March 29, 1949. W. M. BACON 2,465,507

INTERCOMMUNICATING TELETYPEWRITER SYSTEM

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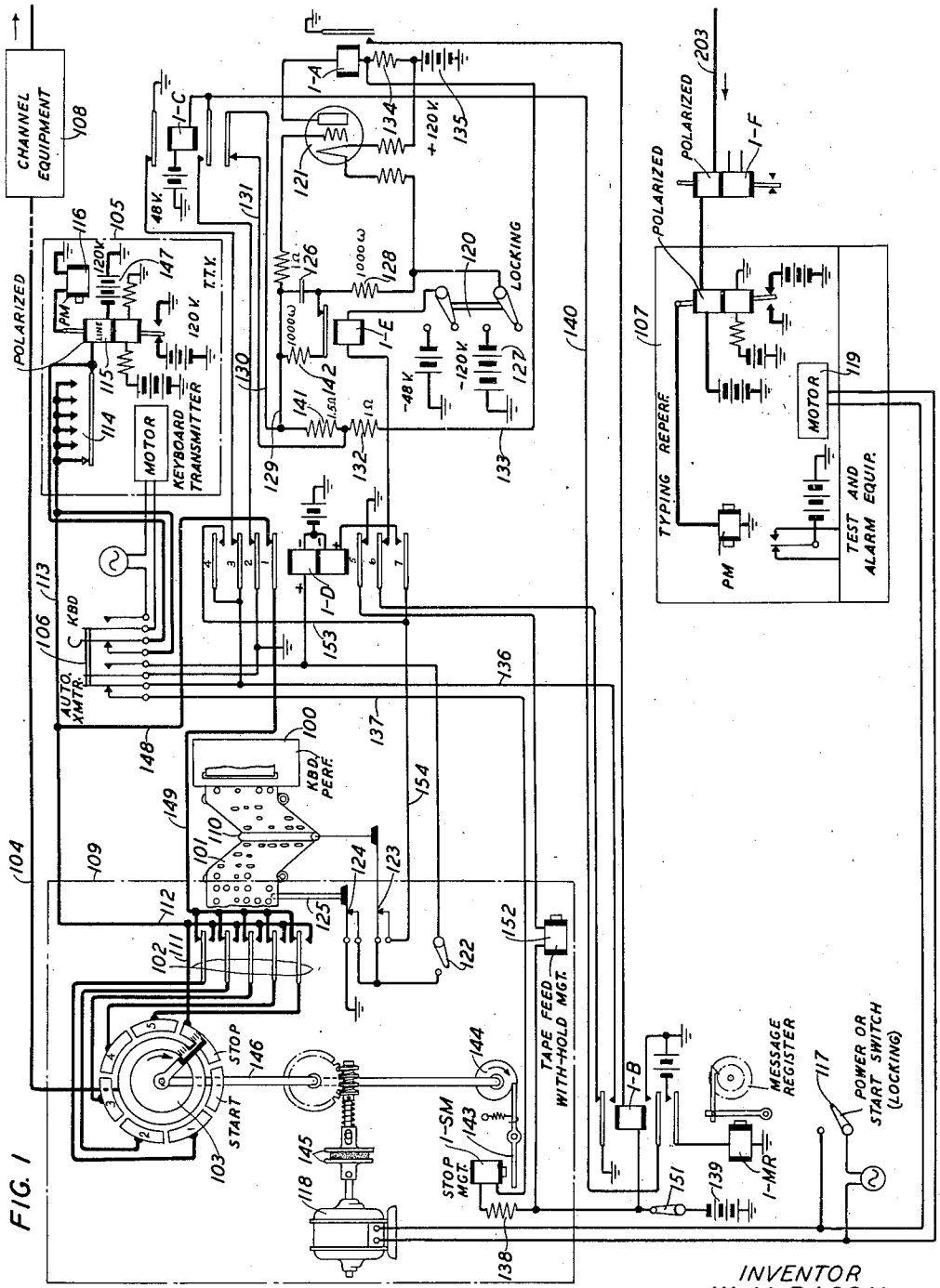

FIG. 1

INVENTOR
W. M. BACON

BY

J. W. Schmied

ATTORNEY

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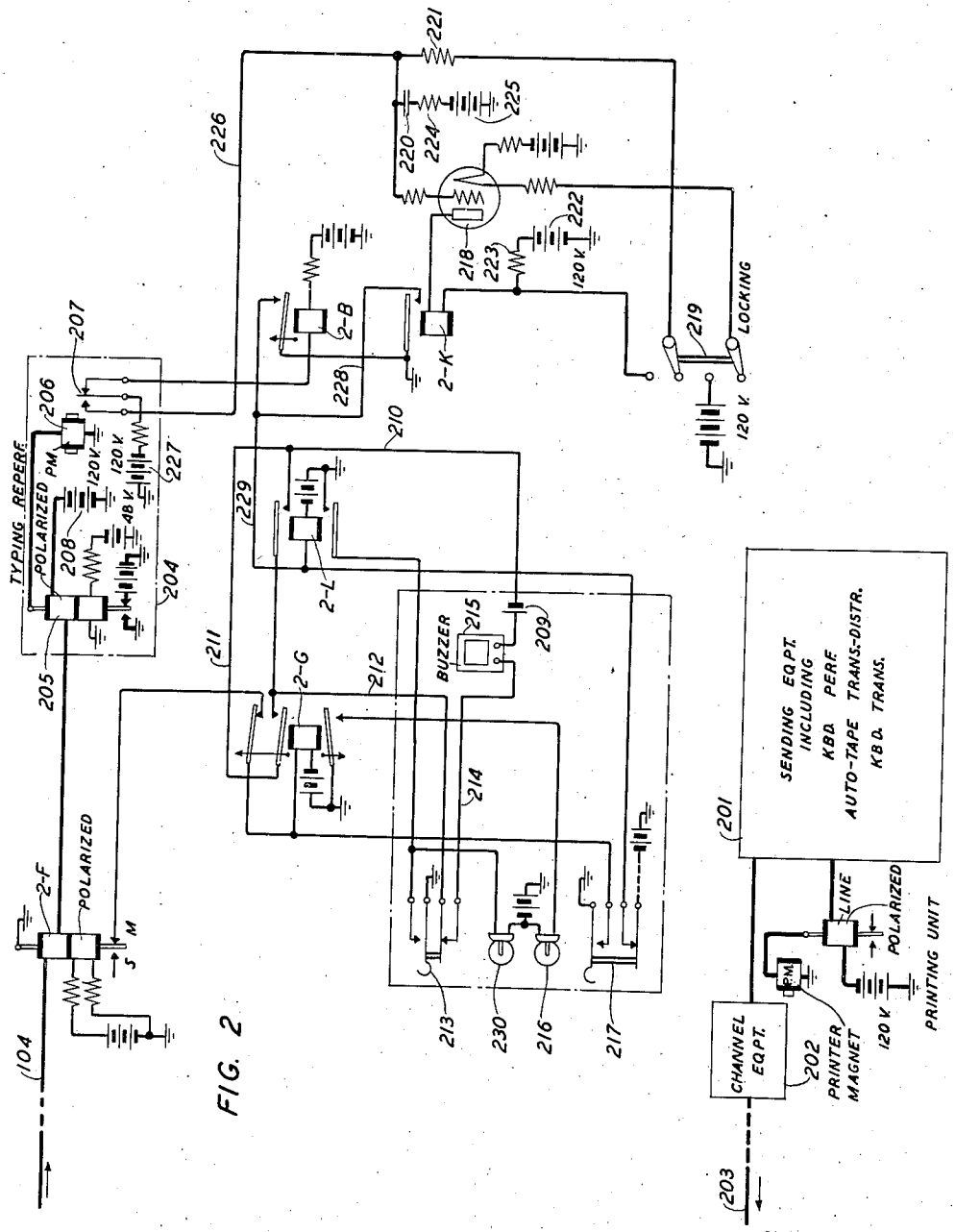

