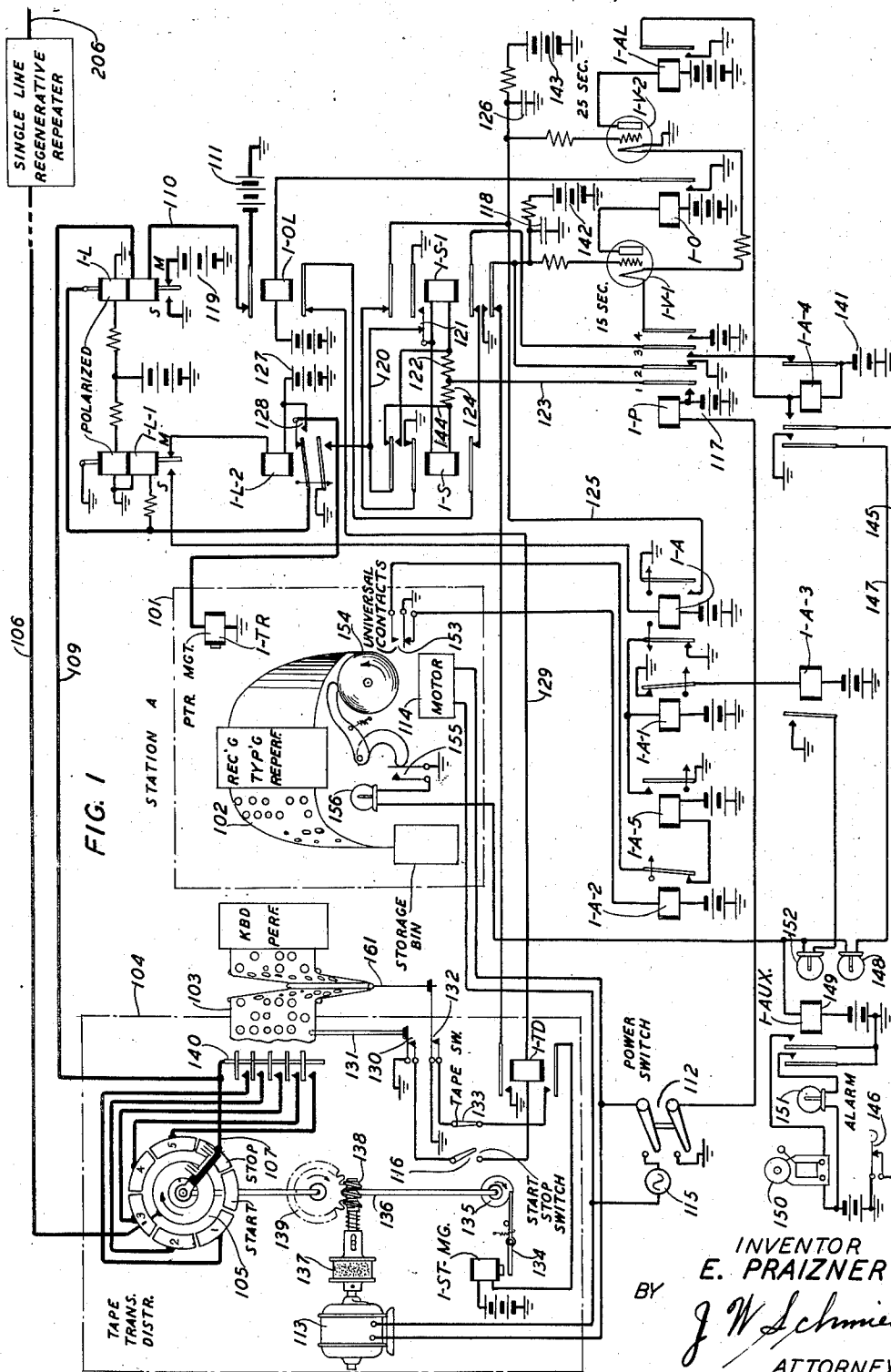


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TELEGRAPH SYSTEM PROVIDED WITH CHANNEL
ASSURANCE AND TRANSMISSION REGULATION
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TELEGRAPH SYSTEM PROVIDED WITH
CHANNEL ASSURANCE AND TRANS-
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This invention relates to an intercommunicating teletypewriter system, and more particularly to testing and alarm circuits for use therewith.

An object of the invention is to indicate to an attendant at one of a plurality of interconnected stations, by means of visual and/or audible alarms, whenever the system conditioned for operation fails to function in a satisfactory manner.

In a so-called half duplex arrangement in which operators at each terminus of a channel transmit by means of a keyboard and receive by means of either a printer or a printing reperforator, the operators take care of situations which result, in general, in simultaneous breaking or garbling of both operators' transmission. However, in a half duplex system with machine or automatic sending and either reperforator or printer receiving, the machine senders are unable to make immediate acknowledgement of messages or request resending. They also lack the ability (except as they are manipulated by attendants) possessed by operators to resend the part of a message lost as a result of a break signal, or, in general, to recognize that they are sending to an open line or to a station ineffective to receive, or except in case special break mechanism is provided, to recognize that the opposite station is at the time sending. These and other conditions have resulted in lost messages or parts of messages.

Therefore, an object of the invention is to prevent such undesired occurrences and to provide half duplex or equivalent channels of transmission and especially those provided with machine senders with equipment in part functioning in lieu of the intelligence of operators, by preventing sending where no sending should occur and by directing the attention of attending personnel to untoward circuit or apparatus conditions. In short, there is greater assurance of an operative circuit and such equipment may be styled circuit assurance equipment. From another aspect, the automatic equipment may be considered as keeping a constant watch upon the channel of transmission in the same manner as would the operator of a keyboard machine upon the channel giving her full attention to that channel.

From a generic standpoint, the object of the invention is to provide assurance against loss of messages by unobserved circuit failure.

According to the present invention an intercommunicating teletypewriter system is equipped with testing facilities automatically operable whenever (1) the line circuit interconnecting two

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stations and normally energized, is conditioned for operation, and (2) a connection established for message communication is discontinued and the system does not restore to its normal, idle condition wherein the line is energized and the interconnected stations are conditioned for operation and testing. This idle condition is also referred to herein as usable or closed condition. The testing facilities form a part of the normally energized line circuit and are directly operable by pulses therein, the effective pulses for operating the alarm equipment being, at least, slightly longer in duration than a teletypewriter character signal combination.

Among the features of the present invention is the provision of equipment for automatically indicating by visual and audible alarm signals (1) when a message is sent from one of the interconnected stations and not received at a remote station connected thereto, at which time the transmitter-distributor at the sending station automatically becomes disabled, (2) when the line circuit in its idle but usable condition fails, (3) when the power, or start, switch at a receiving station is not in its "on" position at the time the corresponding switch at the sending station is in its "on" position, (4) when the power switch at one station is operated to its "off" position, say at the close of a day's business, and the corresponding switch at another station connected in the system is not restored to its "off" position, (5) when a power switch at one of the interconnected stations is inadvertently operated to its "off" position during the course of a day's business, (6) when during transmission of a message any major electrical or mechanical difficulty occurs to affect the reception of the message at which time the transmitter-distributor at the sending station automatically becomes disabled. Another feature is the provision for preventing simultaneous sending from the stations at opposite ends of the interconnecting line circuit.

Another feature is the provision whereby after a call is initiated and no message transmitted, the interconnected stations of the system alternately have access to the interconnecting line for the purpose of transmission, each for a timed period during which period the transmitting device at the other station of those interconnected, is prevented from transmitting but the receiving device thereat can receive.

Another feature is the provision whereby either of the interconnected stations is prevented from sending messages when the other station for which the message is intended is unable to re-

ceive. In this manner loss of transmitted messages is prevented because the transmitter at the sending station becomes locked when any difficulty occurs which would prevent reception of the message.

Another feature resides in its use in a system comprising repeater stations in the line circuit interconnecting the transmitting and the receiving stations, whereby as soon as trouble is effective to prevent transmission to the receiving station, the locking of the transmitting device at either terminal of the interconnecting line circuit prevents the repeaters from "freezing," or locking, in their last operated positions.

