Oct. 20, 1942. J. R. WILKERSON 2,299,264

TELEGRAPH SIGNAL REPEATER

Filed April 20, 1940 2 Sheets-Sheet 1

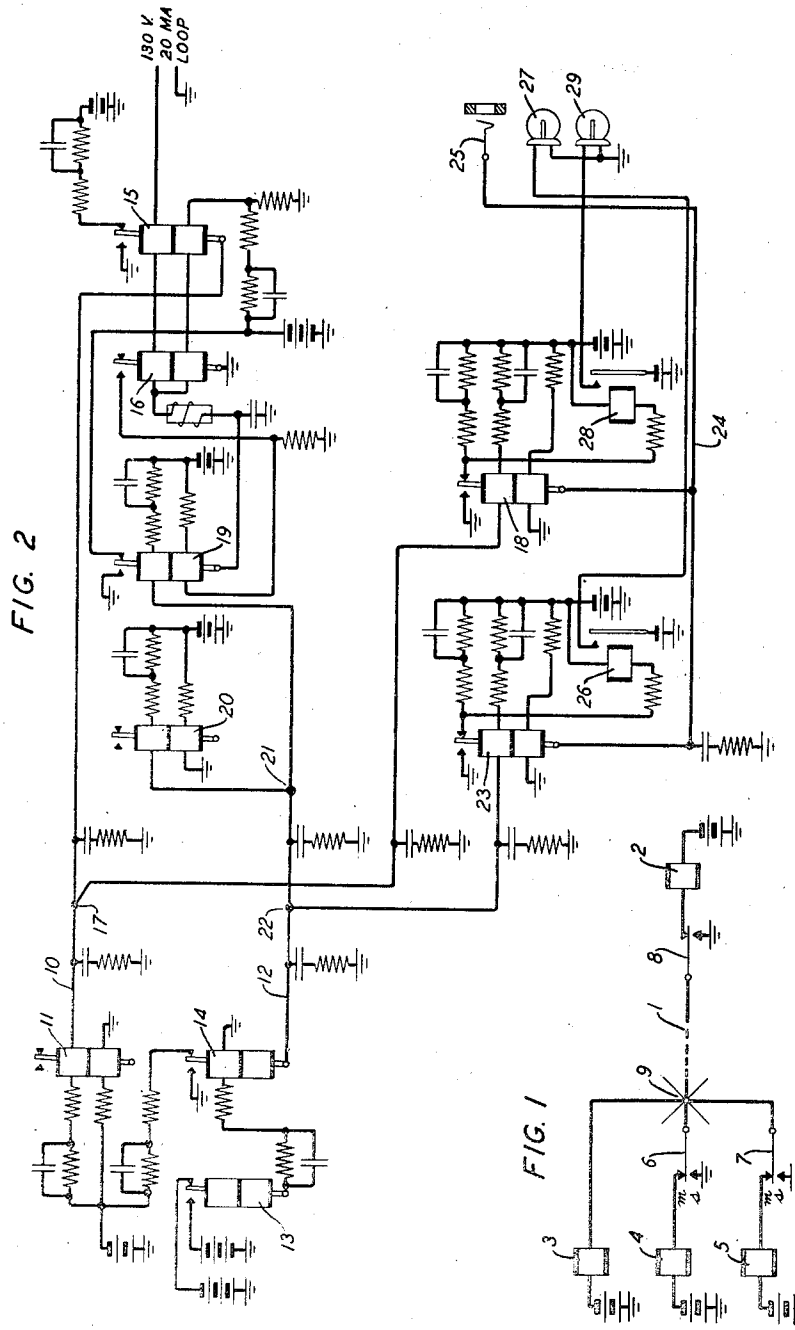

FIG. 2

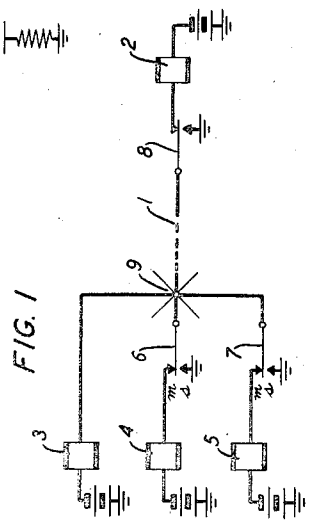

FIG. 1

INVENTOR
J. R. WILKERSON

BY
J. K. Schmied

ATTORNEY

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TELEGRAPH SIGNAL REPEATER

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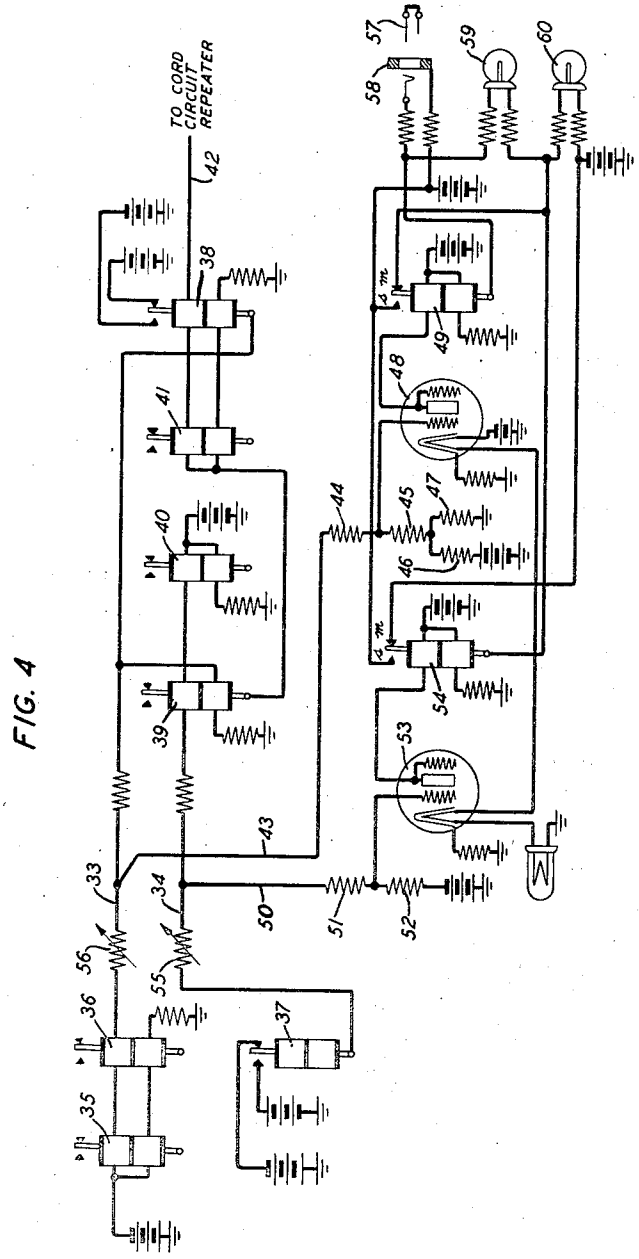

FIG. 4

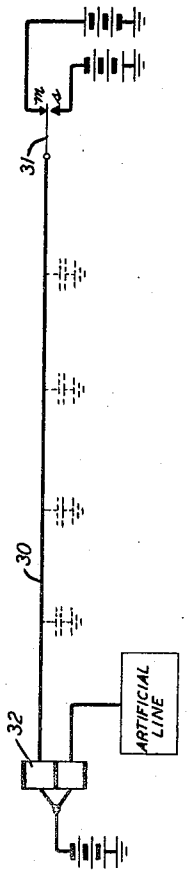

FIG. 3

INVENTOR
J. R. WILKERSON

BY J. W. Schmied

ATTORNEY

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TELEGRAPH SIGNAL REPEATER

Jefferson R. Wilkerson, Brooklyn, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application April 20, 1940, Serial No. 330,686

11 Claims. (Cl. 178—58)

This invention relates to communication systems and particularly to signal repeaters in machine telegraph systems.

The object of the invention is to provide a repeating device which may be connected to the conductors of a trunk without interference with the signals being transmitted thereover, and which will faithfully reproduce the signals being transmitted over said conductors on either of them for operating monitoring or testing devices and which will indicate the direction of transmission or the conductor over which the signals are being transmitted.

Standard practice for arrangements of this nature has heretofore been to insert a repeating arrangement in series with a line, but there is danger of signal mutilation in this practice. In order to guard against this danger, the present circuit arrangement has been designed to work on the "leak" principle. The input circuit is, therefore, designed to be bridged to the line conductors of the line or trunk to be observed or tested, and the impedance of such input circuit has been so arranged that there will be no noticeable signal degradation on such line or truck as a result of such connection.

