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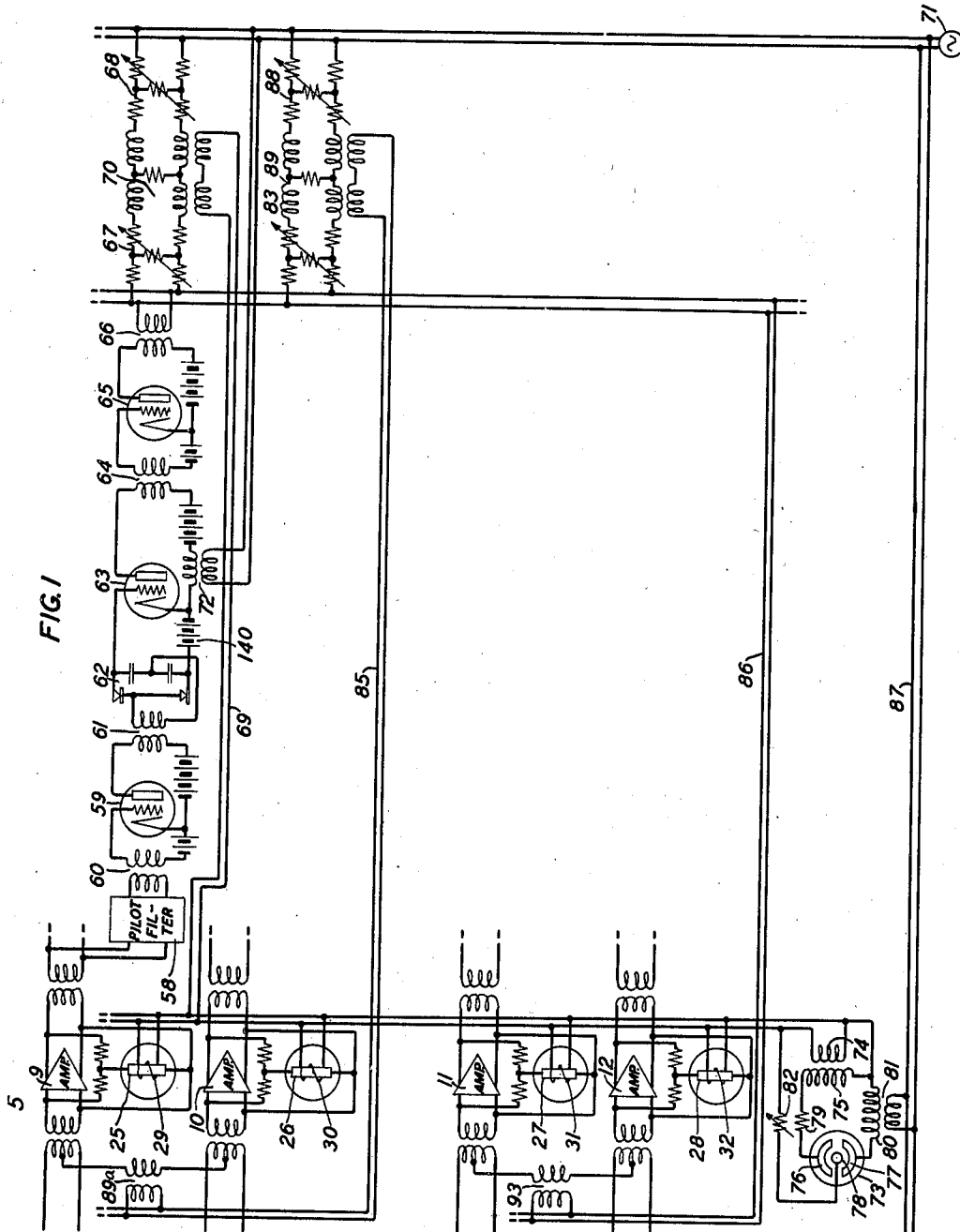
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2,213,037

