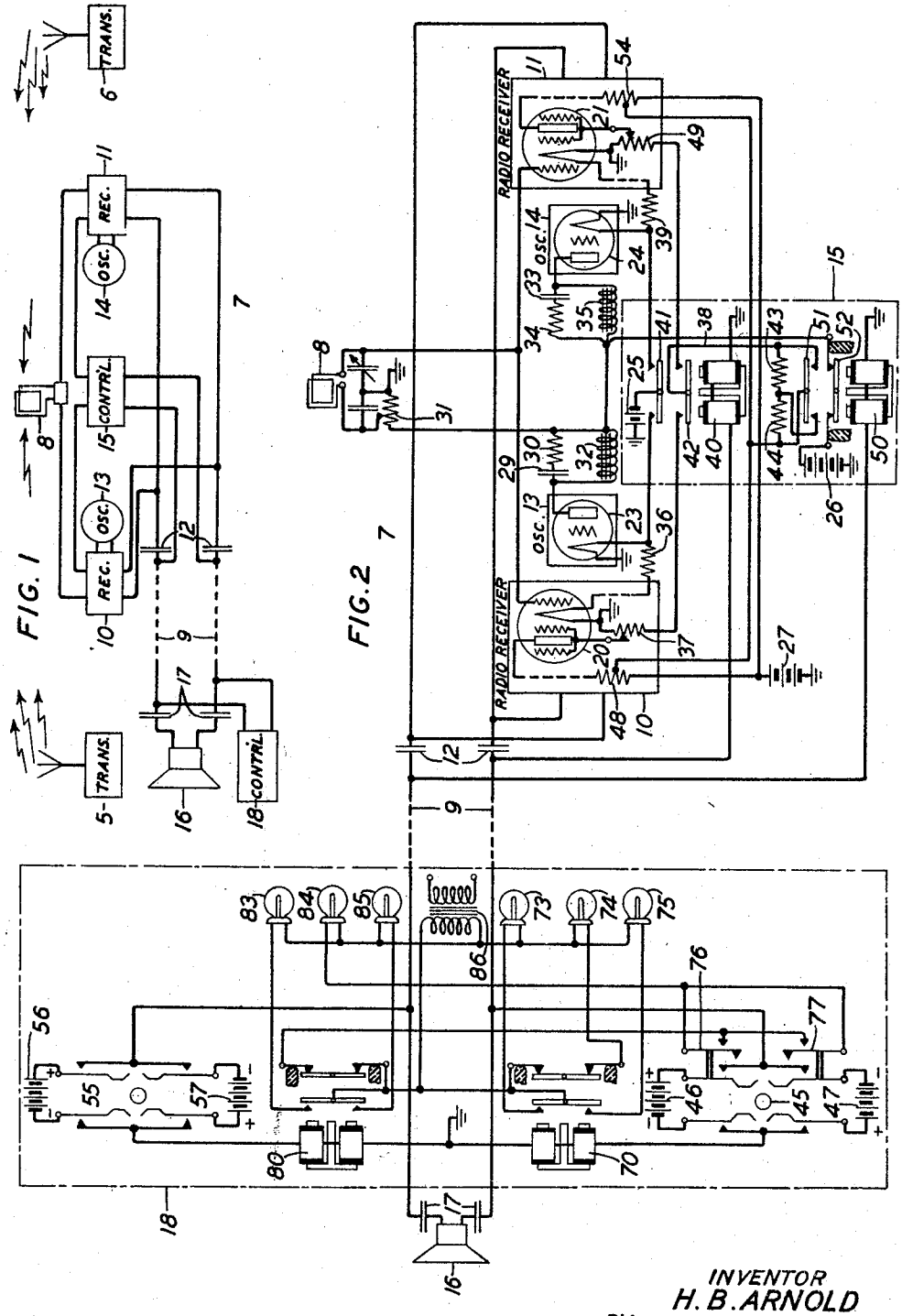

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REMOTE CONTROL SYSTEM

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This invention relates to remote control systems and particularly to systems for remotely controlling the operation of a radio receiving station employed for monitoring the operation of a radio broadcast transmitter.

In the copending application of G. D. Gillett, Serial No. 460,246 of June 10, 1930, there is disclosed and claimed a system for monitoring the operation of radio broadcast transmitters so that one or more transmitters can be operated on the same wave length. In this system there is located at a point in the operating field of two such broadcast transmitters, a radio receiving station which is connected by a wire line to one of the transmitters. The operation of this transmitter is controlled by observing the signals transmitted from the receiver station over the wire line.

