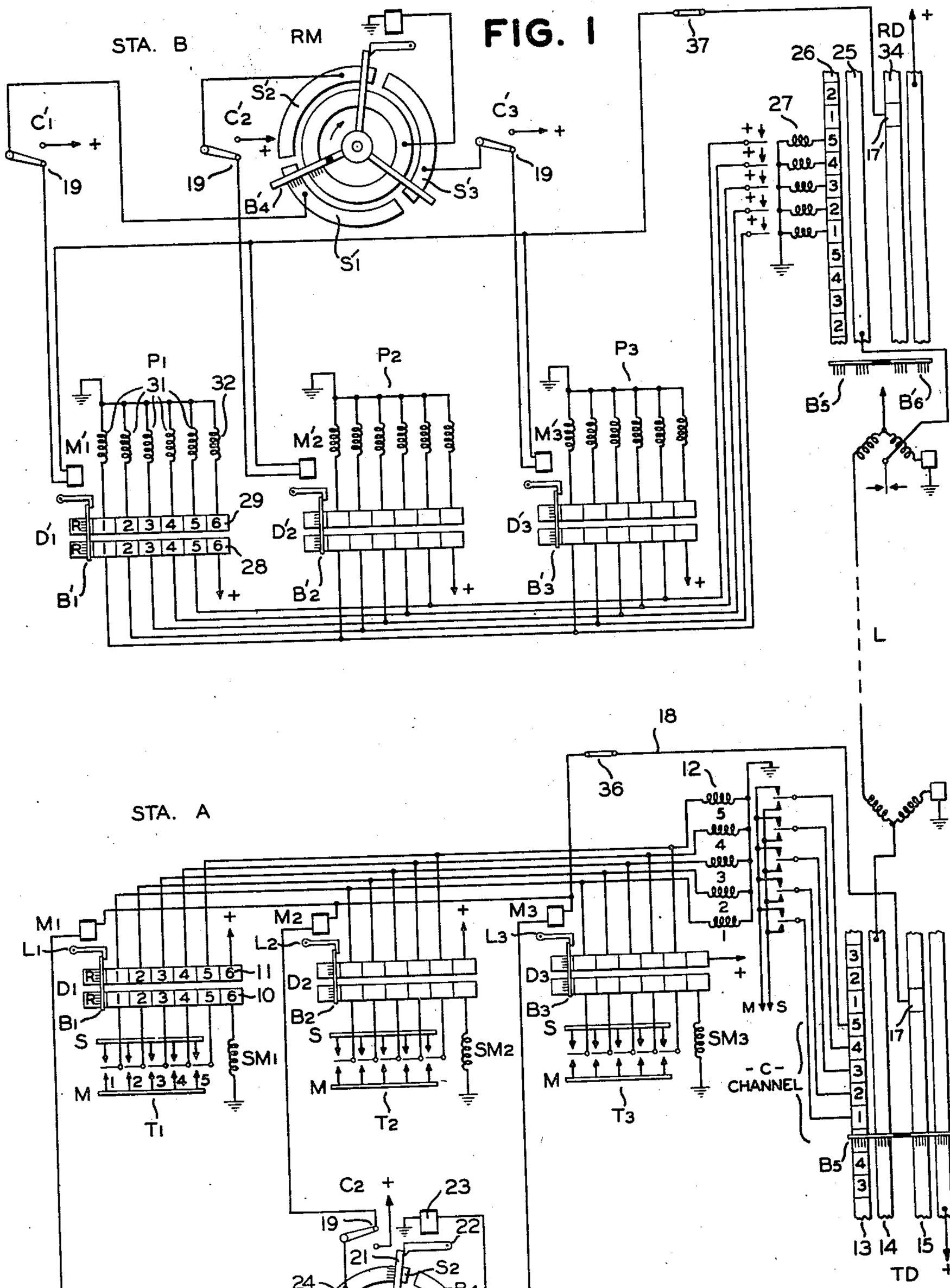
March 9, 1943. P. HOLCOMB, JR 2,313,238

MULTICHANNEL TELEGRAPH SYSTEM

Filed April 13, 1933 5 Sheets-Sheet 1

FIG. 1



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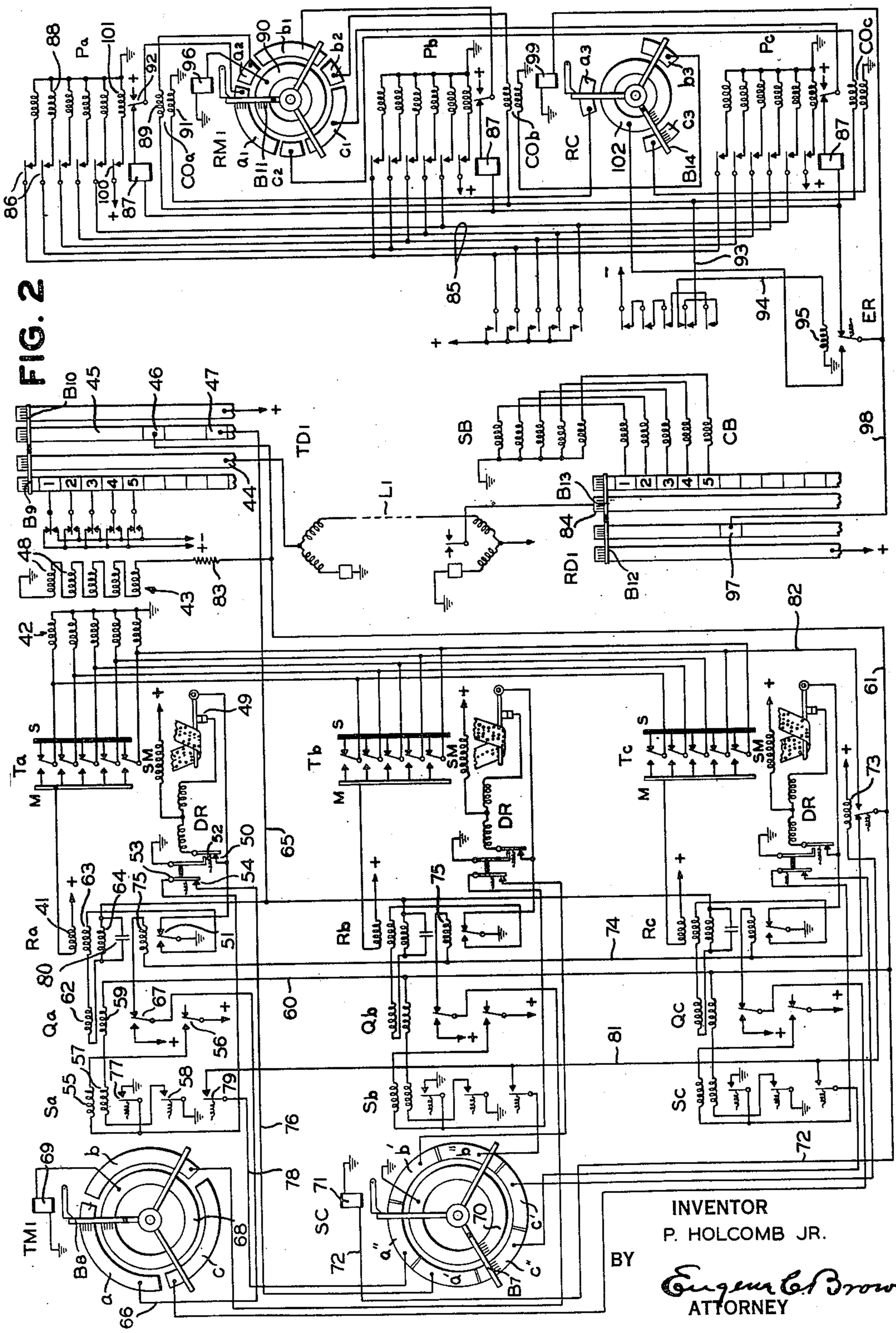
MULTICHANNEL TELEGRAPH SYSTEM

Filed April 13, 1933 5 Sheets-Sheet 2

FIG. 2



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MULTICHANNEL TELEGRAPH SYSTEM

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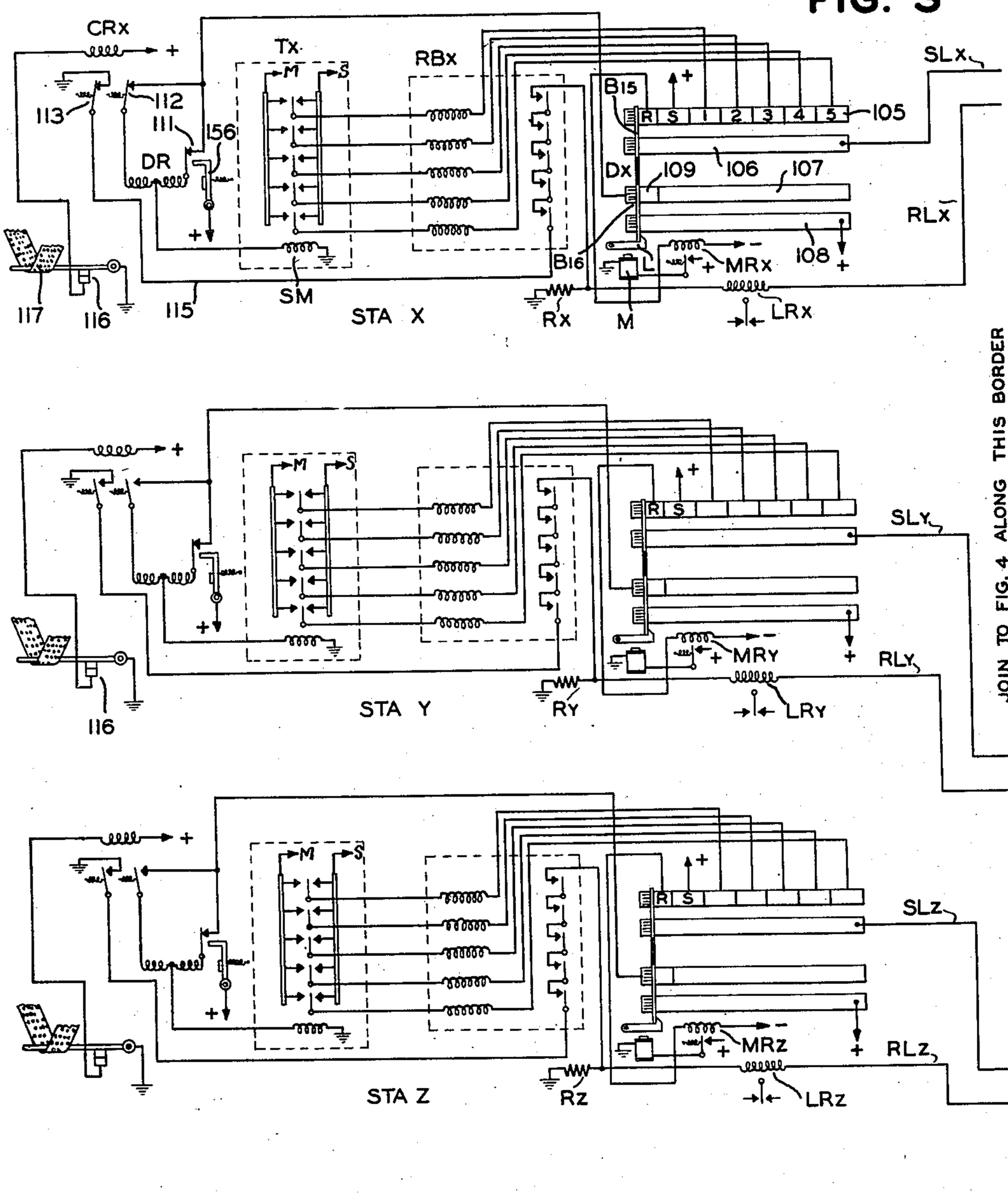
FIG. 3



JOIN TO FIG. 4 ALONG THIS BORDER

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MULTICHANNEL TELEGRAPH SYSTEM

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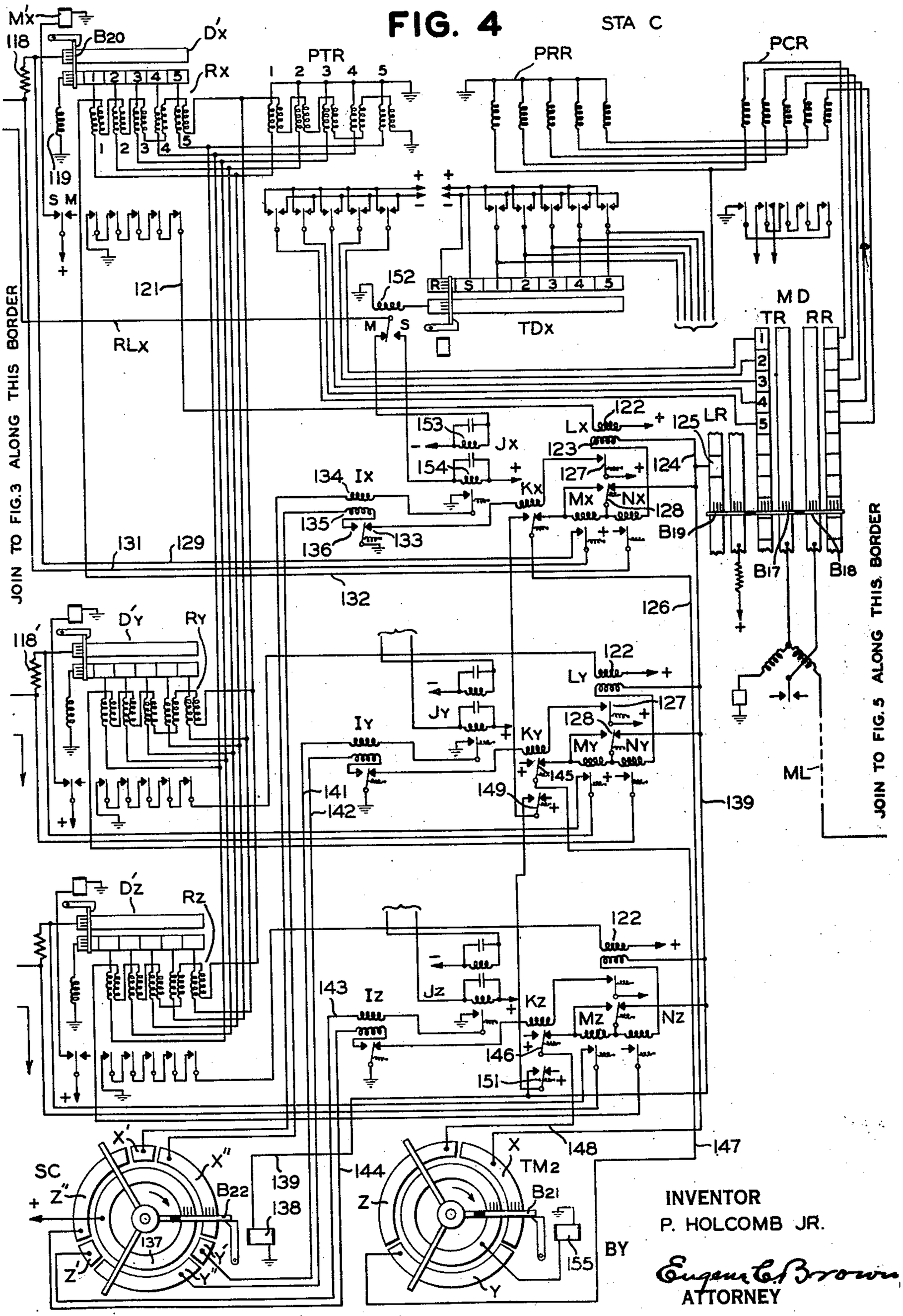
FIG. 4



