Sept. 22, 1942. B. J. KINSBURG 2,296,353

SIGNAL SYSTEM

Filed Oct. 19, 1940

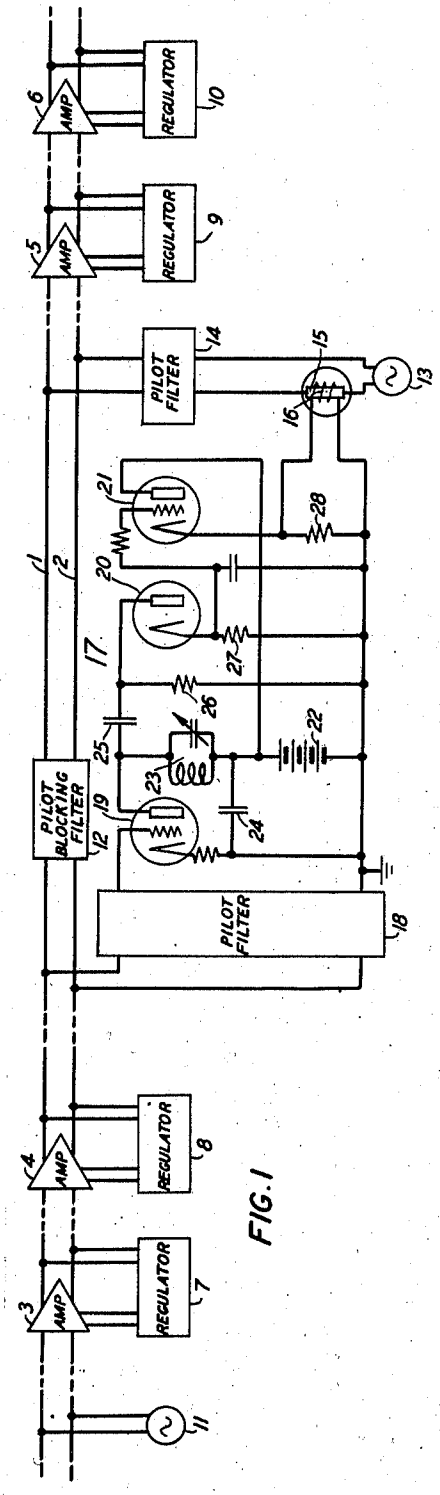

FIG. 1

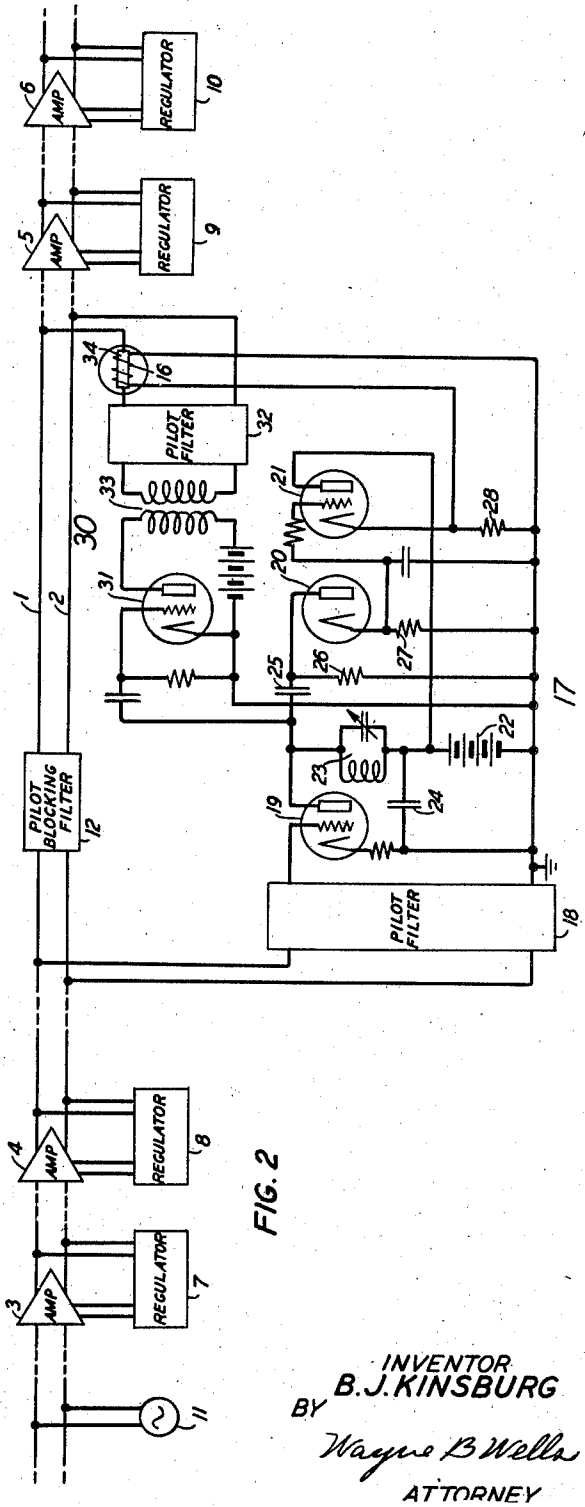

FIG. 2

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Patented Sept. 22, 1942 2,296,353

UNITED STATES PATENT OFFICE

2,296,353

SIGNAL SYSTEM

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Application October 19, 1940, Serial No. 361,879

10 Claims. (Cl. 178—44)

This invention relates to signal systems and particularly to signal systems having dynamic regulators governed by pilot current.

One object of the invention is to provide a signal system having regulators under control of pilot current that shall prevent exaggerated transient transmission irregularities.

Another object of the invention is to provide a signal transmission line having dynamic regulators under control of pilot current for governing the strength of the transmitted signals that shall divide the line into sections in a manner to permit the free transmission of signal currents from one section to another section and to control the pilot current in a section according to the integrated variations of the pilot current in a preceding section while preventing the transmission of transient exaggerated irregularities from one section to another section.

A further object of the invention is to provide a signal transmission line of the above-indicated character that shall divide the line into sections by blocking the transmission of pilot current from one section to another section while permitting the free transmission of signal currents from one section to another section and that shall reintroduce constant amplitude pilot current in a subsequent line section which is controlled according to the integrated variations of the pilot current in the preceding line section.