A feature of the invention is a repeater connected to the two legs of a full duplex line where such line is operated on a half duplex basis, for repeating signals into a single channel leading to monitoring or testing devices.

Another feature is a means for indicating over which leg of such a duplex line the signals are being transmitted at any one time.

In accordance with one embodiment of the invention, one circuit arrangement is provided for connection to the legs of a full duplex line operated on the inverse neutral plan in which any number of connections may radiate from a single point, such connections normally passing through, first, a transmitting contact and, second, a magnet winding of a receiving device. The movement of any one transmitting contact opens the circuit of the associated receiving device and closes a direct operating connection for all the remaining connections to said point. With this plan of operation, the repeater of the present invention may be added to the legs of a full duplex line in the same manner as another branch line without introducing appreciable signal distortion. With the input of the repeater arranged for connection to such inverse neutral circuits, the output may be arranged in a similar manner, that is, each repeating relay may have its armatures in parallel connected to a monitoring or measuring set equal to the loads on the normal or marking contacts of such relays and the spacing contact of either relay may close a direct operating connection for the monitoring or measuring set and the load on the marking contact of the unoperated relay. This last load may take the form of another relay to operate a signal to indicate the direction of transmission over the said duplex circuit.

In accordance with another embodiment of the invention, another circuit arrangement is provided for connection to the legs of a full duplex line operated on the balanced loop plan in which the bridged connections to the repeater must be of high impedance to respond to voltage changes without introducing any signal distortion. According to the balanced loop plan, no such direct connection to the signaling line is made as in the inverse neutral plan and hence the problem of making a bridged connection is not so simple. In this case a high impedance potentiometer is connected to the signaling conductor and the signal taken from a point on the potentiometer is amplified by a vacuum tube. With the input of the repeater arranged for connection to such balanced loop circuits, the output may be arranged to operate a balanced loop monitoring or testing set. The armatures and contacts of the repeating relays are arranged for series operation whereby either may pass signals on to the monitoring or testing set. A signal arrangement is connected to such armatures and contacts to indicate the conductor of the full duplex line which is being used for transmission at any one time.

Other combinations may be arranged. For instance, the input of the repeater may be designed for connection to the legs of a full duplex channel working on the balanced loop plan while the output may be arranged on the inverse neutral plan or vice versa.

A feature of the invention is a separate means responsive to transmission over each leg of a full duplex channel combining to give a single output.

Another feature is the means for indicating which of the separate legs of the said full duplex channel is operating at any given time.

Fig. 1 is a schematic circuit diagram useful to explain the essential features of one type of telegraph circuit, and Fig. 2, a circuit diagram showing this type of telegraph circuit in more detail with the circuit diagram of the repeater forming the subject-matter of the present invention.

Fig. 3 is a schematic circuit diagram explaining

the essential features of a different type of telegraph circuit, and Fig. 4 is a circuit diagram showing this type of telegraph circuit more in detail with a circuit diagram of the repeater forming the subject-matter of the present invention.

Fig. 1 shows the essential elements of that type of telegraph circuit known as the inverse neutral circuit, a line 1 extending between two points is in the normal condition connected at every point to a like battery. Thus, at one end, the line extends through a magnet 2 to a battery and at the other ends extends through magnets 3, 4, and 5 to a like battery. These magnets represent receiving apparatus. The line also extends through contact arrangements here represented as relay armatures 6, 7 and 8, which in their normal positions connect the line 1 to the magnets 4, 5 and 2, respectively. If telegraph impulses are to be sent, let us say from the point controlled by the contact device 8, then the associated receiving magnet 2 is cut off and the line connected to ground whereupon all the magnets 3, 4 and 5 operate. Similarly, if the contact device 7 is to be operated then the associated receiving magnet 5 will be cut off and the magnets 2, 3 and 4 will be operated. By means of this system a hub point 9 may be provided and as many receiving circuits, such as that indicated by the magnet 3 or complete telegraph circuits such as that indicated by the magnet 4 and armature 6 may be connected to this point.

In order to monitor on a line of this character then it is only necessary to connect a receiving device similar to the other receiving device already connected to the line to a hub point such as 9 and such a receiving device will faithfully follow signals sent over the line without interfering with the operation of the line in any manner.

