

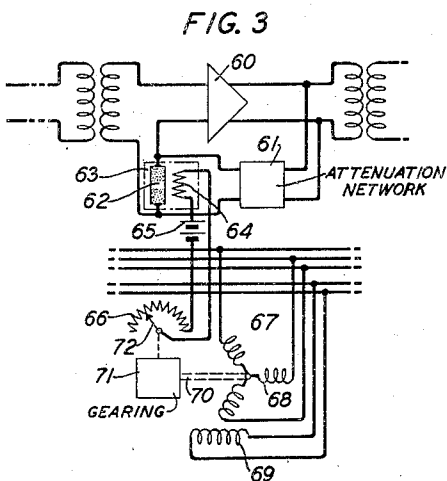
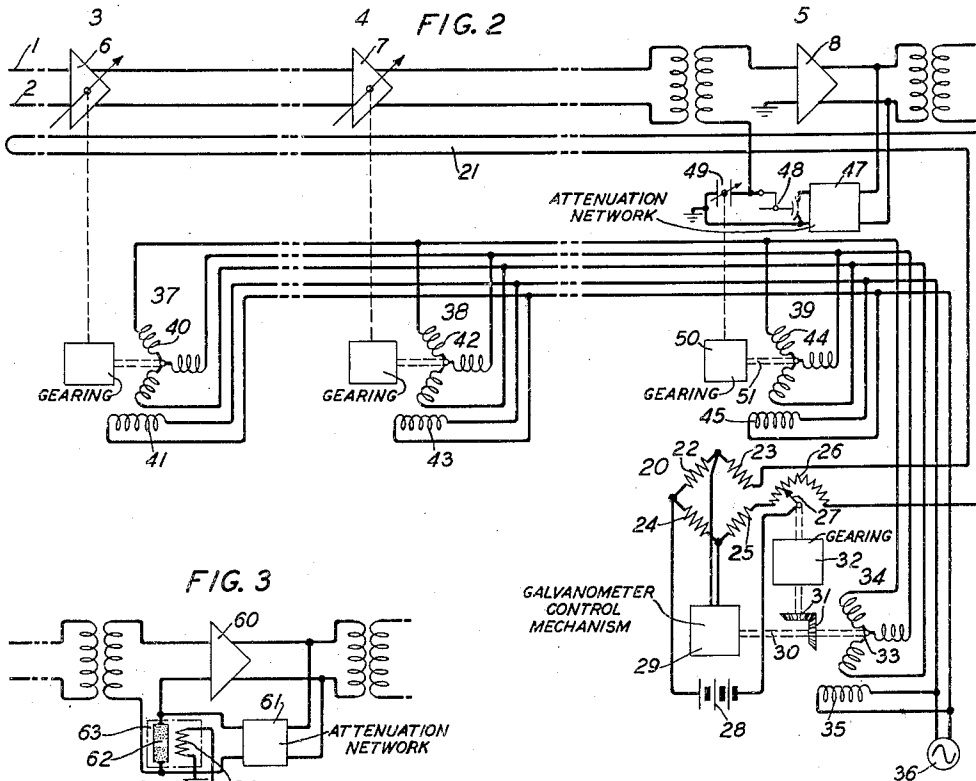
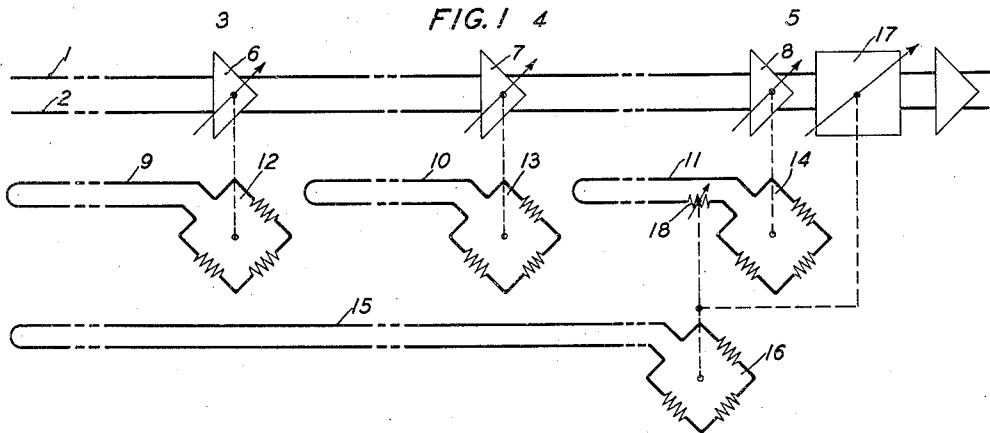
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GAIN CONTROL CIRCUITS

