

June 25, 1940.

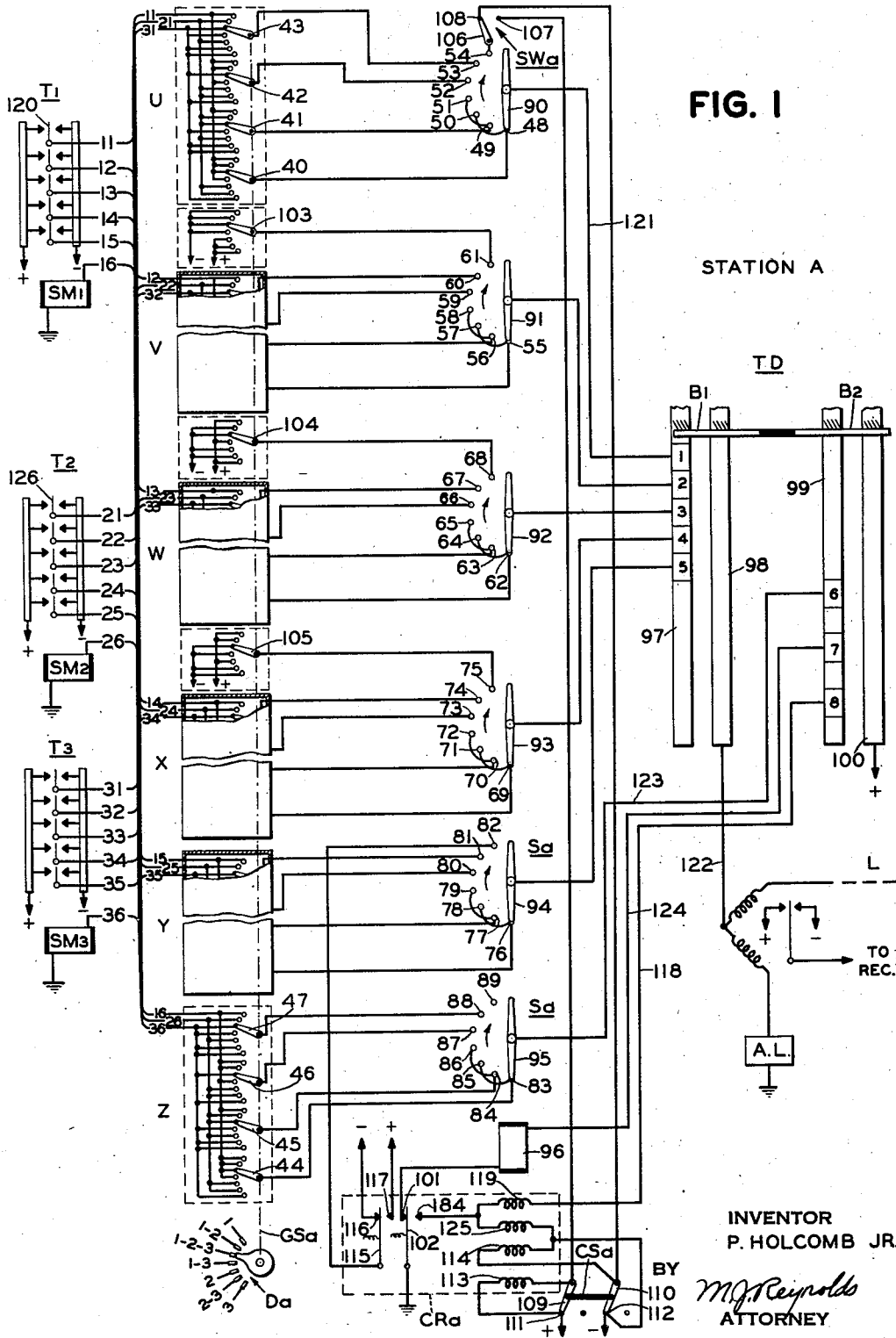
P. HOLCOMB, JR

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MULTICHANNEL TELEGRAPH SYSTEM

Filed July 15, 1937

4 Sheets-Sheet 1



June 25, 1940.

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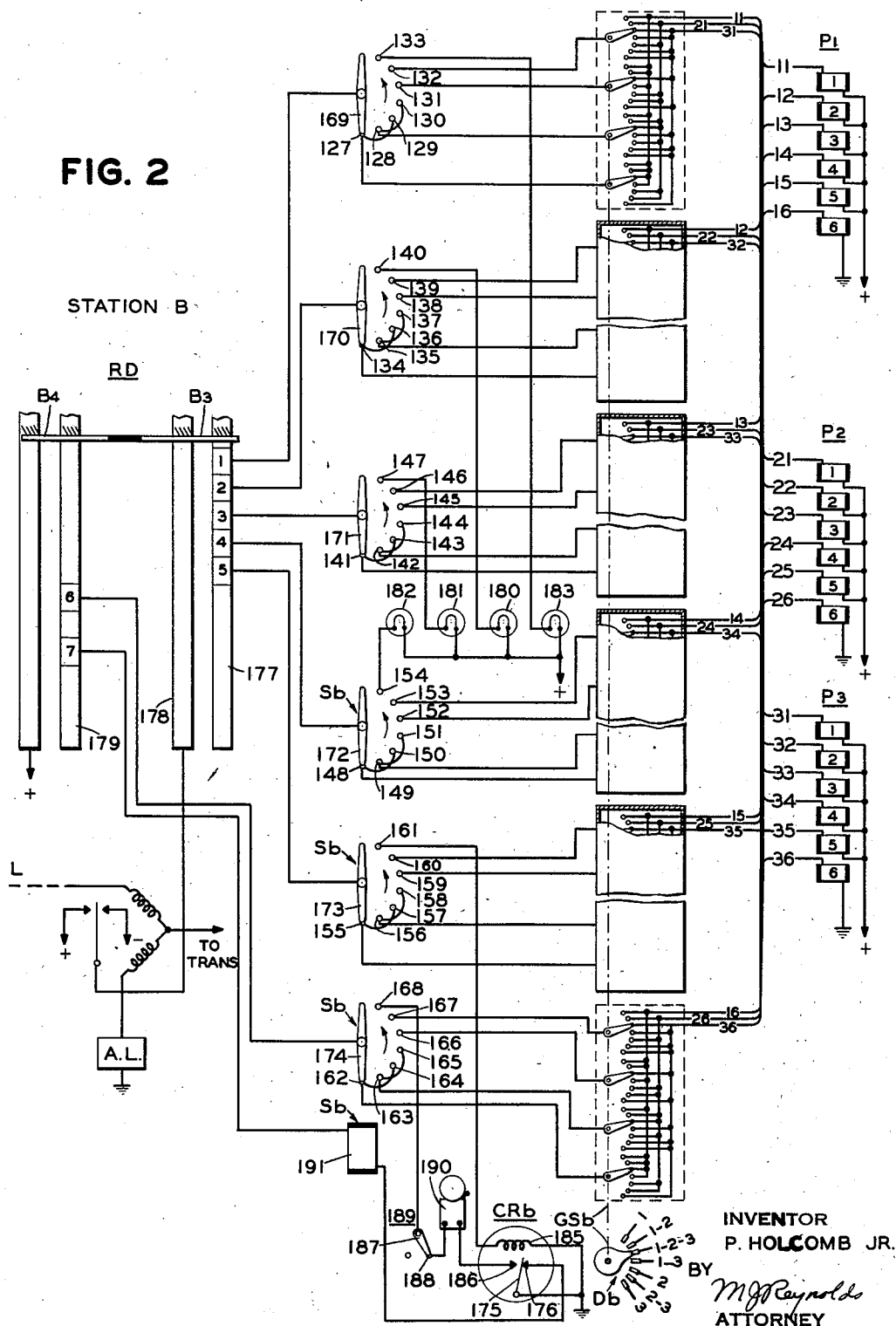
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MULTICHANNEL TELEGRAPH SYSTEM

Filed July 15, 1937

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FIG. 2



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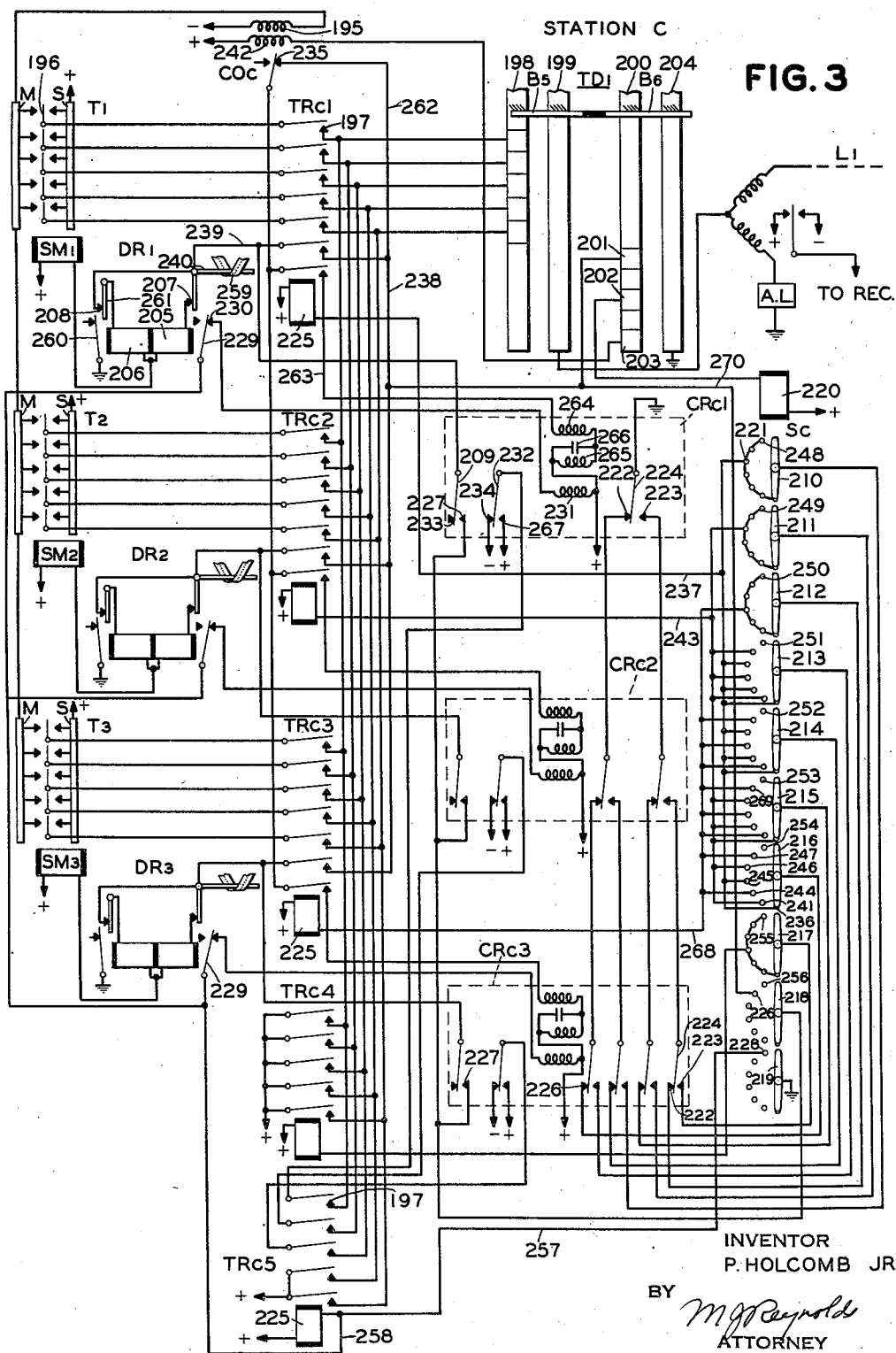
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MULTICHANNEL TELEGRAPH SYSTEM

