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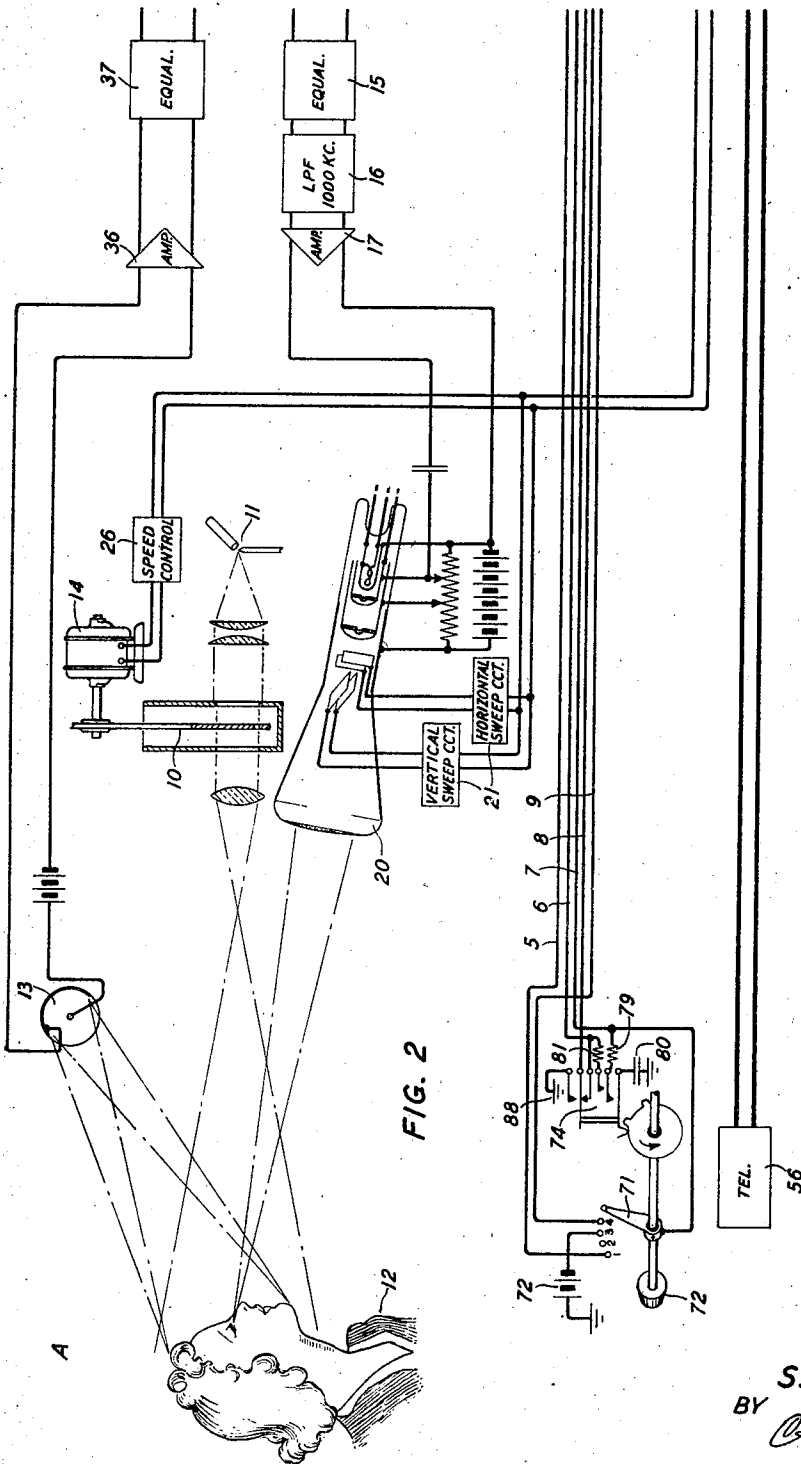
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2,314,471