An object of this invention is to remotely control such a receiver station over the lines used for transmitting the signals.

Since the proper regulation of the transmitter depends upon the continuing operation of the receiving equipment, it has been found desirable to employ at the receiver station a stand-by receiver and associated apparatus. As pointed out in the Gillett application referred to above, it is highly advantageous to supply to the receiver along with the signal an audio frequency tone. Consequently, the control circuit is required to perform the following operations:

1. Turn on and off either of the two radio receivers and their associated tone generators.

2. Turn on and off the tone generator of the receiver in operation.

3. Provide different conditions of gain for each receiver.

In a specific preferred embodiment of this invention, control is effected by means of two three-position polarized relays, one of which is connected between each side of the signal transmission line and ground. One relay controls the energization of the receivers and tone generators and is arranged so that when it is in the neutral position both sets are off and when operated in one direction turns on one set, and when operated in the other direction turns on the other set. The second relay provides three positions, in one of which positions the tone generator is operated.

The relays are operated by two three-position keys located at the distant end of the transmission line. Each of these keys is so connected that in its neutral position no current is applied to the line, while in one extreme position, current is caused to flow in one direction through the line and in the other extreme position current is caused to flow in the opposite direction. In addition there are provided at the control point means for indicating the circuit condition at the receiver station. Filters are used at each line terminal for separating the control and signal currents.

This invention can be more readily understood by reference to the following detailed description in connection with the drawing in which:

Fig. 1 is a schematic drawing of the general lay-out of one embodiment of the invention; and

Fig. 2 is a schematic drawing showing in detail control circuits of the system shown in Fig. 1.

Referring to Fig. 1, there are shown two radio transmitters 5 and 6 which are arranged to operate at the same carrier frequency for transmitting the same program. Intermediate the two transmitters there is located a receiver station 7. This station is preferably so positioned that the amplitude of the waves received from the transmitters 5 and 6 in the antenna 8 are substantially equal. The receiver station is connected by a wire line 9 which terminates at the transmitter 5.

At the receiver station 7 there are located two radio receivers 10 and 11 both having their inputs connected to the loop antenna 8 and their outputs connected to the wire line 9 through condensers 12. Associated with each of the receivers 10 and 11 is an audio frequency oscillator, 13 and 14 respectively. There is also provided a control circuit 15 connected to the wire line 9 beyond the condensers 12.

At the transmission station 5 there is provided a loud speaker 16 connected to the wire line 9 through the condensers 17. There is also provided a control circuit 18 connected directly to the wire line 9.

As is described in detail in the description of Fig. 2, the control circuit 18 may be operated to energize either one of the receivers 10 or 11 so that the waves received in the antenna 8 are detected and transmitted over the wire line 9 to give a response in the loud speaker 16. The control circuit can also be operated to cause the receiver connected at any time to operate at a desired gain with or without the associated audio frequency oscillator supplying an audible frequency tone thereto.

As is described in detail in the copending application of D. E. Gillett, Serial No. 460,246 referred to above, this system can be operated to hold the two transmitters 5 and 6 in substantial isochronism. When the audio frequency oscillator at the receiver station is operated, the carrier waves received in the antenna 8 are modulated in the radio frequency amplifier of the receiver 10 or 11 by the audio frequency tone and the resultant wave amplified and detected and transmitted over the wire line 9 to give an audible indication in the loud speaking receiver 16. If the frequency of one of the transmitters 5 or 6 varies to throw the two transmitters out of isochronism, this audio frequency output wave will go through a fading cycle the frequency of which is the actual difference in the frequencies of the carrier waves in the two transmitters. By observing the frequency of this fading cycle as audibly indicated in the receiver 16, the operator is able to adjust the frequency of the carrier wave of the transmitter 5 so as to hold the two waves to any desired degree of isochronism.

When the receiver 10 or 11 is operated without the audio frequency oscillator, the detected signal or program will go through a similar fading cycle and permit monitoring the operation of the transmitters in the same way. As discussed in the Gillett application, the use of the audible tone from the oscillator makes possible the adjustment of the transmitters when they are operating to transmit a carrier without a modulating signal or program and also to give an indication which is independent of any musical rhythm or beat in the program being transmitted. However, it is often desirable to operate the receiver without the oscillator, for example, to get a direct indication of the quality of the received program at the monitoring point.

