April 21, 1925. 1,534,661

L. M. POTTS

SYSTEM OF TELEGRAPHIC DISTRIBUTION

Filed April 7, 1920 3 Sheets-Sheet 1

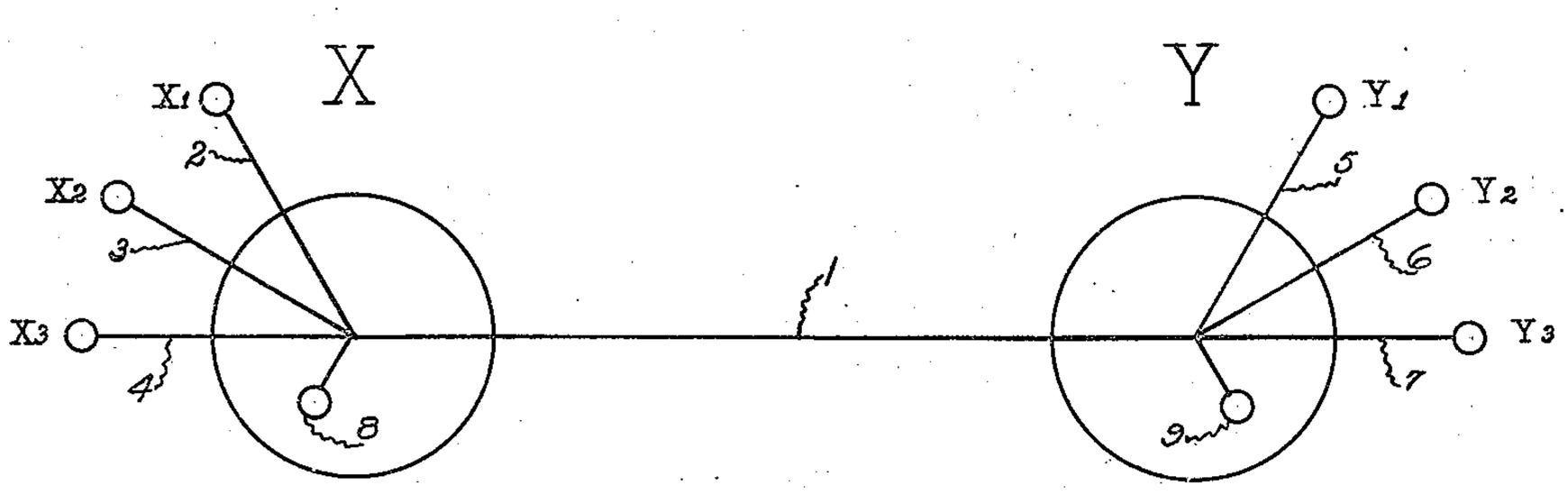

FIG. 1.

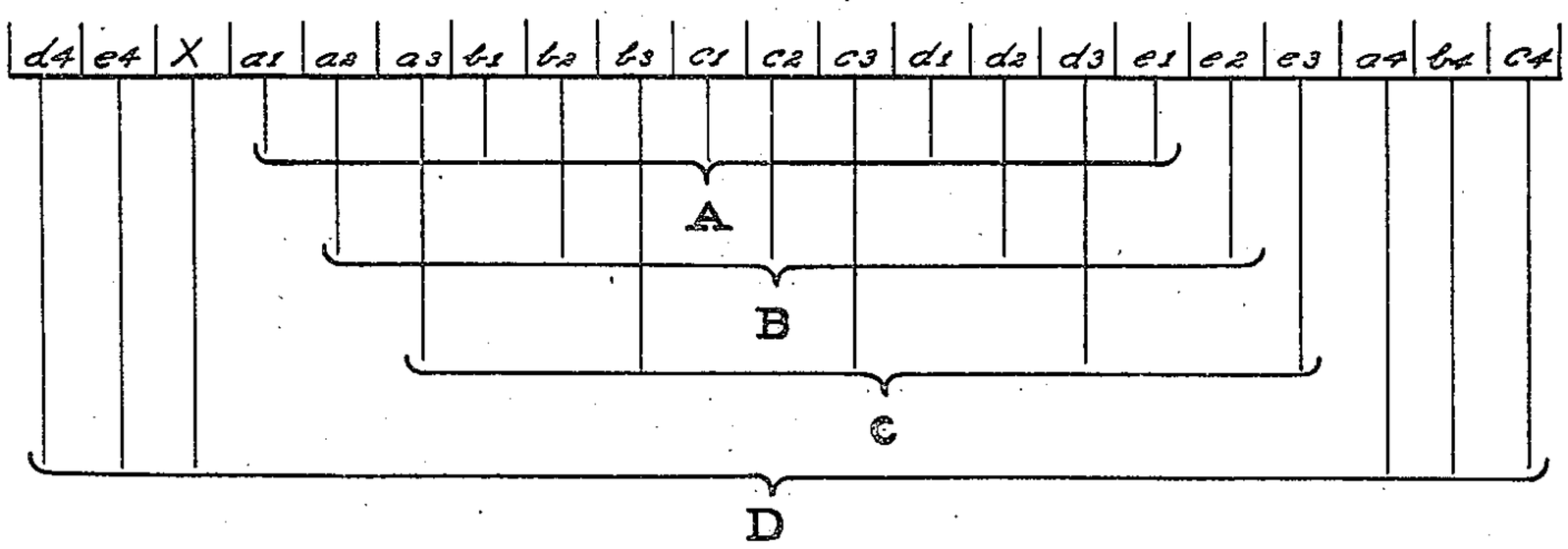

FIG. 2.