Filed July 15, 1937

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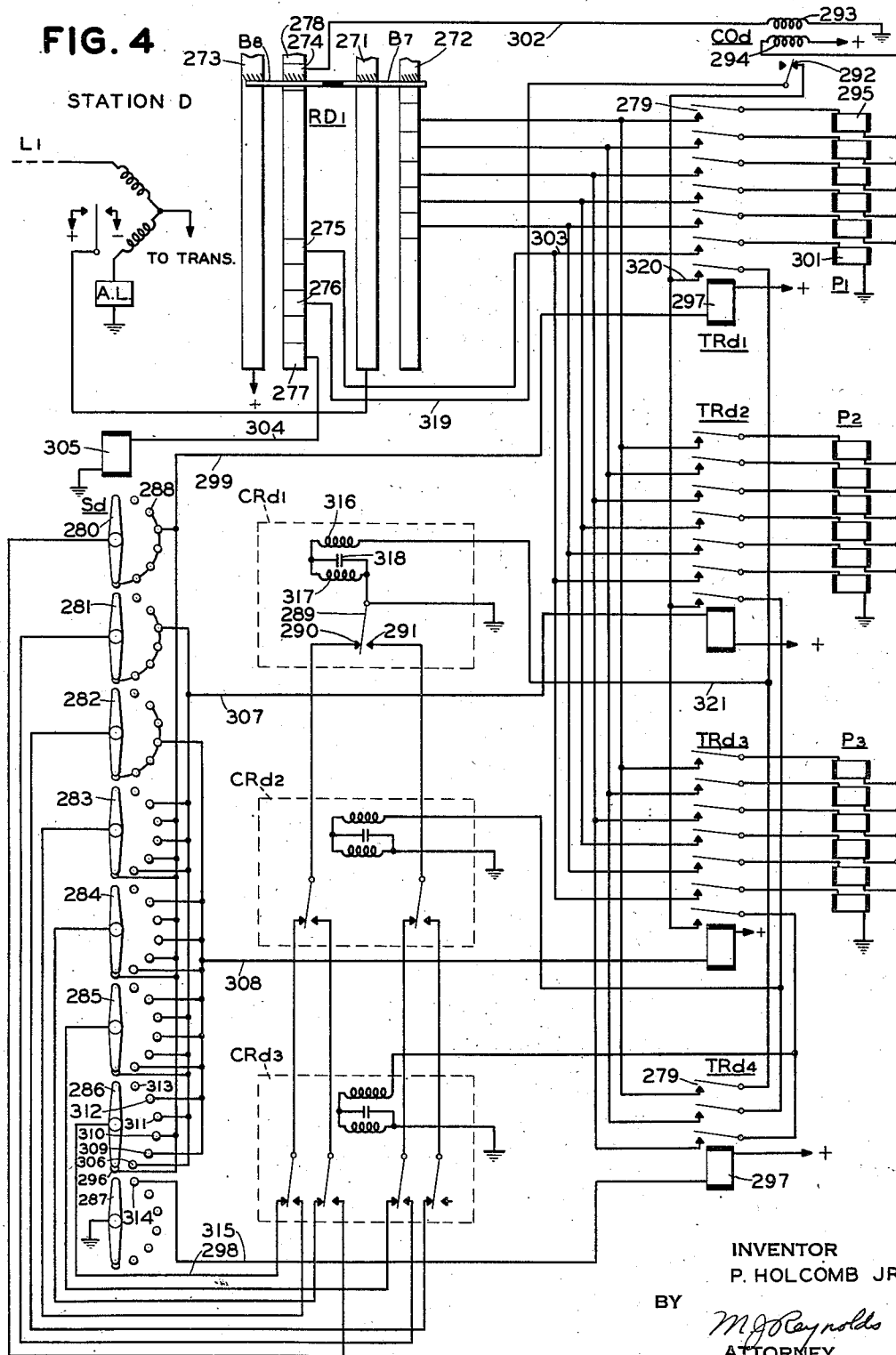
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MULTICHANNEL TELEGRAPH SYSTEM

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UNITED STATES PATENT OFFICE

2,205,406

MULTICHANNEL TELEGRAPH SYSTEM

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Application July 15, 1937, Serial No. 153,748

30 Claims. (Cl. 178—52)

This invention relates to a signalling system and more particularly to a system involving the transmission of signals from a variable number of sources simultaneously over a lane of traffic, such as a multiplex channel, to separate receiving devices or recorders. A system of this character is commonly termed a "varioplex" or "expanding channel" system.

A lane of traffic as used in the following description and referred to in the claims is the route or medium over which signalling is accomplished normally. Among other things a lane of traffic may be comprised of any of the following elements: a wire or a cable strand or conductor, a multiplex distributor channel, a side of a duplex or quadruplex, a carrier current channel, a superimposed circuit, or a radio band channel or circuit. It may also be comprised of any combination of two or more of the aforementioned elements such as a wire and a multiplex distributor channel, a cable conductor, a side of a duplex and a superimposed circuit, etc.

A preferred embodiment of the invention comprises a multiplex telegraph channel or its equivalent and means for connecting to said channel a number of transmitters and their corresponding receiving instruments, either in groups according to any of the possible combinations or singly, each transmitter having characters or signals to transmit, at all times sharing the channel time with the other busy transmitters in the group, or occupying substantially the full channel time when it is the only one busy.

For example: ten transmitters, each controlled by one of ten operators, all of whom may be located in the same central office or in remote branch offices, and none of whose business is sufficient to occupy the full time of the lane of traffic (such as a multiplex channel) but whose aggregate business will keep such a channel busy, are associated with a single multiplex channel in accordance with one embodiment of this invention. If it be assumed that the capacity of the channel is sixty words per minute, when only one operator is transmitting he will have complete possession of the channel and his transmission will be at the rate of sixty words per minute. With two operators connected to the multiplex channel, each will transmit at the rate of thirty words per minute and likewise with three operators connected, the transmission rate for each will be twenty words per minute and so on up to the limit of operators assigned to this particular channel. It will be

apparent that the capacity of the lane of traffic may be divided unequally between the transmitters or sub-channels, if desired.

When there are a number of transmitters operating, it may happen at some particular time that one or more of them will have an abnormally large amount of messages or stored traffic to be transmitted while the rest have relatively little. In order to more nearly equalize the amount of un-transmitted material among the transmitters, it is sometimes advantageous to be able to re-allocate the lane time so that the over-loaded transmitters will operate at a faster rate until their congestion has been relieved.

One object of the invention is to provide an improved signalling system of this character in which the transmitting capacity of the lane may be allocated in accordance with traffic fluctuations.

Another object of the invention is to provide an improved telegraph system comprising a lane of traffic and means of varying the number of signalling channels operating over said lane arranged to utilize a predetermined part of the full lane time as long as any of the channels are operating.

Another object of the invention is to provide a telegraph system of the character described comprising a variable number of transmitters operable in a prearranged order over a lane of traffic and substantially occupying the full lane time, with manual means for stopping and starting the operation of both the sending and receiving apparatus at a predetermined point to effect a re-allocation of lane time.

A further object of the invention is to provide such a telegraph system in which are incorporated automatic means for re-allocating the lane time without the necessity of interrupting the operation of the system.

Further objects of the invention are to provide, in a varioplex system, a simplified switching arrangement for controlling the connection of the operative sending and receiving devices to the lane of traffic and for indicating and effecting re-allocation of channels when desired; to reduce the complexity of the apparatus required; and to provide a system in which the possibility of faulty operation is guarded against or minimized by checking or indicating the channel pattern continuously or at frequent intervals.

In order that a better understanding may be obtained and a ready application made of this

invention, a detailed description of it will now be made having reference to the accompanying drawings which illustrate two embodiments of the invention.

5 In the drawings,

Fig. 1 is a circuit diagram showing the transmitting equipment of a manually controlled system operating over a single synchronous multiplex channel;

10 Fig. 2 is a similar view of the receiving equipment in the station at the other end of the multiplex channel; and

Figs. 3 and 4 are similar views of a modified system in which the re-allocation of channels is effected automatically.

15 It is to be understood that transmitting and receiving apparatus may be provided at each station so that simultaneous two-way communication will be afforded. It will be evident to one skilled in the art that separate channels may be used for the incoming and outgoing signals, and also that communication facilities may be duplexed to accomplish two-way operation of the telegraph system provided by this invention.

