March 30, 1943. F. A. LEIBE 2,315,434

TRANSMISSION SYSTEM

Filed July 3, 1940

FIG. 1

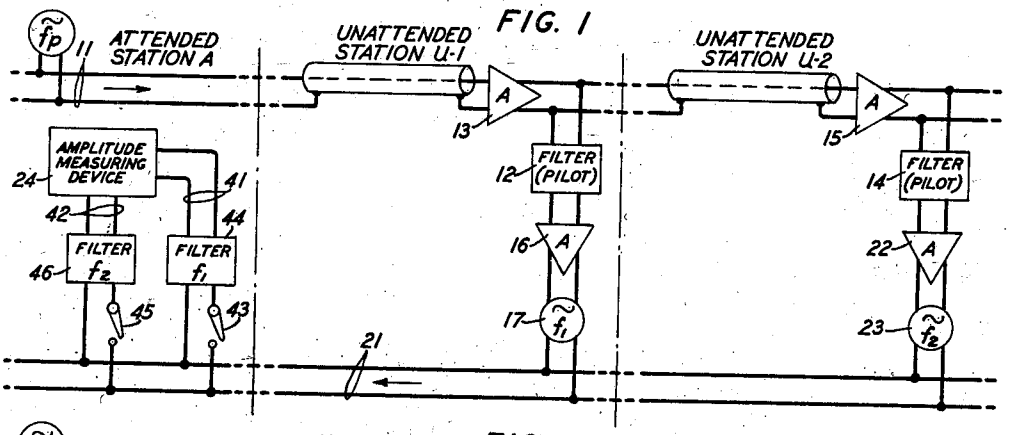


FIG. 2

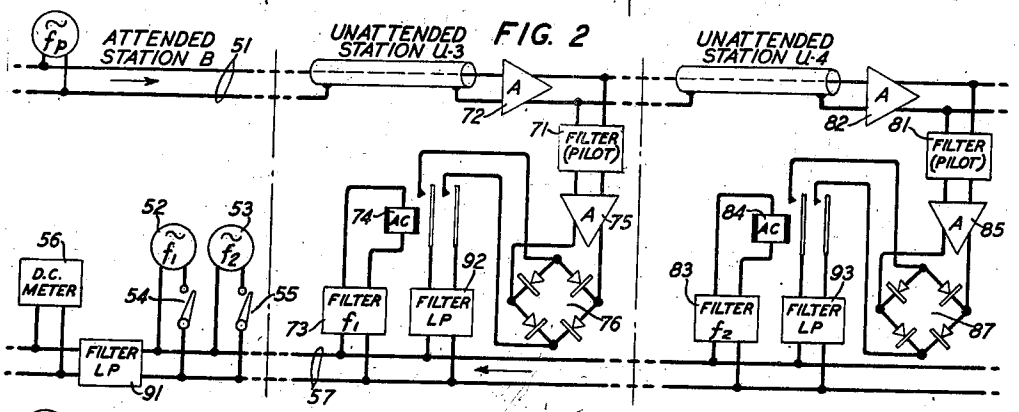
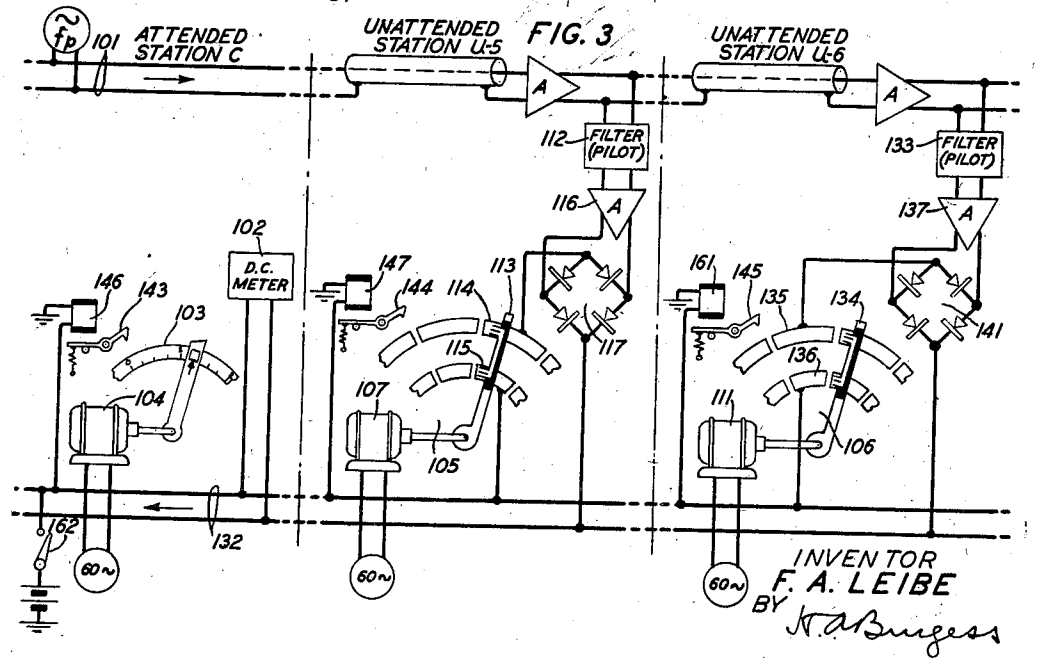