SIGNAL TRANSMISSION SYSTEM

Filed Feb. 11, 1939

4 Sheets-Sheet 1



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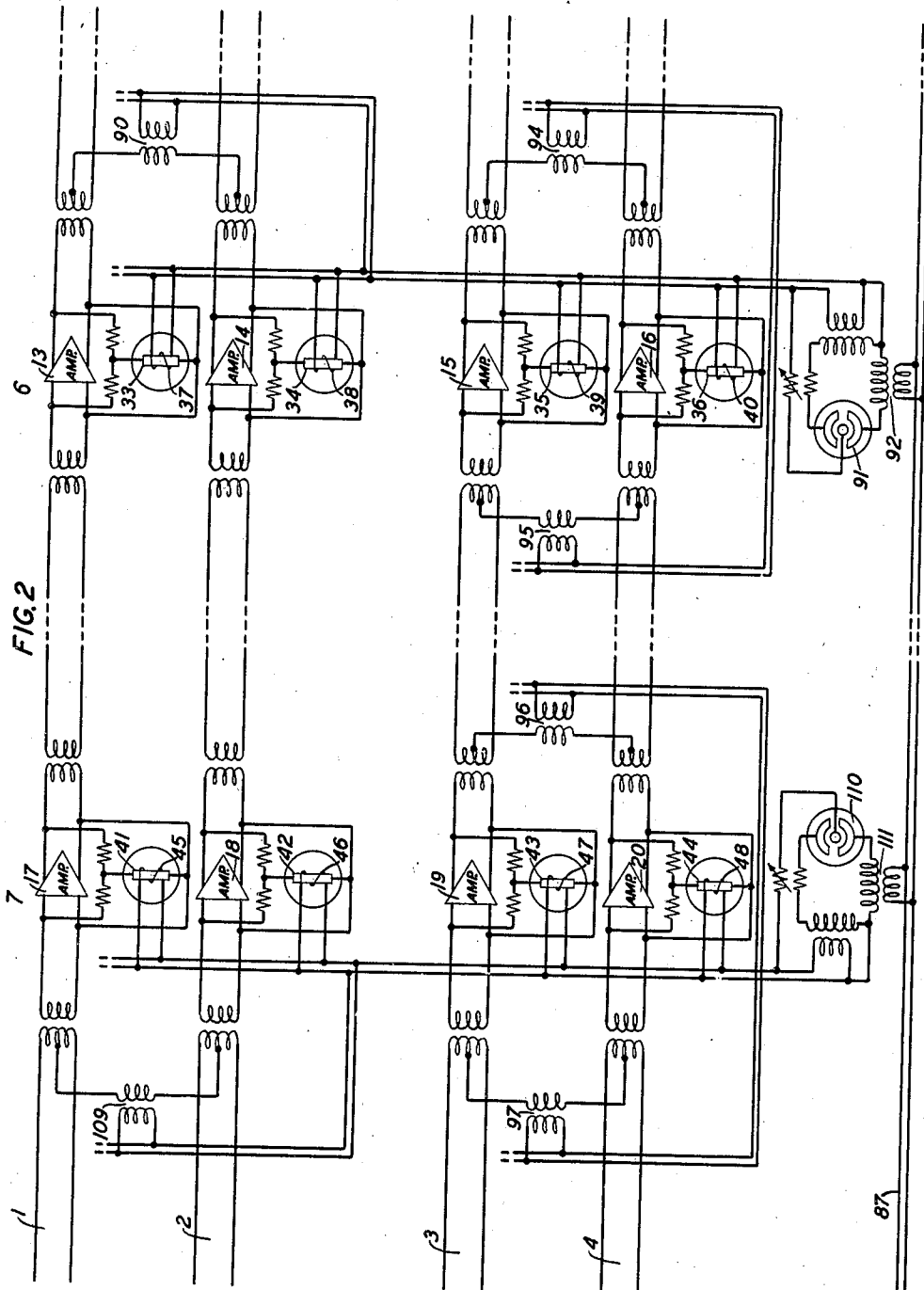
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SIGNAL TRANSMISSION SYSTEM

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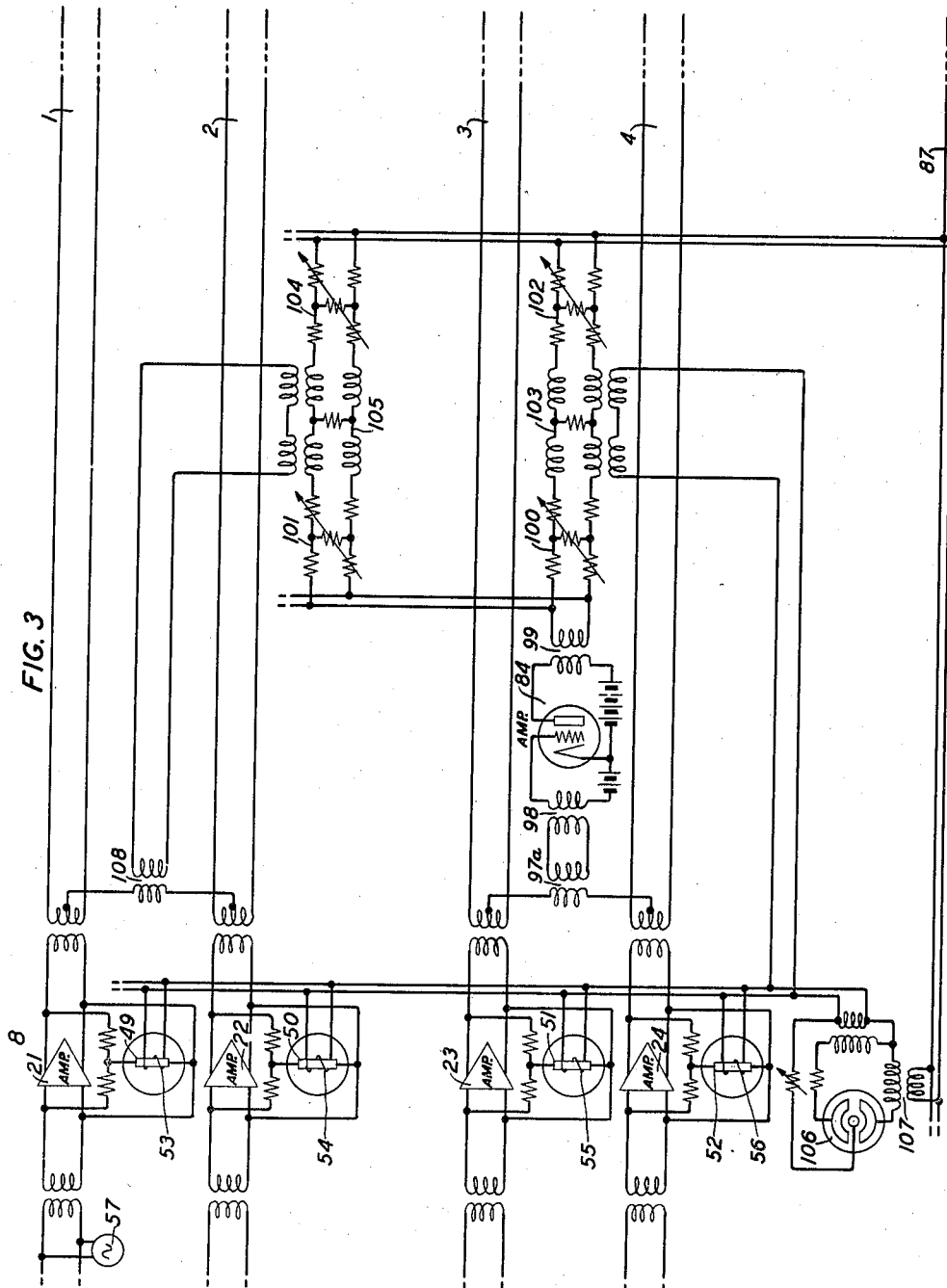
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SIGNAL TRANSMISSION SYSTEM

