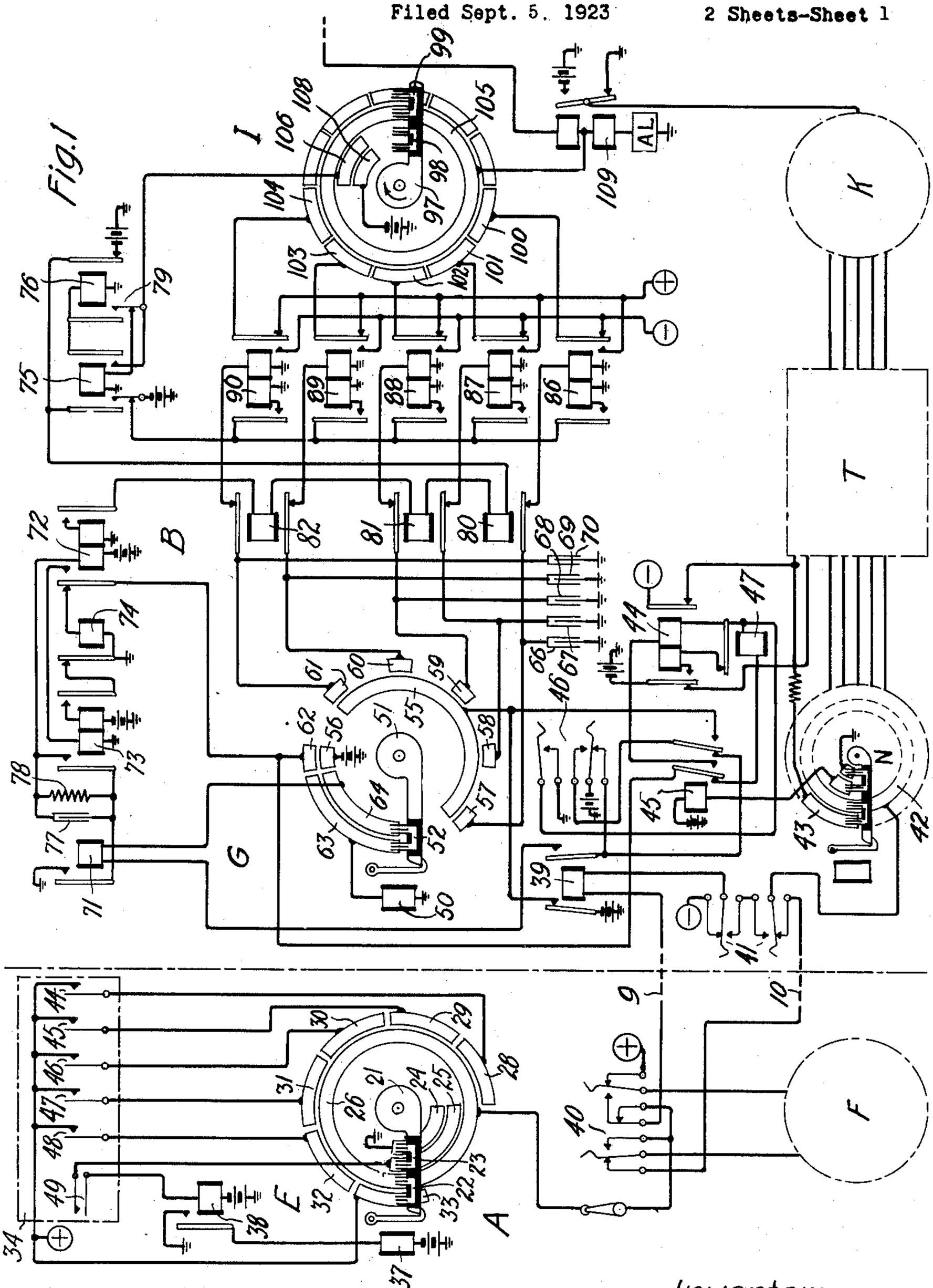
Sept. 30, 1924. 1,509,886

G. S. VERNAM

PRINTING TELEGRAPH SYSTEM

Filed Sept. 5, 1923 2 Sheets-Sheet 1

Fig. 1



Inventor:
Gilbert S Vernam
by Atty

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Filed Sept. 5, 1923 2 Sheets-Sheet 2

