March 30, 1943.

F. A. LEIBE

2,315,435

TRANSMISSION SYSTEM

Filed July 9, 1940

2 Sheets-Sheet 1

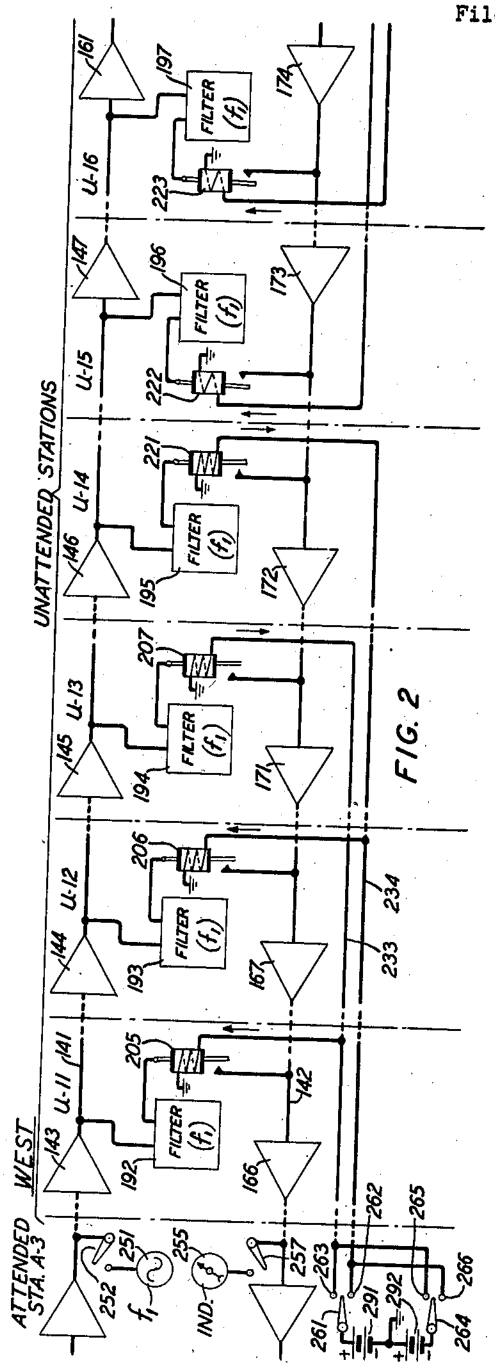

FIG. 2

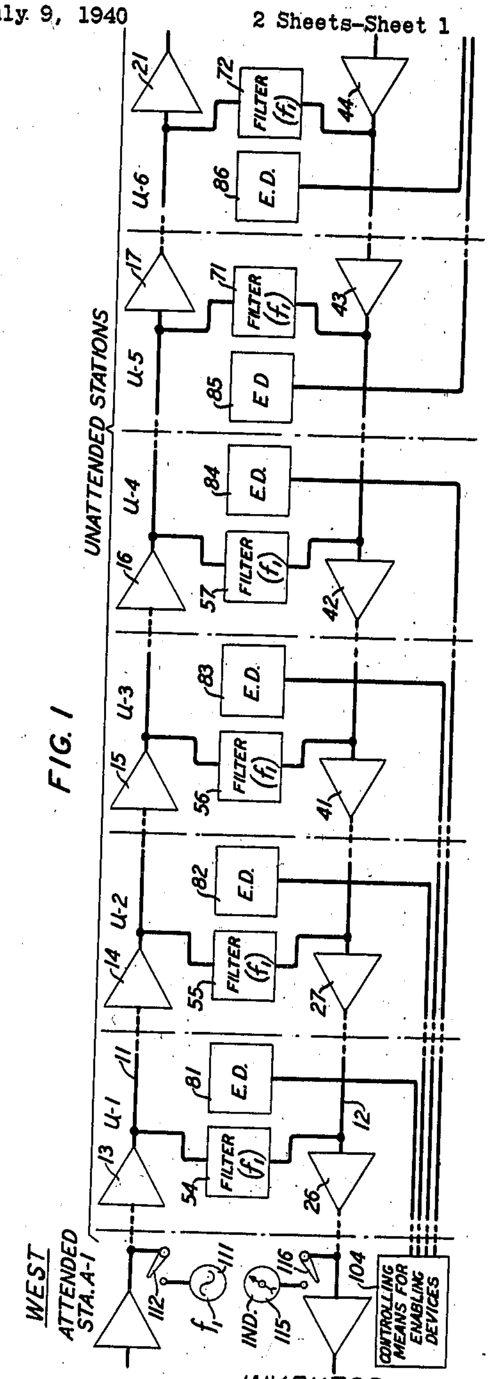

