

Feb. 25, 1941.

P. HOLCOMB, JR

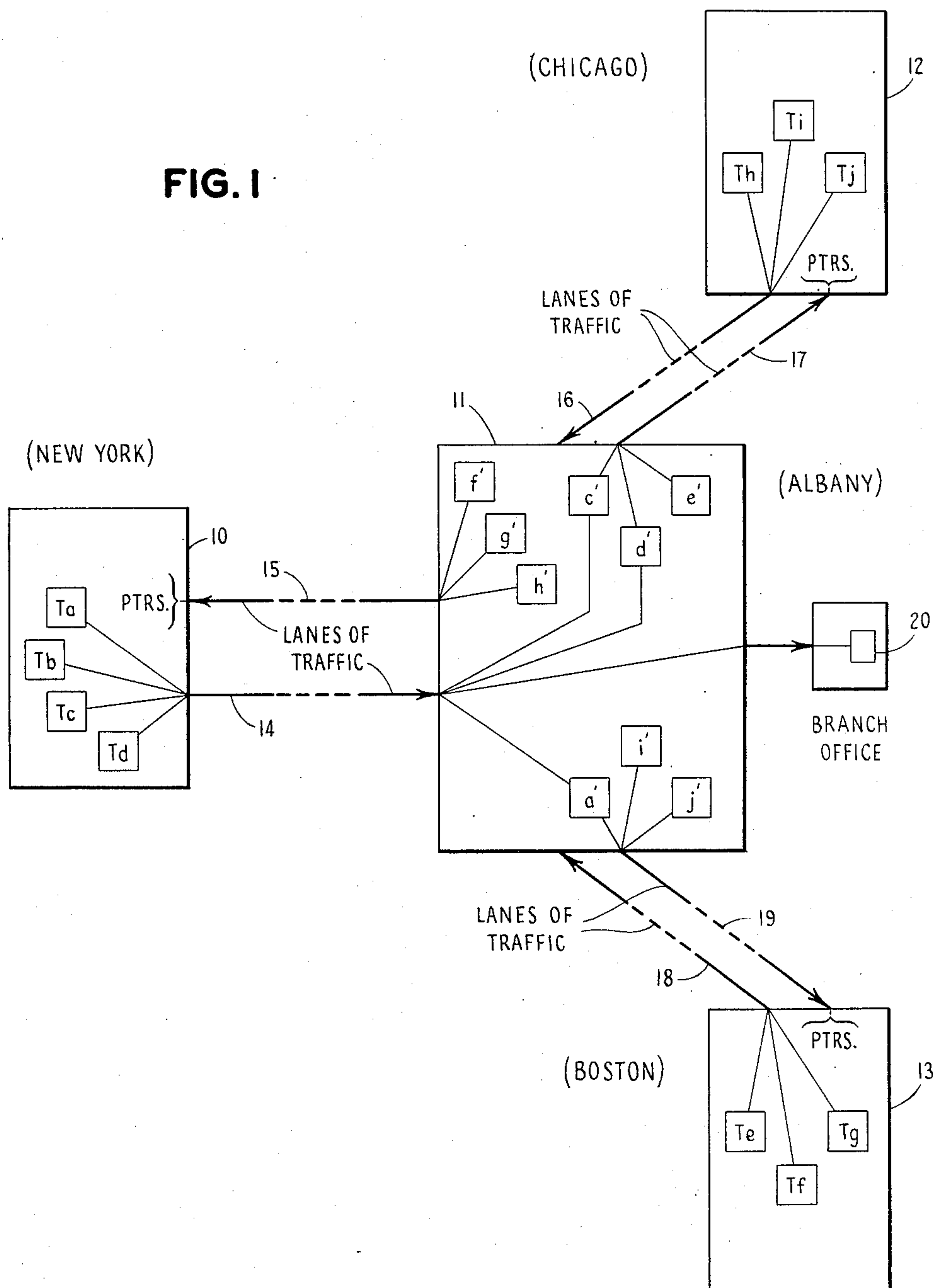
2,233,346

TELEGRAPH SYSTEM

Original Filed Oct. 21, 1936

3 Sheets-Sheet 1

FIG. 1



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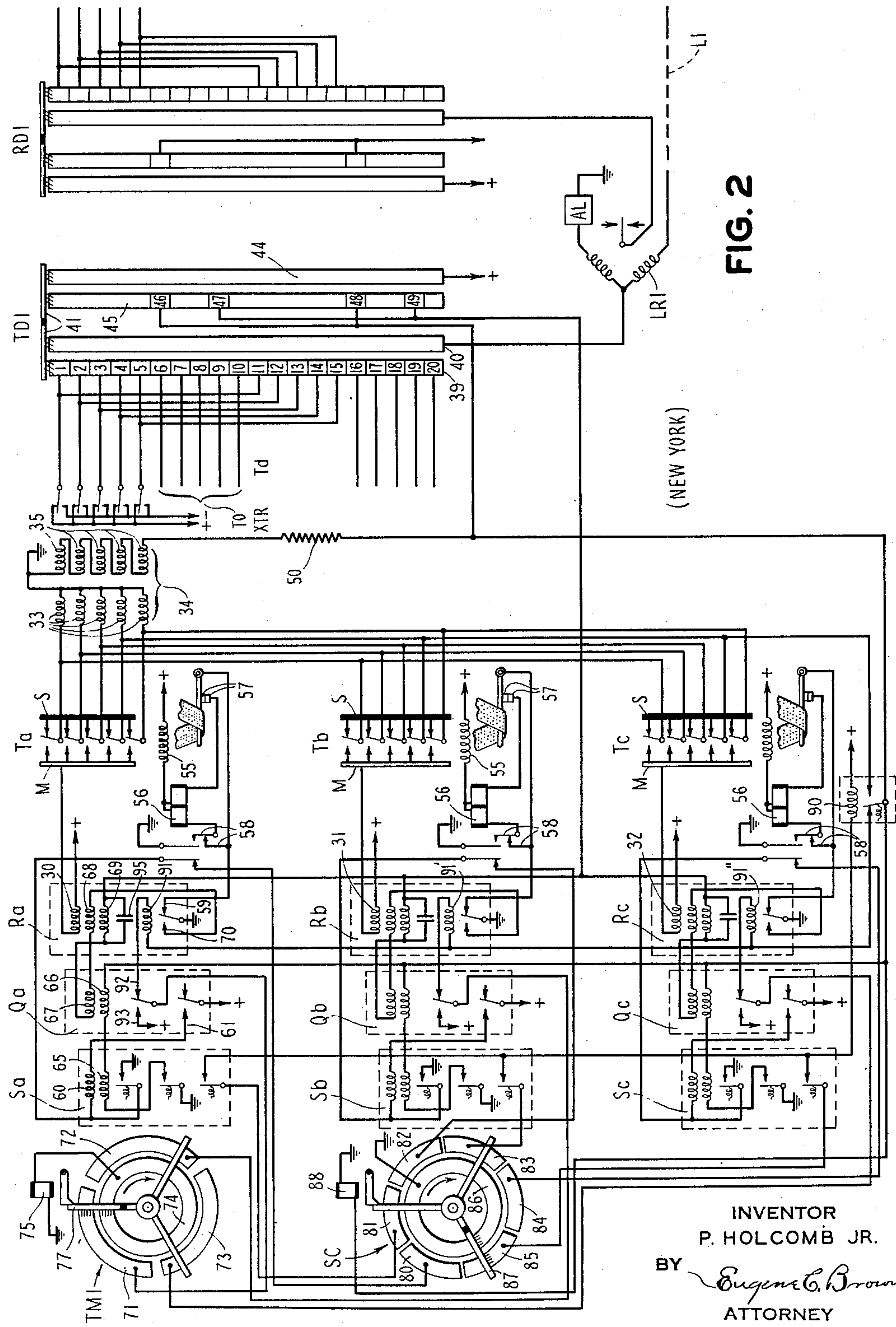