The upper part of Fig. 2 illustrates in more detail a pair of inverse neutral circuits, that part to the left represents a toll terminal repeater. Signals received over the line 10 operate the receiving relay 11. Signals to be transmitted in the opposite direction are sent over line 12 through the operation of a transmitting relay 13 which in turn operates another transmitting relay 14 to directly affect the line 12.

The upper and right-hand portion of Fig. 2 represents a loop repeater used in connection with certain concentration unit telegraph systems. At the extreme right are two conductors marked 130 volt, 20 milliampere loop. Assuming that these two conductors extend through a closed circuit which may be provided with a receiving magnet and a transmitting contact, the closure of this loop causes the operation of relays 15 and 16. Relay 15 is a transmitting relay which in its marking position as shown places a battery connection on line 10 similar to the battery connection reached through the upper winding of relay 11. When the loop is interrupted then relay 15 will place ground on conductor 10 thereby operating relay 11. Line 10 is provided with a hub point 17 leading to one part of a repeater arrangement and it will be noted that the line therefore extends through the upper winding of relay 18 and thence to a battery similar to that on the marking contact of relay 15 and that reached through the upper winding of relay 11. Therefore, when relay 15 moves its contact in response to interruption of the loop it operates relay 18 as well as relay 11.

The other line 12 extending from the armature of relay 14 passes through the winding of relay 19 and in parallel therewith through the winding of relay 20 through a hub point 21. Relay 19 is provided to operate the receiving magnet on the loop to the extreme right of this figure by substituting through the upper windings of relays 15 and 16 a ground connection in place of the battery connection of the right-hand contact of relay 19. Relay 20 is provided for certain supervisory purposes and is shown here to illustrate the operation of the inverse neutral type of circuit.

The circuit 12 is also provided with a hub point 22 from which a conductor leads to a relay 23 and through the upper winding of this relay to a battery similar to that reached through the upper windings of relays 19 and 20. Thus, when relay 13 is operated and in turn relay 14 is operated, relays 19, 20 and 23 respond.

With an arrangement of this nature telegraph signals may be transmitted over the line 10 and telegraph signals may be transmitted over the line 12 but transmission of these two lines will never be simultaneous. Therefore, relays 18 and 23 may both respond to telegraph signals but their operation will not be simultaneous.

The armatures of relays 18 and 23, both on their marking contact as shown, lead to similar batteries and these two armatures are both connected to a conductor 24 leading to a jack 25 which may be connected to a receiving device in the form of a monitoring teletypewriter or some testing means connected eventually to a battery reached through the upper windings of relays 18 and 23. In other words, the conductor 24 also comprises part of an inverse neutral type of circuit. When relay 18 is operated, therefore, ground is placed on the conductor 24 thus affecting the receiving teletypewriter connected to jack 25. At the same time this ground is extended through the armature of relay 23 and through the winding of relay 26 which by operating connects a source of battery to a signal lamp 27. The operation of lamp 27 shows that relay 18 is operated and therefore indicates that transmission is coming over line 10. In a similar manner when relay 23 operates, ground is connected to line 24 and thus through jack 25 to the receiving device connected thereto. At the same time this connection extends through the armature of relay 18 and its marking contact through the winding of relay 28 which operating causes lamp 29 to glow. The operation of lamp 29 indicates that transmission is coming in over line 12 and that consequently relay 23 is operated.

In this manner a monitoring receiving device, either a teletypewriter or some testing device, will respond to signals being sent over either line 10 or line 12 and the two corresponding lamps 27 and 29 will indicate over which of these lines the transmission is coming.

Fig. 3 illustrates the essential principles of what is known as the balanced loop type of telegraph circuit. Here a line 30 extends between a transmitting device 31 and a receiving relay 32. Under ordinary conditions the relay 32 and the marking contact of the transmitting device are connected to batteries of opposite polarity. Relay 32 has two windings, the lower one of which is connected through an artificial line for balancing purposes. When signals are to be transmitted from the device 31, normal connection to the plus potential battery is changed to a connection to the minus potential battery. Since lines of this nature extend sometimes over long distances and there is a certain distributed ca-

pacity to ground, the marking contact of the device 31 is provided so that stable operation of the relay 32 will result. In this type of system it is not possible to provide a hub circuit connection as in the example just given in connection with Figs. 1 and 2. Therefore, a connection to this line must be such that signals passing over the line are detected by the voltage difference on the line at different times.