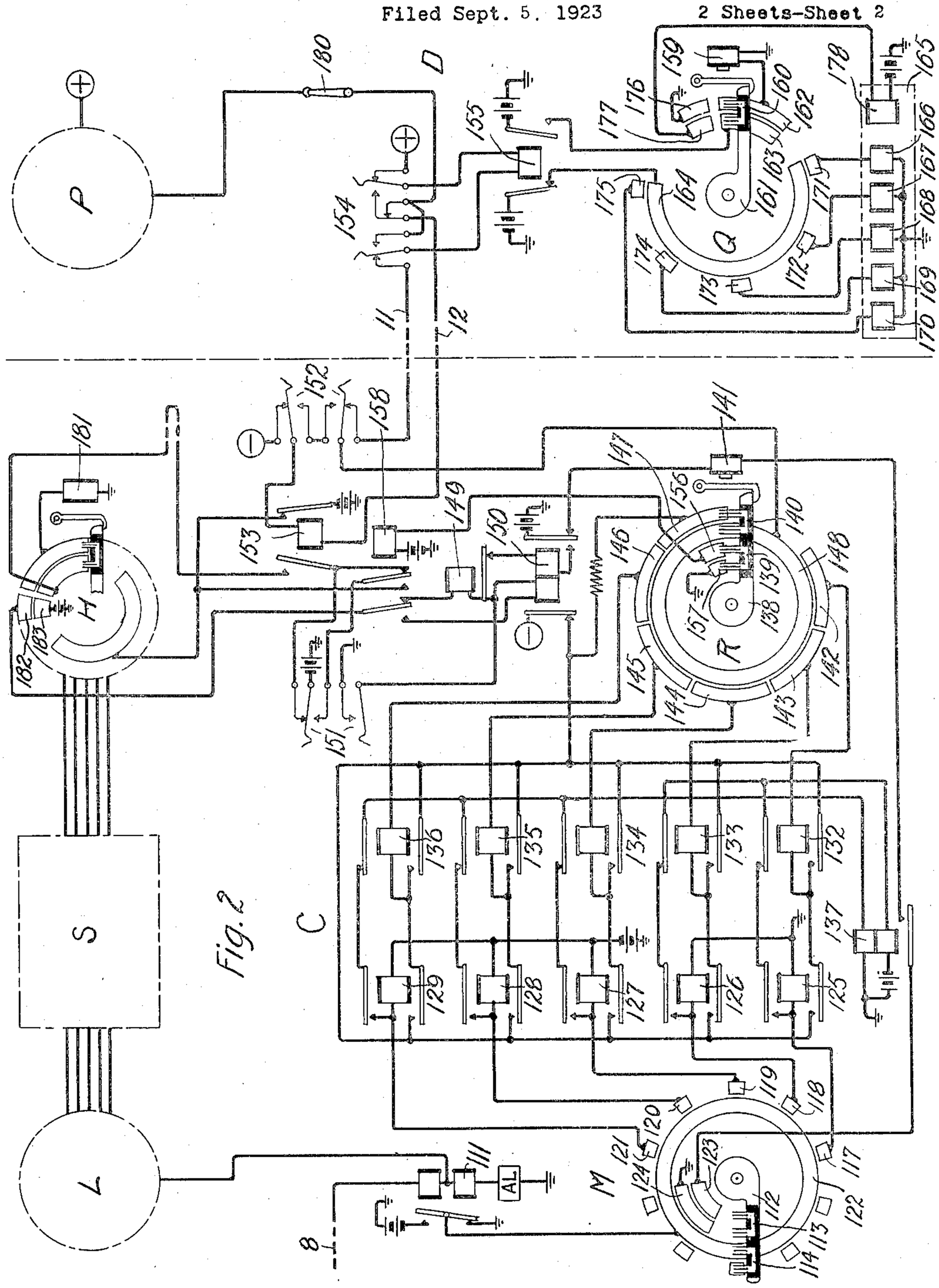

Fig. 2

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Patented Sept. 30, 1924. 1,509,886

UNITED STATES PATENT OFFICE.

GILBERT S. VERNAM, OF BROOKLYN, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

PRINTING-TELEGRAPH SYSTEM.

Application filed September 5, 1923. Serial No. 661,069.

To all whom it may concern:

Be it known that I, GILBERT S. VERNAM, residing at Brooklyn, in the county of Kings and State of New York, have invented certain Improvements in Printing-Telegraph Systems, of which the following is a specification.

This invention relates to telegraph systems.

An object of the invention is the provision in a system providing full duplex operation of means whereby the system may be readily and expeditiously changed from full duplex to half duplex and vice versa.

In accordance with the preferred form, the invention contemplates the provision of a plurality of main or central stations interconnected by a line conductor, and at which duplex equipment and switching means are located for converting the system from either full duplex to half duplex and vice versa between the stations. Specifically, the invention provides a plurality of central stations interconnected by a line conductor and at which duplex equipment and synchronous multiplex telegraph apparatus are located, and having extension circuits extending therefrom to branch offices, which are provided with intermittently operable distributing apparatus for transmitting code combinations of message impulses to the central station, where they are automatically transferred to the duplex line conductor and vice versa. There is also provided at the branch offices and central stations switching means for changing the system from full to half duplex operation and vice versa, and for connecting the receiving apparatus at the branch office serially with the transmitting apparatus and rendering one of the signaling paths between said central station and said branch office ineffective.

The invention is illustrated in the accompanying drawings which represent one embodiment of the invention, and when arranged so that Figure 1 is to the left of Fig. 2, a complete system is shown diagrammatically.