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MULTICHANNEL TELEGRAPH SYSTEM

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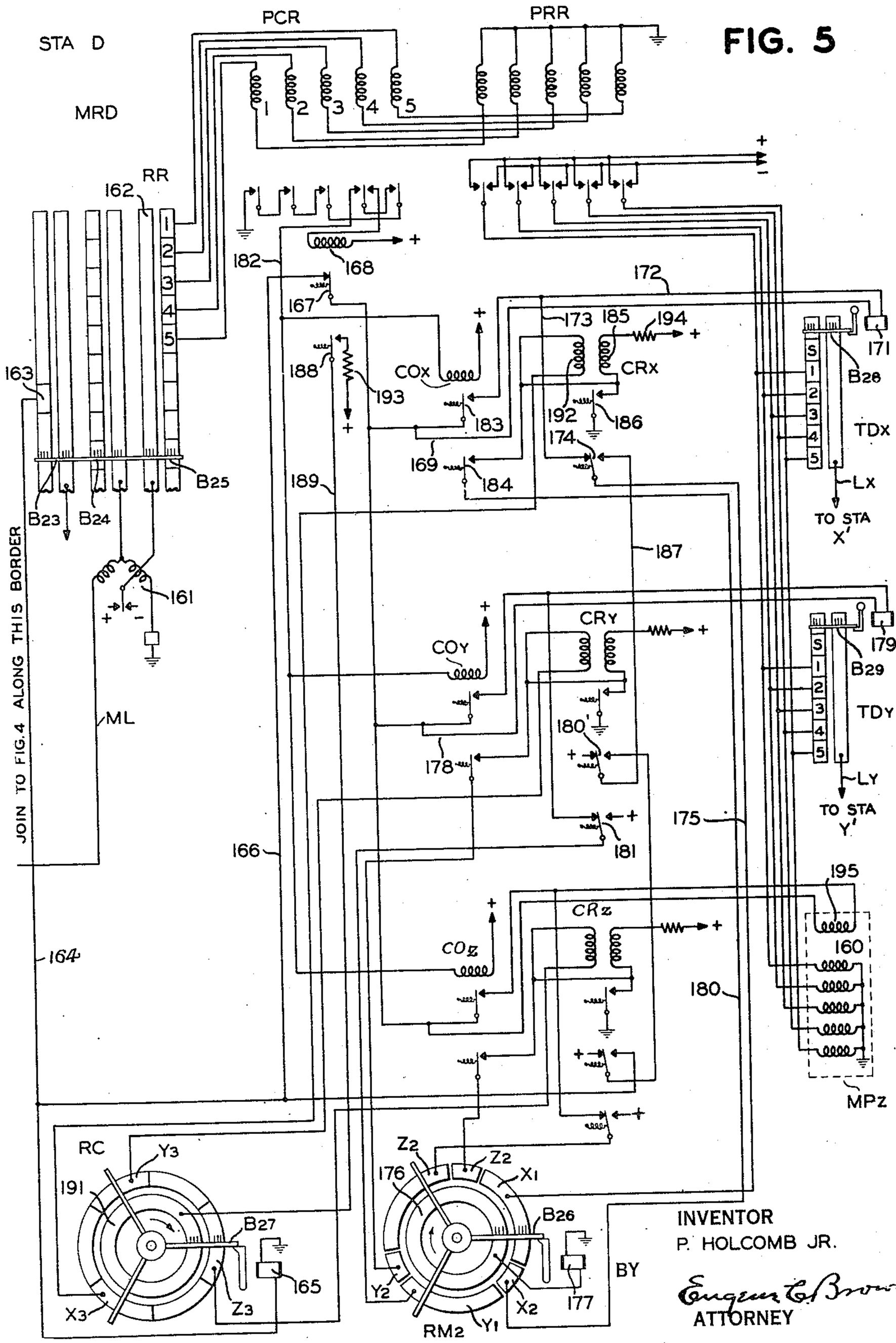
FIG. 5



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Patented Mar. 9, 1943 2,313,238

UNITED STATES PATENT OFFICE

2,313,238

MULTICHANNEL TELEGRAPH SYSTEM

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Application April 13, 1933, Serial No. 666,004

107 Claims. (Cl. 178—52)

This invention relates to a signalling system and more particularly to the transmission of signals from a variable number of sources to receiving devices corresponding to the respective sources of signals.

The expression "a lane of traffic" as used in the following description and referred to in the claims refers to the route or 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 or conductor, a multiplex channel, a side of a duplex or quadruplex, a carrier current channel, a superimposed circuit, or a radio band channel or circuit.

The single line system carrying a single message at a time has the disadvantage that the capacity of the line generally exceeds the capacity of the transmitting operator and as a result the line is not efficiently utilized. Attempts to share the line between two or more operators have usually resulted in confusion and delay due to the inevitable struggle for possession of the line.

The multiplex system, while providing a means whereby a small number of operators may share a single line, has permanent channel assignments and therefore is wasteful of line time unless all channels are constantly in use.

One of the objects of the present invention is to produce a signalling system having extreme flexibility in which any one or more of a large group of transmitters may transmit simultaneously over a single lane of traffic to separate receiving devices or printers and in which the lane will be most efficiently used. This system I have termed a "varioplex" or "expanding channel" system.

Another object is to provide a channel signalling system in which the number of channels may be varied at will and in which there is no idle channel time.

A still further object of the invention is the provision of means for dividing a lane of traffic between any desired number of transmitters, any one or more of which may enter on the lane at any time and share it with every other busy transmitter.

The application of the present invention to a single telegraph line or other single lane of traffic may be likened to a multiplex system operating over that lane in which the number of channels may be expanded substantially instantly from a single channel to any required number of channels.

By way of illustration, if it is assumed that ten operators, who may be located in widely separated branch offices, are assigned to a single lane of traffic, none of which has sufficient business to occupy the full lane, but the aggregate business of which substantially fills the lane, then in accordance with the present invention, if only one of the operators has business to transmit at any instant, such operator may take complete possession of the lane. If the lane has a capacity of sixty words per minute, the message of the single busy operator will be transmitted at that rate. If during the period of such transmission another operator becomes busy he may cut in on the lane without notice to the first operator and share the lane equally with him on the basis of a two channel multiplex system, each transmitter operating at thirty words per minute. If the first operator completes his business before the second operator, he may close his transmitter out of the lane whereupon the second operator will have full possession and his transmitter is automatically speeded up to the full sixty word rate. Similarly if three operators are busy simultaneously they will share the lane equally, each on a twenty word per minute basis and so on up to the limit of the number of transmitters assigned to the particular lane. The rate of transmission of course will vary with the number of busy operators, but each operator is able to occupy a portion of the lane at any time. The number of channels in operation over the lane is therefore continuously shifting, but the lane is always operating at its maximum capacity as long as any operator has business to transmit thereover.

Further objects of the invention are, in a system of the above nature, to provide means for enabling any operator assigned to the lane to enter his transmitter into or close it out of the lane; for enabling this function to be accomplished automatically under the control of any channel operator or channel transmitter; for properly synchronizing the transmitter and receiving channeling apparatus and for varying the number of channels operating over the lane without interfering with other active channels other than to change the rate of transmission thereover.

A still further object is to provide a direct, permanent and instantly accessible connection between a multitude of stations or transmitting positions associated with one central office and a multitude of stations or receiving positions associated with another central office, over a single

line or over a single fixed multiplex channel extending between said central offices.

Another object is to enable one of the fixed channels of a multiplex system to be expanded into any required variable number of sub-channels.

Another object is to enable the speed of operation over each channel of a variable channel system to be automatically adjusted in accordance with the number of working channels.

Still another object is to enable each channel of a variable channel system to be extended from a central receiving station to individual sub-stations or subscribers' offices and to enable the transmitted signals to be recorded on printers individual to each transmitter.

Other objects and advantages of the system will appear as the description proceeds.

The invention will be more fully understood by reference to the following detailed description of preferred embodiments thereof shown on the accompanying drawings in which:

Figure 1 is a circuit diagram of a manually controlled expanding channel system showing the invention applied to one of the fixed channels of a multiplex system.

Figure 2 is a similar view of an automatically controlled system; and

Figures 3, 4 and 5 illustrate more detailed circuit arrangements of a complete automatic expanding channel system with extended channels, Figure 3 showing the transmitting equipment in each of a plurality of sub-stations associated with one central office, Figure 4 showing the transmitting channel controlling equipment at one central office, and Figure 5 showing the receiving equipment at the distant central office.

Reference will first be had to Figure 1 which shows the transmitting equipment at station A and the receiving equipment at station B of an expanding channel system. It is to be understood, however, that the system may be duplexed with transmitting and receiving equipment at each station.

The transmitting equipment at station A comprises a number of tape transmitters T1, T2, T3, etc. (three in the present instance although the number is unlimited). Each tape transmitter comprises the marking and spacing bus bars M and S respectively, a group of five contacts numbered 1 to 5 adapted to be set against one or the other of the bus bars in accordance with the perforations in a tape and a tape stepping magnet SM. The tape transmitter may be of the form shown in patent to G. R. Benjamin, 1,298,440, granted March 25, 1919. The contacts 1 to 5 of each transmitter are connected to the correspondingly numbered segments of rings 10 of start-stop distributors D1, D2, D3, etc. Each distributor has in addition a rest segment R and a sixth pulse segment 6, the latter of which is connected to one terminal of the stepping magnet SM of its associated transmitter, the opposite terminal thereof being grounded. The brushes B1, B2, B3, etc. are normally held at rest on segments R by individual latches L1, L2, L3, etc. under the control of release magnets M1, M2, M3, etc.

The segments 1 to 5 of ring 11 of each distributor are multipled to one terminal of the windings 1 to 5 of a bank 12 of polar relays. The opposite terminals of these relays are grounded. The tongues of relays 12 operate between marking and spacing contacts and are connected to segments 1 to 5 of one channel, for instance the C channel of ring 13 of the multiplex transmitting distributor TD. The solid ring 14 is connected to the apex of the duplexed line L. The distributor TD also has a pair of local rings 15 and 16, the former being provided with a local segment 17 connected by a conductor 18 to one terminal of each of the release magnets M1, M2, M3, etc. The opposite terminals of these magnets are connected to one contact 19 of individually cut-out switches C1, C2, C3, etc. and the pivoted arm of each switch is joined to segments S1, S2, S3, etc. respectively of a transmitting mixer TM. There is one segment S1, S2, etc. for each transmitter T1, T2, etc. assigned to the C channel of the distributor TD. A rotary brush carrier having stop arms individual to each of the segments S1, S2, etc. is provided, one only of the arms indicated by numeral 21 having a pair of brushes B4 mounted thereon. The remaining arms 21', 21'', etc. serve only as stop arms to arrest the brushes on one or another of the segments S1, S2, etc. These arms cooperate with a stop latch 22 controlled by a magnet 23 having one terminal grounded and the other terminal connected to the solid ring 24 of the transmitting mixer.

The operation of the transmitting apparatus is as follows: Assume switches C1, C2 and C3 to be closed on their contacts 19 with a supply of tape for each of the transmitters T1, T2 and T3. Also assume brush B4 to be resting on segment S2 with the brush B6 of the multiplex distributor passing onto local segment 17. When this occurs an impulse is sent from the positive ring 16 through brush B6, segment 17 and conductor 18 to release magnet M2 and thence by way of switch C2 to segment S2 and through brush B4 and ring 24 to release magnet 23 and to ground. Latches L2 and 22 are released simultaneously, the former permitting the brush B2 to pass over the segments of the distributor D2, thereby operating relays 12 in accordance with the combination set up in the tape transmitter T2. The simultaneous escapement of the brush arm 21 permits it to move around to segment S3, being stopped thereon by engagement of the stop arm 21' with the latch 22. As brush B2 of distributor D2 crosses segment 6, a pulse is sent to the tape stepping magnet SM2 of transmitter T2 to step a new combination into the transmitter. The brush B2 comes to rest on segment R against latch L2.

As the brush B5 of the multiplex distributor crosses the segments of the C-channel on the succeeding revolution it transmits the combination stored in relay bank 12 over the line L. Following this transmission, as brush B6 again engages local segment 17, another impulse is sent over conductor 18 through release magnet M3, switch C3 and segment S3 to release magnet 23, releasing the brush B3 of distributor D3 to set up on the relay bank 12 the code combination stored in the contacts of the transmitter T3. Brush B4 of the transmitting mixer is again released coming to rest on segment S1 as stop arm 21'' engages stop latch 22. On the next revolution of the multiplex distributor the code combination previously set up on the transmitter T3 is transmitted over the line L and the code set up in the transmitter T1 is at the same time stored in relay bank 12. This operation continues as long as each transmitter has any material to transmit, the transmitters T1, T2 and T3, etc. operating in succession.

If now the tape supply of one of the transmitters becomes exhausted, or for any other reason the operator in charge desires to discontinue

the transmission from one of the transmitters, for instance transmitter T2, he throws the corresponding switch (C2 in the present instance) over to its positive contact, applying steady positive battery to segment S2 of the transmitting mixer. Consequently as the brush B4 is released from segment S1 at the time of operation of the distributor D1, it does not come to rest on segment S2, but passes directly thereover on to segment S3. This is due to the circuit set up from positive battery at switch C2 through segment S2, brushes B4 and ring 24 to release magnet 23, causing the latch 22 to be withdrawn from the path of the brush arm 21 as the brushes engage segment S2. Consequently the next local pulse transmitted from local segment 17 passes through magnet M3, switch C3 and segment S3 to the release magnet 23, enabling a character from the transmitter T3 to be set up on the multiplex distributor and transmitted over the line following the transmission of a character from transmitter T1. As long as the switch C2 remains on its positive contact transmitters T1 and T3 alternately transmit over the line L upon each revolution of the multiplex distributor. If switch C3 is now moved to its positive contact the transmitter T3 will also be cut out, the brush B4 passing directly from segment S1 over segments S2 and S3 and back on to segment S1 each time a local pulse is supplied from segment 17. Therefore transmitter T1 has full possession of the C-channel sending a character thereover each revolution of the multiplex distributor.

If it is again desired to enter transmitter T2 on the C-channel it is only necessary for the operator to close switch C2 on its contact 19 thus removing the battery from segment S2. On the next escapement of brush B4 from segment S1, it will come to rest on segment S2 and the next local impulse from segment 17 will be diverted through magnet M2 by way of segment S2 to the release magnet 23 bringing transmitter T2 into operation alternately with transmitter T1. These two transmitters share the lane equally.