FIG. 2

INVENTOR
W. M. BACON

BY J. W. Schmied

ATTORNEY

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UNITED STATES PATENT OFFICE

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INTERCOMMUNICATING TELETYPEWRITER SYSTEM

Walter M. Bacon, New York, N. Y., assignor to Bell Telephone Laboratories, Incorporated, New York, N. Y., a corporation of New York

Application January 16, 1945, Serial No. 573,049

20 Claims. (Cl. 178—4)

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This invention relates to intercommunicating teletypewriter systems, and more particularly to automatic testing and alarm circuits for use therewith.

An object of the invention is to indicate to an attendant at one of a plurality of interconnecting stations, by means of visual and/or audible alarm, whenever the system's condition of operation is such that the system fails to function in a satisfactory manner for one or another of a variety of reasons in which case a circuit is not assured.

According to an exemplary and preferred embodiment of the invention, an intercommunicating teletypewriter system is equipped with testing facilities automatically operable whenever (1) the line circuit interconnecting two stations and normally energized is conditioned for operation and (2) transmission of message signals is discontinued and the channel or transmission line does not restore to its normal, idle condition. The testing facilities are not a part of the normally energized line but are controlled by certain signals which are automatically transmitted over the line at regularly recurring intervals of time. The testing facilities include alarm equipments which are automatically operated whenever the line remains open or closed for a prolonged interval.

Among the features of the present invention are the provision of equipment for automatically indicating by visual and audible alarm signals either during the transmission of a message or when the circuit is idle whenever (1) there is a failure of the line between stations due to the line remaining open or locking closed for a prolonged interval of time, (2) there is a failure of the sending machine to send signals to the line, (3) there is a failure of the receiving machine to respond to signals incoming over the line and (4) there is primary power failure at either or both the sending and the receiving machines.

Among other features are the provisions for (1) transmitting selected non-message signals or impulses such as "letters" signals at regular intervals to the remote station during idle periods to furnish at both stations information with respect to the usable condition of the line interconnecting the stations, (2) indicating to the attendant at the receiving station that the message signals transmitted over the interconnecting line circuit are not being recorded at the remote station for a period in excess of another given interval of time, (3) preventing the operation of the tape-feed mechanism of the automatic tape transmitter at the sending station when the "letters" signals are being transmitted

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to the remote station at regular intervals during the idle periods, and (4) providing an automatic non-interfering tape feed-out at the end of each message if required.

In the normal operation of the exemplary embodiment of the invention disclosed as applied to a one-way channel, the probability of the loss of messages is greatly reduced because a continued marking condition of the line for more than the assigned time of about seven seconds (other shorter or longer times may be used) or a continued spacing condition of the line for more than an assigned time of one-half second or more; or a failure to receive periodic check signals causes an alarm to be sounded or registered at the receiving terminal and attending personnel will recognize such alarm and take steps to correct the abnormal condition. In the case of a two-way system on separate lines, information of the abnormal condition may be transmitted back to the opposite terminal to prevent further attempts at transmission until the condition has been corrected; in the case of a duplex line or two-way wires in single cable or upon a single pole line, the abnormal condition may or may not be present upon both channels of transmission depending upon its source or cause.

Apparatus embodying the invention may be utilized with a one-way channel or with each direction of transmission upon a duplex channel. Although the exemplary embodiment is disclosed in detail as a two-wire duplex channel in which each wire carries transmission in one direction only, known methods of consolidating the two wires into a single wire duplex channel are available and can be employed for the purpose by any one having an elementary knowledge of duplex telegraphy; likewise the application of the invention to systems including radio or carrier current links are considered to be comprised within the disclosure because methods of converting two line conditions to two carrier wave conditions and vice versa for modulated or interrupted carrier wave transmission are also well known to those having an elementary knowledge of the art.

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

Figs. 1 and 2 represent an intercommunicating teletypewriter system designed for full duplex operation. Fig. 1 shows station A and Fig. 2 shows station B, the stations being interconnected by two normally closed single line circuits for respectively transmitting in opposite direc-

tions. Each line circuit, channel or path may be equipped at one or more intermediate points with quipment 108 which typifies any or all types of repeaters, electromagnetic, thermionic or regenerative as well as carrier links or radio links, composite legs or any of several of these or other equipment normally used in or as part of a telegraphic transmission path; however, the principles of the invention are applicable to a direct unrepeatered transmission channel although such application of them may not develop the maximum utility of the invention.