The invention in the embodiment disclosed comprises a branch office A, which is connected with a main or central station B by an extension circuit 9, 10, a central or main station C connected with the main station B by a line conductor 8 equipped with duplex apparatus, and a distant branch office D, which like branch office A, is connected with the associated central station C by extension circuits 11 and 12.

At the branch office A there are located transmitting and receiving equipments E and F, respectively, being shown diagrammatically. The extension circuits 9 and 10 may be a pair of line conductors or a single line conductor equipped with duplex apparatus.

Both the central stations B and C are provided with receiving distributors G and H of the start-stop type to receive the code combinations of message impulses from the respective substations or branch offices and transfer them to multiplex synchronous distributors I and L, also located at the central stations B and C, respectively, through the instrumentalities of a series of condensers and storing relays. Also located at the central stations are the synchronous multiplex distributors K and M, each of which serve to receive and distribute the signaling impulses from the line conductor 8 connecting these two stations and transfer the same to the start-stop distributors N and R, respectively, through the instrumentality of storing means operative in conjunction with a series of loop controlled relays, which, according to the present invention, provide an overlap between the selections received on the synchronous multiplex distributor and those transmitted to the extension circuits by the start-stop distributor associated therewith. It is to be noted that a system is provided in which it is capable of operating a number of channels.

Branch office D, like branch office A, is provided with a transmitting distributor P and a receiving distributor Q, which serve their respective purposes. For the sake of clarifying and simplifying the drawings, the apparatus common to one channel has been shown in detail, while that individual to the other channel has been shown schematically.

The transmitting equipment E comprises an intermittently rotary distributor having a brush arm 21, which carries a pair of brushes 22 and 23, which in turn are arranged to make contact with the segments forming concentrically arranged rings. The outer ring is divided into a plurality of segments 28, 29, 30, 31, 32 and 33, which are

connected with the respective contacts of a transmitter shown diagrammatically at 34. In order that the brush arm 21 will be stopped and released once per revolution, a release magnet 37 is provided, which is under the control of a starting relay 38, being connected to a common contact associated with the transmitter 34. The transmitter 34 consists of a plurality of movable contacts 44, 45, 46, 47 and 48, which are connected to the respective segments forming the outer ring of the distributor. Also associated with the transmitter 34 is a common contact 49, which as previously stated, controls the energization of the start relay 38. Although the transmitter 34 has been shown diagrammatically as a keyboard transmitter. any well known type of transmitter may be substituted therefor and still provide equally good results.

At the central station B there is shown a receiving distributor G of the start-stop type and a synchronously operated distributor I, which has its continuous ring 105 connected to the apex of the ratio arms, which includes the receiving relay 109 forming a part of the duplex equipment associated with the line conductor 8. The line relay 109 responds only to incoming impulses, and is non-responsive to outgoing impulses. Upon the operation of the multiplex distributor I, this relay will not respond to the impulses which may be transferred thereby from the start-stop distributor G.

The start-stop distributor G comprises an outer and an inner ring. Forming a part of the outer ring is a plurality of segments 57, 58, 59, 60, 61, 62 and 63, the first five of which correspond to respective ones of the segments forming a part of the outer ring of the start-stop distributor at office A. By the proper orientation of these segments, and inasmuch as they are smaller than the transmitting segments of the transmitting distributor, the central portion of the signaling impulses transmitted over the extension circuits 9 and 10 to the line relay 39 will be picked up for each segment of the sending face of the distributor at the branch office A. The distributor G also comprises brush arm 51 carrying brush 52, the brush arm being held against rotation by a release latch under the control of release magnet 50.

Interposed between the start-stop distributor G and the synchronous multiplex distributor I is a set of condensers in combination with a single group of storing relays operable in accordance with the signal transmitted; and controlled by a series of transfer relays under the control of both the start-stop distributor G and the multiplex distributor I. The set of condensers and the single group of storing relays serve to provide a complete overlap between the selection received from the start-stop distributor G and those transmitted over the line 8 by the multiplex distributor I, so that the signals will be correctly transmitted over line 8 irrespective of what the phase relation is between the brush arm of the start-stop distributor G and the brush arm of the multiplex distributor I, provided, of course, that the mean speed of the brush arm of the start-stop distributor is equal to or slightly less than that of the brush arm of the multiplex distributor I. The condensers 66 to 70, inclusive, are connected directly to the receiving segments forming the outer ring of the start-stop distributor G and will be charged in accordance with the operation of line relay 39. During certain periods of operation, however, the impulses received on the segments 57 to 61, inclusive, will be transferred directly through the armatures and contacts of transfer relays 80, 81 and 82 to the right-hand windings of the set of storing relays 86 to 90, inclusive, as will be more clearly described hereinafter. The energization ~~of~~ the transfer relays 80, 81 and 82 is controlled jointly by the start-stop distributor G and the multiplex distributor I so that no mutilation or piling up of the signaling impulses will result should one distributor be out of phase with respect to the other. Upon the energization of the storing relays 86 to 90, inclusive, a locking circuit is established therefor which is under the control of the multiplex distributor I, and which will be released once per revolution thereof. After a set of impulses has been transmitted from the distributor G to the condensers 66 to 70, inclusive, and upon the release of the transfer relays 80, 81 and 82, a discharge circuit is established for these condensers extending to the right-hand winding of corresponding ones of the storing relays 86 to 90, which thereupon attract their armatures and establish their own locking circuit. These relays will be locked up through their own contacts and left-hand windings. Thus, after their initial energization they are maintained energized independent of the condensers 66 to 70. It is through the contacts of relays 86 to 90 that the polarity of the impulses corresponding to the various characters is varied.

