

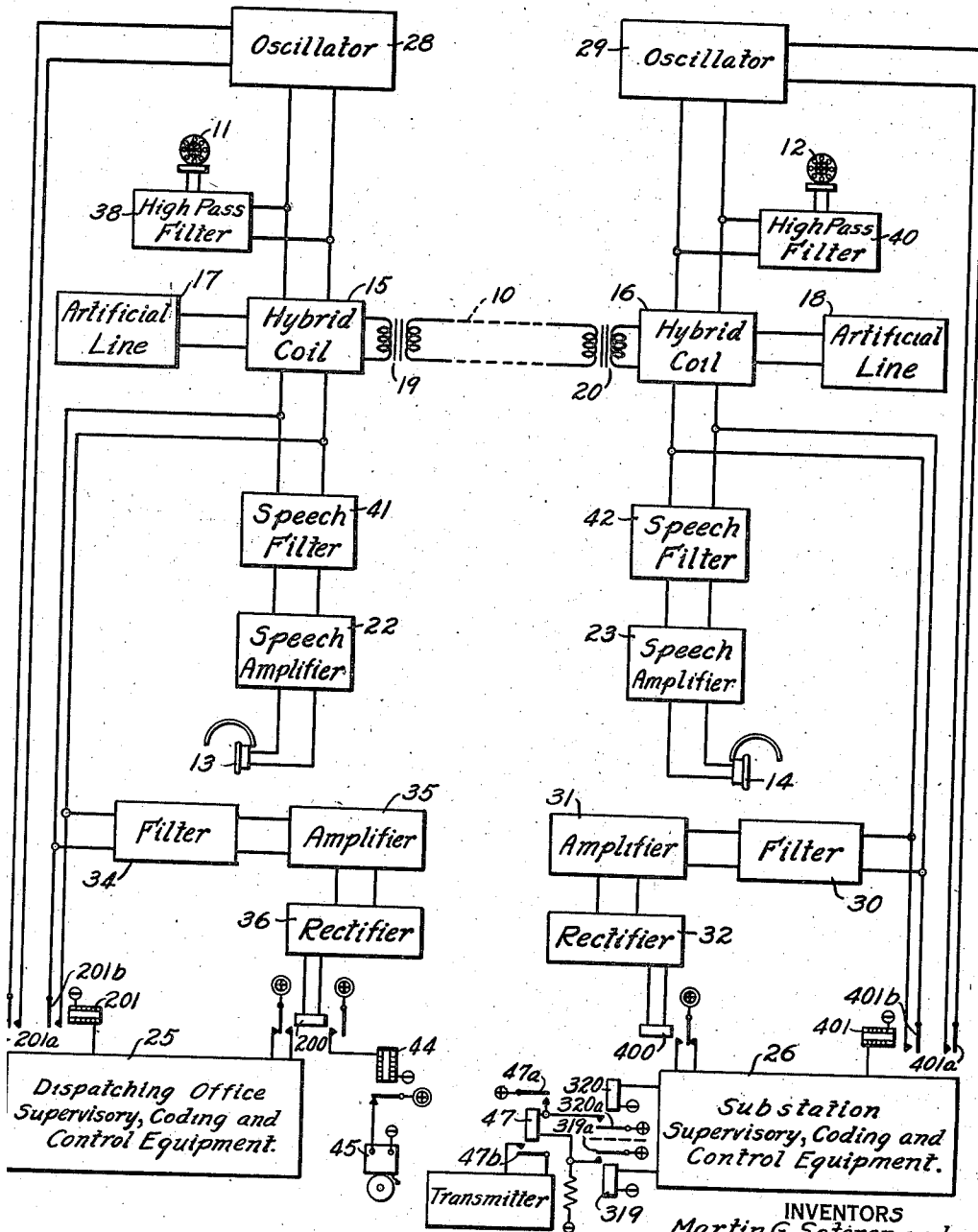
May 28, 1946.