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FIG. 3



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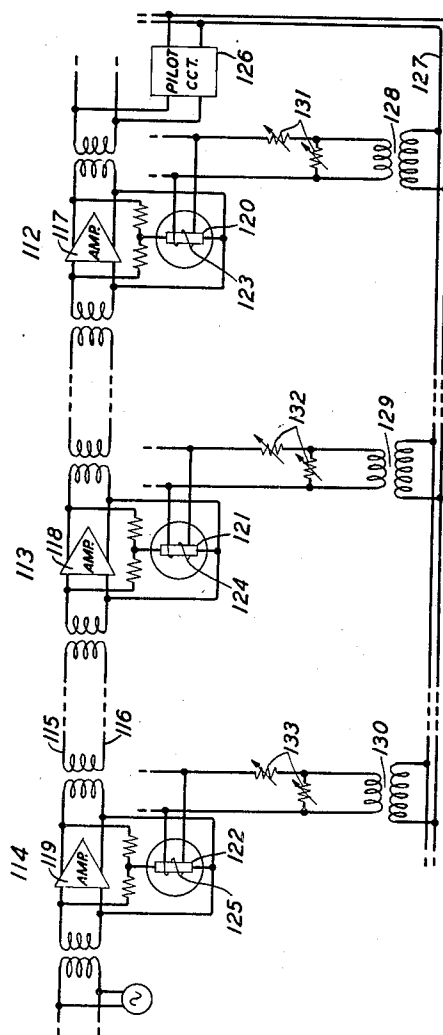
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SIGNAL TRANSMISSION SYSTEM

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4 Sheets-Sheet 4

FIG. 4



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SIGNAL TRANSMISSION SYSTEM

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10 Claims. (Cl. 178—44)

This invention relates to signal transmission systems and particularly to pilot channels for carrier current systems.

One object of the invention is to provide a signal transmission system having amplifiers located at a main station and at auxiliary stations with a source of current at the main station controlled by a pilot current to govern the amplifiers at said stations.

Another object of the invention is to provide a signal transmission system having a pilot channel and carrier channels connected to amplifiers located at a plurality of stations that shall control a low frequency current at one station according to the pilot current on the pilot channel to govern the amplifiers at said stations.

Another object of the invention is to provide a cable system having carrier channels on the different pairs of conductors and a pilot channel on one of the pairs of conductors with amplifiers located at main and auxiliary stations that shall govern a control current at a main station according to the pilot current on the pilot channel to govern the amplifiers at each of said stations.

A further object of the invention is to provide a signal transmission system having amplifiers governed by heat controlled resistance elements and parallelly arranged heater coils controlling the resistance elements that shall have a variable control current energizing said heater coils and an auxiliary constant source that shall operate said heater coils to heat the resistance elements at a fixed temperature in case of failure of said control current.

In a long signal transmission system it is necessary to provide repeaters or amplifiers at intervals along a transmission line to maintain the level of the transmitted signals. The amplifiers along the transmission line should be controlled according to the losses effected by the signals to hold the signal at a fixed level. A carrier cable system may be provided with a number of carrier channels on each pair of conductors and with an amplifier for each pair of conductors at each main or auxiliary station. It is desirable to provide one or more pilot channels on the cable pairs of conductors to control the amplifiers at the various stations.