In order that the impulses may be transferred from the respective parts of the circuit so that no mutilation of the signals will result, such transfer is under the joint control of the start-stop distributor G and the synchronous multiplex distributor I, as will be more clearly described hereinafter.

Also located at the central station B is a pair of multiple contact switches 41 and 46, which when operated serve to change the system from full duplex to half duplex and vice versa. At the branch office A there is also shown a multiple contact switch 40, which when operated to correspond with the

position of the switches 41 and 46 at the central station B, serves to connect the receiving equipment F directly with the contacts of the transmitting distributor at that station and disconnects one of the extension circuits extending from the branch office A to the central station B, whereby the impulses transmitted by the transmitting distributor will be recorded on the receiving printer associated with this distributor for providing a home record.

The apparatus just described constitutes the equipment included at the central station B, which serves to transmit impulses from the branch office A to the line conductor 8 and thence to the central station C, from whence the message impulses are transmitted to the distant branch office.

The apparatus at the central station C, which receives the signals transmitted from the transmitting apparatus located at the central station B, comprises a multiplex distributor M and a distributor of the start-stop type R. The multiplex distributor M comprises among other parts a continuous ring 122 and an outer ring which is divided into a plurality of segments, such as 117, and 121. Like the distributor I, a continuously revolving brush arm 112 carrying brushes 113 and 114 is also provided. Connected to the segments forming a part of the outer ring are the windings of a set of storing relays 125 to 129, which, in combination with a series of control relays 132 to 136, inclusive, provide an overlap between the selections received on the multiplex distributor M and those transmitted over the extension circuits 11 and 12 by the start-stop distributor R.

The start-stop distributor R comprises an outer ring divided into a plurality of segments 142 to 147. The first five of these segments are connected to the windings of the control relays 132 to 136, which are energized upon the passage of the brush 140 over the segments individual thereto, depending upon whether the relays 125 to 129 are at this time energized. The control relays 132 to 136 will remain energized until the brush 140 has passed off the segments to which they are connected due to the establishment of a locking circuit therefor through their own contacts. For bridging the outer ring of the distributor R with the inner ring 148, the brush 140 is carried by a brush arm 138, which is normally held against rotation by a release latch under the control of a release magnet 141. The release magnet 141 is controlled through the contacts of a control relay 137, the energizing circuit of which is completed upon the energization of any one of the relays 125 to 129, inclusive.

The receiving equipment Q at the branch office D comprises the receiving printer diagrammatically shown at 165, which comprises the usual selecting magnets 166 to 170 and the printing magnet 178. The respective magnets have their windings connected to segments 171 to 175 forming a part of the outer ring of the receiving distributor. This distributor, like the distributor G, has a brush arm 161 carrying a brush 160, which is arranged to bridge the segments forming a part of the outer ring with the segments 163, 164 and 177 for controlling the energization of the respective ones of the selecting magnets depending upon the energization of line relay 155.

It is also to be noted that switches similar to those described at the central station B and the branch office A are also located at the central station C and the branch office D, which cooperate with those at the previous stations mentioned for changing the system from full duplex to half duplex and vice versa.

Inasmuch as the apparatus associated with the other channel of the system is identical with the equipment just described, further description thereof is considered unnecessary here. The rectangles designated by the characters S and T represent the equipment similar to that intermediate of the distributors G and I and M and R, respectively, which as previously described, are shown diagrammatically for the sake or clarifying the drawings. Since the operations incident to the selection and transmission of a particular character when the system is operating full duplex are identical with that described in my copending application, Serial No. 528,763, filed January 12, 1922, a description of the operation of the system when so operating is not believed to be necessary here. The following description therefore will be confined to the operation of the system incident to the transmission of a particular character when the system is arranged for half duplex operation.

When it is desired to operate the system shown half duplex, it is necessary that the switch 40 at branch office A and the switches 41 and 46 at branch office B be thrown to a position opposite to that shown in the drawings. Likewise, at the central station C the switches 151 and 152 and the switch 154 at branch office D must be thrown to their reverse position. When the switch 40 at branch office A is thrown to its reverse position, the continuous ring of the transmitting distributor is connected directly through the contacts of this switch to the receiving relay of the receiving distributor thereat, and the line conductor 10 extending to the central station B is disconnected and rendered ineffective. The line conductor 9, which is also connected through the contacts of the switch 40, continues to be connected with the conductor extending from the continuous ring 26 of the transmitting distributor. It is

thus seen that the impulses transmitted through the action of the transmitting distributor will not only be impressed on the line conductor 9 but will also be distributed by the receiving distributor at F to the receiving printer associated therewith for providing a home record of the messages transmitted through the action of the transmitting equipment E. The connections at the branch office D upon the throwing of the switch 154 are identical with those described in connection with the corresponding switch at branch office A.