In long signal transmission lines provided with dynamic regulators governed by pilot current for controlling the strength of the line signals, trouble is at times experienced by reason of exaggerated transient transmission irregularities. If there is a change in the strengths of the signal and pilot currents, the pilot current governs the dynamic regulators to correct for the change in the strength of the signals. A number of the regulators make correction for the change in the signal strength with the result that an overcompensation is effected for the change in signal strength. Then during a period of time the pilot current operates the regulators to effect an oscillatory movement of the signal strength above and below normal value until a steady normal state is reached. The longer the transmission line is in length, the greater will be the transient swings in the signal strength.

The present invention provides means for limiting the transient transmission irregularities on a signal transmission line provided with dynamic regulators. The transmission line is divided into sections with blocking means to prevent the transmission of the transient irregularities from one section to another section while permitting the free transmission of signal currents from one section to another section.

In one form of the invention a blocking filter is inserted in the signal transmission line with dynamic regulators placed on each side of the blocking filter. The blocking filter permits the free transmission of signal currents therethrough while preventing the transmission of the pilot current which controls the dyamic regulators. A source of constant level pilot current is connected to the line section beyond the blocking filter. The pilot current from this source is controlled in accordance with the integrated variations of the pilot current on the line section before the blocking filter. A resistance element having a negative temperature coefficient of resistance is inserted in the circuit between the source of pilot current and the line section beyond the blocking filter. This resistance element is controlled by a heater coil which, in turn, is governed by the pilot current on the line section before the blocking filter.