FIG. I

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March 30, 1943. F. A. LEIBE 2,315,435

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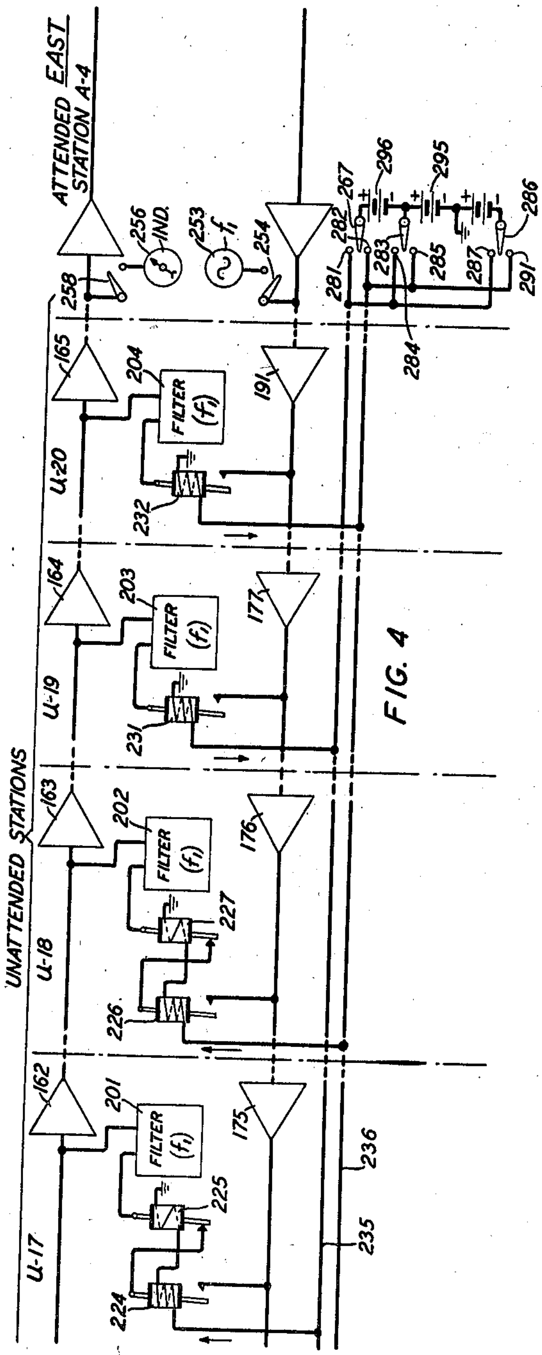