The present invention has been illustrated by means of a cable carrier system. A cable containing a number of pairs of conductors is provided with a main station and a number of auxiliary stations. At each station an amplifier is provided for the channels on each pair of conductors. Each pair of conductors has a number of carrier channels and one pair of conductors has a pilot channel thereon. A control current is provided at the main station for governing the amplifiers at the main station and all the

auxiliary stations. The control current from the source at the main station is controlled in accordance with the amplitude of the pilot current on the pilot channel at the main station.

In one form of the invention the amplifiers at each station are provided with feedback circuits controlled by resistance elements having a high negative temperature coefficient of resistance such, for example, as silver sulphide. It is obvious that elements having high positive temperature coefficients of resistance may be employed. Heater coils are provided for heating the resistance elements at each station. The heater coils at each station are connected in parallel to the source of control current at the main station. The control current supplied to the amplifiers at each station is adjusted to control the rate of gain change at each station and to control the flat gain at each station. The control current at the main station which is controlled in accordance with the pilot current on the pilot channel may not only be supplied to auxiliary stations but also to another main station. The control current which is supplied to a second main station may be amplified and then employed to control another set of auxiliary stations. The rate of gain change and the flat gain at each station under control of the second attended station may be adjusted as above set forth.

Provision may be made to prevent abnormal gain changes in the signal transmission in case of failure of the control current supplied to the amplifiers at any station. A cold cathode gas-filled tube having an ignition circuit and an operating circuit may be employed for insuring a fixed gain by the amplifiers at each station in case of failure of the control current. The control current supplied to the heater coils at a station is connected to the ignition circuit of said tube in opposition to a fixed potential source. The fixed potential source is of substantially the same strength as the control current to prevent ignition of the tube under normal conditions. The fixed source of potential is also connected to the operating circuit of the tube in circuit with the heater coils at the station. In case of failure of the control current the tube is ignited and the heater coils are operated by power supplied to the operating circuit of the tube by the fixed source of potential. When control current is again received the tube is extinguished and power is then supplied to the heater coils by the source of control current.

In a modification of the invention main and auxiliary stations on a coaxial cable system may be controlled as above set forth. The coaxial cable will not only have carrier channels but also a pilot channel. The pilot current on the pilot channel will be filtered from the carrier currents at a main station and a control current at the

main station will be governed according to the amplitude of the filtered pilot current. The control current governed by the pilot current will be employed to govern the amplifiers at the main and auxiliary stations. The control current supplied to the amplifiers at the various stations may be adjusted, if so desired, to control the rate of gain change and the flat gain at the various stations.

- 10 In the accompanying drawings, Figs. 1, 2 and 3 are diagrammatic views of a transmission system constructed in accordance with the invention. The drawings are assembled to show the complete system by attaching Fig. 2 to the left side of Fig. 1 and by attaching Fig. 3 to the left side of Fig. 2; and

Fig. 4 is a diagrammatic view of a modification of the system shown in Figs. 1, 2 and 3 of the drawings.

- 20 Referring to Figs. 1, 2 and 3, a cable system is illustrated wherein carrier currents are transmitted by different pairs of conductors in a cable. In the drawings, only four pairs of conductors, numbered 1, 2, 3 and 4, are illustrated. It is to be understood that the cable may be provided with any desired number of pairs of conductors which are controlled in the same manner as the pairs of conductors 1, 2, 3 and 4.

- A main station 5 and three auxiliary stations 6, 7 and 8 are located along the cable. At each station an amplifier is provided for each pair of conductors. The amplifiers at each station are controlled from the main station 5 according to the amplitude of the pilot current on a pilot channel of one of the pairs of conductors. At the main station 5 amplifiers 9, 10, 11 and 12 are respectively provided for the pairs of conductors 1, 2, 3 and 4. At the auxiliary station 6 amplifiers 13, 14, 15 and 16 are respectively provided for the pairs of conductors 1, 2, 3 and 4. At the auxiliary station 7 amplifiers 17, 18, 19 and 20 are respectively provided for the pairs of conductors 1, 2, 3 and 4. At the auxiliary station 8 amplifiers 21, 22, 23 and 24 are respectively provided for the pairs of conductors 1, 2, 3 and 4.

- 25 The amplifiers at each of the stations are of the feedback type and are controlled by varying a resistance element in the beta circuit. Preferably, the resistance element in the beta circuit of each amplifier has a high negative temperature coefficient of resistance and may, for example, be boron or silver sulphide. The amplifiers 9, 10, 11 and 12 at the main station 5 have resistance elements 25, 26, 27 and 28 located in the beta circuits. Heater coils 29, 30, 31 and 32 are respectively provided for heating the resistance elements 25 to 28, inclusive. The beta circuits of the amplifiers 13 to 16, inclusive, located at the auxiliary station 6, are respectively provided with resistance elements 33 to 36, inclusive. The resistance elements 33 to 36, inclusive, are respectively provided with heater coils 37 to 40, inclusive. The beta circuits of the amplifiers 17 to 20, inclusive, at the auxiliary station 7 are controlled by resistance elements 41 to 44, inclusive. The resistance elements 41 to 44, inclusive, are respectively provided with heater coils 45 to 48, inclusive. The beta circuits of the amplifiers 21 to 24, inclusive, at the auxiliary station 8 are respectively provided with resistance elements 49 to 52, inclusive. The resistance elements 49 to 52, inclusive, are respectively provided with heater coils 53 to 56, inclusive.