FIG. 2

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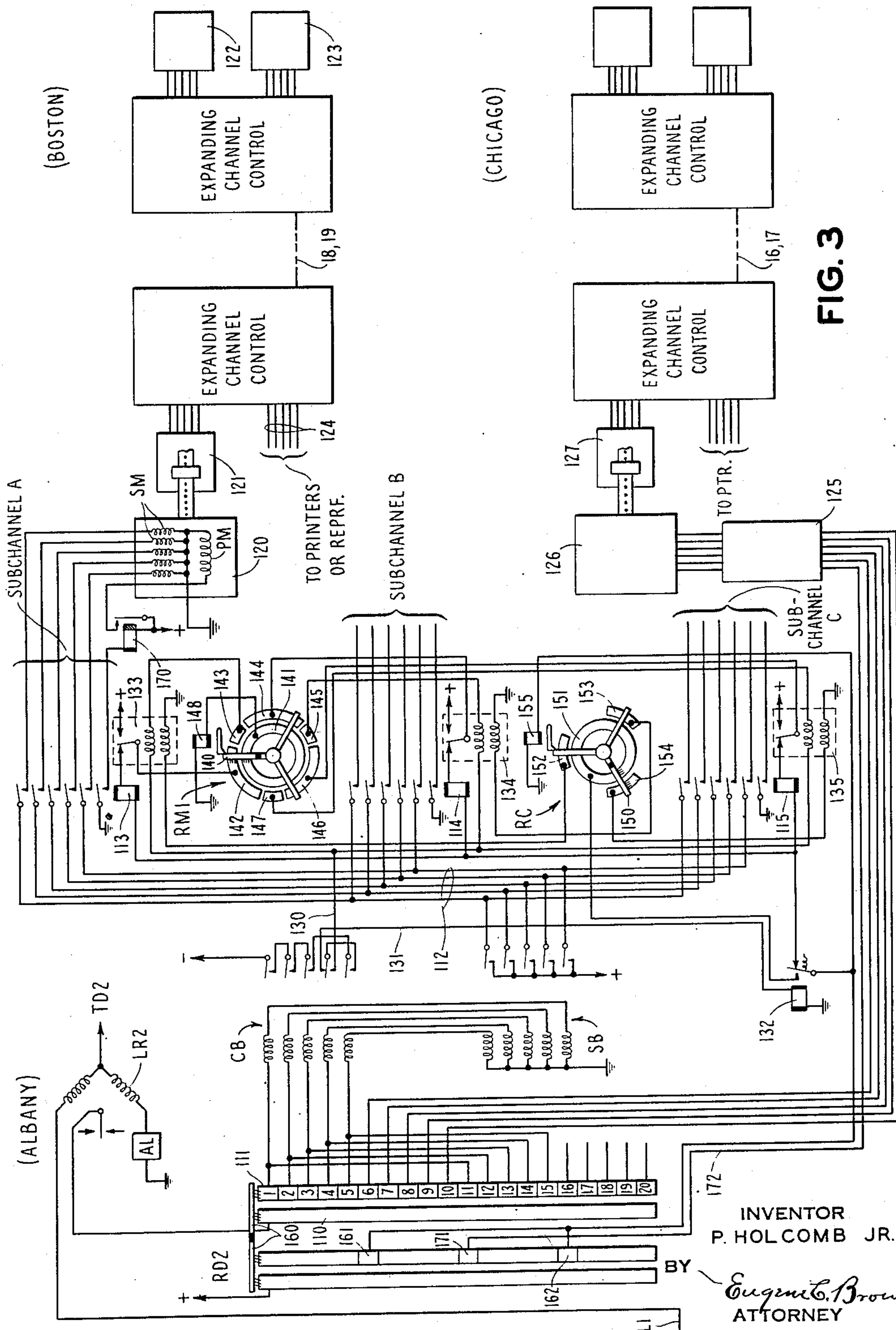
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TELEGRAPH SYSTEM

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3 Sheets-Sheet 3



UNITED STATES PATENT OFFICE

2,233,346

TELEGRAPH SYSTEM

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Application October 21, 1936, Serial No. 106,904
Renewed June 25, 1940

20 Claims. (Cl. 178—52)

This invention relates to signalling or telegraph systems and more particularly to systems of this character employing expanding channels.

