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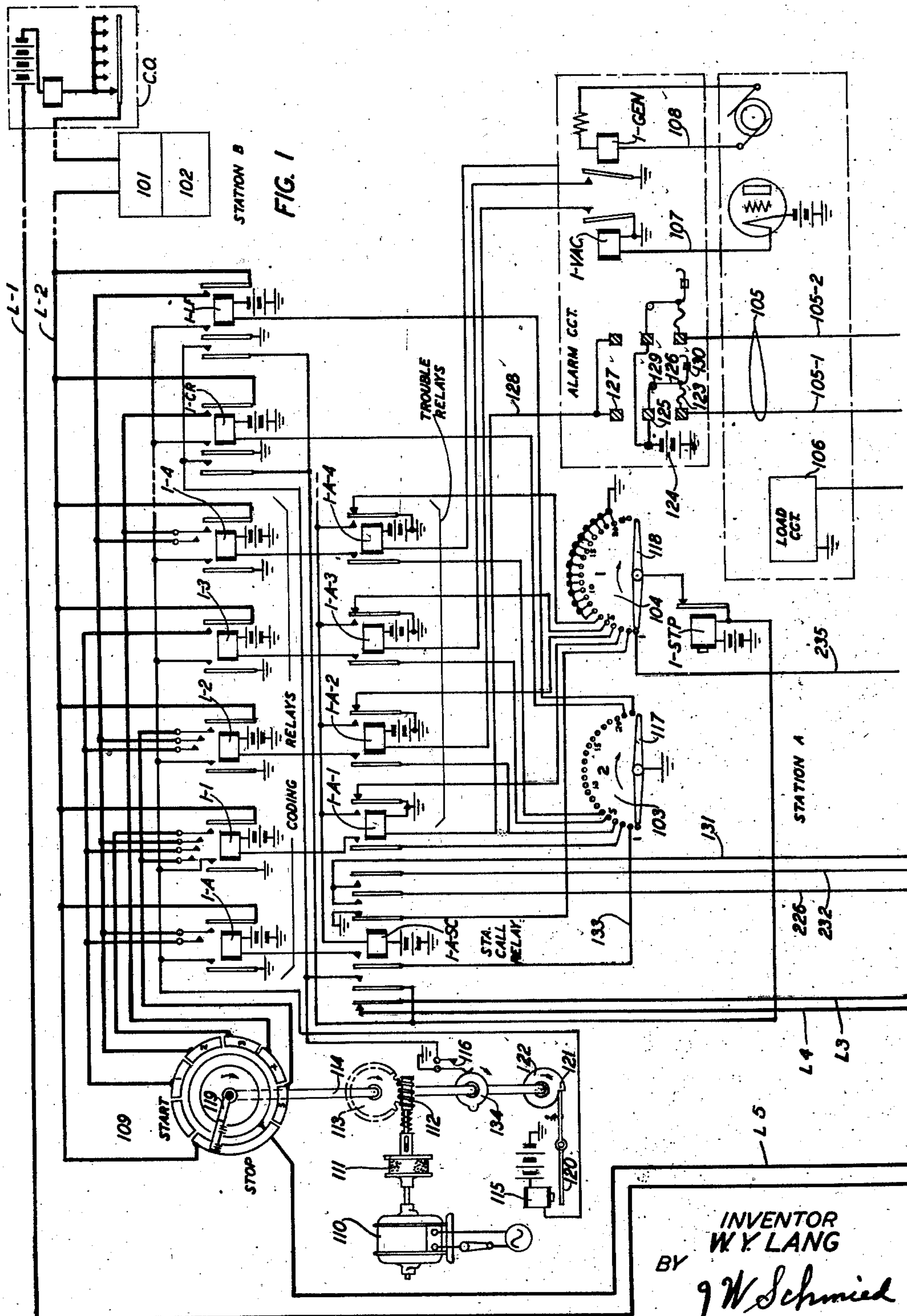
W. Y. LANG

2,424,571

TELEGRAPH ALARM SYSTEM

Filed Sept. 1, 1943

2 Sheets-Sheet 1



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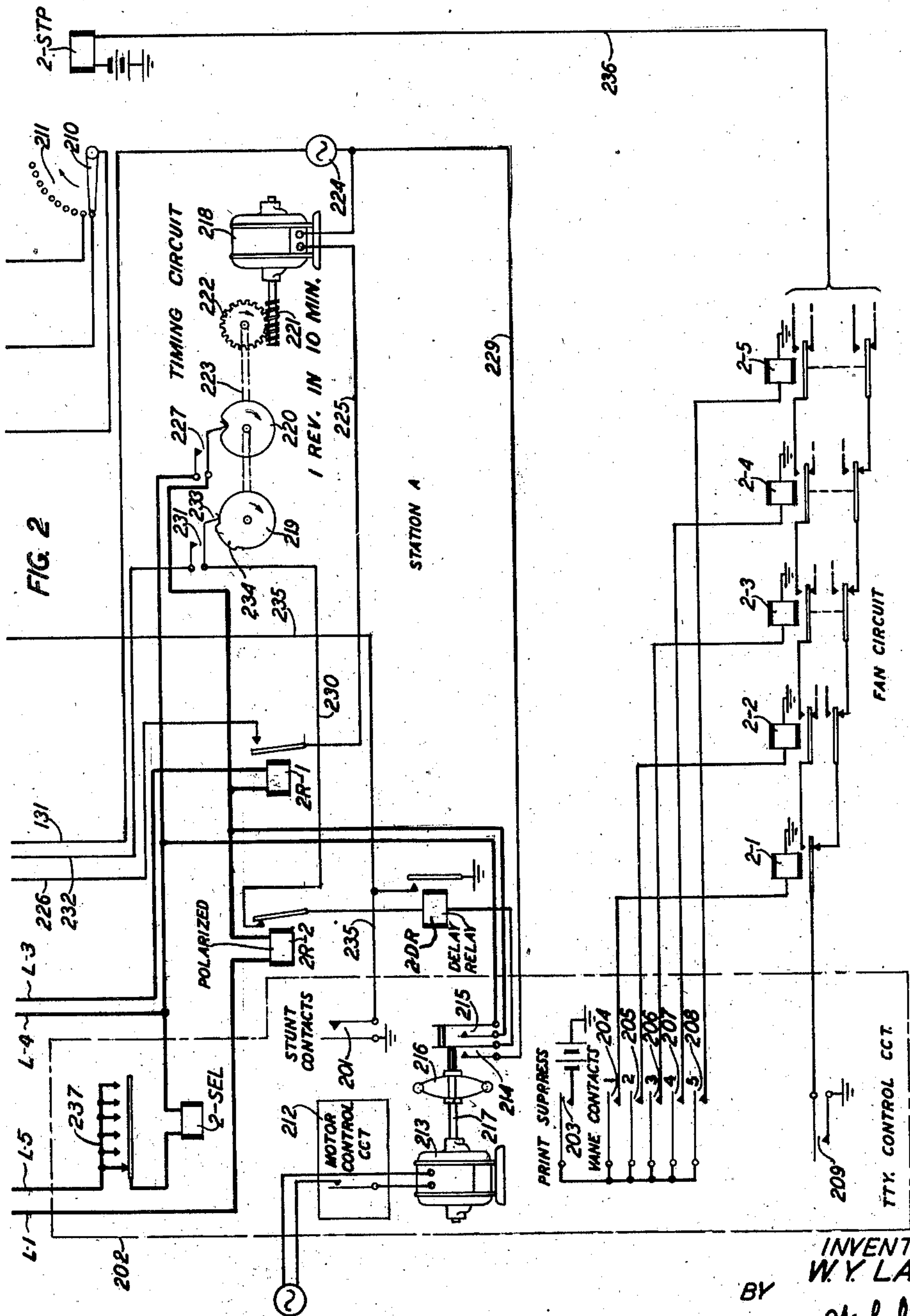
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UNITED STATES PATENT OFFICE