FIG. 3



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TRANSMISSION SYSTEM

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2 Claims. (Cl. 179—175.31)

This invention relates to a transmission system and more particularly to a transmission system utilizing unattended repeater stations.

An object of the invention is to facilitate supervision of a transmission system which involves unattended stations.

A more specific object of the invention is to provide an indication at an attended repeater station of the degree of efficiency with which a remote unattended repeater station is operating.

It is customary in modern transmission systems, particularly those involving a large number of signal channels such as a coaxial cable system, to provide a large number of line repeaters in tandem spaced at intervals which may be as short as five miles or even less, with several unattended repeater stations between attended stations; a section between two attended repeater stations may be from fifty to one hundred miles in length. While repeater equipment is now availavle which is sufficiently reliable in its operation to justify this practice of leaving the majority of the repeater stations unattended, the possibility of an occasional decrease in operating efficiency of an unattended station to an undesirable point can never be entirely ruled out. It is desirable, therefore, that means be provided at the attended stations whereby the operating condition of the group of unattended stations to be supervised therefrom may be readily determined whenever desired without interrupting the normal use of the transmission system.

In accordance with the general method of operation of the supervising system contemplated by the present invention, a pilot frequency is applied to the transmission line and a portion of this pilot frequency leaving the line amplifier of the repeater station being tested is selected by a filter and utilized to control the energy of a signal transmitted over an auxiliary circuit to the attended station.

Full understanding of the arrangement contemplated by the present invention and appreciation of the valuable features thereof will be gained from consideration of the following detailed description in connection with the drawing, in which:

Fig. 1 illustrates schematically a portion of a coaxial transmission system provided with supervisory means utilizing features of the present invention;

Fig. 2 illustrates a similar portion of a transmission system provided with a different type of supervising means; and

Fig. 3 illustrates a similar portion of a transmission system provided with still another type of supervising means.

Referring now to Fig. 1, there is illustrated schematically portions of the equipment of attended repeater station A and unattended repeater stations U—1 and U—2 of a system for transmitting signals over coaxial cable 11 in the direction indicated by the arrow. It will be assumed that unattended stations U—1 and U—2 are included in the group of unattended stations arranged to be supervised from attended station A. It will be assumed also that a pilot current of predetermined frequency is applied to line 11 as well as message currents.

Filter 12 is connected across the output of line amplifier 13 of station U—1, this filter being designed to pass a narrow band of frequencies which includes the pilot frequency. A similar filter 14 is connected across the output of line amplifier 15 of station U—2, this filter having the same pass-band as filter 12.