- The pairs of conductors 1, 2, 3 and 4 may not only have carrier channels but may have pilot

channels thereon. The pair of conductors 1 is assumed to have a pilot channel which carries pilot current from a pilot generator 57. At the main station 5 the pilot current from the generator 57 is selected from the carrier currents by means of a pilot filter 58. The pilot filter 58 is connected to an amplifier tube 59 by means of a transformer 60. The amplifier tube 59 is connected by a transformer 61 to a copper-oxide rectifier 62 of the doubler type. The rectifier 62 is connected to a control tube 63, which in turn is connected by a transformer 64 to an amplifier tube 65. Battery 140 placed between the rectifier 62 and the tube 63 opposes the rectified voltage in order to obtain voltage changes which are more than proportional to the changes by the pilot current. The amplifier tube 65 is connected by a transformer 66 to an adjustable resistance pad 67. The resistance pad 67 is adjusted to control the rate of gain change by the amplifiers 9 to 12, inclusive, at the main station 5. A second resistance pad 68 serves to control the flat gain of the amplifiers 9 to 12, inclusive, at the main station 5. The resistance pads 67 and 68 are connected to each other and to a control circuit 69 by means of a hybrid coil 70.

A source of low frequency current 71 is provided at the main station 5 and may be a 60-cycle power circuit. The source 71 is connected by a transformer 72 to the plate circuit of the control tube 63. The low frequency current supplied to the plate circuit of the tube 63 is controlled according to the amplitude of the pilot current on the pilot channel at the main station 5. Low frequency current from the source 71 is also supplied to the resistance pad 68.

A tube 73, which may be a gas-filled tube or a cold cathode tube is provided for insuring the heating of the coils 29 to 32, inclusive, for the resistance elements 25 to 28, inclusive, at a fixed temperature in case of failure of the control current supply by the control circuit 69. The control circuit 69 is connected not only in parallel to the heater coils 29 to 32, inclusive, but also to a coil 74. The coil 74 is inductively connected to a coil 75 in the ignition circuit of the tube 73. The tube 73 is provided with three electrodes 76, 77, and 78. The electrodes 76 and 77 are in the ignition circuit of the tube and the electrodes 78 and 77 are included in the operating circuit of the tube 73. The ignition circuit of the tube 73 not only includes the electrodes 76 and 77, the coil 75 and a resistance element 79, but also the secondary winding 80 of a transformer 81. The primary winding of the transformer 81 is connected to the source of low frequency current 71. The operating circuit of the tube 73 includes the electrodes 77 and 78, secondary winding 80 of the transformer 81, coil 74 and an adjustable resistance 82.

In a circuit constructed as above set forth the gain of the amplifiers 9 to 12, inclusive, at the main station 5 is controlled according to the amplitude of the pilot current on the pilot channel at the main station 5. The pilot current is selected from the carrier currents at station 5 by means of the filter 58. The pilot current is then amplified by the tube 59 and rectified by the rectifier 62. The rectified pilot current governs the operation of the control tube 63. Low frequency current from the source 71 is supplied to the control tube 63 by means of the transformer 72. The low frequency current is controlled according to the pilot current by means of the control tube 63. The low frequency current governed accord-

ing to the pilot current is amplified by the tube 65 and supplied to the gain rate adjusting pad 67. The pad 67, as before set forth, is adjusted to control the rate of gain by the amplifiers at the station 5 and the pad 68 is adjusted to adjust the flat gain by the amplifiers at the main station 5. The flat gain pad 68 is connected to the source 71 and the two pads 67 and 68 are connected by the hybrid coil 70 to the control circuit 69. The control circuit 69 is connected in parallel to the heater coils 29 to 32, inclusive. The heater coils 29 to 32, inclusive, control the resistance elements 25 to 28, inclusive, which in turn govern the amplifiers 9 to 12, inclusive.

The low frequency control current from the circuit 69 energizes the coil 74, which is inductively connected to the coil 75 in the ignition circuit of the cold cathode tube 73. The power supplied to the ignition circuit from the coil 74 is opposed by power supplied from the low frequency source 71 by means of the transformer 81. The power from the two sources oppose each other and prevent ignition of the tube 73. The two sources of power supplied to the ignition circuit of the tube 73 have the same frequency and are in phase opposition. In case of failure of the control circuit 69, the coil 75 in the ignition circuit of the tube 73 is deenergized and immediately the tube 73 is ignited by power supplied from the source 71. Upon ignition of the tube 73 power is then supplied to the heater coils 29 to 32, inclusive, from the source 71 through the transformer 81. The heating of the resistance elements 25 to 28, inclusive, by power supplied from the source 71 through the transformer 81 is presumed to hold the amplifiers 9 to 12, inclusive, at an average gain.