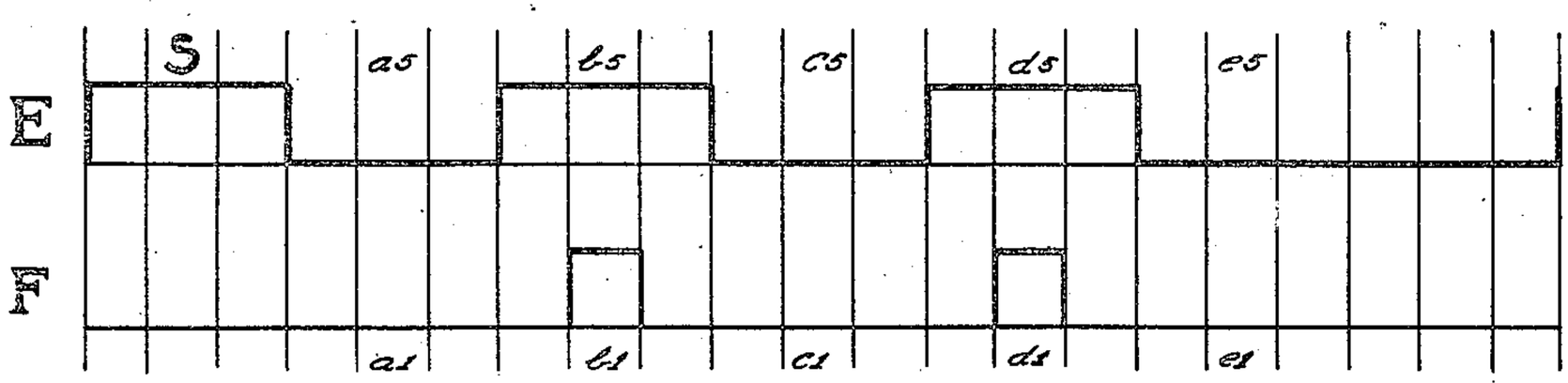

FIG. 3.

INVENTOR.
BY Louis M. Potts
Wm. L. Symons
ATTORNEY.

April 21, 1925. 1,534,661

L. M. POTTS

SYSTEM OF TELEGRAPHIC DISTRIBUTION

Filed April 7, 1920 3 Sheets-Sheet 2

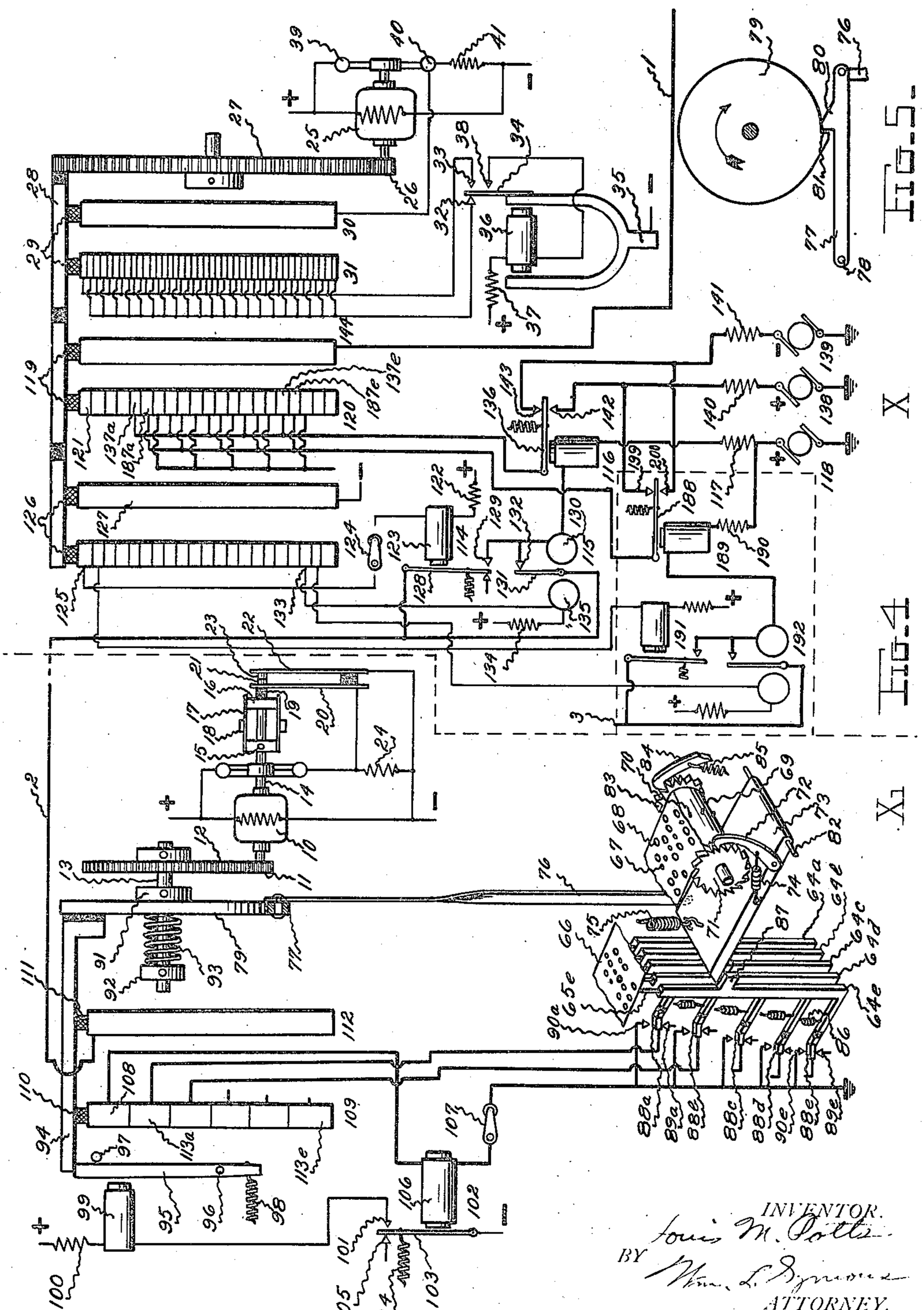

FIG-5.

FIG-4

X

X1

INVENTOR.
Louis M. Potts
BY Wm. L. Symmes
ATTORNEY.

