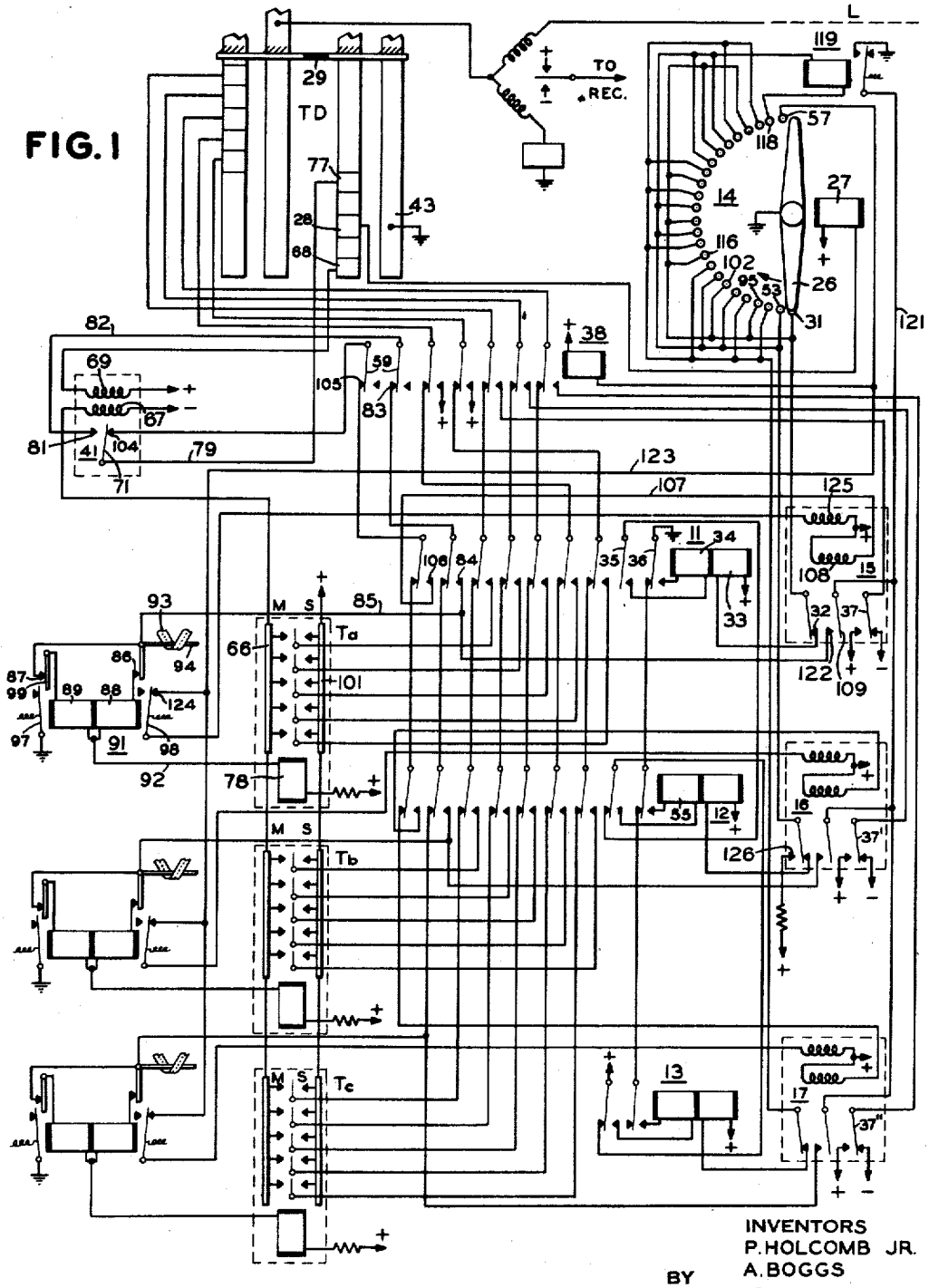
Oct. 24, 1939. P. HOLCOMB, JR., ET AL 2,176,901

MULTICHANNEL TELEGRAPH SYSTEM

Filed Sept. 9, 1937 2 Sheets-Sheet 1

FIG. 1



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MULTICHANNEL TELEGRAPH SYSTEM