This invention will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawings wherein:

Figs. 1 and 2 represent an intercommunicating teletypewriter system. Fig. 1 shows station A and Fig. 2 shows station B the stations being interconnected by a normally closed line circuit including a single line regenerative repeater at one or more intermediate points.

Referring to Fig. 1, station A comprises a typing-reperforator 101 for receiving messages both incoming and outgoing at station A by printing and perforating both the transmitted and the received messages on tape 102, and a transmitter-distributor 104 for translating outgoing message signal combinations of a second tape, such as tape 103, into coded signal current combinations for transmission over the five selective segments of a start-stop rotary distributor 105, to conductor 106 of the normally closed line circuit extending to station B. The typing-reperforator 101 may be of the type disclosed in C. W. Swan, United States Patent 2,308,554, issued January 19, 1943, and the transmitter-distributor 104 may be of the type disclosed in E. F. Watson, United States Patent 2,055,567, issued September 29, 1936. The translated signal combinations at station A are also transmitted over conductor 109 for causing the operation of printer magnet 1-TR provided for operating typing-reperforator 101 to produce a home, or local, copy of the message transmitted to station B.

Tape 103 may lead from a keyboard operated perforator (not shown) or from a reperforator (not shown) operated under control of a line (not shown) incoming to station A or it may be supplied manually with pieces of tape perforated with messages to be sent. Usually, however, the tape 103 will extend from a perforator or reperforator directly to the sensing head of the transmitter and tape stop arm 161 will stop the transmitter distributor 104 when the tape becomes taut. Corresponding elements of station B are arranged in a similar manner. The transmitter-distributors 104 and 204 are considered to typify any type of machine transmitters including those which have mechanical distributors as well as those which have segmental distributors.

Distributor 105, in its idle condition, connects conductor 106 to a circuit extending over its inner ring, brushes and stop segment, conductors 107 and 109, through the lower winding of repeater relay 1-L, conductor 110, back contact and upper armature of relay 1-OL, to grounded negative battery 111. Relay 1-L is one of two polarized relays, the other being relay 1-L-1, which are alternately operated in response to signals incoming and outgoing over the line circuit. Power, or start, switch 112 serves to start, in operation, motor 113 for transmitter-distributor

104 and motor 114 for typing-reperforator 101 as well as the station equipment at each of stations A and B. The operation of the station equipment is effective to make the "ready-for-service" test

at each station in response to the operation of the power switch at either of the stations. So-called station equipment at station A comprises in addition to relays 1-L, 1-L-1 and 1-OL, slow-to-release relay 1-L-2, and relays 1-S and 1-S-1. Also at station A are two time-delay, or timer, circuits comprising vacuum tubes 1-V-1 and 1-V-2, respectively arranged to become conductive in fifteen seconds and twenty-five seconds, and a group of alarm relays 1-A, 1-A-1, 1-A-2, 1-A-3, 1-A-4, and 1-A-5, for furnishing various alarm signals for the different tests that may be made as hereinafter described. Start-stop switch 116 and tape switch 113, when operated, jointly serve to condition rotary distributor 105 for operation.

In Fig. 2, station B comprises a typing-reperforator 201 for receiving at station B both incoming and outgoing messages and for both printing and perforating both the transmitted and the received messages on tape 202, and a transmitter-distributor 204 for translating each signal combination in another message perforated on a second tape, such as tape 203, into a coded signal current combination for transmission over the five selective segments of start-stop rotary distributor 205, to conductor 206, through one or more repeaters to conductor 208 of the normally closed line circuit extending to station A. The typing-reperforator 201 may be of the type disclosed in C. W. Swan, United States Patent 2,308,554, supra, and the transmitter-distributor 204 may be of the type disclosed in Watson 2,055,567, supra. Distributor 205 in its idle condition connects conductor 206 to a circuit extending over its inner ring, brushes and stop segments, conductors 207 and 209, through the lower winding of relay 2-L, conductor 210, contact and upper armature of relay 2-OL, to grounded positive battery 211. Relay 2-L is one of two polarized relays, the other being relay 2-L-1, which are alternately operated in response to signals incoming and outgoing over the line circuit. The translated signal combinations at station B transmitted over conductor 209 cause the operation of printer magnet 2-TR provided for operating typing-reperforator 201 to produce a home, or local, copy of the message transmitted to station A. Power switch 212 serves to start, in operation, motor 213 for transmitter-distributor 204 and motor 214 for typing-reperforator 201 as well as the station equipment at each of stations B and A. The operation of the station equipment at station B is effective to make "ready-for-service" tests at each station in response to the operation of the power switch at either one of the stations. The so-called station equipment of station B comprises in addition to relays 2-L, 2-L-1, and 2-OL, slow-to-release relay 2-L-2 and relays 2-S-1 and 2-S. Also at station B are two time-delay, or timer, circuits comprising vacuum tubes 2-V-1 and 2-V-2 respectively arranged to become conductive in fifteen and twenty-five seconds after ground connections are removed from their respective grid elements, and a group of alarm relays 2-A, 2-A-1, 2-A-2, 2-A-3, 2-A-4 and 2-A-5 for furnishing various alarm signals for the different tests that may be made as hereinafter described. Start-stop switch 216 and tape switch

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233, when operated, jointly serve to condition for operation rotary distributor 205.

A general description of the operation of the apparatus at stations A and B follows. Operation at stations A and B will be herein described as they alternately occur in response to (1) a call originating at station A and (2) a call originating at station B.

Station A

When station A is in its open condition, motors 113 and 114 are not operating, the filament circuits of the vacuum tubes 1—V—1 and 1—V—2 in the time delay circuits are not energized, the grid circuit of vacuum tube 1—V—1 is connected to ground at armature No. 2 of start relay 1—P and the grid circuit of vacuum tube 1—V—2 is connected to ground at the contact and inner upper armature of relay 1—S so that should the filaments of the two tubes become energized, the tubes will remain non-conducting since their respective grids are connected to ground.

Station B

Likewise when station B is in its open condition, motors 213 and 214 are not operating, the filament circuits of vacuum tubes 2—V—1 and 2—V—2 in the time delay circuits are not energized, the grid circuit of vacuum tube 2—V—1 is connected to ground at the outer lower armature and contact of relay 2—S—1 and the grid circuit of vacuum tube 2—V—2 is connected at armature No. 2 of relay 2—P so that should the filaments of the two tubes become energized, the tubes would remain non-conductive since their respective grids are connected to ground.

Station A

At the start of operations, the attendant at one of the stations, say station A, requests over an order wire that the power switch at station B be operated to its "on" position. When power switch 112 at station A, which like that at station B is in its "off" position, is operated to its "on" position, two circuits are closed, one at its upper contacts for connecting source 115 of alternating current to motors 113 and 114, whereby both motors start operating and the other at its lower contacts for connecting ground to the operating circuit for start relay 1—P whereby relay 1—P operates. Relay 1—P, upon operating, performs the following functions: (1) closes at its armature No. 4, a circuit whereby the filament circuit for vacuum tubes 1—V—1 and 1—V—2 becomes energized, (2) closes at its armature No. 3, a connection in a circuit for conditioning transmitter-distributor 104, that is, relay 1—TD, for operation, the latter circuit being capable of operating only after the transmitter-distributor start-stop switch 116 is operated to its closed position, (3) opens at its armature No. 2, the circuit connecting ground to the grid of vacuum tube 1—V—1 whereby the vacuum tube is free to become conductive and (4) connects at its armature No. 1, grounded battery 117 to a circuit having paths for operating relays 1—S—1 and 1—S but the latter relays do not operate until after vacuum tube 1—V—1 becomes conductive to cause the subsequent release of the normally operated slow-to-release relay 1—L—2 as will be herein-after described.