FIG. 4

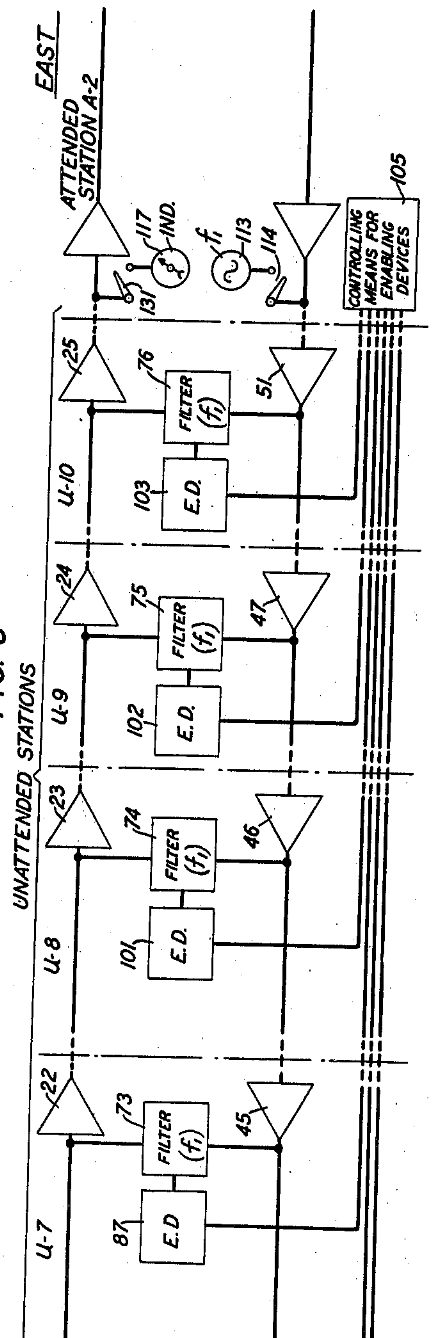

FIG. 3

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TRANSMISSION SYSTEM

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Application July 9, 1940, Serial No. 344,515

2 Claims. (Cl. 179—175.31)

This invention relates to transmission systems and more particularly to transmission systems involving unattended repeater stations.

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

A more specific object of the invention is to indicate at an attended repeater station the condition of unattended repeater stations of the transmission system.

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 stations may be from fifty to one hundred miles in length. While repeater equipment is now available which is sufficiently reliable in its operation to justify this practice of leaving the majority of the stations normally unattended, the possibility of an occasional failure can never be entirely ruled out. It is desirable, therefore, that means be provided at the attended stations whereby the operating condition of the unattended repeater stations to be supervised therefrom may be readily determined whenever desired without interrupting the normal use of the transmission system.

In accordance with a specific embodiment of the invention, a narrow band-pass filter is provided at each unattended repeater station being connected across the west-east and the east-west lines. These filters are normally maintained in disabled condition, i. e., in condition wherein resistance to passage of current is high. In order to test the condition of an unattended repeater station a pilot frequency is applied to the west-east line at the west attended station and the filter associated with the repeater station to be tested is enabled, i. e., placed in condition to readily pass current of frequency included within its pass band. If the west-east line amplifier and the east-west line amplifier of the station under test be fully operative and assuming that the intervening stations are known to be operative, the pilot current will pass through the west-east line amplifier, will be shunted through the filter to the other line, will pass through the east-west line amplifier and will return to the attended station where an indicator will be operated. Failure of the pilot current to return or return of the current in greatly attenuated condition will indicate that either line amplifier at the station under test is not operating satisfactorily.

A feature of the invention is means whereby the filters of a plurality of unattended repeater stations may be selectively enabled from an attended station.

Full understanding of the arrangements 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 drawings, in which:

Figs. 1 and 3 illustrate schematically a two-way transmission system including features of the present invention; and

Figs. 2 and 4 illustrate schematically a system similar to that of Figs. 1 and 3, a specific form of enabling means being shown. During consideration of the drawings, Figs. 1 and 3 should be joined, left and right respectively, and Figs. 2 and 4 should be likewise joined.

Referring now to Figs. 1 and 3, there is illustrated schematically a two-way transmission system joining attended repeater station A—1 (west) and attended repeater station A—2 (east). The system utilizes two lines, which may, for example, be coaxial cable lines, line 11 being the west-east line and line 12 the east-west line. The portion of the system illustrated in Figs. 1 and 3 may conveniently be referred to as a section, attended stations A—1 and A—2 being the "control" stations for the section.