In my prior U. S. application, Ser. No. 666,004, filed April 13, 1933, is disclosed the basic principle of the expanding channel system, i. e., a signalling system wherein a variable number of sending apparatus units, such as telegraph transmitters, with their respective receiving units may be operatively associated with a lane of traffic, the full lane time being divided between the operating units irrespective of number. In this manner, the lane of traffic is utilized at maximum efficiency at all times as the efficiency does not depend upon the number of busy channels or transmitters as in the case of the ordinary multiplex systems.

In general terms, the object of the present invention is to provide a signalling or communication system of the expanding channel type embodying repeaters, the present application being a continuation in part of said prior application disclosing one form of repeater.

Another object of the invention is to provide a telegraph or signalling system wherein the expanding channels utilize two lanes of traffic in series or a lane of traffic in series relation with an ordinary wire, carrier channel, radio channel or the like.

Another object of the invention is to provide a system of the above-mentioned character in which the transmission rates over series channels or lanes may be different, depending upon the character of the channels and the variations in traffic, in order to utilize the channels efficiently.

A further object of the invention is to provide a system having a lane of traffic of which one or more of the expanding channels receives signals from or transmits into another lane or lanes of traffic, the expression "lane of traffic" being defined as the medium over which signalling is accomplished; among other things a "lane of traffic" may be comprised of one or more of the following elements: a wire, a cable strand, a multiplex channel, a side of a duplex or quadruplex, a superimposed circuit, a radio or high frequency carrier channel or the like. As explained in the above-mentioned prior application, an expanding channel is a sub-channel that utilizes a part or all of a lane of traffic, for example a single channel of a multiplex system, the lane time or a predetermined part thereof being divided between the operative sub-channels.

A still further object of the invention is to provide a system of the character described em-

ploying a repeater or a plurality of repeaters in connection with expanding channels.

A still further object of the invention is to provide a telegraph system having an expanding channel and a sending device, such as a transmitter, or a receiving device, such as a printer, operatively associated therewith and adapted to operate at a rate differing from the rate of transmission of the signals of said sending or receiving device over said channel.

In order that this invention may be clearly understood and readily applied in practice, a preferred embodiment of the same illustrated in the accompanying drawings will be described. In the drawings:

Fig. 1 is a diagrammatic view of the general arrangement of the system; and

Figs. 2 and 3, taken together, show the detailed circuits of the system shown in Fig. 1.

Referring to Fig. 1, a telegraph system embodying the invention comprises a plurality of separate exchanges 10, 11, 12 and 13, which may be located, for example, in New York, Albany, Chicago and Boston, respectively. As shown, exchange 10 is connected to exchange 11 by "East" and "West" lanes of traffic, of which the No. 1 East traffic lane is indicated at 14 and the No. 1 West traffic lane is indicated at 15, said lanes utilizing any available communication medium, such as channels of a multiplex (or any other suitable channels or circuits including carrier or radio channels). As pointed out in my prior application referred to above, the character of the lane of traffic utilized by each expanding channel is immaterial. Exchange 11 is also connected to exchange 12 by lanes of traffic 16 and 17, and to exchange 13 by lanes of traffic 18 and 19.

In accordance with the present invention, communication between exchanges 10 and 12 or between exchanges 10 and 13 may be effected by utilizing two or more expanding channel lanes of traffic in series relation or an expanding channel lane of traffic in series relation with a lane of any ordinary circuit or channel by employing repeaters at the exchange 11 or another intermediate point or points at which available traffic lanes terminate. Thus a sending device, such as a code transmitter Ta at exchange 10 is arranged to control a receiving device, such as a printer at exchange 13 through the lanes of traffic 14 and 19 of an expanding channel system and a repeater a' at the intermediate exchange 11; a sending device, such as a code transmitter Tb at exchange 10 is arranged to control a receiving device, such as a printer 20 at a branch office

adjacent exchange 11 through an expanding channel of the lane of traffic 14; and sending devices such as code transmitters T_c and T_d at exchange 10 are arranged to control receiving devices, such as printers at the exchange 12 through the lanes of traffic 14 and 17 and repeaters c' and d' at exchange 13. Likewise, transmitters T_e , T_f and T_g at exchange 13 and transmitters T_h , T_i , and T_j at exchange 12 are arranged to transmit over the lanes of traffic 15, 16, 17, 18 and 19, the respective channels including repeaters e' , f' , g' , h' , i' and j' at the exchange 11. The system illustrated in simplified form can be extended indefinitely and in actual practise, a complete system includes a large number of exchanges and apparatus units, and in many instances the lanes of traffic would accommodate a large number of sub-channels, and the printers or receiving devices would be operated over channels or circuits consisting of more than two series traffic lanes.

It will be apparent that by the provision of instrumentalities for interconnecting two or more lanes of traffic in series relation the advantages and economies of the expanding channel system may be realized even where the transmitting and receiving stations are not connected by a single, direct lane of traffic. Any two telegraph stations may be provided with the equivalent of a direct line or connecting channel without selective switching of transmission circuits even though the connecting circuit includes a plurality of separate channels terminating intermediate the transmitting and receiving stations, as in the case of the transmitter T_a in New York described above which is connected to a printer in Boston through a circuit extending from New York to Albany and a second circuit extending from Albany to Boston. The repeaters, which are described in detail hereinafter, are preferably storage repeaters of such character as to be capable of storing the message signals at one rate and repeating the same at a different rate in order that the rates of transmission in different parts of the system may vary, for example to utilize the channels or telegraph equipment at maximum efficiency. However, the system is not limited to repeaters of this character.

While the invention is illustrated in connection with a printing telegraph system, it will be obvious that either printer or facsimile signals may be transmitted over the channels and that the invention may be utilized in other signalling systems.