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TELEGRAPH ALARM SYSTEM

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This invention relates in general to trouble alarm signaling circuits adapted for use in teletypewriter communication systems and is particularly applicable to carrier current communication systems, unattended telephone repeater stations on metallic lines, unattended pumping stations in a pipe line system, substations on power transmission lines and other unattended stations in similar types of service.

An object of the invention is to record at an attended station or central office trouble that occurs in any one of a plurality of circuits at a distant point or station, and to correct it by means of permutation code signals transmitted from the attended station or central office.

According to the present invention there is provided at each of several unattended outlying stations (1) a plurality of permutation signal coding relays individually operable in response to the occurrence of a trouble condition, (2) a transmitting rotary distributor of the start-stop type, (3) a bulletin type of teletypewriter equipped with special facilities operable alternatively and selectively to perform printing operations or switching operations, the additional facility including a printing suppression feature and a set of selector vane controlled switching contacts for operating a fan circuit, and (4) means responsive to signals received from the attended central office for operating the selector vane controlled contacts to perform, by means of the fan circuit, switching operations for correcting trouble conditions such as the switching-in of spare fuses, spare vacuum tubes and other corrective operations. The occurrence of a trouble condition at any unattended station results in the transmission of motor start signals to start the teletypewriter motors at all stations in the system. Thereupon the outlying station transmits signals representing the identity of the station, and the identity of the trouble conditions which are recorded at all stations as well as at the central office. The outlying station also transmits carriage return and line feed signals to all stations and to the central office.

A feature of the invention is the automatic transmission from a distant unattended station or outlying point, of a series of alarm signals using teletypewriter characters to represent the several types of trouble.

Another feature is the provision of means to prevent two teletypewriter sending equipments at outlying points from sending signals automatically indicating trouble to the central office at the same instant.

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Another feature is the provision of means for recycling after a predetermined interval and re-sending of several alarms.

Another feature is the provision of means for starting the remote unattended station from a central attended point and causing the unattended station to send signals giving the type of trouble present or, if no type of trouble is present, to send a signal upon completion of the search indicating that the said signal has been received.

Another feature is the provision of means for correction of certain of the troubles at the unattended station by teletypewriter signals from the attended station or central office.

Another feature is the provision of communication line facilities between the unattended station and the attended station, or central office, when a trouble man is at the unattended station.

Another feature is the adaptation to a system herein disclosed of a telegraph printing and switching instrumentality in which the switching selections are additional to and substantially commensurate with the printing selection neither of which embraces substantially the full possibility of the signaling code employed.

A better understanding of the invention may be had from the following description and accompanying drawings of which:

Fig. 1 shows in part, the equipment in schematic at one of the outlying stations connected by means of a line circuit through a second outlying station to the central office, and

Fig. 2 shows the balance of the equipment in schematic at the first-mentioned outlying station.

The outlying station wherein the equipment is shown in schematic form in both Figs. 1 and 2, is referred to herein as station A and the second outlying station shown herein in diagrammatic form is referred to herein as station B.

The use of reference characters follows a plan. Thus all relays shown in each figure have reference characters consisting of numerals and letters, the numerals shown as prefixes corresponding to the number of the figure in which the particular relay is located. All other parts of the circuit are designated by numerals only, for instance, those parts of Fig. 1 are designated with numerals between 100 and 199, those in Fig. 2 are designated with numerals between 200 and 299 wherein the first, or hundreds, digit designates the figure in which the particular part is found.

Referring to Figs. 1 and 2, a line circuit com-

prising conductors L1 and L2 extends from the central office C. O. shown in diagrammatic form, through an outlying station B to the outlying station A. The equipment at station B is understood herein to be similar to that at station A. Other outlying stations similar to the station shown in schematic may be had in the system if desired.

The equipment shown in station A is arranged to record four different kinds of trouble in the circuit operation, although any reasonable number of trouble sources may be provided and recorded. To perform these functions there is provided a rotary selector switch comprising terminal banks 103 and 104 each having a number of terminals equal in number to the arrangements, or groups, of circuits wherein trouble might occur plus four, the four extra terminals on each of these banks being provided for purposes which will be hereinafter described. Should the switch banks be equipped with more terminals than desired the remaining terminals over the number of circuit groups provided, would be strapped to a ground connection, and the switch upon being operated to its last active terminal, would continue to operate over its grounded terminals to its starting, or normal, position. The rotary selector switch shown in Fig. 1 is arranged for twenty-two terminals. The terminals of bank No. 103 are arranged as follows: Terminal No. 1 is normal and is always open; terminal No. 2 is connected to the innermost left-hand armature of station call relay 1-A-SC; each of terminals Nos. 3 to 6 is connected to the left-hand armature of a trouble relay of relays 1-A-1, 1-A-2, 1-A-3 and 1-A-4; each of terminals Nos. 7 to 20 are shown open although one or more of these terminals may be connected to one or more other trouble relays if provided; terminal No. 21 is connected to the operating circuit for carriage return relay 1-CR; and terminal No. 22 is connected to the operating circuit for line feed relay 1-LF. Each of the trouble relays is provided for a group of circuits that may be considered as being of one type and therefore each of the trouble relays when operated record a distinct type of trouble. The terminals of bank 104 are arranged as follows: Terminal No. 1 is connected to the normally open stunt contacts 201; terminal No. 2 to the innermost righthand armature of station call relay 1-A-SC, the armature being normally closed to its back contact; each of terminals Nos. 3 to 6 is connected to the normally closed back contact and righthand armature of a trouble relay of relays 1-A-1, 1-A-2, 1-A-3 and 1-A-4; terminals Nos. 7 to 20 are shown connected to ground to permit the brushes of both banks 103 and 104 to return to their respective normal positions when the switch banks have more terminals than desired in the particular system; and terminals Nos. 21 and 22 are open. It is assumed that in a full capacity system there will be considerably more than four alarm circuits, shown herein, to be recorded.