Filed Sept. 9, 1937 2 Sheets-Sheet 2

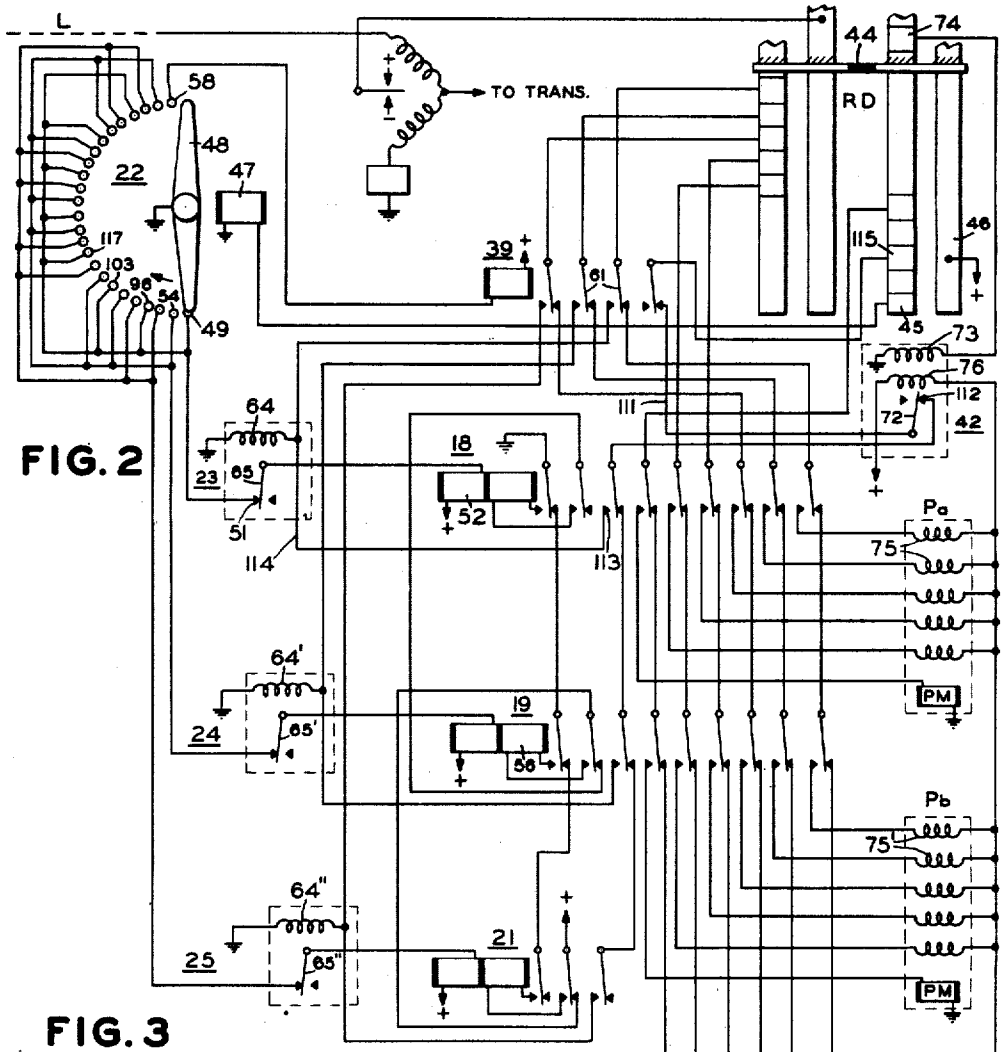


FIG. 2

FIG. 3

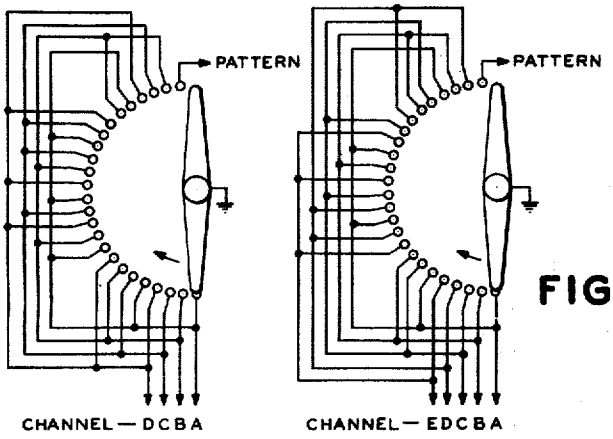


FIG. 4

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UNITED STATES PATENT OFFICE

2,176,901

MULTICHANNEL TELEGRAPH SYSTEM

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Application September 9, 1937, Serial No. 162,962

17 Claims. (Cl. 178—52)

This invention relates to signalling systems of the varioplex or expanding channel type in which a variable number of signalling channels are operated simultaneously over a lane of traffic, and has particular reference to a means of dividing the lane time among the operating channels.

The basic principle of the expanding channel system is disclosed in a prior U. S. application of Philo Holcomb, Jr., Ser. No. 666,004, filed April 13, 1933. In this patent the system is illustrated as applied to a multichannel telegraph system. Briefly, such a system provides for the division of the entire available signalling time of a lane of traffic or a predetermined part thereof between a variable number of transmitters and their associated receivers. However, the present invention relates more particularly to the type of expanding channel system disclosed in another prior U. S. application of Philo Holcomb, Jr., Ser. No. 153,748, filed July 15, 1937, in which the lane time division is effected by means including a plurality of rotary switches.

The primary object of the present invention is to provide a simplified dividing or control means of the aforementioned type for controlling the transmission from operative or "busy" channels over the lane.

Another object of this invention is to provide a selector arranged to effect only an approximate apportionment of the lane time when equal division is not desired.

A further object of this invention is to provide a system of the aforementioned nature wherein one or more of the channels is allotted a greater proportion of the lane time than other operative channels.

These and other more specific objects will become apparent from the following description of a preferred embodiment of the invention shown on the accompanying drawings, in which:

Fig. 1 is the circuit diagram of the sending station showing the apparatus and the interconnections thereof for a system utilizing three channels;

Fig. 2 is the circuit diagram of the receiving station of a three channel system;

Fig. 3 illustrates an arrangement of the selector contacts to secure equal division of the lane time among four channels; and

Fig. 4 shows a configuration of a selector which may be used where five channels are to share the lane time unequally.