Referring to Fig. 1, station A comprises, (1) for sending, keyboard perforator 100 for perforating tape 101, an automatic tape transmitter 102 for translating outgoing message signal combinations on perforated tape 101 into coded signal current combinations for transmission over five segments of start-stop rotary distributor 103 to conductor 104 of the normally closed line circuit extending to station B, keyboard transmitter and printing unit 105, which may be substituted at any time, by means of switch 106, for the automatic tape transmitter 101 for transmitting coded signal current combinations directly to the line conductor 104 and a single line regenerative repeater 108 shown in diagrammatic form and representing one or more repeaters in the line conductor 104, and, (2) for receiving, a diagrammatic showing represented by rectangle 107, of a typing reperforator or other type of teletypewriter for receiving coded signal current combinations over the other line conductor 203 from station B and the necessary test and alarm equipment which functions with the receiving equipment of the system. Rectangle 107 represents equipment similar to the receiving equipment shown in detail in Fig. 2.

Referring to Fig. 2, station B also comprises, (1) for sending, a keyboard perforator and a tape perforated thereby, an automatic tape transmitter, a start-stop rotary distributor and a keyboard transmitter represented diagrammatically by block 201, and one or more single line regenerative repeaters represented by block 202, line conductor 203, and (2) for receiving purposes a typing reperforator 204 or other type of teletypewriter for receiving coded signal current combinations over line conductor 104 from station A and the testing and alarm equipment required for said incoming coded signal current combinations.

The machine transmission means comprises an automatic tape transmitter and rotary distributor at each station combined in a device identified as the transmitter-distributor set 109, a description of which may be had by reference to U. S. Patent 2,262,014 granted to W. Y. Lang on November 11, 1941. The typing reperforators 107 and 204 at stations A and B, respectively, are of the type disclosed in C. W. Swan, U. S. Patent 2,308,554, issued January 19, 1943.

In Fig. 1 the transmitter is provided with the usual tape feed mechanism (not shown) and tape feed withhold mechanism (not shown) operated or controlled by tape feed withhold magnet 152. Tape feed withhold mechanism of suitable nature is known to workers in the art. One form of tape feed mechanism comprises a pawl and ratchet operated mechanically on each revolution of the distributor after the sensing pins have been withdrawn from the tape to advance the tape to bring forward a new code combination for sensing. The tape feed withhold magnet, when energized, lifts the pawl from the ratchet so that the pawl operates idly. Such devices are sufficiently well known to need no description but nevertheless a disclosure may be found in Fig. 6 of the application of Bacon, Serial No. 371,521, filed December 24, 1940, magnet 152 hereof corresponds to magnet 671 of said application, the disclosure of said mechanism is incorporated herein by reference to the same extent as if set forth in full.

Perforated tape 101 may be fed from a keyboard operated perforator 100 or from a reperforator (not shown) operated under control of a line (not shown) incoming at station A or it may be supplied manually with pieces of tape perforated with messages to be sent. Usually, however, tape 101 will extend from a perforator or a reperforator directly to the sensing head of the transmitter and the tape-stop arm 110 will stop transmitter-distributor 109 when the tape becomes taut due to the cessation of perforator 100. Correponding elements of station B are arranged in a similar manner. The transmitter-distributor at each of stations A and B may be considered to typify any type of machine transmitter including those which have mechanical distributors as well as those which have segmental distributors.

Distributor 103 in its idle condition, connects line conductor 104 to a circuit extending over its inner ring, brushes at its stop segment, conductors 111, 112 and 113, right-hand normally closed contacts of switch 106, through the upper winding of polarized line relay 115, to grounded negative battery 147, the opposite end of the circuit of the conductor 104 extending through an intermediate single line repeater 108, through the upper winding of polarized relay 2—F, through the upper winding of polarized relay 205 of the typing reperforator 204, to grounded positive battery 208. Line relay 115 is thereby normally held in its marking or left-hand position as shown to hold printer magnet 116 operated when no messages are being transmitted. Relay 2—F is normally held in its marking, or right-hand, position, as shown, to normally hold slow-to-release relay 2—G operated. Relay 205 is normally held in its marking or right-hand position, as shown to hold the reperforator printing magnet 206 operated. Relay 2—B at station B is also normally held in its operated position by universal contacts 207 of reperforator 204, in their normally closed position. When current switch 151 is operated to its closed position stop magnet 1—SM operates in a circuit traceable to ground at the back contact and upper armature of relay 1—C. Tape feed withhold magnet 152 is also operated when current switch 151 is closed, and thereby prevents tape 101 from advancing during the idle periods, that is, when no messages are being transmitted. Tape 101 is not advanced when the circuit assurance "letters" signals are being transmitted every seven seconds during the idle periods or when "letters" signals for accomplishing tape feed-out at the receiving station are being transmitted thereto. All other equipment during idle periods of the system is in its normally deenergized condition.

Method of operation

When the system is in its idle condition "letters" signals are continuously repeated from station A to station B over line conductor 104 and from station B to station A over line conductor 203 at given intervals, say seven seconds, to give the operator at each end of the

system assurance that his incoming transmission line, his receiving machine and the transmitting machine at the remote terminus of the channel are in operative condition. For the purpose of illustration, it will be hereinafter assumed that station A is sending and station B is receiving and only that equipment which is shown in detail at stations A and B will be described under the method of operation.

Station A

During the idle period, it will be assumed that power switch 117 and battery switches 120 and 151 are in their respective closed, or operated, positions, and message transmission start switch 122 is open. It will also be assumed that automatic transmitter-keyboard switch 106 is in the position shown so that the automatic tape transmitter 109 is operatively connected to line conductor 104 and the keyboard 114 is short-circuited. Motor 118 is normally operating and stop magnet 1—SM is energized so that the brushes on distributor 103 are operating to send feed-out signals to the line until the timing intervals begin.

At the time battery switch 151 was operated to its closed position (1) the operating circuit for stop magnet 1—SM was established to cause the magnet to operate and thereby permit the rotation of the brushes of distributor 103 and (2) the operating circuit for withold magnet 152 was established to operate magnet 152 whereby the tape feed mechanism of automatic transmitter 102 was prevented from operating during idle periods, whereby repeated "letters" signals are sent to the line as will now be described. When battery switch 120 was operated it closed at its lower contacts an energizing circuit for the filament of vacuum tube 121 and at its upper contacts an operating circuit for relay 1—E and relay 1—E operates. Relay 1—E, upon operating, opens a shunt path around condenser 126 which immediately begins to charge to a potential sufficient to render vacuum tube 121 conductive, the circuit being traceable from grounded negative battery 127, lower contacts of switch 120, resistance 128, condenser 126, conductors 129 and 130, outer lower armature and back contact of relay 1—C, conductor 131, resistance 132, conductor 133, resistance 134, grounded positive battery 135. Condenser 126 accumulates a sufficient charge to make vacuum tube 121 conductive and relay 1—A therefore operates. During this charging time repeated "letters" signals will be sent from the transmitter and cause the tape at the receiving station to feed out for about four seconds.