Relay 1-A-SC is the station call relay and a corresponding relay will be furnished for each of the other outlying stations connected to the line, relay 1-B-SC for station B, relay 1-C-SC for station C and so forth. At each station there is a trouble relay for each group of circuits capable of giving an alarm and therefore these relays are provided to indicate trouble when trouble occurs. Of the trouble relays shown at station A, Fig. 1, relay 1-A-1 is connected to record trouble in the fuse alarm arrangement for

circuit group 105, each conductor 105-1, 105-2, and so forth, of which, may be connected in turn to the load circuit 106. Likewise relays 1-A-2 and 1-A-3 are connected to record trouble in the vacuum tube circuit 107 and generator set circuit 108, respectively. Relay 1-A-4 is provided for another type of trouble not shown.

Associated with the station call and trouble relays at each station are other relays, for example such other relays shown at station A which are relays 1-A associated with station call relay 1-A-SC and relays 1-1, 1-2, 1-3 and 1-4 are respectively associated with trouble relays 1-A-1, 1-A-2, 1-A-3 and 1-A-4. Relay 1-A, upon operating, sends out to each of the other stations and to the central office during the operation of start-stop rotary distributor 109 through one revolution, a signal in permutation code, corresponding to letter A to indicate that there is trouble at station A. Likewise each of relays 1-1, 1-2, 1-3 and 1-4, upon operating, send out a signal in permutation code, corresponding to the character, usually a numeral, to indicate the particular type of trouble that has occurred. Therefore there is a coding relay in the second-mentioned, or upper group, for each of the trouble relays such as relays 1-A-1, 1-A-2, 1-A-3 and 1-A-4.

Start-stop distributor 109 is driven by motor 110, through friction clutch 111, worm 112, worm gear 113 and main shaft 114. Start-stop rotary distributor 109 sends permutation code signals on a five-unit basis, but different from the standard start-stop distributor in that the length of stop segment is increased to provide sufficient time for stepping of the rotary switch comprising banks 103 and 104 and recycling of start magnet 115. The stepping of the rotary selector switch and recycling of the distributor are effected by means of contact set 116. Each closure of contact set 116 at the end of each revolution of the distributor causes the rotary selector switch to step each of its brushes 117 and 118, hereinafter referred to as wipers, one step under the control of stepping magnet 1-STP, the stepping of wiper 117 from one terminal to the next, deenergizing a coding relay formerly energized and energizing the next coding relay if trouble is present on the circuit associated with the next coding relay in question. The coding relays control start magnet 115 and when the selected relay of the coding relay group is deenergized magnet 115 becomes released and brush arm 119 is, therefore, stopped by means of armature lever 120 engaging projection 121 on cam 122 which is fixedly mounted on main shaft 114.

In Fig. 2 is represented within closure 202 a bulletin, or page, type of teletypewriter such as disclosed in W. Y. Lang's United States Patent 2,318,168, issued May 4, 1943. The teletypewriter is equipped with special facilities operable alternatively and selectively to perform printing operations or switching operations. The bulletin, or page, teletypewriter is ordinarily provided with a carriage, or type basket, which moves longitudinally on a cylindrical page-width platen for character spacing, and returns to a beginning-of-line position in response to an appropriate selective condition established by a received "carriage return" signal. In addition to the printing mechanism ordinarily provided, the teletypewriter represented within enclosure 202 is also provided with a switching control mechanism (not shown) which comprises a rockable cradle which supports a plurality of pairs of electrical contact

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5 springs spaced substantially in accordance with the spacing of the signal responsive selector vanes. Aligned with each of the pairs of electrical contact springs is a bell crank, one arm of which is in operative relation to its associated contact springs and the other arm of which is presented in the position occupied by an end portion of its associated selector vane when the vane is in marking position. Selectable mechanism is provided for causing the cradle which carries the sets of electrical contacts to be rocked by the function bail of the printer to cause the pairs of contact springs to rock their associated bell cranks toward the end of the selector vane. Those of the selector vanes that are in marking position interfere with rotation of the bell cranks and cause the further motion of the pairs of contacts to result in closure of the paths whereas those of the selector vanes that are presented in the spacing position do not interfere with the associated bell cranks and the bell cranks rock idly without effecting closure of their contacts. Electrical circuits controlled from the pairs of contacts establish switching conditions. The contact pairs controlled from the selector vanes are, in response to a received signal, open or closed in a combination corresponding to the received signal, the closed contact pairs being effective to operate relays in the fan circuit. The relays in the fan circuit, upon operating, extend a ground connection over a path for operating a device or instrumentality for effecting the desired correction in a circuit in which trouble exists. In Fig. 2 is shown part of the switching control mechanism and it includes a printing suppression contact pair 203, a set of selector vane controlled contact pairs 204 to 208, and a contact pair 209 for connecting, immediately following the establishment of a combination at contact pairs 204 to 208, ground to a circuit extended by means of the fan circuit to the device or instrumentality that when operated effects the desired correction. Contact pairs 203 and 209 operate on a sequence function such as shift, blank or a character selected, and are respectively provided to control from the remote central office, the stoppage of motor 213 and the connecting ground to the circuit for correcting trouble that exists. For a complete description of a bulletin, or page, type of teletypewriter wherein is incorporated the above-mentioned switching control mechanism, may be had by reference to Lang's Patent 2,318,168, supra.