April 21, 1925. 1,534,661

L. M. POTTS

SYSTEM OF TELEGRAPHIC DISTRIBUTION

Filed April 7, 1920 3 Sheets-Sheet 3

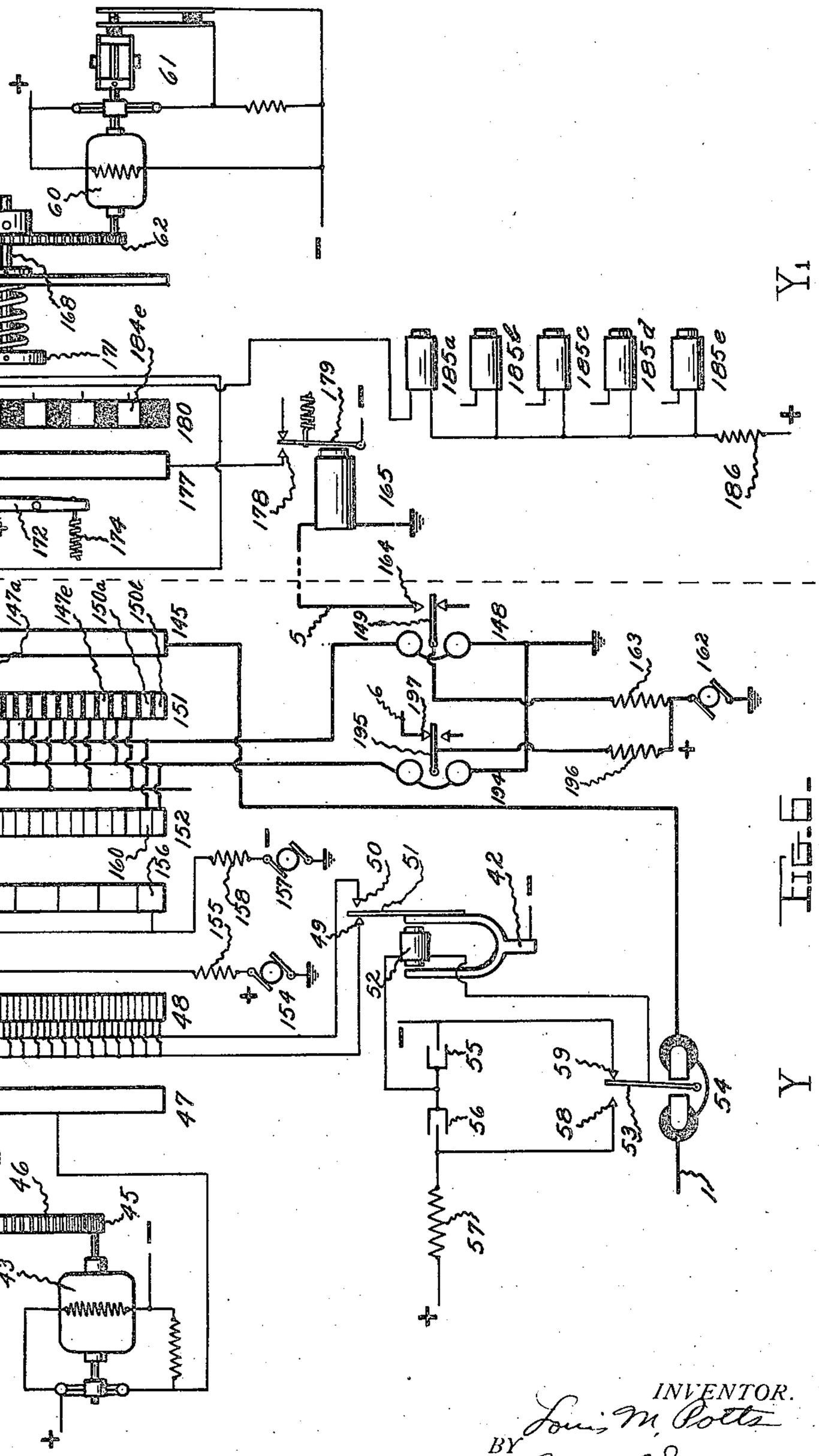

FIG. 6.

INVENTOR.
Louis M. Potts
BY
Wm. L. Symons
ATTORNEY.

Patented Apr. 21, 1925. 1,534,661

UNITED STATES PATENT OFFICE.

LOUIS M. POTTS, OF BALTIMORE, MARYLAND, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SYSTEM OF TELEGRAPHIC DISTRIBUTION.

Application filed April 7, 1920. Serial No. 371,946.

To all whom it may concern:

Be it known that I, LOUIS M. POTTS, a citizen of the United States of America, residing at Baltimore, State of Maryland, have invented certain new and useful Improvements in Systems of Telegraphic Distribution, of which the following is a specification.

This invention relates to printing telegraph systems.

An object of the invention is to provide a system whereby a plurality of telegraph messages originating at separate stations may be transmitted over a plurality of branch lines or extension circuits to a main station where the code combinations of message impulses are automatically and simultaneously transferred to a main line circuit for transmission thereover, and vice versa.

Another object is the provision of a system which is reliable and efficient in operation.

Other objects will appear hereinafter.

It is usual in a synchronous multiplex to group the segments of the different channels together. If such a multiplex is to be distributed to different users on separate wires for each channel, it is usual to provide a series of relays at central for repeating the messages. It has also been proposed to connect together segments in groups so that the segments of each group are distributed at equal intervals around the distributor. Such a method has been used to obtain a number of Morse transmissions on a wire. It is, however, not efficient since the Morse transmission has no predetermined time or phase relation to the impulses on the main line and the impulses on the main line must be shorter and closer together than would otherwise be necessary. The improvement here described enables the segments to be distributed around the distributor so that a single relay can be used for repeating each transmission and at the same time enables the method to be applied to a system using the five unit code and using only five segments on the multiplex commutator, thus efficiently adapting the method to printing telegraphs.

One class of printing telegraphs is operated from signals composed of an invariable "start" impulse followed by five code impulses and an interval separating the consecutive signals. The five code impulses being used in all combinations, so as to give thirty two signals with five elements. The "start" impulse serving to start both the sending and receiving apparatuses into operation at the beginning of each signal, means being provided to automatically stop them at the end of each signal.

The invention is here shown in connection with a system using automatic tape transmission, having one circuit operated as a four channel multiplex having another circuit operated in simplex with apparatus started into operation at the beginning of each signal and automatically stopped at the end of each signal as referred to in the preceding paragraphs, but it must be understood that the invention is not limited to any of these methods of operation.

The invention will be described by referring to the following drawings:

Fig. 1 shows two centrals and associated substations.

Fig. 2 shows the grouping of the segments.