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GAIN CONTROL CIRCUITS

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9 Claims. (Cl. 178—44)

This invention relates to gain control circuits for a transmission line and particularly to gain control circuits which are controlled by pilot lines.

5 One object of the invention is to provide a transmission system having attended and unattended gain control stations on a transmission line that shall effect synchronous operation of the gain at all stations.

10 Another object of the invention is to provide gain control circuits for a transmission line having an attended gain control station, an unattended gain control station and a pilot line associated with the line sections controlled by said stations that shall synchronously control the gain at all stations from the attended gain control station according to the resistance variations of the pilot line with temperature changes.

15 A further object of the invention is to provide a transmission line having an attended gain control station, an unattended gain control station and a pilot line associated with the line sections controlled by said stations with gain control amplifiers at each of said stations operated by a service alternating-current motor at each station and control circuits for operating the service motors synchronously according to the resistance changes in the pilot line by temperature changes.

20 A long signal transmission line is provided with repeater or amplifier stations which are located at intervals along the line to maintain the line attenuation constant irrespective of temperature changes. Some of the stations are attended and other of the stations are unattended. Heretofore each station, whether an attended station or an unattended station, has been complete as to measuring means to determine the change in attenuation on the line section controlled by the station and the apparatus controlled by the measuring means for operating the amplifier to compensate for the change in attenuation on the line section. A system of the type under consideration may be the flat gain regulating system disclosed in the patent to F. A. Brooks, No. 2,075,975, April 6, 1937.

25 According to the invention, complete control apparatus is only provided at an attended station and the unattended stations are operated from attended stations to effect a saving in apparatus at the unattended stations. The invention is described by means of pilot wire gain control circuits of the type disclosed in the above-mentioned patent to F. A. Brooks, 2,075,975.

30 A suitable amplifier which is preferably of the thermionic type is provided in a transmission

line at each of the attended and unattended gain control stations. The transmission line may be a pair of wires in a cable and the transmission line may be of the carrier type, if so desired. A service alternating-current motor is provided at each station for governing the operation of the associated amplifier or repeater. Each service motor preferably comprises a rotor having a three-phase winding and a stator having a single-phase winding. The rotor windings of all the motors are connected in parallel circuit relation and the stator windings of all the motors are connected in parallel circuit relation. Apparatus at an attended station not only controls the operation of the service motor at the attended station but also controls the operation of the service motors at a number of unattended stations. The service motor at each station controls the associated amplifier by governing a condenser or a resistance element in the β circuit for the amplifier.

35 One pilot line extends along the line sections controlled not only by the amplifier at the attended station but also along the line sections controlled by the amplifiers at the unattended stations. The pilot line forms a part of a bridge circuit at the attended station. This pilot line may be a separate pair of wires in the cable or may be a direct-current path on the pair of wires forming the transmission line itself, as shown in the application of I. G. Wilson, Serial No. 145,208, filed May 28, 1937.

40 The bridge circuit at the attended station operates galvanometer control mechanism in accordance with the resistance changes in the pilot line with temperature changes. The galvanometer control mechanism not only controls a resistance in the bridge to rebalance the bridge but also operates the rotor of a distributor dynamo-electric machine. The distributor dynamo-electric machine, which is operated by the galvanometer control mechanism, is similar in construction to the service motors located at the unattended and attended stations. The three-phase rotor winding of the distributor machine is connected in parallel with the rotor windings of the service motors and the single-phase stator winding of the distributor machine is not only connected in parallel to the stator windings of the service motors but also to a single-phase source of power. When the service machine and the distributor machine are connected as above set forth, any movement of the distributor machine rotor will be followed synchronously by the rotors of the service motors. A motor circuit of this type is

disclosed in the patent to C. J. A. Michalke, No. 684,579, dated October 15, 1901.