When ground at the No. 2 armature of relay 1—P was removed from the grid of vacuum tube 1—V—1, the potential at condenser 118 starts to and continues to rise and when such potential reaches a predetermined value, say after an in-

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terval of fifteen seconds, the vacuum tube becomes conductive and relay 1—O operates. Relay 1—O, upon operating, closes an operating circuit for relay 1—OL which operates to send to station B an open pulse, referred to herein as a test, or check, signal. Relay 1—OL, upon operating, opens the normally closed line circuit which extends through the lower winding of relay 1—L, the opening effected being for an interval of longer duration than that of a transmitted teletypewriter signal combination. Relay 1—L, under the influence of the biasing current flowing in its upper winding, operates, causing its armature to move from its right-hand, or marking, contact, to its left-hand, or spacing, contact. Relay 1—L, upon operating, away from its marking contact, disconnects grounded battery 119 from (1) the operating circuit for printer magnet 1—TR which momentarily releases and (2) the lower winding of relay 1—L—1 and relay 1—L—1, under the influence of the biasing current flowing in its upper winding, operates to cause its armature to move from its right-hand, or marking, contact, to its left-hand, or spacing, contact. Relay 1—L—1, upon operating away from its marking contact, opens the operating circuit for slow-to-release relay 1—L—2 which after an interval longer in duration than that of a teletypewriter signal combination, releases to connect ground at its outer lower armature to a back contact and thereby completes the operating circuit for relay 1—S—1 which operates. The latter circuit may be traced from ground at the outer lower armature and contact of relay 1—L—2, conductor 120, make-before-break contacts 121, through the winding of relay 1—S—1, resistance 122, conductor 123, armature No. 1 and contact of start relay 1—P, to grounded battery 117. The connection of ground at the outer lower armature and contact of relay 1—L—2 also closes a second circuit which, at this time, shunts the winding of relay 1—S, the shunting circuit being traceable over conductor 123, resistance 124, conductor 144, back contact and outer upper armature of relay 1—S, to the ground at the outer lower armature of relay 1—L—2.

Relay 1—L—1, upon operating, to its left-hand, or spacing, position, closes an operating circuit for relay 1—A which operates and connects ground through its contact and right armature, to conductor 125 to maintain vacuum tube 1—V—2 non-conductive after relay 1—S—1 operates. Relay 1—S—1, upon operating, performs the following functions: (1) closes at its inner upper armature and contact a locking circuit for itself and prepares an operating circuit for shunted relay 1—S which will not operate at this time, (2) removes ground at its outer upper armature and contact from the grid of vacuum tube 1—V—2 and condenser 126, but the substitute ground is maintained at the operated right-hand armature of relay 1—A to hold vacuum tube 1—V—2 non-conductive at this time, (3) at its inner lower armature and contact, causes another opening in the operating circuit for relay 1—TD and (4) connects ground at its outer lower armature and front contact to the grid of vacuum tube 1—V—1 and condenser 118, whereby vacuum tube 1—V—1 becomes inactive and therefore relays 1—O and 1—OL, in turn, release.

Relay 1—OL, upon releasing, causes the line circuit including the lower winding of relay 1—L to close and the line current then flowing through the lower winding of relay 1—L predominates over the biasing current flowing in the upper

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winding to thereby cause relay 1—L to operate back to its right-hand, or marking, position and relay 1—L—1 with current again flowing in its lower winding, likewise operates to its right-hand, or marking, position. Relay 1—L—1, upon operating to its marking position, (1) closes the operating circuit for slow-to-release relay 1—L—2 which reoperates to remove at its outer lower armature and contact the ground for the shunting circuit for relay 1—S which now operates, and to maintain closed at its inner lower armature and front contact the normally closed operating circuit for printer magnet 1—TR which is normally energized, and (2) opens the operating circuit for relay 1—A which now releases. Relay 1—S, upon operating, (1) transfers at its outer upper armature the lowermost contact of relay 1—L—2, from its back to its front contact, (2) disconnects at its inner upper armature and contact the ground connection from the circuit extending over the contact and outer upper armature of relay 1—S—1 to the grid of vacuum tube 1—V—2, whereby a timing interval for making vacuum tube 1—V—2 active begins, but is not necessarily completed unless a failure occurs, and (3) opens at its outer lower armature and contact another point in the operating circuit for relay 1—TD, the other point still open in the operating circuit for relay 1—TD being at the outer lower armature and contact of operated relay 1—S—1. Relays 1—S and 1—S—1 remain operated by means of the locking circuit for relay 1—S—1.

Station B

Switch 212 at station B, upon being operated to its "on" position, closes (1) at its upper contact a circuit for connecting source 215 of alternating current to the parallel paths extending to motors 213 and 214, respectively, (2) at its lower contact an operating circuit for start relay 2—P which operates. Relay 2—P, upon operating, performs the following functions (1) closes at its armature No. 4, a path for energizing the filament circuit of vacuum tubes 2—V—1 and 2—V—2, (2) closes at its armature No. 3 a connection in a circuit for conditioning the transmitter-distributor 204, that is, relay 2—TD, for operation, (3) removes at its armature No. 2 the ground connection from the grid of vacuum tube 2—V—2 and condenser 226 whereby condenser 226 may begin charging to a value sufficient to make vacuum tube 2—V—2 conductive, the interval of time required being 25 seconds or some other interval of time that may be determined, and (4) prepares at its armature No. 1 a circuit having operating paths for relays 2—S—1 and 2—S.

The open interval, or pulse, which originated through the operation of start switch 112 at station A as previously described, is received at station B over the line circuit which extends over conductor 106, middle ring, brush and stop segment of distributor 205, conductors 207 and 209, through the lower winding of relay 2—L, conductor 210, contact and upper armature of relay 2—OL, to grounded positive battery 211.

The open interval in the line circuit is effective to cause relay 2—L under the influence of the biasing current flowing in the upper winding, to operate and thereby move its armature from its right-hand, or marking, position, to its left-hand, or spacing, position. The armature of relay 2—L, upon being moved away from its marking contact, causes (1) printer magnet 2—TR to release for

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short interval of time as will be hereinafter described, and (2) relay 2—L—1 to be controlled by the biasing current in its upper winding and the armature of relay 2—L—1 moves from its right-hand, or marking, position to its left-hand, or spacing, position. Relay 2—L—1, upon operating to its spacing position, causes relay 2—A to operate and to thereby substitute ground for preventing the charging of condenser 226 at this time to maintain vacuum tube 2—V—2 non-conductive. Also relay 2—L—1, upon opening the connection between its armature and marking contact, permits slow-to-release relay 2—L—2 to release after an interval slightly longer in duration than a teletypewriter signal combination. Relay 2—L—2 upon releasing, (1) disconnects at its inner lower armature and contact, the armature of relay 2—L and substitutes grounded battery 227 at the make-before-break contacts 228 for causing printer magnet 2—TR to restore to its normally operated condition, (2) connects at its outer lower armature and contact a ground connection to a circuit having parallel paths one of which is traceable over conductor 220, make-before-break contact 221, through the winding of relay 2—S—1, resistance 222, conductor 223, armature No. 1 and contact of relay 2—P, to grounded battery 217 and the other is traceable over the outer upper armature and back contact of relay 2—S, conductor 244, resistance 224, conductor 223, to the same grounded battery 217. Relay 2—S is shunted by the latter path, and therefore does not operate at this time. Relay 2—S—1 operates and locks in a circuit traceable to ground at its inner upper armature and contact.

The ground connection for the locking circuit of relay 2—S—1 now prepares an operating ground for relay 2—S which as just stated does not operate at this time because of the shunting circuit to ground at the outer lower armature and contact of relay 2—L—2. Relay 2—S—1, upon operating, further functions to (1) connect in part at its outer upper armature and contact, a path to the grid of vacuum tube 2—V—2 to maintain the 25-second time delay circuit inactive; (2) closes in part at its inner lower armature, the operating circuit for relay 2—TD, which circuit when relay 2—S later operates, extends over the contact and lower armature of relay 2—S; and (3) removes at its outer lower armature and contact the ground connection from the grid of vacuum tube 2—V—1.

When the line recloses because of the release of relay 1—OL at station A, the line current then flowing through the lower winding of relay 2—L predominates over the biasing current flowing in the upper winding to thereby cause relay 2—L to return to its right-hand, or marking, position so that relay 2—L—1 with current again flowing in its lower winding, likewise returns to its right-hand, or marking, position. Relay 2—L—1, upon operating, to its right-hand, or marking, position (1) closes the operating circuit for slow-to-release relay 2—L—2 which now reoperates (a) to remove at its outer lower armature and contact, the ground connection from the shunting circuit for relay 2—S so that relay 2—S operates; and (b) to maintain closed at its inner upper armature and front contact the normally closed operating circuit for printer magnet 2—TR which is normally energized; (2) opens at its left-hand, or spacing, contact, the operating circuit for slow-to-release relay 2—A which now releases removing ground at its contact and right-

hand armature from the grid of vacuum tube 2-V-2.