Fig. 3 shows the impulses on the main line and branch lines.

Fig. 4 is an electrical diagram of a substation transmitting to central.

Fig. 5 shows the transmitter stepping cam.

Fig. 6 is an electrical diagram of a central sending to a substation.

The invention will be described with reference to a system having a main line 1 (see Fig. 1) connecting two central offices X and Y and operated as a four channel synchronous multiplex. Three substations X_1, X_2, and X_3 are connected to central X by wires 2, 3 and 4. Three other substations Y_1, Y_2, and Y_3 are connected to central Y by three wires 5, 6 and 7. One channel may operate apparatuses 8 and 9 local in the centrals X and Y and is useful as a check on the correctness of the operation of the main line.

The distributors for the main line have twenty one segments, and the signals on the branch line have seven time intervals, so that if every third segment is used for each transmission we will get three channels. It is proposed, however, to use only five segments for each channel, one for each element

of the code. Fig. 2 shows three groups A, B and C arranged for three channels. This leaves a group of six segments all adjacent, which can be used for another channel operated locally between the central offices. By watching the operation of the channel used in the central offices a check is furnished on the operation of the other channels. A signal on the branch line composed of the second and fourth code elements will be like the curve E in Fig. 3, while the corresponding signal on the main line will be like curve F in Fig. 3. No time is used on the main line for the start impulse or the interval between signals, these are taken care of locally between the central offices and substations as described later.

In Figure 4 all the apparatus to the left of the broken line is located at substation X_1 and represents the transmitting part of the apparatus. It is to be understood, however, that receiving apparatus may also be located at each of the substations. All the apparatus to the right of the broken line in Figure 4 represents the apparatus at the central station X. Apparatus is here shown to receive signals from substation X_1 and retransmit them to central station Y (Fig. 6). It will be also understood that in practice at station X there may be apparatus for transmitting to substation X_1 similar to the apparatus located at Y. To the left of the dotted line in Figure 6 is apparatus located at central Y to receive the signals from central X and to retransmit them to substation Y_1. It will be understood that at the station Y there may be apparatus similar to that at X to receive signals from substation Y_1 and to retransmit them to central X. To the right of the broken line in Figure 6 is shown apparatus at substation Y_1 to receive the signals transmitted from central Y. It is understood, as in the previous cases, that there may be located at Y_1 transmitting apparatus similar to that shown at substation X_1.

Speed control.

At each of the stations there is suitable automatic means for regulating the speed of the motors which drive the distributors, a method of control by a centrifugally operated contact at substations X_1 and Y_1 and a method of control by an electrically driven tuning fork at centrals X and Y is here shown and at the station Y there is shown means to correct the phase of the tuning fork with respect to the line signals and thus synchronize the apparatus at the two central stations X and Y. The distributing apparatus at the substations X_1 and Y_1 is stopped at the end of each signal and started at the beginning of each signal under the control of the apparatus at centrals X and Y, thus keeping the distributing apparatus at the substations in phase with the apparatus at the central. The method of tuning fork speed control shown is fully described in my U. S. Patent 1,201,621 and will be only briefly described here.

At substation X_1 there is a motor 10, which through gears 11 and 12 drives shaft 13, the functions of which will be later described. The shaft 14 of motor 10 carries rigidly fast thereto a sleeve 15 and a sleeve 16 adapted to slide longitudinally thereon. One or more flexible springs 17 have one end fast to sleeve 15 and the other fast to sleeve 16 and in the centre of each is rigidly fastened a weight 18. Sleeve 16 carries on the centre of its face an insulating tip 19 against which presses a spring 20 carrying on its tip a contact 21. Adjacent to spring 20 is mounted a similar spring 22 carrying a contact 23. The electrical connections are as follows: One terminal of the field and one armature brush of motor 10 are connected to the positive source of current supply (it is to be noted that all the sources of current supply at each station are connected to the same source except in the case of the signalling current). The other terminal of the field is connected direct to the negative source and the other armature brush through resistance 24 to negative. Contact 23 is connected to negative and contact 21 is tapped to the end of resistance 24, where it connects to the brush of motor 10. As motor 10 rotates and changes its speed weights 18 will move out and in slide sleeve 16 longitudinally on shaft 14 and thus open and close contacts 21—23 and open or close the shunt circuit around resistance 24 and so regulate the amount of current flowing in the armature of motor 10. By properly choosing the springs 17 and weights 18 and adjusting contacts 21 and 23 the speed of motor 10 may be made whatever is desired. The relation of the speed of motor 10 to the other apparatuses will be fully explained later.

At central X is a motor 25, which through gears 26 and 27 drives the brush arm 28 which carries two trailers 29 bearing on collecting ring 30 and a segmented ring 31 having forty two segments, twice as many as the sending and receiving rings. Alternate segments of ring 31 are connected together and are connected respectively to contacts 32 and 33 between which vibrates a tongue 34 adapted to alternately engage contacts 32 and 33. Tongue 34 is carried on one prong of a tuning fork 35. An electromagnet 36 has one terminal connected through a resistance 37 to the positive terminal of the direct current source of supply. The other terminal of magnet 36 connects to contact 38. In its normal position tongue 34 touches contact 38 and thus closes the circuit of magnet 36 and causes magnet 36 to attract the prongs of tuning fork 35

and to open the circuit of magnet 36 at contacts 34 and 38 and thus allow the prongs of tuning fork 35 to spring open again. The continued action of magnet 36 and contacts 34 and 38 will cause fork 35 to vibrate continuously. One terminal of the field and armature brush 39 of motor 25 are connected directly to the positive terminal of the current supply, the other terminal of the field is connected to negative and armature brush 40 is connected through a resistance 41 to the negative terminal of the current supply and collecting ring 30 is also connected to brush 40. It will be noted that as trailer brushes 29 pass over successive segments of segmented ring 31 and as tongue 34 alternately engages contacts 32 and 33, the resistance 41 will be shunted at rapidly recurring intervals and the motor armature will be receiving current during certain intervals only through resistance 41 and at other intervals will receive current directly from the negative source. The length of the intervals during which the resistance 41 is shunted will depend upon the phase relation between the vibration of the tuning fork 35 and the rotation of trailer brushes 29. The speed of the motor having been so regulated that it runs at approximately such a speed as to cause the trailer brush 29 to pass from one segment to another on segmented ring 31 in the interval required for the fork 35 to pass from one contact 32 to the other 33, the motor will come up to approximately the correct speed and will quickly assume such a phase position that the motor will automatically receive the correct amount of current to drive it at a speed corresponding to the rate of the tuning fork. If the motor tends to go too fast, for example, due to a rise of voltage, the length of the intervals during which the resistance 41 is short circuited will be decreased, the amount of current flowing into the motor will be decreased and the speed will be maintained. Any other tendencies to speed change will be similarly compensated for.