Relay 1—A, upon operating, closes at its armature and contact, an operating circuit for relay 1—B which operates. Relay 1—B, upon operating, (1) opens at its upper armature and back contact the operating circuit for relay 1—E which now releases, (2) closes at its upper armature and front contact a substitute operating circuit for stop-magnet 1—SM, the circuit referred to hereinafter as the first substitute operating circuit, being traceable from ground, upper armature and front contact of relay 1—B, conductor 136, left-hand normally closed contact of switch 106, conductor 137, through the winding of stop-magnet 1—SM, resistance 138, to grounded negative battery 139 and the magnet 1—SM is held operated after relay 1—C operates, prior to the recurring intervals of seven seconds duration used for the transmission of

test "letters" signals, as will be hereinafter described, (3) closes at its inner lower armature and front contact a circuit traceable from ground, conductor 140, through the winding of relay 1—C, to grounded negative battery and relay 1—C operates to open the original operating circuit for stop-magnet 1—SM and (4) closes at its outer lower armature and front contact an operating circuit for message register magnet 1—MR which operates to furnish a visible record of the number of seven second intervals that occur during the idle periods of the transmission line 104. Relay 1—C, upon operating, (1) as hereinbefore stated, opens at its upper armature and contact the original operating circuit for stop-magnet 1—SM, (2) closes at its inner lower armature and contact a locking circuit for itself which extends over the back contact and No. 2 armature of relay 1—D to ground and (3) opens at its outer lower armature and contact a shunt path around resistance 141 which has a comparatively high resistance value. The locking circuit for relay 1—C is maintained for the duration of an idle period, that is, until message transmission begins. The "letters" signal combination representing the test signals transmitted at seven second intervals comprises a start, or open, impulse, five closed, or current, impulses and a stop, or closed, impulse. For each character signal, the start, or open, impulse is transmitted over the unconnected start segment of distributor 103 to line 104; the next five impulses which are known as the selecting impulses are transmitted from grounded negative battery 147, over either of two paths, one including conductors 113, 143 and 149 and the normally closed contacts of automatic tape transmitter 102 and the other path, including conductors 113 and 112, and any of the normally open contacts of transmitter 102, which happen at this time to be closed because of tape perforations appearing over transmitting, or sensing, pins of transmitter 102, then over segments Nos. 1 to 5, in turn, of distributor 103 to line 104; and the stop, or closed, impulse is transmitted over conductors 113, 112 and 111 and the stop segment. It will be noted that when there is no perforated tape in transmitter 102 or when there are no tape perforations over the transmitting, or sensing, pins, the first-mentioned path short-circuits the second-mentioned path which includes the normally open contacts of transmitter 102.

Relay 1—E, upon releasing, causes condenser 126 to discharge through resistance 142, vacuum tube 121 to become non-conductive and relay 1—A to release. The release of relay 1—A effects the release of relay 1—B. Relay 1—B, upon releasing, (1) opens the operating circuit for message register magnet 1—MR which releases, (2) opens the original operating circuit for relay 1—C and (3) opens the substitute operating circuit for stop magnet 1—SM which now releases and (4) recloses the operating circuit for relay 1—E which again operates. Inasmuch as relay 1—C at this time is locked in its operated position to maintain open the original operating circuit for stop magnet 1—SM and the substitute operating circuit for stop magnet 1—SM is also opened at the front contact and upper armature of relay 1—B now released, stop magnet 1—SM now releases and its armature arm 143 is moved into engagement with cam 144. Cam 144, when so engaged, stops at the end of one revolution the rotation of the brushes of distributor 103.

Relay 1—E, upon operating the second time,

causes condenser 126 to recharge. The recharging circuit, because of relay 1—C being locked in its operated position, includes resistance 141 whose value is such, together with condenser 126, as to cause the "letters" signals to be transmitted at regular recurring intervals each having a definite duration of seven seconds. After each interval of seven seconds vacuum tube 121 becomes conductive, as before, to momentarily operate relays 1—A and 1—B, in turn. Each time that relay 1—B operates during an idle period stop magnet 1—SM operates to release distributor shaft 146 which upon rotating the distributor brushes causes to be transmitted over conductor 104 to station B a "letters" signal. Relay 1—B, upon releasing the second time, opens the operating circuit for stop magnet 1—SM which again releases to cause the rotating brushes of distributor 103, upon reaching their stop segment, to come to rest until the expiration of another seven second interval. When vacuum tube 121 again becomes conductive, relays 1—A and 1—B again operate, in turn. These cycles are repeated continuously during an idle period of conductor 104.

Station B

At a transmission rate of sixty words a minute each complete character code combination requires about one-sixth of a second for transmission. As each "letters" signal is received in the upper winding of polarized relay 2—F at station B, the relay armature during the space, or open, impulse received as a start impulse, moves from its normally closed or marking contact to open the operating circuit of relay 2—G, but relay 2—G which is of the slow-to-release type does not respond to the start impulse of a "letters" signal, or any other permutation code signal. Relay 2—G may be of a type timed to release in anything from about one-half second to several seconds and typifying any suitable timing device for timing such a period. However, the typing reperforator 204 operates in response to each incoming "letters," that is, each of the entire signal combinations including the start, or space, impulse and the stop or mark, impulse to furnish the operator at station B with the information that the "letters" signals are being reecived and that the line circuit including conductor 104 as well as the sending transmitter-distributor and the receiving reperforator is capable of operation. Should a break or continued spacing condition occur in the line circuit of conductor 104, then relay 2—F would remain in its left-hand, or spacing, position for the duration of the sustained open, or break, condition in the line and therefore relay 2—G would release. Relay 2—G, upon releasing, (1) opens at its outer upper armature and contact its normally closed holding circuit, (2) closes at its inner upper armature and contact the buzzer circuit which extends from the negative pole of the separate local battery 209, conductors 210 and 211, inner upper armature and contact of relay 2—G, conductor 212, normally closed contact of switch 213, conductor 214, through the winding of buzzer 215, to the positive pole of battery 209 and the buzzer starts operating to furnish an audible alarm to indicate the open condition of line 104, and (3) closes at its lower armature and contact a circuit for lighting the "break and open" lamp 216 which lights to furnish a visual alarm if the line circuit of conductor 104 is open. Lamp 216 and buzzer 215 will continue to furnish the desired alarms until switch 217 is operated which, upon being operated, closes at its upper contact a substitute operating circuit for relay 2—G which operates to extinguish lamp 216 and stop buzzer 215.