M. G. SATEREN ET AL

2,401,023

CONTROL SYSTEM

Filed April 7, 1945



INVENTORS
Martin G. Saterén and
Willard A. Derr.
BY
G. M. Crawford
ATTORNEY

UNITED STATES PATENT OFFICE

2,401,023

CONTROL SYSTEM

Martin G. Sateren, Sharon, and Willard A. Derr,
Wilksburg, Pa., assignors to Westinghouse
Electric Corporation, East Pittsburgh, Pa., a
corporation of Pennsylvania

Application April 7, 1945, Serial No. 587,182

7 Claims. (Cl. 179-2)

Our invention relates, generally, to control systems and has reference in particular to supervisory control systems.

Generally stated, it is an object of our invention to provide a supervisory control system which is simple and inexpensive to manufacture and is reliable in operation.

More specifically, it is an object of our invention to provide two-way supervision of a telephone line which is used as a signalling channel in a supervisory control system.

It is also an object of our invention to provide for using two different audio frequencies for sending coded impulse signals from opposite ends of a signalling channel for controlling the operation of apparatus at a remote station, and for using the same frequencies for supervising the channel to indicate at both ends thereof when there is a short circuit, an open circuit or abnormal attenuation of the signal.

Another object of our invention is to provide for operating the line relays in a supervisory control system on signal voltages of different frequencies, and for synchronizing the line relays at both ends of the system by deenergizing the amplifiers operating the line relays each time their associated impulse sending relays operate.

Yet another object of our invention is to provide for normally energizing the line relays at both ends of a supervisory control channel through receivers which are responsive only to different audio-frequency tones and for effecting synchronization of the equipment at both stations during signalling by turning off the oscillator at the end which is sending and deenergizing the receiver at that end at the same time.

Still another object of our invention is to provide for operating the line relays at the ends of a signalling channel on signal voltages of different frequencies which are normally applied thereto, and for indicating a fault condition on the channel when the signal voltage from one end becomes too greatly attenuated at the other end or is not received at all for a time interval greater than is normally encountered in impulse signalling.

Other objects will in part be obvious, and will in part be explained hereinafter.

For a more complete understanding of the nature and scope of our invention, reference may be made to the following detailed description, which may be read in connection with the accompanying drawing in which the single figure is a diagrammatic view of a supervisory control system embodying the invention in one of its forms.

Referring to the drawing, the reference numeral 10 may denote generally a telephone line connecting telephone equipment at a control station with telephone equipment at a remote station adjacent the apparatus which is to be controlled. The telephone equipment may be of any suitable type comprising, for example, microphones 11 and 12 and telephone receivers 13 and 14 at the control and remote stations, respectively, which may be connected to the telephone line through associated hybrid coils 15 and 16 having artificial lines 17 and 18, and transformers 19 and 20, respectively. The receivers 13 and 14 may be connected to their respective hybrid coils 15 through suitable amplifiers 22 and 23.

The supervisory control equipment at the control and remote stations may be of any suitable type, being, for example, substantially similar to that described in detail in Patent No. 2,091,301 which issued on August 31, 1937 to Hans P. Boswau. Accordingly, the bulk of the supervisory control equipment at the control station may be represented by the enclosure 25 while that at the remote station may be represented by the enclosure 26.

In order to provide for maintaining two-way supervision of the signal channel, which comprises in the present instance a telephone line which may be interrupted by means of repeaters, transformers, etc., the system of the Boswau patent has been suitably modified. Instead of having the line relays 200 and 400 of the system of the Boswau patent connected in series circuit relation with contact members of the impulse sending relays 201 and 402 and a source of direct current, we prefer to use separate oscillators 28 and 29 at the control and remote stations for operating the line relays 400 and 200 at the remote and control stations selectively. For example, the oscillator 28 may be connected to the telephone line 10 through the hybrid coil 15 for normally applying thereto a potential having a frequency in the lower portion of the audio range, for example, 245 cycles per second. The oscillator 28 may be normally energized and connected to the line 10 through the hybrid coil 15, and disposed to be keyed for sending impulse signals by the impulse sending relay 201 through contact members 201a, which turn the oscillator off in response to operation of the impulse sending relay. The line relay 400 at the remote station may be made selectively responsive only to the frequency of the oscillator 28 by connecting it to the telephone line through a filter 30 responsive only to the same frequency of 245 cycles per sec-

ond. A suitable amplifier 31, and rectifying means 32 may be provided so as to produce direct-current impulses in response to operation of the oscillator 28.

