

July 4, 1944.

T. A. MARSHALL

2,353,055

SATELLITE COMMUNICATION SYSTEM

Filed Sept. 19, 1942

3 Sheets-Sheet 1

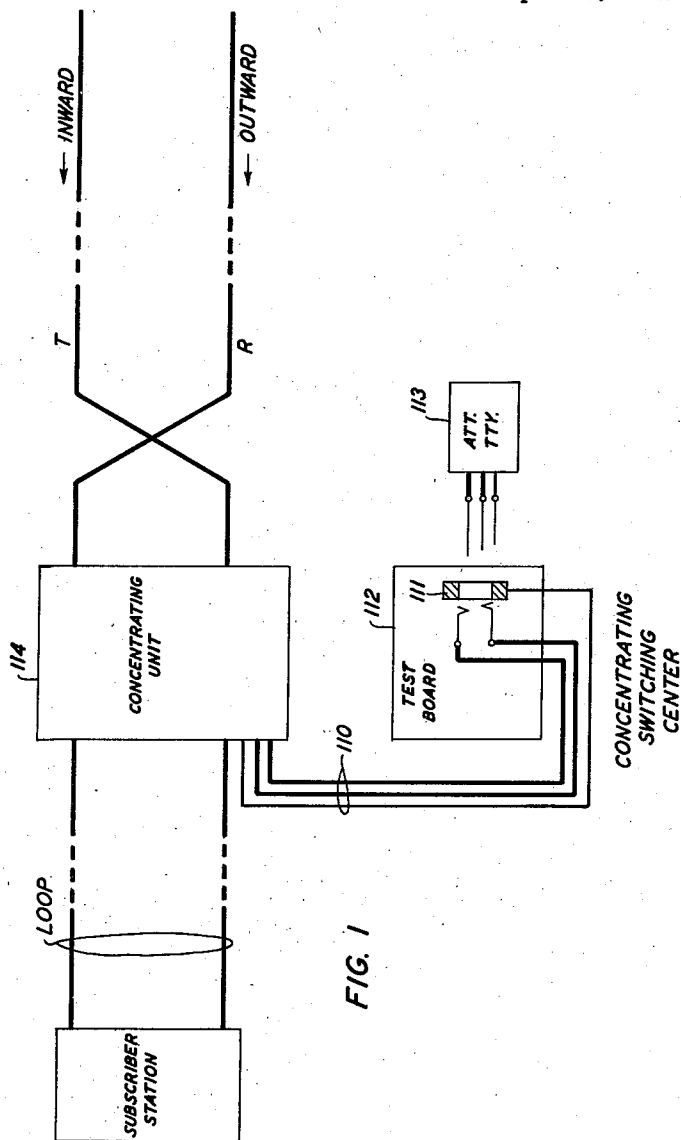


FIG. 4

FIG. 1	FIG. 2	FIG. 3
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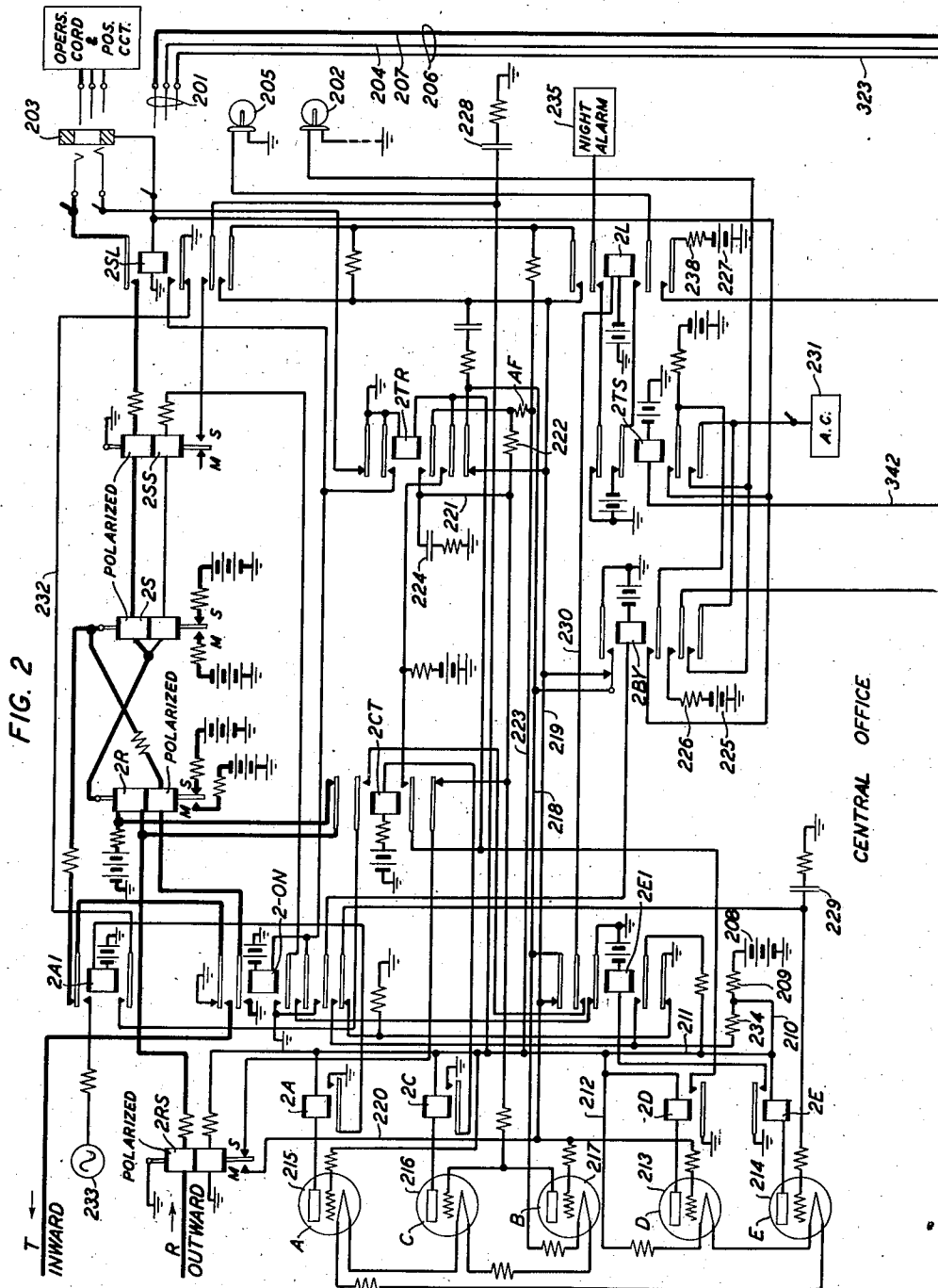
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SATELLITE COMMUNICATION SYSTEM

Filed Sept. 19, 1942

3 Sheets-Sheet 2



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CENTRAL OFFICE

July 4, 1944.