The operation of the equipment previously described with the switches at the several stations in the position noted is as follows. Assume for the sake of clearness that the branch office A desires to communicate with the branch office D, in which case the transmitter 34 will be operated to set up a particular combination, depending upon the message desired to be transmitted. Let it also be assumed that it is desired to transmit a character in which the contacts 44, 46 and 48 are actuated for closing their respective contacts.

Upon the operation of the transmitter 34, contact 49 will be closed for causing the energization of start relay 38. which controls through its contact the energization of release magnet 37. The release magnet 37 upon being energized withdraws its release latch and permits the brush arm 21 to revolve, whereupon the brush 22 consecutively completes circuits extending from the segments 28 to 32, inclusive, and the contacts of the transmitter 34 which have been operated, through the winding of the line relay 39 located at the central station B. Accordingly, impulses will be transmitted to the central station B in accordance with the operation of the contacts 44, 46 and 48 of the transmitter 34. Following the release of the brush arm 21, the brush 22 passes over an open segment, whereupon the circuit of line relay 39, which is normally energized, is broken, and which thereupon releases its armature. It is to be noted also that the passage of the brush 22 over an open segment in addition to effecting the release of the line relay 39, causes the release of the receiving distributor. Line relay 39 having released its armatures, an energizing circuit for the release magnet 50 of the start-stop distributor G is established over a circuit extending from battery through the switch blade and the middle lower contact of switch 46, outermost armature and contact of control relay 45, right-hand armature and contact of line relay 39, winding of impulse relay 71, segment 64, brush 52, segment 63 and the winding of release magnet 50 to ground. The release magnet 50 is energized over the circuit just traced and withdraws its release latch from engagement with the brush arm 51, permitting its rotation. Relay 71 is also energized over the same circuit as the release magnet 50, and in attracting its armature causes a momentary charging of the condenser 77, which is normally short circuited by the high resistance 78, through the left-hand winding of relay 72. Relay 72 thereupon attracts its armatures, which conditions an energizing circuit for relay 73, but it is not completed until the bridging of segments 56 and 62 by the brush 52. At the right-hand armature and contact of relay 72, an energizing circuit is established for the transfer relays 80, 81 and 82 extending from ground, through the right-hand winding of relay 72, armature and contact thereof, windings of relays 80, 81 and 82 in series and the right-hand armature and contact of relay 76 to battery. Relay 72 is locked up over the circuit just traced and is maintained energized until the energization of relay 76 and the subsequent release of relay 75, as will be described later.

Upon the passage of the brush 22 over the segment 28 and since contact 44 of the transmitter 34 is now closed, the energizing circuit for line relay 39 is again established, which attracts its armatures and applies battery to the ring 55 of the distributor G. Accordingly, upon the passage of the brush 52 over the segment 57, a circuit is established, whereupon the condenser 66 is charged. The contact 45 of the transmitter 34 being open, line relay 39 again is deenergized and when the brush 52 passes over the segment 58, the condenser 67 individual to this segment will not be charged. Contacts 46 and 48 of the transmitter 34 being closed, conditions similar to those described in connection with contact 34 will be established for causing the charging of condensers 68 and 70 in accordance with the energization of relay 39 upon the passage of the brush 52 over the segments individual to each condenser. Condenser 69 will, however, not be charged for its selection owing to contact 47 of the transmitter 34 being open so that an open circuit condition is established upon the passage of the brush 52 over the segment to which this condenser is connected.

Just prior to the completion of the cycle of rotation of the brush 51 and provided relay 72 is still energized, an energizing circuit will be established for relay 73 extending from ground, through the winding of relay 73, front contact and armature of relay 72, segment 62, brush 52 and segment 56 to battery. Relay 73 is thereupon energized and locked up, which establishes at its left-hand contact a short circuit for the condenser 77. Otherwise, no effect is produced due to the energization of this relay.

If relay 72 is deenergized at the time brush 52 crosses segments 56 and 62, then relay 74 will be energized instead of relay 73. Relay

74 will open the locking circuit of relay 73, releasing it, if it had previously been energized.