Transmission from station A to station B

In order to start message transmission from station A to station B, it is first necessary to establish what is called herein the normal idle condition (as distinguished from the out-of-service condition) by moving power switch 117 and battery switches 120 and 151 into their operated positions, and to determine whether the transmission is to be performed through the automatic tape transmitter 109 or the keyboard transmitter 105. Assuming that transmission is to be with automatic transmitter 109, the automatic transmitter-keyboard transmitter switch 106 is in the position shown, perforated tape is placed in the transmitter and then message transmission start switch 122 is operated to its closed position. The closure of start switch 122 closes a circuit from ground through the normally closed sixth pin contacts 124, which are closed when tape is in the transmitter, switch 122, through the upper winding of relay 1—D, to grounded battery and relay 1—D operates and (1) locks in a circuit traceable from grounded battery, through its lower winding, front contact and armature No. 7, tape stop or taut tape contacts 123, contacts 124, to ground, (2) opens at its No. 1 armature and back contact the circuit for short-circuiting the transmitter contacts, (3) opens at its No. 6 armature and back contact the operating circuit for relay 1—E which releases at this time to prevent first, the charging of condenser 126 and second, the repeated operation and release of relays 1—A and 1—B for sending the circuit assurance "letters" signal, (4) opens at its No. 5 armature and back contact the operating circuit for tape feed withholding magnet 152 which now releases whereby the tape feed mechanism becomes free to operate, (5) opens at its No. 2 armature and back contact the locking circuit for relay 1—C which now releases inasmuch as relay 1—B is also released, (6) opens at its No. 3 armature and back contact the original operating path for stop magnet 1—SM, (7) closes at its No. 4 armature and front contact a sustained operating path for stop magnet 1—SM which now reoperates to start transmission on message signals. With perforated tape 101 available the message is transmitted because stop magnet 1—SM is held operated. The non-operation of tape feed withhold magnet at this time permits the tape feed mechanism to feed tape so long as a supply is maintained by operation of the keyboard perforator 100.

Should transmission by the distributor 103 use all perforated tape 101, the perforated tape 101 would reach a predetermined minimum, whereupon tape 101 would become taut to actuate tape stop arm 110 in an upward direction to open the taut tape contacts 123 thereby opening the second substitute operating circuit for stop magnet 1—SM, the second substitute operating circuit being different from the corresponding first substitute operating circuit for stop magnet 1—SM which is applied during normal idle condition. The second substitute operating circuit for stop magnet 1—SM is traceable from grounded battery 139, battery switch 151, resistance 138, winding of stop magnet 1—SM, conductor 137, left-hand closed contacts of switch 106, No. 4 armature and front contact of relay 1—D, conductors

153 and 154, and contacts 123 and 124 to ground. The opening of the second substitute operating circuit for stop magnet 1—SM at taut tape contacts 123 causes the release of stop magnet 1—SM thereby stopping the rotating brushes of distributor 103, and transmission ceases until sufficient additional tape is perforated at keyboard perforator 100 to permit tape stop arm 110 to drop into its normal position and thereby again close contacts 123. During this interval wherein the rotatable brushes on distributor 103 are in their stop position marking current will continue to be connected to line conductor 104 until the supply of prepared tape 101 becomes sufficient to close contact 103 to resume transmission. Relay 1—D remains operated during the interval wherein there is no supply of perforated tape providing that the start switch 122 is closed.

A portion of the message previously prepared is held up in the taut tape between the tape perforator 100 and the automatic tape transmitter 102. Normally, if the operator discontinues the production of perforated tape the transmission of signals held in the tape between the perforator 100 and automatic tape transmitter 102 will be delayed until the operation of the tape perforator 100 is again resumed. If the operator, upon ceasing to perforate intelligence or message signals in the tape, perforates sufficient "letters," blanks or other signals on the tape to advance the end of the last message through the transmitter-distributor, and then opens the transmission start switch 122, relay 1—D releases because the taut tape contacts 123 would also become opened. Upon the release of relay 1—D, magnet 1—SM is energized and tape withhold magnet 152 is energized; further "letters" signals are transmitted by rotation of the arm of distributor 103 for four seconds without advancing the tape through the distributor; these "letters" signals step the tape at the receiving end out of the reperforator (or any equivalent receiving device) so that the message may be torn off or conveniently read. Relay 1—D, upon releasing at this time, (1) closes at its No. 6 armature and back contact, the operating circuit for relay 1—E which now operates to permit the condenser 126 to start charging to stop the continuous transmission of "letters" signals to station B. The cessation of "letters" signals occurs when condenser 126 charges, relay 1—A operates, relay 1—B operates, relay 1—C operates and locks and finally relay 1—B releases. (2) Relay 1—D, in releasing, also closes at its No. 3 armature and back contact the original operating circuit for stop magnet 1—SM, which operating circuit extends to the back contact and upper armature of relay 1—C. Condenser 126, upon charging for the first time at the beginning of an idle period, is charged in about 4 seconds in that the charging circuit extends over the outer lower armature and back contact of relay 1—C. However, on the next subsequent charging of condenser 126 relay 1—C is operated and locked in its operated position so that the charging circuit now includes resistance 141 and the recurring intervals for charging condenser 126 are uniformly timed at seven seconds each for sending the "letters" signal to station B during the idle period.

Other alarms

If for any reason the line circuit including conductor 104 remains continuously closed so that station B receives a mark signal for a prolonged interval of time, a universal contact set 207 in

the typing reperforator 204 would furnish an alarm indicating such a condition. The usual universal contacts of the typing reperforator 204 are controlled to close upon any selection of the selective mechanism and may be such as shown in Fig. 96 of the drawing of the copending patent application of W. M. Bacon, F. S. Kinkead and J. A. Krecek, Serial No. 383,490, filed March 15, 1941, which has matured into Patent 2,381,871 granted August 14, 1945. These contacts, therefore, operate once for each character received.