The controlled low frequency current from the amplifier 65 is not only supplied to the rate adjusting pad 67, but also to a rate adjusting pad 83 for the auxiliary station 6 and to an amplifier 84 for controlling the amplifiers at the main station 8 and the amplifiers at the auxiliary station 7. The pad 83 controls the rate of gain by the amplifiers 13 to 16, inclusive, at the auxiliary station 6. An H pad 88 is provided to control the flat gain by the amplifiers 13 to 16, inclusive. The pad 83 is connected to the transformer 66 as before set forth and the pad 88 is connected to the source of low frequency current 71. The two pads 83 and 88 are connected together and to control circuit 85 by means of a hybrid coil 89. The rate of gain pad is employed to adjust the amplifiers for the different conditions to which the cable sections are subjected. One section of the cable controlled by the amplifiers of one station may be underground whereas another section of the cable controlled by the amplifiers at another station may be above ground. The rate of gain change for controlling the underground section must be different from the rate of gain change controlling the section of cable located above ground. The flat gain pad is employed to adjust the amplifiers for the length of cable controlled by them.

The control circuit 85 is connected by a transformer 89A to a phantom circuit formed by the pairs of conductors 1 and 2. A transformer 90 at the auxiliary station 6 is connected to the phantom circuit formed by the pairs of conductors 1 and 2. The secondary winding of the transformer 90 is connected in parallel to the heater coils 37 to 40, inclusive, which control the resistance elements 33 to 36, inclusive. The resistance elements 33 to 36, inclusive, at the aux-

iliary station 6 are controlled in the same manner as the resistance elements 25 to 28, inclusive, at station 5 are controlled.

A three-element tube 91 at station 6 is similar in construction and operation to the three-element tube 73 at the main station 5. The power circuit 87 which connects the transformer 81 at station 5 to the source of low frequency current 71 also connects a transformer 92 at station 6 to the source of low frequency current. The circuit 87 may be one or more pairs of conductors in the cable or may be a phantom circuit formed by two pairs of conductors in the cable. The secondary winding of the transformer 92 is connected to the ignition circuit and the operating circuit of the tube 91. The tube 91 operates in the same manner as the tube 73 for operating the heater elements 37 to 40, inclusive, in case of failure of the power supplied by the control circuit 85.

The control circuit 86 at the main station 5 is connected by a transformer 93 to a phantom circuit formed by the pairs of conductors 3 and 4 between the stations 5 and 6. A transformer 94 at station 6 is connected to the phantom circuit formed by the pairs of conductors 3 and 4 between the stations 5 and 6. The secondary winding of the transformer 94 is connected to the primary winding of a transformer 95. The secondary winding of a transformer 95 is connected to a phantom circuit formed by the pairs of conductors 3 and 4 between stations 6 and 7. A transformer 96 at station 7 has the primary winding connected to the phantom circuit formed by the pairs of conductors 3 and 4 between the stations 6 and 7. The secondary winding of the transformer 96 is connected to the primary winding of a transformer 97. The secondary winding of the transformer 97 is connected to a phantom circuit formed by the pairs of conductors 3 and 4 between stations 7 and 8. At station 8 a transformer 97A has the primary winding connected to the phantom circuit formed by the pairs of conductors 3 and 4 between the stations 7 and 8. The secondary winding of the transformer 97A is connected by a transformer 98 to the amplifier 84. The amplifier 84 is connected by a transformer 99 to H rate of gain pads 100 and 101. The pad 100 controls the rate of gain effected by the amplifiers 21 to 24, inclusive, at station 8. The pad 101 controls the rate of gain effected by the transformers 17 to 20, inclusive, at the auxiliary station 7. A flat gain pad 102 is connected to the rate of gain pad 100 by means of a hybrid coil 103. A flat gain pad 104 is connected to the rate of gain pad 101 by means of a hybrid coil 105. The flat gain pads 102 and 104 are connected to the source of low frequency current 71 by means of the circuit 87.

The heater coils 53 to 56, inclusive, at station 8 are connected to the pads 100 and 102 by means of the hybrid coil 103. The heater coils 53 to 56, inclusive, are controlled according to the pilot current at station 5 and according to the adjustment of the rate of gain pad and flat gain pad to control the amplifiers 21 to 24, inclusive. The operation of the amplifiers 21 to 24, inclusive, at station 8 is similar to the operation of the amplifiers 9 to 12, inclusive, at station 5. A three-element tube 106, which is similar in construction and operation to the tube 73 at station 5, is employed for controlling the gain of the amplifiers 21 to 24, inclusive, in case of failure of the power under control of the pilot current on the pair of conductors 1. The circuit 87, which is connected

to the source of low frequency current 71, is connected by a transformer 107 to the ignition circuit and the operating circuit of the tube 106. The power supplied by the transformer 107 opposes the power supplied to the ignition circuit of the tube 106 from the control circuit connected to the heater coils 53 to 56, inclusive. Upon failure of the power supplied to the heater coils, the ignition circuit of the tube 106 breaks down the tube to effect operation of the operating circuit. The operating circuit of the tube 106 supplies power from transformer 107 to the heater coils 53 to 56, inclusive, to hold the gain of the amplifiers 21 to 24, inclusive, at some normal amount.