The brush 98 of the multiplex distributor I in passing over segments 106 and 108 completes an energizing circuit for relay 75. Relay 75 at its left-hand contact opens the locking circuit of the relays 86 to 90, inclusive, thereby restoring to normal, any of these relays which have previously been energized, and also establishes an auxiliary locking circuit for relay 72 for preventing the release of this relay and relays 80, 81 and 82. Upon the closure of the right-hand contact of relay 75, an energizing circuit for relay 76 is established. Relay 76 in energizing locks itself up through its own left-hand contact and remains in this position until brush 98 passes off segment 106. Relay 76 opens the original energizing circuit of relay 75, which thereupon releases its armature and again conditions a locking circuit of the storing relay 86 to 90, while at the right-hand armature of relay 76 and at the left-hand armature of relay 75 the locking circuit of relay 72 is broken, thereby causing the deenergization of this relay and consequently the deenergization of transfer relays 80, 81 and 82. Upon the release of the transfer relays 80, 81 and 82, the condensers 66 to 70 are connected directly with the right-hand windings of the storing relays 86 to 90, whereupon those which have been previously charged are discharged and cause the energization of the corresponding relays. These relays will thus be energized and locked up over a circuit controlled by relay 75. Inasmuch as the condensers 67 and 69 for the particular selection chosen were not charged, no result will be produced on the relays 87 and 89 corresponding to these condensers, upon the deenergization of the transfer relays 80, 81 and 82. When brush 98 passes off segment 106, relay 76 is released, thus preparing the locking circuit for relay 72 so that the relays 80, 81 and 82 will be energized upon the subsequent operation of relay 72 during the next cycle of rotation.

If the multiplex distributor brush 98 passes over segment 106 so as to deenergize relays 80, 81 and 82 before the start-stop brush 52 has passed over segment 61, one or more of the storing relays will be operated directly on an impulse from the corresponding receiving segment. In such cases the corresponding condensers serve only to slightly prolong the current impulses through the storing relay.

When the phase relation between the brush arms 51 and 97 of the start-stop distributor G and the multiplex distributor I, respectively, is such that the brush 98 is passing over segment 106 at the time that relay 71 is energized by a starting impulse, relay 72 will be energized but it will not be locked up unless relay 76 releases to establish a locking circuit before the cessation of the brief impulse through its left-hand winding allows relay 72 to release and open the locking circuit at its right-hand contact. If relay 72 fails to lock up, relay 80, 81 and 82 will not be energized and the signal selection will be transferred directly from the start-stop distributor G to the storing relays 86 to 90. If during the succeeding revolution the multiplex brush arm 97, which runs at a slightly higher average speed than brush arm 51, has gained sufficiently so that relay 76 can release in time to lock up relay 72, relays 80, 81 and 82 will be energized and the signal selection will be stored on the condensers to be transferred later to the storing relays in the manner previously described. In such a case relay 72 will remain operated for nearly a complete revolution of the brush arms with the result that relay 73 will be energized and locked up when brush 52 crosses segments 56 and 62. The left-hand armature and contact of relay 73 will short circuit condenser 76, thus prolonging the next operating impulse to the left-hand winding of relay 72 to insure that it will remain operated until its locking circuit is established at the right-hand contact of relay 76.

When the brush arm 97 has advanced in phase relation to the start-stop brush arm 51 to an extent such that relay 72 is released when brush 52 crosses segments 56 and 62, an energizing circuit is established for relay 74, which, as previously described, controls the locking circuit of relay 73. Relay 74 in energizing merely opens the locking circuit for relay 73, which is then restored to normal for removing the short-circuit from about condenser 76. Thus, upon engagement of brush 52 with segments 63 and 64, a condition similar to that described for the initial operation of the system will be brought about, that is, the condenser 77 will be charged and a momentary surge of current through the winding of relay 72 produced for causing the energization and locking of this relay.

Upon the passage of the brush 99 over the respective ones of the segments with which the relays 86 to 90 are connected, a polarity of battery depending upon the position of the armature of these relays will be applied to the apex of the ratio arms, in which one end of the line conductor 8 terminates, and which includes the windings of line relay 109. The brush 99 in passing over segment 100, to which the armature of storing relay 86 is connected, impresses on the line conductor 8 an impulse of a positive polarity, which passes over the line and through the windings of line relay 111 for causing the reversal of its armature. The negative pole of the battery associated with the contacts of

this relay is thereupon connected with the continuous ring 122 of the multiplex distributor M so that upon the passage of the brush 114 over the segment to which the storing relay 125 is connected, this relay will be energized. Relay 125 in attracting its upper armature establishes a locking circuit for itself extending from battery through the lower winding of relay 137, upper armature and contact of relay 132, upper armatuire, contact and winding of relay 125 to ground. This relay 125 will thus remain energized until the locking circuit is broken at the contact of the loop control relay 132. Relay 137, which conditions an energizing circuit for the release magnet 141 of the start-stop distributor R, is also energized over the circuit just traced. It may also be noted at this point that relay 137 is energized upon the energization of any one of the storing relays 125 to 129. As the brush arm 97 continues its rotation, conditions depending upon the position of the armatures of the storing relays 86 to 90 will be set up for causing the corresponding positioning of the armature of relay 111 at the central station C. Accordingly, upon the passage of the brush 114 over the corresponding segments, storing relays 126 to 129 will be energized in accordance with the positioning of the armature of relay 111. For the particular selection chosen, storing relays 127 and 129 will be energized over a circuit similar to that traced in connection with relay 125. The energized ones of these storing relays will also be locked up through their contacts in a similar manner. Upon the passage of the brush 114 over the segments to which the relays 126 and 128 are connected, these relays will not be energized owing to the position of the armature of relay 111 at this time.