As hereinbefore stated, if for any reason the line circuit comprising conductor 104 becomes marking and remains so for an interval exceeding thirteen seconds, a vacuum tube condenser-resistance timing circuit would operate to sound an alarm, the principal apparatus so involved being vacuum tube 218, condenser 220, and resistance 221. Accordingly, universal contacts 207 of typing reperforator 204 must operate to their normally open, or left-hand, position at least once every thirteen seconds, this predetermined time interval being required to operate vacuum tube 218 whereby the alarm would operate. During the idle period of the system reperforator 204 responds to the incoming "letters" signal every seven seconds as hereinbefore described and battery switch 219 is in its operated, or alternate, position for energizing vacuum tube 218 and charging condenser 220. Ordinarily, when the universal contacts 207 are operating to their alternate position in their regular routine during both the idle and the transmission periods of the system, a potential of partial value is alternately stored and discharged in condenser 220 as universal contacts operate between their normal and alternate positions and no alarm is sounded. However, if for any reason the line circuit of conductor 104 remains marking for a period exceeding thirteen seconds the potential of condenser 220 attains a value sufficient to make vacuum tube 218 adequately conducting and relay 2—K operates. The charging circuit for condenser 220 is traceable from grounded positive battery 222, resistance 223, upper contacts of switch 219, resistance 221, condenser 220, resistance 224, to grounded negative battery 225, and the discharging circuit is traceable from grounded battery 225, resistance 224, condenser 220, conductor 226, universal contacts 207 in their alternate position, to grounded negative battery 227.

Relay 2—K, upon operating, closes at its armature and contact an operating circuit from ground, its armature and contact, conductors 228 and 229, through the winding of relay 2—L to grounded battery and relay 2—L operates. Relay 2—L, upon operating, (1) closes at its upper armature and contact an operating circuit for buzzer 215, the circuit being traceable from the negative pole of battery 209, conductor 210, contact and upper armature of relay 2—L, conductor 212, normally closed contacts of switch 213, conductor 215, through the buzzer 215 to the positive pole of battery 209 and the buzzer operates to furnish an audible alarm. (2) closes at its lower armature and contact a circuit for lighting lamp 230. The lamp 230 lights to furnish a visual alarm indicating a prolonged marking condition on the line.

Should the universal contacts 207 remain for a protracted period in their alternate position for any reason such as a failure of the receiving machine or a motor power failure slow-release relay 2—B, which is normally operated, will re-

lease and close at its upper armature and contact the operating circuit for relay 2—L which operates to cause buzzer 215 to operate and lamp 230 to light as an alarm condition which remains so long as relay 2—B is released. Switches 213 and 217 may be operated to stop the alarms.

The sixth pin 125 which normally presses against perforated tape 101 as the tape is advanced step-by-step through transmitter 102 serves, as hereinbefore stated, to control contact set 124. Should for any reason the tape be torn or broken or should it pass out of the transmitter the pressure of the tape on pin 125 would be released and contacts 124 would open to release relay 1—D, open the operating circuit for stop magnet 1—SM which would release to stop the rotation of the brushes of distributor 104, and cause the closure of the operating circuit of tape feed withhold magnet 152 whereby the magnet operates to stop the tape advancing mechanism. The operation of the sixth pin 125 may indicate the end of a message or the end of transmission when a procedure of placing individual message tapes in the transmitter is followed. Upon operation of pin 125 the contact 124 is opened, relay 1—D is released (assuming key 106 to the left) and the sending of "letters" signals at timed seven second intervals begins.

The operation at the sending station may be summarized as follows for various conditions:

(1) Line in out-of-service condition. Switches 117 and 151 are open, switch 120 open, switch 122 ordinarily open but might be closed.

(2) Line is put into service condition but idle with switch 106 to right or keyboard position; nothing happens on line 104 unless and until the keyboard transmitter 114 is operated.

(3) Line is put into service condition but idle with switch 106 to left or automatic condition. Switches 117, 151 and 120 are closed, switch 122 is open or opened. Distributor 103 starts sending "letters" signals, relay 1—E operates, condenser 126 charges, relay 1—A operates after about 4 seconds, relay 1—B operates, relay 1—C operates and locks, relay 1—B releases (sending of "letters" signals stops), relays 1—E operates, after seven seconds relay 1—A operates, relay 1—B operates, start magnet 1—SM is energized to transmit one "letters" signal, relay 1—E releases as soon as relay 1—B releases and the cycle is repeated.

(4) Condition same as (3) but switch 122 closed, tape in transmitter but taut tape contact 123 open. No signals are transmitted by the distributor or by the timing mechanism under control of tube 121 because relay 1—D is operated. (This is not assumed as a usual starting condition.)

(5) Conditions just the same as (4) except taut tape switch 123 is closed. Transmitter-distributor 109 operates to send signals until switch 123 or switch 124 opens. If switch 123 opens nothing further happens unless or until the operator opens switch 122 or takes some other action. If, however, switch 124 opens, relay 1—D releases and a sequence of events similar to those of condition (3) occurs.

(6) Normal transmission is occurring with switch 106 in the left or automatic transmitter position, switch 122 is closed. Let us assume tape runs out of the transmitter and contact 124 opens. The same events transpire as in condition (5) when switch 124 opens.

(7) Same as (6) but instead of tape running out of transmitter the taut tape contact 123 opens. The operator holds control and nothing happens until more tape is supplied. Under this condition if the operator moves switch 106 to the right or keyboard position, relay 1—D remains operated, motor 118 continues running but the path of start relay 1—SM is opened at the left contact of switch 106 and the operator can use the keyboard without interference from the automatic transmitter. By restoring switch 106 to the left the operator may return to automatic transmission and supply more tape from perforator 100. If under this condition the operator opens switch 122, relay 1—D releases and "letters" signals are transmitted for four seconds without advancing tape 101 through the transmitter and thereafter there is sent a "letters" signal every seven seconds without advancing the tape through the transmitter.

(8) Operator with or without opening switch 122 (opening is normal procedure) opens switches 117, 139 and 120 to close down the station.

The operation of the receiving station under these conditions may be summarized as follows, on the assumption that all switches are closed to put the receiver in service, supply it with power and key 213 is closed to buzzer 215.

(1) Under condition (1) an alarm will occur in seven seconds; if out of service nothing happens.

(2) Receiving station in service and supplied with power; in thirteen seconds an alarm sounds but if operator at station A actuates the keyboard once during each thirteen seconds no alarm sounds.