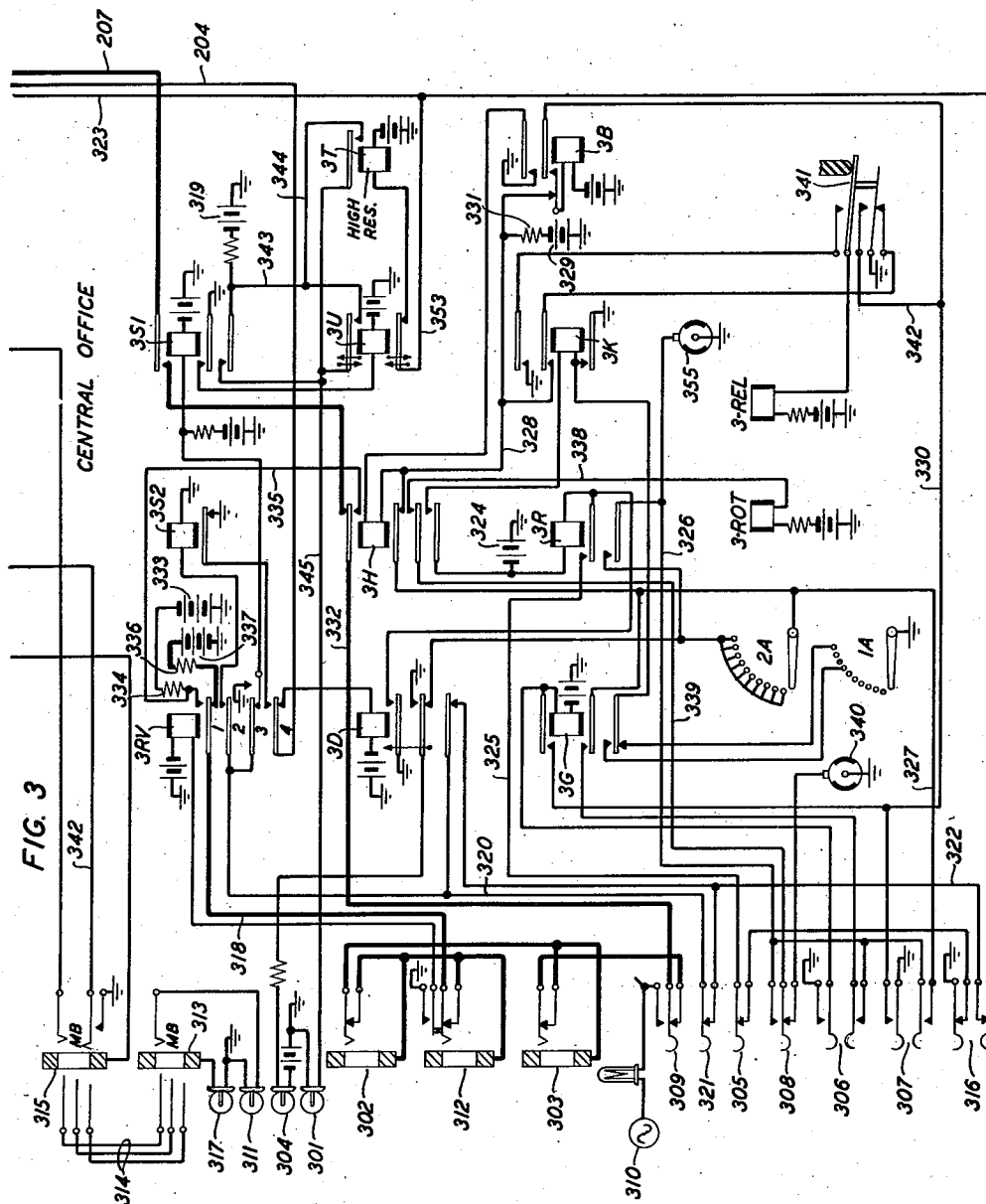
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SATELLITE COMMUNICATION SYSTEM

Filed Sept. 19, 1942

3 Sheets-Sheet 3



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2,353,055

SATELLITE COMMUNICATION SYSTEM

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Application September 19, 1942, Serial No. 458,979

16 Claims. (Cl. 178—2)

This invention relates to communication systems and more particularly to teletypewriter exchange systems wherein satellite arrangements provide for a plurality of subscriber stations being connected through an automatically operated line concentrating unit switching center, to a central office.

In order to assist in understanding the invention, it is desirable to briefly describe the present arrangement of the teletypewriter exchange central office equipment and the method of operating and maintaining the trunk circuits extending to other central offices and the terminating equipment at opposite ends of each trunk.

The operating and maintenance personnel may be divided roughly into two groups:

A. A traffic group which comprises the operators for establishing connections and the supervisory force routing and supervising the traffic; and

B. A plant group whose duty it is to maintain the circuits in proper operating condition, locate the causes of trouble when reported by the traffic group, and to clear the various troubles after the causes have been ascertained.

The various trunk lines are multiplied before several operators at positions of the operator switchboard to permit the operators to establish connections. If an operator finds a particular line or trunk in trouble, she reports this fact to a traffic control bureau which is usually located in some other part of the building and has no direct access to the line or trunk in trouble. It is desirable that the traffic control bureau verify the fact that the trouble exists before notifying the plant people to clear it and in order to do this, the traffic control bureau orders a trouble operator (who is located at one of the positions of the toll switchboard) to extend the line or trunk, in trouble, to the traffic control bureau. The trouble having been verified, it is reported to a trouble clerk in the plant department who makes out a ticket and delivers it to the attendant at a test board whose duty it is to determine the cause of the trouble. The test board is so arranged that each attendant thereat has access to a certain group of lines and/or trunks and the lines or trunks are not multiplied to other positions at the test board. If at the time the trouble is reported to the trouble clerk the attendant at the test board should be busy testing another line or trunk, he would not be able to take up the new trouble immediately, and hence the necessity for making out a ticket and delivering it to the attendant. As soon as the test board

attendant has determined the cause of the trouble he instructs the proper equipment man who has charge of the particular equipment which is in trouble, to clear it. After the trouble is cleared the equipment man notifies the test board attendant, who again tests to determine that the line or trunk and apparatus associated therewith are in proper condition; whereupon he notifies the traffic control bureau that the line or trunk is again ready for service.