20 Inasmuch as any transmission medium may constitute the lane of traffic as defined hereinbefore, and as this transmission medium forms no part of this invention, it is desired that it be understood that the particular lane of traffic shown shall constitute no limitation in the application of the invention.

Reference will be had first to Fig. 1 which shows at station A the transmitting equipment which comprises a number of code telegraph transmitters T1, T2, and T3 (three such are shown although the number is unlimited). The transmitters are illustrated as tape transmitters of the type shown in the patent to Benjamin #1,298,440 granted March 25, 1919, but may be storage transmitters of any other suitable type.

40 As determined by the perforations in the tape the tongues of each transmitter may be set against either the marking or spacing bus bars; and in this description negative potential will be used for marking and positive potential for spacing, although these polarities may be reversed if desired. One terminal of each stepping magnet SM1, SM2 and SM3 is connected to ground. The other terminals of the magnets and the tongues of each transmitter are connected to stationary contacts of the transmitting grouping switch GSa.

50 The arms or movable contacts 40 to 43, 44 to 47, etc., and 103, 104 and 105 of the transmitting grouping switch GSa are arranged so that they all may be moved simultaneously by some means such as a common shaft to which they are secured mechanically (but not electrically). Of the six sections of the grouping switch GSa, interposed between the transmitters T1, T2 and T3 and the selector Sa, the complete internal connections of only those indicated by U and Z are shown. However, it should be understood that sections V, W, X and Y are similar to and connected the same as sections U and Z. The selector switch Sa, which is illustrated as a step-by-step switch having six contact arms or wipers 90, 91, 92, 93, 94 and 95, is arranged to connect the busy transmitters in predetermined order, in accordance with the setting of the grouping switch

60 GSa, to the transmission circuit or lane of traffic. Thus the grouping switch GSa preselects the transmitters to determine the channel pattern, i. e., whether one, two or all three channels are operative to transmit, and the switch Sa controls

75 the operative transmitters so that the lane time

is divided between them. If receiving apparatus is also to be located at station A for duplex operation of the system, the movable arms of the receiving grouping switch are preferably arranged so that they also may be moved simultaneously with those of the transmitting grouping switch GSa in order that the operative channels in both directions may correspond at all times.

The arms of the transmitting grouping switch GSa are connected to stationary bank contacts 10 48 to 53, 55 to 66, etc., engaged by the wipers 90—95 inclusive of the transmitting selector Sa. The six rotatable arms 90—95 are advanced simultaneously one stud at a time by the stepping magnet 96. Five of the rotatable arms of the transmitting selector Sa connect with segments 1 to 5 of ring 97 of the transmitting multiplex distributor TD, the solid ring 98 of which is connected to the apex of the duplex line L. The transmitting distributor TD is also provided with 20 a pair of local rings 99 and 100, the latter being connected to a source of potential. Segment 6 of ring 99 is connected to the sixth rotatable arm 95 of the transmitting selector Sa. Segment 7 of ring 99 is connected to one side of the selector magnet 96, the other terminal of which is connected to ground through contact 101 and tongue 102 of the control relay CRa. Contacts 61, 68 and 75 of the transmitting selector Sa connect respectively through movable arms 103, 104 and 30 105 of the transmitting grouping switch GSa to positive or negative potential depending upon the position of the grouping switch. Contact 54 of the selector Sa is connected to the arm 106 of the signal switch SWa, the contacts 107 and 108 of which are connected to the arms 109 and 110 of the control switch CSa which, in turn, connect respectively to positive and negative potential, either directly at contacts 111 and 112 or through the windings 113 and 114 of the control relay 40 CRa depending on whether the control switch CSa is to the left or to the right. Contact 82 of the selector Sa is supplied with either positive or negative potential by tongue 115 of the control relay CRa which is pivoted between contacts 116 and 117. Also segment 8 of ring 99 is connected through conductor 118 to one side of the winding 119 of the control relay CRa.

The operation of the transmitting apparatus is as follows: Assume that the transmitting grouping switch GSa is set to position 1—2—3, as shown on the dial Da in the drawings, that the pivoted arms 90 to 95 inclusive of the transmitting selector Sa are on contacts 48, 55, 62, 69, 76 and 83, respectively, that the control switch CSa 55 is to the left, that the control relay CRa is unoperated, with tongues 102 and 115 on their left contacts 101 and 116, that all transmitters T1, T2 and T3 have ample supplies of tape and that the brush arm B1 of the transmitting distributor TD 60 is passing onto segment 1 of ring 97. When this occurs an impulse is sent from contact 120 of transmitter T1 over conductor 11 to several of the stationary contacts of section U of the transmitting grouping switch GSa, arm 40 of which 65 provides the only connection beyond the grouping switch and that to contact 48 of the transmitting selector Sa, whence the impulse is carried through rotatable arm 90 and conductor 121 to segment 1 of the ring 97 of the transmitting 70 distributor TD, through brush B1 to solid ring 98 and thence over conductor 122 to the line L. The other contacts of transmitter T1 are connected respectively to segments 2, 3, 4 and 5 of ring 97 of the distributor in a manner similar to that 75

just described for contact 120, so that as brush B1 crosses these segments, marking or spacing impulses from the contacts of transmitter T1 are sent to the line L corresponding to the code combination perforated in the tape in said transmitter. Following this sequence of events brush B2 crosses segment 6 of ring 99 sending an impulse from a source of potential, connected to ring 100, through brush B2, segment 6 and conductor 123 to the rotatable arm 95 of the transmitting selector Sa from which it is transferred to contact 83 of the selector and thence carried through arm 44 of section Z of the grouping switch GSa, over conductor 16 to one terminal of the stepping magnet SM1 of transmitter T1, the other terminal of which magnet is connected to ground. Thus the stepping magnet SM1 is energized momentarily which causes the tape to be stepped forward one character and leaves the transmitter T1 ready to send a new code combination. As brush B2 advances, it crosses segment 7 of ring 99 and an impulse is sent over conductor 124 through the winding of the stepping magnet 96 and to ground through the left contact 101 and tongue 102 of the control relay CRa. Thus the stepping magnet 96 is energized which causes the six rotatable arms 90 to 95 inclusive to advance to contacts 49, 56, 63, 70, 77 and 84.

Passage of the brush B2 over segment 8 of ring 99 sends an impulse over conductor 118 to windings 119 and 125 of the polar control relay CRa; through winding 119 in a spacing direction and through winding 125 in a marking direction, thus having no effect on this relay, its tongues 102 and 115 remaining on their left hand contacts 101 and 116 respectively.

As the brush B1 passes over the segments 1 to 5 of ring 97 on the succeeding revolution a character from transmitter T2 is sent to the line L since arm 41 of the grouping switch GSa, contact 49 and arm 90 of the selector Sa connect contact 126 of transmitter T2 with segment 1 of ring 97, and similar respective connections are made between the other contacts of transmitter T2 and segments 2 to 6 of the transmitting distributor TD. When the brush B2 has passed over segments 6 and 7 of ring 99 on this revolution, a new character will have been stepped into transmitter T2, and the rotatable arms 90 to 95 inclusive of the switch Sa will have been advanced, respectively, to contacts 50, 57, 64, 71, 78 and 85, which are multipled respectively to contacts 48, 55, 62, 69, 76 and 83. It has been shown how, with the present setting of the grouping switch GSa, the latter contacts are instrumental in selecting a character from transmitter T1. Hence, on the third revolution of the brushes B1 and B2, a character will again be sent from transmitter T1. In a like manner a character from transmitter T2 will be sent on the fourth revolution of the brushes B1 and B2. However, on the fifth and sixth revolutions of the brushes B1 and B2, when the rotatable arms 90 to 95 inclusive of the switch Sa are on contacts 52, 59, 66, 73, 80 and 87 and 53, 60, 67, 74, 81 and 88 of the selector Sa, characters are sent from transmitter T3. Thus, in six revolutions of the brushes B1 and B2 of the transmitting distributor TD, two characters have been sent from each of the three transmitters T1, T2 and T3, although not in that order. The seventh revolution of the brushes B1 and B2 finds the selector arms 90 to 95 inclusive on contacts 54, 61, 68, 75, 82 and 89, at which time there is no transmission from any of the transmitters T1, T2 or T3, but instead a combination of sig-

nals, which in this instance are all marking, or negative impulses, is sent. At the receiving station B this signal combination is used to operate a signal, to give an indication of the particular transmitters that are operating, i. e., to show the channel "pattern," and to control the operation of the control relay CRb, all of which functions will be described hereinafter. The pattern signal representing the operative or non-operative condition of the respective transmitters or transmitting channels thus consists of a plurality of signals or impulses each corresponding to one of said channels. Transmission from the transmitters T1, T2 and T3 as described above continues as long as all of the transmitters have message signals or traffic to send, the selector switch Sa stepping continually over its bank contacts.

Referring now to Fig. 2, the receiving apparatus at station B comprises three printers P1, P2 and P3, the receiving grouping switch GSb, the receiving selector Sb, the receiving control relay CRb and the multiplex receiving distributor RD. The interconnections of the printers, grouping switch, selector and distributor are precisely similar to those of the corresponding apparatus at station A previously described in detail, except for contacts 133, 140, 147, 154, 161 and 168 of the selector Sb associated with auxiliary devices which will be considered hereinafter.

Assume that the grouping switch GSb is in position 1—2—3 as shown on the dial Db (all three channels operative), that the rotatable arms 169 to 174 inclusive of selector Sb are on contacts 127, 134, 141, 148, 155 and 162 respectively, that the tongue 175 of control relay CRb is on its marking or right hand contact 176 and that the receiving distributor brush B3 is just passing onto segment 1 of receiving ring 177 of the distributor RD. The multiplex distributor RD is maintained in synchronism with the one at the sending station A in accordance with the usual multiplex practice, so it can be assumed that the sending brush also is just passing onto the corresponding segment of the transmitting distributor. Since circuits have been prepared between receiving distributor segments 1 to 6 and magnets 1 to 6 of printer P1 similar to those described for the transmitting distributor and transmitter T1, the signal combination set up on the latter will be received from the line L on ring 178 and transferred to printer P1. With each passage of the brush B4 over local segment 7 of ring 179 the rotatable arms 169 to 174 inclusive of selector Sb are advanced one contact by energization of the stepping magnet 191 through the local circuit. Hence the signal combinations from transmitters T1, T2 and T3 are received on printers P1, P2 and P3, respectively.