(3) The typing reperforator records "letters" signals for four seconds and then one "letters" signal every seven seconds.

(4) Buzzer 215 sounds an alarm at the end of thirteen seconds.

(5) The receiver responds to the message signals and then continues as per (3).

(6) The receiver responds to the message signals and then continues as per (5).

(7) Thirteen seconds after taut tape occurs and continues at station A the receiving station B sounds an alarm; if transmission occurs from the keyboard at station A in this period or switch 122 has been opened no alarm will sound.

(8) Alarm sounds within 13 seconds if line remains marking.

(9) Under any condition at the transmitter, if no spacing condition is received for thirteen seconds, an alarm will sound.

(10) Under any condition at the transmitter, if no marking condition is received for somewhat over seven seconds, an alarm will be sounded.

What is claimed is:

1. In an intercommunicating system, a channel of impulse transmission having a sending station connected thereto, sending means including distributor means, a tape and tape controlled sending means at said station capable of impressing permutation code message signals on said channel, a taut tape switch for causing said transmitter to pause in sending, means including said distributor automatically operable a predetermined time after said sending means ceases to impress permutation code message signals upon said channel for a reason other than a pause due to said taut tape switch, to send a permutation code test signal over said channel at regularly recurrent intervals each of long duration in comparison with the interval of a permutation code message signal until said sending means is controlled to resume impressing permutation code

message signals on said channel under control of said tape.

2. In combination, a source of permutation code signals, a selector mechanism responsive to signals received from said source, a contact operable to a closed condition by said selector mechanism upon every selective operation by a signal from said source, a condenser having a closed path through which it is charged, a discharge path for discharging said condenser upon operation of said contact to said closed condition, and means arranged to be automatically operated by a charge on said condenser whenever said contact, after a predetermined interval of time, fails to operate to said closed condition in response to signals received by said selector mechanism from said source.

3. In combination, recording telegraph equipment including a selector, a contact associated with said selector and momentarily operated to a closed condition incident to every selective operation of said selector, a timed system including a relay, which without closure of said contact, tends to operate said relay in a definite time, and connections between said system and said contact to retime said system upon each operation of said contact to said closed condition by said selector.

4. A channel of telegraphic transmission comprising a transmitter at one point on the channel for sending signal pulses thereover, a receiver at a remote point upon the channel for receiving said signals, timing means for timing a definite period of time, means under control of said channel and operative by any signal or change of signal condition thereon to reinitiate timing operation of said timing means at zero time, and an indicating device for giving an indication of absence of any change of signal condition upon the completion of timing of said definite period by said timing means.

5. A channel of transmission having at one terminal means connectable thereto for sending marking and spacing conditions, receiving relay means associated with said channel responsive to changes from one to another of said marking and spacing conditions, means associated with said relay means for measuring definite intervals of time, and alarm means actuated by failure of said receiving relay means to respond to a change from either to the other of said marking and spacing conditions for a time equal to or in excess of one such interval.

6. A telegraph channel of communication, a start-stop rotary distributor, an automatic tape transmitter for controlling said distributor in impressing from a perforated tape permutation code signals on said channel, and means automatically effective to send over said channel a permutation code signal at regularly recurring intervals having a duration of at least that of two permutation code signals upon and solely under control of cessation of transmission from the perforated tape in said automatic tape transmitter.

7. A telegraphic channel of communication, principal transmitter means for sending impulses over said channel, and means including supplemental transmitter means capable of being rendered automatically effective to send periodic line check signals at intervals upon and solely under control of cessation of transmission by said principal transmitter means, and responding means at a point upon said channel remote from said principal transmitter means responsive to impulses sent over said line by either of said transmitter means in combination with means operative to register a trouble condition upon failure of said responding means to receive signal pulses for a continuous period in excess of the normal interval between said line check signals.

8. In a transmission system, a channel of impulse transmission having two stations connected thereto, one station having sending means capable of impressing permutation code character signals on said channel, the other station having means capable of receiving permutation code character signals transmitted by the sending means at said one of said stations in combination with still other means at said one station operable during idle periods and initiated into operation automatically when said sending means ceases to so impress permutation code character signals upon said channel to send a permutation code non-character test signal at regularly recurring intervals each of prolonged duration in comparison with the interval of a permutation code character signal until said sending means resumes impressing permutation code character signals on said channel, and timing means and alarm means controlled thereby operable during intervals of message transmission whenever said channel remains continuously in fixed signaling condition for said prolonged interval of time.

9. In an intercommunicating system, a channel of impulse transmission having two stations connected thereto and having sending means capable of impressing permutation code character signals on said channel, said sending means including a tape perforated to represent message signals for transmission over said channel, tape feed mechanism for automatically advancing said perforated tape during message transmission, a timing circuit activated automatically upon discontinuance of message signal transmission by said sending means for causing to be transmitted at regularly recurring intervals during idle periods a permutation code non-character signal over said one channel, and tape feed withholding means for preventing the operation of said tape feed mechanism during the idle periods when the permutation code non-character signal is being transmitted over said channel at recurring intervals.

10. In an intercommunicating system, a channel of impulse transmission having two stations connected thereto and having sending means capable of impressing permutation code character signals on said channel, said sending means including an automatic tape transmitter and a rotary start-stop distributor cooperating therewith for transmitting permutation code signals over said channel, a stop magnet for controlling the operation of said start-stop rotary distributor, a perforated tape for controlling the operation of said automatic tape transmitter, means for maintaining said stop magnet energized during the transmission of permutation code character signals, a plurality of contact sets included in said energizing means, a tape stop arm for opening one of said contact sets when the supply of perforated tape becomes insufficient for further transmission to thereby deenergize said stop magnet and stop the operation of said start-stop distributor until such time as the supply of perforated tape becomes sufficient for further transmission, and an auxiliary pin in contact with said perforated tape for opening another of said contact sets when said perforated tape is broken or torn or the supply of said perforated tape is

exhausted to cause the continuous stoppage of said sending means and the continuous deenergization of said stop magnet.