Referring first to Figs. 1 and 2, there is shown an expanding channel system comprising three tape transmitters T*a*, T*b* and Tc which may be of the type shown and described in Patent No. 1,298,440 granted to Benjamin on March 25, 1919, or any other suitable type, and three printers P*a*, P*b* and P*c*, representing any suitable receivers, operable over one channel of a synchronous multiplex system utilizing the line L. Associated with the transmitters are sending transfer relays 11, 12 and 13. The relays 11 and 12 have nine armatures, six of which are used to connect the transmitters with the sending distributor TD of the multiplex. Two other armatures of said relays are for the purpose of interlocking the transfer relays and the remaining one for a control purpose hereinafter disclosed. The relay 13 is provided with only two armatures. Each of these relays is selectively operated from a transmitting selector 14 through circuits established by their respective control relays 15, 16 and 17. The energization of the control relays depends upon the storage of characters to be transmitted from their respective transmitters in a manner which will subsequently appear. The action of the selector 14 is under the control of the transmitting distributor TD of the multiplex system. The receiving distributor RD of said system is similarly associated with the receivers or printers P*a*, P*b* and P*c* by the receiving transfer relays 18, 19 and 21, the selection and operation of which are effected by the receiving selector 22 coacting with the control relays 23, 24 and 25.

The manner of obtaining and maintaining synchronism between the brush arms of the sending and receiving distributors of a multiplex system, and the operation of transmitters and receivers in connection with such a system are well known in the art. Hence attention will be directed to the novel instrumentalities comprising the present invention, it being understood that other types of control and receiving devices may be employed for purposes of signalling or communication.

The arm 26 of the transmitting selector 14 is driven over the contacts of the selector under the influence of the stepping magnet 27 which is energized from segment 28 of the local distributor ring. Alternative structures include a relay chain, a rotating switch having an arm 26 geared to the rotating brush arm 29 of the distributor, or any equivalent arrangement whereby the arms 26 and 29 are moved over their respective contacts or segments in a predetermined timed relation. In the present embodiment the arm 26 advances at the rate of one contact for every revolution of the distributor arm 29. Each of the selector contacts is connected by a contact of one of

the control relays with the operating winding of a transfer relay, as, for instance, selector contact 31 is connected through the contact 32 of the control relay 15 to the operating winding 33 of the transfer relay 11. Battery is applied to the other end of this winding and ground to the selector arm 26 so that when the arm is engaged with contact 31, the transfer relay 11 is operated. Once operated, it is locked by its locking winding 34 to which battery and ground are suitably applied by the front contacts associated with the tongues 35 and 36. These locking contacts are interconnected with corresponding contacts of the other transfer relays in a manner such that only when any one of the latter is operated is the locking circuit of relay 11 opened and its contacts restored to their unoperated positions. As stated hereinbefore, the operation of one of the transfer relays connects its associated transmitter with the sending distributor for operation therewith.

Each operative transmitter has associated with it a control relay, the tongues of which are positioned to the right, and each inoperative transmitter has associated with it a control relay the tongues of which are positioned to the left. The tongue 37 of control relay 15 and the corresponding tongues of the control relays 16 and 17 supply either marking or spacing potential to the contacts of a pattern relay 38. Periodically the pattern relay 38 is connected to the distributor TD at which time a receiving pattern relay 39 is connected to the receiving distributor RD. When this occurs the transmitters and printers are disconnected from the distributors. This operation is either for the purpose of confirming the existing channel arrangement or for the establishment of a new one.

In a system of this type, channels may cease operation and be switched out of an operative association with the lane of traffic at any time in the cycle of selector operation when the stored characters have been transmitted. For this purpose an exit relay 41 is used in cooperation with the transmitter to be closed out and a corresponding relay 42 at the receiving station. However, when an inoperative channel is to be entered, it may be operatively associated with the lane of traffic at only one predetermined time in the selector cycle. Such a time is that of the aforementioned periodic operation of the pattern relays. The precise manner in which a channel exit or entry is effected will be more fully described hereinafter.

Suppose that all three channels are operating with the tongues of the transmitting control relays 15, 16 and 17 positioned to the right and those of the receiving control relays 23, 24 and 25 positioned to the left, and that the selector arm 26 has just been moved into engagement with selector contact 31 by the passage of the transmitting distributor brush 29 over the local segment 28, which momentarily closed the circuit between the ground on the solid local ring 43 and the battery applied to the winding of the stepping magnet 27 of the selector. Substantially at the same time the receiving distributor brush 44 passed over local segment 45 connecting the battery of the solid local ring 46 to the winding of the stepping magnet 47 of the selector 22 and thereby advancing the arm 48 to selector contact 49. As indicated hereinbefore, a closed circuit is thus established through the closed contact 32 of the sending control relay 15 to the operating winding 32 of the transfer relay 11. At the receiving station, the engagement of selector arm 48 with the contact 49 completes a circuit through the closed contact 51 of the control relay 23 to the operating winding 52 of the transfer relay 18.

With the sending and receiving transfer relays 11 and 18 operated, transmitter Ta and printer Pa are connected with their respective distributors TD and RD so that on the following revolution of the brushes 29 and 44, a character is sent from transmitter Ta and recorded on printer Pa. The selector arms 26 and 48 are then advanced to contacts 53 and 54 respectively, thereby operating the transfer relays 12 and 19. The operation of these relays opens the locking circuits of the relays 11 and 18, permitting the tongues of the latter relays to be restored to their normal unoperated positions and thereby close the locking circuits for the former relays through the windings 55 and 56 respectively.