Operation continues in this manner as long as all transmitters T1, T2 and T3 are supplied with perforated tape, one character being sent over the line L on every revolution of the distributor brushes, except for the one revolution when the rotatable arms 169 to 174 inclusive of the receiving selector Sb are on the seventh contacts 133, 140, 147, 154, 161 and 168 respectively, at which time the arms of the transmitting selector are on corresponding contacts. Then, marking signals are received on segments 2, 3 and 4 of ring 177 of the receiving distributor RD, said signals operating indicators 180, 181 and 182 and giving the attendant an indication that transmitters T1, T2 and T3 are connected at station A. The marking signal received on segment 5 of

ring 177 of the receiving distributor sends a marking impulse to control relay CRb which keeps its tongue 175 on the right hand contact 176. When a marking impulse is received on segment 1 of ring 177, it operates a signal 183. The signals or indicators 180—183, inclusive, may be neon lamps or other signalling devices.

When it becomes desirable to re-allocate the lane time between the transmitters for any reason such as the supply of tape for one or more transmitters, for instance the transmitter T3, becoming exhausted, the attendant at the sending end (Fig. 1) throws the control switch CSa to the right. When next the rotatable arms 90 to 95 inclusive of the selector Sa rest on contacts 54, 61, 68, 75, 82 and 89 and the brush B1 crosses segment 1 of ring 97, the marking (negative) signal that is sent to line L originates, as before, at the battery connected to contact 112 of the control switch CSa but now passes through winding 114 of the control relay CRa in a marking direction, thus moving the tongues 102 and 115 to their right or marking contacts 184 and 117. If the signal switch SWa is set on its right contact 107 to send a spacing signal to line from segment 1 of ring 97, this signal originates at contact 111 of the control switch CSa and passes through winding 113 of the control relay CRa in a marking direction, the effect on this relay being the same as in the preceding instance. Thus switch SWa controls a signal at the receiving station without affecting the apparatus at the sending station, thereby providing a control or signalling channel that may be used for any desired purpose. As soon as the tongue 102 reaches contact 184, the relay CRa is locked through its winding 125, marking potential being applied from contact 112 of the control switch CSa and ground from the tongue 102. As the brush B1 passes over segments 2, 3 and 4 of ring 97 marking signals are transmitted as before. On crossing segment 5, however, a spacing signal is sent to line L since tongue 115 of the control relay CRa is now on its right contact 117. The passage of brush B2 over segment 6 of ring 99 produces no result, the circuit being incomplete beyond the arm 95 of selector Sa. Also the contact of brush B2 with segment 7 of ring 99 does not result in a stepping of the selector Sa since the ground for the stepping magnet 96 has been removed from contact 101 of the control relay CRa. The engagement of brush B2 with segment 8 of ring 99 sends an impulse in a spacing direction through winding 119, contact 184 and tongue 102 of the control relay CRa to ground, thus cancelling the effect of the locking winding 125 and allowing the retractile springs to restore tongues 102 and 115 to their left contacts, which are their normal operating positions.

This sequence of events is repeated on each revolution of the distributor as long as the control switch CSa is maintained in its right hand position, the selector switch Sa stopping its normal rotation during this period. The attendant then turns the transmitting grouping switch GSa to the new setting, shown on the dial Da as 1—2 in this case if transmitter T3 is to be eliminated. An inspection of the grouping switch will now show that there are no complete circuits between the contacts of transmitter T3 and the selector Sa. It will also be seen that when the selector arms are advanced, signals will be transmitted alternately from transmitters T1 and T2. In addition, with the selector Sa still being held in the position in which it was stopped, marking

potential is applied to segments 2 and 3 and spacing potential to segment 4 of ring 97 by the grouping switch arms 103, 104 and 105, respectively. Thus an indication is sent to the receiving station of the desired re-allocation of the channels.

After allowing a prearranged length of time to elapse or after receiving some signal from the attendant at the receiving station B indicating that he has set his receiving grouping switch in position 1—2, the attendant at the transmitting station A throws his control switch CSa to the left. On the following engagement of segment 1 of ring 97 by the brush B1 the control relay CRa is unaffected since its operating windings 113 and 114 are shunted by arms 109 and 110 of the control switch CSa. Hence a marking signal is sent to line L when brush B1 reaches segment 5 of ring 97, and the stepping magnet 96 is energized when brush B2 reaches segment 7 of ring 99 thus rotating the arms 90 to 95 inclusive to such a position that a character will be transmitted from transmitter T1 on the following revolution of the distributor as described above. Operation will then go on as before except that characters will be sent alternately from transmitters T1 and T2, the transmitting time previously utilized by transmitter T3 being divided between the other transmitters.

Referring to Fig. 2, the results produced by the manipulations of the transmitting control switch and grouping switch on the receiving apparatus will be described. Assume that the control switch CSa at the transmitting station A has been thrown to the right. When next the rotatable arms 169 to 174 inclusive of selector Sb are in contact with studs 133, 140, 147, 154, 161 and 168 and the brush B3 passes over segments 1 to 4 of ring 177 of the receiving distributor RD, marking impulses are sent to indicators 180, 181 and 182, and signal 183 as before. As segment 5 of ring 177 is reached by the brush B3 a spacing signal is sent through the winding 185 of the control relay CRb moving the tongue 175 to its left hand contact 186. As brush B4 crosses local segment 6 of ring 179 an impulse is sent through contact arm 174 and contact 168 of the switch Sb, the arm 187 and right hand contact 188 of the cut-off switch 189, the bell 190, contact 186 and tongue 175 of the control relay CRb to ground, thus operating the bell 190. As segment 7 of ring 179 is crossed by brush B4, the selector stepping magnet 191 is not energized since its ground has been removed from contact 176 of the control relay CRb. Hence the receiving selector Sb has been stopped in the position corresponding to that in which the transmitting selector Sa was stopped. The bell 190 is operated on each revolution of the distributor and attracts the attention of the attendant who may silence it if he desires by the cut-off switch 189.

As soon as the transmitting grouping switch has been set to its new position 1—2 the attendant at the receiving station B refers to the indicators 180, 181 and 182, the latter now rendered inoperative because of the reception of a spacing signal on segment 4 of ring 177, and sets his receiving grouping switch CSb accordingly to position 1—2. This cuts off printer P3 from the selector Sb and provides for the reception of characters alternately on printers P1 and P2. He then notifies the attendant at the transmitting station A that the receiving apparatus is ready to proceed on the new schedule. He may do this by

5 sending a note on one of the other channels of the multiplex or, if this system is being operated duplex so that he also has transmitting equipment, he will have thrown his transmitting control switch to the right immediately upon arriving in answer to the bell 190, and thus will have stopped transmission from station B. Then, as soon as he turns his receiving grouping switch GSb (and his transmitting grouping switch with it) to the new position 1—2, the change will be indicated at station A in the same manner as the change at station A was indicated at station B. The attendants at stations A and B then throw the control switches CSa and CSb to the left. 15 The next revolution of the distributor finds a marking signal being received on segment 5 of ring 177 which is transferred to the winding 185 of the control relay CRb and causes the tongue 175 to be moved to its right hand contact 176, thus restoring the ground to the selector stepping magnet 191. When brush B4 then crosses segment 7 of ring 179 the selector arms are advanced to positions such that, on the following revolution of the distributor, the character received from transmitter T1 is registered on printer P1. Operation then continues as before with characters being received alternately on printers P1 and P2.

30 The operation of the signal lamps 180, 181 and 182 may be utilized to designate the channel "pattern" by employing arbitrary code signals to indicate changes from an existing "pattern." For example, each of the eight possible code combinations may refer to one of eight channels, in the status of which a change is desired; that is, if operative the channel is to be switched out and if inoperative, the channel is to be entered onto the system. Thus, the re-allocation signaling may be accomplished by a code signal rather than by the use of lamps or other indicating devices which are individual to each channel and which require individual operating pulses.

45 The transmitting control switch CSa is used also for synchronizing the transmitting and receiving selectors Sa and Sb when the system is being put into operation. When the transmitting and receiving distributors TD and RD have been synchronized in accordance with the usual multiplex practice, the selectors will not necessarily be in step with one another. The transmitting control switch is thrown to the right and when next the transmitting selector arms 90 to 95 inclusive are on contacts 54, 61, 68, 75, 82 and 89, further stepping of the selector is prevented as described above. Subsequently, when the arms 169 to 174 inclusive of the receiving selector reach contacts 133, 140, 147, 154, 161 and 168, further stepping of this selector also is prevented until such time as the transmitting control switch is thrown to the left when both selectors are stepped along in synchronism.

60 Each arm of the transmitting selector Sa is shown (Fig. 1) associated with a bank of seven contacts, six of which are instrumental in selecting an element of the various transmitters T1, T2 and T3 in cooperation with the grouping switch GSa. The seventh contact is used for re-allocating the lane time and for synchronizing the transmitting and receiving selectors Sa and Sb in the manner described above. On reducing this invention to practice, in order that such a system be not unduly wasteful of lane time, it will be advantageous to use a larger number of contacts in each bank of the selector Sa, for example 75 twenty-five. In a system having three channels

or transmitters, they can be divided into four groups of six contacts for transmitter selection purposes. In this case the contacts of one group may be distributed as indicated and multiplied to corresponding contacts of the other groups of the selector switch bank. The twenty-fifth contact will be available for reallocating and synchronizing purposes. Where more than three transmitters are used in this system, the transmitting selector Sa must be provided with more than 10 seven contacts in each bank to accommodate the extra transmitters if equal division of the transmitting time between operative or busy channels is desired. In any event the receiving selector Sb will of necessity be arranged substantially 15 similar to the transmitting selector Sa. Obviously when the number of channels exceeds four or five, "code" signals may be sent for reallocating purposes.