Relay 2-S, upon operating, (1) prepares at its outer upper armature and front contact a path for shunting relay 2-S-1 when slow-to-release relay 2-L-2 again releases; (2) connects at its inner upper armature and front contact the ground connection to the grid of vacuum tube 2-V-2 whereby the tube is maintained non-conductive; (3) closes at its lower armature and contact, the operating circuit for relay 2-TD which operates providing start-stop switch 216 is in its "on" position. The attendant at station B now has access to the line for transmitting messages to station A.

However, if start-stop switch 216 is not in its "on" position, relay 2-TD will not operate to give transmitter-distributor 204 access to the line for message transmission purposes, and therefore no ground connections are at this time applied to the grid of vacuum tube 2-V-1. At the end of the fifteen second interval of no-grounded connection, vacuum tube 2-V-1 becomes conductive to operate relay 2-O and relay 2-OL is subsequently operated. Relay 2-OL, upon operating, opens the line circuit and an open pulse is thereby transmitted back to station A. The open pulse returned by station B causes relays 2-L and 2-L-1 to operate their respective armatures to spacing positions, as hereinbefore described. Relay 2-L-1, upon operating to its spacing position, causes (1) slow-to-release relay 2-L-2 to release; and (2) relay 2-A to operate. Relay 2-L-2, upon releasing at this time, completes the shunting path for relay 2-S-1, which releases, the shunting path having previously been prepared at the outer, upper armature and front contact of relay 2-S. Relay 2-S-1, upon releasing, (1) disconnects at its inner upper armature and front contact the original operating ground for relay 2-S but relay 2-S does not release because of the holding ground now connected at the outer lower armature and contact of relay 2-L-2; (2) opens at its inner, lower armature and contact, the operating circuit for relay 2-TD thereby locking-out the transmitter-distributor 204; (3) connects ground at its contact and outer lower armature to the grid of vacuum tube 2-V-1 which becomes non-conductive to cause the release of relays 2-O and 2-OL, in turn, and the return of relays 2-L and 2-L-1, in turn, to their normal, or right-hand, positions. Relay 2-OL, upon releasing, recloses the line circuit to end the open pulse transmitted to station A. Relay 2-L-1, upon returning to its normal, or marking, position permits relay 2-A to release and relay 2-L-2 to return to its normally operated position. Relay 2-L-2, upon returning to its operated position, removes at its outer lower armature and contact the holding ground for relay 2-S which now releases. Relay 2-S, upon releasing, connects a second ground at its inner upper armature and front contact to the grid of vacuum tube 2-V-1 to maintain tube 2-V-1 inactive.

The receipt at station B of message signals transmitted from station A, when station A has access to the line, operates relays 2-L and 2-L-1 accordingly and slow-to-release relay 2-A operates. The steady ground connection at the right-hand armature of relay 2-A, maintains vacuum tube 2-V-2 inactive. At the same time, vacuum tube 2-V-1 is maintained inactive by the normal ground connection restored by the release of relay 2-S-1. Relay 2-L-2 being of

the slow-to-release type does not operate in response to the message signals which are of short duration compared to the testing open pulses.

Station A

The receipt at station A of the return open pulse from station B operates relays 1-L and 1-L-1 to their respective spacing positions thereby operating relay 1-A and causing normally operated slow-to-release relay 1-L-2 to release. Relay 1-L-2, upon releasing at this time, closes at its outer lower armature and contact a circuit extending over outer upper armature and front contact of relay 1-S, resistance 122, conductor 123, armature No. 1 and contact of relay 1-P, to grounded battery 117 which circuit forms a shunt around the winding of relay 1-S-1 which releases. Relay 1-S-1, upon releasing, (1) closes at its outer upper armature and contact a circuit, in part, for making vacuum tube 1-V-2 non-conductive; (2) transfers, at make-before-break contacts 121, the operating path of relay 1-S to a holding path extending to ground at the contact and outer lower armature of relay 1-L-2; (3) closes at its inner lower armature and contact the operating circuit, in part, of relay 1-TD and (4) closes at its outer lower armature and back contact a circuit, in part, for making vacuum tube 1-V-1 non-conductive.

The reclosure of the line circuit due to the subsequent release of relay 2-OL at station B causes relays 1-L and 1-L-1 to move their armatures to their respective right-hand, or marking, positions and relay 1-L-2 subsequently reoperates. Relay 1-L-2, upon reoperating, (1) transfers at its inner lower armature and contact, the operating circuit of printer magnet 1-TR from grounded battery 127 to grounded battery 119, (2) removes at its outer lower armature ground from the holding path for relay 1-S which releases. Relay 1-S, upon releasing, (1) connects at its inner upper armature and contact the ground connection to the circuit previously closed, in part, at the outer upper armature and contact of relay 1-S-1 for making vacuum tube 1-V-2 non-conductive and (2) closes at its lower armature and contact the circuit for operating relay 1-TD when required, the latter operating circuit being traceable, when closed, from grounded battery at the armature and contact of relay 1-A-4, contact and armature No. 3 of relay 1-P, inner lower armature and contact of relay 1-S-1, contact and lower armature of relay 1-S, lower armature and contact of relay 1-OL, conductor 129, through the winding of relay 1-TD, switch 116 in its alternate, or operated, position, to ground at contacts 130 of sixth pin 131. The sixth pin 131 is normally in continuous engagement with the unperforated part of the moving tape 103 but should the tape breaks apart or its supply at transmitter 140 becomes exhausted, then pin 131 automatically moves in the direction that causes contacts 130 to open and thereby stops the rotation of the brushes of distributor 105.

Relay 1-TD, upon operating, closes at its lower armature and contact a circuit for operating start magnet 1-ST-MG, the circuit being traceable from ground at contacts 132, tape switch 133, contact and lower armature of relay 1-TD, through the winding of start magnet 1-ST-MG, to grounded battery. Relay 1-TD, upon operating, also connects at its upper armature and contact a ground connection to the grid of vacuum tube 1-V-1 and the tube is maintained non-

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conductive for the duration of the transmission of the message.

Magnet 1—ST—MG operates to withdraw pivoted lever 134 from engagement with the locking cam 135, and shaft 136 under the influence of motor 113, friction clutch 137, worm 138 and worm gear 139, starts rotating to move the brushes of distributor 105 over the distributor segments as well known in the art.

Stations A and B

The transmitter-distributor 104 is controlled by friction clutch 137, worm 138, gear 139, shaft 136 and stop cam 135; transmitter-distributor 204 is shown operated in a similar manner except that it is controlled by friction clutch 237, worm 238, gear 239, shaft 236 and stop cam 235. Typing reperforators 101 and 201 have motors which are running continuously from the time that their respective power switches are in their "on" positions but the perforating, printing and tape advancing operations are effective only when signals are being received by the printer magnet, such as that designated 1—TR at station A and 2—TR at station B.

Transmission of message

The message transmitted at station A causes relays 1—L and 1—L—1 to follow the signal impulses and relay 1—L—2 being of the slow-to-release type remains in its normally operated position during message transmission. Relay 1—L, upon following the signals, causes printer magnet 1—TR to operate accordingly and to thereby produce on tape 102 a home, or local, copy of the transmitted message. The transmitted message signal incoming at station B over the line circuit causes relays 2—L and 2—L—1 to follow the signals but relay 2—L—2 being of the slow-release type does not respond to the message signals. Accordingly, printer magnet 2—TR follows the signals repeated by relay 2—L to produce a copy of the message on tape 202. Relay 1—A at station A and relay 2—A at station B operate in response to the operation of relays 1—L—1 and 2—L—1, respectively, but being of the slow-release type do not release during the time the message is being transmitted over the line circuit. Ground is therefore maintained connected to the grid of each of vacuum tubes 1—V—2 and 2—V—2 to prevent their respectively associated 25-second time delay, or timer, circuits from operating. The ground at the upper armature of relay 1—TD, at this time in an operated position, is connected in a circuit extending over the back contact and outer lower armature of relay 1—S—1, at this time in a released position, to the grid of vacuum tube 1—V—1 and therefore the 15-second timer circuit at station A is prevented from operating during message transmission from station A. It will be noted that when station B is receiving the transmitter-distributor 204 is locked out by the open condition of the operating circuit for relay 2—TD.