It will be seen that in order to connect the transmitter Tc and the printer Pc to the lane, it is only necessary to de-energize transfer relays 12 and 19, the necessary connections thereby being established through back contacts of the other transfer relays. Hence the sending and receiving transfer relays 13 and 21 for this channel are provided only with locking contacts. As the selector arms 26 and 48, continuing their traverse over their respective contacts, reach the contacts 57 and 58 respectively, they will have connected each of the three channels to the lane of traffic an equal number of times, although not necessarily in the same order each time.

The arrival of the arms 26 and 48 at contacts 57 and 58 respectively effects the operation of the pattern relays 38 and 39. No locking arrangements are provided for these relays so that as soon as the selectors 14 and 22 are stepped to their next contacts the relays will be restored to normal. It will be noted, however, that one of the transfer relays at both the sending and receiving stations is in its operated position at this time. In the present instance these relays are 13 and 21, although the same condition will exist regardless of which pair of transfer relays happens to be operated when the selectors operate the pattern relays. But there are no operative connections between any transmitter or printer and their respective distributors, since the circuits therefor are open at the break, or back, contacts associated with the tongues 59 and 61 of the pattern relays 38 and 39 respectively.

The front contacts of the fourth and fifth armatures of the pattern relay 38 are connected to spacing potential and perform no function in the present system other than that of preventing an open line circuit when the fourth and fifth distributor segments are traversed by the brush 29. The front contacts of the first three armatures of this relay are connected to the tongues 37, 37' and 37'' of the control relays 15, 16 and 17 which, in the present case, are positioned to the right thereby connecting with marking potential. However, if the transmitter associated with one or more of the control relays is inoperative, the tongue of this control relay 15, 16 or 17 will be connected with spacing potential. The polarity of the potentials applied to the first three segments of the transmitting distributor TD through the contacts of the pattern relay 38 is indicative of the transmitters which are operative and those which are inoperative and is transmitted to the receiving station on the revolution of the distributors following the operation of the

pattern relays. Here the segments of the receiving distributor RD are connected through the front contacts and tongues 61 of the pattern relay 38 to the windings 64, 64' and 64'' of the polarized control relays 23, 24 and 25, the tongues 65 of which are positioned to the right or to the left according to whether the received impulse is of spacing or marking polarity.

After the transmission of the pattern, the wipers of the selectors 14 and 22 are successively advanced over their respective contacts and operation continues as before. It should be noted that the marking bus bars 66 of all transmitters are supplied with battery through a winding 67 of the polarized exit relay 41 and that a local segment 68 of the multiplex distributor is connected to a second winding 69 of this relay. Every character sent from a transmitter includes at least one marking impulse except a blank signal which comprises all spacing impulses. Hence with the transmission of every character, except a blank, the function of which will become apparent, current is conducted through the winding 67 in a direction to move the tongue 71 to the left and thereby provide a circuit for effecting the tape-stepping function of the transmitter. Also, before another character is transmitted, the winding 69 is energized by the engagement of the brush 29 with local segment 68 which causes the tongue 71 to be moved to the right.

A similar polarized relay 42 is provided at the receiving station and its tongue 72 is positioned to the right under the influence of its winding 73 which is energized by the engagement of brush 44 with local segment 74. Spacing potential is supplied to all of the selecting magnets 75 of the printers Pa, Pb and Pc through the winding 76 of the relay 42 so that whenever a marking potential is applied to any of these selecting magnets, the tongue 72 of the relay is moved to the left.

Now, assume that the selector arms 26 and 48 are engaged with their respective contacts 31 and 49, and a character has just been sent from transmitter Ta. When the transmitting brush 29 engages local segment 77, the stepping magnet 78 of transmitter Ta is energized, the circuit therefor including conductor 79, contact 81 of the exit relay 41, conductor 82, back contact 83 of relay 38, front contact 84 of the transfer relay 11, conductor 85, contacts 86 and 87 and the oppositely poled windings 88 and 89 of the auto-stop relay 91 and conductor 92. The closure of this circuit has no effect on the relay 91 since its windings are substantially equal and are poled in opposition to one another. When the circuit to the stepping magnet 78 is opened as the brush 29 leaves segment 77, the tape 93 is stepped forward one character. Suppose that the character storage is depleted to the extent that this movement of the tape raises the tape bar 94 which opens the autostop contacts 86, and this condition exists until the selector arms 26 and 48 are engaged with their respective contacts 95 and 96. Following the transmission of the character then set up in the transmitter Ta, the engagement of brush 29 with the segment 77 again energizes the stepping magnet 78 but this time the circuit includes only the winding 89 of the relay 91. This results in the operation of this relay, the attendant positioning of its tongues 97 and 98 on their front contacts and the locking up of the relay 91 and the stepping magnet 78 by the engagement of the tongue 97 with the contact member 99. The contact 87 is also opened by this operation. The energization of magnet 78 withdraws the feeler pins from the tape and all of the tongues of the transmitter Ta are in contact with the spacing bus bar 101.