Obviously at the receiving station B it is necessary to provide some means of determining from which transmitter each character signal originated and to distribute the received signals to their proper destination. If the number of transmitters assigned to the C-channel of the multiplex system was fixed it would only be necessary to distribute the signals in succession to a corresponding number of receivers. However, since the signals may originate at one or more of the large group of transmitters in a variable manner, it is necessary to vary the distribution of the signals at the receiving station in accordance with the variations in the assignments of the transmitters at the transmitting station. This is accomplished through a receiving mixer RM maintained in phase with the transmitting mixer TM. The construction of the receiving mixer is identical with that of the transmitting mixer, but the brush B'4 thereof is set back one segment relative to brush B4. That is, when brush B4 is on segment S2, for instance, brush B'4 will be on segment S'1, if all three transmitters are in operation.

Signals transmitted over the line L are received on the solid ring 25 of the receiving distributor RD and distributed by the C-channel segments of ring 26 to a bank of polar relays 27 which store the received combination and apply it to segments 1 to 5 of ring 28 of each of the start-stop distributors D'1, D'2, D'3, etc. The corresponding numbered segments of ring 29 of these distributors are connected to the selecting magnets 31 of the receiving printers, P1, P2, P3, etc. Segment 6 of each distributor applies the pulse for the operating magnet 32 of each printer. The brushes B'1, B'2, B'3, etc. of these distributors are normally held at rest on segment R by individual latches controlled by the release magnets M'1, M'2, M'3, etc. These magnets have one terminal connected to the segments S'1, S'2, S'3, of the receiving mixer through the control switches C'1, C'2 and C'3 respectively, the opposite terminals of the magnets being joined to the local segment 17' of ring 34 of the multiplex distributor.

The multiplex distributors TD and RD are maintained in synchronism in accordance with usual multiplex practice and the brushes B5 and B'5 thereof may be considered to cross the segments of the C-channel simultaneously.

If it is assumed that all of the switches C1, C2, etc. and C'1, C'2, etc. are on their contacts 19 with brush B4 resting on segment S2 and brush B'4 resting on segment S1 with a signal combination stored in relay bank 12 from the transmitter T1, then as brush B5 crosses the transmitting segments of the C-channel the combination originating in transmitter T1 will be transmitted to line and set-up on the contacts on receiving relay bank 27 and hence on the segments on distributors D'1, D'2, D'3, etc. Immediately thereafter brush B6 engages local segment 17 causing brush B4 to move on to segment S3 and releasing brush B2 to set up a combination from the transmitter T2 on relay bank 12. At the same time receiving local brush B'6 engages segment 17', thereby freeing brush B'1 which distributes the combination stored in relays 27 to the selecting magnets of printer P1. The brush B'4 passes at this time to segment S'2. Following the transmission of signals from transmitter T2 on the next revolution of the multiplex distributors the brush B'2 of distributor D'2 is released by the pulse from local segment 17', the circuit being completed through segment S'2, thus causing operation of printer P2. In this manner each of the printers operate in succession following the transmission of signals from their corresponding transmitters.

If it is now desired to close transmitter T2 out it is obvious that the printer P2 must also be eliminated. This is accomplished by moving switch C'2 to its positive contact thereby applying battery to segment S'2 and causing the brush B'4 to pass over segment S'2 without stopping each time it is escaped from segment S'1. If the transmitter T2 and printer P2 are to be cut-out without stopping transmission from the other transmitters, switch C'2 should be operated in proper timed relation to the operation of switch C2. This is effected automatically in the systems shown in Figs. 2, 3, 4 and 5, but in the embodiment of Figure 1, it is contemplated that each of the transmitters T1, T2, T3, etc. are under the control of a common operator, as are printers P1, P2 and P3. Under such conditions the transmitter and corresponding printer may be entered or closed out of the line manually.

When the operator at station A decides to close-out a transmitter from the lane, as for instance transmitter T2, he sends a message from this transmitter to the operator at station B advising him that at a certain time transmit-

ter T2 will be closed-out. When this time arrives a manual switch 36 in conductor 18 is opened, stopping all the transmitters. The switch C2 is then moved to its positive contact. The attendant at station B, noting that his printers have ceased operation throws switch C'2 to its positive contact. The switch 36 is then closed causing transmitters T1 and T3 to operate alternately. At the receiving station printers P1 and P3 also operate alternately, but since the receiving mixer was not stopped it may be out of phase with the transmitting mixer thereby causing signals from transmitter T1 to be received on printer P3 and signals from transmitter T3 to be received on printer P1. He notes the operation of these printers and if they are not in synchronism with the transmitters, as may be determined by a test character or series of characters sent over one or the other of the transmitters T1 or T3, he immediately opens the manual switch 37, in circuit with local segment 17' thereby preventing the release of the brush arm B'4 during one revolution of the multiple distributor and changing the relative position of brush B'4 with respect to the brush arm of the transmitting mixer, to thereby restore the proper phase relation between the transmitters and the printers.

The printers P1 and P3 once phased with the transmitters T1 and T3 are maintained in proper relation therewith by the mixers TM and RM respectively.

When it is desired to restore the transmitter T2 and the printer P2 into operation, the attendant at station A transmits another message through either transmitter T1 or T3, advising the receiving attendant at station B of the desired change in the assignments. The switch 36 at the transmitting station is then opened interrupting all transmission and the attendant at each station closes the switch C2 and C'2 respectively, to the contacts 19 after which switch 36 is again closed restoring transmission. The receiving attendant then phases the receiving printers with the incoming signals by means of switch 37 and operation is resumed on the basis of three sub-channel operation.

It will be noted from the foregoing that the number of transmitters and printers in operation over a single channel of the multiplex distributor is dependent only upon the positions of the switches C1, C2, etc. and C'1, C'2, etc. at the transmitting and receiving stations respectively.

While in the system described the switches C1, C2, etc. and C'1, C'2, etc., are operated manually, in the system shown in Figure 2 I have shown an arrangement for cutting the transmitters and printers in and out automatically. In Figure 2 the start-stop distributors D1, D2, D3, and the receiving start-stop distributors D'1, D'2, D'3, have been omitted, the tape transmitters directly operating the storage relays at the transmitting station and the multiplex distributor at the receiving station operating directly into the storage relay bank.

Referring now to Figure 2, the tape transmitters T*a*, T*b* and T*c* are shown each having a marking bus bar M, provided with positive battery through the winding 41 of polar relays R*a*, R*b*, R*c*, respectively, and having a spacing bus bar S with insulated contacts. The tongues of each transmitter are connected through the windings 42 of a common relay bank 43 to ground. The tongues of relay bank 43 are connected to the segments of one channel of a multiplex transmitting distributor TD1, having a solid ring 44 connected to the apex of the outgoing line L1. The distributor TD1 has a local ring 45, provided with two spaced local segments 46 and 47. Local segment 46 is connected through the auxiliary windings 48 of relay 43 to ground, these windings being poled so as to restore the contacts to their spacing side each time a local pulse is produced from this segment.

The control apparatus for each transmitter T*a*, T*b* and T*c* is identical and therefore only that associated with transmitter T*a* will be described. The tape transmitter T*a* has a stepping magnet SM, one terminal of which is connected to positive battery and the other terminal of which is connected to the midpoint of the winding of differential relay DR. The opposite terminals of the winding of the relay DR are joined through auto-control contacts 49 and relay contacts 50 respectively, to the right contact 51 of relay R*a*. The two armatures 52 and 53 of relay DR are normally released to the left, whereby contacts 50 and 54 are closed. Armature 52 is connected to ground and armature 53 is connected through the operating winding 55 of relay S*a* and thence to the left contact of tongue 56 of a polar relay Q*a*. Relay S*a* has a locking winding 57 and associated locking contact 58 connected in series with a holding winding 59 on relay Q*a* and through conductors 60 and 61 to local segment 46. The operating winding 62 of relay Q*a* is connected in series with the operating winding 63 and the restoring winding 64 of relay R*a*. The opposite terminal of winding 63 is connected to the left contact of the relay and the opposite terminal of winding 64 is connected through conductor 65 to local segment 47.

A transmitting mixer TM1 is common to all of the transmitters and has a segment *a*, *b*, *c*, etc., individual to each transmitter. Segment *a* is connected by conductor 66 to tongue 67 of relay Q*a*. Segment *b* is similarly connected to the corresponding tongue of relay Q*b* and segment *c* is similarly connected to relay Q*c*. The solid ring 68 of the transmitting mixer TM1 is grounded through the release magnet 69.

In addition to the mixer, I have provided a sending clock SC, common to all of the transmitters, having two sets of segments *a'* and *a''*, individual to the transmitter T*a*; *b'* and *b''* individual to transmitter T*b*, and *c'* and *c''* individual to transmitter T*c*. The solid ring 70 of the sending clock is grounded. The clock has a stop arm corresponding to each transmitter, one only of the stop arms being provided with a pair of brushes B7. The release magnet 71 of the sending clock has its ungrounded terminal connected through conductors 72 and 61 to local segment 46.

The operation of the transmitting mechanism is as follows:

Assume all transmitters T*a*, T*b*, T*c*, etc., to have a copious supply of tape, with auto-control contacts 49 closed and the tongues of relays R*a*, R*b*, etc., and Q*a*, Q*b*, etc., on their right hand contacts with all other relays in their unoperated positions. Also assume brush B8 of the transmitting mixer TM1 to be at rest on segment *a* and local brush B10 of the multiplex distributor TD1 to be approaching local segment 46. As brush B10 engages this segment a local pulse will be sent over the following paths: (1) the windings 48 of relays 43 in a spacing direction; (2) over conductors 61 and 72 to the release magnet 71 of the sending clock SC, releasing the brush B7

thereof to pass on to its next group of segments; (3) over conductor 61, tongue and left contact of relay 73 (common to all of the transmitters) conductor 74, winding 75 of relay R*a* and the right contact and tongue 67 of relay Q*a* and thence by way of conductor 66 to segment *a* of the transmitting mixer and by brush B8 and solid ring 68 to the release magnet 69 and to ground.

The completion of this last circuit releases brush arm B8 to pass on to segment *b* and removes ground at the tongue of relay R*a* from the stepping magnet SM releasing this magnet and permitting the contacts of the transmitter T*a* to move upwardly, as will be understood by reference to the Benjamin patent aforesaid, momentarily setting up a combination on the tongues of the transmitter T*a*. Since all code combinations, except the blank signal which is used for special purpose as hereinafter described, have at least one marking impulse, one of the tongues of the transmitter T*a* will engage the marking bus bar M completing a circuit from battery through winding 41 of relay R*a*, bus bar M, one or more of the tongues of the transmitter and the corresponding windings 42 of relay 43 to ground. The completion of this circuit sets up the combination on the tongues of relays 43 and energizes relay R*a* to restore its tongue to contact 51 reapplying ground to the stepping magnet SM through the windings of the differential relay DR. The magnet SM therefore again withdraws the pins of the transmitter from engagement with the tape and steps the tape forward one character. The transmitting pins are held depressed until transmitter T*a* is again reached in its regular order for operation.

All of the above operations occur while brush B10 is passing from local segment 46 to local segment 47. As brush B10 now engages local segment 47 nothing happens since the circuit over conductor 65 is open at the left contact of relay R*a*. As the brushes B9 and B10 continue their rotation they cross the segments of the channel associated with the transmitters T*a*, T*b*, etc. sending the combination applied thereto by transmitter T*a*, over the multiplex line L1.

On the next engagement of brush B10 with local segment 46 similar circuits are completed through: (1) windings 48 of relay 43; (2) release magnet 71 of the clock SC; and (3) winding 75 of relay R*b*, this latter circuit being grounded through the segment *b* of the mixer TM1. A character from the transmitter T*b* is therefore set up on the relay bank 43 for subsequent transmission to line and brush B8 of the mixer TM1 is advanced on to segment *c*. In this manner each of the transmitters T*a*, T*b* and T*c* operate in succession as long as each has a supply of tape.

If now the supply of tape to one of the transmitters becomes exhausted as for instance transmitter T*a*, its auto-control contacts 49 will open. This occurs of course when transmitter T*a* steps following the setting up of a new character on relays 43, just after local segment 46 has been crossed, with brush B8 on segment *a* of the mixer TM1. The opening of contact 49 diverts the current flowing through the stepping magnet SM entirely through the left hand winding of the differential relay DR unbalancing the relay and causing the armatures 52 and 53 to be operated thereby applying a locking ground to the stepping magnet through armature 52 and opening contacts 54 at armature 53. As the brushes B9 and B10 complete their revolution the code set up in relays 43 is sent over the multiplex line. When it is again turn for the transmitter T*a* to transmit, the passage of brush B10 on to local segment 46 restores the tongues of relay 43 to their spacing side setting up a blank or all spacing signal on the segment of the multiplex distributor TD1. The circuit completed from local segment 46 over conductor 61 and the tongue of relay 73 through winding 75 of relay R*a* and contact 67 of relay Q*a* to segment *a* of the transmitting mixer, steps the mixer on to segment *b* but does not release the pins of the transmitter by the removal of the ground at the tongue of relay R*a* since as stated the stepping magnet SM is locked up continuously over ground from the armature 52 of the differential relay DR. Consequently the spacing combination remains on the segments of the multiplex distributor and as the distributor completes its revolution the spacing combination is transmitted to line.

The purpose of this spacing combination at the receiving station is to close-out the printer associated with the transmitter T*a*. Since none of the tongues of the transmitter T*a* is permitted to move to its marking side at this time, the restoring circuit for relay R*a*, through winding 41 is not completed and the tongue of the relay remains on its left hand side in which position it was operated by the local impulse. Consequently as brush B10 moves on to local segment 47 a circuit is completed from ground at the tongue of relay R*a*, the left contact thereof, winding 63 of relay R*a*, winding 62 of relay Q*a* and winding 64 of relay R*a*, and thence by conductor 65 to local segment 47 and by way of brush B10 to battery. The windings 63 and 64 of relay R*a* are in opposition to each other but winding 63 predominates as long as the brush B10 is on segment 47, the current through the winding 63 being in such direction as to maintain the tongue of the relay on its left contact. However as soon as brush B10 leaves segment 47 the condenser 80 discharges through the winding 64 restoring the tongue to its right hand contact 51.

The current through winding 62 of relay Q*a* moves the tongues to this relay to their left contacts applying battery through tongue 67 to segment *a* of the transmitting mixer. Battery is also applied to winding 55 of relay S*a* at the tongue 56 of relay Q*a*, the circuit for winding 55 being incompleted at the armature 53 of the differential relay DR, which is open at this time, and therefore relay S*a* does not operate. The application of positive battery to segment *a* completes the closing-out of the transmitter T*a* since upon each subsequent revolution of the brush B8 of the mixer TM1, it passes directly over the segment *a* coming to rest only on segments *b* and *c* and therefore enabling only the transmitters T*b* and T*c* to operate over the line L1.