Following the passage of the brush 99 over segment 104, the brush 98 engages segments 106 and 108, whereupon an energizing circuit is established for relay 75 for causing the energization of relay 76 and the opening of the locking circuit of the storing relays 86 to 90, which have previously been energized. Similarly, relay 75 releasing while relay 76 was operated causes the deenergization of transfer relays 80, 81 and 82 for transferring the impulses stored in the condensers 66 to 70 in accordance with the next selection to the storing relays 86 to 90.

Following the passage of the brush 114 over segment 121, brush 113 engages segments 124 and 123 and completes the energizing circuit for release magnet 141 of the distributor R. Release magnet 141 upon being energized will draw the release latch from engagement with the brush arm 138, thereby permitting its rotation. It is to be noted at this point that the control relay 158, which is normally energized, is connected to the segment 156 and is controlled by the brush 139 passing over the segments. The length of the segments 156 and 157 is such that relay 158 releases and closes its back contacts prior to the deenergization of line relay 153, which is deenergized upon the passage of the brush 140 off segment 147. Thus, the release of the start-stop distributor H is prevented as the energizing circuit of its release magnet 181 is open at the front contact of control relay 158.

The brush 140 carried by the brush arm 138 consecutively connects the segments 142 to 147 with the continuous ring 148. Thus, upon the passage of the brush 140 over the segments to which the windings of the control relays 132 to 136 are connected, these relays will be energized and locked up for a period equal to the length of the segments to which they are connected, provided the corresponding storing relay is energized. Prior to the engagement of the brush 140 with the segment 142 and upon the passage of this brush off segment 147, an open circuit condition is established whereupon line relay 153 at station C and line relay 155 at branch office D are released. No action takes place due to the release of the line relay 153 as the circuit controlled by the left-hand armature of this relay is open at the front contact of control relay 158. Relay 155 in releasing its armature establishes an energizing circuit for the release magnet 159, which may be traced from battery, through the right-hand armature and back contact of relay 155, segment 163, brush 160, segment 162 and the winding of release magnet 159 to ground. The energization of the release magnet 159 frees the brush arm 161 for rotation, which is then rotated, causing the engagement of the brush 160 with the segments to which the selecting magnets 166 to 170 of the receiving printer 165 are connected.

The brush 140 in passing over segment 142 causes the transmission of a closed circuit condition since the storing relay 125 for the particular selection chosen is energized. The transmission of this closed circuit condition causes the energization of line relay 155 at office D, and since this condition occurs at the time brush 160 is passing over segment 171, selecting magnet 166 will be energized for performing its particular function. The brush 140 in passing over segment 143, and inasmuch as the storing relay 126 is not energized, the control relay 133 will also not be energized and thus an open circuit condition will be transmitted to the line relay 155. Likewise, for this condition the selecting magnet 167 of the printer will not be energized upon the passage of the brush 160 over the segment 172 to which its selecting magnet is connected.

A condition similar to that just described for selecting magnet 166 will be established upon the brush 160 passing over the segments 173 and 175 for causing the energization of the corresponding selecting magnets 168 and 170. However, since the storing relay 128 is not energized for this selection, no effect will be produced on the selecting magnet 169 upon the passage of the brush 160 over the segment 174 to which it is connected.

Upon the passage of the brush 160 off segment 175, this brush bridges segments 176 and 177 for establishing the energizing circuit for the magnet 178. Thus, the signals transmitted from the branch office A will be recorded on the receiving printer 165 at the branch office D over one channel of the line conductor 8 equipped for duplex operation, but when the switches at the respective stations are thrown to the position previously noted, the apparatus individual to the other channel is disabled, whereupon no signals are transmitted over this channel and the system thus acts as a half duplex system.

Upon the passage of the brush 113 off segments 124 and 123, the energizing circuit of release magnet 141 is broken, thereby causing the deenergization of this magnet and the restoration of its release latch to normal for causing the stoppage of the brush arm 138 after it has completed one cycle of rotation.

It is apparent from the previous description that the present invention provides switching means whereby the system may be readily and expeditiously changed from full duplex to half duplex operation and vice versa, and enables the use of a single line conductor between the branch offices and the central stations, and still permits the recordation of the impulses transmitted from each of the individual stations. In this way a home record is provided of all messages transmitted from the respective stations.