Therefore, when the selector arms 26 and 48 have moved to their respective contacts 102 and 103, an all-spacing signal is sent from transmitter Ta. As indicated hereinbefore, the tongues 71 and 72 of the transmitting and receiving exit relays 41 and 42 respectively are positioned to the right. At the transmitting station the engagement of the distributor brush 29 with local segment 77 establishes a circuit comprising conductor 79, contact 104 of relay 41, back contact 105 of relay 38, front contact 106 of transfer relay 11 and conductor 107 to the winding 108 of the control relay 15, whereupon this relay moves its tongues 32, 37 and 109 to the left. Also at the receiving station, a circuit is provided including the outer armature and back contact of relay 39, conductor 111, contact 112 of the exit relay 42, front contact 113 of the transfer relay 18 and conductor 114 so that when the battery of spacing polarity which is applied to the solid local ring 46 is connected to segment 115, the winding 64 of the control relay 23 is energized so as to position its tongue 65 to the right. As long as the tongues of the transmitting and receiving control relays 15 and 23 are maintained in these positions, the associated channel has no connection with the lane of traffic.

When the selector arms 26 and 48 reach their respective contacts 116 and 117, corresponding to channel A, there is no operation of the transfer relays 11 and 18, since the operating circuits therefor stand open at the control relays 15 and 23 respectively. Hence channel C remains connected to the lane for the transmission of a second character. The next selector position normally alloted to the now idle channel A is given over to channel B for reasons similar to the above. An inspection of the selector contacts will reveal that the contacts vacated by channel A are equally divided between channels B and C in a complete cycle of the arms 26 and 48. It will also be readily seen that should either channel B or C be subsequently switched out, the entire lane time will be available to the one remaining. The configuration of the selector is such that, regardless of which channels are connected to the lane, they will invariably share the lane time equally in any complete traverse of the arm over the selector contacts.

When all channels are idle, transmitter Tc and receiver Rc are connected to the lane for the entire time, excluding that during which the pattern relays 38 and 39 are connected. But since the tongues of this transmitter are locked against their spacing contacts, and since the pattern relay contacts are supplied with spacing battery from the control relays 15, 16 and 17, the entire lane time is given over to the transmission of all-spacing signals. In order to maintain synchronism in a multiplex system of telegraphy, it is necessary to supply potential to the line at all times. Hence this condition is fulfilled by the present arrangement, and since an all-spacing combination of signals represents a "blank" character, it is automatically deleted by the printer Pc.

For the method of entering a channel, consider the case where channels B and C are operating and additional tape is perforated for transmitter Ta thereby allowing the auto-stop contact 86 to close. This may occur at any time in the cycle of operation of the selector 14, but further than the closure of the contact 86 nothing

happens until the selector arm 26 reaches contact 118. Then, in addition to the operation of transfer relay 12, the entry relay 119 connected in series relation with the right hand winding of relay 12 is also energized. The energization of relay 119 connects a ground to conductor 121 from which it is transferred by the closed contact 122 of the control relay 15 to conductor 85. This is a normal occurrence when any transmitter is inoperative, but until the tape loop 93 has lengthened sufficiently to allow the auto-stop contact 86 to close, it does not affect the autostop relay which is locked up through its armature 97 as described above. But with the contact 86 closed, the ground applied by relay 119 energizes the winding 88 of the autostop relay which neutralizes the magnetic effect of the winding 89, restores the auto-stop relay to normal and deenergizes the stepping magnet 78 of transmitter Ta, thereby advancing the tape 93 one character and permitting the transmitter pins to engage the tape.

The next movement of the selector arm 26 to contact 57 connects a ground to conductor 123, and the auto-stop contact 124 further transfers it to the winding 125 of the control relay 15, thereby energizing the latter which results in the repositioning of its tongues to the right. It should be noted that, at the same time, the corresponding windings of the control relays 16 and 17 are similarly energized, but since the tongues of these relays are already positioned to the right, the energization of these windings serves only to confirm the tongue positions. As described hereinbefore, the pattern relay 38 is also operated at this time and on the next revolution of the distributor the new pattern is transmitted to the receiving station where the tongue of the control relay 23 is repositioned to the left in response to the marking impulse sent from the transmitting control relay 15, thus completing the entry of channel A.

It should be noted in connection with the operation of the entry relay 119 from contact 118 of the transmitting selector 14 that, in the event that transmitter Tb is inoperative and the tongues of its associated control relay 16 are positioned to the left, the battery for operating the entry relay is supplied from the back contact 126 of the control relay. Also, it is possible for any number of channels to be entered simultaneously into active association with the lane of traffic, and if there is no change in the channel pattern the existing pattern is confirmed.

An expanding channel system comprising three channels, as disclosed herein, may be considered the simplest form illustrative of the basic concepts of the present invention. It is, by no means, limited to three channels, and Fig. 3 shows an arrangement of the selector contacts to accommodate four channels affording equal division of the lane time. The apparatus necessary for the additional channel will comprise a transmitter and a printer and sending and receiving transfer and control relays, similar to the apparatus shown in Figs. 1 and 2. As shown, the order of connection of the channels to the selector bank contacts is A—B—C—D—A—C—B—D—A—B—D—C—A—D—B—C—A—C—D—B—A—D—C—B.

It is evident that the equal division of the lane time among any combination of operative channels may be effected by suitably arranging a predetermined number of selector contacts, or positions, so that the positions vacated by inoperative channels are apportioned equally to the operative channels. In order that the determination of the minimum number and the arrangement of the selector positions may be better understood, a brief outline thereof will be given.