The sending clock SC performs no function during the normal operation of the transmitters nor in the closing-out of a transmitter from service but acts to time the re-entry of a transmitter. It will be noted that the release magnet 71 of the sending clock is connected directly to the local segment 46 of the multiplex distributor so that it receives an impulse for each revolution of the distributor and is stepped over one pair of segments for each of such local impulses. At no time is battery applied to any of the segments to cause the brush to move past a normal stopping position without stopping therein, as in the case of the transmitting mixer TM1. Therefore

the mixer and the clock are not necessarily in step.

When it is desired to enter a station on the line, as for instance the station T*a* previously closed-out, the auto-control contacts **49** of the transmitter T*a* are closed by accumulation of the tape loop thereby grounding both sides of the relay DR causing a balance to be produced through the windings of the relay and releasing the armatures **52** and **53** thereof. This may occur of course with the brush B7 of the clock SC in any of its positions. Eventually however the brush B7 is stepped around to the *a'*, *a''* segments and as it is escaped thereon from segment *c''* it first passes over segment *a'* coming to rest on segment *a''*. As it crosses segment *a'*, ground is applied through solid ring **70** and brush B7 to the conductor **76** and thence over contacts **54** and armature **53** of relay DR and through the winding **55** of relay S*a* and the left contact and tongue **56** of relay Q*a* to positive battery. Relay S*a* is thus operated, locking up over its contact **77**. As brush B7 engages segment *a''* ground is applied through the solid ring **70**, segment *a''*, conductor **78**, armature **79** of relay S*a* and conductor **81** to the winding of relay **73** and to positive battery, moving the tongue of this relay to its right hand side. On receipt of the first local impulse on segment **46** following these operations, the impulse is transmitted over conductor **61**, the tongue and right contact of relay **73** and conductor **82** to the fourth winding **42** of relay **43** in a marking direction and in opposition to the impulse supplied at the same time from segment **46** through the windings **48** of this relay in a spacing direction. Due to the resistance **83** in circuit with the windings **48** the current through the windings **42** always predominates so that the tongue of the number four relay is moved to its marking side and the tongues of the remaining relays are set on their spacing sides. The marking force of coils **42** is always greater than the spacing resetting force through windings **48** so that the marking force always prevails, should the two opposing forces be applied simultaneously. This combination, having the number four impulse marking, is thus set up on the segments of the transmitter TD1. Since the tongue of relay **73** is on its right hand side at this time the local impulse 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 over conductors **61** and **60** to winding **59** of relay Q*a* and winding **57** of relay S*a* to ground at tongue **58** of this latter relay, thereby restoring relay Q*a* to its right hand side and removing battery at contact **67** of this relay from segment *a* of the transmitting mixer. The winding **57** of relay S*a* merely retains this relay on its right hand side until the foregoing operation is completed. With relay Q*a* restored to its right side the transmitter T*a* is completely entered on the line.

The special code combination with the fourth impulse marking is now set up on the multiplex distributor. On the next revolution of the multiplex distributor this combination is sent over the line L1 and serves at the receiving station to enter the printer associated with the transmitter T*a*.

It should be noted that the entry of transmitter T*a* may occur with the mixer TM1 in any position, the mixer being held in that position for the entering cycle. As the mixed continues to revolve following the entry of the transmitter T*a*, it will eventually reach segment *a* at which time the first character code combination will be set up in the storage bank **43** from the transmitter T*a* in the ordinary manner. One purpose of this arrangement is to facilitate re-synchronism of the transmitting and receiving mixers if they should lose step for any reason; for example, during a long period when the channels are all idle or as a result of line or apparatus trouble. Mixer synchronism is thus obtained or confirmed whenever transmission is stopped and resumed. This can be done when necessary or at predetermined times.

It will be noted that the closing-out of a 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 that the entry of a new station is preceded by the transmission of a special entry code combination having the fourth impulse marking, occuring whenever the brush of the clock SC is on the segments corresponding to the transmitter being entered. With these conditions in mind, the receiving apparatus at the distant station will be described.

Signals transmitted over the line L1 are received upon the solid ring **84** of the multiplex receiving distributor RD1 and distributed to the relays of a coding bank CB and a storage bank SB. The tongues of the storage bank SB are connected over conductors **85**, which are multipled to the switch arms **86** of a number of multicontact switches controlled by magnets **87**. The contacts of the switch arms **86** are connected through the selecting magnets **88** of each of the receiving printers P_a, P_b, and P_c. Each printer has associated with it a cut-out relay CO*a*, CO*b*, etc. provided with two windings **89** and **91** and a single tongue **92**.

The tongues of the control bank of relays CB are coded so as to supply negative battery to a conductor **93** whenever the blank or all-spacing combination is received and to apply the same battery to a conductor **94** whenever the entry code combination having the fourth impulse marking is received. The winding **95** of an entry relay ER is included in the conductor **94**.

At the receiving station there is also a receiving mixer RM1 and a receiving clock RC, common to all of the printers. The mixer RM1 is provided with a pair of segments for each printer, each pair comprising a long segment *a1*, *b1*, *c1*, and a short segment *a2*, *b2*, *c2*. The solid ring **90** of the receiving mixer is connected through the release magnet **96** to ground. Segment *a1* is connected to the tongue **2** of relay CO_a and segments *b1* and *c1* are connected to the tongue of the corresponding relay CO_b, CO_c. The short segment *a2* is connected to the winding **89** of relay CO_a multipled to the conductor **93** and the segments *b2* and *c2* are similarly connected to the corresponding winding of relays CO_b and CO_c, also multipled to conductor **93**.

The receiving clock RC has three segments *a3*, *b3* and *c3*, each connected to one terminal of the winding **91** of the relay CO_a, CO_b, CO_c, respectively.

The operation of the receiving apparatus is as follows: Assume each of the transmitters T*a*, T*b* and T*c* to be transmitting over the channel with the brush B11 of the receiving mixer RM1 on segment *a1* and the combination from the transmitter T*a* to have just been received and stored in the storage bank SB. Then as brush

B12 of the multiplex distributor RD1 passes on to local segment 97, an impulse will be sent over the following circuits: (1) conductor 98 to the release magnet 99 of receiving clock RC to advance its brush on to the succeeding segment; (2) over conductor 98, tongue and right contact of relay ER, to the magnet 87 associated with printer P*a* and thence by the left contact and tongue 92 of relay CO_a to segment *a*1, brush B11 and ring 90 to the release magnet 96, escaping brush B11 on to segment *b*1. The operation of magnet 87 closes the contacts 86 and a sixth pulse contact 100, operating the selecting magnets 88 of the printer in accordance with the combination stored in relay bank SB and energizing the operating magnet 101 of the printer to effect the printer operation. The printer P*a* therefore records the character transmitted by the transmitter T*a*.

As brushes B12 and B13 continue their revolution crossing the code segments 1 to 5, a character from transmitter T*b* is set up on the bank SB and immediately thereafter as brush B12 again engages local segment 97, this character is recorded on the printer P*b*. At the same time brush B11 of the receiving mixer RM1 and brush B14 of the receiving clock move into the succeeding positions.

If now transmitter T*a* is closed-out, such condition is indicated by the reception of a spacing code combination at a time when the brush B11 rests on segment *a*1. This code combination is set up on the storage bank SB and on the control bank CB. As stated, the control bank CB is coded so as to apply negative battery to the conductor 93, at this time preparing a circuit through winding 89 of relay CO_a to segment *a*2 of the receiving mixer. As the next local impulse occurs the magnet 87 associated with printer P_a operates, but since the signal is of an all-spacing character, it is deleted by the cut-out mechanism normally forming a part of the printer mechanism. Brushes B11 and B14 are escaped at the same time and as brush B11 crosses the small segment *a*2 it completes the circuit previously prepared through the winding 89 of relay CO_a, moving the tongue 92 to its right hand or positive contact, thereby applying positive battery continuously to segment *a*1 and closing out printer P_a from further operation due to the continuous passage of the brush B11 over segment *a*1 and *a*2 upon subsequent revolutions of the brush arm.

Succeeding signals transmitted by transmitters T_b and T_c are therefore received only on printers P_b and P_c, respectively.

If transmitter T_a is to be entered on the circuit again such 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 B14 of the receiving clock RC is at rest on segment *a*3, since the receiving clock and the sending clock are both invariably stepped ahead one position upon each revolution of the multiplex distributors and therefore maintained in exact phase relation.

The entry code combination applies negative battery to the winding 95 of relay ER operating the same to its left hand contact thereby disconnecting the local segment 97 from the conductor 99 so that none of the circuits through the segments of the receiving mixer are completed and the receiving mixer is held at rest 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. A circuit for the local pulse is completed, however, over conductor 98 and the left contact and tongue of relay 95 to solid ring 102 of the receiving clock and thence by brush B14 and segment *a*3 to winding 91 of the relay CO_a in a direction to restore the tongue 92 to its left hand contact, thus removing positive battery from segment 91 of the receiving mixer RM1. Consequently the printer P_a is again restored to the circuit so that it will respond to subsequent signals transmitted from the transmitter T_a.

In this same manner any of the printers may be cut in or out of the circuit following the discontinuance of the operation or the restarting of any of the transmitters.

It will be noted that each transmitter and corresponding printer are entered at the time of the first engagement of the brushes of the receiving and transmitting clocks on the segments corresponding to the transmitter and printer to be entered. They do not start transmitting and receiving signals, however, other than the entry code signal until the transmitter and receiving mixers have been stepped around to the position corresponding to such entering transmitters and printers. Since this type of entry involves both a time element and the transmission and reception of a code signal, I have termed it for convenience time-code entry. The function of entry involves selection of one of a number of receiving devices or channels, and the selecting means shown and described above is the equivalent of ordinary "code selection" but has the additional advantage of higher efficiency by permitting the transmission of character signals between the selection or entry signals.

A different type of entry, which I have termed time and turn entry, is effected only when the brushes of the clock and the mixers simultaneously engage the segments associated with a particular entering transmitter and printer. This latter type of entry is shown in Figures 3, 4 and 5.

Only three transmitters and receiving printers have been shown in the foregoing example but the number may be expanded indefinitely. For instance 1000 or more outlying stations, each having only a few messages a day may share a single channel or lane of traffic between say New York and Chicago. Each of these outlying stations will have the equivalent of a direct line connection between the stations thereby enabling messages to be transmitted at any time from any of the stations. With a large group of such substations assigned to a channel, the load will be distributed fairly evenly throughout the day and ordinarily only a few of the stations will be transmitting at any instant. Therefore the rate of transmission from any station will be fairly good. If for any reason a considerable number of such stations desire to use the channel simultaneously, the rate of transmission from each station will be reduced until the congestion is relieved but the direct line facility will not be otherwise interfered with. Where a large number of sub-stations associated with each of the main stations are assigned to a single lane of traffic extending between the main stations, extended channel equipment is obviously required. An expanding channel system involving the extension of the sub-channels to individual substations is shown in Figs. 3, 4 and 5 and will now be described.

In Figure 3 the transmitting equipment at three branch offices or sub-stations X, Y and Z is

shown. Obviously any number of such stations may be provided. The equipment at each station is identical and therefore only that provided at one of these stations will be described.

The transmitting equipment comprises a tape transmitter T_x the contacts of which are connected through the windings of a relay bank RB_x to the numbered segments of ring 105 of a start-stop distributor D_x. The ring 105 also has a rest segment R connected to marking battery through the winding of a marginal relay MR_x and a start segment S conencted to spacing battery. The solid ring 106 is connected to a sending line SL_x extending to central office equipment shown in Figure 4. The distributor D_x has a pair of local rings 107 and 108, the former having a local segment 109 and the latter being connected to positive battery. The brushes B15 and B16 are normally held at rest by the latch L controlled by the start magnet M. Magnet M is controlled through the tongue and the front or make contact of relay MR_x.

The ungrounded terminal of the stepping magnet SM of transmitter T_x is connected to the midpoint of the winding of a differential relay DR, one end of which is connected through normally closed contacts 111 to the local segment 109 of ring 107. The opposite end of the winding of relay DR is connected through the normally closed contacts 112 of a control relay CR_x to segment 109. Relay CR_x has a second tongue 113 joined by conductor 115 to the lowermost tongue of relay bank RB_x and thence through the remaining tongues, when they are all on their spacing contacts, to the receiving line RL_x extending from the central station. The line RL_x has a receiving relay LR_x in circuit therewith and normally terminates at ground through a resistance R_x. However, when the contacts of relay bank RB_x are all on their spacing sides and relay CR_x is energized in order to ground its tongue 113, the resistance R_x is shunted out of the line RL_x, the line being grounded through the conductor 115. Relay CR_x is controlled by the auto-control contacts 116 whenever the tape loop 117 decreases to a predetermined minimum as is well understood in the art.

Before describing the operation of the transmitting apparatus it will be well to consider the apparatus at the central station indicated as station C (Fig. 4). This station is provided with a multiplex distributor MD having a set of transmitting rings TR transversed by a brush B17, a set of receiving rings RR provided with a brush B18 and a set of local rings LR having a brush B19. Segments 1 to 5 of one channel of the transmitting ring TR which by way of example may be the C-channel, are connected to the tongues of a bank of polar transmitting relays PTR. The ungrounded terminals of the windings of relays PTR are connected in series with the main or left hand winding of a set of polar control relays R_x and thence to segments 1 to 5 of the receiving ring of a start-stop distributor D'_x. The solid ring of distributor D'_x is joined to the sending line SL_x through a resistance 118. The brush B20 of distributor D'_x is normally held on rest segment R by a latch controlled by the start magnet M'_x. The rest segment of distributor D'_x is grounded through the winding of a relay 119 having its spacing contact S connected to the ungrounded terminal of the starting magnet M'_x. The tongues of relays R_x, when they are all on their spacing side, apply ground to a conductor 121 connected to one terminal of the main winding 122 of a relay L_x. Relay L_x has a holding winding 123, one terminal of which is connected by conductor 124 to local segment 125 of the multiplex rings LR and the opposite terminal of which is connected through the windings of relays N_x and M_x to the right and normally closed or break contact of relay K_x and thence by way of conductor 126 to segment x of the transmitting mixer TM_2. Relay L_x has two tongues 127 and 128, the former of which applies battery to relay K_x whenever relay L_x is energized. The tongue 128 normally rests on its right contact which is connected to local segment 125 and when the relay is energized, engages its left contact to shunt out the winding of relay M_x.

The tongue and operated contact of relay M_x serve to shunt out the resistance 118 included in the line SL_x, over conductors 129 and 131, whenever relay M_x is energized. Relay N_x when energized applies positive battery by way of conductor 132 to the auxiliary or right hand windings, in series, of relays R_x and PTR, to move the tongues of relays 1, 2, 3 and 5 thereof to their spacing contacts and the tongue of relay 4 to its marking contact, thereby at the contacts of relays R_x removing ground from the relay L_x and through the contacts of relays PTR setting up an entry code combination on the segments of transmitting ring TR of the multiplex distributor.

The circuit for relay K_x is completed from tongue 127 of relay L_x when the latter relay is energized, through normally closed contact 133 of relay I_x. Relay I_x has a main winding 134 and a locking winding 135. The main winding is connected between the tongue of a marginal relay J_x and a short segment x' of a sending clock SC. The locking winding of relay I_x is connected between the locking contact 136 of the relay and a large segment x'' of the sending clock.