The hybrid coil 105, which is connected to the pads 101 and 104, is also connected to the primary winding of a transformer 103. The secondary winding of the transformer 103 is connected to a phantom circuit extending between the station 2 and station 1 on the pairs of conductors 1 and 2. A transformer 109 at station 7 has the primary winding connected to the phantom circuit extending between the stations 7 and 9 on the pairs of conductors 1 and 2. The secondary winding of the transformer 109 is connected in parallel to the heater coils 45 to 48, inclusive. The heater coils 45 to 48, inclusive, control the resistance elements 41 to 44, inclusive, to control the gain effected by the amplifiers 17 to 20, inclusive. In the circuit above traced the amplifiers 17 to 20, inclusive, are controlled according to the amplitude of the pilot current at station 5. The rate of gain by the amplifiers at station 7 is controlled by adjusting the pad 101 and the flat gain by the amplifiers at station 7 is controlled by adjusting the pad 104. In the control of the amplifiers at station 7 it will be noted that a low frequency current at station 5 governed according to the pilot current is transmitted to station 8 and from station 8 to station 7.

A three-element tube 110, which is similar in construction and operation to the tube 73 at stations 5 is employed for effecting heating of the coils 45 to 48, inclusive, in case of failure of the normal operating power supply to the coils. A transformer 111 is provided for connecting the ignition circuit of the tube 110 to the circuit 37 connected to the source of low frequency power 71 at station 5. The tube 110 is operated in the same manner as the tube 73 at station 5.

In the circuit above described it will be noted that only one band-pass filter is required for controlling the amplifiers at a number of stations. The pilot current is selected at only one station, namely station 5. The pilot current which is selected at station 5 is employed for controlling a low frequency current. The low frequency current is transmitted to various other stations for control purposes.

Referring to Fig. 4 of the drawings, a modified control circuit is shown for use on a coaxial cable system. Three stations comprising a main station 112 and two auxiliary stations 113 and 114 are shown connected to the coaxial cable comprising conductors 115 and 116. Three amplifiers 117, 118 and 119 are respectively provided at the three stations 112, 113 and 114. The amplifiers 117 to 119, inclusive, are of the feedback type having the beta circuits thereof controlled by a resistance element having a high negative temperature coefficient of resistance. Resistance elements 120 to 122, inclusive, respectively associated with the beta circuits of the amplifiers 117 to 119, inclusive, are assumed to

be composed of silver sulphide. Heater coils 123 to 125, inclusive, are provided for heating the resistance elements 120 to 122, inclusive.

A pilot current control circuit 126 is connected to the coaxial cable at the main station 112 for controlling the amplifiers 117 to 119, inclusive. The pilot current control circuit 126 is similar to the pilot current control circuit shown in Fig. 1 of the drawings. This control circuit may comprise a pilot filter, an amplifier, a rectifier, a control tube and an amplifier tube similar to the parts 58, 59, 62, 63 and 65 shown in Fig. 1 of the drawings. The circuit 126 is connected to a circuit 127 extending between the stations 112, 113 and 114. The circuit 127 is connected to the heater coil 123 by means of a transformer 128. The circuit 127 is connected to the heater coil 124 by a transformer 129. The heater coil 125 is connected to the circuit 127 by a transformer 130. L pads 131, 132 and 133 are respectively placed in the connections to the coils 123, 124 and 125 for controlling not only the rate of gain but also the flat gain by the amplifiers at stations 112, 113 and 114. It is assumed in the circuit under consideration that the sections of the cable controlled by the amplifiers 117, 118 and 119 are all subjected to substantially the same temperature conditions.

In the circuit shown in Fig. 4 in the drawings the pilot current on the coaxial cable is selected and employed for controlling a low frequency current at the station 112. This low frequency current is then transmitted by the circuit 127 to the various stations for controlling the gain at each of the stations. The pilot current control circuit operates in the same manner as the pilot current control circuit described when reference is made to Figs. 1, 2 and 3 of the drawings.

Modifications in the circuits and in the arrangement and location of parts may be made within the spirit and scope of the invention and such modifications are intended to be covered by the appended claims.

What is claimed is:

1. In combination, a transmission line having a signal channel and a pilot channel, a number of stations on said line, an amplifier at each of said stations for the signal and pilot channels, a source of low frequency current at one of said stations, and means for controlling the amplitude of said low frequency current according to the amplitude of the pilot current on the pilot channel, for feeding said varied low frequency current back to the various stations and for controlling the amplifier at each station according to the amplitude of the varied low frequency current.

2. In combination a pair of conductors having a number of carrier channels and a pilot channel thereon, a main station and auxiliary stations connected to said conductors, each of said stations having an amplifier for the carrier and pilot channels, a source of alternating current at the main station, means free from moving parts at said main station for varying the amplitude of said alternating current according to the strength of the pilot current at the main station, and means for controlling the amplifiers at said stations according to the amplitude of the alternating current.