Fig. 2 shows schematically the details of the control circuit by which the apparatus at the receiver station 7 is controlled from the transmitter station 5 over the wire line 9. For the purposes of simplification, the radio receivers 10 and 11, and oscillators 13 and 14 are shown only as boxes with a single tube in each. The receivers may be of any well known type, for example, each may comprise a radio frequency amplifier in which the received waves are amplified and modulated by the audio frequency tone from the oscillator, a detector and an audio frequency amplifier. The single tubes 20 and 21 shown in the receivers 10 and 11 are of the screen grip type and comprise the first of two of the radio frequency amplifiers. They are shown for the purpose of indicating how the power supply connections are made to the radio receivers since the control is effected through the power supply connections. Similarly, each of the oscillators 13 and 14 is indicated merely as a box with a tube 23 and 24 respectively indicated in each. The tubes are shown merely for the purpose of indicating how the power supply connections are made and the details of the oscillator circuits are omitted.

Battery 25 supplies cathode heating current to the tubes of the receivers and oscillators. Battery 26 supplies space current to the tubes of the oscillators. Battery 27 supplies space current to the tubes of the radio receivers 10 and 11.

The output circuit of the oscillator 13 comprises a blocking condenser 29 in series with a resistance 30 and a potentiometer 31 connected between the plate and grounded cathode. A portion of the potential drop across the potentiometer 31 is fed across the tuned loop circuit. In this way the audio frequency tone from the oscillator is impressed on the grid-cathode circuit of the first tube of the radio receiver 10 along with the radio wave received in the loop 8. The choke coil 32 is provided in the link circuit of the oscillator tube 23 to separate the direct current component of the space current from the generated alternating current.

Similarly condenser 33, resistance 34 and choke coil 35 are provided in the plate circuit of the tube 24 of the oscillator 14. The loop circuit 8 including the potentiometer 31 is common to the circuit of the two oscillators and receivers.

The amplitude of the audio tone supplied by the oscillator 13 or 14 is controlled by the potentiometer 31. This is preferably set so that audio tone amplitude is such as to overmodulate the received carrier waves, the modulation taking place in the radio frequency amplifier of the radio receiver. After the resultant waves are detected in the radio receiver detector the low frequency beat note representing the frequency difference between the two carriers will appear superimposed on the audio tone causing a rise and fall in the intensity thereof with easily recognizable minimums. While the system is normally operated with the audio tone modulation as just described it sometimes may be desirable to operate it with normal recep-

tion, for example, to check the actual reception conditions. For this purpose there is provided a control for rendering the audio oscillators inoperative and inceasing the screen grid bias to give an increased gain as will be described later.

The control of the receivers and oscillators is effected by means of two three-position polarized relays 40 and 50. Relay 40 is connected between the lower wire of the transmission line 9 and ground. Relay 50 is connected between the upper wire of the transmission line 9 and ground. The condenser 12 prevents the direct current for operating the relays 40 and 50 from reaching the recievers 10 and 11.

Relay 40 controls the turning on and off of the radio receivers 10 and 11 and their associated oscillators 13 and 14 respectively. When the relay 40 is in the unoperated position, the cathode heating circuits of the receiver and oscillators and the screen grid polarizing circuits of the receivers are open. The operation of the relay closes these circuits for the selected receiver.

The operation of the relay in such a direction as to close the left-hand contacts of armatures 41 and 42 closes the cathode heating circuit of the receiver 10 and the oscillator 13 from ground, through battery 25, armature of relay 41, and in parallel through cathode of the oscillator tube 23 to ground and resistance 36 and the receiver cathode heating circuit to ground. At the same time, the circuits for the screen grids of the tubes of the radio receiver 10 are closed from the screen, through the manual gain control potentiometer 37, armature 42 of relay 40, connection 38, resistances 43 and 44, lower half of resistance 48, battery 27 to ground. The resistances 43 and 44 provide means for remotely controlling the gain of the receivers as is described below in connection with the description of the operation of relay 50.

Similarly, when the relay 40 is operated to its right-hand position, the cathode heating circuit of the radio receiver 11 and the oscillator 14 and the screen grid circuit of the radio receiver 11 are closed through the right-hand contacts of the armatures 41 and 42, the resistances 39, 49 and 54 of the receiver 11 and the oscillator 14 set, these resistances corresponding to the resistances 36, 37 and 48 respectively of the receiver 10 and the oscillator 13 set.