TWO-WAY TELEVISION AND SPEECH TELEVISION

Filed Aug. 24, 1940

4 Sheets-Sheet 1



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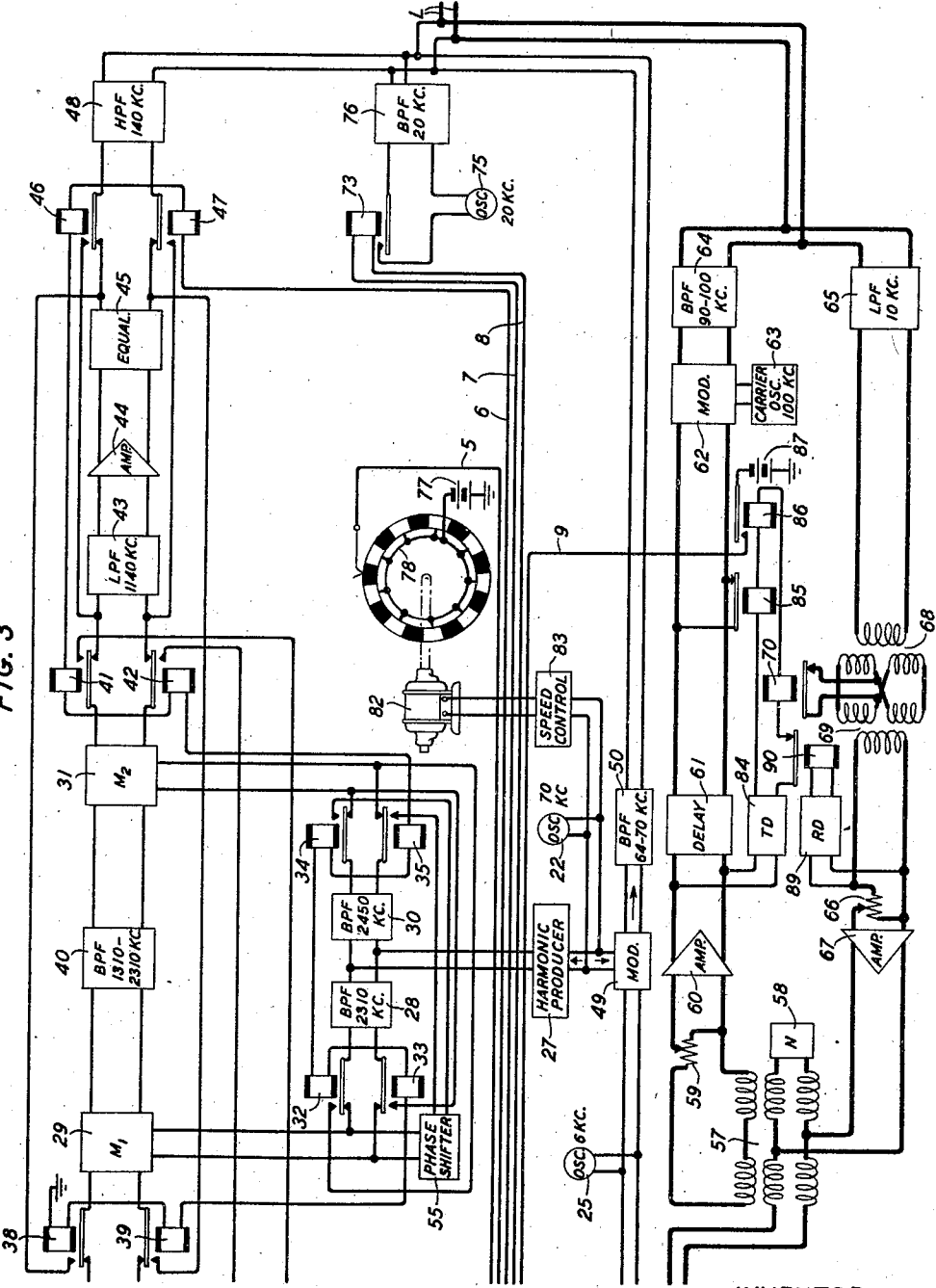
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TWO-WAY TELEVISION AND SPEECH TELEVISION