In Fig. 1 of Lang's Patent 2,318,168, supra, the five contact pairs each comprising spring members 72 and 79 correspond to selector vane control contact pairs 204 to 208 in the present application, contact pair 127 corresponds to printing suppression contact pair 203, and spring member contact 133 corresponds to contact pair 209, the five relays designated 131 and provided for use in the fan circuit corresponds to relays 2-1, 2-2, 2-3, 2-4 and 2-5. In response to a particular signal these relays of the fan circuit operate in a combination whereby a circuit is completed to operate a device, such as stepping magnet 2-STP. Magnet 2-STP, upon operating, causes brush 210 to move one step to its next terminal in bank 211 of a rotary selector switch, which in the case shown herein, connects a new fuse to the load circuit 106. Other stepping magnets similar to magnet 2-STP may be provided for correcting other circuits in which trouble occurs. Each of the other stepping magnets is operated by a circuit closed by a different combination of operated and unoperated relays in the

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fan circuit, the different combinations being effected by other particular signals received in the printer. For a complete description of the teletypewriter motor control mechanism shown diagrammatically as in enclosure 212, reference may be had to United States Patent 1,904,164, granted to S. Morton et al. on April 18, 1933. As the teletypewriter motor 213 starts and comes up to speed, contact pairs 214 and 215 close due to the action of centrifugal governor 216 which is mounted on the motor shaft 217. The action of a centrifugal governor during operation is described in United States Patent 1,860,556, granted to J. H. Sole on May 31, 1932.

15 The teletypewriter control circuit comprises polarized relay 2R-2 which is always connected in the line circuit, relay 2R-1 which is connected in the line circuit during idle periods only, and not when alarm signals are being transmitted, a delay device 2DR such as a dash-pot relay having a solenoid, or plunger, in a mercury bath to give it a comparatively long time delay characteristic so that it requires a definite time to operate with alternating current applied continuously, but on short breaks of current immediately recycles to its fully released position, and a timing device comprising motor 218, a set of notched cams such as cams 219 and 220 driven by motor 218 through worm 221, worm gear 222 and shaft 223. Relays 2R-1 and 2R-2 are normally operated, as shown. The timing device serves to prevent repeated transmission of trouble conditions except at stated intervals as determined by the speed of rotation of the cam which is preferably one revolution in ten minutes. A suitable type of time delay relay having slow-operate and fast-release characteristics is well known in the art.

Method of operation

40 Assume that trouble occurs at an outlying point such as station A and that the indication of such trouble is caused by an excessive voltage in circuit 105-1 which includes fuse 123 whereby fuse 123 becomes burned out. Relay 1-A-1 is associated with the fuses in circuit group 105 and therefore when fuse 123 burns out a circuit is closed for operating relay 1-A-1 traceable from grounded battery 124, bus-bar 125, alarm spring 126 in its operated position in engagement with bus-bar 127, conductor 128, through the winding of relay 1-A-1 to ground and relay 1-A-1 operates. Fuse 123 is of the grasshopper type such as shown in United States Patent 2,148,542, granted to A. E. Dietz on February 28, 1939. The fuse element 123 holds under tension a coiled indicating spring 129 to which a glass bead 130 is attached, and a flat alarm spring 126. They are mounted on opposite sides of a fibre strip about 1 3/8 inch long and 1/2 inch wide and connected by fuse element 123, through a hole in the strip. When the fuse burns out both springs are released. The indicating spring gives a visible signal by the glass bead being out of its normal position and the alarm spring 126 makes contact with alarm bus-bar 127.

Relay 1-A-1, upon operating, closes at its right-hand armature and contact an operating circuit for station call relay 1-A-SC which now operates. When relay 1-A-SC operates its normally closed outermost left-hand armature and contact opens. Since this armature and contact are in the line circuit the line circuit now becomes open. The line circuit which is normally closed, extends from the positive pole of telegraph

battery at the central office, over conductor L—1, through the winding of relay 2R—2 and 2R—1, in series, over conductor L—3, outermost left-hand armature and contact of relay 1—A—SC, over conductor L—4, through the winding of selector magnet 2—SEL, transmitter contacts 237, over conductor L—5, center ring, brushes and stop segment of rotary distributor 109, over conductor L—2, through station B and the teletypewriter equipment at the central office to the negative pole of the telegraph battery. Relay 2R—1, the winding of which is in the line circuit and is normally operated, releases and closes at its armature and contact a circuit traceable from alternating current source 224, through the winding of motor 218, conductor 225, armature and contact of relay 2R—1, conductor 226, middle right-hand armature and contact of relay 1—A—SC, conductor 131 to the other side of source 224, and motor 218 starts. Motor 218 is arranged as hereinbefore stated to operate cam shaft 223 at a speed of one revolution in ten minutes, that is, it rotates slowly through one revolution and then stops. When motor 218 starts it rotates cams 219 and 220 through one revolution and contacts 227 associated with cam 220 close to reclose the line circuit.

The open line condition followed by a closed line condition operates the motor stop mechanism 212 of the teletypewriter and connects power to the teletypewriter as described in United States Patent 1,904,164, supra. The set of timer cam contacts 227 which close the line circuit also short-circuit relay 2R—1 which remains released, and the contact and outermost left-hand armature of relay 1—A—SC, the contacts which just opened the line circuit. As the teletypewriter motor 213 starts and comes up to speed, a set of centrifugal contacts 214 and 215 close. Contacts 214 close a circuit extending from one side of alternating current source 224, conductor 229, contacts 214, through the winding of delay relay 2DR, armature and contact of relay 2R—2, conductor 230, contacts 231 which are closed for the first part of the ten-minute interval wherein cam 219 completes one revolution, conductor 232, outermost right-hand armature and contact of relay 1—A—SC, conductor 131, back to the other side of source 224, and relay 2DR operates if current in the line circuit is not interrupted such as would be when teletypewriter signals are being transmitted. The other pair of centrifugal contacts 215 effects another closure of the line circuit, the path effecting the closure being parallel to that closed at contacts 227 which are closed for approximately the entire interval of the ten-minute duration of one revolution of cam 220; that is, while the spring member of contacts 227 rides over the unindented portion of cam 220. Therefore, as long as motor 213 is operating, the line circuit cannot be opened by the repetition of a trouble condition or the occurrence of a new trouble.