Transmission of message—Station B to station A

The message transmitted from station B causes relays 2—L and 2—L—1 to follow the signal impulses transmitted by transmitter 240 during the time that distributor 205 is operating, but relay 2—L—2 being of the slow-release type, remains in its normally operated position. Relay 2—L, upon following the signals, causes printer magnet 2—TR to operate accordingly and to thereby produce in tape 202 a home, or local,

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copy of the message transmitted from station B, the copy being in both perforated and printed form. The transmitted message signals incoming at station A over the line circuit at which time distributor 105 is not operating, cause relays 1—L and 1—L—1 to follow the incoming signals, but relay 1—L—2 does not respond. Accordingly, the printer magnet 1—TR follows the signals repeated by relay 1—L to produce on tape 102 both the perforated and printed copy of the message. Relay 1—A at station A and relay 2—A at station B operate in response to the operation of relays 1—L—1 and 2—L—1 respectively, but being of the slow-release type do not release during the time the message is being transmitted and received over the line circuit. The ground connections at the right-hand armatures of relays 1—A and 2—A are maintained connected to the grids of vacuum tubes 1—V—2 and 2—V—2 to prevent their respectively associated 25-second delay, or timer, circuits from operating. The ground at the outer lower armature of relay 2—S—1, at this time in a released position, is connected to the grid of vacuum tube 2—V—1, and, therefore, the 15-second timer circuit at station B is prevented from operating during message transmission from station B. It will be noted that when station A is receiving, transmitter-distributor 104 is locked out by the open condition of the operating circuit for relay 1—TD.

Description of tests ready for service test

When it is desired to place the system in operation, the operation at either station A or station B is initiated by operating the local power, or start, switch to its "on" position and at the same time a request is made over an order, or call, wire to operate to its "on" position, the power, or start, switch at the opposite station. However, by prearrangement the start switches at the two stations may be operated at the same or substantially the same time. Also the single pole, single throw switches at each station, such as switches 116 and 133 at station A and switches 216 and 233 at station B, are operated to their respective closed positions, that is, if both stations are prepared to transmit messages.

Assume that the operator at station A initiates a call to station B, power switch 112 at station A and power switch 212 at station B are operated to their respective "on" positions. At station A power switch 112, upon being operated, closes (1) at its upper contacts a circuit for operating motors 114 and 115 and both motors start operating and (2) at its lower contacts, closes an operating circuit for relay 1—P which operates to start the functions of initiating the call to station B. Relay 1—P, upon operating, (1) closes at its No. 4 armature a circuit for energizing the filament circuit of vacuum tubes 1—V—1 and 1—V—2 which are now in condition for becoming conductive except for grounded grid elements, (2) closes at its No. 3 armature a circuit extending from grounded battery 141, right-hand armature and contact of relay 1—A—4, contact and armature No. 3 of relay 1—P, inner lower armature and contact of relay 1—S—1, contact and lower armature of relay 1—S, lower armature and contact of relay 1—OL, conductor 129, through the winding of relay 1—TD, start-stop switch 116 in its closed position if station A is prepared to transmit a message to station B, contact 130 to ground and relay 1—TD operates to make the transmitter-distributor 104 accessible to the line circuit extending to station B,

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(3) opens at its No. 2 armature the ground connection normally connected to the grid element of vacuum tube 1—V—1 and grounded battery 142, and condenser 118 therefore begins to charge to a value approaching the potential of grounded battery 142 and (4) prepares at its No. 1 armature a circuit extending over conductor 123 and then through parallel paths one extending through resistance 122, winding of relay 1—S—1, normally closed make-before-break contacts 121, to the open contact of the outer lower armature of relay 1—L—2, and the other extending through resistance 124, back contact and outer-upper armature of relay 1—S to the open contact of the outer lower armature of relay 1—L—2. However, the ground on the contact and upper armature of relay 1—TD in its operated position maintains inactive the vacuum tube 1—V—1 thereby preventing the 15-second timer circuit at station A from operating during the time that transmitter-distributor 104 is sending a message to station B.

Should the start-stop switch 116 be operated to the open position to resume the transmission of test signals from station A, relay 1—TD would release, removing the shunting ground at its contact and upper armature. After fifteen seconds, condenser 118 charges to a predetermined value that is sufficient to cause vacuum tube 1—V—1 to become conductive, or active, and relay 1—O consequently operates. Relay 1—O, upon operating, causes relay 1—OL to operate, thereby opening the line circuit, and locks out relay 1—TD, that is, it prevents transmitter-distributor 104 from operating. The opening of the line circuit by relay 1—OL allows the biasing current in the upper winding of relay 1—L to move the armature of the latter relay from its marking, or right-hand, contact to its spacing, or left-hand, contact and therefore grounded battery 119 is removed from the circuit of two parallel paths, one extending through the lower winding of relay 1—L—1 whereby relay 1—L—1 moves its armature from its marking, or right-hand, contact to its spacing, or left-hand, contact and the other extending over the inner lower armature and contact of relay 1—L—2 and through the winding of printer magnet 1—TR to ground whereby magnet 1—TR releases. Printer magnet 1—TR releases for a short interval of time, as will be hereinafter described, as soon as the armature of relay 1—L moves away from its marking contact. The removal of the armature of relay 1—L—1 from its marking contact, opens the operating circuit for normally operated slow-to-release relay 1—L—2 and after an interval of time having a duration slightly longer than that required for the transmission of a start-stop teletypewriter signal, relay 1—L—2 releases and thereby connects grounded battery 127 over the make-before-break contacts 128, to the operating circuit for the printer magnet 1—TR of the perforator 101 and the printer magnet 1—TR is restored to its normally operated condition, the interval of time during which printer magnet 1—TR is released being slightly longer than that required for the transmission of a start-stop teletypewriter signal.

Relay 1—L—1, upon moving into its spacing, or left-hand, position, causes alarm relay 1—A to operate and to thereby add another ground connection to the grid element of vacuum tube 1—V—2 and grounded battery 143. Vacuum tube 1—V—2 at this time is prevented from becoming

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conductive during the time that relay 1—A is operated.

Relay 1—L—2, upon releasing, closes at its outer lower armature the ground connection to the parallel paths hereinbefore described and relay 1—S—1 operates, but relay 1—S is shunted by conductor 144 and therefore does not operate immediately. Relay 1—S—1, upon operating, (1) connects at its outer lower armature and front contact the ground connection to the grid of vacuum tube 1—V—1 and grounded battery 142 whereby vacuum tube 1—V—1 returns to its non-conductive state and relays 1—O and 1—OL release, (2) closes at its inner upper armature and contact a locking circuit for itself and (3) opens at its outer lower armature and contact a second point in the operating circuit for relay 1—TD to maintain transmitter-distributor 104 in a locked-out condition. Relay 1—OL, upon releasing, recloses the line circuit and thereby causes both relays 1—L and 1—L—1 to return to their respective marking positions and relay 1—L—2 to its normally operated condition. Relay 1—L—1, upon returning to its marking position, causes relay 1—A to release and thereby removes the ground connection from the grid of vacuum tube 1—V—2.