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FIG. 3



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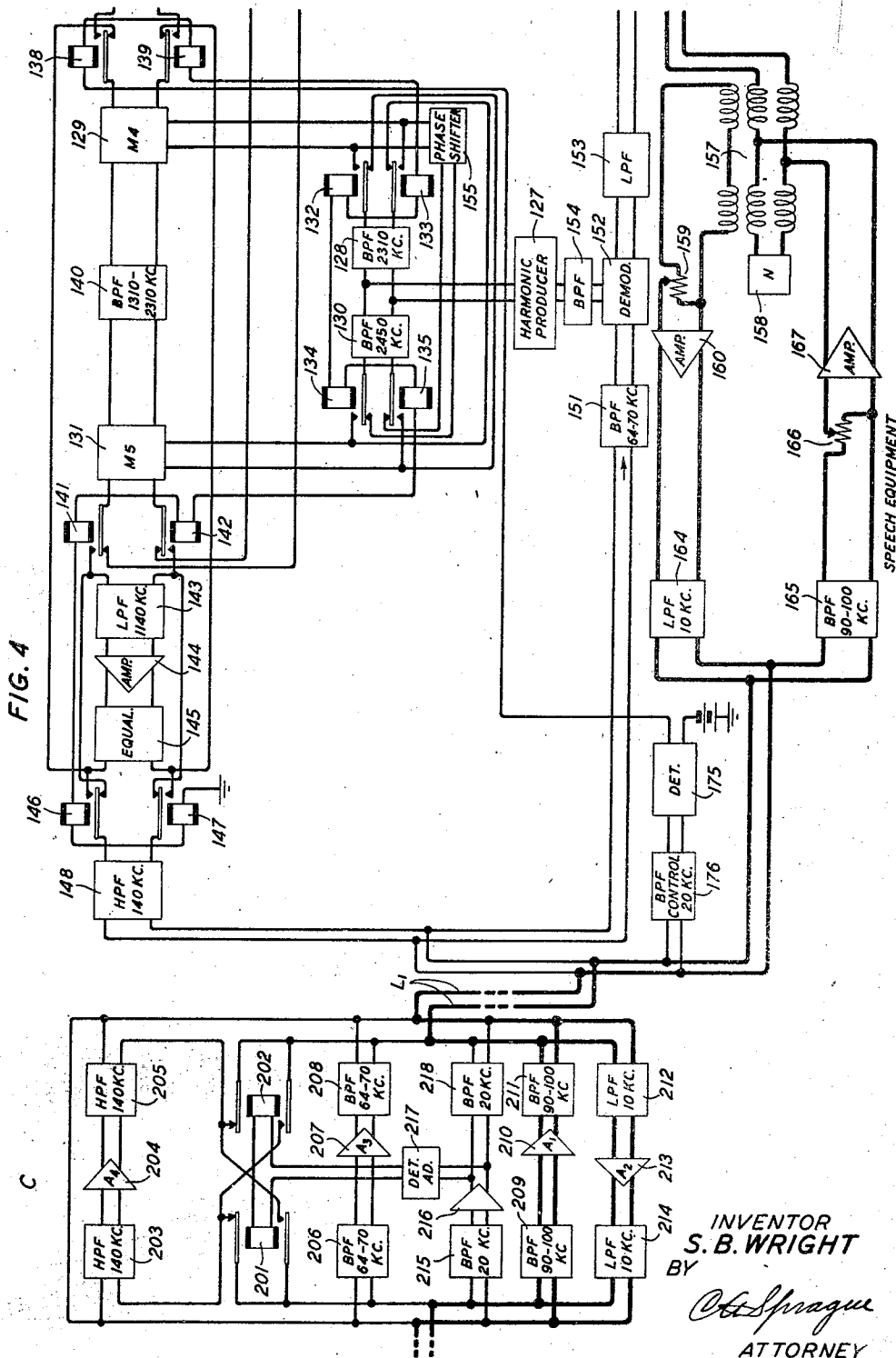
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TWO-WAY TELEVISION AND SPEECH TELEVISION

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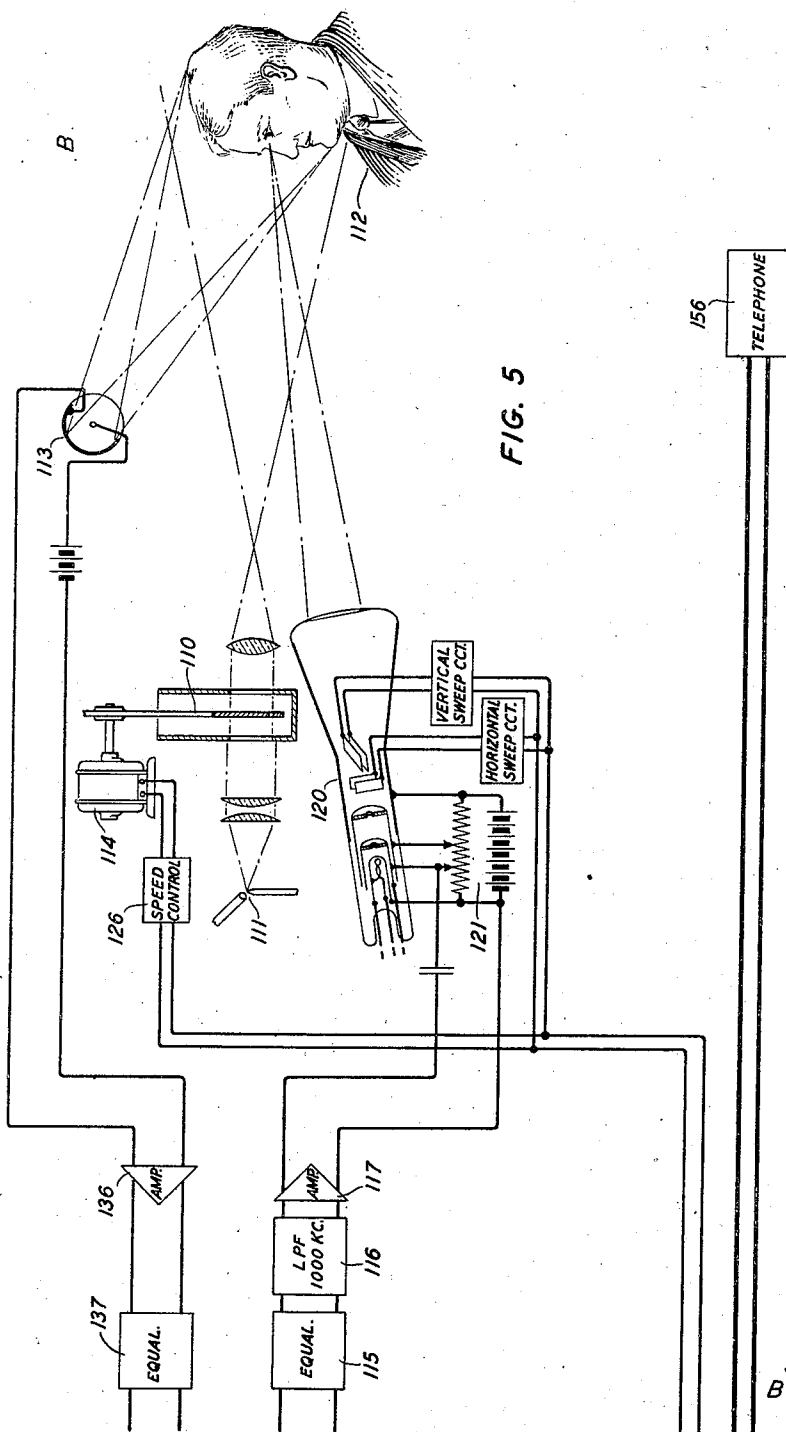
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TWO-WAY TELEVISION AND SPEECH TELEVISION