When delay relay 2DR operates it connects ground at its armature and contact to a circuit traceable over conductor 235, to terminal No. 1 of selector switch bank 104 and with selector switch wiper 118 normally in engagement with terminal No. 1 a circuit is extended over the contacts and armature and through the winding of stepping magnet 1—STP to grounded battery, and magnet 1—STP operates over its buzzing circuit one step to terminal No. 2. Upon reaching terminal No. 2 wiper 118 is connected to a path that extends to the innermost right-hand armature and contact of relay 1—A—SC, which

at this time is operated and therefore the buzzing circuit for magnet 1—STP is not completed and the brush 118 stops on terminal No. 2. Wiper 117, however, which steps in unison with wiper 118 comes to rest on its associated terminal No. 2 and thereby closes a circuit extending over conductor 133, innermost left-hand armature and contact of relay 1—AS—C, through the winding of relay 1—A of the coding group to grounded battery, to operate relay 1—A. Relay 1—A, upon operating, conditions at its right-hand armature and contacts, the line circuit which at this time is arranged to transmit in conjunction with rotary distributor 109 a combination of current impulses corresponding to the letter A, that is, impulses Nos. 1 and 2 are "current" or "closed" and impulses Nos. 3, 4 and 5 are "no current" or "open." Also relay 1—A, upon operating, closes at its left-hand armature and contact an obvious operating circuit for start magnet 115 which operates and attracts armature 120. The armature, upon being operated, is withdrawn from the projection 121 on cam 122 and the distributor 114 is driven by motor 110 through friction clutch 111, motor 110 being continuously operating when the start switch of its operating circuit is closed. Brush arm 119 of the distributor is caused to rotate once over its segments and the line circuit is thereby closed as its brush passes over segments Nos. 1 and 2, and opened as it passes over segments Nos. 3, 4 and 5. Brush of arm 119 then comes to rest on the stop segment. At a point shortly before the brush of arm 119 comes to rest contact 116 on cam 134 is momentarily closed to momentarily operate stepping magnet 1—STP. The release of stepping magnet 1—STP at this time steps wipers 117 and 118 to their respectively associated No. 3 terminals. Relay 1—A releases and opens the operating circuit for start relay 115 which releases. Wiper 117, upon engaging its terminal No. 3, closes a circuit traceable from ground, wiper 117 on terminal No. 3, left-hand armature and contact of relay 1—A—1, through the winding of relay 1—1 of the coding group to grounded battery. Relay 1—1 operates and closes the operating circuit for start magnet 115 and the brush of rotary distributor arm 119 again starts to rotate over the distributor segments to complete another revolution. This second revolution of the distributor arm causes to be transmitted over the line circuit a signal combination corresponding to the numeral 1, segment 1, 2, 3 and 5, in conjunction with the right-hand armature and contacts of relay 1—1 transmitting "current" or "closed" impulses and segment No. 4 transmitting a "no current" or "open" impulse. Therefore letter A and No. 1 are transmitted to the central office to indicate that trouble exists at station A, in the first circuit group which comprises circuit 105.

Should trouble occur in the second group of circuits which comprises conductor 107, relays 1—A—2 and 1—2, in addition to relay 1—A—SC, would operate, and the signals representing letter A and the number 2 would be transmitted. Likewise should trouble occur in the third group of circuits which comprises conductor 108, relays 1—A—3 and 1—3, in addition to relay 1—A—SC, would operate and the signals representing the letter A and the number 3 would be transmitted.

Should trouble occur at any one of the other outlying points, such as station B or C, the signal representing the letter B or C would be transmitted before the signal representing the number of the circuit group in which trouble occurs.

Near the end of the revolution of distributor arm 119 during which the No. 1 was transmitted to the line circuit, contact 116 is again closed to momentarily operate stepping magnet 1—STP to cause the wipers 117 and 118 to move to their respective No. 4 terminals. Relay 1—A—2 being unoperated at this time has a ground connection at its right-hand armature and back contact to momentarily operate the buzzing circuit for stepping magnet 1—STP and wipers 117 and 118 therefore move on to terminals No. 5. Likewise relays 1—A—3 and 1—A—4 being unoperated at this time the buzzing circuit of magnet 1—STP again operates to step wipers 117 and 118 first on to their No. 6 terminals and then on to their No. 7 terminals. Assume that at station A there are only four circuit groups in which trouble may occur in which event terminal No. 7 and those succeeding, except the last two, are connected to ground so that the stepping function of wipers 117 and 118 continues until the brushes reach the next to the last terminal. The next to the last and the last terminals on bank 103 are respectively connected to relays 1—CR and 1—LF. Relays 1—CR and 1—LF, upon operating, cause to be transmitted in conjunction with the segments of distributor 109, signals respectively corresponding to the "carriage return" and the "line feed" signal combinations. Upon the receipt of these combinations the central office is notified that a complete search of the controlled equipment at the outlying station has been made and remedial measures may then be taken to correct the recorded troubles in the event that these troubles are of a type which can be corrected from a distant point. The means for correcting these troubles will be hereinafter described.

As the timing motor 218 has been in operation since the closure of the contacts of relay 2R—1 following the operation of the station call relay 1—A—SC it will be noted in the circuit of contacts 231 on cam 219 that the slow-to-operate relay 2DR cannot again apply ground to terminal No. 1 on selector switch bank 104 until the timing cams 219 and 220 have made a complete revolution and contacts 227 on cam 220 open the path which serves during each revolution as a short-circuit around relay 2R—1. As hereinbefore stated it is assumed that the time for the complete revolution of timing cams is of the order of ten minutes. It is practicable, however, to make this time more or less, depending on the needs of the station and the installation of certain equipment therein. If, in the meantime, the trouble which caused the alarm has been cleared, the timing motor, upon rotation of the cams through 360 degrees, stops and the circuit is in condition for reporting another trouble call. The timing motor continues to operate until all troubles at the station are corrected.

If at any time including the interval when the timer is preventing a recycling operation on the trouble call, a central office attendant wishes to check for the condition of the controlled apparatus with respect to the remedial measures which have been taken, or with respect to other troubles which may have occurred, an upper case sequential combination which consists of three signals transmitted in turn, namely, "shift," "blank" and that corresponding to the desired station letter, is sent from the central office. This combination operates and closes momentarily stunt contacts 201 in the desired station teletypewriter. These contacts, upon closing, connect ground to conductor 235 which extends to

terminal No. 1 on selector switch bank 104 whereby the buzzing circuit of stepping magnet 1—STP operates to step wipers 117 and 118 to their respective No. 1 terminals. The No. 1 terminals are dead except when trouble occurs and the selector switch steps its wipers 117 and 118 around the complete arc sending only carriage return and line feed signals upon completion of its search, or moves to those points where there are troubles, sends the code signals for those troubles, and then moves to the next to the last and last terminals which complete circuits for sending carriage return and line feed respectively.