The clock SC is similar in construction to the transmitting mixer TM_2, each having a single pair of brushes B21 and B22 respectively, mounted upon one of the stop arms of which there is one provided for each station X, Y and Z, etc., assigned to the particular lane of traffic. The start magnet 138 of the sending clock SC is controlled over conductor 139 from the local segment 125 of the multiplex distributor.

Each of the stations Y and Z also have at the central station C a receiving distributor $D'y$, $D'z$, and a group of relays I, J, K, L, M and N. The windings of the Iy relay are connected to segments y' and y'' of the sending clock by conductors 141 and 142, and the windings of relay Iz are connected to segments z' and z'' thereof by conductors 143 and 144. Similarly the tongues 145 and 146 respectively, of the relays Ky and Kz are connected to segments y and z, respectively, of the transmitting mixer TM2 over conductors 147 and 148. The relays Ky and Kz each have an additional tongue 149 and 151, respectiveiy, connected as follows: the left or operated contact of the tongues 145 and 146 of relays Ky and Kz are connected to positive battery and the right or normally closed contact of tongues 149 and 151 are also connected to positive battery. The tongue 149 is joined to the operating or left hand contact of relay Kx and the left contact of tongue 149 is joined to the tongue 151 of relay Kz. The left contact of tongue 151 is connected to the local

segment 125 over the conductor 139. The purpose of these connections will appear in the description of the operation of the system.

The segments of the C-channel of the receiving rings RR of the multiplex distributor are connected to the windings of two banks PCR and PRR, of polar relays in series. The contacts of relays PCR control the receiving channelling mechanism and their function will be described in connection with Figure 5. The contacts of the polar receiving relays PRR are multiplied to the segments 1 to 5 of a group of start-stop transmitting distributors, one only TD_x of which is shown, one of these distributors being provided for each of the substations X, Y, Z, etc. These distributors are more fully described with reference to Figure 5.

The distributor TDx has in addition to the numbered code segments, a rest segment R and a start segment S. The solid ring of the distributor is connected to the winding of a polar relay 152. The tongue of this relay is joined to the outgoing line RL. The marking and spacing contacts of relay 152 are connected respectively to the windings 153 and 154 of relay J_x, these windings being so arranged that current through either one of them tends to move the tongue of the relay to its grounded contact. The relay is marginal, however, so that it does not operate on the normal current flow therethrough.

With the above circuit arrangements in mind, the operation of the transmitting mechanism at stations X, Y and Z and the associated mechanism at station C will be described.

Assume that each of the stations X, Y, and Z are operating and the last character was transmitted from station Z. The brush B21 of the transmitting mixer TM_2 will be at rest on the x segment at this time. As local brush B19 of the multiplex distributor MD engages local segment 125 a pulse will be sent out over two paths, (1) conductor 139 and the escapement magnet 138 of the sending clock SC allowing the clock to step one set of segments; (2) through the tongue 128 of relay L_x, winding of relay M_x and the tongue and right hand contact of relay K_x and thence by conductor 126 to the x segment of the mixer TM_2 and by way of the brushes B21 to the release magnet 155, stepping brush B21 on to the y segment, and at the same time operating relay M_x to its left contact and thereby shortcircuiting the resistance 118 in the line SL_x extending from the branch office X. The shunting of the resistance 118 increases the current in the line SL_x over the circuit extending from negative battery at one terminal of the winding of relay MR_x (Fig. 3), thence by segment R of distributor D_x brush B15, line SL_x and brushes B20 (Fig. 4) to the winding of relay 119 and thence to ground. The current flowing through relay 119 at this time being in a marking direction, maintains its tongue on its dead contact M.

The relay MR_x is marginal and responds to the increase current caused by shunting out resistance 118, thereby completing a circuit for the start magnet M of distributor D_x. Brushes B15 and B16 are thus released passing over the start segment S and the five code segments associated with the transmitter T_x. As local brush B16 leaves segment 109 battery is removed from the stepping magnet SM permitting the tape pins to rise and setting up a combination on the segments 1 to 5 and thereby enabling brush B15 to transmit a start impulse followed by five code impulses over line SL_x.

The start impulse received on the distributor D'_x at station C operates the relay 119 to its spacing side completing a circuit for the start magnet M'_x of distributor D'_x and releasing the brush B20 which crosses its code segments in phase with brush B15 of distributor D_x. Consequently the combination set up on the tape transmitter T_x is distributed to the relays R_x and PTR in series. If this combination is anything except an all spacing combination the contacts of relay R_x are left open at one point and these relays serve no useful purpose at this time. The relays PTR, however, through their contacts set up the received combination on the segments of the transmitting ring TR of the multiplex distributor. As the multiplex transmitting brush B17 completes a revolution, the combination just set up on the segments of the C-channel are sent over the multiplex line ML to the receiving station.

Immediately thereafter as local segment 125 is again crossed, another impulse is applied to magnet 138 of the sending clock SC and through relay M_y, tongue 145 of relay K_y and segment y of the transmitting mixer TM_2 to the start magnet 155 stepping the mixer-brushes on to segment z. Relay M_y shortcircuits resistance 118' associated with line SL_y releasing the brushes of the D_y distributor at station Y to transmit a character from this station, for subsequent transmission over the multiplex transmitter MD.

Similarly the next local impulse from segment 125 operates relay M_x to release a character from station Z at the same time stepping the clock SC and the mixer TM_2 forward one step.

This operation continues as long as each of the stations X, Y and Z have material to transmit. However, if the supply of tape at one of the transmitters, for instance at station X, becomes exhausted, auto-control contacts 116 are opened deenergizing relay CR_x and opening its contacts 112 and 113. The opening of contact 112 causes battery from ring 108 and segment 109 of distributor D_x to be diverted through right hand winding only of differential relay DR to the stepping magnet SM. Relay DR is therefore operated its armature 156 opening contact 111 and applying locking battery to the relay DR and the stepping magnet SM. The pins of the transmitter T_x are therefore held depressed continuously and therefore retained on their spacing bus bar. As local brush B19 of the multiplex distributor MD again crosses local segment 125 following the transmission of a character from station Z, that is with brush B21 on segment x of the transmitting mixed TN_2, the relay M_x will be again operated to short circuit resistance 118, releasing the brushes of distributor D_x, thus causing the all spacing signal set up on the tongues of transmitter T_x to be transmitted over the line SL_x and to be eventually set up on the segments of the multiplex distributor ring TR. At the same time the relays of bank RB_x (at station x) are all moved to their spacing sides thereby connecting conductor 115 to the receiving line RL_x. This all spacing or blank signal operates the relays R_x at station C to their spacing sides thereby applying ground over conductor 121 to winding 122 of relay L_x operating the tongues of this relay to their left hand sides. Tongue 127 applies battery to relay K_x which in turn moves its tongue to its left hand side. When this occurs positive battery normally applied to tongue 149 of relay K_y is extended over

the tongue of relay K_x and conductor 126 to segment x of the transmitting mixer TM_2. Consequently each time the brush B21 of the mixer engages segment x it completes a circuit for the release magnet 155, thereby withdrawing the stop-arm and permitting brush B21 to rotate directly past the x segment, on to the y segment. The station X therefore loses its turn and transmission takes place alternately from stations Y and Z.

If the supply of tape at station Y should now become exhausted this station will be cut out in a similar manner, first transmitting a blank or all spacing signal over the line thereby setting the contacts of relays R_y on their spacing sides and applying ground to winding 122 of relay L_y. As outlined above this causes the operation of relay K_y whereby its tongues are all moved to their left hand sides. When this occurs positive battery is applied to segment x of the transmitting mixer TM_2 from the right contact and tongue 151 of relay K_z, left contact and tongue 149 of relay K_y and left contact and tongue of relay K_x, and thence by conductor 126 to segment x. Battery is also supplied to segment y of the transmitting mixer TM_2 from the left contact and tongue 145 of relay K_y and conductor 147 to segment y. With stations X and Y both discontinued, a character is transmitted from station Z for each revolution of the multiplex distributor.

If the tape supply at station Z should now become exhausted this transmitter will first send a blank signal and as a result thereof apply ground from the contacts of relays R_z to the winding 122 of relay L_z, which latter relay causes the operation of relay K_z. As the tongues of this relay engage their left hand contacts battery for station X is obtained from the local segment 125 through tongue 151 of relay K_z, the left contact of tongue 149 of relay K_y and thence through tongue of relay K_x to segment x. Battery for segment y is obtained from the source previously traced and battery for segment z is obtained from the left contact and tongue 146 of relay K_z.

With all stations closed out it is obvious that the C-channel will be idle and brush B21 stopped each revolution on the x segment being released therefrom by each local impulse from segment 125. The transmitting mechanism at station X will not be released, however, since the circuit for relay M_x is open at the right contact of relay K_x.

The angular speed of the transmitting mixer brush B21 should be equal to or greater than the angular speed of the multiplex distributor brushes in order that it may complete its revolution in a time no greater than that required by the multiplex distributor. The series circuit from the local segment 125 through the left contacts and lower tongues of relays K_z, K_y and K_x to segment x of the transmitting mixer is mainly for the purpose of preventing the stop arm of brush B21 from engaging the brush in an uncertain manner after a period when no transmitters are operating. Thus it is seen that automatic synchronism of the expanding channels on the mixers is secured when they return to operation after a period when all channels are idle. This provides a method of self-synchronization since all channels can be stopped during line trouble and resume operation in phase when the trouble clears.

It should be noted that the sending clock SC is controlled directly from the local segment 125 and therefore is stepped once for each revolution of the multiplex distributor, whereas the brush B21 of the transmitting mixer TM_2, in case station X is not operating, passes directly from segment Z to segment Y, and in case both stations X and Y are not operating the brush B21 passes from segment Z around to the same segment again. The clock SC and transmitting mixer TM_2 therefore are not maintained in step. The purpose of the sending clock SC is to enable a station to be entered on the line again, when it is desired to resume operation thereof, in proper timed relation with the reassociation of its receiving mechanism with the line at the receiving station. Therefore it is necessary to maintain the clock SC in synchronism with a corresponding clock at the receiving station. Since the transmitting and receiving distributors at each station are maintained in synchronism continuously and since the clock SC and the corresponding receiving clock to be described hereinafter are both stepped directly from the transmitting and receiving distributors the clocks are maintained in synchronism.

If now it is desired to restore the transmitter into operation at one of the sub-stations, for instance station X, due to an increase in the size of the loop of tape 117 the station will be entered automatically in the following manner. The increase of the loop 117 closes contacts 116, thereby operating relay CR_x and closing its contacts 112 and 113. When this occurs current from local segment 109 of the distributor D_x passes through the left winding of the differential relay DR balancing that in the right winding and releasing the armature 156. Current for the stepping magnet SM is thus provided solely from the local segment 109. It will be recalled that at the time station X was discontinued from operation, polar relays RB_x were moved to their spacing side, connecting the conductor 115 directly to the line RL_x. The closure of tongue 113 of relay CR_x now applies ground to the line RL_x over the conductor 115, thus short circuiting the resistance R_x which is normally in the line RL_x, thereby increasing the current flowing over the line RL_x from either the marking or spacing contact of relay 152 at station C and hence increasing the current through either the winding 153 or 154 of relay J_x, depending upon the position of the tongue of the relay 152. Relay J_x is thus operated to apply ground to the winding 134 of the relay I_x. Consequently as the clock SC is stepped around, eventually crossing segment x', a circuit will be completed over winding 134 of relay I_x from the solid ring 137 of the sending clock SC. At this time I_x is operated and an instant later as the brush B22 engages segment x'' a locking circuit for relay I_x is established from ring 137 of the clock, brush B22, segment x'' and locking winding 135 of relay I_x to the grounded tongue of the relay. Movement of the tongue of relay I_x away from its normal contact 133 interrupts the circuit for relay K_x, allowing its tongue to return to the righthand contact and thereby removing battery from segment x of the transmitting mixer TM_2. The brush B21, it will be recalled, rests on segment x between each local impulse from the segment 125 of the multiplex distributor MD. On the next crossing of the local segment 125 following the operation of relay I_x and the release of relay K_x, a local pulse is sent from segment 125 by way of conductor 124 through locking coil 123 of relay L_x (thereby firmly holding the tongues of the relay on their lefthand side), thence through the winding of relay N_x, tongue 128 and left contact of relay L_x

(short circuiting relay M_x) and right contact and tongue of relay K_x to conductor 126 and thence to the x segment of transmitting mixer TM_2 and to the escapement magnet 155.

The operation of relay N_x applies battery to the supplemental or right hand windings of relay banks R_x and PTR, which are connected in series in such manner as to move the tongues of relays 1, 2, 3 and 5 of each bank to their spacing sides and the tongues of relays 4 to their marking sides. This special combination having the number 4 impulse only of marking character is arbitrarily selected to control the entry of the printer corresponding to the station X at the receiving station. The operation of this control mechanism at the receiving station will be described later in connection with Fig. 5. With this code combination now set up on the contacts of the transmitting ring TR it will be transmitted to the line on the next revolution of the brushes of the multiplex distributor MD.

The operation of the fourth relay of bank R_x to its marking side also interrupts the ground connection to winding 122 of relay L_x, permitting the tongues of this relay to return to their normal righthand side as soon as the holding circuit through winding 123 is interrupted by passage of brush B19 off of local segment 125. The tongue of relay N_x returns to normal simultaneously with the tongues of relay L_x, since their winding are in series. Relay K_x is restored to normal when its winding is deenergized by opening of tongue 127. Relay I_x remains operated until the brush B22 of the sending clock SC leaves its segment x'' when it returns to normal. Relay Jx is released on the following revolution of the multiplex local brush B19, when relay M_x sends a start impulse to outstation x, which starts distributor D_x and sets up a character on relay bank RB_x. Relay M_x has been in its normal unoperated position all the time. With relays I_x, J_x, K_x, L_x, M_x and N_x all in their normal positions the entry of station X is completed.

If now one of the other stations, for instance station Y, desires to resume operation the autocontrol contacts 116 at this station are closed, resulting in the operation of relay J_y to its grounded side as described with reference to relay J_x and thereby causing relay I_y to be operated the first time that the brush B22 of the sending clock crosses segment y' and comes to rest on segment y''. The operation of relay I_y releases relay K_y removing the battery from the y segment of the transmitting mixer TM_2 so that it now comes to rest on the y segment following its escapement from the x segment, the first time that brushes B21 and B22 engage their respective segments y and y'' simultaneously. If the brushes of the transmitting mixer TM_2 and the sending clock SC do not engage these segments simultaneously, station Y is not cut in at this time since the battery is removed from segment y only while the brush 22 of the sending clock is on segment y''. Since the sending clock is advanced one position only for each local impulse, whereas the brush of the transmitting mixer may move over several positions for each local impulse, it is obvious that after a few revolutions of the clock the brushes B22 and B23 will be stepped on to segments y and y'', respectively, from the same local impulse. When this occurs brush B21 is stopped on segment y due to removal of battery from this segment at the contact 145 of relay K_y. Therefore the next local pulse from segment 125 finds a path to ground through the winding of relay N_y, tongue 128 and left the contact of relay L_y, right contact and tongue of relay K_y and conductor 147 to segment y and thence through the release magnet 155 to ground. When this circuit is completed station Y is entered, relay N_y causing the movement of the 4th relay of banks R_y and PTR to their marking sides, and the movement of the 1st, 2nd, 3rd and 5th relays to the spacing sides, resulting in the transmission of this special entry code over the line as described with reference to the entry of station X. At the same time relay L_y is released by interruption of its ground at the tongue of the fourth relay of bank R_y or by the completion of the travel of brush B19 over segment 125 and battery is permanently removed from segment y of the transmitting mixer TM_2 due to the movement of tongue 127 of relay L_y away from its left contact, thereby interrupting the circuit over relay K_y (through the contacts of which the battery was supplied to segment y).