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TWO-WAY TELEVISION AND SPEECH
TELEVISION

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14 Claims. (Cl. 178—5.6)

This invention relates to signaling and particularly to a two-way television and speech transmission system.

An object of the invention is to provide a novel form of signaling system in which the transmission of signals, television signals, for example, is alternately in opposite directions.

In accordance with the invention the direction of transmission of signals, television signals for example, is controlled (1) manually by a subscriber at a terminal station, (2) automatically at desired intervals, or (3) by signals from another source, speech signals for example.

In the communication system herein shown and described for the purpose of illustration, there are provided two terminal stations, each equipped with television transmitting and receiving apparatus and with telephone transmitting and receiving apparatus connected by a transmission line including a repeating station. Television signals are transmitted over a single transmission channel in opposite directions during non-concurrent time intervals. Speech signals are transmitted between the terminal stations over two additional transmission channels, one channel for transmitting in one direction and another channel for transmitting in the opposite direction. At one of the terminal stations there is provided a manual multiposition switching means, under control of the subscriber at that station, for controlling the direction of television transmission between stations. When the switching means is in one position, the system is conditioned for transmitting television images from one terminal station to the image producing apparatus at the second terminal station and, when the switching means is in another position, the system is conditioned for transmitting the television images from the second terminal station to the image producing apparatus at the first terminal station. A third position of the manual switching means is provided for permitting the direction of transmission of the television signal to be reversed under control of speech signals generated at a terminal station and, when the manual switching means is in a fourth position, the direction of transmission of the television signals is automatically periodically reversed under control of a rotating commutator.

Figs. 2, 3, 4 and 5, when arranged side by side as indicated by the diagram of Fig. 1, constitute a diagrammatic view of a signaling system in accordance with the present invention.

Referring to the drawings, there is disclosed a signaling system comprising terminal stations

A and B which are connected by a suitable transmission line L, L', a coaxial conductor cable, for example, including a repeater station C.

At station A there is provided television scanning apparatus comprising a scanning disc 10 driven by a motor 14 and having apertures spirally arranged near the peripheral portion thereof for directing light from source 11 upon elemental areas in succession of the subject 12, and a photoelectric cell 13 for receiving light reflected from the successively illuminated elemental areas. There is also provided the well-known cathode ray image producing apparatus 20 for producing under control of an image current received from station B, television images which may be viewed by the subject 12, the deflection of the cathode ray beam of the cathode ray tube 20 being controlled by the usual sweep control apparatus 21. Synchronizing current from oscillator 25, which is here assumed to have a frequency of 6 kilocycles, is applied to a speed control circuit 26 for controlling the speed of motor 14, as disclosed for example in U. S. Patent 1,999,376, granted to H. M. Stoller, April 30, 1935. Synchronizing current from oscillator 25 is also supplied to the cathode ray sweep circuits 21 for maintaining the image production in synchronism with the image scanning at station B. Current from a 70-kilocycle oscillator 22 is supplied to a harmonic producer 27. The harmonic producer 27 is connected to a band-pass filter 28 which selects a 2310-kilocycle current component to be impressed upon the modulator-demodulator 29, and is also connected to a band-pass filter 30 which selects a 2450-kilocycle current component to be impressed upon the modulator-demodulator 31.

It will be assumed for the present that all of the relays which are employed for changing the direction of transmission of the television channel are in their normal or unactuated condition, as shown in the drawings. Therefore, band-pass filter 28 is connected to modulator-demodulator 29 through the armatures of relays 32 and 33 while band-pass filter 30 is connected to modulator-demodulator 31 through the armature of relays 34 and 35.

The image current generated by photoelectric cell 13 is amplified by amplifier 36 and is thence transmitted through equalizing network 37 and through the armatures of relays 38 and 39 to the modulator-demodulator 29. Assuming that the television frequency band width is one megacycle, there will be produced in the modulator-demodulator 29 a modulated wave having a lower

side-band extending from 1310 kilocycles to 2310 kilocycles which frequency band is passed through a band-pass filter 40 to the modulator-demodulator 31 where there will be produced a modulated wave the lower side-band of which extends from 140 kilocycles to 1140 kilocycles. The current having this frequency band is transmitted from modulator-demodulator 31 through the armatures of relays 41 and 42, 1140 kilocycle low-pass filter 43, amplifier 44, equalizer 45, armatures of relays 46 and 47 and 140 kilocycle high-pass filter 48 to the transmission line L.