At the central Y there is located an electrically driven tuning fork 42, electric motor 43, trailer brushes 44 driven through gears 45 and 46 by motor 43. Trailer brushes 44 pass over collecting ring 47 and segmented ring 48. Segmented ring 48 has the same number of segments as segmented ring 31. Alternate segments of segmented ring 48 are connected to the contacts 49 and 50, which are alternately engaged by tongue 51, carried by tuning fork 42. Operating magnet 52 of tuning fork 42 has one terminal connected to vibrating tongue 53 of main line relay 54, connected in trunk line 1 and operated by the current passing over said line. The other terminal of magnet 52 is connected midway between two condensers 55 and 56, the other terminal of condenser 55 being connected to the negative supply terminal and the other terminal of condenser 56 being connected through a resistance 57 to the positive supply terminal. The last mentioned terminals of condensers 55 and 56 are also connected to contacts 58 and 59 of relay 54. When tongue 53 passes from contact 58 to 59 or vice versa due to a reversal of the line current condensers 55 and 56 are charged and discharged through magnet 52. The impulses so formed at succeeding reversals of the line current maintain the motion of fork 42 in phase with the reversals of the line current. Segmented ring 48, gears 46 and 45, and tuning fork 42 being identical with the corresponding parts at central X, trailer brushes 44 will move in synchronism with trailer brushes 29 at station X.

It is to be noted that segmented ring 48 has twice as many segments as the number of unit impulses transmitted on line 1 during one revolution of the trailer brush 44. The reason for this number of segments in ring 48 is that the tuning fork 42 must always be in the same phase position at each reversal of the line current so that the correcting impulses may always operate in the same phase of the tuning fork, as more fully explained in my Patent 1,201,621 previously referred to.

At station Y_1 there is a motor 60, centrifugal regulator 61, driving gears 62 and 63, all similar to the corresponding parts at sub-station X_1 and performing in a similar manner.

Transmission from substation.

At substation X_1 is shown an automatic transmitter controlled by perforated tape, any other method of transmission may of course be used. This method is shown as one way of carrying out the invention. The automatic transmitter comprises five slides 64^a to 64^e. The slides 64^a to 64^e carry on their upper end pins 65^a to 65^e, adapted to engage the under surface of the perforated paper strip 66. The paper strip 66 has a central row of perforations 67 called "feed holes". A series of holes 68 has previously been perforated in any suitable manner in the tape in various combinations to represent the signals to be successively transmitted and are so arranged on the tape with respect to the feed holes 67 that, as the tape is moved along step by step by a mechanism described below, the perforations 68 will successively come into alignment with the corresponding pins 65^a to 65^e. The perforated tape 66 passes over a cylinder 69 carrying a row of equally spaced pins 70, adapted to engage the "feed holes" 67. Cylinder 69 has mounted on one end a ratchet wheel 71, a pawl 72 engages ratchet wheel 71 and is pivoted to an

arm 73. Pawl 72 is pressed into engagement with ratchet 71 by spring 74 and arm 73 is held upward by a spring 75. Pivoted to arm 73 is a link 76, the other end of which is pivoted to an arm 77, which is in turn pivoted at a point 78 (see Fig. 5). Arm 77 engages the circumference of a disc 79, which carries a cam projection 81. Disc 79 is rotated intermittently by means later described. As disc 79 is rotated the high part 81 of disc 79 will engage projection 80 on arm 77, push it downward, turn arm 73 about its pivot 82 and cause pawl 72 to engage ratchet wheel 71 and advance cylinder 69 one step and thereby paper strip 66 will be advanced one step, or the distance between two succeeding groups of perforations 68. Just as disc 79 comes to rest, arm 77 will rise and with it link 76, arm 73, and pawl 72. Pawl 72 will then be allowed to engage the next tooth in ratchet 71. By the repetition of this process paper strip 66 is advanced step by step. On the opposite end of cylinder 69 is a star wheel 83, a correcting arm 84, whose wedge shaped tip is pressed by spring 85 into the notches in star wheel 83, thus insuring a positive stopping position for tape 66 so that perforations 68 will be in alignment with corresponding pins 65^a to 65^e.

Slides 64^a to 64^e are each pressed upward by individual springs 86. The slides 64^a to 64^e carry horizontal arms 87 which project under the arm 73. As arm 73 is moved up and down by the action of the disc 79, the pins 65^a to 65^e are successively moved away from the paper strip 66 and again allowed to engage with the paper under tension of springs 86. Slides 64^a to 64^e also carry arms with insulated tips 88^a to 88^e. The tips 88^a to 88^e in their downward position engage a series of stops 89^a to 89^e, and in their upward position a series of contacts 90^a to 90^e. When arm 73 rises and allows pins 65^a to 65^e to move upward, if any pin 65^a to 65^e engages a portion of the paper containing no perforation corresponding insulated tip 88^a to 88^e will remain in engagement with the corresponding lower stops 89^a to 89^e. If, however, any pin 65^a to 65^e engages a perforated portion of strip 66, the corresponding insulated tip 88^a to 88^e will engage the corresponding upper contact 90^a to 90^e. It will be noted then, that as paper strip 66 is stepped along, the insulated tips 88^a to 88^e will successively assume combinations of positions corresponding to the combinations of perforations 68 in strip 66.