The output of filter 12, after amplification by auxiliary amplifier 16, is applied to constant-frequency oscillator 17 which is arranged to produce a wave of frequency f_1; the output of oscillator 17 is connected across the auxiliary signaling line 21. The amplitude of the wave of frequency f_1 produced by oscillator 17 and applied to line 21 is dependent upon the output of auxiliary amplifier 16, which depends, in turn, on the operating efficiency of line amplifier 13 in acting on the pilot frequency.

The output of filter 14, after amplification by auxiliary amplifier 22, is applied to constant-frequency oscillator 23 which is arranged to produce a wave of frequency f_2; the output of oscillator 23 is connected across the auxiliary signaling line 21. The amplitude of the wave of frequency f_2 produced by oscillator 23 is dependent upon the output of auxiliary amplifier 22 which depends, in turn, on the operating efficiency of line amplifier 15 in acting on the pilot frequency.

A suitable amplitude measuring device 24 is provided at attended station 11, being connected to auxiliary line 21 through connecting lines 41 and 42. The connection through line 41 may be completed by closing switch 43; this connection includes band-pass filter 44 which is designed to pass a narrow band of frequencies which includes f_1, the frequency produced by oscillator 17. The connection through line 42 may be completed by closing switch 45; this connection includes band-pass filter 46 which is designed to pass a narrow band of frequencies which includes f_2, the frequency produced by oscillator 23.

Now in order to obtain at station A an indication of the degree of efficiency with which line amplifier 13 of unattended repeater station U—1 is operating, it is merely necessary to close switch 43 whereupon the wave of frequency f_1 produced by oscillator 17 and applied to line 21 will be applied over line 41 to amplitude measuring device 24, filter 44 being designed, as above stated, to pass a narrow band of frequencies which includes the frequency f_1. As previously brought out the amplitude of the wave f_1, produced by oscillator 17, is dependent upon the output of auxiliary amplifier 16 which, in turn, is dependent upon the output of line amplifier 13 so that the reading of amplitude measuring device 24 will be a direct indication of the efficiency with which line amplifier 13 is operating.

Similarly, in order to obtain indication of the degree of efficiency with which line amplifier 15 of unattended repeater station U—2 is operating, it is merely necessary to close switch 45 whereupon the wave of frequency f_2 produced by oscillator 23 and applied to auxiliary signaling line 21 will be supplied to amplitude measuring device 24 over line 42, filter 46, as above stated, being designed to pass a narrow band of frequencies which includes the frequency f_2. Under these conditions the reading of amplitude measuring device 24 will be direct indication of the degree of efficiency with which line amplifier 15 is operating.

It is obvious that more unattended stations than the two illustrated in Fig. 1 may be supervised from station A, it being necessary merely to assign a different test frequency (corresponding to frequency f_1 of station U—1 and f_2 of station U—2) to each station and to provide an additional selective path (corresponding to lines 41 and 42) at station A for each additional test frequency assigned.

Referring now to Fig. 2, there is illustrated schematically portions of the equipment of attended repeater station B and unattended repeater stations U—3 and U—4 of a system for transmitting signals over coaxial line 51 in the direction indicated by the arrow. It will be assumed that unattended repeater stations U—3 and U—4 are included in the group of unattended stations arranged to be supervised from attended station B. It will be assumed also that a pilot current of predetermined frequency is applied to line 51 as well as the message currents.

Two constant frequency oscillators, 52 and 53, are provided at station A; oscillator 52 produces a fixed frequency f_1 and its output may be applied to auxiliary signaling line 57 by closing switch 54 while oscillator 53 produces a fixed frequency f_2 and its output may be applied to the auxiliary signaling line by closing switch 55. A direct current meter 56 is also provided at station B, being connected across auxiliary signaling line 57.