The minimum number of selector positions for associating a plurality of channels with a lane of traffic is to be determined and the positions are to be arranged in a closed group in such a manner that the following two results will be obtained. First, in one complete traverse of the group of selector positions, the channels are each associated with the lane an equal number of times. Second, when the selector positions vacated by one or more inoperative channels are reassigned to the operative channels, the positions of which immediately precede the vacated positions, one complete traverse of the group will associate the operative channels with the lane an equal number of times, but a greater number than in the first instance. The first result is obtained by providing the same number of selector positions for each channel. To attain the second result, the sequence of the selector positions must be properly arranged in a closed group.

It is necessary first to determine the minimum number of selector positions required in the group. Since the selector positions vacated by an inoperative channel are to be re-assigned in equal numbers to the operative channels having positions immediately preceding the vacated ones, a fundamental characteristic is that each channel have positions which are individually preceded the same number of times by each of the other channel positions.

As an example, assume that four channels, A, B, C and D, are to be arranged to operate in such a manner. When (1) channel A becomes inoperative, in order that its share of the lane time be equally divided among the remaining channels, there must be at least three selector positions normally assigned to channel A; one preceded by a B, another by a C and a third by a D channel position, thereby forming sub-groups of two positions each. Whatever the sequence of these sub-groups, the position for channel B will be immediately preceded by either a CA or a DA sub-group, but not by both. But subsequently when (2) channel B becomes inoperative, in order that its own share of the lane time plus that reassigned to it by the withdrawal of channel A be equally divided between channels C and D, there must be a channel B position preceded by both a CA and a DA sub-group. To accomplish step 2 and still comply with step 1 necessitates the repetition of the three subgroups of step 1 differently arranged, which introduces a multiplying factor of two into the determination of the number of positions needed for channel A. It is apparent that subsequently when (3) channel C becomes inoperative, with the selector configuration as developed thus far, the entire lane time will be available to channel D. Thus step 3 may be accomplished without a further increase in the number of positions for channel A, or expressed mathematically, by multiplying the number of channel A positions by one. But according to an aforementioned requirement it was determined that each channel be normally assigned an equal number of selector positions. Since, at this point, that number has been determined for only one channel, A, and since there are four such channels to be accommodated in the present instance, the total

number of selector positions must be expressed as the number needed for one channel increased by the multiplying factor of four. Thus, differently stated, four channels require a minimum number of selector positions which is expressed as factorial 4 or, in general, if there are N channels, as factorial N.

Having determined the minimum number of selector positions necessary, it remains only to assign them to the channels in a manner such that each channel has an equal number of selector positions, and to arrange the positions in a sequence such that each channel has positions which are individually preceded the same number of times by each of the other channel positions.

One such arrangement of the sending and receiving selectors for four channels is shown in Fig. 3. However, it will be appreciated that other equally suitable arrangements are possible, and the present invention is intended to embrace all such arrangements.

When an expanding channel system in accordance with this invention comprises a large number of channels, the number of selector positions necessary to effect an equal division of the lane time may be so great as to be impractical. In this instance an approximate division of the lane time will be satisfactory or even desirable, in which case the number of selector positions may be greatly reduced. For example, it may be determined from the foregoing mathematical treatment of the problem that, in order to provide for equal division of the lane time among any combination of five channels, factorial 5, or one hundred and twenty, selector positions would be required.

However, Fig. 4 shows one of a great number of arrangements of the selectors having twenty-four available positions in which an approximate division of the lane time may be effected among five channels. As shown, the order in which the channels may be connected to the lane is A—B—C—D—E—A—C—B—E—D—A—D—C—E—B—A—E—C—D—B—C—A—B—D. It may be seen that, with this arrangement channels A, B, C and D are connected to the lane five times and channel E four times in one complete cycle of selector operation, when all five channels are busy. Of course, when any one of the channels alone is busy, it will have the entire lane time available to it, that being an inherent characteristic of the present system.

It is not deemed necessary to enter into a detailed analysis of the division of lane time among the various channels for all possible combinations thereof. Suffice it to note that equal division is attained in numerous instances such as combinations A—B—C—D, A—B—D, A—B, etc., and that the most unequal division is that of 14—10 for such combinations as A—C, A—E, etc.

An expanding channel system of this type may be operated advantageously by dividing the lane time unequally among the operating channels. For example, if one or more of the channels normally is more active than the others, these busy channels, when operating, may be alloted a greater proportion of the lane time than is assigned to less active channels. It should be obvious that such an arrangement may be effected by suitably interconnecting the contacts of the selectors and the transfer relays.

The communication system described herein provides a means of operating a variable number of channels over a lane of traffic whereby the lane is kept busy at all times, all "busy" channels always have an opportunity to transmit over the lane of traffic, and in which the sequencing device employed is quite simple. Also such a system is susceptible to various modifications, some of which have been suggested herein, and it is contemplated that the present invention embrace all modifications which come within the scope of the appended claims. No claim is made broadly to the verioplex system or other features disclosed in the prior applications of P. Holcomb, Jr.