A west-east line amplifier and an east-west line amplifier are provided at each unattended repeater station, the west-east amplifiers being designated as 13, 14, 15, 16, 17, 21, 22, 23, 24 and 25 and the east-west amplifiers being designated as 26, 27, 41, 42, 43, 44, 45, 46, 47 and 51. A band-pass filter is also provided at each unattended repeater station, these filters being connected between lines 11 and 12. The filters are designated 54, 55, 56, 57, 71, 72, 73, 74, 75 and 76 respectively. Suitable enabling means are provided for each of these filters, the enabling devices being designated as 81, 82, 83, 84, 85, 86, 87, 101, 102 and 103 respectively.

In the section illustrated, unattended repeater stations U—1 to U—4, inclusive, are arranged for control from attended repeater station A—1, and unattended repeater stations U—5 to U—10, inclusive, are arranged for control from attended repeater station A—2. Means, designated as 104, for controlling enabling devices 81 to 84, inclusive, are provided at station A—1 and means, designated as 105, for controlling the remaining enabling devices are provided at station A—2. The band-pass filters of those stations arranged for control from station A—1 are connected across the output of the respective west-east amplifier and the input of the respective east-west amplifier while the band-pass filters of those stations arranged for control from station A—2 are connected across the output of the respective east-west amplifier and the input of the respective west-east amplifier.

Source 111 provided at station A—1 supplies a wave of special pilot frequency f_1 to west-east line 11 when connected thereto by switch 112; source 113 provided at station A—2 supplies a wave of the same pilot frequency to east-west line 12 when connected thereto by switch 114. While it is desirable in order to obtain uniformity of equipment design that pilot current of the same frequency be supplied by both sources 111 and 113, it will be apparent, of course, that so far as the operating principles of the circuit are concerned two different pilot frequencies may be utilized. In such event, the filters would be modified accordingly with respect to the band of frequencies passed. A suitable pilot indicator 115, which is arranged to respond only to current of frequency f_1 and which may comprise a filter and voltmeter, is provided at station A—1 and may be connected to line 12 by switch 116; a similar indicator 117 is provided at station A—2 and may be connected to line 11 by switch 131.

In order to describe the arrangement further, let us assume first that we wish to test line amplifiers 13 and 26 of unattended repeater station U—1. This unattended station is included in the group controlled from station A—1. Control means 104 is first operated to cause energization of enabling device 81 thereby enabling band-pass filter 54 which is arranged to pass only a narrow band of frequencies, the frequency f_1 being included. Switch 112 is operated thereby connecting the pilot frequency f_1 to line 11 and switch 116 is operated thereby connecting pilot indicator 115 to line 12.

Now, assuming that both line amplifiers of station U—1 are operating properly, the pilot wave of frequency f_1 applied to line 11 will pass through amplifier 13, band-pass filter 54, (this being the only band-pass filter in enabled condition), amplifier 26 and back over line 12 to station A where indicator 115 will be operated. Should either amplifier 13 or 26 be inoperative the pilot frequency will not, of course, be returned over line 12, which fact will be indicated by non-operation of indicator 115; should either amplifier be operating at an efficiency substantially below its normal value, the pilot frequency will be returned with greater than normal attenuation, which fact will be indicated by operation of indicator 115 to some point below the normal operate point.

Should failure of either line amplifier 13 or 26 be indicated, the respective one at fault may be found by restoring filter 54 to disabled condition and connecting indicator 117 of station A—2 to line 11 and source 113 to line 12 respectively, indicator 115 and source 111 remaining connected to lines 12 and 11 as before. The condition of amplifier 13 will then, of course, be shown by operation or non-operation of indicator 117 and the condition of amplifier 26 by operation or non-operation of indicator 115.

The line amplifiers of unattended repeater stations U—2, U—3 and U—4 may be tested in a manner similar to that described above, the associated filter being enabled through controlling means 104. The amplifiers of unattended stations U—5 to U—10, inclusive, are tested in a similar manner but under control of apparatus located at attended station A—2. That is, source 113 and indicator 117 are utilized and the control of the enabling devices is exercised by means 105.

The enabling devices and the selective controlling means may take various forms including various selectively operated relay arrangements, variable inductance coils utilizing ferromagnetic cores and the like. One specific arrangement utilizing polarized relays is illustrated in Figs. 2 and 4 and will now be described in detail.