When the traffic control bureau originally ascertained that the trouble existed, the trouble operator at the toll switchboard was ordered to render the troubled circuit busy and the busy condition existed during the period of making out the ticket, testing and clearing the trouble. Upon receiving the report that the line or trunk is again in condition for service, the traffic control bureau must thereupon notify the trouble operator to remove the busy condition so that the operator at the operator switchboard may use the line or trunk for traffic.

The applicant has found it desirable to simplify the operation of testing each trunk extending from a central office to a line concentrating unit switching center and each of the subscriber lines connected either directly to the switching center or over any one of these trunks.

An object of the invention is to test at the central office the operational effectiveness of each of the trunk circuits extending between the central office and the line concentrating unit switching center, and each of the subscribers' lines connected directly to the switching center.

According to the present invention a testing position, in addition to a plurality of the usual operator positions, is provided at the operator switchboard at the central office. At the testing position each of the trunks incoming from the line concentrating unit switching center is terminated, in multiple appearance, at a jack. Also terminating at the testing position of the operator switchboard in addition to a plurality of cord circuits, is another cord circuit connected to a testing trunk circuit which extends to a test board located in a part of the building other than that wherein the operator switchboard is located. Therefore, a test board attendant may, at any desired time or at regular intervals request over an order wire the operator at the testing position of the operator switchboard to connect the testing trunk plug to the jack of any particular trunk extending to the line concentrating unit switching center, so that the test board attendant may originate a call to another test board

attendant at the line concentrating unit switching center, or to any of the subscribers' stations directly connected to the switching center or to any other subscriber's station directly connected to the central office, and supervises such connections in the same manner as an operator at an operator switchboard.

A feature of the present invention is the provision for making an over-all test on any one of the trunks extending to the line circuit switching center, with the supervisory signals coming from a subscriber station or attendant teletypewriter trunk circuit at the line concentrating unit switching center, or for making the tests locally with supervisory signals simulated at the jack associated with the particular line or trunk in the test board at the central office.

Another feature is the direct means for testing trunks extending to the line concentrating unit switching center by requesting the operator at the test position of the operator switchboard to connect the testing trunk circuit to any one of the trunks through its multiple jack which appears at the test position.

Another feature is the provision of a high resistance sleeve conductor in the testing trunk cord circuit which, when connected to a trunk, operates a guard lamp at the test board but does not operate a sleeve relay in the particular trunk selected.

Another feature is the provision of a make-busy jack in the testing trunk circuit arranged to be patched with a cord circuit to the make-busy jack of the selected trunk whereby a busy lamp and an answer lamp are arranged to light over the sleeve and the tip conductors, respectively, of the testing trunk cord circuit, the answering lamp lighting one-half second later than the busy lamp.

Another feature is the provision for extinguishing the answer lamp and the busy lamp at the test board successively when the call is abandoned before it is answered. Resumption of the call within four seconds relights the answer lamp. Resumption later than four seconds is like a new call.

Another feature is the provision for answering a call at the test board by restoring a locking key to normal whereby the above-mentioned high resistance of the sleeve conductor of the testing trunk cord is reduced, to operate the sleeve relay of the selected trunk and circuits are closed to cause the guard lamp at the test board to light and extinguish the answer lamp.

Another feature is the provision when a recall signal is received at the test board, to furnish interrupted ground potential to a circuit for flashing a supervisory lamp. The lamp is extinguished by the momentary operation of a non-locking restore key.

Another feature is the provision for originating a call at the test board after the selected trunk is made busy, by operating the locking key connecting the testing trunk cord to the selected trunk and then restoring the locking key. A supervisory lamp at the test board will light steadily after the key is released.

Another feature is the provision of a relay arranged to release when ground potential is removed from the ring conductor of the trunk, indicating that the line concentrating unit is ready to receive call directing pulses. The relay, upon releasing, causes the supervisory lamp to flash.

Another feature is the provision of applying

a steady ground potential to the ring conductor of the testing trunk cord circuit when the connection of a subscriber's line, in response to the call directing pulses, is completed at the line concentrating unit for causing the supervisory lamp to change from a flashing light condition to a steady light condition.

Another feature is the provision of applying ringing current to the selected trunk by operating a key at the test board which current is transmitted to the line concentrating unit as 20-cycle dot signals.

Another feature is the provision of changing the supervisory lamp from a steady light condition to a flashing light condition when the call to or through the line concentrating unit is answered. A momentary operation of the restore key at the test board extinguishes the supervisory lamp.

Another feature is the provision for testing the functioning of the selected trunk circuit on a disconnect by the operator before a subscriber disconnects, by operating a locking key at the test board which opens the sleeve circuit of the testing trunk cord causing the trunk sleeve relay to release. The release of the trunk sleeve relay causes the answer lamp at the test board to light. If the subscriber disconnects before the locking key is restored the answer lamp is extinguished and in five seconds is followed by the extinguishing of the busy lamp.

Another feature is the provision of means for testing the functioning of the selected trunk circuit when the party at the opposite end of the trunk disconnects, whereby ground is applied to the ring conductor of the testing trunk cord to cause the supervisory lamp at the test board to light.

Another feature is the provision of means for testing the functioning of the selected trunk circuit when the operator disconnects after the party at the opposite end of the trunk circuit disconnects. This condition is simulated by operating the locking key to open the sleeve circuit of the testing trunk cord. The busy lamp at the test board is extinguished one and one-half seconds after the operation of the key. The guard lamp at the test board is maintained lighted and the trunk sleeve relay remains released removing the condition which has kept the busy lamp lighted.

The drawings consist of three sheets. The first sheet contains Figs. 1 and 4, the second sheet Fig. 2, and the third sheet Fig. 3.

Fig. 1 is a diagrammatic showing of a subscriber station connected through a line concentrating unit switching center to a central office. Other subscriber stations, not shown, may likewise be connected to the line concentrating unit switching center. The equivalent of a subscriber loop is shown connected to a jack at the attendant's test board at the line concentrating unit switching center for the purpose of testing any one of the trunks extending between the central office and the line concentrating unit switching center. The subscriber station may be similar to that shown in Fig. 3 of the copending application of C. W. Lucek, Serial No. 431,854, filed February 21, 1942. Likewise, the subscriber line terminating circuit, the link circuit, the sequence circuit, the trunk circuit, the director circuit, all-trunks-busy circuit, and the miscellaneous alarm circuit provided at the line concentrating unit switching center, represented by rectangle 114, may be similar to the corresponding circuits

shown in the copending application of C. W. Lucek, supra.