Relay 1—L—2, upon reoperating, that is, returning to its normally operated condition, removes ground connection at its outer lower armature, from the shunt conductor 144 and relay 1—S now operates in a circuit traceable through the locking ground for relay 1—S—1. Relay 1—S, upon operating, opens another point in the operating circuit for relay 1—TD as an assurance against the transmitter-distributor 104 operating at this time. Therefore with relay 1—A released, and relays 1—S—1 and 1—S in their respective operated positions, ground connections are removed from the grid of vacuum tube 1—V—2 and condenser 126 is allowed to begin charging to a predetermined value from grounded battery source 143. In the event that the open pulse, or test signal, say of 0.326-second duration which is equal in time to two blank character signals, does not reach station B either because of a break in the line circuit, or that power switch 212 at station B is not moved to its operated, or "on," position, no open pulse will be received from station B and the failure to receive such line signal from station B allows condenser 126 to completely charge to the predetermined value, say in 25 seconds, whereby vacuum tube 1—V—2 becomes conductive to operate relay 1—AL. Relay 1—AL, upon operating, causes relay 1—A—4 to operate. Relay 1—A—4, upon operating, (1) opens at its right-hand armature and contact, the operating circuit for relay 1—TD and transmitter-distributor 104 thereby locks out of use, (2) closes at its inner left-hand armature and contact a locking circuit for itself, traceable over conductor 145, release key 146 to ground and (3) closes at its outer left-hand armature and contact a circuit traceable from ground, conductor 147, through lamp 148, through the winding of alarm auxiliary relay 149, to grounded battery and relay 149 operates. Relay 149, upon operating, closes, at its left-hand armatures and contacts, circuits for respectively operating audible alarm 150 and visible alarm lamp 151. Alarms 150 and 151 furnish a major alarm which indicates that the system is not "ready for service." At station B all the equipment does not operate in response to an incoming open pulse when switch 212 is in its "off" position. Only relays 2—L, 2—L—1 and

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2—A operate and relay 2—L—2 releases, these relays changing their positions for the duration only of the incoming open pulse. Slow-to-release relay 2—A, upon operating, opens at its left-hand armature and contact the operating circuit for the normally operated slow-to-release relay 2—A—1 which now releases and causes another normally operated relay, such as relay 2—A—3 to release. Relay 2—A—3, upon releasing, closes the operating circuit for lamp 252 and auxiliary alarm relay 249. Lamp 252 furnishes a visual signal to indicate that switch 212 is in its "off" position and relay 249 operates to respectively close the energizing circuits for signal lamp 251 and signal bell 250 both of which furnish additional indications that switch 212 is in its "off" position.

Assume that the operator at station B initiates a call to station A by operating power switch 212 to its "on" position, but that the power switch 212 at station A remains in its "off," or "normal" position. Power switch 212, upon being operated to its "on" position, starts motors 213 and 214 and closes an operating circuit for relay 2—P which operates. Relay 2—P, upon operating, (1) closes at its No. 4 armature and contact a circuit for energizing the filament circuit of vacuum tubes 2—V—1 and 2—V—2, (2) closes at its No. 3 armature and contact a connection in a circuit for conditioning relay 2—TD for the transmitter-distributor 204, (3) removes at armature No. 2 ground connection from the grid of vacuum tube 2—V—2 and (4) prepares at its No. 1 armature and contact an operating circuit for relay 2—S—1.

Also assume that power switch 212 at station A has not been operated to its "on" position or that the line is continuously opened so that no pulse is received from station A. The failure to receive at station B the pulse, say of 0.326-second duration, before the termination of the 25-second interval after ground is disconnected at the No. 2 armature and contact of relay 2—P causes condenser 226 to charge to its predetermined value to thereby allow vacuum tube 2—V—2 of the 25-second timer circuit to become conductive. The conductivity of vacuum tube 2—V—2 results in the operation of relay 2—AL. Relay 2—AL, upon operating, operates relay 2—A—4. Relay 2—A—4, upon operating, (1) disconnects at its right-hand armature and contact grounded battery 241 from the operating circuit of relay 2—TD and thereby transmitter-distributor 204 is locked out of use, (2) closes at its inner left-hand armature and contact a locking circuit for itself which may be traced over conductor 245, release key 246, to ground, and (3) closes at its outer left-hand armature and contact the operating circuit for auxiliary alarm relay 249 which circuit may be traceable from grounded battery, through the winding of auxiliary relay 249, lamp 248, conductor 247, to ground and relay 249 operates. Relay 249, upon operating, closes at its armatures and contacts parallel circuits for operating audible alarm 250 and visual alarm 251, respectively, which furnish the major alarm for failure to receive at station B the "ready for service" test signal.

When stations A and B are in an idle circuit condition, the line circuit is under continuous test for continuity. Thus, each station has, in turn, at regular recurring intervals should the line circuit remain in its idle condition, a definite time sequence for access to the line circuit for the transmittal of messages, during which period,

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if the line circuit becomes busy, the next "open" signal, or "ready for service" test, is cancelled. The duration of each interval of time wherein a station has access to the line circuit is equal in time to two blank character signals, or about 0.326 second.

Failure to restore the power switch to the "off" position

10 Failure to restore the power switch to the "off" position at either station A or station B will result in the operation of vacuum tube 1—V—2 timing circuit if the failure is at station A, or vacuum tube 2—V—2 timing circuit if the failure is at station B, thereby originating an alarm as hereinbefore described.

Machine trouble

If at any time during the reception of signals over the line circuit the typing reperforator at the receiving station should develop a major mechanical trouble and fail to operate properly, a visual and audible alarm as hereinbefore described would operate. The alarm circuits at stations A and B are identical and therefore a description of the operation resulting from the failure of the reperforator at station A will suffice for that resulting from the failure of the reperforator at station B. At station A when the line circuit is idle slow-to-release relay 1—A—1 normally holds relay 1—A—3 operated. Relay 1—A—2 is also normally held operated in the circuit extending through ground at the normal closure of universal contacts 153 of the typing reperforator 101. On receipt of the incoming message relay 1—A will eventually operate and remain operated during the reception of the message signals. The operating circuit for relay 1—A—1 which is of the slow-to-release type will therefore be opened and this relay will tend to release. Universal contacts 153 which operate to their alternate, or upper, contact after the perforation of each signal combination in tape 102, will be alternately removing ground from their normal, or lower, contact and connecting ground to their alternate, or upper, contact. Relay 1—A—2 which is also of the slow-to-release type, is maintained in its operated condition from the operating universal contacts 153 and on successive operations of universal contacts relay 1—A—5 will operate over the operated contact of relay 1—A—2. When relay 1—A—5, which is also of the slow-to-release type, operates it will in turn maintain relay 1—A—1 operated, thereby holding relay 1—A—3 in its normally operated position. Should the typing reperforator 101 cease to operate universal contacts 153 would stay in a fixed position on either the upper or lower contact and subsequently either one of the slow-to-release relays 1—A—2 and 1—A—5 together with slow-to-release relay 1—A—1 would release, thereby causing relay 1—A—3 to release. Relay 1—A—3, upon releasing, causes the audible and the visual alarm to operate in an obvious manner.

"Tape-out"

The tape supply reel for each of the reperforators is provided with a contact device which causes contacts to close a circuit for lighting a lamp and for causing to close another circuit for operating an audible alarm and lighting second lamp, in case the supply of tape for the respectively associated reperforator becomes low or exhausted, thus indicating to the attendant that it is necessary to provide an additional supply reel

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of tape for the reperforator whereat the supply is low. For example, if the supply of tape on reel 154 becomes low or exhausted contacts 155 will close and complete an obvious circuit for lighting lamp 156 and operating relay 149. Relay 149 operates and as hereinbefore described, closes circuits for lighting lamp 151 and ringing bell 150 to furnish the necessary alarm or indication. The lighting of lamp 156 indicates the source of trouble.

What is claimed is:

1. A channel of impulse transmission having two stations intertransmissably related thereto, each having sending means capable of impressing impulses upon said channel and means capable of receiving impulses transmitted by the sending means at the far station in combination with means operable, when neither of said sending means is so impressing impulses upon said channel, repeatedly to send test signals back and forth over said channel at frequent intervals, and means operable by failure of a test signal to arrive to indicate the defective condition of the channel.

2. A channel of impulse transmission with reciprocally operating, sending and receiving mechanisms at the terminals thereof for sending backward and forward over said channel a series of test signals, with means immediately responsive to a complete test signal incoming over said channel for conditioning the mechanism receiving the completed test signal to send another complete test signal over said channel in the opposite direction, and means for automatically repeating said reciprocal operation at regularly recurring intervals.