The detailed circuits of the system shown in Fig. 1 are illustrated in Figs. 2 and 3. Referring to these figures of the drawings, three of the transmitters associated with one lane of traffic are indicated at T_a , T_b , and T_c . These transmitters may be tape transmitters of the type shown in Benjamin Patent No. 1,298,440 granted March 25, 1919. Any number of transmitters may be allotted to each lane of traffic of the system as pointed out in my above-mentioned prior application. As shown, each transmitter has an insulated spacing bus bar S and a marking bus bar M connected to positive battery through the winding 30, 31 or 32 of polar relays R_a , R_b and R_c , respectively. The tongues of each transmitter are connected through the windings 33 of a common relay bank 34 to ground. The armatures of relays 34 are connected to segments 1 and 11, 2 and 12, 3 and 13, 4 and 14, and 5 and 15, respectively, of transmitting ring 39 of a multiplex transmitting distributor TDI associated

with a line conductor L_1 , said segments forming two channels of the distributor. Thus the expanding channels are arranged in this instance to utilize a lane of traffic formed by two channels of the multiplex associated with the line L_1 .

The solid ring 40 of the distributor TDI is connected to the apex of the windings of the differential line relay LR_1 of the terminal duplex set of line L_1 in accordance with usual practise. The transmitting rings 39 and 40 and the local rings 44 and 45 of the distributor are bridged by the rotating brushes 41. The ring 45 contains local segments 46, 47, 48 and 49 in connection with the multiplex channels allotted to relay bank 34. The remaining multiplex channels may be utilized for other expanding channels or for conventional transmitting apparatus well known in the art. Local segments 46 and 48 are connected in parallel through a resistance 50 and the windings 35 of relay bank 34, the latter windings being poled so as to restore the contacts to normal or spacing positions each time a local pulse is received from the local ring 45.

The control apparatus for each transmitter T_a , T_b and T_c is identical and therefore it is only necessary to consider that associated with one of said transmitters. The tape transmitter T_a has a stepping magnet 55 connected to the midpoint of the windings of a differential relay 56. The other terminals of the windings of relay 56 are joined through the auto-control contacts 57 of the transmitter and the break contacts 58 of said relay to contact 59 of relay R_a . The inner armature of relay 56 associated with contacts 58 is grounded and the outer armature is connected through the operating winding 60 of relay S_a and thence to the left hand contact 61 of the lower armature of polar relay Q_a . Relay S_a has a locking winding 65 connected in series with a holding winding 66 of polar relay Q_a to the local segments 46 and 48 of the transmitting distributor TDI . Relay Q_a is also provided with an operating winding 67 connected in series with operating and restoring windings 68 and 69, respectively, of relay R_a . The opposite terminal of winding 68 is connected to the left hand contact 70 of relay R_a and the opposite terminal of winding 69 is connected to local segments 47 and 49 of the distributor.

A transmitting mixer TM_1 is common to all of the transmitters and has segments 71, 72 and 73 each individual to one of the transmitters and connected to the upper armatures of relays Q_a , Q_b and Q_c , respectively. The solid ring 74 of the transmitting mixer TM_1 is connected to ground through the release magnet 75.

In addition to the mixer, a sending clock SC common to all of the transmitters is provided, said sending clock having two segments 80 and 81 individual to transmitter T_a ; two segments 82 and 83 individual to transmitter T_b ; two segments 84 and 85 individual to transmitter T_c ; and a solid ring 86 which is grounded.

In the construction shown, the transmitting mixer TM_1 and sending clock SC each comprises a rotary brush carrier provided with brushes 77 and 87 bridging their respective sets of contact segments and a number of equally spaced stop arms, equal in number to the number of transmitters of the expanding channel system, controlled by release magnets 75 and 88. The brush carriers are rotated in any suitable manner, as by frictional driving connections with the driving motor of the multiplex distributor TDI . The purpose of the transmitting mixer

TM1 is to render operative in succession the transmitters which have characters or signals to send so as to transmit successive characters from each of the busy transmitters over the lane of traffic. The purpose of the sending clock SC is to time the entry of an idle transmitter as soon as it has message characters to send, this event necessarily occurring simultaneously with the entry of a printer or repeater on the receiving side of the lane of traffic. The release magnet 88 of the sending clock SC is connected to local segments 47 and 49 whereby the brush carrier of the clock is stepped twice during each revolution of the distributor brushes whereas the movement of the brush carrier of the mixer TM1 is non-uniform and depends upon the number of transmitters which are busy at any instant.

Assuming that all transmitters have a copious supply of tape, with auto-control contacts 57 of each transmitter closed and the tongues of relays Ra, Rb, Rc, Qa, Qb and Qc on their right hand contacts, all other relays in their unoperated positions and the brush 77 of the transmitting mixer TM1 in engagement with segment 71, when the local brush 41 of the transmitting distributor TDI engages the local segment 46, a local pulse will be sent over the following paths: (1) through the windings 35 of relay bank 34 to operate the armatures of said relays against their spacing contacts; (2) through the release magnet 88 of the sending clock SC releasing the brush 87 to pass on to its next group of segments; (3) through the armature and left hand contact of a relay 90, common to all the transmitters, winding 91 of relay Ra, upper armature and contact 92 of relay Qa, segments 71 and 74 and release magnet 75 of the transmitting mixer TM1 whereupon brush 77 of said mixer passes onto segment 72 and the armature of relay Ra is actuated into engagement with its left hand contact and the circuit of the stepping magnet 55 of transmitter Ta is broken. The feeler pins of transmitter Ta move upwardly, momentarily setting up a combination on the contacts of the transmitter corresponding to the character in the tape opposite the feeler pins.

Since all code combinations, except the blank signal which is used for a special purpose as explained hereinafter, have at least one marking component, one or more of the transmitter contacts will engage the marking busbar M thereby closing a circuit through the winding 30 of relay Ra, the actuated transmitter contacts and one or more of the windings 33 of the relay bank 34. The code combination is thus set up on the relay bank 34, one or more of said relays being operated to apply marking potential to one or more of the distributor segments 11—15. The energization of relay Ra as described restores its armature to the contact 59, thereby reenergizing the stepping magnet 55 to withdraw the feeler pins of the transmitter from the tape and advance the tape one character. The pins are held in the retracted position until the transmitter Ta is again reached in its regular order for operation.

All of the above operations occur while the local brush is passing from local segment 46 to local segment 47. The circuit connected to segment 47 includes windings of relays Ra and Qa but this circuit is open at this time at the left hand contact of relay Ra. As the brushes 41 continue their rotation, the transmitting segments 11—15 of the multiplex channel associated with the transmitters Ta, Tb, etc., are connected

to the line L1, thus sending the combination set up on the relay bank 34 by the transmitter Ta.