In gain control circuits as constructed above set forth, a single pilot line will have resistance variations according to all sections of the transmission line and will control the bridge circuit to operate the galvanometer control mechanism according to the attenuation changes in the transmission line. The galvanometer control mechanism not only rebalances the bridge but operates the distributor machine to effect operation of the service motors at the attended and unattended stations. The service motors operate the various amplifiers at the attended and unattended stations to compensate for any change in attenuation on the transmission line which may be caused by temperature changes.

In the accompanying drawing, Fig. 1 is a diagrammatic view of flat gain regulating circuits and twist gain regulating circuits for attended and unattended gain control stations.

Fig. 2 is a diagrammatic view of flat gain regulating means of the type shown in Fig. 1 with the gain of the unattended stations controlled from the attended station.

Fig. 3 is a diagrammatic view of a modified station in the gain control circuits shown in Fig. 2 of the drawing.

Referring to Fig. 1 of the drawing, a transmission line comprising conductors 1 and 2 is shown provided with two unattended gain control stations 3 and 4 and one attended gain control station 5. Suitable gain control amplifiers 6, 7 and 8 are respectively provided at the stations 3, 4 and 5. The amplifiers 6, 7 and 8 are for flat gain control purposes and are shown controlled by separate pilot lines in separate bridge circuits. Pilot lines 9, 10 and 11 are respectively provided at the stations 3, 4 and 5, for controlling bridge circuits 12, 13 and 14. The bridge circuits operate apparatus, not shown in Fig. 1, for controlling the amplifiers 6, 7 and 8.

According to the present invention, the pilot lines 9 and 10 and the bridge circuits 12 and 13 are dispensed with and all control for the unattended stations 3 and 4 is effected from the attended station 5. A twist gain regulator is also shown in Fig. 1 of the drawing. The twist gain regulator is governed by a pilot line 15 connected to a bridge circuit 16. The pilot line 15 extends along all sections of the transmission line which are controlled by the stations 3, 4 and 5. The bridge circuit 16 controls an attenuation equalizer 17 in the manner disclosed in the patent to F. A. Brooks, No. 2,075,975. The bridge circuit 16 and the apparatus controlled thereby also makes a correction in the pilot line 11 for the attended station as indicated by the adjustable resistance 18.

Referring to Fig. 2 of the drawing, a flat gain regulating system of the type shown in Fig. 1 of the drawing is illustrated with the control of the gain at the unattended stations effected at the attended station. Like parts in the circuit shown in Fig. 2 of the drawing are indicated by similar reference characters. The attended station 5 is provided with a bridge circuit 20 under control of a pilot line 21. The pilot line 21 extends along the sections of the transmission line controlled by the unattended stations 3 and 4 and the attended station 5. Although only two unattended stations are shown in the drawing, it is to be understood that any desired number of unattended stations may be associated with one attended station. The bridge circuit 20 com-

prises resistance elements 22, 23, 24, 25 and an adjustable resistance element 26. The adjustable resistance element 26 is controlled by a switch arm 27. A battery 28 is connected across two opposite vertices of the bridge, and galvanometer control mechanism 29 is connected across the other two vertices of the bridge. The galvanometer control mechanism 29 may be of the type disclosed in the above-mentioned patent to F. A. Brooks, No. 2,075,975. The galvanometer control mechanism 29 operates a shaft 30 which, through beveled gears 31 and gearing 32, operates the switch arm 27 to control the resistance 26. The switch arm 27 controls the resistance 26 to rebalance the bridge circuit after each operation of the galvanometer control mechanism 29. The shaft 30 is also connected to the rotor 33 of a distributor dynamo-electric machine 34. The rotor is provided with a three-phase winding and the stator of the machine is provided with a single-phase winding 35 connected to a single-phase source of power 36.