Similarly station Z may be cut in, this occurring only when the brushes of the sending clock SC and the transmitting mixer TM_2 pass on to segment Z' and Z concurrently. This type of entry of the transmitting stations into the circuit depending upon positioning of both the clock and mixer I have for convenience termed "time and turn entry."

It will be noted that upon closing out a station from the channel, a blank or all spacing signal was transmitted from the multiplex distributor MD over the multiplex line ML and that on entry of one of the stations, a special entry code combination was transmitted preceding the sending of character code signals from the transmitter. As stated before the blank signal and the special entry combination control the closing out and entry of the receiving apparatus for the associated station at the opposite end of the multiplex line ML. The equipment by which this is accomplished is shown in Fig. 5 and reference will now be had thereto.

The signals received from station C over the line ML are repeated by the relay 161 to the solid ring 162 of the receiving ring RR of the multiplex receiving distributor MRD. These signals are repeated from the segments of the C-channel to two banks PCR and PRR of polar relays in series. Relays PRR set up the received combination on the segments of each of the start-stop transmitting distributors TD_x, TD_y and the windings 160 of a multiplex printer MP_z. The solid ring of distributor TD_x is joined by a line L_x to an associated branch office, a simplex printer located in the central office or to any other destination X'. Similarly the solid ring on distributor TD_y is connected to a line L_y extending to sub-station Y'. The contacts of relays PCR are coded, both to the blank signal indicating when a station is to be closed-out and to the entry code signal having the fourth impulse marking, which indicates when a station is to be entered. During normal transmission, when neither of these combinations are sent, it performs no function.

Following the reception of a character as from the X transmitter, the local brush B23 engages local segment 163 which sends an impulse over two paths, the first by way of conductor 164 to the release magnet 165 of the receiving clock RC and the other by way of conductor 166 and normally closed contact 167 of relay 168, thence by conductor 169 to the release magnet 171 of the distributor TD_x and thence by conductors 172

and 173 and the left contact and tongue 174 of control relay CR_x and conductor 175 to the x_1 segment of the receiving mixer RM_2 and by solid ring 176 of the mixer to the release magnet 177. The brushes B26 and B27 of the receiving mixer RM_2 and receiving clock RC_1 thus receive one release pulse for each local impulse from the multiplex distributor.

The release of brush B28 of the distributor TD_x transmits the received code combination, with the addition of a rest and start impulse, over the line L_x to the receiving apparatus at the distant end thereof.

If it is assumed that all the stations X, Y and Z are transmitting, then the next received character will come from the transmitter Y. This character code also operates relays PCR and PRR, the combination being set up on each of the transmitting distributors TD_x, TD_y, and the polar windings 160 of the selecting magnets of printer MP_z. The next local pulse from segment 163 escapes the brush of the receiving clock and also completes a circuit over the conductor 166, left contact and tongue of relay 167 and conductor 178 to the release magnet 179 of the transmitting distributor TD_y and thence by tongue 181 of control relay CR_y to the y_1 segment of the receiving mixer RM_2 and thence to the release magnet 171, advancing the brush B26 on to segment z_1, and releasing the brush B29 of the distributor TD_y to repeat the combination over the line L_y.

In a similar manner the next character received from the transmitting station Z escapes the brushes of the receiving clock RC_1 and receiving mixer RM_2 and completes a circuit for the operating magnet 195 of the printer MP_z. It will be understood that the selecting magnets 160 of printer MP_z are polar, thereby responding to the polar signals set up on the contacts of relay bank PRR, or the magnets 160 may be neutral and preceded by individual polar relays. Obviously printers' reperforators or storing devices may be used in any of the positions occupied by the distributors TD_x and TD_y or printer MP_z.

This operation continues as long as each of the stations X, Y and Z are transmitting. If any one of these stations is closed-out at the transmitting end, the concluding signal from the station being closed-out will consist of the all spacing combination. Assume that station X is to be closed-out indicated at station D by the reception from station X of a blank or all spacing combination, this will be received upon the relays PCR and PRR and will be set up on the segments of each of the transmitting distributors TD_x, TD_y, etc. However, since its only function is to control the closing-out of the position of the X station on the receiving mixer RM_2, it is not transmitted over the line L_x, but is deleted as will presently appear.

The all spacing combination moves the tongues of each of the relays PCR to their lefthand contacts, thus completing a circuit from ground through the tongues and lefthand contacts of each relay to conductor 182 and thence to the winding of cutout relay CO_x, moving the tongues of this relay to their righthand sides and short circuiting, through tongue 183, the release magnet 171 of distributor TD_x and preparing a circuit through tongue 184 to the operating winding 185 of relay CR_x. As the next local impulse from segment 163 is received, following this blank combination, it finds a path to ground through conductors 166, the tongue 167 of relay 168, tongue 183 of relay CO_x and thence by way of conductor 173 and tongue 174 of relay CR_3 and conductor 175 to the x_1 segment of receiving mixer RM_2 and thence through the release magnet 177 to ground. A part of the local impulse also passes directly through the release magnet 165 of the receiving clock, advancing the brushes of each of these rotary devices one step. The brush B28 of distributor TD_x is not released, however, since the magnet 171 is short-circuited. Therefore the blank combination is not sent over the line L_x. As the brush B26 escapes from segment x_1 of the receiving mixer RM_2, it crosses a small segment x_2, thereby applying ground through the release magnet 177, ring 176, brushes B26, segment x_2, conductor 180, tongue 184 of relay CO_x, which is on its righthand side at this time, to the operating winding 185 of relay CR_x and thence to battery. Relay CR_x is thus operated and locks up through the winding 185 and tongue 186. The tongue 174 of relay CR_x upon being moved to its right hand side, applies continuous positive battery to segment x_1 of receiving mixer RM_2 from the right contact and tongue 180' of relay CR_y, conductor 187 and the right hand contact and tongue 174 of relay CR_x and thence to segment x_1. This circuit is maintained as long as station X is closed out. Consequently each time the brush B26 of the receiving mixer RM_2 leaves segment z_1 it passes directly over the segments x_1 and x_2 coming to rest on segment y_1. The transmitting distributor TD_x is therefore effectively removed from the circuit and all signals received are distributed alternately to the distributors TD_y and TD_z.

Similarly if station Y should discontinue transmitting, an all spacing combination would be received as the concluding combination from the Y station transmitter. This combination would operate relay CO_y through the circuit established by the relays PCR, which in turn would short-circuit the release magnet 179 of distributor TD_y and at the same time escape the brush B26 of mixer RM_2 from segment y_1 to segment z_1. This brush in passing segment y_2 would operate relay CR_y to apply battery continuously to the y_1 segment of the receiving mixer RM_2 thereby permitting the brush B26 on subsequent revolutions, to pass directly over the y_1 segment without stopping thereon. With channels X and Y thus eliminated, all signals would be transmitted directly to the printer MP_z, this printer receiving one character for each revolution of the multiplex receiving distributor MRD.

If now one of the transmitters, at station X for instance, desires to again transmit, this desire will be signified at receiving station D by the reception of the entry combination having the fourth impulse marking. As explained in connection with the sending clock SC at station C, this impulse always arrives in its proper turn, that is following a character transmitted from station Z at a time when the brush of the receiving clock RC_1 is on the x_3 segment. This entry combination is set up on the contacts of relays PCR and PRR. Since it performed no function at the printer, it is also deleted. It completes a circuit, however, from ground through the left contacts and tongues of relays 1, 2, 3, and 5 of bank PCR and through the tongue and right contact of relay 4 and thence through the winding of relay 168. This latter relay opens its contacts 167 and closes contacts 188 applying battery through resistance 193 and

conductor 189 to the solid ring 191 of the receiving clock RC_1, the circuit being completed by way of segment x_3, on which the brush B27 rests at this time, to the release winding 192 of relay CR_x and to ground through the tongue 186 of the relay. In order to insure release of relay CR_x at this time, resistance 193 should be equal to or a little less than resistance 194 connected to winding 185 of the relay. This relay upon releasing removes battery at tongue 174 from segment x_1 of the receiving mixer RM_2. Consequently on the next opportunity brush B26 comes to rest on the x_1 segment thereby entering the transmitting distributor TD_x so that it responds to signals transmitted from station X.

In a similar manner the receiving apparatus corresponding to station Y may be entered, each station assuming its proper place on the channel and the signals therefrom being distributed through the proper distributors TD*x*, TD*y*, etc., to their proper destination. It will be understood of course that the receiving clock RC is kept in step with the sending clock SC, each being released one step for each revolution of the multiplex distributors which are maintained in accurate synchronism and likewise the transmitting mixer TM_2 and the receiving mixer RM_2 are kept in step with each other, but not necessarily in step with the clocks. As long as these devices maintain this phase relation any station may be entered or closed out as desired without interrupting transmission or reception from any of the other stations. It will also be apparent that when all channels are cut out, the brush of mixer RM_2 is stopped and released at X channel in synchronism with the brush of transmitting mixer TM_2, providing self-synchronization as pointed out above.

It will be understood of course that the invention may be embodied in various other forms and applied to lanes of traffic other than a multiplex channel. Therefore I do not desire to be limited to the particular embodiment shown but contemplate all applications of the principles herein set forth, as coming within the scope of the appended claims. No claim is made herein to the broad features involved in repeating signals into or from the expanding channel system, except start-stop means or its equivalent, these features forming the subject matter of my copending application Serial No. 106,904, filed October 21, 1936, now Patent No. 2,233,346, issued Feb. 25, 1941.

What I claim is:

1. In a telegraph system, a plurality of transmitters and a plurality of receivers, one for each transmitter, a single set of transmitting contacts operable in cycles, a sequencing device having means individual to each of said transmitters for operatively and invariably associating one of said transmitters with said contacts during each cycle of operation thereof and selective means for varying the number of transmitters and receivers operable in turn over said contacts.

2. In a telegraph system, a lane of traffic, a plurality of transmitters operating in succession over said lane, means for discontinuing the operation of one of said transmitters and means for transmitting a discontinuing signal condition over said lane of traffic.

3. In a telegraph system, a lane of traffic, a plurality of transmitters operating in succession over said lane, means for entering additional transmitters on to said lane and means for transmitting an entering signal over said lane preliminary to the entering of an additional transmitter.

4. In a telegraph system, a lane of traffic, a plurality of transmitters operable in predetermined order to transmit characters over said lane, means for entering a transmitter on to the lane or closing a transmitter from the lane and means for automatically modifying the electrical condition of the lane to indicate when a transmitter is entered on to or closed therefrom.

5. In a telegraph system, a lane of traffic, transmitting and receiving stations at opposite ends of the lane of traffic a plurality of transmitters, means for operatively associating each of said transmitters with said lane of traffic and for closing out each transmitter therefrom, and means for signalling to the receiving station the entry of a transmitter on and the exit of a transmitter from the lane at the transmitting station.

6. In a telegraph system, a lane of traffic, a plurality of transmitters operatively associated with said lane and normally occupying the full lane time, a mixer for determining the order of operation of said transmitters, means for preparing an additional transmitter for entry on to the lane and a timing device for operatively associating said additional transmitter with said mixer whereby it will share said lane with said other transmitters.

7. In a telegraph system, a lane of traffic, a plurality of transmitters operatively associated with said lane in succession, a sequencing device operable through successive positions individual to each of said transmitters for determining the order of operation of said transmitters, means for preparing an additional transmitter for entrance on to the lane, a control device operable through a succession of positions, one of said positions being provided for each of said transmitters, means for preparing a position on said sequencing device for said entering transmitter when said control device reaches the position assigned to said entering transmitter, and means for operatively associating said entering transmitter with the lane when said sequencing device reaches the position assigned to said entering transmitter.

8. In a telegraph system, a lane of traffic, a plurality of transmitters certain of which are active and others of which are inactive, a sequencing device having an actual position of operation for each of said active transmitters and a potential position of operation for each of said inactive transmitters, and means to operate said sequencing device in steps from one active position to the next to determine the order of operation of said transmitters over said lane.

9. In a telegram system, a lane of traffic, a plurality of transmitters certain of which are active and others of which are inactive, a sequencing device having an actual position of operation for each of said active transmitters and a potential position of operation for each of said inactive transmitters, means for changing the potential position of any one of the transmitters on the sequencing device to an actual position thereon, and means to operate said sequencing device in steps from one active position to the next to determine the order of operation of said transmitters over said lane.

10. In a telegraph system, a lane of traffic, a plurality of transmitters certain of which are active and others of which are inactive, a sequencing device having an actual position of operation for each of said active transmitters and

a potential position of operation for each of said inactive transmitters, means to operate said sequencing device in steps from one active position to the next to determine the order of operation of said transmitters over said lane, a timing device having an actual position for each transmitter, means operable whenever an inactive transmitter is to be rendered active and means acting following the operation of said last means for changing the potential position on the sequencing device of said transmitter to an actual position, whenever the timing device and the sequencing device concurrently attain the positions individual to said entering transmitter.

11. In a telegraph system, a central station, a plurality of substations, a transmitter at each substation, a single-conductor line circuit connecting each substation to said central station for transmitting from the substation to the central station, a lane of traffic extending from said central station to a remote station, means including said line circuits for transmitting from any of said substations over said lane of traffic and means for varying the rate of transmission from said substations over the lane of traffic in accordance with the number of substations transmitting.

12. In a telegraph system, a transmitting station and a receiving station, a lane of traffic extending between said stations, a plurality of transmitters associated with one of said stations, a recorder individual to each transmitter associated with the other station, means for transmitting telegraph code signals one at a time from any one or more of said transmitters over said lane of traffic, the operating transmitters, irrespective of number, invariably occupying the full lane time and means for recording the signals transmitted from each of said transmitters on its associated recorder.

13. In a telegraph system, a transmitting station, a receiving station, a lane of traffic extending between said stations, a plurality of transmitters associated with said transmitting station, a recorder individual to each transmitter associated with said receiving station, sequencing devices at the transmitting and receiving stations for determining the number and order of operation of said recorders and means for maintaining said sequencing devices in fixed phase relation.

14. In a telegraph system, a transmitting station, a receiving station, a lane of traffic extending between said stations, a plurality of transmitters associated with said transmitting station, a recorder individual to each transmitter associated with said receiving station, a sequencing device at the transmitting station for determining the number and order of operation of said transmitters, a sequencing device at the receiving station for determining the number and order of operation of said recorders, means for maintaining said sequencing devices in fixed phase relation, and means for increasing or decreasing the number of transmitters operating over said lane of traffic.