In Fig. 4 the upper part of the drawing is a schematic of a full duplex system employing two circuits such as that schematically shown in Fig. 3. Line 33 and line 34 extend to the left into a toll terminal repeater. This comprises receiving relays 35 and 36 connected to the line 33 and a transmitting relay 37 controlling line 34. To the right the upper part of Fig. 4 illustrates a repeater known as a concentration unit trunk repeater for affecting a cord circuit repeater indicated at the extreme right. Thus, a relay 38 operated from the cord circuit repeater will switch the line 33 from one to another type of battery. Telegraph signals coming over line 34 will operate relays 39 and 40 and relay 39, having its armature connected to upper windings of relays 41 and 38, will repeat signals into the cord circuit repeater indicated by the conductor 42.

Line 33 is connected by a conductor 43 to a potentiometer circuit including resistances 44, 45, 46 and 47. From an intermediate point of this potentiometer circuit a connection is made to the grid of tube 48 and the change of potential on line 33 caused by the operation of relay 38 will affect the tube 48 so that the relay 49 will respond. Thus, relay 49 faithfully follows telegraph signals being transmitted over the line 33.

In like manner a conductor 50 is connected to the conductor 34 and leads through a potentiometer circuit including the resistances 51 and 52 from an intermediate point of this potentiometer circuit a connection is made through the grid of tube 53 so that relay 54 connected to the plate of this tube will faithfully follow telegraph signals over the line 34.

The difference in the potentiometer circuits to which the grids of tubes 48 and 53 are connected illustrate the different conditions to be expected on these types of lines. For instance, due to the resistance of the line here illustrated by the variable resistances 55 and 56 and to the distributed capacity indicated in Fig. 3, the condition near the transmitting end may be expected to be different from the condition expected at the receiving end. Thus, the tube 48 is illustrated as effectively connected to the line near its transmitting end while the tube 53 is illustrated as effectively connected to the line at its receiving end. The proportioning of the potentiometers for providing the grid connections for tubes 48 and 53 is a matter of engineering practice and may be changed to fit any given condition.

Relays 49 and 54 operate a closed loop monitoring device here illustrated merely by a closed loop connected to a plug 57 which may be connected to the sleeve and tip conductors of jack 58. When the two relays 49 and 54 are both in the position shown, a circuit may be traced from plus battery through the sleeve of jack 58 over the loop including the monitoring teletypewriter or measuring device, the tip of jack 58, the armature and marking contact of relay 49, the armature and marking contact of relay 54 to minus battery. The movement of the armature of either of these relays breaks this circuit and consequently affects the device connected to jack 58. Thus, if signals are being transmitted over line 33, relay 49 will respond and similarly transmit signals to the monitoring device connected to jack 58. Similarly, if signals are being transmitted over line 34, relay 54 will be operated and will transmit similar signals to the monitoring device connected to jack 58.

A signal lamp 59 corresponds to relay 49. Thus, when relay 49 operates to its spacing contact a circuit may be traced from positive battery through the spacing contact of relay 49, the tip circuit of jack 58 through the lamp 59, through the armature and marking contact of relay 54 to minus battery thus causing the lamp 59 to glow and indicate that relay 49 is operating and thus also indicate that signals are being transmitted over the line 33.

In a similar manner a lamp 60 is operated whenever relay 54 is operated. At this time a circuit may be traced from minus battery through lamp 60, the armature and spacing contact of relay 54 to positive battery connected to the sleeve of jack 58. Thus, the glowing of lamp 60 will indicate that relay 54 is operated, which in turn, indicates that signals are being transmitted over the line 34.

What is claimed is:

1. In a communication system, a plurality of communication channels in combination with a repeater for interposition between monitoring and testing devices and said plurality of communication channels comprising means responsive to signals on each communication channel, said means being constructed and arranged to repeat signals without interfering with the operation of or distorting the signals passing over said communication channels, a corresponding plurality of incoming channels for connecting said means to said communication channels, and a single outgoing channel into which signals from all said incoming channels are repeated over said repeater for connection to said monitoring and testing devices.