Service alternating-current motors 37, 38 and 39 are respectively provided at the stations 3, 4 and 5. The service motor 37 is provided with a three-phase rotor winding 40 and a single-phase stator winding 41. The service motor 38 is provided with a three-phase rotor winding 42 and a single-phase stator winding 43. The service motor 39 is provided with a three-phase rotor winding 44 and a single-phase stator winding 45. The three rotor windings 40, 42 and 44 for the service motors 37, 38 and 39 are connected in parallel to the rotor winding for the distributor machine 34 and the stator windings 41, 43 and 45 for the service motors 37, 38 and 39 are connected in parallel to the stator winding 35 and to the source 36. The service motors 37, 38 and 39 when connected as above set forth will follow any movement effected by the rotor of the distributor machine 34. The distributor machine 34, as before set forth, is operated in accordance with the resistance changes in the pilot line 21. The pilot line 21 has resistance changes in accordance with temperature changes and according to attenuation changes in the transmission line.

The amplifier 8 at the attended station 5 is controlled by a β circuit comprising an attenuation network 47, a manually adjustable condenser 48, and an automatically adjustable condenser 49. The condenser 49 is adjusted under control of the service motor 39 at the attended station 5. The rotor for the service motor 39 at the attended station 5 is connected to gearing 50 by shaft 51 and the gearing 50 in any suitable manner is connected to the adjustable condenser 49 for controlling the β circuit of the amplifier 8 according to the operation of the service motor 39. The control of the β circuit for the amplifier 8 is the same as that referred to in the above-mentioned patent to F. A. Brooks, No. 2,075,975. In a similar manner, the service motors 37 and 38 at the unattended stations 3 and 4 control the amplifiers 6 and 7. A detail showing of the control at the unattended stations has been deemed unnecessary in view of the showing at the attended station.

In the system disclosed in Fig. 2 of the drawing, a change in temperature not only effects a change in the attenuation on the transmission line sections, but also changes the resistance of the pilot line 21. The pilot line 21 controls the bridge 20 which governs the operation of the galvanometer control mechanism 29. The gal-

vanometer control mechanism 29 rebalances the bridge circuit and effects operation of the distributor machine 34. The distributor machine 34 effects synchronous operation of each of the service motors 37, 38 and 39 at the unattended and attended stations. The service motors 37, 38 and 39 in turn control the gain of the amplifiers 6, 7 and 8 at the stations 3, 4 and 5 to compensate for any change in attenuation on the transmission line caused by temperature changes.

Referring to Fig. 3 of the drawing, a modified control of an amplifier at one of the stations is illustrated. Although an attended station is illustrated in Fig. 3 of the drawing, it is understood that similar control may be provided at the unattended stations. An amplifier 60 in the transmission line is provided with a β circuit comprising attenuation network 61 and a resistance element 62 which may be composed of silver sulphide, boron or any other suitable resistance material having a high temperature coefficient of resistance. The silver sulphide element 62 is placed in a suitable oven 63 and is heated by a coil 64. The heating coil 64 is connected in circuit with a battery 65 and an adjustable resistance 66. The adjustable resistance 66 is controlled according to the operation of a service motor 67 which is similar in construction and operation to the service motor 37, 38 and 39 shown in Fig. 2 of the drawing. The service motor 67 is shown comprising a three-phase rotor winding 68 and a single-phase stator winding 69. The rotor is connected through a shaft 70 to gearing 71 which operates a switch arm 72 for controlling the resistance 66. The resistance 66 controls the heating of the silver sulphide element 62 and accordingly the gain of the amplifier 60. A resistance control as above described may be used in the circuit shown in Fig. 2, if so desired.

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 divided into sections and having an attended gain control station and an unattended control station connected thereto, gain control means at each of said stations for controlling the gain on the transmission line, and means operated according to the temperature changes to which the transmission line sections are subjected to for synchronously operating the control means at said stations to simultaneously change the gain at each station and maintain the line attenuation constant without oscillating action.

2. In combination, a transmission line having an attended gain control station and an unattended gain control station connected thereto, gain control means at each of said stations, an alternating current motor at each of said stations for operating the associated gain control means, a pilot line associated with the transmission line sections controlled by each of said stations and subjected to the same temperature conditions, and means controlled by said pilot line for synchronously operating said motors to simultaneously change the gain at the stations without oscillating action and maintain the line attenuation constant.