20 The devices for controlling the selectors Sa and Sb for re-allocating and synchronizing purposes are not absolutely essential for the successful operation of this improved telegraph system and may be omitted in the interest of economy without impairing the system in any way other than 25 retarding the reallocating and synchronizing operations. The omission of this control feature will allow the elimination of the following apparatus: from Fig. 1, the signal switch SWa, arms 103, 104 and 105 of the grouping switch GSa and their associated contacts, the control relay CRA, control switch CSa and segment 8 of local ring 99, and from Fig. 2, the indicators 180, 181, and 182, signal 183, control relay CRb, bell 190 and cut-off switch 189. It will be necessary to connect the magnets 96 and 191 of the transmitting and receiving selectors Sa and Sb directly to ground, the transmitting selector Sa contacts 54 to 53, 61 to 60, etc., and the receiving selector Sb contacts 133 to 132, 140 to 139, etc. 40

45 Re-allocation of lane time can then be arranged by an exchange of communications between the terminal attendants either on one of the channels operating over the lane or on some other convenient lane of traffic, or by making the changes in accordance with a pre-arranged schedule. To synchronize the transmitting and receiving selectors Sa and Sb, the grouping switches GSa and GSb are set to position 1—2—3 and transmitter T3 is rendered operative. Signals are sent from this transmitter and the receiving selector Sb is manually, as well as automatically, operated until these signals are always received on printer P3 as explained below.

55 If the selectors Sa and Sb are equipped with banks of 25 contacts each, connected as indicated above, the contacts corresponding to 52, 53 and 54; 59, 60 and 61, etc. (Fig. 1); and 131, 132 and 133; 138, 139 and 140, etc. (Fig. 2), are employed in transmitting character signals from transmitter T3 and receiving them on printer P3. Inasmuch as this is the only time in the entire cycle of operation of the selector Sa that three successive characters are sent from the same transmitter, it is apparent that there is only one time 65 when these characters will be received on a corresponding printer. This will occur when the receiving selector Sb is in synchronism with the transmitting selector Sa.

70 While the foregoing description has been devoted to but two possible combinations of the three transmitters and three printers in the illustrated embodiment of the invention, the grouping switches GSa and GSb and the selectors Sa and Sb as shown in Figs. 1 and 2 are arranged 75

so that any desired combination of one or more channels may be connected to a lane of traffic for operation in a manner similar to that described above. The seven possible combinations are indicated on the dials *Da* and *Db*. By assuming the grouping switches *G_{Sa}* and *G_{Sb}* set in the various positions corresponding to those on the dials *Da* and *Db*, and by inspecting the various circuits between the transmitters and printers and their respective distributors *TD* and *RD* it will be apparent that provisions are made for all possible combinations with equal division of the transmitting time. At any time, when the selectors *Sa* and *Sb* have been stopped for re-allocation of lane time or for any other reason, one or more transmitters and printers may be entered onto or closed out from the lane by resetting the grouping switches *G_{Sa}* and *G_{Sb}* to any desired position.

If desired, one or more channels may be allotted more transmitting time than a less important channel by multiplying the more important channel more frequently to the contacts of selector switches *Sa* and *Sb*. Thus if the first channel is more important than the third channel, transmitter *T₁* may be connected to one set of bank contacts of selector *Sa* illustrated as individual to transmitter *T₃* when channels 1—2—3 or 1—3 are selected by switch *G_{Sa}*. In this case, the transmitting rate from transmitter *T₁* will be increased and from *T₃* will be reduced when both of these channels are in operation.

In the system described above, transmitters and printers are entered onto or closed out from the lane by the manual operation of the control switches *CS_a* and *CS_b*, and the grouping switches *G_{Sa}* and *G_{Sb}*. A system in which the entrance and exit of the transmitters and printers are automatically effected is shown in Figs. 3 and 4 as will presently appear.

In Fig. 3 is shown the apparatus comprising the sending station *C*. Three tape transmitters *T₁*, *T₂* and *T₃* are shown, each having a marking bus bar *M*, supplied with negative potential through the winding 195 of the polarized cutout relay *COC* and a spacing bus bar *S* to which positive potential is applied directly. The five tongues 196 of each transmitter are connected through five of the seven contacts 197 of one of the transfer relays *TRC₁*, *TRC₂* or *TRC₃* to segments of ring 198 comprising one channel of a multiplex distributor *TD₁* which also has a solid ring 199 connected to the apex of the line *L₁*. The transmitting distributor *TD₁* is also provided with a local ring 200 which has three segments 201, 202 and 203, and associated with it a solid ring 204 which is connected to ground. The control apparatus for each transmitter is similar and hence only that associated with transmitter *T₁* will be described in detail.

Associated with each of the transmitters *T₁*, *T₂* and *T₃* is a polarized control relay *CRC₁*, *CRC₂* or *CRC₃* respectively. These relays are controlled by the tape being fed into the transmitters and, through their contacts, are instrumental in effecting the operation of one of the transfer relays *TRC₁* to *TRC₄* inclusive as described hereinafter. The tape transmitter *T₁* has a stepping magnet *SM₁*, one terminal of which is connected to positive potential and the other terminal of which is connected to the mid-point of the differential autostop relay *DR₁*. The opposite terminals of the windings 205 and 206 of the relay *DR₁* are joined through auto-stop contact 207 and relay

contact 208 respectively, thence (1) through the sixth contact 197 of transfer relay *TRC₁* to local segment 201 of distributor *TD₁* and (2) to tongue 209 of control relay *CRC₁*.

The selector switch *Sc* is common to the control apparatus of all transmitters *T₁*, *T₂* and *T₃* and consists of rotatable arms 210 to 219 inclusive which are stepped simultaneously by the stepping magnet 220 over contact bank 221 having a row of contacts individual to each arm. Arms 210 to 217 inclusive are connected to left-hand contacts 222 and to right-hand contacts 223 of the control relay *CRC₃*, one of which is grounded depending on the settings of the tongues 224 of the relays *CRC₁*, *CRC₂* and *CRC₃*. The contacts of bank 221 associated with the arms 210 to 217 inclusive are connected to windings 225 of the transfer relays *TRC₁* to *TRC₄* inclusive. Contact 226 of selector *Sc* is connected to segment 201 of the local distributor ring 200, and arm 218 to contacts 227 of the control relays *CRC₁*, *CRC₂* and *CRC₃*. Arm 219 of selector *Sc* is connected to ground, and contact 228 adapted to be engaged by said arm is connected to one terminal of the winding 225 of transfer relay *TRC₅*, and also to the tongues 229 of the differential relays *DR₁*, *DR₂* and *DR₃*. This ground is further extended through contacts 230 of relays *DR₁*, *DR₂* and *DR₃* to the windings 231 of the control relays *CRC₁*, *CRC₂* and *CRC₃*.

The operation of the transmitting apparatus is as follows:

It is assumed that the transmitters *T₁*, *T₂* and *T₃* have copious supplies of tape and that the autostop contacts 207, contacts 208 of relays *DR₁*, *DR₂* and *DR₃* are closed and tongues 229 of these relays are closed on their right-hand contacts 230. The tongues 209, 224 and 232 of the control relays *CRC₁*, *CRC₂* and *CRC₃* are assumed to be on their left-hand contacts 223, 222 and 234 respectively; arms 210 to 219 inclusive of the selector *Sc* on the first contacts of bank 221 as shown; contacts 235 of cut-out relay *COC* closed to the right and brush *B₅* of distributor *TD₁* is about to engage the segments of ring 198.

Transfer relay *TRC₁* is operated by a circuit complete from the battery connected to one terminal of its winding 225 to ground on the tongue 224 of relay *CRC₁*. This circuit may be traced through the tongues 224 of relays *CRC₁*, *CRC₂* and *CRC₃*, their left-hand contacts 222, selector arm 216, its bank contact 236, conductor 237 and the winding 225 of relay *TRC₁*. The operation of this relay closes its contacts 197, thereby transferring the combination of signals set up on transmitter *T₁* by the perforated tape to the segments of ring 198 of distributor *TD₁*. As the brush *B₅* passes over these segments, the signals are further transferred to the solid ring 199 and sent to the line *L₁*. Since all code combinations, except the blank signal which is employed for a special purpose as hereinafter described, have at least one marking impulse, one of the tongues 196 of the transmitter *T₁* will engage the marking bus bar *M*. Thus, as the brush *B₅*, in passing over the segments of ring 198, engages one which is connected to a tongue 196 of transmitter *T₁* set against the marking bus bar *M*, the marking battery is passed through the upper winding 195 of the cut-out relay *COC* which is so poled that the contact 235 is opened.

Following the passage of the brush *B₅* of the transmitting distributor *TD₁* over the segments of ring 198, brush *B₆* engages segment 201 of ring 200. The ground applied to ring 204 is connected

by the brush B6, segment 201 of ring 200, conductor 238, the sixth contact 197 of the transfer relay TRC1 and conductor 239 to the autostop lever 240. At this point the path is divided, one branch comprising autostop contact 207 and one winding 205 of relay DR1, and the other branch the contact 208 and the opposing winding 206, at which point it again joins the first branch. Because of the opposition of the two windings 205 and 206, the relay DR1 remains unoperated. From this mid-point of the differential relay DR1 the ground is carried to one side of the stepping magnet SM1. The other side of this magnet is connected to positive potential so that the contact of brush B6 of the distributor TD1 with segment 201 of ring 200 causes the tape for transmitter T1 to be stepped ahead one character.

Brush B6, as it continues, next engages segment 202, thereby applying a ground to the selector magnet 220 which advances the rotatable arm 216 of the selector Sc to its second bank contact 241. Passing on to segment 203 of the distributor TD1, the brush B6 applies a ground to winding 242 of cut-out relay COC. The other side of this winding is connected to positive potential and is so poled that the contact 235 of relay COC is again closed to the right.

When the arms of the selector Sc were advanced, as described above, the ground originating at tongue 224 of the control relay CRC1 was transferred by arm 216 to its second bank contact 241 and thence to conductor 243 for the operation of transfer relay TRC2. Thus, when next the brush B5 of the distributor TD1 engages the contacts of ring 198, a character is sent from transmitter T2 and contact 235 of cut-out relay COC is opened. Subsequently the brush B6 passes over segments 201, 202 and 203, stepping the tape of transmitter T2 ahead, advancing the selector arms 210 to 219 inclusive and reclosing contact 235 of the cut-out relay COC. A signal combination is next selected, by the engagement of arm 216 of selector Sc with its bank contact 244, from transmitter T3 and sent to line L1 in a manner similar to that described above. As the brushes B5 and B6 of the distributor TD1 continue to revolve and arm 216 of the selector Sc is advanced successively over its other bank contacts 245, 246 and 247, another character from each of the transmitters T1, T2 and T3 is selected and sent to line L1.