3. In a carrier current transmission system, a transmission line having a number of carrier channels thereon, a pilot channel on said line transmitting a pilot current of relatively high frequency, main and auxiliary stations on said

line, each of said stations having an amplifier for the carrier and pilot channels, a source of relatively low frequency current at the main station, means free from moving parts at said main station for filtering said pilot current from the line and for varying the amplitude of said low frequency current under control of said pilot current, and means controlled according to the amplitude of said low frequency current at each of said stations for governing the amplifiers at said stations to control the gain on said line.

4. A transmission line having a signal channel and a pilot channel thereon, a main station and a number of auxiliary stations on said line, an amplifier at each of said stations, a source of low frequency current at the main station, means at said main station for selecting the pilot current on the pilot channel from the signal currents and for rectifying the selected pilot current, means comprising a control tube governed by said rectified pilot current at the main station for modulating said source of low frequency current to produce a low frequency control current having an amplitude varying according to variation in the selected pilot current at the main station, and means for transmitting said control current to each of said stations and for controlling the amplifier at each of said stations according to variations in the control current.

5. A cable having a number of pairs of conductors thereon, carrier channels on each of said pairs of conductors, a pilot channel on one of said pairs of conductors, a main station and a plurality of auxiliary stations on said cable, an amplifier for each of said pairs of conductors at each of said stations, a source of low frequency current at the main station means at said main station for selecting the pilot current from the carrier currents on the pair including the pilot channel and for rectifying the selected pilot current, means comprising a control tube governed by said rectified pilot current at the main station for modulating said source of low frequency current to produce a relatively low frequency current having an amplitude varying according to variations in the pilot current, and means for transmitting said low frequency current to each of said stations and for controlling the amplifiers at each of said stations according to variations in the low frequency current.

6. In combination, a cable having a number of pairs of conductors therein, carrier channels on each of said pairs of conductors, a pilot channel on one of said pairs of conductors, a gain control station on said cable, an amplifier having a beta circuit for each of said pairs of conductors at the gain control station, resistance elements having high negative temperature coefficients of resistance for controlling the beta circuits of said amplifiers, a plurality of parallelly connected coils for heating said resistance elements, a source of low frequency control current connected to said heater coils for controlling said resistance elements, means for controlling the amplitude of the low frequency current according to the amplitude of the pilot current at said station, a three-element cold cathode tube having the starting electrodes connected to said source of control current in parallel to said heater coils and a source of constant potential connected to said starting electrodes in opposition to said control current to prevent ignition of said tube and connected to the third electrode of said tube in circuit with said heater coils to effect constant

heating of said coils in case of failure of said control current and ignition of said tube.

7. In combination, a transmission line having a number of carrier channels and a pilot channel, a main station and auxiliary stations on said line, an amplifier at each of said stations for the carrier and pilot channels, a source of low frequency current at the main station, means for controlling the amplitude of said low frequency current according to the amplitude of the pilot current on the pilot channel at the main station, for separately supplying said varied low frequency current to the various stations and for controlling the amplifier at each station according to the amplitude of the varied low frequency current, and means for varying the low frequency currents respectively supplied to the stations to control the rate of gain change and the flat gain change effected by the low frequency control current at the various stations.

8. In combination, a cable having a number of pairs of conductors therein, carrier channels on each of said pairs of conductors, a pilot channel on one of said pairs of conductors, a main station and a number of auxiliary stations on said cable, an amplifier for each of said pairs of conductors at each of said stations, a source of low frequency current at said main station, means for controlling the amplitude of said low frequency current according to the amplitude of the pilot current at the main station, for separately supplying said varied low frequency current to the various stations and for controlling the amplifiers at each station according to the varied low frequency current, and means for varying the low frequency currents respectively supplied to the stations to control the rate of gain change and the flat gain change effected by the low frequency current at the various stations.

9. In combination, a transmission line having a number of carrier channels and a pilot channel, a number of stations on said line, an amplifier for the carrier and pilot channels at each of said stations, a source of current at one of said stations, means for controlling the amplitude of the current from said source according to the amplitude of the pilot current on the pilot channel, means for feeding said controlled current to the various stations, means for adjusting the controlled current according to the flat gain and the rate of gain change desired for change in the pilot current, and means for controlling the amplifier at each station according to the amplitude of the controlled current from said source.

10. In combination, a transmission line having a number of carrier channels and a pilot channel, a number of stations on said line, an amplifier for the carrier and pilot channels at each of said stations, means comprising an element having a large temperature coefficient of resistance associated with each of said amplifiers for controlling the gain, a source of current at one of said stations, means for controlling the amplitude of the current from said source according to the amplitude of the pilot current on the pilot channel, means for feeding said controlled current to the various stations, means for adjusting the controlled current according to the flat gain and rate of gain change desired for change in the pilot current and means for controlling the resistance elements respectively associated with the amplifiers according to the amplitude of the controlled current from said source.