Fig. 2 shows a schematic of the trunk circuit terminating equipment at the central office which equipment corresponds to Fig. 25 of the application of C. W. Lucek, supra.

Fig. 3 shows a schematic of the testing trunk circuit adapted for testing trunks extending between the central office and the line concentrating unit switching center.

Fig. 4 is a diagram showing the relative arrangements of Figs. 1 to 3.

The numbering of the apparatus and parts of the circuit shown in the various figures, for the most part, follows a plan in which the first digit represents the figure number. Thus reference characters on Fig. 3, for instance, are numerals in the 300 series, the hundreds digit designating the figure. Relays and magnets are designated by the letters; each letter being prefixed by the number of the figure in which it is used.

The complete operation of the system is set forth hereinafter. The functions of the testing trunk circuit when connected to an automatic signaling concentrating unit trunk circuit which terminates at an operator switchboard as shown in Fig. 25 of the copending application of C. W. Lucek, supra, are as follows:

For testing the automatic signaling concentrating unit, or main trunk shown in Figs. 1 and 2, make-busy jack 313 is patched by means of cord circuit 314 to make-busy jack 315 in the automatic signaling trunk circuit. Make-busy jack 315 in the main trunk circuit and the make-busy jack 313 of the testing trunk circuit are located in the attendant's test board as shown in Fig. 3. Test plug 201 of the testing trunk circuit is arranged for connection to a multiple appearance of the trunk circuit, at the test position of the operator switchboard. The test board attendant's teletypewriter is connected to test jack 302 or looping jack 303 and the automatic signaling key 316 is operated. Guard lamp 301 will light, and the test board attendant will be able to make the following over-all test:

(a) The connection of the make-busy jack 313 to the make-busy jack 315 lights the busy lamp, such as lamp 202, at each trunk appearance at the operator switchboard and makes the corresponding sleeve circuit, say of jack 203, busy. If the trunk circuit is already busy at the operator switchboard appearance while the connection is made to the make-busy jack 315, busy lamp 317 will be lighted and if the trunk is awaiting answer at the operator switchboard, answer lamp 311 and busy lamp 317 will be lighted. If the trunk is idle neither lamp 311 nor 317 lights.

(b) If the trunk circuit is found to be idle, the automatic signaling trunk test key 316 should be operated and then the test plug 201 may be inserted into a multiple appearance jack, say jack 203, of the trunk circuit at the operator switchboard. Guard lamp 301 lights.

(c) A call from the distant concentrating unit switching center, shown and described in the Lucek application, supra, will cause busy lamp 317 and answer lamp 311 to light. Answer lamp 311 lights one-half second later than busy lamp 317.

(d) Abandoning of the call before it is answered causes answer lamp 311 to be extinguished and be followed in five and one-half seconds by the extinction of busy lamp 317. Resumption within four seconds relights answer lamp 311. Resumption afterwards is like a new call.

(e) The call is answered by releasing automatic signaling key 316. The answer lamp 311 is extinguished.

(f) A recall from the concentrating unit switching center of the trunk circuit places a momentary ground on the ring conductor 204 of testing trunk plug 201 which results in flashing of supervisory lamp 304, which may be extinguished by a momentary operation of restore key 305.

(g) A call may be originated by operating the automatic signaling key 316 and releasing it in a moment. Supervisory lamp 304 will light steadily after the key is released.

(h) A director-ready signal will change the supervisory lamp 304 to flashing.

(i) When connection is automatically made to the desired line or the test trunk at the concentrating unit switching center in response to teledirection signals received from the test board attendant's teletypewriter at the central office, supervisory lamp 304 changes from flashing to a steady light condition.

(j) If ringing is not on an automatic start basis in the concentrating unit switching center, the bell at the desired subscriber station connected directly to the concentrating unit may be rung or the trunk answering lamp 311 lighted by operating the ringing key 309.

(k) When the subscriber answers or the teletypewriter at an unattended station starts, supervisory lamp 304 changes from a steady light condition to a flashing condition and may be extinguished by a momentary operation of restore key 305.

(l) A test for a disconnect by an operator before the subscriber has disconnected may be made by operating the automatic signaling key 316. Answer lamp 311 should light. Disconnection by the subscriber extinguishes answer lamp 311 which is followed in five seconds by the extinction of busy lamp 317.

(m) When the subscriber disconnects supervisory lamp 304 lights steadily.

(n) A disconnect by an operator after the subscriber disconnects may be simulated by operating the automatic signaling key 316. Busy lamp 317 is extinguished one and one-half seconds after the operation of the automatic signaling key 316.

The line concentrating unit switching center which may also be called a satellite center, or office, is referred to hereinafter as the switching center.

For a description of the operation of the trunk terminating equipment shown in Fig. 2 reference may be made to the copending application of J. A. Kreck, Ser. No. 348,629, filed July 31, 1940.

Establishing connection to automatic signaling concentrating unit trunks

The automatic signaling, or main, trunks may be tested over-all, with the supervisory signals coming from a subscriber or attendant's teletypewriter trunk circuit at the distant switching center or they may be tested locally with the supervisory signals simulated at the jacks associated with the particular automatic signaling trunk in the telegraph test board at the central office. In making tests of an automatic signaling trunk extending to the switching center it is necessary that make-busy jack 313 of the testing trunk be patched by means of patching cord 314 to the make-busy jack of the selected main trunk, for example, say jack 315 of the main trunk termi-

nating equipment shown in Fig. 2. Test plug 201 of the testing trunk is inserted in jack 203 which is a multiple appearance of the selected trunk at the test position of the operator switchboard. The test board attendant's teletypewriter is inserted by means of its attached cord and plug, into test jack 302. The automatic signaling trunk key 316 is used and its operation is hereinafter described. The test board attendant's teletypewriter may also be inserted in looping jack 303 for testing outgoing trunks or in jack 312 for calling the operator at the test position of the operator switchboard.

When the trunk circuit shown in Figs. 1 and 2 is in the idle condition, both the inward and the outward paths are in spacing condition. No relays or vacuum tubes are energized except receive supervisory relay 2RS which is normally held in its spacing position by the spacing condition of the outward path which extends through the upper winding of the relay. Relay 2RS will maintain condenser 224 discharged while the trunk is in an idle condition.