The next stepping of the selector Sc brings the arms 210 to 218 inclusive into engagement with bank contacts 248 to 256 inclusive to which there are no connections. Hence at this time there is no transmission from any of the transmitters T1, T2 and T3. Also arm 219 is in engagement with its bank contact 228 which connects a ground, by way of conductor 257, to one terminal of the winding 225 of transfer relay TRC5, the other terminal of which is connected to battery thus operating this relay. This ground is also applied, by means of conductor 258 to the tongues 229 and the right-hand contacts 230 of the differential autostop relays DR1, DR2 and DR3, to one terminal of each of the windings 231 of the control relays CRC1, CRC2 and CRC3. These windings have their other terminals connected to battery and hence are energized being so poled that the tongues 209, 224 and 232 are held on their left hand contacts 233, 222 and 234 respectively. Since these tongues have been set against their left-hand contacts throughout the entire operation of the transmitting mechanism up to this point, this last event serves only

as a confirmation of the settings at this time. The tongues 232 in cooperation with their left-hand contacts 234 and three of the contacts 197 of transfer relay TRC5 apply marking potential to the first three segments of ring 198 of the distributor TD1. Two other contacts 197 of the transfer relay TRC5 apply spacing potential to the other two segments of ring 198. Thus on the following revolution of the brush B5 a pattern signal corresponding to the transmitters that will be operating at the beginning of the next cycle of the selector Sc, in this case transmitters T1, T2 and T3, is sent to the line L1.

It should be noted that this pattern is transmitted once in every cycle of the selector Sc and, at the receiving station D, is used to maintain the printers of all three channels operating, as described hereinafter. It will also appear presently that just prior to the transmission of the pattern, the tongues 209, 224 and 232 of any of the control relays CRC1, CRC2 or CRC3 associated with an entering transmitter T1, T2 or T3 are moved to their left contacts 233, 222 and 234 respectively by the application of the ground of arm 219 of the selector Sc to the windings 231 of relay CRC1, CRC2 and CRC3, thereby entering the transmitter onto the lane of traffic, here constituted by a multiplex channel.

More efficient use of the lane time can be obtained by using a selector with a greater number of bank contacts in each row instead of a minimum of seven as shown. For instance, with rows of twenty-five contacts, the contacts may be divided into four groups of six contacts, each group similar to the first six contacts of switch Sc, plus one contact for switching purposes as described above, and thus a greater percentage of the lane time can be utilized for the transmission of traffic. Hereinafter, whenever reference is made to lane time, it is desired that it be construed to mean that portion of it actually devoted to the transmission of traffic.

As long as each of the transmitters T1, T2 and T3 is supplied with perforated tape, operation continues as described. But assume, now, that the supply of tape for one of the transmitters, for instance T1, has become exhausted. The shortening of the tape loop 259 will raise the lever 240 opening the autostop contact 207. When next the transmitter T1 is associated with the lane and brush B6 engages segment 201 of ring 200, the circuit that is completed between the ground on ring 204 and the battery connected to the stepping magnet SM1 has but one path through the differential relay DR1; namely, that comprised of contact 208 and winding 206. This condition unbalances the autostop relay allowing it to operate. Thus tongue 229 is moved to the left, breaking its connection with contact 230 and tongue 260 is engaged with arm 261 which applies a locking ground to the stepping magnet SM1 and opens the contact 208 of relay DR1. Hence the pins of the transmitter T1 are held withdrawn from the tape which sets all of the tongues 196 against the spacing bus bar S, and the stepping magnet SM1 is entirely cut off from segment 201 of ring 200. The brushes B5 and B6 of distributor TD1 continue to revolve sending a character from transmitter T2 and one from T3. Then transmitter T1 is again connected to the lane, but instead of a character, a blank, or all spacing, signal is sent.

The purpose of this blank is to cut out, at the receiving station D, the printer associated with transmitter T1. At the transmitting station

C it provides for the elimination of transmitter T1. The absence of marking signals from this last transmission results in the contact 235 of cut-out relay COc remaining closed. Thus, when brush B6 engages segment 201 of ring 200, a circuit is completed from the ground on ring 204 to the battery connected to winding 265 of relay CRc1. This circuit includes brush B6, local segment 201, conductor 262, contact 235 of relay COc, the seventh contact 197 of relay TRc1, conductor 263 and the windings 264 and 265 of relay CRc1. The winding 264 is poled to hold the tongues 209, 224 and 232 against their left contacts 233, 222 and 234 respectively, and winding 265 is oppositely poled but winding 264 predominates. Thus, as long as brush B6 remains on segment 201, the relay CRc1 is unaffected. But as soon as brush B6 leaves segment 201, condenser 266 discharges through the winding 265 of relay CRc1 moving the tongues 209, 224 and 232 to their right hand contacts 227, 223 and 267 respectively.

Now, an inspection of the tongues 224 and their associated contacts 222 and 223 of relays CRc1, CRc2 and CRc3 will disclose that the ground connected to tongue 224 of relay CRc1 has been transferred from arm 216 to arm 215 of the selector Sc. Also the bank contacts associated with arm 215 are connected alternately to conductors 243 and 268 which, in turn, are connected to windings 225 of transfer relays TRc2 and TRc3 respectively. Hence, as the brushes B5 and B6 of distributor TD1 continue to revolve, the entire lane time is now divided equally between transmitters T2 and T3.

In a similar manner, either one or both of the transmitters T2 and T3 will be cut out, whenever the tape loops 259 associated with them become short enough to open their respective autostop contacts 207, by the resultant operation of relays CRc2 and CRc3. Suppose, now, that it is desired to enter a transmitter onto the lane, for instance, the one that was just cut off, T1. As soon as the transmitter T1 is supplied with additional perforated tape, the loop 259 lengthens allowing contact 207 of the autostop relay DR1 to close. But before being entered onto the lane this transmitter must wait until the arm 215 of selector Sc is engaged with its bank contact 269 which connects transmitter T3 to the lane. After the transmission of a character from transmitter T3 and when brush B6 is passing over local segment 201, in addition to the circuit established between the ground on ring 204 and the battery on the stepping magnet SM3, another circuit is completed from the ground on ring 204 to the battery on the stepping magnet SM1. This circuit is comprised of brush B6, local segment 201, conductor 270, bank contact 226 and arm 218 of selector Sc, contact 227 and tongue 209 of relay CRc1, conductor 239, contact 207 and winding 205 of relay DR1 and the stepping magnet SM1 of transmitter T1. The closing of this circuit through the winding 205 of relay DR1 neutralizes the effect of the winding 206 which restores the tongues 229, 260 and 261 of said relay to normal, closing contacts 208 and 230. At the same time, the stepping magnet SM1 of transmitter T1 is also unlocked rendering it ready for regular operation.

When the arms of the selector Sc are further advanced bringing arm 219 into engagement with bank contact 228, circuits are established between the ground on arm 219 and the winding 225 of relay TRc5, and the windings 231 of re-

lays CRc1, CRc2 and CRc3 as described above. It will be remembered that, when transmitter T1 was closed out of the lane previously, the tongues 209, 224 and 232 of relay CRc1 were set against their right hand contacts 227, 223 and 267 respectively where they have remained up to this point. Hence, since the windings 231 of the control relays CRc1, CRc2 and CRc3 are poled to move the tongues 209, 224 and 232 of these relays to their left hand contacts 233, 222 and 234 respectively, as indicated hereinbefore, energizing them at this time results in the movement of the tongues of relay CRc1 only, those of relays CRc2 and CRc3 already being in these positions. This movement transfers the ground on tongue 224 of relay CRc1 from selector arm 215 back to arm 216 which will, in turn, associate all three transmitters T1, T2 and T3 with the lane of traffic as before. Tongue 232 of relay CRc1 will also furnish marking battery to the first segment of ring 198 so that, when next the brush B5 crosses the segments of this ring, the new pattern signal will be transmitted to the receiving station D where a printer will be connected to the lane for the reception of signals from transmitter T1.

The transmitting apparatus is arranged so that the lane time is always divided equally among the particular transmitters T1, T2 and T3 that are connected to the lane. This division of lane time among transmitters T1, T2 and T3 and between transmitters T2 and T3 is effected by applying a ground to arms 216 and 215 respectively of selector Sc as described above. With other positions of the tongues 224 of the relays CRc1, CRc2 and CRc3, as determined by the settings of the auto-stop contacts 207 of relays DR1, DR2 and DR3, the ground is applied to other of the arms 210 and 217 inclusive of selector Sc. The ground on arm 210, 211 or 212 will give complete possession of the lane to either transmitter T1, T2 or T3 respectively. Similarly, the ground connected to arm 213 will divide the lane time between transmitters T1 and T2, and connected to arm 214 will effect a division of lane time between transmitters T1 and T3. If none of the transmitters is connected to the lane when the armatures of relays CRc1, CRc2 and CRc3 engage their respective right hand contacts, the ground is applied to arm 217 of selector Sc which results in the operation of relay TRc4 during the entire lane time. The contacts 197 of this relay connect spacing battery to all five of the segments of ring 198.

It should be noted that a transmitter can be closed out of the lane at any time when that transmitter is connected to the lane in its regular turn. But a transmitter can be entered only at a time when none of the transmitters is connected to the lane. One such period in a complete cycle of operation of the selector Sc is provided and is devoted exclusively to that function. In this embodiment of the invention, the entrance and exit of individual transmitters is automatically controlled by the tape supplied to the transmitters, and the concurrent entry of the corresponding printer or printers is effected without requiring more transmission time than that required to send a single character.