In the event that the operator at branch office D desires to interrupt the transmission of the operator at branch office A, it only becomes necessary for such operator to actuate break key 180. Assuming that a message is being received as previously described, the operation of the break key 180 holds the extension circuit open to break or interrupt the distant sending station. When the brush 139 of distributor R passes on to segments 156 and 157, control relay 158 will be operated momentarily and it will connect the circuit of the release magnet 181 to negative battery through the back contact of line relay 153, thus starting the brush arm of distributor H. The brush arm 138 of the distributor R will again be set in rotation as the break relay 150 is deenergized and the circuit of the release magnet 141 is completed through the front contact of the relay 137. This will cause the release of the control relay 158, thus connecting the common segment of the distributor H to negative battery and operating all five of the storing relays represented by S to send out the letter signals.

When the brush of the distributor H passes over segments 182 and 183 a circuit is completed for the break relay 150. This relay opens the extension circuit, establishes a holding circuit through a back contact on the break release relay and at the same time opens the starting circuit for the release magnet 141 associated with the distributor R. Inasmuch as the extension circuit is now open the energizing circuit of the release magnet 181 of the distributor H is again completed when the brush 139 of the distributor R passes on to segments 156 and 157. During this second revolution, an idle signal is sent over the line as the line relay 153 is released and the control relay 158 is operated. The brush of the distributor H in crossing over segments 182 and 183 completes an energizing circuit for break release relay 149. This relay operates and opens the locking circuit of the break relay 150, restoring the circuit of the release magnet 141 to normal.

When the break relay releases, the above operations will be repeated unless the operator has released the break key 180 in the meantime. If the break key has been released, the extension circuit will be closed as soon as the break relay 150 releases, as described above. If the distant station has now stopped sending, no further selections will be received and the brush arm of the distributor R will stop, operating the control relay and restoring the circuit to its normal condition. The former receiving station or the branch office D may now commence sending.

The effect of this break operation at the other end of the line will now be described. At this station signals are being transmitted from the branch office A and the receiving brush arm 51 will be rotating, but the sending brush arm of the distributor N will be normally at rest. The control relay 45 will be energized and this will prevent the operation of the break relay 44.

When the letter signal referred to above is received, all five of the selecting relays, as shown between the distributors M and R (Fig. 2), will be operated and the starting circuit for the release magnet and the distributor N will be closed through the local segments on the multiplex distributor K. When this brush arm starts, the control relay 45 will release and this will prepare a circuit for operating the break relay 44. When the brush 52 of the distributor G crosses segments 56 and 62, a circuit is completed for the break relay 44 which will

operate and lock itself, open the extension circuit and open the circuit of the release magnet of distributor N.

The control relay 45 being released, the brush arm 51 of the distributor G will stop against its release latch for a brief interval. This control relay will operate when the brush of the distributor N crosses over the segments corresponding to segments 156 and 157 of the distributor R, and this will start the brush arm 51 of the distributor G again. Brush 52 on again crossing segments 56 and 62 causes the energization of break release relay 47, which, as previously described for break release relay 149, causes the de-energization of break relay 44.

The operation of the break relay 44, as described above, will hold the extension circuit open for slightly more than the time of one revolution of the brush arm. This will break the substation in the same manner as when operated over a start-stop circuit, thus stopping transmission from that station.

Although the invention has been disclosed and described with reference to a particular type of system, it is obvious that various modifications may be made without departing from the spirit and scope of the present invention.

What is claimed is:

1. In a telegraph system, a plurality of stations interconnected by a line conductor, duplex equipment located at each of said stations, distributing apparatus associated with each end of said line, extension circuits extending from said stations, transmitting and receiving equipment associated with each of said extension circuits, means at said stations for changing said system from full duplex to half duplex operation and vice versa, and means associated with the extension circuits for connecting said receiving equipment serially with said transmitting equipment.

2. In a telegraph system, a plurality of stations interconnected by a line conductor, duplex equipment located at each of said stations, distributing apparatus associated with each end of said line, extension circuits extending from said stations to branch offices provided with two signaling paths, means at said stations for changing said system from full duplex to half duplex operation and vice versa, and means at said branch offices for connecting said receiving equipment serially with the transmitting equipment thereat and rendering one of said signaling paths ineffective.

3. In a telegraph system, a plurality of main stations interconnected by a line conductor, duplex equipment located at each of said named stations, distributing and storing means associated with each end of said line, extension circuits extending from each of said main stations to branch offices providing two signaling paths, transmitting and receiving equipment associated with each of said extension circuits at said branch offices, multiple contact switches at said main stations for changing said system from full duplex to half duplex operation and vice versa, and means at said branch offices for connecting said receiving equipment serially with the transmiting equipment thereat and rendering one of said signaling paths ineffective.

4. In a telegraph system, a plurality of main stations connected by a duplex line conductor, multiplex synchronous apparatus at each of said main stations, a start-stop system extending from one of said stations to a distant station, means for transmitting code combinations of message impulses over said multiplex system, means for automatically transferring said message impulses from said multiplex system to said start-stop system, means at said start-stop system for recording said impulses, switching means for changing said system from full duplex to half duplex operation and vice versa, and means located at the branch offices for connecting said recording means serially with said transmitting means for providing a home record.

In testimony whereof, I have signed my name to this specification this 4th day of September, 1923.

GILBERT S. VERNAM.