Trunk busy at operator switchboard

If the automatic signaling trunk circuit is busy at the operator switchboard appearance while the make-busy jack 313 is patched to the make-busy jack 315 in the trunk circuit, busy lamp 317 will be lighted over a circuit traceable from grounded battery 225, say of 48 volts, resistance 226, say of 284 ohms, contact and middle lower armature of trunk-busy relay 2BY, sleeve conductors of jack 315, cord 314 and jack 313, through the lamp 317 to ground. If a calling signal incoming over outward path R is awaiting answer at the operator switchboard, as indicated by the lighting of call, or line, lamp 205, busy lamp 317 will light because busy relay 2BY is operated, and answer lamp 311 will light over the circuit traceable from grounded battery 227, say of 48 volts, resistance 228, say of 284 ohms, outer lower armature and contact of lamp relay 2L, tip conductors of jack 315, cord circuit 314 and jack 313, through the lamp 311 to ground.

In response to a calling signal incoming over outward path R relay 2RS follows all pulses of the calling signal. During the idle condition of the trunk relay 2RS will keep condenser 224 discharged. Marking pulses permit condenser 224 to charge and will energize the filament circuit of vacuum tubes 213 to 217. When a marking pulse in excess of one-half second is received as the result of a call, condenser 224 will charge sufficiently to cause tube 216 to draw plate current and operate relay 2C which, in turn, operates relay 2CT. Relay 2CT, upon operating, will open the spacing contact circuit of relay 2RS so that tube 216 will remain conductive. Relay 2CT, upon operating, will also condition relay 2R so as to follow the signal pulses from the outward path, and will operate relay 2TR. Relay 2TR, upon operating, will lock itself in an operated position and operate relay 2—ON. Relay 2—ON, upon operating, applies power to the repeater relays 2R, 2S and 2SS and operates busy relay 2BY. Relay 2BY, upon operating, lights busy lamp 202, energizes the filament circuit of the vacuum tubes independently of the marking contact of relay 2RS and applies a busy potential to the sleeve of jack 203. Meanwhile, the tube filaments being energized, tube 215 becomes conductive and prior to the operation of relay 2—ON operates relay A which, in turn, operates relay 2A1 so that the 20-cycle current from source 233

will be transmitted over the inward path T when relay 2—ON becomes operated. Relay 2—ON, upon operating, also locks itself in a circuit extending to the back contact and inner upper armature of relay 2E1, and transfers condenser 229 from ground to a high resistance charging path including resistances 234 and 209 and grounded positive battery 208. When condenser 229 has charged for a period of one-half second tube 214 becomes conductive and relay 2E operates to operate, in turn, relay 2E1. Relay 2E1, upon operating, will close the operating path of relay 2L, which, upon operating, will light call, or line, lamp 205 and operate night alarm 235. The circuit for operating relay 2L is traceable from grounded battery on the winding of relay 2L, conductor 230, middle upper armature and contact of relay 2E1, contact and inner upper armature of relay 2CT, contact and lower armature of relay 2A1 to ground at the innermost lower armature and back contact of trunk sleeve relay 2SL.

If the trunk shown in Fig. 2 is idle at the time jacks 313 and 315 are patched together, neither the busy lamp 317 nor answer lamp 311 will light. However, the trunk may be made busy by the attendant at the test board by inserting the plug of patching cord 314 in make-busy jack 315 to connect ground to the ring spring of the jack and thereby close the circuit extending over conductor 342, through the winding of relay 2TS, to grounded battery and relay 2TS operates to connect source 231 of alternating current to a circuit extending over the outer lower armature and contact of relay 2TS to the trunk-busy lamp 202 which lights indicating that the trunk is busy.

Connecting the testing trunk plug 201 at the test position of the operator switchboard

If the trunk is found to be idle, plug 201 will be connected to the multiple appearance at the testing position of the operator switchboard after first operating automatic signaling trunk test key 316. Operation of key 316 to its open condition provides a high resistance circuit extending from grounded battery, through a high resistance winding, say 20,000 ohms, of relay 3T, contact and lower armature of relay 3U, conductors 353 and 323, sleeve conductors of plug 201 and jack 203, through the winding of trunk sleeve relay 2SL to ground, and relay 3T operates but relay 2SL does not operate at this time. Relay 3T, upon operating, closes at its armature and contact a circuit traceable from grounded battery 319, say of 48 volts, conductors 343 and 344, contact and armature of relay 3T, conductor 345, through guard lamp 301, to ground and guard lamp 301 lights to indicate that testing trunk cord 206 is connected to a main trunk.

Incoming call

An incoming call from the distant switching center 114, which originated at either the center itself or one of the subscriber stations connected thereto, will cause busy lamp 317 to light over the sleeve circuit as hereinbefore described and answer lamp 311 to light over the tip circuit of jack 313, also as hereinbefore described. The answer lamp 311 lights one-half second later than the busy lamp 317.

Abandonment of call before answer

If a call is abandoned before it is answered, answer lamp 311 will be extinguished and be followed by the extinction of busy lamp 317. Re-

sumption of the call within four seconds relights answer lamp 311. Resumption later is like a new call.

Answering call at the test board in the central office

The attendant's teletypewriter being connected to test jack 302, the call is answered by restoring the automatic signaling trunk test key 316. The restoration of key 316 reduces the resistances of sleeve conductor 323 by connecting conductor 323 to a path extending over conductor 322, normally closed contacts at the spring of key 321, conductor 320, No. 3 armature and back contact of relay 3RV, through the winding of relay 3S1, to grounded battery, say of 48 volts, and relays 2SL and 3S1 operate. Relay 3S1, upon operating, causes relay 3U to operate. Relay 2SL, upon operating, closes at its upper armature and contact, a circuit including the tip conductors of plug 201 and jack 203, which circuit is now completed over the upper armature and contact of relay 3S1, through to the attendant's teletypewriter and the attendant may now communicate over the trunk extending to the switching center 114. Relay 3S1, upon operating, also closes at its outer lower armature and contact the operating circuit for guard lamp 301 which lights to indicate to an attendant at a multi-position test board that the testing trunk circuit is connected to a trunk circuit. The operation of key 316 to its normally closed position causes relay 3T to release and the operation of relay 2SL disconnects ground from conductor 232 to cause the release of lamp relay 2L and the release of relay 2L extinguishes answering lamp 311.

Receiving a recall

A recall signal received from the switching center 114 end of the trunk causes relay 2TR to release thereby causing a momentary ground to be placed on the ring conductors of jack 203 and plug 201 which operates relay 3D for a sufficiently long time to operate relay 3R. Relay 3R operates and locks up over its inner lower armature and contact under the control of restore key 305 and closes at its outer lower armature and contact an interrupted ground circuit for causing supervisory lamp 304 to flash. Supervisory lamp 304 is extinguished by a momentary operation of restore key 305 which unlocks relay 3R.