Correction

For the correction of certain of the types of troubles, for example, on a carrier system for stepping up the gain of an amplifier, cutting into the circuit a tube to replace a burnt-out tube, cutting into the circuit a fuse to replace a burnt-out fuse and other troubles of the type, there is provided a bank 211 of terminals associated with the selector vanes of a teletypewriter of the type disclosed in United States Patent 1,904,164, supra. The means of selecting these terminals on wiper 211, cutting them into the circuit and operating the brush for establishing connection to these terminals is described in Lang's Patent 2,318,168, supra. As set forth in Lang's Patent 2,318,168, the five vanes and their respectively associated contacts 204 to 208 are connected to a fan circuit and thus thirty-two combinations of contacts of the fan circuit relay contacts may be obtained to control thirty-two separate circuits. In addition to these thirty-two contacts which may be selected, it is also practicable to incorporate a contact associated with the teletypewriter of the transfer type, closing to one side in the "letters," or lower case, position, and to the other side in the "figures," or upper case, position. Thus, the number of circuits which can be controlled can be considerably increased. It is desirable, of course, in the selection of switching characters for a circuit of this type to avoid selection of characters which might accidentally cause a false operation due to a minor failure in the teletypewriter mechanism. One example of this might be the combination selected for motor control. Although this combination to stop the motor must always be preceded by a "blank" signal combination, it is reasonable to assume that due to the faults which may occur in any piece of mechanical apparatus, the sending of this combination, not preceded by a "blank" signal, might accidentally stop the motor.

As a means of correcting the trouble a rotary selector switch 211 having ten terminals is provided. An attendant at the central office or at any attendant station sends the "break" signal combination for rendering the teletypewriter inoperative in so far as printing and spacing is concerned and then sends a signal combination which is transmitted to the contacts controlling the fan circuit. As the circuit is closed through the fan circuit, ground is applied to the operating circuit for stepping magnet 2—STP on switch 211. Stepping magnet 2—STP operates and steps wiper 210 to its next or second terminal, the second terminal being connected to a path comprising conductors 105—2, for inserting a new fuse in the load circuit.

The operating circuit for stepping magnet 2—STP which comprises conductor 236 may be any one of the thirty-two separate circuits obtained through the operation of the relays in the

fan circuit. Another one of these thirty-two separate circuits may be extended to the stepping magnet of a second rotary selector switch similar to switch 211 whereby the second switch in stepping to the second terminal on each of several banks, connects a load circuit to the filament, grid and plate elements of a second vacuum tube, similar to the tube controlling relay 1—VAC assuming that tube has burned out and recorded its trouble at the central office. Likewise other of the thirty-two separate circuits may be used for substituting new apparatus for the apparatus that has developed trouble. For example, a second generator set may be substituted in place of the one controlling relay 1—GEN.

The fan circuit selected by the attendant at the distant station or central office may also serve to connect to a second point on a potentiometer for controlling the output gain of a load circuit. The release magnet of a rotary selector switch having ten terminals arranged in a 90 degree arc and similar to that shown in United States Patent 1,759,652, granted to F. S. Kinkad on March 10, 1931, could also be controlled by contacts of the fan circuit to facilitate reduction in output gain in those cases wherein the gain is too high. However, in the case of replacement, burnt-out apparatus such as tubes and fuses, when a maintenance attendant visits the unattended station and replaces the burnt-out material, is then returned to their No. 1 position by manual manipulation.

Preventing simultaneous transmission from unattended stations

The means for preventing simultaneous transmission from two or more unattended stations to the central office is under the joint control of delay relay 2DR and cam 219 of the timing device. The delay relay as hereinbefore stated requires a definite time to operate with alternating current applied continuously, but on short breaks of current resulting from signal impulses on the line circuit immediately recycles to its fully released position. Assume that the line circuit is seized by a trouble alarm circuit at station A, one of the unattended stations, relay 1—A—SC at station A operates and opens at its outermost left-hand armature and contact, the line circuit which also includes the winding of relay 2R—1, and relay 2R—1 releases. Relay 2R—1, upon releasing, closes the operating circuit for the timing circuit motor 218 and the motor operates for an interval of ten minutes, that is, until shaft 223 rotates through one revolution. Immediately after shaft 223 starts to rotate, cam 220 closes contacts 227 which remain closed for almost the entire ten minute interval, and the line circuit is again closed to short circuit relay 2R—1 and the outermost left-hand armature and contact of relay 1—A—SC. The opening of the line circuit for a short interval followed by a closed condition closes contacts in the motor control circuit 212 to start motor 213 of the station teletypewriter. When motor 213 comes up to speed, contacts 214 close a circuit extending from one side of alternating current source 224, conductor 229, through the winding of delay relay 2DR, closed armature and contact of relay 2R—2, contacts 231 which are now closed, that is, for the first part of the ten minute interval, conductor 232, outermost right-hand armature and contact of relay 1—A—SC, conductor 131, to the other side of source 224 and delay relay 2DR operates if the alternating current is not interrupted such as would be the case when

teletypewriter signals are being transmitted or received. The other pair of centrifugal contacts 215 effects another closure of the line circuit over a path that is parallel to the path closed at contacts 227. When delay relay 2DR operates, it connects ground at its armature and contact to a circuit for operating stepping magnet 1—STP and the magnet operates to step wipers 117 and 118 to the second contacts on their respective banks 103 and 104.

When relay 1—A—SC operated, it conditioned at its innermost left-hand armature and contact a circuit for operating relay 1—A and now when stepping magnet 1—STP operates its wiper 117 to the second contact on bank 103, a circuit is thereby completed from ground on wiper 117, through the winding of relay 1—A to grounded battery and relay 1—A operates in preparation for transmitting the teletypewriter signal combination for letter A to correspond to station A. Relay 1—A, upon operating, closes at its left-hand armature and contact, a circuit for operating start magnet 115 of the rotary distributor 109 and the distributor, upon operating, through one revolution, transmits to the line circuit the signal combination for letter A.