Gear 12 is rigidly attached to shaft 13, Fast to shaft 13 are two collars 91 and 92, and mounted loosely on shaft 13 is disc 79. A spring 93 presses at one end against collar 92 and at the other end against disc 79, thus creating a pressure between disc 79 and collar 92, consequently as shaft 13 is continuously rotated by motor 10, disc 79 will tend to rotate. Disc 79 carries an insulated arm 94. The tip of arm 94, engages arm 95, pivoted about point 96 and normally held against stop 97 by spring 98. When arm 95 is against stop 97, arm 94 will be prevented from rotating. Arm 95, however, is adapted to be operated by a magnet 99. Magnet 99 has one terminal connected through a resistance 100 to the positive supply main. The other terminal of magnet 99 is connected to contact 101 of neutral relay 102. Tongue 103 of relay 102 is connected to negative. Spring 104 normally holds tongue 103 against stop 105. One terminal of the coil 106 is connected to ground, through a switch 107, the function of which will be described later. The other terminal of coil 106 is connected to segment 108 of segmented ring 109. Segmented ring 109 is so oriented that a trailer brush 110 stops on segment 108, when the tip of arm 95 engages arm 94. Connected to arm 94 is another trailer brush 111, adapted to engage collecting ring 112. Collecting ring 112 is connected to branch line 2. Segmented ring 109 contains six equal segments. Segments 113^a to 113^e are connected to the corresponding insulated tips 88^a to 88^e. Contacts 90^a to 90^e are all connected to ground. Line 2 passes to central and connects through relays 114 or 115 and 116 and resistance 117 to one pole of generator 118, the other terminal of which connects to ground.

The mechanical details having been described and the electrical connections traced the operation of transmitting from substation X_1 to central X will be briefly described. It will be assumed that the tip of arm 95 engages arm 94. A circuit will now be completed from the positive pole of generator 118, through resistance 117, relay 116, relays 115 or 114, line 2, as later described, collecting ring 112, trailer brush 111, arm 94, trailer brush 110, segment 108, coil 106, switch 107 to ground and back to the negative brush of generator 118. Magnet 106 will be energized, tongue 103 will engage contact 101 and thus complete a circuit from positive through resistance 100, coil 99, contact 101, tongue 103 to negative. Magnet 99 will be energized, arm 95 attracted and disengaged from the tip of arm 94. Arm 94 and trailer brushes 110 and 111 will rotate with shaft 13. As trailer brush 110 passes from segment 108 the circuit of coil 106 will be broken and thereby the circuit of magnet 99. Arm 95 will return to stop 97 under tension of spring 98, and will be in a position to stop arm 94 upon the completion of one revolution. As trailer brush 110 passes to segments 113^a to 113^e current will be transmitted to line or not depending upon whether the corresponding pins 65^a to

65e have been prevented from rising by the paper 66 or have been allowed to rise in consequence of being opposite a perforation 68. If a pin 65a to 65e is opposite a perforation a circuit will be completed as follows: from the positive terminal of generator 118, resistance 117, relay 116, relays 115 or 114, line 2, collecting ring 112, trailer brush 111, arm 94, trailer brush 110, segment 113a to 113e, insulated tips 88a to 88e, contacts 90a to 90e, to ground. If a pin 65a to 65e engages an unperforated portion of paper strip 66, the circuit will be open at contact 90a to 90e. Successive impulses will be transmitted on line 2 dependent upon the combination of perforations engaged by pins 65a to 65e. It will be observed that as arm 94 makes successive revolutions successive code signals each preceded by a "start" impulse not represented by a pin 65a to 65e will be transmitted on line 2 and relay 116 will be operated in a corresponding manner.

The connections and functions of relays 114 and 115 will now be explained. It is necessary that trailers 110 and 119 shall pass over corresponding segments of segmented rings 109 and 120 at the same time, or, in other words, that trailer brush 110 shall be started at the beginning of a signal by an impulse sent when trailer brush 119 is passing over segment 121. Relays 114 and 115 perform this function. Relay 114 is a neutral relay. Its circuit is traced as follows: positive through a resistance 122, coil 123, switch 124, segment 125, trailer brushes 126, collecting ring 127, to negative. It will be noted that by this arrangement when trailer brush 126 reaches segment 125, the above circuit will be closed and tongue 128 will make contact with contact 129, and close the line circuit through forward coil 130 of polarized relay 115, provided switch 107 at substation X_1 is closed and trailer brush 110 is on segment 108. Tongue 131 of relay 115 will then go forward and make contact with contact 132 and relay 115 being a polarized relay the line 2 will remain closed at central X until trailer brush 126 reaches segment 133. When such is the case a circuit will be closed as follows: positive supply main, resistance 134, back coil 135 of relay 115, segment 133, trailer brushes 126, collecting ring 127 to negative. Tongue 131 will be pulled away from contact 132 and the line will be again opened at contacts 131 and 132. If when trailer brush 126 reaches segment 125, the switch 124 at station X is open the relay 114 will not operate and brush arm 94 will then stop so that trailer brush 110 is on segment 108 and will not again start until switch 124 is closed and will even then not start until trailer brush 126 reaches segment 125, so that the proper relation between the rotation of trailer brushes 110 and 126 will be maintained. It is to be noted that the transmission can thus be stopped at central X without "splitting signals" since the line cannot be opened until the signal is complete.

It is to be noted that the "start" impulse and the lag interval between succeeding signals are both controlled by the sunflower device at central X and that only the code impulses are controlled by apparatus at the substation X_1.

Transmission from central X to central Y.

At central X tongue 136 of relay 116 is connected to a group of segments 137a to 137e arranged according to group A, Fig. 2. As tongue 136 vibrates under the control of the tape transmitter at substation X_1, and trailer brushes 119 rotate in step with trailer brushes 110—111, impulses like curve F, Fig. 3, will be transmitted over a circuit as follows: positive pole of generator 138 or negative pole of generator 139, resistance 140 or 141, back contact 142 or forward contact 143, tongue 136, segments 137a to 137e, trailer brushes 119, collecting ring 144, line 1, polarized relay 54, collecting ring 145, trailer brushes 146, segments 147a to 147e, polarized relay 148, to ground and return to the other pole of generators 138 or 139. Segments 147a to 147e are grouped the same as segements 137a to 137e at central X.