Origin of a call

A call may be originated at the attendant's test board in the central office after the trunk circuit is made busy as hereinbefore stated by restoring the automatic signaling trunk key 316. The sleeve circuit is closed through the winding of relay 3S1 and relay 3S1 and relay 3U operate. Supervisory lamp 304 will light steadily after key 316 is released due to a steady ground potential on the ring conductor 204 causing relay 3D to operate.

A brief description of the operation of the trunk circuit is as follows: The restoration of key 316 permits trunk sleeve relay 2SL to operate and close an operating circuit for relay 2—ON which operates to send a marking signal over the inward path T to prepare the line concentrating unit circuits at the switching center for teledirection, that is, the transmission of characters for selecting the desired subscriber station line terminated at the distant switching center. Ground potential will be present on ring con-

ductor 204 to light supervisory lamp 304 until a marking signal is received over outward path R from the switching center as an indication to the test board attendant that the line concentrating unit is prepared for teledirection. The marking condition on the outward path will result in the operation of relay 2RS to its marking position and condenser 224 charges to a potential sufficient to cause vacuum tube 216 to draw plate current and operate relay 2C. Relay 2C, upon operating, operates relay 2CT. Relay 2CT, upon operating, opens the spacing contact circuit of relay 2RS so that tube 216 remains conductive. Relay 2CT, upon operating, also conditions relay 2R to follow the signals received from the outward path R and operates relay 2TR. Relay 2TR, upon operating, causes supervisory lamp 304 to become extinguished, to indicate the condition to the attendant who will then transmit the teledirection characters. If the subscriber line of the number called is busy, out-of-order busy, or unassigned distinctive teletypewriter signals will be returned from the director circuit in the line concentrating unit to indicate the condition to the attendant. If the line is idle, connection will be established to it automatically by the concentrating unit termination of the trunk. Since in this case the called line is idle the equivalent of a disconnect condition will exist and outward path R will return to its spacing condition to relight supervisory lamp 304 by the release of relay 2TR during the time that the subscriber station is being rung. When the subscriber answers, the outward path will again be changed to a marking condition and the resultant extinguishing of the supervisory lamp will indicate the answer of the call to the test board attendant.

Director ready signal

When the switching center 114 is ready to receive call directing pulses, ground at the outer upper armature and back contact of relay 2TR will be removed from ring conductor 204 and relay 3D will release and supervisory lamp 304 will flash from interrupted ground potential supplied by interrupter 325 in a circuit traceable over the outer lower armature and contact of relay 3R and the back contact and middle lower armature of relay 3D.

Connection to subscriber line or test trunk

Selection of the desired line or teletypewriter trunk at switching center 114 may be made by teledirection from the test board attendant's teletypewriter. When the connection is made, steady ground potential is applied to the ring conductor 204, causing relay 3D to operate steadily and supervisory lamp 304 to change from a flashing to a steady light condition.

Ringing the subscriber line or test trunk

If ringing is not on an automatic start basis at the switching center, the subscriber station-set bell may be rung by operating the ring key 309 which applies ringing current from source 310 to the circuit extending over tip conductor 201 to the trunk circuit shown in Fig. 2. This current is transmitted over the telegraph transmission trunk circuit to the switching center as 20-cycle dot signals from source 233.

Distant subscriber or distant test board attendant answers

When the switching center test board attend-

ant or the subscriber answers, or a subscriber unattended station starts, supervisory lamp 304 changes from a steady light condition to a flashing condition due to the removal of steady ground potential from the ring conductor 204 of the testing trunk cord. Momentary operation of restore key 305 unlocks relay 3R and extinguishes the flashing lamp 304.

Disconnection while subscriber station is still connected for communication

A test for the functioning of the automatic signaling trunk circuit shown in Fig. 2 on a disconnect by the operator before the subscriber disconnects may be made by operating the automatic signaling trunk key 316 which, when operated, opens the sleeve conductor 323 of the testing cord 206. Relays 3S1 and 3U release. Relay 3U, upon releasing, closes a circuit extending through the high resistance winding of relay 3T to grounded battery. During the open interval of the sleeve conductor 323 of cord 206 before relay 3T is connected, the trunk sleeve relay 2SL is given an opportunity to release on the busy condition being maintained by the presence of the connection to the make-busy jack 315 of the trunk circuit. The release of the sleeve relay in the trunk circuit causes relay 2L to operate, which, upon operating, causes the lighting of answering lamp 311. If the subscriber disconnects before the automatic signaling trunk key 316 is restored, the answer lamp 311 is extinguished and in five seconds is followed by the extinction of the busy lamp 317.

Subscriber disconnects first

When the subscriber disconnects, steady ground potential is applied to the ring conductor 323 of the test cord 206 for operating relays 3D and 3R and consequently lighting supervisory lamp 304.

Disconnection by the operator at the central office after the subscriber disconnects

This condition is simulated by operating the automatic signaling trunk key 316 to open the sleeve conductor 323. Busy lamp 317 is extinguished one and one-half seconds after the operation of key 316. Relays 3S1 and 3U release. Relay 3T operates to maintain guard lamp 301 lighted. During the open sleeve interval before relay 3T is connected to the sleeve, the trunk sleeve relay is given an opportunity to release. It remains released removing the condition which has kept the busy lamp 317 lighted.

What is claimed is:

1. In a telegraph exchange system, a central office, comprising an operator switchboard, a test board, main trunks terminating at said central office each having an appearance at a position of said switchboard and a position of said test board, a testing trunk at said test board, having means for connection at said switchboard to any one of said main trunks, and means at said test board for determining the condition of any one of said main trunks, said means comprising patching means for interconnecting at said test board said testing trunk and one of said main trunks, signal devices connected to said patching means, and operable means arranged, when operated, to cause said signal devices to indicate whether a selected trunk is busy, idle or in the condition wherein a call from a distant point is awaiting an answer.

2. In a telegraph exchange system, a central

office comprising an operator switchboard, a test board, main trunks terminating at said central office each having a three-conductor appearance at a position of said switchboard and a position of said test board, a three-conductor testing trunk at said test board and having means for connection at said switchboard to any one of said main trunks, a trunk sleeve relay connected to one of said conductors at each of the appearances at said switchboard and arranged for connection to one of the conductors of said testing trunk, a high resistance operable element connected in parallel to said one conductor of said testing trunk, a signal device for holding a main trunk busy against subsequent seizure after said testing trunk is connected to the particular main trunk, and operable means arranged when operated to cause the operation of said element to operate said signal device and to prevent the operation of the sleeve relay in said particular main trunk.