3. In combination, a transmission line having an attended gain control station and an unat-

tended gain control station connected thereto, gain control means at each of said stations, an alternating current motor at each of said stations for operating the associated gain control means, a pilot line associated with the transmission line sections controlled by said stations, a bridge circuit at the attended station having said pilot line included in one arm thereof, and means comprising galvanometer mechanism governed by said bridge circuit for synchronously operating said motors to simultaneously control the gain at the stations and maintain the transmission line attenuation constant without oscillatory action.

4. In combination, a transmission line divided into sections and having an attended gain control station and an unattended gain control station connected thereto, a service alternating current motor at each of said stations, means at each station operated by the service motor at the station for controlling the gain at the station, said means at each station having a continuous and uninterrupted action in adjusting the gain when operated by the associated service motor, a pilot line associated with the transmission line sections controlled by said stations, a bridge circuit at the attended station including said pilot line in one arm thereof, and means controlled according to the operation of said bridge circuit for synchronously operating said motors to simultaneously control the gain at the stations and control the attenuation of the transmission line without oscillating action.

5. In combination, a transmission line divided into sections and having an attended gain control station and an unattended gain control station connected thereto, a service alternating current motor at each of said stations, means at each station operated by the service motor at the station for controlling the gain at the station, said means at each station having a continuous and uninterrupted action in adjusting the gain when operated by the associated service motor, a pilot line associated with the transmission line sections controlled by said stations, and means controlled by said pilot line at the attended station for effecting synchronous operation of the motors at all stations to simultaneously control the gain on the transmission line at each of said stations without oscillatory action.

6. In combination, a transmission line having an attended gain control station and an unattended gain control station connected thereto, an alternating current service motor at each of said stations having a wound rotor and a wound stator, a distributor dynamo electric machine having a rotor winding connected in parallel to the rotor windings of said service motors and a stator winding connected in parallel to the stator windings of said service motors and to a source of alternating current so that any movement of the machine rotor is synchronously followed by the service motor rotors, gain control means at each of said stations operated by the associated service motors, and means for operating the rotor of said machine according to the temperature changes to which the transmission line is subjected to operate said service motors simultaneously, to control the gain at the stations simultaneously and maintain the line attenuation constant.

7. In combination, a transmission line having an attended gain-control station and an unattended gain control station connected thereto, an alternating current service motor at each of said stations having a wound rotor and a wound

stator, a distributor dynamo-electric machine having a rotor winding connected in parallel to the rotor windings of said service motors and a stator winding connected in parallel to the stator windings of said service motors and to a source of alternating current so that any movement of the machine rotor is synchronously followed by the service motor rotors, gain control means at the stations operated by the associated service motors, each of said gain control means having a continuous and uninterrupted action in adjusting the gain when operated by the associated service motor, a pilot line associated with the transmission line sections controlled by said stations, a bridge circuit at said attended station having said pilot line included in one arm thereof, and means governed by said bridge circuit for synchronously operating said motors to control the gain simultaneously at said stations and maintain the transmission line attenuation constant.

8. In combination, a transmission line having an attended gain control station and a number of unattended gain control stations connected thereto, a bridge circuit at the attended station having a pilot line connected thereto, said pilot line being associated with the transmission line sections controlled by the attended and the unattended stations, galvanometer control mechanism at said attended station under control of

said bridge for rebalancing said bridge and for operating a master machine having a wound rotor and a wound stator, a service motor at each of said stations having a rotor winding and a stator winding, the rotor windings of said service motors being connected in parallel to the machine rotor winding and the stator windings of the service motors being connected in parallel to the stator winding of the machine and to a source of alternating current and means operated by the service motor at each of said stations for simultaneously controlling the gain at each station on the transmission line to maintain the line attenuation constant without hunting action.

9. In combination, a transmission line having a main gain control station and an auxiliary gain control station connected thereto, a gain control amplifier at each of said stations, control means at each of said stations for operating the associated gain control amplifier, and means operated according to the temperature changes to which the transmission line is subjected for synchronously operating said control means at each station from the main station to simultaneously change the gain at each station without oscillatory action and maintain the line attenuation constant.

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