Attention is directed to the fact that relay 116 is actually transmitting to line 1 only during a third of the time occupied by the individual impulses on line 2. Segments 113a to 113e and segments 137a to 137e are so oriented with respect to one another that segments 137a to 137e fall in the middle of segments 113a to 113e as shown in curves E and F Fig. 3. By this arrangement relay 116 will transmit perfect signals on line 1 even though the signals actuating relay 116 from line 2 may be considerably mutilated.

Transmission from central Y to substation Y_1.

Relay 148 will receive during each revolution of trailer brushes 146 five impulses from segments grouped as shown in A Figure 2. These impulses will move tongue 149 forward or back according to the signals sent. These impulses are separated by an interval twice as long as the impulses. Relay 148 being polarized will remain in the position placed by one impulse until it receives the next impulse, so that for each of the short impulses transmitted over line 1 relay 148 will remain in a corresponding position three times the length of the short impulse or a length of time equal to the length of the original impulses transmitted over line 2. During the interval occupied by trailer brushes 146 in passing over segments 150a to 150e and 150x, corresponding to group D Figures 2, relay 148 is not controlled by im-

pulses on line 1 and distributed by segmented ring 151, but by local impulses distributed by segmented ring 152. Segment 153 is connected to the positive pole of generator 154 through resistance 155 and segment 156 is connected to the negative pole of generator 157 through resistance 158. Segments 159 and 160 are connected to relay 148 along with the segments 147^a to 147^e and together they are adapted to give to relay 148 seven impulses having equal time interval between each two succeeding impulses. Five of the seven impulses are controlled over line 1 and two locally, one of the later invariably positive and the other invariably negative. The circuit of the positive impulse, which controls the "start" impulse, may be traced as follows: positive pole of generator 154, resistance 155, segment 153, trailer brushes 161, segment 159, coils of relay 148, to ground and return. The circuit of the negative impulse, which controls the lag interval between succeeding signals may be traced as follows: negative pole of generator 157, resistance 158, segment 156, trailer brushes 161, segment 160, coils of relay 148, to ground and return.

Under the control of the seven impulses referred to in the preceding paragraph, the tongue 149 of relay 148 will vibrate like the tongue 136 of relay 116 and send an invariable start impulse followed by a combination of the five impulses corresponding to the signal sent and a lag interval after the five code impulses over a circuit which may be traced as follows: positive pole of generator 162, resistance 163, tongue 149, contact 164, line 5, coil of relay 165, to ground and return.

Reception at substation Y_1.

At station Y_1 there is a brush arm 166 fastened to a disc 167 but insulated therefrom. Disc 167 is mounted loosely on shaft 168 which is rigidly attached to gear 63. Rigidly attached to shaft 168 is a collar 169 against which disc 167 is pressed by spring 170, the other end of spring 170 presses against a collar 171 also rigidly attached to shaft 168. By this pressure friction will be maintained between disc 167 and collar 169 and as shaft 168 is driven by motor 60, there will be a tendency for arm 166 to rotate. However, arm 166 is normally prevented from rotating by arm 172, which is held against stop 173 by spring 174 and arm 166 remains at rest with a tendency to rotate except when arm 172 is moved, as explained later. Arm 166 carries trailer brushes 175 and 176. Trailer brush 175 passes over collecting ring 177 which is connected to the forward contact 178 of relay 165. The tongue 179 of relay 165 is connected to negative. Trailer brush 176 passes over segmented ring 180. Segment 181 upon which trailer brush 176 normally rests connects to one terminal of magnet 182, the other terminal of which connects through resistance 183 to positive. The remaining segments 184^a to 184^e are connected to one terminal of a series of magnets 185^a to 185^e, the other terminals of which are connected together and through resistance 186 to positive.

The operation of receiving signals at substation Y_1 will now be described. When relay 165 is operated by the start impulse on line 5 tongue 179 will engage contact 178 and will complete a circuit as follows: positive terminal, resistance 183, magnet 182, segment 181, trailer brush 176, brush arm 166, trailer brush 175, collecting ring 177, contact 178, tongue 179, to negative. Magnet 182 will thus be energized and attract arm 172 and release brush arm 166 and allow it to make a complete revolution. When trailer brush 176 reaches segment 184^a a circuit may be traced as follows, provided the signal being transmitted involves the A element: positive terminal, resistance 186, magnet 185^a, segment 184^a, trailer brush 176, and as previously described in connection with the "start" impulse. If the signal being transmitted does not contain the A element the circuit will be open and magnet 185^a will not be energized. In a similar manner the other magnets 185^b to 185^e may be operated. The magnets 185^a to 185^e may be the selecting magnets for any suitable recording mechanism. For example, they may be the selecting magnets in my U. S. Patent 1,309,745 granted July 15, 1919. The five selecting magnets being operated in all combinations so that the recording mechanism may record thirty two different signals.

So far only the operation from substation X_1 to Y_1 has been described. This only involves the group of segments A Fig. 2. The group of segments B, C and D Fig. 2 are connected together and used in a manner similar to the group A to provide communication between other substations, X_2, X_3, Y_2 and Y_3. In Fig. 4 segments 187^a to 187^e are connected together and connect to the tongue 188 of a relay 189. The coil of relay 189 is connected to a resistance 190 to generator 118. Associated with relay 189 are two relays 191 and 192 which correspond to relays 114 and 115 and perform the same function for line 3. Line 3 may connect to a transmitting device similar to the one shown at substation X_1 and described above. Relay 189 will transmit on line 1 a series of impulses for the group of segments B similar to the group transmitted for group A. At central Y there is a relay 194 which is connected to a group of segments on segmented ring 151 and segments on segmented ring 152 in the same manner as relay 148. Relay 194 is controlled by the impulses sent out by

relay 189 at central X. Tongue 195 connects through resistance 196 to positive pole of generator 162 and contact 197 connects to a line 6 which may go to a substation Y_2 and control selective apparatus there similar to the apparatus at Y_1. The segments corresponding to the group C may also be connected and operated in a similar manner. The group D may be used to operate local apparatus 8 and 9.

Attention is called to the fact that the front contact 143 of relay 116 is connected to the negative pole of generator 139 and the back contact 142 to positive pole of generator 138, while the contacts of relay 189 are reversed i. e. front contact 199 is connected to the positive pole of generator 138 and back contact 200 to negative pole of generator 139. This is done in order that there may be reversals on line 1 even where none of the channels are in operation and is essential for the purpose of maintaining synchronism between the sunflower devices at central Y and Y as explained above.