3. In a telegraph exchange system, a central office, comprising an operator multiposition switchboard, a test board, main trunks terminating at said central office each having a three-conductor appearance at each position of said switchboard and a position of said test board, a three-conductor testing trunk at said test board and having means for connection at said switchboard to any one of said main trunks, two-conductor means at said test board for indicating a call incoming over any one of said main trunks, said means comprising two-conductor patching connector for associating at said test board the particular main trunk with said testing trunk, and signaling elements arranged to successively operate in response to the incoming call, one of the conductors of said patching connector being effective to operate one of said signaling elements at one time and another of the conductors of said patching connector being effective to operate another of said signaling elements at another time.

4. In a telegraph exchange system, a central office comprising an operator multiposition switchboard, a test board, main trunks terminating at said central office, each having a three-conductor appearance at each position of said switchboard and a position of said test board, a three-conductor testing trunk at said test board having means for connection at said switchboard to any one of said main trunks, and two-conductor means at said test board for indicating a call incoming over any one of said main trunks and said testing trunk, signaling means successively operative in response to an incoming call arranged to successively return to normal when the call is abandoned before the call is answered, and means controlling one of said signaling elements arranged to reoperate said one element after being returned to normal, if the call is renewed within four seconds.

5. In a telegraph system for answering incoming calls at a test board, a central office comprising an operator multiposition switchboard, a multiposition test board, main trunks terminating at said central office, each having an appearance at each position of said switchboard and a position of said test board, a testing trunk at said test board and having means for connection at said switchboard to any one of said main trunks, patching means at said test board for associating any one of said main trunks with said testing trunk and sources of potential in said main trunk for energizing said patching

means when effectively associated with one of said main trunks at said testing trunk, signaling elements at said test board, operable means in said testing trunk, a teletypewriter arranged for connection to said testing trunk, means for energizing two said signaling elements in response to a call incoming over one of said main trunks when said one main trunk is effectively associated with said testing trunk by said patching means, high resistance means responsive to the operation of said operable means for operating the third of said signaling elements, and other means effective to deenergize said third signaling means and to maintain energized said third signaling means independently of said high resistance means for the duration of the connection established between said teletypewriter and said one main trunk through said testing trunk in response to the incoming calls when said operable means is restored to normal.

6. In a telegraph exchange system for recalling the test board attendant in a communication connection, a central office comprising an operator multiposition switchboard, a multiposition test board, main trunk terminating at said central office, each having a three-conductor appearance at each position of said switchboard and a position of said test board, a three-conductor testing trunk at said test board and having means for connection at said switchboard to any one of said main trunks, an operable device in said testing trunk arranged to operate when a ground potential is applied to one conductor of any one of said main trunks in engagement with said testing trunk, another operable device in said testing trunk arranged to operate and lock in its operated position in response to the operation of the first-mentioned operable device, a signaling element at said test board arranged to operate intermittently during the time that said other operable device is locked in its operated position, and an operable element located at said test board and arranged when operated momentarily to deenergize said operable devices and said signaling element.

7. In a telegraph exchange system for originating a call at an attendant's test board for a connection to a main trunk, a central office comprising an operator multiposition switchboard, a multiposition test board, main trunks terminating at said central office, each having a three-conductor appearance at each position of said switchboard and a position of said test board, a testing trunk at said test board and having means for connection at said switchboard to any one of said main trunks, patching means at said test board for associating any one of said main trunks with said testing trunk and a source of potential in said main trunks for energizing said patching means when effectively associated with one of said main trunks and said testing trunk, operable means at said test board, signaling elements at said test board and said switchboard, means responsive when (1) said patching means is effectively associated with said one main trunk and said testing trunk, (2) said operable means is operated, and (3) said testing trunk is connected to said one main trunk, for operating one of the signaling elements located at said switchboard and associated with said one main trunk, and means responsive to the release of said operable means for (1) making said one main trunk busy to other calls, (2) for maintaining operated the said one signaling element at said switchboard, (3) for completing an operative connection

between said one main trunk and said testing trunk, and (4) for operating a signaling element at said test board to furnish supervision for the duration of the connection originated at the attendant's test board.

8. In a telegraph system for sending call directing signals from an attendant's test board to any one of a plurality of main trunks, a central office, comprising an operator multiposition switchboard, a multiposition test board, main trunks terminating at said central office, each having a three-conductor appearance at each position of said switchboard and one position of said test board, a three-conductor testing trunk at said test board and arranged for connection at said switchboard to any one of said main trunks, a teletypewriter connected at said test board to said testing trunk for sending call directing signals over one of said conductors in said testing trunk and one of said conductors in said main trunk in engagement with said testing trunk, an operable device at said test board, a high resistance operable element in said testing trunk and arranged to operate in response to the operation of said operable device, a second and a third operable element in said testing trunk successively responsive to the restoration to normal of said operable device, said second operable element being effective, when operated, to connect said teletypewriter through said testing trunk to said engaged main trunk for transmission of call directing signals.

9. In a telegraph exchange system having a satellite communication arrangement, a central office, a switching center, a plurality of subscriber's lines connected to said switching center, a plurality of main trunks interconnecting said center and said central office, said central office comprising an operator multiposition switchboard and a multiposition test board, a three-conductor appearance for each of said main trunks at each position of said switchboard and one position of said test board, a three-conductor testing trunk at said test board and arranged for connection at said switchboard to any one of said main trunks, a teletypewriter connected at said test board to said testing trunk for sending call directing signals to said switching center, an operable device located in said testing trunk and arranged to operate in response to the initiation of a call at said test board to said switching center and to release in response to the completion of said call at said switching center, a second operable device arranged to operate and lock in an operated position in response to the operation of the first-mentioned operable device, a signaling element arranged to operate to one condition in response to the operation of the first-mentioned operable device and to another condition when the first-mentioned device is released during the time that said second operable device is in its locked position, said signaling element in said other condition, furnishing an indication that the switching center is ready to receive call directing signals for selecting the desired subscriber line.