A filter 71 is connected across the output of line amplifier 72 of unattended station U—3; this filter is designed to pass a narrow band of frequencies which includes the pilot frequency. A second filter, 73, is connected across auxiliary signaling line 57, this filter being designed to pass a narrow band of frequencies which includes the frequency f_1 produced by oscillator 52. The output of filter 73 is connected through the operating winding of alternating current relay 74, while the output of filter 71 is connected to the two make contacts of the relay through auxiliary amplifier 75 and rectifier bridge 76.

Filter 81, which is connected across the output of line amplifier 82 of unattended repeater station U—4, is designed to pass the same narrow band of frequencies as filter 71 which band, as previously stated, includes the pilot frequency. Filter 83 which is connected across auxiliary signaling line 57 is designed to pass a narrow band of frequencies which includes the frequency f_2 produced by oscillator 53. The output of filter 83 is connected through the operating winding of alternating current relay 84 while the output of filter 81 is connected to the two make contacts of the relay through auxiliary amplifier 85 and rectifier bridge 86. Low pass filters 91, 92 and 93 are designed to permit passage of direct current and to prevent passage of frequencies f_1 and f_2, thereby affording proper separation of the direct current and alternating current paths.

Assuming now that it be desired to obtain an indication at attended station B of the degree of efficiency with which line amplifier 72 of unattended station U—3 is operating, switch 54 is closed, thereby applying current of frequency f_1 to auxiliary line 57. This current is passed by filter 73 and causes operation of relay 74. As previously pointed out, a pilot current is applied to the line at all testing periods and this pilot current is passed by filter 71. Operation of relay 74 completes at the two make contacts thereof a path over which this pilot current, after amplification by amplifier 75 and rectification by rectifier bridge 76 is applied to auxiliary signaling line 57 over which it is transmitted to attended station B. This current is measured by direct current meter 56 and the reading, after due allowance has been made for the known amplification factor of amplifier 75, will be an indication of the degree of efficiency with which line amplifier 72 is operating.

The apparatus of unattended station U—4 is not affected by the above operation in view of the fact that the applied frequency f_1 is not passed by filter 83. Should it be desired to observe the operation of line amplifier 82, switch 55 is closed, thereby applying current of frequency f_2 to auxiliary line 57. This current is passed by filter 83 and causes operation of alternating current relay 84. Operation of relay 84 connects the amplified and rectified pilot current passed by filter 81 to the auxiliary signaling line 57 over which it is transmitted to attended station B. This current is measured by meter 56, the reading of which provides an indication of the degree of efficiency with which amplifier 82 is operating.

While only two unattended repeater stations, U—3 and U—4, have been illustrated, it will be obvious that more than two unattended stations may be controlled from attended station B in a manner similar to that described, the equipment of the additional stations being similar in general to that of the stations illustrated.

Referring now to Fig. 3 there is illustrated schematically portions of the equipment of attended repeater station C and unattended repeater stations U—5 and U—6 of a system for transmitting signals over coaxial line 101 in the direction indicated by the arrow. It will be assumed that unattended stations U—5 and U—6 are included in the group of unattended stations arranged to be supervised from attended station C. It will be assumed also that a pilot current of predetermined frequency is applied to line 101 as well as the message currents.

A direct current meter 102 and an indicator

103 are provided at attended station C, the indicator being driven by motor 104.

A rotary distributor 105 is provided at unattended repeater station U—5 and a similar rotary distributor 106 is provided at unattended repeater station U—6, these distributors being driven by constant speed motors 107 and 111, respectively. The motors 104, 107 and 111 are all driven from constant frequency sources so that indicator 103, distributor 105 and distributor 106 all operate in synchronism. In instances where current of the same frequency is transmitted over the line for repeater energization, this current may be utilized for operation of the motors.

Filter 112 provided at unattended station U—5 is designed to pass a narrow band of frequencies which includes the pilot frequency. When brush 113 of rotary distributor 105 is in engagement with conductive segments 114 and 115 of the distributor commutator, the output of filter 112, after amplification by auxiliary amplifier 116 and rectification by rectifier bridge 117, is applied to auxiliary signaling line 132.