Relay 2R—2 is arranged to respond to the signal impulses transmitted over the line circuit. Delayed relay 2DR is arranged to release quickly and therefore releases when relay 2R—2 releases in response to the start impulse of the signal combination for letter A. Relay 2DR does not again operate until the beginning of next succeeding interval of ten minutes duration, that is, it cannot operate twice during the time that the raised portion 234 of cam 219 is in engagement with the lower spring of contacts 231 during a single revolution of cam shaft 223.

During the time that the line circuit is under the control of station A, the corresponding delay relay at each of the other unattended stations, such as station B, is in its released position due to teletypewriter signals being on the line circuit and the teletypewriter motors, corresponding to motor 213, at the other unattended stations are operated but without effect other than recording the characters corresponding to the signals transmitted from station A. Should, at the time signals are being transmitted from station A, a relay corresponding to relay 1—A—SC at any one of the other unattended stations become operated due to trouble in a circuit at such other station, the timing circuit motor at such other station will operate but also without effect because of the inability of delay relay 2DR to operate at this time, to thereby operate its respectively associated stepping magnet corresponding to stepping magnet 1—STP. Therefore, inasmuch as the wipers, corresponding to wipers 117 and 118 at such other station do not move off their respective normal contacts, no signals are transmitted from such other station.

In the event that troubles occur at exactly the same instant on circuits having corresponding positions in the order of sequence for transmission, at two or more unattended stations, which would be on very rare occasions, the incoming signals at the central office would be unintelligible and the central office attendant would take control of the line circuit by transmitting a "break" signal which stops transmission and operation at the station teletypewriters. A few minutes later, say 5 to 8 minutes after the "break" signal is transmitted and the line circuit is reclosed, the attendant transmits upper case sequential combinations of signals such as a "shift" signal fol-

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lowed by a "blank" signal and a character signal representing any one of the unattended stations such as stations A, B, etc. The upper case sequential signal combination, upon being received at the desired station closes the stunt contacts corresponding to contacts 201 at such station and as the wipers, such as wipers 117 and 118 at station A, reach their normal positions, the central office attendant is permitted, as hereinbefore stated, to check the condition of the control apparatus at the desired stations, each of the stations, in turn, being selected and those whereat the troubles occur being given the required remedy under the control of the central office attendant.

Should trouble occur at one or more stations after another station has control of the line circuit, each of the stations subsequently developing a trouble would have to wait until the troubles at the first station were automatically reported to the central office before being able to take control of the line circuit.

What is claimed is:

1. In a teletypewriter system for transmitting telegraphic messages, a station, a remote point, a channel interconnecting said station and said remote point, means for transmitting telegraphic messages over said channel, electroresponsive equipment at said station and a functioning element operably included therein, a substitute element, means in said equipment automatically operable when the first-mentioned element fails to function, for sending over said channel a permutative code to indicate at said remote point the trouble condition of the first-mentioned element, other means operable when telegraphic message signals are being transmitted over said channel for withholding the transmission of the trouble indicating signals until a predetermined interval after the message transmission is completed, electroselective means permutatively selectable according to various codes, a teletypewriter at said remote point, recording means and switching means included in said electroselective means respectively arranged to be selectively operated as desired, by signals in various codes incoming over said channel from said teletypewriter, and a selectably operable circuit responsive to the operation of said switching means for replacing with said substitute element in operative relation in said station in place of the first-mentioned element.

2. In a teletypewriter system for transmitting telegraphic messages, a plurality of stations, a channel interconnecting said stations, means at each of said stations for transmitting and receiving telegraphic messages to and from the other of said stations, the receiving means at certain of said stations comprising printing mechanism and switching mechanism with means for selecting either of said mechanisms in response to selecting signals incoming over said channel from the other of said stations, groups of circuit arrangements at each of said certain stations, means at said certain of said stations for automatically identifying trouble conditions in any one of said circuit arrangements at its own particular station, other transmitting means at said certain stations automatically operable under the control of said identifying means for transmitting signals to each of said stations to furnish thereat information as to the nature and location of said trouble condition as soon as the trouble occurs, other means operable during the transmission of a telegraphic message over said channel for withholding the transmission of

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the trouble indicating signals until a predetermined interval after the message transmission over said channel is completed, and means at said certain stations responsive to signals from the first-mentioned transmitting means at said other stations for automatically replacing the circuit arrangement in trouble condition at said one particular station.

3. A communication system comprising a plurality of outlying stations, a main station, a channel interconnecting said stations, a printing telegraph instrumentality at each of said stations for intercommunicating over said channel between said stations, means at each of said outlying stations for identifying trouble conditions at its own particular station, other means including a source of permutation code signals under the control of said means for automatically transmitting permutation code signals over said channel, receiving means included in said instrumentality at said main station and said other outlying stations for converting said transmitted permutation code signals into characters to record and indicate the nature and location of said trouble condition, and still other means interchangeably accessible with said converting means to said channel at each of said outlying stations and responsive to signals transmitted from the instrumentality at said main station for automatically effecting the necessary correction of said trouble condition at said particular station.

4. A communication system comprising a plurality of outlying stations, a main station, a channel interconnecting said stations, a printing telegraph instrumentality at each of said stations for communication between said stations over said channel, said instrumentality at each of said outlying stations comprising in addition to the printing mechanism a switching mechanism selectively operative from said instrumentality at said main station, means at each of said outlying stations for identifying any one of a plurality of trouble conditions at its own particular station, other means responsive to said means for automatically transmitting telegraph signals over said channel, receiving means included in each of said instrumentalities for converting and recording signals incoming over said channel to indicate the nature and location of said one trouble condition, and still other means in each of said outlying stations responsive to signals transmitted from said main station for selectively operating said switching mechanism at the instrumentality at the station whereat said one trouble condition occurs to correct for said one trouble condition.

5. A communication system comprising a main station, outlying stations, a channel interconnecting said stations, a plurality of circuit arrangements at each of said outlying stations, a printing telegraph instrumentality at each of said outlying stations, another printing telegraph instrumentality at said main station, means in each of said instrumentalities for providing communication between said stations, other means provided at each of said outlying stations and arranged to automatically respond to the occurrence of trouble conditions in any one of said circuit arrangements at its own outlying station, still other means provided at each of said outlying stations and responsive to the operation of said other means for transmitting permutation code signals indicating the trouble condition and the station at which the condition exists, and means included in said printing telegraph instrumentalities for recording characters repre-

sent the signals transmitted, and correcting means at said one station responsive to signals transmitted from the printing telegraph instrumentality at said main stations for correcting said trouble condition in the circuit arrangement at said one outlying station.