A filter which selects the pilot frequency is connected to the line section before the blocking filter. The output from the pilot filter is amplified and then rectified. The rectified current is amplified and supplied to the heater coil for controlling the resistance element in the pilot current circuit connected to the line section beyond the blocking filter. In the above manner the variations in the pilot current on the line section before the blocking filter are integrated for controlling the pilot current impressed on the line section beyond the blocking filter. The transient transmission irregularities in the line section before the blocking filter are not transmitted to the line section beyond the blocking filter. However, the integrated value of the pilot current variations on the line section before the filter is employed to control the pilot current on the line section beyond the filter.

In the accompanying drawing:

Fig. 1 is a diagrammatic view of a signal system constructed in accordance with the invention; and

Fig. 2 is a modification of the signal system shown in Fig. 1.

Referring to Fig. 1 of the drawing, a transmission line comprising conductors 1 and 2 is provided with a number of amplifiers four of which, 3, 4, 5 and 6, are shown. The amplifiers 3, 4, 5 and 6 may be of any suitable type and are controlled by regulators 7, 8, 9 and 10. The regulators may be of the type disclosed in the

patent to R. R. Blair 2,179,915, November 14, 1939. The regulators are of the dynamic type and effect a quick response in correcting any change in the signal strength. Carrier current signals are carried by the line comprising conductors 1 and 2 and a pilot current supplied by a source 11 is provided for controlling the operation of the regulators.

A signal transmission line constructed as above indicated and provided with dynamic regulators for controlling the amplifiers is liable to be subjected to exaggerated transient irregularities. If there is a change in the signal strength, the pilot curent will operate each of the regulators for correcting the signal currents. Inasmuch as a number of regulators attempt to make the corrections, it is apparent that overcompensation will be effected. The signal strength will be carried above and below normal value for a period of time. These transient irregularities will increase according to the length of the line and the number of amplifiers thereon.

In order to limit the transient irregularities which may be transmitted along the conductors 1 and 2, the line is divided in sections by means of a pilot blocking filter 12. The filter 12 blocks the transmission of pilot current and permits the free transmission of the signal currents. A new pilot current which may have the same frequency as the source 11 or a different frequency is supplied from a source 13 to the line section beyond the blocking filter 12. The circuit between the source 13 and a line section beyond the filter 12 includes a pilot filter 14 and a resistance element 15. The resistance element 15 has a negative temperature coefficient of resistance and may, for example, be composed of silver sulphide. The resistance element 15 is controlled by a heater coil 16 to govern the strength of the pilot current supplied from the source 13 according to the integrated variations of the pilot current on the line section before the filter 12.

A control circuit 17 which is connected to the line section before the filter 12 is provided for controlling the heater coil 16. The circuit 17 comprises a pilot filter 18, an amplifier tube 19, a two-element rectifier tube 20 and a direct current amplifier tube 21. The pilot filter 18 is directly connected to the line section before the filter 12. The output circuit from the filter 18 is connected to the input circuit of the amplifier 19. Plate potential for the amplifier tube 19 and also for the amplifier tube 21 is supplied by a battery 22. The alternating current output circuit of the tube 19 comprises a tuned circuit 23 and a condenser 24. The rectifier tube 20 is coupled to the output circuit of the tube 19 by means of a condenser 25 and a resistance element 26. The rectifier circuit of the tube 20 includes the resistance element 26 and resistance element 27. The potential drop across the resistance element 27 is impressed on the grid of the direct current amplifier 21. The output circuit of the direct current amplifier 21 includes a resistance element 28, the potential drop across which is impressed on the heating coil 16.

In a signal system constructed as above indicated signal currents may be freely transmitted from one end of the line to the other whereas pilot current from the source 11 cannot be transmitted beyond the pilot blocking filter 12. Accordingly, any transient swings produced on the line section before the blocking filter 12 cannot be transmitted to the line section beyond the blocking filter. It is necessary, however, to control the pilot current from the source 13 according to the integrated value of the pilot current on the line before the blocking filter 12. Control of the pilot current from the source 13 according to the integrated value of the pilot current before the blocking filter is effected by means of the control circuit 17. Although only one blocking filter is shown in Fig. 1 of the drawing, it is to be understood that any number of blocking filters may be employed to divide the line into any desired number of sections.