Filter 133 of unattended station U—6 is designed to have the same pass band as filter 112, that is, it passes a narrow band of frequencies which includes the pilot frequency. When brush 134 of distributor 106 is in engagement with conductive segments 135 and 136 of the distributor commutator, the output of filter 133, after amplification by auxiliary amplifier 137 and rectification by rectifier bridge 141 is applied to auxiliary signaling line 132.

Indicator 103, which as previously pointed out operates in synchronism with rotary distributors 105 and 106, is arranged to show which distributor is, at any given instant, in position to connect the output of an unattended station filter to line 132. For example, for the positions illustrated indicator 103 would show "U—5." In the next interval when brush 134 contacted segments 135 and 136 it would show "U—6" and so on. At any given time the reading of meter 102 will be, of course, an indication, after due allowance has been made for amplification by the local auxiliary amplifier, of the degree of efficiency with which the line amplifier of that unattended station flashed by indicator 103 is operating.

In order to bring indicator 103 and distributors 105 and 106 back into step should they get out of synchronism, latches 143, 144 and 145 may be pulled into position (by operation of respective relays 146, 147 and 161 over an obvious circuit completed by closing switch 162) to engage the respective rotating members and momentarily hold them all in the same relative position so that when released all will start from the same relative point. To permit this holding action the indicator and distributor arms are coupled to their respective motors by a friction drive.

It will be apparent, of course, that the group of unattended repeater stations supervised from attended station C may well include more than the two stations illustrated and that the equipment of the additional stations will be similar in general to that of the stations illustrated.

In the use of the type of supervising system contemplated by the present invention it may be necessary in certain instances to modify the readings in view of temperature changes, i. e., in cases where the talking pair is provided with regulating means to compensate for temperature changes while the auxiliary pair is not so compensated. For example, a chart may be provided to show necessary modifications of the readings for various temperatures and the resistance of the auxiliary pair may be measured to obtain an indication of the cable temperature. Suitable modifications of the readings may then be made.

While certain specific embodiments of the invention have been selected for detailed description, the invention is not, of course, limited in its application to these embodiments. The embodiments described should be taken as illustrative of the invention and not as restrictive thereof.

What is claimed is:

1. In a signaling system, an attended station, a first unattended repeater station and a second unattended repeater station, said unattended stations being geographically separated from said attended station and from each other, a transmission line joining said attended station and said unattended stations, a line amplifier at each of said unattended stations, means at said attended station for applying a pilot current of predetermined frequency to said line, a shunt path at each of said unattended stations for diverting a portion of said pilot current of predetermined frequency after amplification by the respective line amplifier of the unattended station, a filter in each of said paths for excluding therefrom currents of other than said predetermined frequency, means at each of said unattended stations for rectifying the respective portion of said pilot current diverted through the shunt path of the respective unattended station, an auxiliary signaling line connecting said attended and said unattended stations, means connected to said auxiliary line at said attended station for indicating the energy of direct current signals received over said auxiliary line, means at each of said unattended stations for connecting the output of said rectifying means to said auxiliary line, and means at said attended station for selectively controlling the operation of said last-mentioned means at the unattended stations.

2. In a signaling system, an attended station, a plurality of unattended repeater stations geographically separated from said attended station and from each other, a transmission line joining said attended station and said unattended stations, an auxiliary line also joining said attended station and said unattended stations, means at said attended station for applying a pilot current of predetermined frequency to said transmission line, means at each of said unattended stations for amplifying said pilot current, a shunt path at each of said unattended stations for diverting a portion of said pilot current after amplification by a respective one of said amplifying means, a filter in each of said paths for excluding therefrom currents of other than said predetermined frequency, means in each of said shunt paths for rectifying the respective portion of said pilot current diverted through the respective shunt path, means connected to said auxiliary line at said attended station for indicating the energy of direct current signals received over said auxiliary line from said unattended stations, and means for selectively connecting the outputs of each of said rectifying means to said auxiliary line.

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