The line relay 200 at the control station may likewise be made selectively responsive to the oscillator 29 of the remote station by connecting it to the telephone line through a filter 34 which is responsive only to the frequency of the oscillator 29, an amplifier 35, and rectifier means 36 for providing direct-current impulses in response to operation of the oscillator 29. The oscillator 29 may be normally energized for applying to the line a voltage of a different frequency in the lower portion of the audio range, for example, 170 cycles per second. Operation of the oscillator 29 to send coded impulses in response to operation of the impulse sending relay 401 may be effected by providing for deenergization of the oscillator through contact members 401a of the impulse sending relay.

In order to provide for operating the supervisory control equipment at relatively high speeds, synchronization of the relays at the control and remote stations is essential. Since the line relays at the remote and control stations operate on different frequencies, we have found it desirable to provide for deenergizing the line relay at each station in response to operation of its associated impulse sending relay. This may be accomplished by deenergizing the associated amplifier each time the impulse sending relay operates. Contact members 201b and 401b may, therefore, be provided for momentarily shunting the amplifiers at the control and remote stations to deenergize the associated line relays each time the impulse sending relays operate. Thus the line relays at each station are subjected in a like manner to the time response characteristics of their amplifiers, rectifiers, etc., and readily remain in step.

In order to prevent interference between the telephone equipment and the supervisory control and line supervision equipment, high-pass filters 38 and 40 may be connected between the microphones 11 and 12 and the oscillators 28 and 29, respectively. The filters 38 and 40 may be used to eliminate from the telephone circuit audio frequencies in the lower portion of the audio range which are not necessary for intelligible speech. For example, they may block all frequencies below about 300 cycles per second, and thus prevent operation of the supervisory equipment in response to voice tones. Suitable speech filters 41 and 42 for blocking frequencies of the same range may be connected between the telephone receivers 13 and 14 and their respective hybrid coils to prevent interference with telephone reception, of the signal and supervisory frequencies.

Since the line relays 200 and 400 are normally energized and are released only for relatively short intervals during impulse signalling, provision may be made for indicating a fault condition of the telephone line whenever the line relays remain deenergized for a time interval greater than that required for signalling. Accordingly, means, such as the time delay relay 44, may be utilized at the control station for completing an energizing circuit for indicating means such as the alarm bell 45 whenever the line relay 200 remains in the deenergized position for more than a predetermined time.

At the remote station, operation of the apparatus to be controlled may be effected by the supervisory control equipment through the controlled

relays 319 and 320 of the Boswau patent which may be arranged for respectively energizing and shunting down a control relay 47 for operating a transmitter or the like in a manner similar to that described therein for closing and opening a circuit breaker. In order to provide adequate protection for the controlled apparatus, which may be a transmitter or the like, the control relay 47 may be provided with a holding circuit through contact members 47a to indirect positive. Accordingly, whenever the line relay 400 remains deenergized long enough for the release relay 402 of the Boswau patent (not shown) to drop and remove direct positive from the supervisory equipment, the control relay 47 is deenergized and opens contact members 47b thereby deenergizing the transmitter, etc.