The system shown in Fig. 2 of the drawing is a modification of the system shown in Fig. 1 and like parts have been indicated by similar reference characters. The line shown in Fig. 2 is divided into sections by a pilot blocking filter the same as the line shown in Fig. 1. Moreover, a control circuit 17 which is similar to the control circuit 17 shown in Fig. 1 is provided for controlling a heater coil 16. A circuit 30 comprising an overloaded amplifier tube 31 and a pilot filter 32 is provided for supplying pilot current to the line section beyond the blocking filter 12. The input circuit of the amplifier tube 31 is connected across the output circuit of the amplifier tube 19. The overloaded amplifier tube 31 is thus supplied with amplified pilot current from the line section before the blocking filter 12. The output current from the amplifier tube 31 has a substantially constant amplitude and is supplied through a transformer 33, the pilot filter 32 and a resistance element 34 to the line section beyond the blocking filter 12. The resistance element 34 has a negative temperature coefficient of resistance and is similar to the resistance element 15 shown in Fig. 1 of the drawing. The resistance element 34 is controlled by control circuit 17 according to the integrated pilot variations on the line section before the blocking filter 12.

Modifications in the systems 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 a signal system a signal transmission line, blocking means on the line dividing it into sections, means supplying pilot current to said sections on each side of the blocking means, said blocking means preventing the transfer of pilot current therethrough while permitting the free transfer of signals therethrough, amplifiers in respective sections each including a regulator controlled by the pilot current in its section and attaining a state of stable operation within a limited period of time after a change occurs in pilot current strength, and means for controlling the pilot current beyond said blocking means according to the integrated variations of the pilot current before the blocking means integrated over a period of time greater than said limited period required for said regulator to attain a state of stable operation.

2. In a signal system, a transmission line, blocking means dividing the line into sections, dynamic regulators on each side of said blocking means, means impressing pilot current on the line on each side of said blocking means for controlling the dynamic regulators, said blocking means preventing the transfer of pilot current therethrough while permitting the free transfer of signals therethrough and said dynamic regulators attaining a state of stable operation within a limited period of time after a change occurs in

said pilot current strength, and means for controlling the pilot current beyond said blocking means according to the integrated variations of the pilot current before the blocking means integrated over a period of time greater than said limited period required for said regulators to attain a state of stable operation.

3. In a signal system, a transmission line having a plurality of dynamic regulators thereon controlled according to the strength of pilot current, said dynamic regulators attaining a state of stable operation within a limited period after a change occurs in the strength of said pilot current, blocking means on said line for the pilot current frequency dividing the transmission line, means for reintroducing pilot current in the line beyond said blocking means, and means for controlling said reintroduced pilot current according to the average of the fluctuations in the pilot current before said blocking means averaged over a period approximately equal to that required by said regulators to attain a state of stable operation after the occurrence of a change in the strength of the controlling pilot current.

4. In a signal system, a transmission line carrying signal currents and pilot current, blocking means on said line for the pilot current frequency, dynamic regulators for said line on each side of said blocking means, means for impressing pilot current on the line beyond said blocking means, said dynamic regulators being controlled by the strength of the pilot current in the respective portions of the line and attaining a state of stable operation within a limited period after a change occurs in said pilot current strength, and means controlled by pilot current on the line before said blocking means for governing the pilot current introduced in the line beyond the blocking means in accordance with the integrated value of the pilot current variations before the blocking means integrated over a period approximately equal to that required by the regulators to attain a state of stable operation after the occurrence of a change in the strength of the pilot current.