The relay 50 controls the gain at which the radio receivers 10 and 11 are operated and the turning on and off of the oscillators 13 and 14. When the relay 50 is in the neutral position, the plate circuits of the oscillators 13 and 14 are closed. In both operated positions these plate circuits are opened, and the potential of the screen grids of the receiver tubes increased. The two operated positions correspond to different degrees of increase of the screen grid potential and hence different gains for the receivers. They are provided to meet different operating conditions; for example, one may provide the proper gain for operation under day transmission conditions and the other for night.

When the relay 50 is in its neutral position (as shown in the drawing), the plate current circuits of the oscillators 13 and 14 are completed from ground, through battery 26, armature 52 of relay 50, and choke coil 32 to the plate of the oscillator tube 23 or choke coil 35 to the plate of the oscillator tube 24. As a result when the relay 40 is operated to complete the cathode heating circuit of either the tube 23 or 24, that tube will be in a condition for producing oscillations. When the relay 50 is operated to either its left or right-hand position, the connection from the plate current battery 26 through the armature 52 is broken at either the left or right-hand contact of that armature so as to render the oscillators inoperative. When the relay 50 is operated to its left-hand position, the resistance 44 is shunted out of the screen grid circuits of the receivers 10 and 11 by means of the connection through the armature 51 and its left-hand contact. This causes the receivers to operate at an intermediate gain position. When the relay 50 is operated to its right-hand position, both of the resistances 43 and 44 are shunted out of the screen grid circuit so that the receivers operate at a condition of high gain.

The relays 40 and 50 are controlled by means of current supplied over the wire line 9, the control being effected by means of the control circuit 18 located at the station of the transmitter 5. Keys 45 and 55 control the supplying of direct current to the lower and upper wires of the line 9 to control the relays 40 and 50 respectively.

When the key 45 is operated to its upper position battery 46 is connected to supply positive current to the lower wire of the line 9 causing the relay 40 to operate, for example, to its left-hand position to energize the receiver 10. In a similar manner, when the key 45 is operated in its lower position, the battery 47 is connected to supply negative current to the lower wire of the line 9 to operate the relay 40 to its right-hand position so as to energize the receiver 11.

The batteries 56 and 57 associated with the key 55 permit a similar operation of the relay 50 by actuating the key 55. When the key 55 is operated in its upper position, the battery 56 is connected to supply positive current in the upper wire of the line 9 and causes the relay 50 to operate to its left-hand position to render the oscillator 13 or 14 inoperative and cause the receiver to operate at an intermediate gain. Similarly, when the key 55 is operated to its lower position, battery 57 is connected to supply cur-

rent of negative polarity to the upper wire of the line 9 causing the relay 50 to operate to its right-hand position rendering the oscillator 13 or 14 inoperative and causing the receiver to operate at its maximum gain.

Relays 70 and 80 and their associated lamps 73, 74, 75 and 83, 84, 85 are provided to give an indication of the operative condition of the control circuit. Relay 70 is connected in series with the key 45, lower wire of the line 9 and relay 40. Relay 80 is similarly connected in series in the operating circuit for the relay 50. Thus, when the key 45 or 55 is operated, the respective relay 70 or 80 will operate in the same manner as the relays 40 and 50 of the controlled station completing a circuit for lighting the respective indicating lamp 73, 74, 75, 83, 84 or 85.

The lighting current for these lamps is supplied from an alternating current source such as an ordinary lighting circuit through the transformer 86.

The auxiliary contacts 76 and 77 are provided on the key 45 so that indicating lamps 83, 84 and 85 will light only when the key 45 is in one of its extreme positions to render a radio receiver and its associated oscillator operative.

What is claimed is:

1. In combination in a radio system, a receiving antenna, a signal transmission line, a pair of normally deenergized radio receivers having their inputs connected to said antenna and their outputs connected in parallel to said line, relay means responsive to current of one polarity for energizing one of said radio receivers and responsive to current of the opposite polarity for energizing the other of said radio receivers, an audio frequency oscillator connected to supply waves to each of said radio receivers for modulating the received wave, other relay means responsive to current of one polarity for causing that one of said radio receivers energized at a particular time to operate at a predetermined gain and responsive to currents of the opposite polarity for causing said one of said radio receivers to operate at a different predetermined gain, connections whereby when said other relay means is in the unoperated position that one of the audio frequency oscillators associated with that one of said radio receivers in an operative condition at the time will be energized, and means for supplying current of the desired polarity for operating each of said relay means over said signal transmission line.

2. A combination according to the next preceding claim in which said signal transmission line is a two-wire line and each of said relay means is connected between one of said wires and ground.