On the engagement of the local brush 41 with the local segment 48, similar circuits are completed through the windings 35 of relay bank 34, the release magnet 88 of the sending clock SC, the winding 91' of relay Rb and the release magnet 75 of the transmitting mixer TM1 through segment 72 thereof. A character from the transmitter Tb is therefore set up on the relay bank 34 for subsequent transmission to the line, the tape in said transmitter is stepped to the next character and the brush carrier of the transmitting mixer TM1 is advanced one step to render the transmitter Tc operative. The combination set up on the relay bank is transmitted upon the engagement of the distributor brushes with the transmitting segments 1—5 of the second channel of the multiplex allotted to the transmitters Ta, Tb and Tc. In this manner each of the transmitters Ta, Tb and Tc operates in succession to send over first one and then the other of the multiplex channels as long as each of the transmitters has a supply of tape.

If now the supply of tape to one of the transmitters, for example transmitter Ta, becomes exhausted, its auto-control contacts 57 will open. This occurs, of course, when transmitter Ta stops following the setting up of a new character on relays 34 just after local segment 46 or 48 of the distributor has been crossed with the brush 77 of the transmitter mixer TM1 on the segment 71. The opening of contacts 57 diverts the current flowing through the stepping magnet 55 of the transmitter entirely through the left hand winding of the differential relay 56, thereby unbalancing the relay and causing its armatures to be attracted. The operation of relay 56 applies a locking current to the stepping magnet 55 of the transmitter through the inner armature of the relay and the make-before-break contacts 58. As the transmitting distributor brushes complete their revolution, the code set up in the relay bank 34 is sent over the line. When it is again time for the transmitter Ta to transmit, the passage of brush 41 onto local segment 46 or 48 of the distributor restores the armatures of the relay bank 34 to spacing, thus setting up a blank or all spacing signal on the transmitting segments of the distributor TDI. The circuit completed from local segment 46 or 48 through the winding 91 of relay Ra and contact 92 of relay Qa to segment 71 of the transmitting mixer TM1 steps the brush carrier of the mixer to segment 72 but does not release the feeler pins of the transmitter Ta since, as described above, the stepping magnet 55 of the transmitter is locked up through the inner armature of relay 56. Consequently the spacing combination remains on the segments of the multiplex distributor and as the transmitting brush of the distributor engages the next channel allotted to the transmitters Ta, Tb, etc., the spacing combination is transmitted to the line.

The purpose of this spacing combination is to close out the printer, repeater or other receiving device, at the receiving station which is associated with the transmitter Ta. Since none of the feeler pins of the transmitter Ta is permitted to actuate the transmitter contacts to marking potential at this time, the restoring circuit for relay Ra through the winding 30 is not completed and the armature of relay Ra remains in engagement with its left hand contact 70. Consequently as the brush 41 of the transmitting distributor

engages the local segment 47 or 49, a circuit is completed from ground at the armature of relay Ra, through the contact 70, the winding 68 of relay Ra, the winding 67 of relay Qa, the winding 69 of relay Ra, to the local segment 47 or 49 connected to battery through the local brush 41. The windings 68 and 69 of relay Ra are in opposition to each other but the winding 68 predominates as long as the distributor brush is on segment 47 or 49, the polarity of said windings being such as to maintain the armature of the relay in engagement with the contact 70. However, as soon as the local brush of the transmitting distributor leaves contact 47 or 49, the condenser 95 discharges through winding 69 restoring the armature of relay Ra into engagement with the right hand contact 59.

The current through winding 67 of relay Qa actuates the armatures of this relay into engagement with their left hand contacts, thus applying battery through the upper armature and left hand contact 93 of relay Qa and the segment 71 of the transmitting mixer TM1 to the release magnet 75 to release the brush carrier of the mixer. Battery is also applied to winding 60 of relay Sa at the lower armature and contact 61 of relay Qa but the circuit of winding 60 is open at the outer armature of the differential relay 56 and relay Sa is not energized. The transmitter Ta is thus closed out since upon each subsequent revolution of the brush 77 of the transmitting mixer TM1, the brush passes directly over the segment 71 coming to rest only upon the segments 72 and 73 which only enables the transmitters Tb and Tc to transmit over the line L1. The other transmitters are closed out in a similar manner when the supply of tape is exhausted and their respective auto-control contacts are opened.

The sending clock SC performs no function during the normal operation of the transmitters nor in the closing out of a transmitter in service but acts to time the re-entry of a transmitter when the transmitter is ready to transmit to the line as indicated by the reclosure of the auto-control contacts. It will be noted that the release magnet 88 of the sending clock is connected directly to the local segments 46 and 48 of the multiplex distributor so that it is stepped twice during each revolution of the distributor and at no time is the release magnet continuously energized to move past a normal stopping position without stopping as in the case of the transmitting mixer TM1. Therefore the mixer and the sending clock are not necessarily in step.

When one of the idle transmitters, as for example the transmitter Ta, receives a supply of tape, the transmitter is entered on the line by the closing of the auto-control contacts 57 by the accumulation of the tape loop. The closing of contacts 57 completes the circuit of the right hand winding of relay 56, causing a balance to be produced through the windings of said relay and the armatures to be released. This may occur, of course, with the brush 87 of the sending clock SC in any of its positions. Eventually, however, the brush 87 is stepped around to the segments 80 and 81. As it crosses segment 80 ground is applied through the solid ring 86 and the brush 87, segment 80, the outer armature and back contact of relay 56, the winding 60 of relay Sa and the left hand contact 61 and armature of relay Qa to positive battery. Relay Sa is thus operated, locking up over a circuit through its upper armature and front contact that is independent