3. A telegraph system comprising a channel of transmission having associated therewith two automatic storage transmitters at geographically separated points, each of said transmitters having a start switch, an automatically operating timing means at each point, and means at each of said points operative in response to the operation of its local one of said timing means for controlling the other of said timing means over said channel whereby first one and then the other of said transmitters is given access to said channel upon the completion of one or more messages transmitted successively over said channel when its start switch is closed.

4. A telegraph system comprising a channel of transmission having associated therewith two automatic storage transmitters at geographically separated points, an automatically operating timing means at each point, each of said operating timing means includes other means for sending over said channel in one direction an impulse at regularly recurring intervals of time, each of a predetermined duration, circuit means at one of said points responsive to the completion of an impulse sent from the other of said points for automatically seizing said channel for message transmission to the other of said points, other circuit means at the other of said points responsive to the completion of an impulse from said one point for automatically seizing said channel for message transmission to said one point.

5. A telegraph system comprising a channel of transmission having associated therewith two automatic storage transmitters at geographically separated points, an automatically operating timing means at each point, said operating timing means including means operable at regularly recurring intervals of time only at such times as when no message signals are being transmitted in

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either direction over said channel or prepared for transmission, to send a test signal intermediate other test signals received from the other separated point, means operable at the above-mentioned times to alternately lock said transmitters against transmission of message signals, and other means controlled by each of said timing means during the locked out intervals of its associated transmitter for preventing the reception of message signals.

6. A telegraph system comprising a channel of transmission having associated therewith two automatic storage transmitters at geographically separated points, each said transmitter having a start switch, automatically operating timing means at each point, each said means controlling the other over said channel whereby first one and then the other of said transmitters is given access to said channel if its start switch is closed, and means operative by one of said transmitters seizing said channel during a period wherein it has access to said channel to suspend operation of said timing means during the continuance of transmission by the seizing transmitter.

7. A telegraph system comprising a channel of transmission having associated therewith two message signal transmitters at geographically separated points, each said transmitter having a start switch, a plurality of automatically operating timing means of different operating time intervals at each separated point, one timing means at each point having means for controlling its associated timing means of different time interval at the local point and said plurality of timing means at the distant point, test signaling means at each separated point responsive to the operation of its local said one timing means for alternately transmitting over said channel at recurring intervals a test signal, test signaling means including means operable depending upon the duration of operation of its local said one timing means for allowing its local one of said transmitters to seize for a predetermined interval of time the channel for message signaling purposes, other operable means responsive to a test signal incoming over said channel for releasing the local said one timing means and locking out said local one transmitter, still other means responsive to the release of said operable means for causing the local operating timing means of said different operating time to start operating, and alarm means responsive to the complete operation of said local operating timing means of said different operating time for indicating that trouble exists in the system.

8. A signal transmission system comprising a plurality of stations, message sending and message receiving means at each of said stations, an impulse transmission channel interconnecting said stations, each of said stations having test signal sending means for impressing open impulses on said channel alternately as between said stations at regularly recurring intervals of time and test signal receiving means for receiving said open impulses transmitted over said channel from the other of said stations when said message sending means at both of said stations are idle, and alarm means automatically operative when said channel remains closed for a prolonged period of time to indicate a defective condition of said channel.

9. A signal transmission system comprising a plurality of stations, a transmission channel interconnecting said stations, transmitting and distributing means at each of said stations for trans-

mitting messages over said channel, means at each of said stations for receiving messages transmitted over said channel from another of said stations, means for automatically transmitting test signals over said channel, first from the call originating one of said stations and then from the call terminating one of said stations during the time that the transmitting and distributing means at the call originating station is idle but in a condition for transmission over said channel, and means for disabling the transmitting and distributing means at said call originating station when a test signal transmitted in either direction over said channel is not received.

10. A signal transmission system comprising a plurality of stations, a transmission channel interconnecting said stations, transmitting and distributing means at each of said stations for transmitting messages over said channel, means at each of said stations for receiving messages transmitted over said channel, a switch at each of said stations for conditioning for operation its local one of said transmitting and distributing means, means for automatically transmitting test signals over said channel, first from one of said stations and then from the other of said stations during the time that said switches are in their operated condition, and means at each of said stations responsive to a test signal incoming over said channel when the switch at one only of said stations is not in its operated position, for indicating that said one only switch is not in its operated position.

11. A signal transmission system comprising a plurality of stations, a transmission channel interconnecting said stations, transmitting and distributing means at each of said stations for transmitting messages over said channel, means at each of said stations for receiving messages transmitted over said channel, a switch at each of said stations for conditioning for operation its local one of said transmitting and distributing means, means for automatically transmitting test signals over said channel, first from one of said stations and then from the other of said stations during the time that said switches are in their "on" positions, and means at each of said stations responsive to a test signal transmitted from one of said stations when the switch at said one station is not returned to normal at the time the switch at the other of said stations is restored to normal, for indicating that said switch at said one station is in its off-normal position.

12. A signal transmission system comprising a plurality of stations, a transmission channel interconnecting said stations, transmitting and distributing means at each of said stations for transmitting messages over said channel, means at each of said stations for receiving messages transmitted over said channel, a switch at each of said stations for conditioning for operation its local one of said transmitting and distributing means, means for automatically transmitting test signals over said channel, first from one of said stations and then from the other of said stations during the time that said switches are in their "on" positions, and means at each of said stations responsive to a test signal automatically transmitted during transmission of a message when one of said switches is inadvertently restored to normal to give an indication that said one switch is in its "off" position.

13. A signal transmission system comprising a plurality of stations, a transmission channel interconnecting said stations, transmitting and dis-

tributing means at each of said stations for transmitting messages over said channel, means at each of said stations for receiving messages transmitted over said channel, a switch at each of said stations for conditioning for operation its local one of said transmitting and distributing means, means for automatically transmitting test signals over said channel, first from one of said stations and then from the other of said stations during the time that said switches are in their "on" positions, and means responsive to any defect in the electrical and/or mechanical operation of any one of said transmitting and distributing means and/or receiving means, effective to interfere with the transmission of said messages in either direction, for automatically disabling said transmitting and distributing means at the sending station.

14. A signal transmission system comprising a plurality of stations, a transmission channel interconnecting said stations, transmitting and distributing means at each of said stations for transmitting messages over said channel, means at each of said stations for receiving messages transmitted over said channel, a switch at each of said stations for conditioning for operation its local one of said transmitting and distributing means, means for automatically transmitting test signals over said channel, first from one of said stations and then from the other of said stations during the time that said switches or in their "on" positions, and means controlled by said means for automatically transmitting test signals for preventing simultaneous sending from said plurality of stations.

15. A signal transmission system comprising a plurality of stations, a transmission channel interconnecting said stations, an operable switch at each of said stations for conditioning said system for operation, time delay means located at each of said stations and each arranged to be conditioned for operation in response to the operation of its locally associated switch, energy storing elements in each of said time delay means for providing a predetermined distinctive time interval before the effective operation of each of said delay means occurs, a test signal transmitting means at one of said stations effective to transmit a test signal of a definite time duration over said channel in response to the effective operation of its locally associated time delay means, other time delay means located at each of said stations and each arranged to be conditioned for operation in response to the operation of its locally associated switch, energy storing elements in each of said other time delay means, having a predetermined distinctive time interval before the effective operation of each of said other time delay means occurs, electromagnetic means at the other of said stations effective in response to the test signal incoming over said channel to prevent the operation of the first-mentioned time delay means at said other station, other test signal transmitting means at the other of said stations effective to transmit a return test signal of a definite time duration over said channel subsequent to the reception of the first-mentioned test signal, the second-mentioned test signal transmitting means being operative in response to the operation of one of said other time delay means at the other of said stations, other electromagnetic means at said one station effective in response to the second-mentioned test signal incoming over said channel to prevent the operation of the second-mentioned time delay means

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at said one station, and alarm means at each of said stations operative in the event that the test signal incoming over said channel is not received at the particular station to indicate that the system is not functioning satisfactorily.