Referring now to Figs. 2 and 4, the system disclosed is similar to that of Figs. 1 and 3, attended repeater stations A—3 (west) and A—4 (east) being connected by west-east line 141 and east-west line 142. Unattended repeater stations U—11 to U—14, inclusive, are arranged for control from station A—3 and unattended repeater stations U—15 to U—20, inclusive, are arranged for control from station A—4. A west-east line amplifier and an east-west line amplifier are provided at each unattended station, the west-east amplifiers being designated 143 to 147, inclusive, and 161 to 165, inclusive, and the east-west amplifiers being designated as 166, 167, 171 to 177, inclusive, and 191.

A band-pass filter is provided at each unattended repeater station, being connected across lines 141 and 142. These filters are designated 192 to 197, inclusive, and 201 to 204, inclusive. An enabling device, comprising in certain instances a single polarized relay and in other instances a pair of such relays, is associated with each filter, these relays being designated 205 to 207, inclusive, 221 to 227, inclusive, and 231 and 232. Stations U—11 to U—14, inclusive, are arranged to be controlled from station A—3 and the enabling devices of those stations are selectively controlled over lines 233 and 234 by means provided at station A—3; stations U—15 to U—20, inclusive, are arranged to be controlled from station A—4 and the enabling devices of those stations are selectively controlled over lines 235 and 236 by means provided at station A—4.

Source 251 provided at station A—3 supplies a wave of special pilot frequency f_1 to line 141 when connected thereto by switch 252; a similar source 253 at station A—4 supplies a wave of the same pilot frequency to line 142 when connected thereto by switch 254. A suitable pilot indicator 255 is provided at station A—3 and a similar indicator 256 is provided at station A—4, connection of these indicators to lines 142 and 141 being controlled by operation of switches 257 and 258, respectively.

Suitable sources of potential for control of enabling relays 205, 206, 207 and 221 are provided at station A—3, the selective application of these potentials to lines 233 and 234 being controlled by operation of switch 261 to contacts 262 and 263 and by operation of switch 264 to contacts 265 and 266. Similarly, suitable potential sources for control of the remaining enabling relays are provided at station A—4, the selective application of these potentials to lines 235 and 236 being controlled by operation of switch 267 to contacts 281 and 282, switch 283 to contacts 284 and 285, and switch 286 to contacts 287 and 291.

In order to further illustrate the operation of the system, let us assume that line amplifiers

143 and 166 of unattended repeater station U—11 are to be tested from attended station A. The general testing scheme is the same as that described above in reference to Figs. 1 and 3 and will not be described here; the specific enabling arrangement will be described in detail however.

In order to test the line amplifiers of station U—11, band-pass filter 192 must, of course, be "enabled." As represented schematically in the drawings, the output of filter 192 is connected to line 142 through the make contact of relay 205 so that with relay 205 unoperated, as shown, filter 192 offers infinitely high impedance to passage of current. With relay 205 in operated position, however, the output path to line 142 is completed at the make contact of the relay and filter 192 will pass a narow band of frequencies which includes the special pilot frequency f_1. The arrangement is preferably such that the loss through filter 192 in enabled condition is substantially such with regard to the normal loss in the line that the pilot level returning to the point of measurement will be approximately the same as the outgoing pilot level. In order to operate relay 205, thereby enabling filter 192, switch 261 is moved to contact 263 thereby completing an operating circuit for relay 205 traced from positive side of battery 291, switch 261, contact 263, line 233, operating winding of relay 205 and back to the negative side of battery 291.

The enabling relays are adapted to operate only on current in the respective directions indicated by the arrows so that relay 207 does not operate at this time even though its operating winding is also connected to line 233. In order to cause operation of relay 207, should it be desired to test the line amplifiers of station U—13, switch 264 is moved to contact 265 thereby completing an operating circuit for relay 207 traced from positive side of battery 292 to ground, operating winding of relay 207, line 233, contact 265, switch 264 to negative side of battery 292.