15. In a telegraph system, a transmitting station, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters associating with the transmitting station, a plurality of recorders associated with the receiving station, means at the transmitting station for entering any of said transmitters for operation over said lane, means for modifying the electrical condition of the lane when a transmitter is so entered and means at the receiving station responsive to said electrical condition for entering a recorder individual to said entering transmitter, the entered transmitters sharing the full capacity of the lane of traffic.

16. In a telegraph system, a lane of traffic, a plurality of channels associated with said lane of traffic, each of said channels having sending and receiving or signal devices at opposite ends of the lane of traffic, certain of said channels being idle at times, and means for causing the operating channels to occupy invariably substantially the full capacity of the lane of traffic, said means including electrical switching means for operatively connecting the channels to the lane of traffic.

17. In a telegraph system, a lane of traffic, a plurality of channels, each of said channels having sending and receiving or signal devices at opposite ends of the lane of traffic, certain of said channels being engaged in the transmission of intelligence and the others not being engaged in the transmission of intelligence, the particular channels which are busy or idle changing according to the traffic requirements at the moment, and means for causing the operating channels to occupy invariably substantially the full capacity of the lane of traffic, said means including control means for rendering said channels operative in predetermined order.

18. In a communicating system, a lane of traffic, a plurality of sources of permutation telegraph signals, means for transmitting character signals from all of said sources in succession over said lane of traffic, means for discontinuing the transmission of signals from one of said sources and means for transmitting signals from each of said other sources at more frequent periods.

19. In a communication system, a lane of traffic, a plurality of sources of permutation telegraph signals, means for transmitting character signals from all of said sources in succession over said lane of traffic, means for starting transmission from an additional source of signals and means for decreasing the frequency of transmission from the other sources of signals to allow time for the transmission of signals from said additional source.

20. In a communication system, a lane of traffic, a plurality of telegraph transmitters, means for rendering said transmitters operative one after the other, means for transmitting at least one whole character signal from each of said transmitters over said lane of traffic before the next transmitter is rendered operative, means for varying the number of transmitters operating over said lane at any time and means for varying the period of transmission from the operating transmitters inversely to the variation in the number of transmitters operating.

21. In a communication system, a lane of traffic, means for transmitting a variable number of messages over said lane of traffic with the character signals of the various messages intermingled and means for varying the frequency of transmission of the characters of each message in accordance with the number of messages being transmitted.

22. In a telegraph communication system, a lane of traffic, means for transmitting character signals of a message over said lane of traffic with one or more character signals of other messages interspaced between each character signal of said first message, means for varying the number of such interspaced characters and

means for varying the frequency of transmission of each character signal of said first message in accordance with the number of such interspaced characters.

23. In a permutation code telegraph system, a transmitting distributor having a contact for each unit of the permutation code, a plurality of transmitters, a line, means for transmitting at least a single character signal at a time, over said contacts to said line from a variable number of said transmitters in predetermined order, a receiving distributor having a contact for each unit of the permutation code, a plurality of receiving instruments and means for distributing over said latter contacts the received character signals originating at each transmitter to a different one of said receiving instruments.

24. In a telegraph system, a plurality of transmitters, a plurality of receivers, each individual to one of said transmitters, a transmitting distributor having a set of contacts common to all of said transmitters, and means for transmitting a single code combination at a time over said common contacts from a variable number of said transmitters to corresponding receivers in predetermined order.

25. In a telegraph system, a transmitting station, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters associated with the transmitting station, a plurality of recorders associated with the receiving station, said transmitters and recorders being normally unentered on said lane, and means for entering any one or more of said transmitters and a corresponding recorder on to the lane, the entered transmitters operating in succession to transmit characters over the lane to separate ones of said recorders.

26. In a telegraph system, a plurality of transmitters, a synchronous multiplex system, a single channel of said multiplex system common to all of said transmitters, and means for transmitting from a variable number of said transmitters in succession over said single multiplex channel, said means including electrical switching means for operatively connecting the transmitters to said channel.

27. In a telegraph system, a synchronous multiplex system, a plurality of transmitters operable over said multiplex system, means for varying the number of operating transmitters and means for causing the operating transmitters to utilize the same predetermined part of the entire capacity of the multiplex system irrespective of the number of transmitters operating.

28. In a telegraph system a plurality of telegraph transmitters, a storage device, means for transferring a character signal from one of said transmitters at a time to said storage device, a sequencing device for determining the order of transfer of said signals from said transmitters to said storage device, means including the sequencing device for varying the number of transmitters operable into said storage device, a lane of traffic and means for transmitting character signals stored in said storage device over said lane of traffic.

29. In a telegraph system a plurality of telegraph transmitters, a storage device, means for transferring a character signal from one of said transmitters at a time to said storage device, a sequencing device for determining the order of transfer of said signals from said transmitters to said storage device, means including the sequencing device for varying the number of transmitters operable into said storage device, a lane of traffic, means for transmitting each character signal stored in said storage device over said lane of traffic, a receiving storage device responsive to character signals transmitted over said lane of traffic to store the same, receiving instruments, means to transfer each character signal from said receiving storage device to one of said receiving instruments and a sequencing device for determining the receiving instrument to respond to each character signal.

30. In a telegraph system, a source of signals representing character signals of a plurality of messages intermingled in predetermined order, a plurality of receiving instruments, a storage device common to said receiving instruments, means for storing each character signal in said storage device, means for distributing each character signal stored in said storing device to one of said receiving instruments and a sequencing device for determining the particular receiving instrument to which each character signal is distributed.

31. In a telegraph system, a source of code telegraph signals representing character signals of a plurality of messages intermingled in predetermined order, a receiving distributor having contacts upon which all of said character signals are received, a plurality of receiving instruments associated with said contacts and potentially receptive to each received character signal and a sequence device for determining the particular receiving instrument upon which each character signal is actually received.

32. In a telegraph system, a lane of traffic over which telegraph signals are received, a plurality of receiving instruments, a sequencing device having an element individual to each receiving instrument, each element serving when selected to condition its associated receiving instrument to respond to character signals received over said lane of traffic, means for selecting said elements in predetermined order and selective means for passing by one or more of said elements without conditioning the associated receiving instrument for operation whereby to vary the number of receiving instruments responsive in succession to successively received signals, the frequency of selection of the receiving instruments increasing as the number of active receiving instruments decreases.

33. In a telegraph system, a lane of traffic, a plurality of receiving instruments certain of which are active and others of which are inactive, a sequencing device having an actual position of operation for each of said active receivers and a potential position of operation for each of said inactive receivers, said sequencing device operating in steps from one active position to the next to determine the order of operation of said receivers in response to signals received over said lane of traffic.

34. In a telegraph system, a lane of traffic, a plurality of receiving instruments certain of which are active and others of which are inactive, a sequencing device having an actual position of operation for each of said active receivers and a potential position of operation for each of said inactive receivers and means for changing the potential position of any one of the receiving instruments on the sequencing device to an actual position thereon, said sequencing device operating in steps from one active position to the next to determine the order of operation

of said receivers in response to signals received over said lane of traffic.

35. In a telegraph system, a plurality of telegraph instruments certain of which are active and others of which are inactive, a sequencing device comprising a segmented distributor having an individual segment for each telegraph instrument, a rotary brush movable over said segments, means for stopping said brush on each segment associated with an active telegraph instrument and for passing it continuously over a segment associated with an inactive telegraph instrument and means for selecting for operation the telegraph instrument associated with a particular segment while the brush is at rest on said segment.

36. In a telegraph system, a plurality of telegraph instruments, a sequencing device for selecting said instruments for operation in definite order, said sequencing device comprising a segmented distributor having a segment individual to each instrument, a rotary brush movable over said segments, means for stopping said brush on each segment in succession, means for selecting for operation the telegraph instrument associated with a particular segment while the brush is at rest thereon and selective means for causing said brush to pass directly over one or more of said segments without stopping.

37. In a telegraph system, a plurality of telegraph instruments, a sequencing device for selecting said instruments for operation in definite order, said sequencing device comprising a segmented distributor having a segment individual to each instrument, a rotary brush movable over said segments, a stop element individual to each segment for stopping the brush on the associated segment, means for selecting for operation the instrument associated with a particular segment while the brush is at rest thereon and selective means for rendering one or more of said stop elements ineffective to stop the brush on the associated segments whereby to omit the selection of the corresponding telegraph instruments.

38. In a telegraph system, a plurality of telegraph instruments, a sequence device for determining the order of operation of said telegraph instruments, said sequence device comprising a segmented commutator having a segment individual to each telegraph instrument, a brush rotatable over said segments, means associated with each segment for stopping the brush thereon, means for periodically releasing the brush for movement on to a succeeding segment and selectively controlled means including each segment actuated as the brush engages the selected segment for rendering the stopping means associated with said segment ineffective to stop the brush thereon.

39. In a telegraph system, a plurality of telegraph instruments, a sequence device for determining the order of operation of said telegraph instruments, said sequence device comprising a series of contacts, at least one of said contacts being individual to each telegraph instrument, a rotatable member cooperating therewith, means for stopping the rotation of said member at the contacts of the desired instruments, and means for preventing said member from stopping at the contacts of inactive instruments.

40. In a telegraph system, a lane of traffic over which character signals of a plurality of messages are received with the character signals of one message intermingled with those of the other messages in predetermined order, a plurality of receiving devices operable in said predetermined order in response to said character signals and means also responsive to received signals for conditioning an additional receiver to respond in its turn to said character signals.

41. In a telegraph system, a lane of traffic over which character signals of a plurality of messages are received with the character signals of one message intermingled with those of the other messages in predetermined order, a plurality of receiving devices operable in said predetermined order in response to said character signals and means also responsive to received signals for varying the number of receiving devices responsive to said received character signals.

42. In a telegraph system, a lane of traffic, a plurality of storage transmitters associated with said lane to transmit thereover in predetermined order, means for dis-associating each transmitter from the lane whenever the supply of stored characters for the transmitter is reduced to a predetermined number and for re-associating the idle transmitter with the lane when the supply of stored characters increases to a predetermined number, the active transmitters at all times occupying a uniform portion of the full lane time.

43. In a telegraph system, a lane of traffic, a plurality of tape transmitters associated with said lane to transmit thereover in predetermined order, means controlled by the tape supplied to each transmitter for dis-associating each transmitter from the lane whenever the supply of perforated tape to the transmitter is reduced to a predetermined length and for re-associating the idle transmitter with the lane when the supply of tape increases to a predetermined length, and means for transmitting an exit signal over the lane whenever a transmitter is rendered idle and an entry signal whenever an idle transmitter is rendered active.

44. In a telegraph system. a lane of traffic, a plurality of storage transmitters associated with said lane to transmit thereover in predetermined order, means controlled by the number of stored characters for dis-associating said transmitter from or re-associating it with the lane of traffic and means for indicating over said lane of traffic such change in the status of a transmitter.

45. In a telegraph system, a lane of traffic, a plurality of transmitters associated with said lane to transmit thereover in predetermined order, an auto-control contact for each transmitter, means controlled by the auto-control contact of any transmitter for dis-associating said transmitter from or reassociating it with said lane of traffic, the transmitters actively associated with said lane of traffic invariably occupying a predetermined part of the full lane time.

46. In a telegraph system, a transmitting station, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters associated with the transmitting station, a plurality of recorders associated with the receiving station, an entry selecting device at each station operating in conjunction with each other, means including the entry selecting device at the transmitting station for entering a transmitter for operation over said lane, means for modifying the electrical condition of the lane when a transmitter is so entered and means, including the entry selecting device at the receiving station, responsive to said electrical condition for entering a recorder for said entering transmitter.

47. In a telegraph system, a transmitting sta-

tion, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters associated with the transmitting station, a plurality of recorders associated with the receiving station, means at the transmitting station for entering a transmitter for operation over said lane, means for modifying the electrical condition of the lane when a transmitter is so entered and means at the receiving station responsive to said electrical condition for entering a recorder for said entering transmitter.

48. In a telegraph system, a transmitting station, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters associated with the transmitting station, a plurality of recorders associated with the receiving station, a transmitting clock at the transmitting station and a receiving clock at the receiving station, said clocks being maintained in predetermined phase relation, means including the transmitting clock for timing the entry of any of said transmitters for operation over said lane, means for transmitting an entry signal over the lane when a transmitter is so entered, means including the receiving clock responsive to said entry signal for timing the entry of a recorder individual to said entering transmitter and means at each station for determining the order of operation of said entered transmitter and recorders.

49. In a telegraph system, a transmitting station, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters associating with the transmitting station, a plurality of recorders associated with the receiving station, means at the transmitting station for timing the entry of any of said transmitters for operation over said lane, means for transmitting an entry signal over the lane when a transmitter is so entered. means at the receiving station responsive to said entry signal for timing the entry of a recorder for said entering transmitter and a sequencing device at each station for determining the order of operation of said entered transmitters and recorders.

50. In a telegraph system, a lane of traffic, a plurality of telegraph instruments operatively associated with said lane, means for preparing an additional telegraph instrument for operative association with the lane, a timing device operable through a succession of positions, one of said positions being provided for each of said telegraph instruments, and means including said timing device when it reaches the position assigned to said entering telegraph instrument for operatively associating said instrument with the lane.

51. In a telegraph system, a lane of traffic, a plurality of telegraph receivers, certain of which are actively associated with said lane for operation in predetermined order in response to telegraph signals received thereover and others of which are inactively associated therewith, a timing device operable through a succession of positions, a position being provided for each of said telegraph receivers, and means including said timing device responsive to a predetermined received signal for rendering active the receiver corresponding to the position of said timing device at the time said predetermined signal is received.

52. In a telegraph system, a lane of traffic, a plurality of telegraph receivers operatively associated with said lane, a sequencing device for determining the order of operation of said telegraph receivers in response to character code signals received over said lane and means including a timing device responsive to a predetermined received signal for operatively associating an additional telegraph receiver with said sequencing device whereby it will be caused to respond in its proper turn to said received character signals.

53. In a telegraph system, a plurality of substations, a central station, means for transmitting a single character signal from each of said substations at a time to said central station and means at the central station for determining the order of transmission of signals from said substations to said central station.

54. In a communication system, a plurality of substations, a central station, means for transmitting character signals from each of said substations in succession to said central station, means for discontinuing the transmission of signals from one or more of said substations and means for transmitting signals from each of the other substations at more frequent periods.

55. In a permutation code telegraph system, a central station, a plurality of remote substations, a transmitting distributor at said central station having a set of contacts common to all of said substations and comprising an individual contact for each unit of the permutation code, means including a single line conductor extending from each of the substations to said central station for transmitting character signals thereto from each substation, a transmitting channel terminating at said central station and associated with said distributor and means including said single set of contacts for transmitting said character signals from the substations over said transmitting channel with the character signals from the respective substations interspersed.

56. In a printing telegraph system, a central station, a plurality of substations, means for transmitting at least one character signal from one substation at a time to said central station, a sequencing device at the central station for determining the order of transmission of said signals from the substations, means including said sequencing device for varying the number of substations transmitting to said central station, a lane of traffic terminating at the central station and means for transmitting each character signal received from said substations over said lane of traffic.