16. In a communication system, a plurality of stations each provided with an impulse transmitter and an impulse controlled receiver, a channel of impulse transmission for interconnecting said stations for two-way communication, one way at a time, test signal sending means at each of said stations for impressing open impulses on said channel at regularly recurring intervals, test signal receiving means for receiving said open impulses transmitted over said channel from the other of said stations when message sending means at both of said stations are idle, means under control of the test signal sending means at both stations for permitting the test signal sending means at said stations to alternately transmit an open impulse over said channel and other means responsive to an off-normal condition of said channel, such as remaining continuously closed or continuously opened, for furnishing an alarm at all of said stations.

17. A channel of transmission provided at each terminus with means for sending message signals or check signals, means operative to time a period following the last transmission of either of said types of signal, and means operative dependent upon non-reception of any signal within the period to lock in a trouble condition.

18. A channel of transmission provided at one end with a transmitter operating under control of stored message signals supplied at intervals as they become available, means operative to initiate transmission from said transmitter, timing means operative at the end of said transmission to time a given period of time, pulse sending means automatically operative at the end of said period of time for sending an additional signal of comparatively long duration, a second transmitter operating under control of stored message signals as they become available and arranged for connection to the opposite end of said channel, means at said opposite end of said channel responsive at the completion of said additional signal incoming at said opposite end for giving said second transmitter access to said channel for transmitting its stored message signals as they become available to said one end, other timing means at said opposite end operative at the end of transmission from said second transmitter to time a given period of time, pulse sending means at said opposite end automatically operative at the end of the second-mentioned period of time for sending to said one end a reply additional signal equal in duration to the first-mentioned additional signal, and means operative upon receipt of said reply signal within an extension of definite duration of the first-mentioned period of time for giving the first-mentioned transmitter access to the channel for transmitting other message signals to the opposite end, and so on indefinitely.

19. A channel of transmission provided with equipment in accordance with claim 18 at each terminus wherein the pulse sending means comprises a time delay circuit cooperating with message signal responsive means, a slow-to-release means non-responsive to message signals, and other means arranged to operate only in the interim between the start of operation of said message signal responsive means in response to said incoming additional signal and the release of

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said slow-to-release means for initiating transmission of message signals from the transmitter at the local terminus whereby said transmitter at the local terminus has access to said channel for transmission at any time between the receipt of the last signal received at the local terminus and the transmission of its next outgoing additional signal, but not thereafter until a further additional or message signal has been received.

20. A communication system having sending equipment at each terminus of a channel of communication, means operative during an idle condition of said sending equipment to send a signal including at least a pulse from one terminus to the other, timing means at the sending terminus to count off a predetermined interval following the sending of said signal, timing means at the receiving terminus to count off a time interval of shorter duration from the receipt of said signal and then send a return pulse, and means at sending terminus operative to inhibit transmission over such system if the return pulse is not received prior to the expiration of the predetermined interval.

21. In a system comprising a telegraph channel provided with message transmitting equipment at a sending terminal, operating means for transmitting messages over said channel under control of said equipment, supplemental means for sending a non-message signal of one pulse only at intervals upon cessation of operation of said equipment to transmit message signals, a receiver responsive to message signals and associated with said channel for reception thereof, supplemental reception means operative upon cessation of arrival of message signals to respond to said non-message signals and further means operable in response to non-arrival of said non-message signals but held non-operated in response to arrival thereof.

22. In a system comprising a telegraph channel provided with message transmitting equipment at a sending terminal, operating means for transmitting messages over said channel under control of said equipment, supplemental means for sending a non-message signal of one pulse only at intervals upon cessation of operation of said equipment to transmit message signals, a receiver associated with said channel at a remote point, operative to receive message signals thereover and means operative upon failure to receive message signals thereover and means operative upon failure to receive message or non-message signals during a definitely timed period.

23. In a telegraph system, a channel of telegraph transmission provided with means for sending message signals and operating means therefor, means for sending at regularly recurring intervals during the idle periods between message transmission periods a check pulse, means for automatically operating the third-mentioned means independently of the second-mentioned means, a recorder for receiving and recording said message signals, and means responsive to each operation of the third-mentioned means for operating said recorder, said recorder operating in response to each check pulse transmitted.

24. In a telegraph system, a two-way channel of transmission provided with message signal sending means and operating means therefor at each terminus for transmitting to signal receiving means provided at the opposite terminus, supplemental means for sending at regularly recurring intervals during the idle intervals between

message transmission intervals a check pulse over said channel to check the operativeness and continuity of said channel, and means responsive to each operation of said supplemental means for operating said signal receiving means, said receiving means operating in response to each checking pulse transmitted and received.

25. A signal receiving system having a selector operable to make selections in accordance with permutation code, contact means operable in response to every selection by said selector, timing means for measuring off a predetermined time which is reinitiated upon every operation of said contact means, a circuit, and means for closing said circuit operatively controlled by failure of said contact means to operate over a continuous period of time greater in duration than said predetermined time.

26. A signal receiving station comprising a conductive path, contact means, timing means for modifying the conductive condition of said path upon expiration of a given time interval during which said contact means remains unoperated, and a permutation code selector, said contact means being operative in response to every selection received over said path for operating said selector.

27. A telegraph system comprising a channel of transmission, a machine sender and receiving means at one terminal, sending means and receiving means at the other terminal, said system and its transmission and reception equipment capable of assuming an idle condition, means operative during said condition for sending check or non-communication signals from one end of the channel to the other independently of the operation of said machine sender and receiving means at either terminal, and means automatically operative for sending check or non-communication signals from the other end to the one end independently of the operation of said machine sender and receiving means at either terminal, and means whereby such signal sent from each such end controls the transmission of such signal from the other.

28. A telegraph system comprising a channel of transmission provided at either terminus with an automatic storage control transmitter, means including pulse sending means at either terminus of the system and pulse receiving means responsive to such pulses to alternately assign a time within which the transmitter at each terminal may begin sending, means for inhibiting the operation of said pulse sending means for an indefinite period while the transmitter at one terminal sends, and means for reinitiating the operation of said pulse sending means after such transmitter ceases sending and maintaining such operation until one or another of said transmitters resumes sending.

29. A start-stop telegraph channel having at each terminus of the channel a plurality of senders, at least one of which is a storage controlled machine sender and supplemental equipment including a pulse sender at each terminus whereby first one terminus and then the other assigns a time in which transmission may begin by the other, means for preventing initiation of transmission at either terminus except within the assigned time and means effective upon the beginning of transmission within the assigned time and continuation thereof by the sender at one terminus to hold the channel available for continued sending, all under control of the transmitting sender.

30. A telegraph channel of transmission having means for transmitting pulses from each terminus of the channel toward the other, means operative upon cessation of transmission from one terminus to measure a time interval within which a responding pulse should be received, and means operative upon failure to receive any responding pulse within the measured time interval to sound an alarm.

31. A telegraph channel of transmission having means for transmitting pulses from each terminus of the channel toward the other, means operative upon cessation of transmission from one terminus to the other to measure a time within which a responding pulse should be received, and means operative upon failure to receive any responding pulse within the measured time interval to prevent further transmission away from said one terminus until the cause of failure to receive the responding pulse has been rectified.

32. The method of reducing loss or mutilation of messages transmitted over a system which includes a start-stop channel of telegraph transmission and automatic transmitter means effective to transmit thereover from time to time as stored message material is supplied to said transmitter means to be transmitted which comprises, upon said channel becoming temporarily idle as a result of cessation of message transmission by said transmission means, sending check signals from time to time over said channel, receiving said check signals at the far end of said channel, receiving and verifying the receipt of said check signals by causing each of them to control the sending of a conditioning check signal back toward said transmitter means, enabling initiation of message transmission by said transmitter means by said conditioning check signal, and preventing the initiation of message transmission by said transmission means incident to sending a check signal away from it until a further conditioning check signal is received back.

33. A telegraph system comprising a normally energized line circuit of impulse transmission, reciprocally operating, sending and receiving mechanisms at the terminals of said circuit for sending backward and forward over said channel a series of test signals, means included in said line circuit immediately responsive to a complete test signal incoming over said circuit for conditioning the mechanism receiving the completed test signal to send another complete test signal over said circuit in the opposite direction, and means for automatically repeating said reciprocal operation at regularly recurring intervals.

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