of the contacts of the sending clock SC. As brush 87 of the sending clock SC engages segment 81, ground is applied through solid ring 86, brush 87, segment 81, the lower armature and front contact of relay Sa and the winding of relay 90 to positive battery thereby energizing relay 90. Upon receipt of the first local impulse from either segment 46 or 48 following these operations, the impulse is transmitted through the armature and right hand contact of relay 90 to the fourth winding 33 of relay bank 34 in a marking direction and in opposition to the impulse supplied at the same time from segment 46 or 48 through the windings 35 of this relay bank in a spacing direction. On account of the resistance 50 in circuit with the windings 35 the current through the winding of the fourth relay 33 always predominates so that the armature of said relay is moved to its marking side while the armatures of the remaining relay are operated to their spacing sides. The marking force of coils 33 is always greater than the spacing resetting force through the winding 35 so that the marking force always prevails where both windings are energized simultaneously. Thus this combination having the fourth impulse marking is set up on the segments of the transmitting ring of the distributor TD1. Since the armature of relay 90 is on its right hand side at this time, the local impulse from segment 46 or 48 of the distributor does not reach the segments of the transmitting mixer TM1 and consequently the mixer remains at rest for this cycle of operation. The local impulse does find a path, however, through the winding 66 of relay Qa and the winding 65 of relay Sa to ground at the middle armature of the latter relay, thereby restoring relay Qa to its right hand side and removing battery at contact 61 of this relay from segment 71 of the transmitting mixer TM1. Winding 65 of relay Sa merely holds this relay on its right hand side until relay Qa operates. With relay Qa restored to its right hand side, the transmitter Ta is completely entered on the line and serves to transmit in its turn with the remaining operative transmitters as described above.

At first the special code combination with the fourth impulse marking is set up on the transmitting distributor. Therefore, on the next revolution of the distributor brushes this combination is sent over the line L1 to enter the printer or repeater at the receiving station on the line as will be described hereinafter.

It should be noted that the entry of transmitter Ta may occur with the mixer TM1 in any position, the mixer being held in that position for the entering cycle. As the mixer continues to revolve following the entry of the transmitter Ta, it will eventually reach segment 71 at which time the first character code combination on the tape in said transmitter will be set up in the relay bank 34 in the ordinary manner.

The closing out of the transmitter is always followed by the transmission of a blank or all spacing signal over the line as the concluding signal from that transmitter and the entry of an idle transmitter on the line is preceded by the transmission of a special entry code combination having the fourth impulse marking and occurring whenever the brush of the clock SC reaches the segments corresponding to the transmitter being entered on the line. With these conditions in mind the receiving apparatus at the distant station will now be described. Obviously,

the means for controlling the disconnection and reconnection of a transmitter to the expanding channel may be varied if desired and may further utilize other special signals or code combinations which are not employed for transmitting character signals.

Signals transmitted over the line L1 are received by the line relay LR2 (Fig. 3), which by way of example is shown as being located in the exchange or office in Albany, whereas the transmitter Ta is arranged to control a printer located in Boston, so that an additional channel from Albany to Boston is involved in the communication circuit. The line relay LR2 impresses the received signals upon the solid ring 110 of the receiving distributor RD2, the signals being transferred through segments 1 to 5 and 11 to 15 of the receiving ring 111 to the relays of a code bank of relays CB and a storage bank of relays SB. The armatures of the storage relays SB are connected through the conductors 112 in multiple to the armatures of multicontact relays 113, 114 and 115.

The circuits connected through the contacts of relays 113, 114 and 115, respectively, extend to the receiving apparatus of subchannels A, B and C corresponding to transmitters Ta, Tb and Tc, respectively. Subchannel A includes, at this office, repeating means such as a tape reperforator 120 and tape transmitter 121 arranged to repeat the received signals over another lane of traffic extending to Boston. The tape reperforator 120 may be similar to that disclosed in the patent to Hoover and Haupt, No. 1,851,838, granted March 29, 1932. Other well known storage devices may be employed, if desired, but a device having infinite storage capacity is preferred since provision is thus made for an unlimited accumulation of message signals at this point. The tape transmitter 121 may be similar to the transmitters Ta, Tb and Tc, and the manner in which this transmitter is entered on the associated lane of traffic whenever tape is fed out of the reperforator 120 will be clear from the foregoing description of the operation of transmitters Ta, Tb and Tc. A printer 122 at the remote end of the channel is arranged to respond to the message signals from the transmitter 121. The transmission rate over the second expanding channel is determined by the capacity of the traffic lane available and the number of operative transmitters or repeaters utilizing the traffic lane, and may be different from the rate of operation of reperforator 120 over the first traffic lane.

The line circuits or lanes 18, 19 may be combined in a duplex circuit, as in the case of the line L1, and one or more transmitters 123 are arranged to control printers or repeaters connected to the conductors 124, in the same manner as the transmitters Ta, Tb and Tc, for receiving signals from Boston. For the sake of simplicity, these detailed circuits are not shown.

Subchannel B of the lane of traffic from New York to Albany is connected to a printer, for example in a branch office in Albany as disclosed in my prior application to provide communication between New York and Albany; subchannel C is connected to a repeater associated with a lane of traffic to Chicago, arranged similarly to that shown in connection with subchannel A. The channel of the multiplex represented by the segments 6—10 is connected through a control apparatus unit 125 to repeater 126, 127 associ-

ated with a lane of traffic to Chicago which, as indicated, is similar to the Boston channel.

Referring again to the expanding channel system shown in detail in the drawings, the armatures of relays CB are coded so as to supply negative battery to a conductor 130 whenever a blank or all-spacing signal is received and to apply the same battery potential to a conductor 131 whenever the entry code combination having the fourth impulse marking is received, thereby operating entry relay 132. At the receiving end of the lane of traffic there is also a receiving mixer RM1 and a receiving clock RC, common to all of the receiving printer and repeater units, and polar cut-out relays 133, 134 and 135, each individual to one of the receiving units. The receiving mixer RM1 comprises a brush carrier having a brush 140 rotating in synchronism with the brush 77 of the transmitting mixer TM1 and latch mechanism similar to that of the transmitting mixer. The brush 140 is arranged to connect a solid ring 141 with six contact segments 142, 143, 144, 145, 146 and 147, one after the other. The solid ring 141 is connected to a release magnet 148. The receiving clock RC comprises a rotating brush carrier provided with a brush 150 rotating in synchronism with the brush 87 of the sending clock SC and controlled by latch mechanism similar to that of the sending clock. The brush 150 is arranged to connect a solid ring 151 with three contact segments 152, 153 and 154, one after the other, when released by the release magnet 155. The solid ring 151 is connected to the make contact of relay 132. The segments 152, 153 and 154 of the receiving clock RC are connected to windings of the polar relays 133, 134 and 135 respectively, the other windings of said relays being connected to the short segments 143, 145 and 147, respectively, of the receiving mixer RM1.