The receiving apparatus at station D, shown in Fig. 4, consists of a selector Sd, control relays CRd1, CRd2 and CRd3, transfer relays TRd1 to TRd4 inclusive, cut-out relay COd, printers P1, P2 and P3 and the distributor RD1. Brushes B7 and B8 of the latter are maintained in synchronism with brushes B5 and B6 of the transmitting

distributor TD1 of Fig. 3 in the usual manner. Brush B7 of receiving distributor RD1 acts as the means of transferring the line signals from solid ring 271 to the segmented ring 272, the five segments of one channel shown corresponding to the transmitting multiplex channel shown in Fig. 3. Brush B8 connects the positive potential of solid ring 273 to the segments 274 to 277 inclusive of the local ring 278. The interconnections of the apparatus are substantially similar to those of corresponding apparatus at station C of Fig. 3.

The printers P1, P2 and P3 are associable with the lane by five of the seven contacts 279 of the transfer relays TRd1, TRd2 and TRd3, respectively. These transfer relays are operable by the passage of arms 280 to 286 inclusive of the selector Sd over their respective contact banks 288. The tongues 289 and contacts 290 and 291 of the control relays CRd1, CRd2 and CRd3 cooperate to apply a ground to one of the arms 280 to 286 inclusive of selector Sd for the operation of one of the transfer relays TRd1, TRd2 or TRd3. The control relays CRd1, CRd2 and CRd3 are the polarized type and are operated either by signals received from the line L1 or by local impulses from ring 278. For use in cutting off any of the printers P1, P2 or P3 from the lane the polarized relay COd is provided whose contact 292 is closed when its winding 293 is energized by the engagement of brush B8 with local segment 274; and whose contact 292 is opened when its winding 294 is energized by the reception of a marking signal by one of the five selecting magnets 295 of any of the printers P1, P2 or P3.

The operation of the receiving apparatus is as follows:

Assume that the tongues 289 of the control relays CRd1, CRd2 and CRd3 are set against their left hand contacts 290, that arm 286 of selector Sd is in engagement with its first bank contact 296 and all other arms 280 to 285 inclusive and 287 are engaged with their respective corresponding bank contacts as shown. Also assume that the brush B8 of distributor RD1 is just engaging local segment 274. A circuit is established between the ground of tongue 289 of relay CRd1 and the battery on the winding 297 of transfer relay TRd1 comprised of the tongues 289 and left hand contacts 290 of control relays CRd1, CRd2 and CRd3, conductor 298, arm 286 and bank contact 296 of selector Sd, conductor 299 and winding 297 of relay TRd1. With this relay operated, its contacts 279 are closed connecting the selecting magnets 295 of the printer P1 to the segments of ring 272, and the printing magnet 301 with the local segment 275 of ring 278. The passage of brush B8 over segment 274 completes a circuit from battery on ring 273 over conductor 302, through winding 293 of cut-out relay COd to ground, this winding being poled to close the contact 292. Brush B7 then passes over the five segments of ring 272 transferring the character signals being received from line L1 to the selecting magnets 295 of printer P1. Common to one terminal of all selecting magnets 295 of all printers P1, P2 and P3 is positive potential supplied through the winding 294 of relay COd. Hence, only when marking, or negative, battery is applied to a selecting magnet 295 from the distributor RD1 is it and the winding 294 of relay COd energized, the latter being poled to open the contact 292. Since all code combinations, except the blank signal, have at least one marking impulse, at least one of the selecting magnets 295

of printer P1 and the winding 294 of relay COd will be energized whenever any character is received. When brush B7 has passed over the last of the five segments of ring 272, brush B8 engages local segment 275 of ring 278. The printing magnet 301, with one terminal grounded, and with its other terminal being supplied with battery from ring 273 by brush B8, segment 275, conductor 303 and the sixth contact 279 of relay TRd1, is energized completing the printing of the character. Moving along, the brush B8 passes over segment 276 with no result at this time, and on to segment 277 from which the battery of ring 273 is transferred by conductor 304 to the stepping magnet 305 of the selector Sd and thereby advancing the arms 280 to 287 inclusive of selector Sd to their second bank contacts.

With arm 286 of selector Sd connected by its bank contact 306 to conductor 307, the transfer relay TRd2 is operated. Thus the next character received by the distributor RD1 is directed to printer P2. Similarly, the third character is registered on printer P3 through relay TRd3, when the selector arm 286 is connected to conductor 308 by its bank contact 309. This entire cycle is repeated as the selector arm 286 is stepped successively over its bank contacts 310, 311 and 312. When the arms 280 to 286 inclusive of the selector Sd reach their respective bank contacts corresponding to contact 313 associated with arm 286, none of the printers P1, P2 or P3 is connected to the lane. Instead, transfer relay TRd4 is operated, the ground on selector arm 287 being applied by contact 314 and conductor 315 to the winding 297 of relay TRd4. The closing of the contacts 279 of this relay connects the windings 316 and 317 of control relays CRd1, CRd2 and CRd3 with the first three segments respectively of ring 272 of the receiving distributor RD1. Thus, when the pattern is received on the next revolution of the brushes B7 and B8, it is used to set the tongues 289 of relays CRd1, CRd2 and CRd3 to correspond with similar ones at the transmitting station C of Fig. 3. In this case all marking, or negative, signals are received as described above in connection with Fig. 3 because all printers P1, P2 and P3 are to remain in operation. Since the same results are produced on all control relays CRd1, CRd2 and CRd3, the action of only relay CRd1 will be described. The windings 316 and 317 are oppositely poled, but winding 316 predominates and winding 317 is shunted with the condenser 318. Negative potential applied to winding 316 by the engagement of brush B7 with the first segment of ring 272 moves the tongue 289 to its right hand contact 291 and upon the removal of the battery, when brush B7 has left the segment, the discharge of the condenser 318 through winding 317 moves the tongue 289 back to its left hand contact 290. Thus, when the selector arm 286 is again stepped to its bank contact 296, the receiving apparatus is set to operate as before which it does until the blank signal is received on printer P1.

It will be remembered from the description of Fig. 3 that just prior to being closed out of the lane, a blank (or all spacing) signal was sent from transmitter T1. With operation of the receiving apparatus of Fig. 4 proceeding as described above, this blank signal is received on printer P1 when connected to the lane by the contacts 279 of relay TRd1 in one of its regular turns. Since all signals are spacing, or of positive potential, none of the selecting magnets 295 of printer P1 nor the winding 294 of the cut-

out relay COd are energized and consequently contact 292 of the latter relay remains closed. The engagement of the brush B8 with local segment 275 produces no result because the blank signal is automatically deleted from printer P1. The passage of brush B8 over segment 276 at this time completes a circuit, comprised of conductor 319, contact 292 of relay COd, conductor 320, the seventh contact 279 of relay TRd1 and conductor 321, to winding 316 of control relay CRd1 thereby applying positive potential to the windings 316 and 317 of this relay. This results in the movement of the tongue 289 to its right hand contact 291 as soon as brush B8 leaves segment 276. An examination of the tongues 289 and contacts 290 and 291 of the relays CRd1, CRd2 and CRd3 now will show the ground of tongue 289 of relay CRd1 applied to selector arm 285, the bank contacts associated with which are connected alternately to transfer relays TRd2 and TRd3. Hence with this new arrangement, only printers P2 and P3 are connected to the lane.

But when, subsequently during the switching period, the transmitter T1 of Fig. 3 is again entered onto the lane, and the original pattern sent to the receiving station D of Fig. 4, the tongue 289 of relay CRd1 is once more set on its left hand contact 290, thereby providing for the connection of printer P1 to the lane. Thus the manner in which the entrance and exit of the receiving printers to and from the lane concurrently with the entrance and exit of the transmitters is effected by line signals under the control of the corresponding transmitting apparatus will be apparent.

While only three transmitters and three receiving printers have been considered in the foregoing descriptions, it should be understood that this invention provides for a communication system which is not so limited but rather, one that can be expanded to include any desired number of transmitters and printers operating over a single lane of traffic, each transmitter having the equivalent of a direct wire connection with its associated printer. While telegraph transmitters and printers have been mentioned, any desired sending and receiving or recording devices may be employed. Although the actual transmitters in a telegraph system are preferably located in a central station, the points of origin of the traffic may be in widely separated sub-stations having individual connections with the central station where it is stored by some well known apparatus. Similarly, the receiving recorders may be located in outlying sub-stations having extended channel connections to the central station. Also it will be evident to anyone skilled in the art that the embodiments of this invention described in these specifications are but two of many forms in which the novel features may be incorporated, and that lanes of traffic other than a multiplex channel may be used as the transmission medium. Consequently, no limitations on the invention are contemplated other than those imposed by the scope of the appended claims.

What is claimed is:

1. In a communication system, a lane of traffic, a plurality of transmitting devices, means for operating a variable number of said devices to transmit over the lane of traffic and for dividing a predetermined part of the lane time between operating transmitting devices, said means including a sequencing device having a plurality of operative positions and connected to effect trans-

mission from one of the transmitting devices in each of said positions, means for advancing said sequencing device from one position to another, and an auxiliary switch means for predetermining the transmitting device to be rendered operative in each position of said sequencing device.

2. In a communication system, a lane of traffic, a plurality of transmitting devices, means for operating a variable number of said devices to transmit over the lane of traffic and for dividing a predetermined part of the lane time between operating transmitting devices, said means including a step-by-step switch providing contact wipers and a plurality of contacts engaged by each of said contact wipers, connections to said contacts and contact wipers whereby transmission from one of said transmitting devices is effected in each successive position of said step-by-step switch, and an auxiliary switch means for predetermining the transmitting device to be rendered operative in each position of said step-by-step switch.

3. In a communication system, a lane of traffic, a plurality of transmitting devices, means for operating a variable number of said devices to transmit over the lane of traffic and for dividing a predetermined part of the lane time between operating transmitting devices, said means including a step-by-step switch controlling the connection of said transmitting devices to the lane of traffic, means for operating said step-by-step switch after each transmitting cycle, and means including an auxiliary multi-position switch for predetermining the transmitter or transmitters which may be connected to the lane of traffic by said step-by-step switch.