11. A telegraph system comprising a channel of transmission having associated therewith at separated points sending means capable of impressing permutation code character signals for transmission over said channel and receiving means capable of receiving and recording the permutation code character signals transmitted from said sending means over said channel, a power switch and a message transmission start switch for said sending means, said power switch having means when energized for conditioning said system for operation and said start switch having means when energized for starting message transmission over said channel, automatically operated timing means respectively associated with said sending means and said receiving means, said timing means having different operating time intervals, other sending means automatically operable during the idle periods when said system is conditioned for operation for sending over said channel to said receiving means permutation code non-character test signals at recurring intervals of uniform duration under the control of one of said timing means, contact means included in said receiving means operative in response to each permutation code character signal incoming over said channel, and alarm means controlled by the other of said timing means and responsive when said contact means remains in its normal position for a prolonged interval of time during the intervals between message signal transmission.

12. An impulse transmission system comprising a plurality of stations, a channel interconnecting said stations, means at one of said stations for sending permutation code signals over said channel, timing means activated automatically only during the idle periods between the transmission of message code signals for measuring and counting predetermined intervals of time, and means cooperative with said sending means and operable once during each of said intervals for sending over said channel one of said permutation code signals for testing the transmission continuity of said system.

13. A telegraph transmission system comprising a plurality of stations, a channel interconnecting said stations, tape sensing transmitting means at one of said stations, other means cooperating with said tape transmitting means for sending permutation code signals over said channel, a tape perforated with message signals in permutation code, means for advancing said tape through said tape sensing transmitting means, and means automatically operable when said tape passes out of engagement with said tape advancing means to transmit over said channel independently of said tape transmitting means and said tape advancing means signals consisting exclusively of a predetermined successive number of letters signals.

14. A telegraph transmission system comprising a plurality of stations, a line circuit interconnecting said stations, tape sensing transmitting means at one of said stations, other means cooperating with said tape sensing transmitting means for sending permutation code signals of marking and spacing over said line circuit, a perforator means for supplying a tape perforated thereby with message signals in permutation code, means for advancing said perforated tape through said tape transmitting means, means including contacts controlled when the supply of perforated tape reaches a predetermined minimum for stopping transmission of message signals, means at the other of said stations for measuring a marking and a spacing condition in the line circuit having a duration in excess of predetermined intervals of time, and other means at the other of said stations operable after the expiration of said predetermined intervals commencing immediately following the cessation of transmission of message signals for indicating that no signals are incoming over said line circuit.

15. A telegraph transmission system comprising a plurality of stations, a line circuit interconnecting said stations, means at one of said stations for sending permutation code signal groups over said circuit to the other of said stations, timing means at one of said stations operable only during the idle periods between the transmission of message signals for measuring intervals of time of equal and prolonged duration in comparison with the interval of a permutation code signal, means operable during each of said intervals and cooperating with said sending means for sending over said circuit one of said permutation code signal groups for testing the transmission continuity of said circuit, timing means at said other station for measuring intervals of time each of a duration greater than any one interval measured at said one station, contact closing means at said other station responsive to each incoming permutation signal code group for nullifying the effectiveness of said timing means at said other station when signals are received from said circuit, and an alarm means responsive to the operation of said timing means at said other station when signals fail to be received from said circuit, indicating that the said circuit remains in its normally closed condition for a period at least equal to the duration of an interval measured by said timing means at said other station.

16. A telegraph transmission system comprising a plurality of stations, a line circuit interconnecting said stations, tape sensing transmitting means at one of said stations, means cooperating with said tape sensing transmitting means for sending permutation code signals over said line circuit, a tape perforator means for supplying tape perforated with message signals in permutation code, other means responsive to each code combination perforated in said tape for advancing said tape through said tape sensing transmitting means, starting means operable to condition said system for transmission of signals, a tape-controlled contact arranged to open when the supply of perforated tape is less than a predetermined minimum, a tape feeler and a contact controlled thereby, circuit means operable when said starting means, said tape-controlled contact and said tape feeler contact are closed for sending message signals over said line circuit, a second circuit means operable when said starting means and said tape feeler contact are closed and said tape-controlled contact is open for stopping transmission of message signals to the line circuit but permitting continuance of perforating message signals in the tape, a third circuit means operable when said starting means are opened and said tape-controlled contact and said tape feeler contact are closed for permitting the transmission of message signals to the line circuit, a fourth circuit means operable when said starting means are operated and said tape-controlled contact is open for stopping said trans-

mission of message signals to the line but permitting the transmission of a single permutation code signal to the line circuit at regular recurring intervals of time independently of said tape advancing means.

17. Transmitter means including a tape-controlled transmitter having tape sensing feelers for sensing signal impressed tape at a transmitting point, a distributor, an outgoing line to which said transmitter means is connected over said distributor, tape advance means associated with said feelers for stepping said tape, a feeler for sensing the presence of tape at said transmitting point, a contact actuated by said feeler upon absence of tape at said transmitting point, means controlled by actuation of said contact to initiate the sending of code combinations to said line over said distributor independently of said tape sensing feeler, and delayed action means for stopping the sending of such code combinations.

18. Transmission means including a tape sensing head having tape sensing code elements, a distributor having start means for transmitting, one at a time, code combinations sensed by said elements, a feeler for detecting the presence of tape in said head and operating a contact when said head becomes void of tape, means operated incident to operation of said contact for setting up on said distributor a definite code combination and energizing said start means to start condition, and delayed action means also set into operation incident to operation of said contact to deenergize said start means and thereby stop said distributor after transmission of a substantial number of said definite code combinations.

19. In combination, a recording telegraph signal receiver including a permutation code responsive selector mechanism operable in cycles individual to each received permutation code signal, a transfer contact means momentarily operable off-normal by said selector mechanism in each operating cycle thereof, a condenser having a closed charging circuit, a discharge path for said condenser adapted to be completed by said contact means during the off-normal operation thereof, a circuit including an electron discharge device controlled by said condenser, and an alarm device operable by said last-mentioned circuit upon activation of said electron discharge device by said condenser when charged.

20. A telegraphic channel of communication, a start-stop rotary distributor, an automatic transmitter for controlling said distributor in impressing from a perforated tape permutation code signals on said channel, means automatically effective to send over said channel a permutation code signal at regularly recurring intervals each having a duration of at least that of two permutation code signals upon and solely under control of cessation of transmission from the perforated tape in said transmitter, responding means at a point upon said channel remote from said distributor responsive to permutation code signals sent over said channel by said transmitter and the first-mentioned means, and other means operative to register a trouble condition upon failure of said responding means to receive permutation code signals for a continuous period having a duration in excess of the duration of at least that of two permutation code signals.

WALTER M. BACON.

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