At station C, when the relays 201 and 202 thereat are unactuated, as shown, the image current transmitted from station A over line L passes through the 140 kilocycle high-pass filter 203, the input of which is connected to line L through the upper armature of relay 201. The output of filter 203 is connected through amplifier 204 to the input of 140 kilocycle high-pass filter 205, the output circuit of which is connected through the upper armature of relay 202 to the line L' going to terminal station B.

When the relays at station B are unactuated, as shown, the image current coming from repeater station C is transmitted through 140 kilocycle high-pass filter 148 and through the armatures of relays 146 and 147 to the input of 1140 kilocycle low-pass filter 143. The output of this filter is connected through the amplifier 144, equalizer 145 and the armatures of relays 138 and 139 to the input of modulator-demodulator 129, the output of which is connected through band-pass filter 140 to the input circuit of modulator-demodulator 131. The output of modulator-demodulator 131 is connected through the armatures of relays 141 and 142, equalizer 115, 1000 kilocycle low-pass filter 116 and amplifier 117 to the image producing cathode ray tube 120 which produces an image of the subject 12 scanned at station A so that it may be viewed by the subject 112 at station B.

At station A the 6-kilocycle synchronizing current from oscillator 25 and the 70-kilocycle current from source 22 are impressed upon modulator 49 for producing a current having 64-kilocycle and 70-kilocycle components which are selected by the band-pass filter 50 and transmitted over line L to repeater station C where the current is transmitted through a circuit comprising band-pass filter 206, amplifier 207 and band-pass filter 208 and thence over line L' to station B. At station B this current is transmitted through band-pass filter 151 and impressed upon demodulator 152.

The 6-kilocycle component of the current produced by demodulator 152 is selected by low-pass filter 153 and impressed upon the speed control circuit 126 for controlling the speed of driving motor 114 for scanning disc 110 so that the scanning of the subject 112 at station B will be maintained in synchronism with the image production by means of cathode ray tube 20 at station A. The 6-kilocycle synchronizing current from filter 153 is also impressed upon the sweep circuits 121 for maintaining the image production at station B in synchronism with the scanning of the subject 12 by means comprising scanning disc 10 at station A.

The 70-kilocycle component of the current produced by the demodulator 152 is selected by band-pass filter 154 and impressed upon the harmonic producer 127 for producing a current having 2450 kilocycle and 2310 kilocycle components. The 2450 kilocycle component selected by band-

pass filter 130 is transmitted through armatures of relays 134 and 135 and through phase shifter 155 to the modulator-demodulator 129. This phase shifter may be adjusted to compensate for any difference in phase which may exist between the received television signal impressed upon the modulator-demodulator 129 and the 2450-kilocycle current impressed upon the modulator-demodulator 129 from the filter 130 in order that the signal may be properly detected. The lower side-band of the 1310 kilocycle to the 2310-kilocycle current from the output of modulator-demodulator 129 is selected by band-pass filter 140 and impressed upon the modulator-demodulator 131 upon which is also impressed 2310-kilocycle current from band-pass filter 128 transmitted through a circuit including the armatures of relays 132 and 133. There is thus produced in the output of modulator-demodulator 131 an image current having a zero to 1000-kilocycle lower side-band which is transmitted through equalizer 115, low-pass filter 116 and amplifier 117 to the cathode ray image producing device 120.

When the various switching relays at stations A, B and C are energized in the manner which will be explained below, the system is conditioned for transmitting to station A the image current produced at station B as the result of scanning the subject 112 by the scanning apparatus comprising scanning disc 110, light source 111 and photoelectric cell 113. The television transmitting circuit of station B may be traced from photoelectric cell 113 through amplifier 136, equalizer 137, armatures of relays 138 and 139, modulator 129, band-pass filter 140, modulator 131, armatures of relays 141 and 142, low-pass filter 143, amplifier 144, equalizer 145, armatures of relays 146 and 147, high-pass filter 148 to line L'. At repeater station C the line L' is connected to the input of filter 203 through a circuit including the lower armature of relay 202. The image current from line L' is thus transmitted through filter 203, amplifier 204 and filter 205 to line L, the output of filter 205 being connected to the line L through a circuit including the lower armature of relay 201. At station A the circuit may be traced from line L through filter 48, armatures of relays 46 and 47, low-pass filter 43, amplifier 44, equalizer 45, armatures of relays 38 and 39, modulator-demodulator 29, band-pass filter 40, modulator-demodulator 31, armatures of relays 41 and 42, equalizer 15, low-pass filter 16 and amplifier 17 to the cathode ray tube 20 which produces an image of the subject 112.