4. In a telegraph system, a lane of traffic, a plurality of transmitting channels, means for operating a variable number of said channels to transmit over the lane of traffic and for dividing the lane time between the operating channels, pattern signal transmitting means for transmitting signals over the lane of traffic to indicate a desired change in the allocation of channels and for transmitting other signals to confirm channels which are to remain connected or disconnected, and means for rendering said pattern signal transmitting means operative at predetermined intervals.

5. In a communication system, a lane of traffic, a plurality of sources of permutation code signals, means for operating a variable number of said sources to transmit signals over the lane of traffic and for dividing a predetermined part of the lane time between operating sources, means for sending a controlling signal over the lane of traffic consisting of code impulses, each impulse representing one of said sources of signals, and means responsive to said controlling signal for entering a receiving device corresponding to a source of signals seeking entry onto the lane of traffic.

6. In a communication system, a lane of traffic, a plurality of communication channels, means for operating a variable number of channels over the lane of traffic and for dividing the lane time between operating channels, means for periodically transmitting a channel pattern signal consisting of an impulse corresponding to each of said plurality of channels to permit the entry of an additional channel, and devices at the receiving end of said lane of traffic responsive to said pattern signal.

7. In a communication system, a lane of traffic, a plurality of communication channels, means for

for operating a variable number of said channels over the lane of traffic and for dividing the lane time between operating channels, and means for transmitting a channel pattern signal whenever one of said channels becomes inoperative to prepare for the exit of said inoperative channel and means responsive to said signal to disconnect said channel.

8. In a communication system, a lane of traffic, a plurality of communication channels, means for operating a variable number of said channels over the lane of traffic and for dividing the lane time between operating channels, and means for transmitting a channel pattern signal consisting of impulses corresponding to the operative or non-operative condition of a group of said channels whenever a change of status is desired on one of said channels.

9. In a telegraph system, a lane of traffic, a plurality of code telegraph transmitters, and means for operating a variable number of said transmitters to transmit message characters over the lane of traffic and for dividing a predetermined part of the lane time between operating transmitters, said lane of traffic including a synchronous multiplex channel having synchronous distributors at the sending and receiving ends thereof and said means including switches arranged to connect the respective code contacts of the transmitters directly to the segments of the transmitting distributor individually during the time each transmitter has access to the multiplex channel.

10. In a telegraph system, a lane of traffic, a plurality of communication channels, means for operating a variable number of said channels over said lane of traffic, a control or auxiliary signalling channel, and signalling means for operating said control channel over said lane, said signalling means including a two-position switch and an indicator or recorder responsive to said switch positions.

11. In a telegraph system, a lane of traffic, a plurality of tape transmitters, a selecting means having multiple contacts for connecting said transmitters with said lane, and manual means for arranging operative ones of said transmitters in groups and for connecting said operative transmitters to successive contacts of said selecting means.

12. In a telegraph system, a lane of traffic, a plurality of sources of permutation code intelligence signals, selecting means for automatically transferring from said sources said intelligence signals to said lane of traffic, and means including a multi-position manual switch for associating any one or any group of said sources with said selecting means.

13. In a telegraph system, a lane of traffic, a plurality of transmitters having tape controlled code contacts, means for selecting any of said transmitters individually or in groups of two or more, said means comprising a manually operated multi-stage switch, each stage comprising a contact wiper and a plurality of contacts, engaged thereby, said contacts being connected to corresponding code contacts of said transmitters, means for moving said wipers to concomitantly engage corresponding contacts of the stages of said switch, and means to selectively connect said wipers to said lane of traffic.

14. In a telegraph system, a lane of traffic, a plurality of tape transmitters having code contacts, a multi-stage selector switch, a manually operated grouping means for associating those of

said transmitters to be operated over said lane with said switch, said switch having one stage individual to each code contact of a transmitter, each of said stages comprising a plurality of stationary contacts associated with corresponding code contacts of said transmitters and a movable contacting member automatically operable simultaneously with corresponding contacting members of other stages to successively engage said stationary contacts for transference of said code contact to said lane of traffic, and means including said selector switch to equally divide substantially the full lane time between the operating transmitters.

15. In a telegraph system, a lane of traffic, a plurality of transmitters, means including a selecting switch for operating a variable number of said transmitters over said lane of traffic, and a manually controlled means for arresting said selecting switch at a predetermined point and modifying the electrical condition of the lane to indicate the stopping of the selecting switch.

16. In a telegraph system, a lane of traffic, a plurality of communication channels, sending and receiving sequencing means for operating a variable number of said channels over said lane, manual means for arresting said sending sequencing means and modifying the electrical condition of said lane, and means responsive to said electrical condition for arresting said receiving sequencing means.

17. In an expanding channel telegraph system, a lane of traffic, a plurality of communication channels, sending and receiving selecting devices for operating a variable number of said channels over said lane and for dividing the same predetermined part of the lane time among the operating channels irrespective of the number of operating channels, means for applying an electrical condition to said lane, and means responsive to said condition to synchronize said selecting devices.

18. In a telegraph system, a lane of traffic, a plurality of communication channels, means for operating a variable number of said channels over said lane and for dividing a predetermined part of the lane time among the operating channels, said means including sequencing devices having a plurality of operative positions and connected to effect transmission on one of said operative channels in each of said positions, signal storage means constituting a source of signals for said channels, and means responsive to said storage means to effect a re-allocation of the positions of said sequencing devices when the operative or inoperative status of one or more of said channels changes.

19. In a telegraph system, a lane of traffic, a plurality of communication channels, means for operating a variable number of said channels over said lane, said means including a sequencing device having a plurality of operative positions, there being one or more of said positions connected to effect the operation of each of said operative channels, signal storage means constituting a source of signals for said channels, and means responsive to said storage means to re-allocate the positions of an inoperative channel to the remaining ones of said operative channels at any time during a cycle of said sequencing device.

20. In a telegraph system, a lane of traffic, a plurality of communication channels, means for successively connecting a variable number of

said channels with said lane for operation there-
over, signal storage means constituting a source
of signals for said channels, and means respon-
sive to said storage means at predetermined in-
tervals to effect the entry of one or more addi-
tional channels onto said lane.

21. In a telegraph system, a synchronous
multiplex system including sending and receiv-
ing distributors, a plurality of communication
channels comprising code sending and receiving
devices at opposite ends of said multiplex system,
means including step-by-step switches at oppo-
site ends of said system for connecting the code
instrumentalities of the respective sending and
receiving devices to the multiplex distributors,
and means including said distributors for op-
erating said switches in synchronism.

22. In a telegraph system, a lane of traffic, a
plurality of communication channels, a multi-
position switch arranged to render any of said
channels operative to send over said lane either
individually or in groups of two or more, and
means whereby said channel transmission is con-
tinued in each of the respective positions of said
switch irrespective of the grouping of the chan-
nels.

23. In a telegraph system, a lane of traffic, a
plurality of communication channels, means for
operating a variable number of said channels
over the lane of traffic and for dividing the lane
time among the operating channels, means op-
erative periodically for transmitting signals over
the lane of traffic to identify operating channel
transmitters, and means responsive to said sig-
nals to indicate the identity of said operating
transmitters.

24. In a telegraph system, a lane of traffic, a
plurality of communication channels, means for
operating a variable number of said channels
over the lane of traffic and for dividing the lane
time among the operating channels, means op-
erative periodically to indicate the operative con-
dition of the channel transmitters and for trans-
mitting pattern signals over the lane character-
istic of said condition, and means responsive to
said signals to control the operativeness of the
channel receivers.

25. In a telegraph system, a lane of traffic, a
plurality of communication channels, cyclic
means for operating a variable number of said
channels over the lane of traffic and for dividing
the lane time among the operating channels,
means immediately responsive to a change of
status of any of said channels to prepare for re-
allocation of the lane time, and means for effect-
ing said re-allocation only at predetermined
points in the cycle of operation of said first
named means.

26. In an expanding channel telegraph sys-
tem, a lane of traffic, a plurality of communica-
tion channels, sending and receiving selecting
devices for operating a variable number of said
channels over said lane and for dividing a pre-

determined part of the lane time among operat-
ing channels, means for synchronizing said de-
vices comprising a manually controlled relay hav-
ing contacts to arrest one of said devices in a
"stop" position and for successively transmitting
over said lane signals indicative of said "stop"
position, a second relay having contacts opera-
tive to arrest the other of said devices in its
"stop" position, and circuit arrangements to
render said second relay responsive to one of
said signals only when the other of said devices is
in its "stop" position.

27. In an expanding channel telegraph system
having sending and receiving selecting devices for
operating a variable number of communication
channels over a lane of traffic, the method of
synchronizing said devices which comprises ar-
resting said sending device in its "stop" position,
transmitting successively, over said lane, signals
indicative of said arrested condition, and ar-
resting the receiving device in its "stop" position
by one of said signals.

28. In a telegraph system, a lane of traffic, a
plurality of communication channels each com-
prising code sending and receiving devices at op-
posite ends of said lane of traffic, certain of said
channels being idle at times, means including a
step-by-step switch at one end of said system for
successively connecting the code instrumentalities
of different sending devices to said lane of traffic
and means for testing at intervals the busy or
idle condition of all of said channels.

29. In a telegraph system, a lane of traffic, a
plurality of communication channels each com-
prising code sending and receiving devices at op-
posite ends of said lane of traffic, certain of said
channels being idle at times, means for succes-
sively associating said channels with the lane of
traffic in a manner to devote the lane time prin-
cipally to the busy channels, said means includ-
ing stepping switches at opposite ends of the sys-
tem, said switches having stepping magnets and
contact banks containing separate contacts rep-
resenting separate ones of said channels, and
means for concurrently energizing the stepping
magnets of both of said switches.

30. In a telegraph system, a lane of traffic, a
plurality of communication channels each com-
prising code sending and receiving devices at op-
posite ends of said lane of traffic, certain of said
channels being idle at times, means for succes-
sively associating said channels with the lane of
traffic in a manner to devote the lane time
principally to the busy channels, said means in-
cluding stepping switches at opposite ends of the
system, said switches having stepping magnets
and contact banks containing separate contacts
representing separate ones of said channels and
means for concurrently energizing the stepping
magnets of both switches, and means including
said switches for testing at intervals the busy or
idle condition of all of said channels.

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