In operation, the oscillators 28 and 29 may be normally energized so that the line relays 400 and 200 are normally in the energized position. Accordingly, the relay 44 is normally maintained in the energized position, and the relay 47 is maintained in the energized position so long as the transmitter at the remote station is being operated. Telephone conversation may be had over the telephone line 10 independently of the signal and supervision frequencies since these are blocked from the telephone equipment. Operation of the supervisory control equipment may be effected in a manner substantially similar to that described in the Boswau patent hereinbefore referred to, since each time the impulse sending relay 201 at the control station or 401 at the remote station is operated in sending an impulse signal, its associated line relay 200 or 400 is deenergized by shunting of the amplifier 35 or 31, respectively, each time the oscillator 28 and 29 is momentarily deenergized to send an impulse signal. Accordingly, impulse signals may be sent in the usual manner for effecting point selection, point check, operation and supervision of the apparatus at the remote station. When the operation code is sent to set the transmitter at the remote station into operation, the operation relay 320 operates and connects the control relay 47 to the source through contact members 320a. A holding circuit is established through armature 47a. When the operation code is sent to shut the transmitter down the relay 319 operates and shunts the control relay at contact members 319a. Each time the line relays 200 and 400 are deenergized during impulse signalling, the time-delay relay 44 is also deenergized. Due to its time-delay characteristics, however, this relay remains in the energized position during any of the periods of deenergization normally encountered during signalling. However, should a short circuit, open circuit, or other fault condition occur on the telephone line, particularly during an interval when the transmitter is operating, the voltages received by the amplifiers 30 and 35 will be sufficiently attenuated to cause deenergization of the line relays so long as the fault condition exists. When such a fault condition exists for a period of time greater than the period of deenergization encountered during signalling, the line relays drop, and the time-delay relay 44 and the control relay 47 return to the deenergized position. Accordingly, an indication of the fault condition is given at the control station by the sounding of an alarm bell 45. At the remote station, the relay 47 effects an indication of the fault condition by opening contact members 47b, thus deenergizing the apparatus being controlled. Whenever the transmitter is shut down the alarm

45 is still operable to indicate a fault condition since the oscillator 29 is normally energized.

From the above description and the accompanying drawing, it will be apparent that we have provided in a simple and effective manner for providing two-way supervision of a signal channel or a supervisory control system, over a telephone line. Operation of the supervisory control equipment may be effected without interference with operation of the telephone equipment since these circuits are effectively isolated. Positive indication is provided for indicating at both ends of the line a fault condition on the line, regardless of the location of the fault. Since the same oscillators and receivers are used for both the supervisory control equipment and for line supervision, a minimum of apparatus is required and maintenance thereof is greatly simplified.

Since certain changes may be made in the above described construction, and different embodiments of the invention may be made without departing from the spirit or scope thereof, it is intended that all the matter contained in the above description and shown in the accompanying drawing shall be considered as illustrative but not in a limiting sense.

We claim as our invention:

1. In a signal system for two stations connected by a signalling channel, means at one station for supplying to the channel electrical energy of one frequency, means at the other station for supplying to the channel electrical energy of a different frequency, supervisory control equipment at each of the stations including sending means for interrupting the supply of electrical energy to the channel at each station for producing coded impulse signals and receiving means including control means responsive only to the frequency of the other station, and means at each station responsive to deenergization of the control means for greater than a normal impulsing interval for indicating a channel fault condition.

2. The combination with a telephone system wherein a telephone line connects a pair of stations provided with telephone equipment, of means for removing from the telephone equipment voice frequencies below a predetermined frequency, means at one station for normally applying to the line electrical energy at a frequency below said predetermined frequency, means at the other station for applying to the line electrical energy at a different frequency below said predetermined frequency, means including a receiver at each station responsive only to the frequency of the other station and rectifier means for producing direct-current control voltages, supervisory control means at each station including normally energized receiving means responsive to the direct-current voltages and sending means cooperative with the receiving means to interrupt the energization of the line and deenergize the receiving means to produce coded impulse signals, and means at each of the stations responsive to deenergization of the receiving means for a period greater than that of the coded impulse signals for indicating a fault condition.