What is claimed is:

1. In a telegraph system, a lane of traffic, a plurality of communication channels having access to said lane according to a prearranged schedule, means to afford sustained operation of any of said channels over said lane until succeeded by a second channel, said means including a plurality of interlocking relays any one of which is adapted to retain operated until another of said relays is operated, and selecting means periodically operable to seek out and operate the one of said relays associated with said second channel.

2. In a telegraph system a lane of traffic, a plurality of communication channels, a sequencing device characterized by multiple contacts connected to said channels in a manner to effect a predetemined division of the lane time among operative channels, means for selectively operating said operative channels over said lane in a prearranged sequence, said means including a wiper contact of said sequencing device operable at a uniform rate in a step-by-step fashion over said contacts and means to continue operation of a channel while said wiper is traversing contacts associated with idle channels.

3. In a telegraph system of the expanding channel type comprising a lane of traffic and a plurality of communication channels operable over said lane, means for effecting and maintaining a connection between any of said channels and said lane until another connection is made, and means for dividing the lane time among the operative ones of said channels according to a prearranged plan, said second means including a switch having a plurality of contacts connected to said first means and traversed in a step-by-step fashion by a wiper contact, said contacts being arranged so that when certain channels are inoperative, the contacts associated with operative channels are immediately followed by a predetermined number of contacts associated with inoperative channels.

4. In a telegraph system, a lane of traffic, a plurality of communication channels operable over said lane, means for apportioning the lane time among the channels so that preferred ones of said channels when operative are afforded a greater portion of the time, said means including a selecting device having a plurality of contacts, a preponderant number of which are associated with said preferred channels and disposed in preferred locations in said device, and a wiper contact operable periodically to effect successive engagements with said contacts, and means including selective interlocking relays for connecting said channels to the lane, said relays being operated by said contact engagements.

5. In a multichannel telegraph system, a lane of traffic, a plurality of channels associated therewith and means for dividing a predetermined part of the transmitting time of the lane of traffic among the channels which have signals to transmit, said means comprising a step-by-

step or rotating switch including a series of contacts, at least one for each of said channels and circuit connections whereby a channel is rendered operative if it has signals to transmit when the switch arm of said switch reaches a contact corresponding to said channel and whereby a previously selected operative channel is rendered operative again if said first channel has no signals to transmit.

6. In a multichannel telegraph system, a lane of traffic, a plurality of channels associated therewith, means for dividing a predetermined part of the transmitting time of the lane of traffic among the channels which have signals to transmit, said means comprising a step-by-step or rotating switch having a switch arm engaging sequentially a series of contacts to which the respective channels are multipled in a manner to effect approximately equal division of the lane time among the channels which have signals to transmit, and means for invariably operating said switch to successive positions at predetermined intervals irrespective of the number of busy channels.

7. In a multichannel telegraph system in which certain channels are inoperative at times, means for repeatedly testing all the channels in a predetermined order and each for a predetermined period, and means including said testing means for rendering the busy channels operative to transmit for predetermined periods depending upon the time required for the testing means to reach another busy channel.

8. In a telegraph system, a plurality of transmitters, a lane of traffic, means for connecting said transmitters one at a time to said lane of traffic, said means including a series of transfer relays so interconnected that the energization of any one of said relays releases the relay previously operated, and means for operating said relays sequentially if the corresponding channels have character signals to transmit and for omitting from the sequence the transfer relays corresponding to idle transmitters.

9. In a multichannel telegraph system in which certain channels are inoperative at times, a common lane of traffic for said channels, means for repeatedly testing all the channels in a predetermined order and means including said testing means for rendering the busy channels operative to transmit over the lane of traffic either for a predetermined period or until a successive busy channel is reached, the channels being multiplied to the testing means in such order as to divide the lane time approximately equally among the busy channels at all times.

10. A multichannel signalling system comprising a lane of traffic, a plurality of transmitters associated therewith, a plurality of receivers, one for each transmitter, responsive to signals transmitted by the transmitters over the lane of traffic, sending and receiving selectors, groups of transfer relays controlled by the respective selectors to connect the transmitters and receivers to the lane of traffic, and means associated with said selectors whereby upon selection of an idle transmitter another busy transmitter and its corresponding receiver are operatively connected to the lane of traffic.

11. A variable channel signalling system for operating over a multiplex circuit, said circuit comprising a sending distributor and a receiving distributor connected to the terminals of a lane of traffic, N storage transmitters, N receivers, sending and receiving selectors each characterized by factorial N contacts and operable in timed relation with said sending and receiving distributors for selectively associating said transmitters and said receivers with said lane, the contacts of said selectors being interconnected with said transmitters and said receivers in a manner to divide the lane time substantially equally among the operative transmitters and receivers, two groups of transfer relays each with interconnecting contacts, the one connected to and operated by said sending selector and the other connected to and operated by said receiving selector, the one of said groups for connecting said transmitters to said sending distributor and the other of said groups for connecting said receivers to said receiving distributor, and sending control relays and receiving control relays with contacts positioned according to the amount of said character storage for their associated transmitters to open or close the operating circuits between said transfer relays and said sending and receiving distributors.