57. In a telegraph system, a central station, a plurality of substations, means for transmitting character signals from each substation in turn to said central station, a lane of traffic terminating at the central station, means for transmitting character signals received from each substation over said lane, means for increasing the number of substations transmitting to said central station and means whereby said additional substations when entered assume their proper share of the lane time.

58. In a telegraph system, a central station, a plurality of substations, transmitting apparatus at each substation, means for transmitting character signals from the transmitting apparatus at each substation in predetermined order to said central station, means at each substation for rendering idle the transmitting apparatus thereat, means for transmitting a special signal to said central station whenever such a transmitter is rendered idle, and means at said central station responsive to said signals for increasing the frequency of transmission of character signals from the remaining substations.

59. In a telegraph system, a central station, a plurality of substations, tape transmitting appa-

ratus at each substation, means for transmitting character signals from the tape transmitting apparatus at each substation to said central station in predetermined order, a lane of traffic terminating at the central station, means for transmitting signals received from said substations over said lane, means controlled by tape approaching each transmitter for rendering the transmitter idle or potentially active, means for indicating to the central station such change in the status of the transmitter and means at the central station responsive to said indication for disassociating said substation from or associating it with said lane of traffic.

60. In a telegraph system, a lane of traffic, a plurality of telegraph instruments, certain of which are active and others of which are inactive to transmit over said lane, a sequencing device for determining the order of operation of said transmitters, a timing device for timing the entry of an inactive transmitter on to the lane of traffic, said sequencing device and timing device both being operable through a succession of positions, a position being provided on each device for each transmitter, means for preparing an inactive transmitter for entry in any position of said sequencing and timing devices, and means for completing the entry of said inactive transmitter when said sequencing and timing devices are both in the positions assigned to the entering transmitter.

61. In a telegraph system, a lane of traffic, a plurality of transmitters associated therewith, certain of which are conditioned for active operation over said lane and others of which are not conditioned for active operation over said lane, a seeker having a rest position for each of said transmitters, means for releasing said seeker periodically from its last position of rest, means for causing said seeker to select the next position associated with an actively conditioned transmitter and to come to rest thereon and means controlled through said seeker for effecting transmission from the transmitter associated with the selected position.

62. In a telegraph system, a transmitting station, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters associated with the transmitting station, a plurality of retransmitters at the receiving station, an entry device at each station maintained in predetermined co-relation, means including the entry device at the transmitting station for entering a transmitter for operation over said lane, means for modifying the electrical condition of the lane when a transmitter is so entered, means including the entry device at the receiving station responsive to said electrical condition for entering a retransmitter for said entering transmitter and means whereby said retransmitter when entered serves to repeat each received signal originating at the corresponding transmitter.

63. In a telegraph system, a transmitting station, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters associated with the transmitting station, a retransmitting device at the receiving station for certain of said transmitters, an entry and exit device at each station maintained in predetermined co-relation, means including the entry and exit device at the transmitting station for entering a transmitter for operation over said lane, means for modifying the electrical condition of the lane when a transmitter is so entered and means including the entry and exit device at the receiving station responsive to said electrical condition for entering a retransmitter for said entering transmitter, said retransmitter when entered serving to repeat each received signal originating at the corresponding transmitter.

64. In a telegraph system, a central transmitting station, a central receiving station, a lane of traffic connecting said stations, a plurality of substations associated with the central transmitting station, a plurality of substations associated with the central receiving station, means for transmitting character signals in predetermined order from each of said first substations to its associated central transmitting station and thence over said common lane of traffic to said central receiving station and means at said central receiving station for distributing character signals to one of said second mentioned substations individual to the substation of origin of each received character signal and means for varying the number of substations so connected over said lane of traffic, the frequency of transmission of character signals from each substation being dependent upon the number of substations transmitting.

65. In a communication system, a lane of traffic, means for transmitting a variable number of messages over said lane of traffic with portions of the various messages intermingled, and means for varying the frequency of transmission of the portions of each message in accordance with the number of messages being transmitted.

66. In a telegraph communication system, a lane of traffic, means for transmitting one or more character signals of a message over said lane of traffic with one or more character signals of other messages interspaced between character signals of said first message, means for varying the number of interspaced characters and means for varying the rate of transmission of said first message in accordance with the number of such interspaced characters.

67. In a permutation code telegraph system, a transmitting distributor having a contact for each unit of the permutation code, a plurality of transmitters, a lane of traffic, means for transmitting character signals from a variable number of said transmitters in predetermined order over said lane of traffic, a receiving distributor having a contact for each unit of the permutation code, receiving instruments and means for distributing over said latter contacts the received character signals originating at each transmitter to its proper receiving instrument.

68. In a telegraph system, a transmitting station, a receiving station, a channel of communication extending between said stations, a plurality of transmitters associated with said transmitting station, a recorder individual to each transmitter associated with said receiving station, and time-code entry and exit means at the transmitting and receiving stations for determining the number and order of operation of said transmitters and recorders.

69. In a telegraph system, a transmitting station, a receiving station, a channel of communication extending between said stations, a plurality of transmitters associated with said transmitting station, a plurality of recorders associated with said receiving station, means at the transmitting station for determining the number and order of operation of said transmitters, and time-code controlled means at the receiving station for determining the number and order of operation of said recorders.

70. In a telegraph system, a lane of traffic, time-code means for varying the number of channels operating over said lane of traffic, and means for causing the operating channels to occupy invariably substantially the full lane time.

71. In a telegraph system, a lane of traffic, time and turn means for varying the number of channels operating over said lane of traffic, and means for causing the operating channels to occupy invariably substantially the full lane time.

72. In a communication system, a lane of traffic, a plurality of receivers, means for transmitting character signals over said lane of traffic to desired ones of said receivers in predetermined order and time-code controlled means for varying the number of receivers operable over said lane of traffic.

73. In a telegraph system, a plurality of transmitters greater in number than two, a single channel of a multiplex system common to all of said transmitters, and means for transmitting from a variable number of said transmitters in succession over said single multiplex channel.

74. In a telegraph system, a lane of traffic, a plurality of code transmitters operatively associated with said lane of traffic, means for controlling said transmitters to transmit character code combinations thereover in predetermined order and to prevent transmission from one transmitter while another is sending a unit of the code, said transmitters together normally occupying a predetermined part of the lane time, means for entering one or more additional transmitters on to the lane without materially interrupting transmission thereover and means whereby said additional transmitters when entered assume their proper share of said predetermined part of the lane time.

75. In a telegraph system, a lane of traffic, a plurality of code transmitters operatively associated with said lane of traffic, means for controlling said transmitters to transmit character code combinations thereover in predetermined order and to prevent transmission from one transmitter while another is sending a unit of the code, and means for varying the number of transmitters operating over the lane without interrupting transmission thereover or changing the lane time occupied by the operating transmitters.

76. In a telegraph system, a lane of traffic, time-code means for varying the number of channels operating over said lane of traffic, and means for causing the operating channels to occupy invariably substantially the same lane time.

77. In a telegraph system, a lane of traffic, time and turn means for varying the number of channels operating over said lane of traffic, and means for causing the operating channels to occupy invariably substantially the same lane time.

78. In a telegraph system, a lane of traffic capable of transmitting only a single signal at a time, a plurality of transmitters associated therewith, means including a sequencing device for operating a variable number of said transmitters at different times and dividing the entire lane time between the operating transmitters and means at the receiving end of the lane of traffic for separating and separately recording the signals from the respective transmitters.

79. A signalling system comprising a signalling channel capable of transmitting only a single signal at a time, n signalling devices associated therewith and means for connecting said devices to said channel successively and intermittently for a definite, predetermined period of time, and for connecting $n-1$ of said devices to said channel successively and intermittently for a definite, predetermined period of time, said connecting means including means whereby a predetermined part of the signalling capacity of the channel is used irrespective of whether n or $n-1$ devices are operative.

80. A telegraph system comprising a series of code transmitters, of which a variable number are busy at different times, control means for successively selecting the busy transmitters of the series and means for sending operating pulses to said transmitters resulting in transmission of characters from each selected transmitter, said control means embodying circuit connections whereby operating pulses are withheld from the idle transmitter or transmitters.

81. A communication system comprising a lane of traffic, receiving and selecting devices associated therewith, means including said receiving devices and said lane of traffic for transmitting intelligence and means for operating a selecting device over said lane, said means for transmitting intelligence being operable between the commencement and completion of the selecting function.

82. A telegraph system comprising a lane of traffic, a plurality of receivers associated therewith, means operable over said lane for rendering any of said receivers operative and means for controlling an operative receiver over said lane while said means for rendering a receiver operative is functioning to select another receiver.

83. A telegraph system comprising a lane of traffic, transmitting means including transmitters associated with said lane of traffic, means for operating a variable number of said transmitters to transmit a predetermined number of character signals from each operative transmitter in predetermined order over said lane of traffic, means for stopping the operation of the other transmitters and means for dividing lane time acorded to said transmitters between operative transmitters.

84. A telegraph system comprising a lane of traffic, a plurality of transmitters, separate receiving devices for the respective transmitters, means for operating said transmitters to transmit signals to said receiving devices over said lane of traffic, means for varying the number of transmitting and receiving devices that are operative, and means for varying the portion of the lane time accorded to one of said transmitters as the number of other transmitters which are operative varies.

85. A telegraph system comprising two offices, an expanding channel system terminating at one office, a transmitter at the second remote office, a lane of traffic connecting said offices, means at the second office for indicating that entry on the expanding channel system at the first office is desired and means at the first office for thereupon effecting a connection between said second office and the expanding channel system.

86. A telegraph system comprising two offices, an expanding channel system terminating at one office, a transmitter at the second remote office, a lane of traffic connecting said offices, means at the second office for indicating that entry on the expanding channel system at the first office is desired, means at the first office for thereupon entering the transmitter on the expanding chan-

nel system and means at the second office for indicating that entry of the transmitter has been effected.

87. A telegraph system comprising two offices, an expanding channel system terminating at one office, a transmitter at the second remote office, a lane of traffic connecting said offices, means for operating said transmitter to transmit character signals over said lane of traffic and means at said one office controlled from said second office for disconnecting said transmitter from the expanding channel system.

88. A telegraph system comprising two offices, an expanding channel system terminating at one office, a transmitter at the second remote office, a lane of traffic connecting said offices and means at the first office for entering said transmitter on the expanding channel system in response to signalling current transmitted over the lane of traffic from the second office.

89. A telegraph system comprising two offices, an expanding channel system terminating at one office, a transmitter at the second remote office, sending and receiving channels connecting said second office to the first office, means operable over one of said channels for entering said transmitter on the expanding channel system and means for thereafter operating said transmitter to transmit character signals.

90. A telegraph system comprising a multiplex distributor providing a sending channel, a plurality of sending devices and selector means including a sequential contact device or mixer for successively associating said sending devices with the sending channel of the multiplex distributor.

91. A telegraph system comprising two offices, an expanding channel system terminating at one office and start-stop means for repeating signals from the second remote office into a channel of the expanding channel system.

92. A telegraph system comprising two offices, an expanding channel system terminating in these offices, said system including character code transmitters at one office arranged to send a varying number of code units from each transmitter in a given time, devices at the second office arranged to receive varying numbers of code units in a given time, a third office and means for repeating said variable rate signals from the second office to said third office before more than a few additional characters have been received.

93. A telegraph system comprising two offices, an expanding channel system terminating at one office, a code transmitted at the second remote office, a lane of traffic connecting said offices, means for entering said transmitter on the expanding channel system and means for correlating the rate said transmitter sends code combinations to the transmitting rate of the expanding channel system.

94. An expanding channel system comprising a lane of traffic, a plurality of sources of signals, a relay group embodying a relay individual to each of said sources and means for controlling said relay group to preselect operative sources of signals to be associated with said lane of traffic.

95. An expanding channel system comprising a plurality of signal receiving devices and means for controlling the mixing of the signals including a relay individual to each signal receiving device, the contacts of the relays being in series relation.

96. An expanding channel system comprising a lane of traffic, a plurality of signal receiving devices, a relay group embodying a relay individual to each of said devices and means for controlling said relays to preselect signal receiving devices to be associated with said lane of traffic.

97. In an expanding channel system, a lane of traffic, channels operating over said lane of traffic, channel mixing devices at the sending and receiving ends of the lane of traffic, means including said channel mixing devices for controlling the connection of the channels to the lane of traffic and electrical means for securing and maintaining synchronism of the channel mixing devices.

98. In an expanding channel system, a lane of traffic, channels operating over said lane of traffic, channel mixing devices at the sending and receiving ends of the lane of traffic, means including said channel mixing devices for controlling the connection of the channels to the lane of traffic and electro-mechanical means for synchronizing the channel mixing devices, said means employing a change in the number of operating channels.

99. In a telegraph system, a transmitting station, a receiving station, a lane of traffic connecting said stations, a plurality of transmitters at the transmitting station, a plurality of recorders at the receiving station, means at the transmitting station for closing out a transmitter, means for transmitting a signal from the transmitting to the receiving station and means controlled by said signal for closing out the recorder corresponding to said transmitter.

100. In a telegraph system, a plurality of transmitters, a plurality of recorders, a lane of traffic associated therewith, means for operating recorders over said lane of traffic in accordance with signals transmitted from the corresponding transmitters and means for signalling the expansion of the transmitting time of a transmitter.

101. In a telegraph system, a plurality of transmitters, a plurality of recorders, a lane of traffic associated therewith, means for operating recorders over said lane of traffic in accordance with signals transmitted from the corresponding transmitters and means for signalling the contraction of the transmitting time of a transmitter.

102. In a telegraph system, a plurality of transmitters, a plurality of recorders, a lane of traffic associated therewith, means for operating recorders over said lane of traffic in accordance with signals transmitted from the corresponding transmitters and means for effecting expansion of the transmitting time of one of said transmitters at a predetermined time.

103. In a telegraph system, a plurality of transmitters, a plurality of recorders, a lane of traffic associated therewith, means for operating recorders over said lane of traffic in accordance with signals transmitted from the corresponding transmitters and means for effecting contraction of the transmitting time of one of said transmitters at a predetermined time.

104. In a telegraph system, a plurality of transmitters, a plurality of recorders, a lane of traffic associated therewith, means for operating recorders over said lane of traffic in accordance with signals transmitted from the corresponding transmitters and means for expanding the operating time of a recorder in response to a signal.

105. In a telegraph system, a plurality of transmitters, a plurality of recorders, a lane of traffic

associated therewith, means for operating recorders over said lane of traffic in accordance with signals transmitted from the corresponding transmitters and means for contracting the operating time of a recorder in response to a signal.

106. In a telegraph system, a plurality of transmitters, a plurality of recorders, a lane of traffic associated therewith, means for operating recorders over said lane of traffic in accordance with signals transmitted from the corresponding transmitters and means for expanding the operating time of a recorder at a predetermined time.

107. In a telegraph system, a plurality of transmitters, a plurality of recorders, a lane of traffic associated therewith, means for operating recorders over said lane of traffic in accordance with signals transmitted from the corresponding transmitters and means for contracting the operating time of a recorder at a predetermined time.

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