6. A teletypewriter system comprising outlying stations, a main station, a normally closed line circuit interconnecting said stations, a teletypewriter at each of said stations for communication between stations over said line circuit, a motor for each of said teletypewriters arranged to operate in response to a break for a brief interval in said normally closed line circuit, a plurality of circuit arrangements at each of said outlying stations, means at each of said outlying stations for automatically transmitting permutation code signals to the other of said stations whenever a trouble condition exists in any one of said circuit arrangements at its own particular outlying station, normally closed contacts at said outlying station included in said line circuit arranged to be maintained open during the operation of said means, timing cams, a motor arrangement for continuously driving said cams during the time that a trouble condition exists in any one of said circuit arrangements, normally open contacts on one of said cams arranged to reclose said line circuit at said one outlying station for the duration of one revolution of said timing cams whereby a break for a brief interval is effected in said line circuit, normally operated means arranged to release in response to the opening of said normally closed contacts to start the motor arrangement whereby the rotation of said timing cams is started, other normally open contacts on another of said cams arranged to close for an interval of comparatively short duration during each revolution of said cams, a time delay device responsive to the closure of said other normally open contacts only during the time that said teletypewriter motor is operating at high speed to cause said transmitting means to repeat said permutation code signals over said line circuit.

7. A teletypewriter system comprising outlying stations, a main station, a normally closed line circuit interconnecting said stations, a plurality of circuit arrangements at each of said outlying stations, means at each of said outlying stations for automatically transmitting over said line circuit permutation code signals to the other of said stations whenever a trouble condition exists in any one of said circuit arrangements at its own particular station, a teletypewriter and motor therefor at each of said stations connected in said line circuit for communication purposes, receiving means in said teletypewriter at each of said outlying stations comprising selectable switching means and printing means, both responsive at different times to permutation code signals incoming over said line circuit motor starting means in each of said teletypewriters at said outlying stations responsive to a start signal incoming over said line circuit, said start signal comprising an open condition for a brief interval followed by a closed condition in said line circuit, and selective means at each of said outlying stations responsive to the operation of said switching means for correcting for any trouble condition in a circuit arrangement at its own particular outlying station.

8. A teletypewriter system comprising outlying stations, a main station, a normally closed line circuit interconnecting said stations, a plu-

ality of circuit arrangements at each of said outlying stations, means at each of said outlying stations for automatically transmitting over said line circuit permutation code signals to the other of said stations whenever a trouble condition exists in any one of said circuit arrangements at its own particular station, a teletypewriter and a motor therefor at each of said stations connected in said line circuit for communication purposes, switching means and printing means in said teletypewriter at each of said outlying stations selectable in response to permutation code signals incoming over said line circuit motor starting means in each of said teletypewriters at said outlying station arranged to operate in response to a start signal incoming over said line circuit, said start signal comprising an open condition in said line circuit for a brief interval followed by a closed condition, a fan circuit responsive to the operation of the switching means of the teletypewriter at each said outlying station, an operable device responsive to a selectively operated path controlled by said fan circuit for correcting the trouble condition in said one circuit arrangement.

9. A teletypewriter communication system comprising a plurality of subscribers' stations, a central office, a normally energized line circuit interconnecting said stations and said central office, a teletypewriter and a driving motor therefor at each of said stations and said central office for communication between said stations and said central office over said line circuit, motor starting means included in each of said teletypewriters and responsive to the operation of a character or function key of any one of said teletypewriters for a slightly prolonged interval of time for starting the motor of its own teletypewriter, a printing mechanism and a switching mechanism included in each of said teletypewriters and arranged to be conditioned for operation interchangeably in response to certain permutation code signals transmitted from any one of said teletypewriters, groups of circuit arrangements at each of said stations, means at each of said stations for transmitting over said line circuit signals to the other of said stations and said central office whenever trouble is encountered by any one of said circuit arrangements, means at each of said stations and said central office for recording the information identifying the circuit arrangement in trouble and the station at which said troubled circuit arrangement is located, means in each of said teletypewriters for disabling the printing mechanism and causing said switching mechanism to be accessible to signals incoming over said line circuit in response to a permutation code signal transmitted from any one of said teletypewriters, a fan circuit having a plurality of paths selectively energized under control of said switching mechanism, a plurality of switching devices respectively controlled by said paths for automatically replacing troubled circuit arrangements at each said stations with operable circuit arrangements.

10. An electrical system comprising a control station and a subsidiary station connected by a transmission channel, a series of elements at said subsidiary station, the first element of the series being adapted to perform a given function in said subsidiary station, means whereby other elements of said series may be substituted, one at a time, for said first element to perform said function, automatic means operated by an inoperative condition of any one of said elements when

assigned to perform said function to send pulses to said control station selectively indicative of said fact, means operable under control of said control station, to send signals, means operative selectively under control of said signals to replace said one element with a substitute element of said series, an additional means whereby an inoperative condition of said substitute element may similarly cause to be sent pulses indicative of said fact to said control station, and means whereby said substitute element may be similarly replaced under control of pulses from said control station.

11. An electrical system comprising two or more outlying stations, a main station, a transmission channel interconnecting said stations, a series of elements at each of said outlying stations, a first element of the series at each of said outlying stations being adapted to perform a given function, means whereby other elements of each said series may be substituted, one at a time, for the first element of its own series to perform the given function of its series, automatic means at each of said outlying stations operative by an inoperative condition of any one of the elements of its series assigned to perform its given function to send to said main station pulses indicative of said inoperative condition and the location of said one element, and a slow-acting relay located at each of said outlying stations and operable at predetermined intervals of fixed duration during the normal, or idle, condition of said transmission channel for preventing simultaneous, and therefore interfering, sending over said channel intelligence indicative of the inoperative condition of elements at more than one of said outlying stations.

12. An electrical system comprising two stations, a transmission channel interconnecting said stations, a series of elements at one of said stations, the first element of the series being

adapted to perform a given function at said one station, means whereby other elements may be substituted, one at a time, for said first element to perform said function, automatic means operated by an inoperative condition of any one of said elements when assigned to perform said function, to transmit to said other station intelligence indicative of the inoperativeness of said element of said series when said element is substituted for use, means for repeating to said other station, at intervals, transmission of the intelligence so long as said inoperativeness remains, means under control of said other station for seizing said channel of transmission at the completion of any one interval, and means at said one station selectively responsive to signals incoming over said channel of transmission from said other station to substitute for use one of said other elements to perform said function.

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