12. A variable channel signalling system for operation over a multiplex circuit, said circuit comprising sending and receiving distributors connected to the terminals of a lane of traffic, a plurality of storage transmitters, a plurality of receivers, one for each transmitter, sending and receiving selectors characterized by multiple contacts and operable in timed relation with said sending and receiving distributors for selectively associating said transmitters and said receivers with said lane, the contacts of said selectors being interconnected with said transmitters and said receivers in a manner to apportion the lane time approximately equally among the operative transmitters and receivers, a group of sending transfer means and a group of receiving transfer means for connecting said transmitters and said receivers with their respective distributors, means including said selector for individually establishing said connections, means including said transfer means for disestablishing said connections only upon the subsequent establishment of any other connection in the same group, sending and receiving control means, and means controlled by character storage in the transmitters for influencing said control means to determine the establishment or non-establishment of said connections according to whether said transmitters and receivers are operative or inoperative.

13. A variable channel signalling system for operation over a multiplex circuit, said circuit comprising sending and receiving distributors connected to the terminals of a lane of traffic, a plurality of tape transmitters operable over said lane, a potential receiver for each of said transmitters, tape controlled means for selectively rendering said transmitters and said receivers operative or inoperative, sending and receiving selectors characterized by multiple contacts and operable in timed relation with said sending and receiving distributors for selectively associating said transmitters and said receivers with said lane, and means cooperating with said contacts to re-assign the contacts associated with inoperative transmitters and receivers to the operative transmitter and receiver, the selector contact for which immediaely precedes said re-assigned contacts, the order of said contacts being such as to invariably effect an approximately equal division of the lane time among said operative transmitters and receivers irrespective of the number operative.

14. A variable channel signalling system for

operation over a multiplex circuit, said circuit comprising sending and receiving distributors connected to the terminals of a lane of traffic, a plurality of tape transmitters operable over said lane, a potential receiver for each of said transmitters, tape controlled means for selectively rendering said transmitters and said receivers operative or inoperative, sending and receiving selectors characterized by multiple contacts and operable in timed relation with said sending and receiving distributors for selectively associating said transmitters and said receivers with said lane, and means cooperating with said contacts to re-assign the contacts associated with inoperative transmitters and receivers to the operative transmitter and receiver, the selector contact for which immediately precedes said re-assigned contacts, the order of said contacts being such as to invariably effect a predetermined division of the lane time among said operative transmitters and receivers irrespective of the number operative.

15. In a telegraph system, a lane of traffic, a plurality of communication channels, a selecting means having a plurality of contacts to which the respective channels are multiplied in a manner to effect a predetermined division of the lane time among operative channels, means for sequentially applying to each of said contacts an operating condition for a definite period of time to connect any of the operative channels to said lane, means for effecting sustained operation of any of said operative channels over said lane until said operating condition is applied to one of said contacts connected with another operative channel, and means for substituting said other channel for said first channel.

16. In a telegraph system, a lane of traffic, a plurality of communication channels, means for selectively effecting connections between operative ones of said channels and said lane, said means including a switch having a plurality of contacts traversed by a wiper contact at a definite rate irrespective of the number of operative channels, said plurality of contacts being connected in groups to the respective channels according to a prearranged plane, means for preventing the connection of an inoperative channel to the lane while the wiper contact is traversing one of said plurality of contacts associated with the inoperative channel, and means for maintaining any of said connections until another connection is made.

17. In a multichannel telegraph system, a plurality of channels, a lane of traffic over which said channels are adapted to operate, means for controlling said channels, said means comprising a sequencing device having a plurality of positions corresponding to each of said channels, and means for continuing the operation of a previously connected operative channel when said sequencing device reaches a position corresponding to an inoperative channel, the order of said positions being such that each operative channel is afforded a predetermined portion of the lane time.

PHILO HOLCOMB, JR.
ALBERT BOGGS.

CERTIFICATE OF CORRECTION.

Patent No. 2,176,901. October 24, 1939.

PHILO HOLCOMB, JR., ET AL.

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, first column, line 75, for the reference numeral "32" read 33; page 5, second column, line 10, for "verioplex" read varioplex; line 20, claim 1, for the word "retain" read remain; page 6, first column, line 53, claim 9, for "multiplied" read multipled; and second column, line 69, claim 13, for "immediaely" read immediately; page 7, first column, line 26, claim 15, for "multiplied" read multipled; and second column, line 13, claim 16, for "plane" read plan; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 16th day of January, A. D. 1940.

Henry Van Arsdale,
Acting Commissioner of Patents.

(Seal)

operation over a multiplex circuit, said circuit comprising sending and receiving distributors connected to the terminals of a lane of traffic, a plurality of tape transmitters operable over said lane, a potential receiver for each of said transmitters, tape controlled means for selectively rendering said transmitters and said receivers operative or inoperative, sending and receiving selectors characterized by multiple contacts and operable in timed relation with said sending and receiving distributors for selectively associating said transmitters and said receivers with said lane, and means cooperating with said contacts to re-assign the contacts associated with inoperative transmitters and receivers to the operative transmitter and receiver, the selector contact for which immediately precedes said re-assigned contacts, the order of said contacts being such as to invariably effect a predetermined division of the lane time among said operative transmitters and receivers irrespective of the number operative.

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17. In a multichannel telegraph system, a plurality of channels, a lane of traffic over which said channels are adapted to operate, means for controlling said channels, said means comprising a sequencing device having a plurality of positions corresponding to each of said channels, and means for continuing the operation of a previously connected operative channel when said sequencing device reaches a position corresponding to an inoperative channel, the order of said positions being such that each operative channel is afforded a predetermined portion of the lane time.

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