Relays 206 and 221 are operated in a manner similar to that described by operation of switch 261 to contact 262 and switch 264 to contact 266, respectively.

Considering now the unattended repeater stations controlled from attended station A—4, here we have a slightly more involved layout as six stations are included in this group rather than four as in the group controlled from station A—3. Relays 231 of station U—19 and 232 of station U—20 are the same as those referred to above and are operated in a manner similar to that previously described by operation of switch 286 to contact 287 and operation of the same switch to contact 291, respectively.

Now at station U—17 we have two relays connected in series, relay 224 which is of the type heretofore described and relay 225 which is designed to operate only on current of a value substantially higher than that which will operate relay 224 and the other relays heretofore described. In order to enable filter 201 of station U—17, switch 283 is moved to contact 284 thereby completing an operating path for relay 224 traced from positive side of battery 295, switch 283, contact 284, line 235, winding of relay 224, winding of relay 225 to ground and back to the negative side of the battery. Relay 224 operates over this path and closes its make contact to enable filter 201; relay 225 does not operate, however, as the current flowing is not sufficient to operate this "high-current" relay.

The arrangement at station U—18 is similar to that of U—17 just described except for the fact that the relay windings are connected to line 236 instead of line 235. In order to enable filter 202, therefore, switch 283 is moved to contact 285 instead of 283.

Operation of high-current relay 222 in order to enable filter 196 of station U—15 is caused by moving switch 267 to contact 281 thereby bringing batteries 295 and 296 both into play over a path traced from positive side of battery 296, switch 267, contact 281, line 235, winding of relay 222, to ground and back to the negative side of battery 295. Relay 222 operates over this path and closes its make contact to enable filter 196. While relay 224 is also operated over this path, filter 201 is not enabled in view of the fact that the current flow is sufficient at this time to operate relay 225 also thereby opening the enabling path of the filter at the break contact of the last-mentioned relay.

The arrangement of station U—16 is similar to that of station U—15 except for the fact that the relay winding is connected to line 236 instead of line 235 so that operation of high-current relay 223 necessary to enable filter 197 is accomplished by operating switch 267 to contact 282 rather than contact 281. While relay 226 is also operated over this path, filter 202 is not enabled due to operation at the same time of relay 227.

While certain specific embodiments of the invention have been selected for detailed description, the invention is not, of course, limited in its application to those embodiments described. 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 comprising an attended station and a plurality of unattended repeater stations geographically separated from the attended station and from each other and having an east transmission line joining the attended station and the unattended stations for speech transmission in one direction and a west transmission line joining the attended station and the unattended stations for speech transmission in the opposite direction, means at the attended station for applying a testing current to the east line, a frequency selective path at each of the unattended stations joining when enabled the east line and the west line, the frequency of the testing current being within the band of frequencies passed by the frequency selective paths, means for normally disabling said frequency selective paths and means at the attended station for selectively enabling said frequency selective paths one at a time for transmission of the testing current from the east line to the west line.

2. In a signaling system comprising an attended station and a plurality of unattended repeater stations geographically separated from the attended station and from each other and having a west transmission line joining the attended station and the unattended stations for transmission in one direction and an east transmission line joining the attended station and the unattended stations for transmission in the opposite direction in which each unattended station includes a pair of line amplifiers, one amplifier of each pair being in series with the west transmission line and the other amplifier of each pair being in series with the east transmission line, a band-pass filter at each of the unattended stations connected when enabled across the output

of one of the amplifiers of a respective pair and the input of the other amplifier of the same respective pair, said band-pass filters normally being in disabled condition and offering an excessively high resistance to passage of current, means at said attended station for applying a testing current to one of said lines, the frequency of said testing current being that passed by said band-pass filters when enabled, a normally open enabling circuit for each of said band-pass filters, a relay connected in each of said enabling circuits effective upon operation to close the associated enabling circuit and means at said attended station for selectively operating said relays one at a time to thereby enable the associated filter and provide a path for transmission of testing current from one of said transmission lines to the other of said transmission lines.

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