2. In a communication system, a repeater for interposition between monitoring and testing devices and a plurality of communication channels comprising communication channels, means responsive to signals on each communication channel, said means being constructed and arranged to repeat signals without interfering with the operation of or distorting the signals passing over said communication channels, a corresponding plurality of incoming channels for connecting said means to said communication channels, a single outgoing channel into which signals from all said incoming channels are repeated for connection to monitoring and testing devices, and means for indicating which of said incoming channels the signals being repeated into said outgoing channels are traversing.

3. In a communication system, a repeater having a plurality of incoming paths connected to a corresponding plurality of intelligence conveying communication channels, each said incoming path comprising a high impedance leakage path having a terminal adapted to be connected to said connected communication channel, means for amplifying signal voltages impressed upon said terminals of said leakage paths, and means for repeating said amplified signals into a single outgoing path.

4. In a communication system, a plurality of intelligence conveying communication channels, a repeater having a plurality of incoming paths

connected to a corresponding plurality of said communication channels, each said incoming path comprising a high impedance leakage path from said connected communication channel, means for amplifying signals traversing said leakage paths, means for repeating said amplified signals into a single outgoing path, and means controlled by said outgoing path for indicating which of said incoming paths the signals being repeated into said outgoing channel are traversing.

5. In a communication system, a plurality of intelligence conveying communication channels, a repeater having a plurality of incoming paths connected to a corresponding plurality of said communication channels, each said incoming path comprising a high impedance leakage path from said connected communication channel, said path forming a potentiometer having an intermediate connection, a vacuum tube amplifier connected to said potentiometer connection for amplifying signals traversing said leakage path, and relay means for repeating said amplified signals into a single outgoing path.

6. In a communication system, communication channels, a repeater having a plurality of incoming paths for connection to a corresponding plurality of said communication channels, each said incoming path comprising a high impedance leakage path from said connected communication channel, said path forming a potentiometer having an intermediate connection, a vacuum tube amplifier connected to said potentiometer connection for amplifying signals traversing said leakage path, relay means for repeating said amplified signals into a single outgoing path, and means for indicating which of said incoming paths the signals being repeated into said outgoing path are traversing.

7. In a communication system, communication channels, a repeater having a plurality of incoming paths for connection to a corresponding plurality of said communication channels, each said incoming path comprising a high impedance leakage path from said connected communication channel, said path forming a potentiometer having an intermediate connection, a vacuum tube amplifier connected to said potentiometer connection for amplifying signals traversing said leakage path, relay means for repeating said amplified signals into a single outgoing path, and a signal lamp for each of said incoming paths responsive to said relay means for indicating which of said incoming paths the signals being repeated into said outgoing path are traversing.

8. In a communication system, communication channels, a repeater having a plurality of incoming paths for connection to a corresponding plurality of said communication channels, each said communication channel comprising an inverse neutral circuit and each said incoming path comprising a leg of an inverse neutral circuit, and relay means in each said incoming path for repeating signals traversing the said communication channel to which it is connected into a single outgoing path.

9. In a communication system, communication channels, a repeater having a plurality of incoming paths for connection to a corresponding plurality of said communication channels, each said communication channel comprising an inverse neutral circuit and each said incoming path comprising a leg of an inverse neutral circuit, and means for indicating which of said incoming paths the signals being repeated into said outgoing path are traversing.

10. In a communication system, communication channels, a repeater having a plurality of incoming paths for connection to a corresponding plurality of said communication channels, each said communication channel comprising an inverse neutral circuit and each said incoming path comprising a leg of an inverse neutral circuit, relay means in each said incoming path for repeating signals traversing the said communication channel to which it is connected into a single outgoing path, said outgoing path comprising an inverse neutral circuit, and means for indicating which of said incoming paths the signals being repeated into said outgoing path are traversing, said last means comprising legs of said inverse neutral outgoing circuit.

11. A telegraph system comprising two one-way channels of communication one of which is provided with transmitting and receiving equipment for transmitting in one direction and the other of which is provided with transmitting and receiving equipment for transmitting in the opposite direction, means connected to the first of said channels for deriving signals therefrom without interfering with communication thereover, means connected to the second of said channels for deriving signals therefrom without interfering with communication thereover in combination with a single path upon which signals from both of said channels are impressed, and means associated with said path to indicate from which channel signals impressed upon said path have been derived.

JEFFERSON R. WILKERSON.