For two-way telephone communication between the subscribers or subjects 12 and 112 there is provided a telephone subscriber's set 56 which is connected to the hybrid coil 57 provided with a balancing network 58. From the hybrid coil 57 the speech transmission path extends through gain control potentiometer 59, amplifier 60, delay network 61, modulator 62, supplied with 100-kilocycle carrier current from source 63, and 90-kilocycle to 100-kilocycle band-pass filter 64 to line L. At repeater station C, the telephone current from station A is transmitted through band-pass filter 209, amplifier 210 and band-pass filter 211, the output of which is connected to line L'. At station B the speech current is transmitted through band-pass filter 165, gain control potentiometer 166 and amplifier 167 to hybrid coil 157, having a balancing network 158, and from the hybrid coil to the subscriber's set 156.

Speech signals generated in the subscriber's set 156 at station B are transmitted through hybrid coil 157, gain control potentiometer 159, amplifier 160, 10-kilocycle low-pass filter 164 to line L'. At repeater station C the speech signals are transmitted through low-pass filter 212, amplifier 213 and low-pass filter 214 to line L. At station A, the speech signals are transmitted through low-pass filter 65, transformers 68 and 69, gain control potentiometer 66, amplifier 67 and hybrid coil 57 to subscriber's set 56. The transformer 68 has two secondary windings and the transformer 69 has two primary windings. There is provided a relay 70 through the armature of which the secondary windings of transformer 68 and the primary windings of transformer 69 are connected so as to establish two series-aiding circuits through the transformers when the relay 70 is unactuated, thereby permitting speech signal transmission through the circuit as described in U. S. Patent 1,749,851, granted to H. C. Silent, March 11, 1930. When the relay 70 is energized to open the circuit through this armature the windings are opposed to prevent speech signal transmission through the transformers.

The apparatus for controlling the direction of television transmission over the single channel provided for this purpose will now be described. There is provided a manually operated switch under control of the subscriber 12 at station A, this switch having an arm 71 which may be brought into engagement with a desired contact 1, 2, 3, or 4 by turning the knob 72. When the switch arm 71 is brought into engagement with contact 1, the direction of transmission between stations A and B is automatically reversed periodically at such a rate, for example, that at each station the successive image scanning periods, during each of which a complete image is produced, are separated by equal image scanning periods during which successive images are produced at the other station. When the switch arm is in position 2, the system is in condition for television transmission continuously from station A to station B and, when the switch arm is in position 3, the system is conditioned for television transmission continuously from station B to station A. When the switch is in position 4 the direction of television transmission is reversed under control of speech currents. As shown in the drawing the cam switch 74 is operated when the switch arm 71 is on point 1 or 4 and released when it is on points 2 and 3.

It will be observed that there is no circuit connection to contact 2 of the manually operated switch so that, when the switch arm 71 is in position 2, the switching relays at stations A, B and C are deenergized and the system is conditioned for transmission of television images from the control station A to the distant station B, as described above.

When the switch arm 71 is moved to contact 3, grounded battery 72 is connected to the series circuit which may be traced from battery 72 through lead 7, relay 73, lead 8, contact of cam switch 74, lead 6 and through relays 47, 46, 41, 42, 35, 34, 32, 33, 39 and 38, in order, to ground. The operation of relay 73 completes a circuit through the relay armature for transmitting 20-kilocycle current from oscillator 75 through band-pass filter 76 to line L. At station C the 20-kilocycle current is transmitted through band-pass filter 215 and amplifier 216 to detector 217 for supplying operating current to the windings of switch relays 201 and 202. The 20-kilocycle current is also

transmitted from the output of amplifier 216, through band-pass filter 218 to line L'. At station B the 20-kilocycle current from line L' is transmitted through band-pass filter 176 to detector 175 for supplying energizing current to the relays connected in the series circuit which may be traced from grounded battery through the output of detector 175, and through relays 138, 139, 133, 132, 134, 135, 142, 141, 146 and 147, in order, to ground. When these various switching relays at stations A, B and C are operated the system is conditioned for television image transmission from station B to station A, as described above.

When the switch arm 71 is brought into position 1, grounded battery 77 is intermittently connected, through the conducting segments of commutator 78, to the series circuit which may be traced through lead 5, switch contact 1, switch arm 71, lead 7, relay 73, lead 8 and cam switch 74, to ground at 88, to cause the intermittent operation of relay 73 and, as a result, the transmission of current from oscillator 75 to stations C and B for causing the intermittent operation of the switching relays thereat. Another circuit which is completed when the switch arm 71 is in position 1 may be traced from grounded battery 77 through commutator 78, lead 5, switch arm 71, resistor 79 and condenser 80 to ground and, in shunt with the condenser 80, through resistor 81, lead 6 and relays 47, 46, 41, 42, 35, 34, 32, 33, 39 and 38, in order, to ground. The commutator 78 is driven by motor 82, the speed of which is maintained constant by current from oscillator 22 supplied to the speed control circuit 83 as described in the Stoller patent, supra. The artificial line comprising resistors 79 and 81, and condenser 80 delays the operation of relays 47, 46, 41, 42, 35, 34, 32, 33, 39 and 38 at station A to compensate for the delay in transmission over line L to station B and, if desired, a similar network may be employed at station C for delaying the operation of relays 201 and 202 to compensate for the transmission delay over line L' going from station C to B. Thus the relays at stations A, B and C for reversing the direction of transmission may be switched substantially simultaneously during an interval commencing subsequent to the completion of a single scanning of the field of view at station A and prior to the commencement of scanning of the field of view at station B. Thus, after the subject 12 at station A has been scanned for a period of $\frac{1}{20}$ second, for example, and after the image current has been transmitted over line L, L' to control the image production at station B, the switching relays are operated to condition the television transmission channel for transmitting the image current, generated at station B as a result of scanning subject 112, to station A for controlling the production of an image at that station.