10. In a telegraph exchange system having a satellite communication arrangement, a central office, a switching center, a plurality of subscriber lines connected to said switching center, a plurality of main trunks interconnecting said center and said central office, said central office comprising an operator multiposition switchboard and a multiposition test board, a three-conductor appearance for each of said main trunks at each position of said switchboard and a position of said test board, a three-conductor testing trunk at

said test board arranged for connection at said switchboard to any one of said main trunks, a teletypewriter removably connected at said test board to said testing trunk for sending call directing signals to said switching center, an operable device located in said testing trunk and arranged in response to a connection automatically established between one of said main trunks and one of said plurality of subscribers' lines by said call directing signals to operate to a steady condition, a signaling element located in said testing trunk and arranged in response to the operation of said operable device to a steady condition to change from a varying condition to a steady condition to indicate to a test board attendant that the desired subscriber line at the switching center has been selected and connected to said one main trunk in response to the call directing signals transmitted from said teletypewriter.

11. In a telegraph exchange system having a satellite communication arrangement, a central office, a switching center, a plurality of subscriber lines connected to said switching center, a plurality of main trunks interconnecting said center at said central office, said central office comprising an operator multiposition switchboard and a multiposition test board, a three-conductor appearance for each of said main trunks at each position of said switchboard and a position of said test board, a three-conductor testing trunk at said test board arranged for connection at said switchboard to any one of said main trunks, a teletypewriter removably connected at said test board to said testing trunk for sending call directing signals to said switching center, means responsive to the call directing signals from said teletypewriter for automatically connecting said one of said main trunks to one of said subscriber lines, a source of ringing current, switching means in said testing trunk for applying ringing current from said source to said automatically established connection of said one subscriber line, and a signaling element at said test board arranged to operate when the ringing current from said source is applied to the automatically established connection.

12. In a telegraph exchange system having a satellite communication arrangement, a central office, a switching center, a plurality of subscriber lines connected to said switching center, a plurality of main trunks interconnecting said center at said central office, said central office comprising an operator multiposition switchboard and a multiposition test board, a three-conductor appearance for each of said main trunks at each position of said switchboard and a position of said test board, a three-conductor testing trunk at said test board arranged for connection at said switchboard to any one of said main trunks, a teletypewriter removably connected at said test board to said testing trunk for sending call directing signals to said switching center, to select a desired subscriber line, an operable device located at said testing trunk and arranged in response to a connection being automatically established between one of said main trunks and one of said plurality of subscriber lines by said call directing signals, to operate to a steady condition, a second operable device arranged to operate and lock in an operated position in response to the operation of the first-mentioned operable device, an indicating signal and a source of alternating current arranged to be connected to said indicating signal when said second operable device operates whereby a flashing signal is furnished to in-

dicade that said automatically established connection is in a condition for telegraphic message communication, and a switching member for restoring said second operable device to normal.

13. In a telegraph exchange system according to claim 10, wherein each of said main trunks comprises a sleeve relay normally operated when its associated trunk is in a busy condition, interconnected make-busy jacks, an answer lamp signal, and means for maintaining the trunk busy during a busy condition when the sleeve relay is given an opportunity to release, and said testing trunk comprises switching means, a plurality of relays, one relay of said plurality having a relatively high resistance value and certain other relays of said plurality being normally operated during an established connection between said testing trunk and any one of said main trunks, means cooperating with one of said certain relays for normally maintaining the sleeve relay of said one trunk operated during the established connection between said testing trunk and said one main trunk, circuit means responsive to the operation of said switching means for releasing said certain relays successively, other circuit means responsive to the release of said certain relays for operating said relay of relatively high resistance value and a sleeve conductor circuit in said testing trunk and said one main trunk connected thereto effective during its open condition interval created between the time of the operation of said switching means and the complete release of the last operated of said certain relays, to operate said relay of relatively high resistance value and to afford the opportunity to release to said trunk sleeve relay, said busy means of said one trunk including relays cooperating with said make-busy jacks in busy condition to operate said answer lamp signal.

14. In a telegraph exchange system according to claim 10, wherein each of said main trunks comprises a make-busy jack, an answer lamp signal, a busy lamp signal, and means for maintaining the trunk busy when said trunk is in a busy condition, and said testing trunk comprises switching means, a plurality of relays, one relay of said plurality having a relatively high resistance value, and certain other relays of said plurality being normally operated during an established connection between said testing trunk and any one of said main trunks, means cooperating with one of said certain relays for maintaining the sleeve relay of said one trunk operated during the established connection between said testing trunk and said one main trunk, circuit means responsive to the operation of said switching means for releasing said certain relays successively, other circuit means responsive to the release of said certain relays for operating said relay of relatively high resistance value, and sleeve conductor means in said testing trunk and said one main trunk connected thereto effective during the open condition interval created between the time of the operation of said switching means and the complete release of the last operated of said certain relays to operate said relay of high resistance value and to release said trunk sleeve relay, and means in said one main trunk cooperating with said make-busy jack in busy condition, said busy means of said one trunk including relays cooperating with said make-busy jack in busy condition to operate said answer and said busy lamp signals, and restoring means responsive to the opening of the established connection at the subscriber line end for releasing, first, said answer lamp and then, after a predetermined interval, said busy lamp.

15. In a telegraph exchange system according to claim 10, wherein said one of said main trunks comprises means for connecting ground potential to one of the conductor circuits of said testing trunk when said established connection is opened at the subscriber line end of the established connection, to reoperate, in turn, said operable device and said signaling element whereby the flashing condition of said signaling element is changed to a steady condition to indicate that the telegraphic message communication is concluded, and means responsive to the removal of said testing trunk from one said main trunk for restoring the testing trunk and said one main trunk to normal.

16. In a telegraph exchange system according to claim 10, wherein each of said main trunks comprises a sleeve relay normally operated when its associated trunk is in a busy condition, interconnected make-busy jacks, an answer lamp and a busy lamp signal controlled by said make-busy jacks when in busy condition, and means for maintaining the trunk busy during the busy condition when the sleeve relay is given an opportunity to release, and said testing trunk comprises switching means, a plurality of relays, one relay of said plurality having a relatively high resistance value, and certain other relays of said

plurality being normally operated during an established connection between said testing trunk and any one of said main trunks, means cooperating with one of said certain relays for normally maintaining the associated sleeve relay of said one trunk operated during the established connection between said testing trunk and said one main trunk, circuit means responsive to the operation of said switching means for releasing said certain relays successively, other circuit means responsive to the release of said certain relays for operating said relay of high resistance value, a sleeve conductor circuit in said testing trunk and said one main trunk connected thereto effective during its open condition interval created between the time of operation of said switching means and the complete release of the last operated of said certain relays to operate said high resistance relay and to give an opportunity to release to said associated sleeve relay, a guard signaling element responsive to the operation of said high resistance relay, and circuit means in said one trunk responsive to the operation of said switching means for releasing said busy lamp signal said release being effected after a predetermined interval that said switching means remains in an operated position.

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