Assuming that each of the transmitters Ta, Tb and Tc is transmitting over the lane of traffic with the brush 140 of the receiving mixer RM1 on segment 142 and the combination from the transmitters Ta to have just been received and stored in the bank of storage relays SB, then as brush 160 of the multiplex receiving distributor RD2 passes on to the local segments 161 or 162 of the local ring, an impulse will be sent over the following circuits: (1) through the release magnet 155 of the receiving clock RC to advance the brush 150 thereof to the next segment; (2) through the armature and back contact of relay 132, the winding of relay 113 associated with subchannel A, the left hand contact and armature of relay 133, segment 142, brush 140 and solid ring 141 of the receiving mixer RM1, and through the release magnet 148 of the mixer, escaping brush 140 to segment 144. The energization of relay 113 connects the selecting magnets of the reperforator 120 to the armatures of the storage relays SB, setting up in the reperforator the combination stored in the storage relays and also through its lower armature and front contact closes the circuit of slow operating relay 170. The relay 170 is arranged to energize the punch magnet of the reperforator and step the tape therethrough as is well known in the art.

As the brushes 160 of the receiving distributor RD2 continue their revolution crossing the receiving segments 11—15 or 1—5, a character from transmitter Tb is set up on the storage bank SB. Immediately thereafter as the brush 160 engages the local segment 161 or 162, this character is recorded on the printer connected to subchannel

B. At the same time the brush 140 of the receiving mixer R1 and the brush 150 of the receiving clock RC move into their succeeding positions.

As the brushes 160 of the receiving distributor RD2 cross the receiving segments 6—10, the character received over the second channel of the multiplex is stored in the tape at the reperforator 126 for subsequent transmission to the channel associated with the tape transmitter 127. The local ring of the distributor may be provided with a segment such as the segment 171 connected through conductor 172 to the control unit 125 for operating the connecting relay and punch magnet of the reperforator 126 in a manner similar to that described above.

If now the transmitter Ta is closed out as described above, such condition is indicated by the reception of an all-spacing code combination on the receiving distributor of the multiplex at a time when the brush 140 of the receiving mixer RM1 rests on the segment 142. This combination is set up in the storage bank SB and the control bank CB, the latter being arranged as described to apply negative battery to the conductor 130 upon receipt of this code combination, thus preparing a circuit through the upper winding of polar relay 133 to the segment 143 of the receiving mixer RM1. As the next local impulse occurs, brushes 140 and 150 are escaped at the same time as described above and as the brush 140 crosses the small segment 143, it completes the circuit through the upper winding of relay 133, moving the armature of said relay to its right hand contact and thereby applying positive battery continuously to the segment 142 of the receiving mixer RM1. This closes out the repeater associated with subchannel A from further operation because the brush 140 of the receiving mixer will pass without stopping over the segment 142 upon subsequent revolutions of the brush carrier. Therefore, succeeding signals transmitted by the transmitters Tb and Tc will be received only on the printer and repeater associated with subchannels B and C, respectively.

If transmitter Ta is entered on the circuit again, this operation will be indicated at the receiving station by the reception of the entry code combination having the fourth impulse marking. This will occur only when the brush 150 at the receiving clock RC is at rest on segment 152 since the receiving clock RC and the sending clock SC are both invariably stepped ahead two positions upon each revolution of the multiplex distributors and are therefore maintained in synchronism.

The entry code combination applies negative battery to the winding of relay 132 whereupon said relay becomes energized and disconnects the local segments 161 and 162 from the windings of relays 113, 114 and 115, and the receiving mixer RM1 is thus held in its last position in the same manner that the transmitting mixer TM1 was held at rest during the transmission of this entry code combination. The operation of relay 132 also closes a circuit from the segment 161 or 162 to the solid ring 151 of the receiving clock RC and thence by brush 150 and segment 152 to the lower winding of relay 133 in a direction to restore the armature thereof to its left hand contact, thus removing positive battery from the segment 142 of the receiving mixer RM1. Consequently the repeater associated with subchannel A is re-entered on the lane of traffic so that it will respond to subsequent signals transmitted from the transmitter Ta. Upon the re-

ception of the next code combination upon segments 1—5 or 11—15, the described circuit of relay 132 is interrupted and the receiving apparatus of the lane of traffic is restored to normal with the repeater 120, 121 entered upon the lane. In a similar manner the receiving apparatus associated with subchannels B and C are automatically disconnected from the lane of traffic and reconnected thereto at the same time that the corresponding transmitters Tb and Tc are disconnected and reconnected to the transmitting end of the lane.

It will be obvious that the tape transmitter 121 or an equivalent automatic transmitter may be arranged to transmit over other types of circuits than a subchannel of the lane of traffic to Boston as indicated. Furthermore, various types of repeating apparatus including mechanical storage transmitters known in the art may be employed in lieu of the tape reperforator and tape transmitter described in detail. Instead of employing two channels of a synchronous multiplex system as the lane of traffic for the various subchannels, as illustrated in the drawings, it will be obvious that one channel or three or more channels might be used or one or more circuits or channels of a different character. The lane of traffic may also consist of combinations of different types of channels, such as a synchronous multiplex channel and a carrier channel, or other arrangements of circuits or channels of any desired character. Various other modifications of the particular embodiment shown will occur to those skilled in the art and may be made without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In a communication system, a first lane of traffic, means for transmitting signals, means for varying the number of channels operating over said lane of traffic and causing the operating channels to occupy invariably substantially the full lane time, a second lane of traffic and means for repeating certain of the message signals transmitted over said first lane of traffic into said second lane of traffic.

2. In a communication system, a first lane of traffic, means for varying the number of channels operating over said lane of traffic and causing the operating channels to occupy invariably substantially the full lane time, a second lane of traffic in series relation with said first lane of traffic and means for varying the number of channels operating over said second lane of traffic and causing the operating channels to occupy invariably substantially the full lane time.