When the switch arm 71 is moved to contact 4, the system is conditioned for television transmission from station A to station B when neither subscriber is talking into the transmitter of the subscriber's set or when subscriber 112 is talking. Thus, under these conditions, the subscriber 112 at station B can see an image of the subscriber 12. However, when the subscriber 12 talks into the transmitter of subscriber's set 56 the television channel is switched or conditioned for transmitting an image of the subscriber 112 at station B to station A, thus enabling the subscriber 12 to see an image of subscriber 112. To cause the energization of the switching relays, the speech current generated in the subscriber's

set 56 is transmitted through hybrid coil 57 and amplifier 60 to the delay circuit 61, which stores the speech energy, while a portion of the speech current is diverted into detector 84, the output current of which flows through the windings of relays 70, 85, and 86 in series to cause these relays to operate. It should be noted at this point that, when speech current is being received at station A through the circuit including transformers 68 and 69, a portion of the speech energy is diverted to the circuit including detector 89 and relay 90. The relay 90 when thus energized opens the series circuit including the windings of relays 70, 85 and 86 to prevent their energization. The operation of relay 85 will open the short circuit across the output of delay network 61 to permit the speech current to be transmitted over the circuit to modulator 62 and the operation of relay 70 will prevent the transmission of speech current through transformers 68 and 69, as explained above, thus preventing echoes from being received at station A. The operation of relay 86 will complete a circuit from grounded battery 87, through the relay armature, lead 9, contact 4, and switch arm 71, lead 7, relay 73, lead 8 and through a contact of switch 74 to ground at 88. Another circuit which is completed when the switch arm 71 is in position 4 may be traced from grounded battery 87 through the armature of relay 86, lead 9, contact 4, switch arm 71, resistor 79, condenser 80 to ground and, in shunt with condenser 80, through resistor 81, lead 6 and relays 47, 46, 41, 42, 35, 34, 32, 33, 39 and 38, in order, to ground. Due to the operation of relay 73, current is thus transmitted from oscillator 75 to stations C and B for controlling the operation of switching relays thereat, and the switching relays at station A are directly energized by current from battery 87 to condition the television channel for transmission from station B to station A.

In the system as specifically shown and described herein, when the television channel is under control of the speech waves, the direction of transmission of the television signals is opposite to the direction in which the speech waves are being transmitted. With this arrangement, the subscriber who starts speaking first can see an image of the subscriber to whom he is talking and, when that subscriber stops talking and the second subscriber starts talking the direction of television transmission is reversed and the second subscriber can see an image of the first subscriber. If desired, of course, the system may be arranged to transmit an image of the subscriber who is speaking to the listening subscriber. Moreover, if desired, station B as well as station A, may be provided with speech terminal equipment, like that shown at station A, and the control circuit including detector 175 omitted from station B, so that the direction of television transmission can be switched under control of speech current produced at either station A or station B. In this case, the stations A and B normally would be conditioned for transmitting television signals and, if the subscriber 112 at station B, for example, were speaking, the television circuit at station B would be switched to the receiving condition so that the subscriber at station B would be able to see an image of the subscriber 12.

What is claimed is:

1. A combined television and sound system comprising stations connected by a plurality of communication channels, means for transmitting sound signals over one of said channels, and

means associated with said one channel and controlled by said sound signals, for controlling another of said channels for the transmission thereover of television signals.

2. A combined television and sound system comprising stations connected by a plurality of communication channels, means for transmitting sound signals over one of said channels, means for transmitting television signals in either direction over another of said channels, and means controlled by said sound signals for determining the direction of transmission of said television signals over said other channel.

3. A combined television and telephone system comprising a plurality of terminal stations, television transmitting and receiving apparatus and telephone transmitting and receiving apparatus at each of said stations, a television transmission channel connecting said stations, switching means at each of said stations for connecting the television transmitting apparatus and the television receiving apparatus to said transmission channel alternatively, and means under control of the telephone signals produced at one of said terminal stations for controlling said switching means at at least one of said terminal stations.