Refer to Figure 3. The curve E represents the signals on branch line 2 for a signal composed of the second and fourth elements of the code. Curve F shows the same signal on the main line. Attention is called to the fact that the impulses on the main line are one-third the length of the corresponding impulses on the branch line and that the impulses on the main line fall in the middle of the impulses on the branch line. The relay tongue 136 operates from the impulses on the branch line before the corresponding impulse is transmitted on the main line and the impulse on the main line is completed before the relay tongue operates for the next impulse on the branch line, so that any irregularities in the beginning or ending of the impulses on the branch line will not affect the main line impulses. The amount of margin is approximately the time interval of an impulse on the main line both at the beginning and end of the impulses so that the signals on the branch line may be considerably mutilated without affecting the main line signals.

Without limiting myself to the specific apparatus here shown what I claim is:

1. In a telegraphic system, a main line, and a branch line, the method of operation which consists in transmitting on said main line a series of impulses representing a plurality of characters, dividing the impulses of the several characters into groups, separating each impulse of the groups by the same number of impulses of other groups, transmitting on the branch line a group of code combinations of message impulses in accordance with the impulses on the main line, each impulse of the group immediately succeeding the preceding impulse of the same group without an appreciable time interval between the end of one impulse and the beginning of the next succeeding impulse.

2. In a telegraph system, a main line and a branch line, the method of operation which consists in transmitting on said branch line a series of groups of code combinations of message impulses, each group representing a signal, each of the impulses of a group succeeding the immediately preceding impulse without an appreciable time interval between the end of one impulse and the beginning of the next succeeding impulse, each of said groups having the same number of impulses, the impulses of each group varying in combination to represent different signals, and transmitting on said main line a group of impulses each controlled by a corresponding impulse of the said group of impulses transmitted on the branch line, succeeding impulses of the group transmitted on the main line being separated by the same number of impulses belonging to groups independent of the group controlled by impulses transmitted on said branch line.

3. In a telegraph system, a main line, synchronous multiplex telegraph apparatus operable over said main line, an extension circuit, telegraph apparatus arranged to transmit over said extension circuit a start impulse followed by code combinations of message impulses, a relay operated by all of the impulses on said extension circuit, and means including said synchronous multiplex telegraph apparatus to transmit over said main line current impulses to represent said code combinations of message impulses from contacts operated by said relay.

4. In a telegraph system, multiplex synchronous telegraph transmitting apparatus, a single transmitting relay to control the transmission of all the code combinations of message impulses for one channel of said multiplex, distantly controlled means to control said relay during the transmission of said impulses, and local means to control said relay during certain other intervals.

5. In a telegraph system, selective receiving means comprising a series of elements operated in combinations, a synchronous multiplex telegraph receiving device accommodating a plurality of channels, means to transmit code combinations of message impulses to said multiplex receiving device, an extension circuit extending between said selective receiving means and one channel of said multiplex receiving device, and a relay for each channel of said receiving device individual; to the segments in said channel for transmitting directly to the extension circuit impulses from said synchronous multiplex receiving device to affect the operation of said selective receiving device.

6. In a telegraph system, a main line, means to transmit code combinations of mes-

sage impulses on said main line, a continuously rotating sun-flower device having the segments thereof arranged in groups, a single relay connected directly to the segments in one of said groups, selective receiving means controlled by said relay in response to code combinations of message impulses, and an intermittently rotary distributor for distributing the impulses transmitted by said relay to said selective receiving means in the proper order.

7. In a telegraph system, a central station, a substation, automatic transmitting means at said substation for transmitting code combinations of message impulses, a continuously rotating sun-flower device at said central station having certain segments thereof connected in groups, a single relay connected directly to all the segments in one of said groups, a main line, means for transmitting the code combinations of message impulses from said transmitting means at the substation to said main line, timing means located at the central station for regulating the rotation of said sun-flower device, and timing means at the substation for regulating the transmitting means and so adjusted that said relay operates with a definite time relation to the speed of said sun-flower device.

8. In a telegraph system, a main line, a branch line, means to transmit impulses on said main line, a sunflower device adapted to distribute the impulses transmitted over said main line, a sunflower device adapted to distribute impulses generated locally, a relay having its coils connected to a group of segments of said first mentioned sunflower device, said coils also being connected to certain segments of said second mentioned sunflower device, and contacts operated by said coils so as to transmit on said branch line successive groups of impulses, each group representing a signal, each signal comprising an invariable part controlled by the impulses distributed by the second mentioned sunflower device and a variable part controlled by the impulses distributed by said first mentioned sunflower device.

9. In a telegraph system, a branch office, a central station, a branch line connecting said branch station to said central station, means located at the branch office to transmit over said branch line code combinations of message impulses, a relay operated by said impulses, a sunflower device, a contact operated by said relay and connected to a group of segments on said sunflower device, consecutive segments of said group being separated by the same number of segments connected to controlling means independent of said relay, the last segment of said group being separated from the first segment of said group by a larger number of segments than separates consecutive segments, said last mentioned separating segments being also connected to controlling means independent of said relay, a main line, and means including the contact of said relay and said sunflower device to transmit on said main line code combinations of message impulses corresponding to said impulses transmitted on said branch line.

10. In a telegraph system, a main line, means to transmit electric impulses on said line, a polarized relay, synchronous telegraph apparatus comprising a sunflower device adapted to distribute certain of said impulses to said relay, the coils of said relay being connected to a group of segments of said sunflower device equally spaced apart and separated by the same number of segments connected to apparatus independent of said relay, the last segment of said group being separated from the first segment by a greater number of segments than separate the consecutive segments, a local sunflower device, said coil also being connected to certain segments of said local sunflower device located so as to control said relay in the long interval between the last segment and first segment of the said group of segments on the first mentioned sunflower device, a branch line, a contact controlled by said relay and connected in said branch line, means including said contact to transmit on said branch line impulses corresponding to the impulses distributed by the first mentioned sunflower device to said relay.

In testimony whereof I affix my signature.

LOUIS M. POTTS