3. In a communication system, a first lane of traffic, means for transmitting signals over said lane, means for varying the number of channels operating over said lane of traffic and causing the operating channels to occupy invariably a predetermined part of the capacity of the lane, a second lane of traffic and means for transmitting signals over said second lane and causing a variable number of channels to occupy invariably a predetermined part of the capacity of the second lane, said last-mentioned means including means for repeating signals transmitted over the first lane of traffic.

4. An expanding channel system comprising a plurality of lanes of traffic in series relation, code telegraph transmitters associated with each lane, means for controlling certain of said transmitters to repeat signals received from another transmitter and means to divide a predetermined part of

the lane time of each of said lanes of traffic between the operative associated transmitters irrespective of the number which are operative.

5 An expanding channel system comprising
 5 two lanes of traffic in series relation, a plurality of signal transmitters associated with each lane, means for controlling a transmitter on the second lane in accordance with the operation of a transmitter on the first or preceding lane and means
 10 to divide a predetermined part of the lane time of each of said lanes of traffic between the operative associated transmitters irrespective of the number which are operative.

6. In a communication system, a lane of traffic,
 15 a plurality of code telegraph transmitters, means for rendering any one or more of said transmitters operative to transmit over said lane and for dividing a predetermined part of the entire lane time between operative transmitters, and signal
 20 storage and repeating means between each of said transmitters and said lane of traffic.

7. In a communication system, a lane of traffic, a plurality of code telegraph transmitters, means for rendering any one or more of said transmitters
 25 operative to transmit over said lane and for dividing a predetermined part of the entire lane time between operative transmitters, and means for operating one of said transmitters at a rate different from that at which the signals therefrom
 30 are transmitted over said lane of traffic.

8. In a communication system, a lane of traffic, a plurality of code telegraph transmitters, means for rendering any one or more of said transmitters operative to transmit over said lane
 35 and for dividing a predetermined part of the entire lane time between operative transmitters, and multiple-character signal storage means between one of said transmitters and said lane of traffic.

9. In a printing telegraph system, a lane of traffic, a plurality of printers, means for operatively associating a variable number of said printers with said lane and for dividing the entire lane time between operative printers, and multiple-character signal storage means between said
 40 lane and one of said printers.

10. In a printing telegraph system, a lane of traffic, a plurality of printers, means for operatively associating a variable number of said printers with said lane and for dividing an invariable
 50 portion of the lane time between operative printers irrespective of number, and code signal storage means between said lane and one of said printers.

11. A signalling system comprising two lanes of traffic, a plurality of signalling sub-channels including receiving devices, means for operatively
 55 associating a variable number of said receiving devices with one of said lanes and for dividing an invariable portion of the lane time between operative receiving devices irrespective of number, and signal storage means between said lanes of traffic in the subchannel to which one of said receiving devices is connected.

12. A telegraph system comprising a lane of traffic, a plurality of signal storage devices of the infinite storage type associated therewith,
 65 means for operating any one or more of said devices over said lane, means for entering any of said devices thereon, means whereby said last mentioned means is operable over said lane and means whereby the operative storage devices
 70 divide a predetermined part of the entire lane time at all times.

13. A telegraph system comprising a lane of traffic, a plurality of signal storage devices associated therewith, a transmitter individual to

each of said storage devices and arranged to repeat the signals stored therein, means for operating any one or more of said storage devices over said lane, a sequencing device and means
 5 for operating said sequencing device through successive positions individual to each of said storage devices for determining the order of operation of said storage devices when more than one is operative at the same time.

14. A telegraph system comprising a lane of traffic, a plurality of signal storage devices of the infinite storage type associated therewith, a transmitter individual to each of said storage devices and arranged to repeat the signals stored therein, means for operating any one or more of
 15 said storage devices over said lane, a sequencing device, means for operating said sequencing device through successive positions individual to each of said storage devices for determining the order of operation of said storage devices when
 20 more than one is operative at the same time and means for automatically connecting a storage device to and disconnecting the same from said lane of traffic.

15. A telegraph system comprising a lane of traffic, a plurality of tape reperforators associated therewith, a tape transmitter individual to each of said reperforators, means for operating any one or more of said tape reperforators over said lane for periods depending upon the number of
 30 channels operating and means including said reperforators for controlling said transmitters.

16. A signalling system comprising two lanes of traffic, a plurality of signalling sub-channels including receiving devices, means for operatively
 35 associating the variable number of said receiving devices with one of said lanes and for dividing a predetermined portion of the lane time between operative receiving devices irrespective of number and a signal repeater between said
 40 lanes of traffic in the sub-channel to which one of said receiving devices is connected.

17. A telegraph system comprising three offices, an expanding channel system connecting the first and second offices, said system embodying means including code transmitters at the
 45 first office arranged to send a varying number of code character signals from each transmitter in a given time, receiving devices at the second office arranged to receive said signals and means
 50 at the second office for repeating said variable rate signals to the third office.

18. A telegraph system comprising a character storage device, a signalling circuit terminating in said device, and an expanding channel system including transmitting subchannels of which the transmitting capacity varies, means for varying the number of said subchannels in operation and means for causing the transmitting capacity of said operating subchannels to vary depending
 60 upon the number of operating subchannels, said expanding channel system further including a code transmitter and means for operating said transmitter under the control of said character storage device.

19. A telegraph system comprising a signal storage device of the infinite storage type, a signalling circuit terminating in said device and an expanding channel system including transmission subchannels of which the transmitting
 70 capacity varies, means for varying the number of said subchannels in operation and means for causing the transmitting capacity of said operating subchannels to vary depending upon the number of operating subchannels, said expand-
 75

ing channel system further including transmitting means operatively associated with said signal storage device.

- 5 20. A telegraph system comprising a signal storage device of the infinite storage type, a signalling circuit terminating in said device and an expanding channel system including transmission subchannels of which the transmitting capacity varies, means for varying the number

of said subchannels in operation and means for causing the transmitting capacity of said operating subchannels to vary depending upon the number of operating subchannels, said expanding channel system further including transmitting means arranged to repeat the signals stored 5 in said signal storage device.

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