4. A combined television and telephone system comprising two terminal stations, television transmitting and receiving apparatus and telephone transmitting and receiving apparatus at each of said stations, a television transmission channel connecting said stations, switching means at each of said stations for connecting the television transmitting apparatus and the television receiving apparatus to said transmission channel alternatively, and means under control of the telephone signals produced at one of said terminal stations for controlling said switching means at both of said terminal stations.

5. A combined television and telephone system comprising two terminal stations, television transmitting and receiving apparatus and telephone transmitting and receiving apparatus at each of said terminal stations, a transmission channel including a repeater station for connecting the terminal stations, switching means at each of said stations for conditioning the system for television transmission from either terminal station to the other terminal station alternatively, and means under control of said telephone signals for controlling said switching means at each of said stations.

6. A combined television and telephone system comprising two terminal stations, television transmitting and receiving apparatus and telephone transmitting and receiving apparatus at each of said terminal stations, a transmission channel including a repeater station for connecting the terminal stations, switching means at each of said stations for conditioning the system for television transmission from either terminal station to the other terminal station alternatively, and means for preventing the control of said switching means by telephone signals produced at one of said terminal stations while telephone signals are being transmitted from the other terminal station to the telephone receiving apparatus at the first terminal station.

7. In a carrier current signaling system including a plurality of terminal stations, signal generating means and signal reproducing means at one of said terminal stations, carrier current modulating-demodulating means at said station, and switching means for impressing signals produced

by said signal generating means upon said modulating-demodulating means to produce a signal modulated carrier current and for transmitting the signal modulated carrier current or, alternatively, for impressing a received signal modulated carrier current upon said modulating-demodulating means to produce a demodulated signaling current and for impressing said demodulated signaling current upon said signal reproducing means.

8. A two-way carrier television system including a plurality of terminal stations, television transmitting and receiving apparatus at each of said stations, carrier current modulating-demodulating means at each of said stations, carrier current transmission means connecting said stations, switching means for connecting the television transmitting apparatus and the transmission means to the modulating-demodulating means at one of said stations and for connecting the transmission means and the television receiving apparatus to the modulating-demodulating means at the other of said stations or, alternatively, for connecting the television receiving apparatus and the transmission means to the modulating-demodulating means at said one station and for connecting the television transmitting apparatus and the transmission means to the modulating-demodulating means at said other station.

9. A carrier current system in accordance with claim 7 in which there is provided a second signal generating means for controlling said switching means.

10. A two-way carrier television system in accordance with claim 8 in which there is provided means for actuating said switching means at regularly spaced time intervals.

11. In a carrier current signaling system, a first and a second modulator-demodulator, a first and a second source of carrier current of different frequency, respectively, and switching means for connecting the first source of carrier current to the first modulator-demodulator and the second source of carrier current to the second modulator-demodulator or, alternatively, for connecting the second source of carrier current to the first modulator-demodulator and the first source of carrier current to the second modulator-demodulator.

12. In a carrier current signaling system a first and a second modulator-demodulator, means for connecting the output of the first modulator-demodulator to the input of the second modulator-demodulator, a first and a second source of carrier current of different frequency, respectively, a source of signals, a signal reproducing means, a transmission path, switching means for connecting the first source of carrier current and the source of signals to the first modulator-demodulator and for connecting the second source of carrier current and the transmission path to the second modulator-demodulator when the switch-

ing means is in a certain condition or, alternatively, for connecting the second source of carrier current and the transmission path to the first modulator-demodulator and for connecting the first source of carrier current and the signal reproducing means to the second modulator-demodulator when the switching means is in a different condition, and means for energizing said switching means for changing the condition thereof.

13. In a carrier signaling system, a first modulator-demodulator, a second modulator-demodulator, a first source and a second source of carrier current, the frequency of the first source being lower than that of the second source, a source of signals, a transmission path, signal reproducing means, a first switching means for connecting said source of signals to said first modulator-demodulator, a second switching means for connecting said first source of carrier current to said first modulator-demodulator, thereby producing a modulated carrier signaling current, means for selecting one side-band of the modulated current produced in said first modulator-demodulator and impressing it upon said second modulator-demodulator, a third switching means for connecting said second source of carrier current to said second modulator-demodulator a fourth switching means for connecting said second modulator-demodulator to said transmission path, said transmission path including means for selecting one side-band of the modulated current produced in said second modulator-demodulator, and means for operating all of said switching means simultaneously for disconnecting the circuits previously connected by said switching means and for connecting the transmission path to said first modulator-demodulator through said first switching means, for connecting said second source of carrier current to said first modulator-demodulator through said third switching means, for connecting said first source of carrier current to said second modulator-demodulator through said second switching means, and for connecting said signal reproducing means to said second modulator-demodulator through said fourth switching means, thereby demodulating a modulated carrier current received over said transmission path and impressing it upon said signal reproducing means.

14. A television system comprising a plurality of terminal stations each having terminal television transmitting and receiving apparatus, a transmission channel connecting said terminal stations, switching means for reversing the direction of television image transmission between the terminal apparatus at said terminal stations, a plurality of means for controlling the operation of said switching means and manually operable means for selecting said controlling means alternatively.

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