3. The combination with a telephone system having a telephone line connecting telephone equipment at remotely located stations, of filter means for blocking audio frequencies below 300 cycles from the telephone equipment, supervisory control means at each station for controlling from one station apparatus at the other station including impulse sending means and impulse receiving means, means at the one sta-

tion for normally applying a potential of one frequency below 300 cycles to the telephone line and operable under the control of the impulse sending means at said one station to remove said potential from the line, means at the other station for normally applying a different frequency below 300 cycles to the line and operable under the control of the impulse sending means at said other station to remove said potential from the line, receiving means at said one station responsive only to said different frequency for operating the impulse receiving means at said one station, receiving means at said other station responsive only to said one frequency for operating the impulse receiving means at said other station, indicating means at said one station responsive to deenergization of the impulse receiving means at said one station for greater than a normal impulsing period for indicating a fault condition of the line, and control means at the other station for insuring deenergization of the apparatus at said other station upon the occurrence of a fault condition on the line.

4. The combination in a supervisory control system for a radio transmitter located at a remote station having telephone equipment connected by a telephone line to telephone equipment at a control station, of high-pass filter means connected between the telephone equipment and the line at both stations for blocking frequencies below a predetermined voice frequency in the lower range of the audio range, means at the control station for normally applying to the line a potential of a frequency below said predetermined frequency, means at the remote station for normally applying to the line a potential of another frequency below said predetermined frequency, supervisory control means at each station including an impulse sending relay operable to remove the line potential from said station and impulse receiving means normally operable in response only to the potential from the other station for maintaining an operating potential on the supervisory control means, and means controlled by the impulse receiving means for indicating a line fault condition if either line potential is removed for a greater period than normally used in signalling.

5. For use in controlling apparatus at a remote station having telephone equipment connected by a hybrid coil to a telephone line extending to a control station wherein it is connected by a hybrid coil to telephone equipment, a signalling system comprising, high-pass filter means connected between the hybrid coil and the telephone equipment to block audio frequencies in the lower range of voice frequencies, supervisory control equipment at each of the stations including an impulse sending relay and an impulse operated relay for controlling apparatus at the remote station, an audio oscillator at the control station normally applying to the line a potential in one range of frequencies in the lower range of voice frequencies and controllable by the impulse sending relay to send coded impulse signals, means at the remote station including a receiver responsive only to said one range of frequencies for operating the remote station impulse operated relay, means at the remote station operative after the impulse operated relay remains in the deenergized position for a greater time than required for impulse signalling to effect deenergization of the apparatus at the remote station.

6. In a supervisory system for apparatus at a

remote station, means at the remote station and a control station for applying potentials of different frequencies to a signalling channel connecting the stations, receiver means at the remote station normally operable to receive only the frequency of the control station, supervisory control receiving means at the remote station operated from the receiver, supervisory control sending means at each of the stations, each of said sending means controlling the operation of the means at its station to produce coded impulses for operating the receiving means at the other station and controlling the operation of its associated receiving means to operate said receiving means in step with the receiving means at the other station, and control means at each of the stations responsive to deenergization of the receiving means for longer than a coded impulse for indicating a fault condition of the signalling channel.

7. In a supervisory control system for controlling apparatus at a remote station from a control station over a telephone line connecting telephone equipment at the stations, high-pass fil-

ters connected between the telephone equipment and the line for blocking frequencies below 300 cycles, an oscillator at the control station for normally applying to the line a potential of a frequency below 300 cycles, an oscillator at the remote station for normally applying to the line a potential of a different frequency below 300 cycles, receiving means at each station responsive only to the frequency of the other station for producing a unidirectional potential, supervisory control means at each station including an impulse receiving relay operable under the control of its associated receiver and an impulse sending relay operable to key the associated oscillator to send coded impulse signals and to render the associated amplifier ineffective simultaneously, and means at the remote station responsive to deenergization of the impulse receiving relay for greater than a normal impulse signal period for effecting deenergization of the apparatus being controlled.

MARTIN G. SATEREN.
WILLARD A. DERR.