3. In a system for simultaneously operating a plurality of radio transmitters at the same carrier frequency having a monitoring receiving station and a wire line connecting said receiving station with one of said transmitters, in combination, two radio receivers located at said monitoring station, an antenna adapted to receive waves from both of the transmitters connected to the inputs of both of said receivers, an oscillator associated with each of said receivers for supplying waves for modulating the wave received thereby, means opaque to direct current but capable of transmitting alternating current for connecting the outputs of both of said receivers to said transmission line, relay means connected between one wire of said transmission line and ground, said relay means being responsive to direct current of one polarity for energizing one of said radio receivers and responsive to direct current of the opposite polarity for energizing the other of said radio receivers and when in a non-operated position arranged to deenergize both of said radio receivers, other relay means connected between the other of said wires of said transmission line and ground and arranged when in a non-operated position to render operative that one of the oscillators associated with that one of the radio receivers then in an operating condition and being responsive to direct current of one polarity for rendering inoperative said oscillator and causing said radio receiver to operate at an increased gain and being responsive to direct current of the opposite polarity for rendering inoperative said oscillator and causing said receiver to operate at a different increased gain, signal responsive means connected to the terminal of said transmission line at said radio transmitter station, and control means at said transmitter station for supplying operating current for said relay means between each of the wires of said transmission line and ground.

4. In combination a two-wire signal transmission line, an antenna, two audion radio receivers having their inputs connected to said antenna and their outputs connected to one terminal of said transmission line, an audion oscillator for supplying waves to each of said radio receivers for modulating the received wave, relay means having an operating winding connected between one of the wires of said transmission line and ground and responsive to current of one polarity for supplying cathode heating current to the audions of one of said radio receivers and of the oscillator associated with said one of said radio receivers and responsive to current of the opposite polarity for supplying cathode heating current to the audions of the other of said radio receivers and of the oscillator associated with said other of said radio receivers, said relay means being arranged so that when it is in the unoperated position the cathode heating current supply to both of said receivers and oscillators is disconnected, other relay means having

an operating winding connected between the other wire of said transmission line and ground being arranged so that when it is in the unoperated position space current is supplied to both of said oscillators, and being responsive to current of one polarity for interrupting the supply of space current to said oscillators and conditioning said radio receivers to operate it at a predetermined increase in gain and being responsive to an operating current of the opposite polarity for interrupting the supply of space current to said oscillators and conditioning said radio receivers to operate at a different predetermined gain, means connected to the other terminal of said signal transmission line for giving an indication of the output of said radio receivers and means also connected to said other terminals of said signal transmission line for supplying operating current between each of the wires of said line and ground for controlling the operation of both of said relay means.

5. In combination a two-wire signal transmission line, a receiving antenna, two radio receivers each having an audion of the screen grid type and having their inputs connected to said antenna and their outputs connected to one terminal of said transmission line, an audion oscillator for supplying waves to each of said radio receivers for modulating the received wave, a resistance network for controlling the voltage applied to the screen grid of the audion of said radio receivers, relay means having an operating winding connected between one of the wires of said transmission line and ground and responsive to current of one polarity for supplying cathode heating current to the audions of one of said radio receivers and of the oscillator associated with said one of said radio receivers and for connecting the screen grid of said one of said radio receivers to said resistance network and responsive to current of the opposite polarity for supplying cathode heating current to audions of the other of said radio receivers and of the oscillator associated with said other of said radio receivers and for connecting the screen grid of the audion of said other of said radio receivers to said resistance network, said relay means being so arranged that when it is in the unoperated position the cathode heating current supply to both of said receivers is disconnected and the connection between the screen grids of both of said receivers and said resistance network is interrupted, other relay means having an operating winding connected between the other wire of said transmission line and ground and being arranged so that when it is in the unoperated position space current is supplied to both of said oscillators and being responsive to current of one polarity for interrupting the supply of space current to said oscillators and to condition said resistance network to cause said radio receivers to operate at a predetermined increase in gain and being responsive to an operating current of the opposite polarity for interrupting the supply of space current to said oscillators and conditioning said resistance network to cause said radio receivers to operate at a different predetermined gain, means connected to the other terminal of said signal transmission line for giving an indication of the output of said radio receivers, and means also connected to said other terminals of said signal transmission line for supplying operating current between each of the wires of said line and ground for controlling the operation of both of said relay means.

In witness whereof, I hereunto subscribe my name, this 21st day of December, 1931.

HENRY B. ARNOLD.