5. In a signal system, a signal transmission line, a blocking filter dividing the line into sections, dynamic regulators on each side of said filter, means impressing pilot current on each side of said filter for controlling the dynamic regulators, said blocking means preventing the transfer of pilot current therethrough while permitting the free transfer of signals therethrough and said dynamic regulators attaining a state of stable operation within a limited period after a change occurs in the strength of said pilot current strength, a circuit for supplying pilot current to the line beyond said filter, resistance means in said circuit for governing the pilot current, and means for controlling said resistance means according to integrated variations of the pilot current on the line before said filter integrated over a period of time approximately equal to that required by the regulators to attain a state of stable operation after the occurrence of a change in the strength of the pilot current

6. In a signal system, a signal transmission line having signal currents and pilot current thereon, a blocking filter on said line permitting the free flow of signal currents therethrough and blocking the passage of pilot current, dynamic regulators on each side of said filter for controlling the signal currents, a source of pilot current connected to the line beyond said filter, said dynamic regulators being controlled by the strength of the pilot current in the respective portions of the line and attaining a state of stable operation within a limited period after a change occurs in the strength of said pilot current, a resistance element having a negative temperature coefficient of resistance for governing the pilot current from said source, and means controlled according to the integrated variations of the pilot current on the line before said filter integrated over a period of time approximately equal to that required by the regulators to attain a state of stable operation after the occurrence of a change in the strength of the pilot current for governing the temperature of said resistance element.

7. In a signal system, a signal transmission line having signal currents and pilot current thereon, a blocking filter for dividing the line into sections, amplifiers including dynamic regulators on each side of said filter, said filter blocking the flow of pilot current and permitting the free flow of signal currents, a source of pilot current connected to the line beyond said filter, said dynamic regulators being controlled by the strength of the pilot current in the respective portions of the line and attaining a state of stable operation within a limited period after a change occurs in the strength of said pilot current, a resistance element having a negative temperature coefficient of resistance for governing the pilot current from said source, a heater element for controlling the temperature of said resistance element, a pilot filter for obtaining pilot current from the line before said blocking filter, and means for amplifying and rectifying said selected pilot current to control said heater and govern the pilot current beyond said blocking filter according to the integrated variations of the pilot current on the line before the blocking filter integrated over a period of time approximately equal to that required by the regulators to attain a state of stable operation after the occurrence of a change in the strength of the controlling pilot current.

8. In a signal system, a signal transmission line having signal currents and pilot current thereon, a blocking filter for dividing the line into sections, said filter blocking the flow of pilot current and permitting the free flow of signal currents therethrough, dynamic regulators on the line on each side of said blocking filter under control of pilot current, a pilot filter connected to the line before said blocking filter for selecting the pilot frequency, means for controlling a portion of the output from the pilot filter to obtain a constant output and for supplying this constant output pilot current to the line beyond the blocking filter, and means controlled by the integrated output from the pilot filter for governing the pilot current supplied to the line beyond the blocking filter.

9. In a signal system a signal transmission line having signal currents and pilot current thereon, a blocking filter for dividing the line into sections, said filter blocking the flow of pilot current and permitting the free flow of signal currents therethrough, dynamic regulators on the line on each side of said blocking filter under control of pilot current, a pilot filter connected to the line before said blocking filter for selecting the pilot frequency current, control means comprising an overloaded amplifier operating on a portion of the pilot filter output for obtaining a constant pilot current and for supplying the constant pilot current to the line beyond the blocking filter, a resistance element having a negative temperature coefficient of resistance inserted in the connec-

tion of the constant pilot current to the line, a heater coil for controlling said resistance element, and means controlled by the integrated output from the pilot filter for controlling said heater coil to govern the pilot current supplied to the line beyond said blocking filter.

10. In a signaling system a signal transmission line, means to impress pilot current on said line, a plurality of amplifiers included in said line at separated points, dynamic regulators individual to said amplifiers for controlling the gain of said amplifiers in accordance with the strength of the pilot current at the said respective amplifiers, said regulators responding to changes in pilot current integrated over a limited period of time, and a slow-acting pilot regulator located at a point in said line between groups of said amplifiers for controlling the strength of the pilot current transmitted to the group of amplifiers toward the receiving end of said line in accordance with the strength of the pilot current incoming from the group of amplifiers toward the transmitting end of said line, said slow-acting regulator responding only to changes in pilot current integrated over a longer period of time than that over which changes in pilot current are integrated to effect response in said individual dynamic regulators.

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