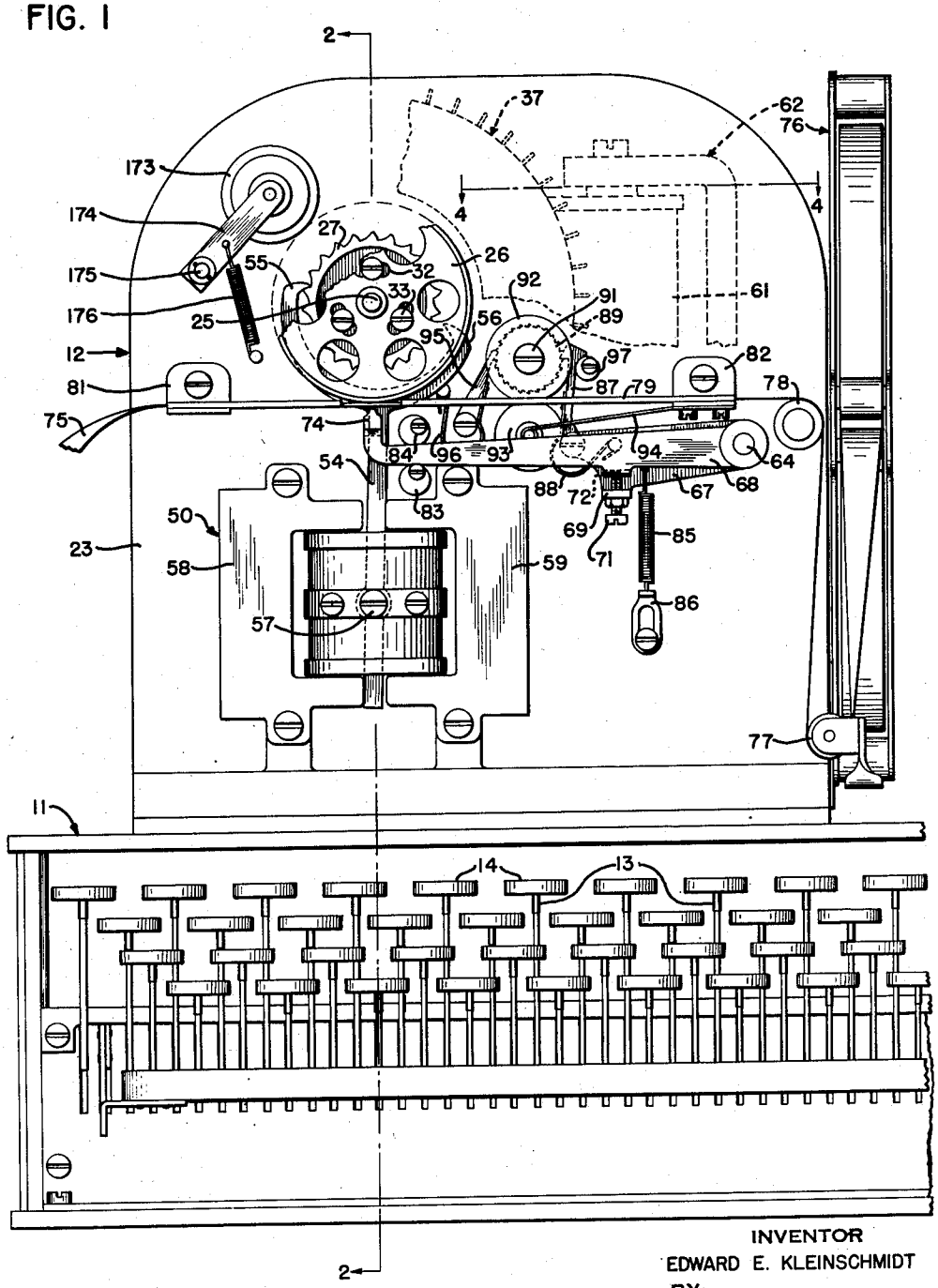
Dec. 21, 1937. E. E. KLEINSCHMIDT 2,102,899

PRINTING TELEGRAPH SYSTEM AND APPARATUS

Filed April 25, 1936 · 4 Sheets-Sheet 1

FIG. 1



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PRINTING TELEGRAPH SYSTEM AND APPARATUS

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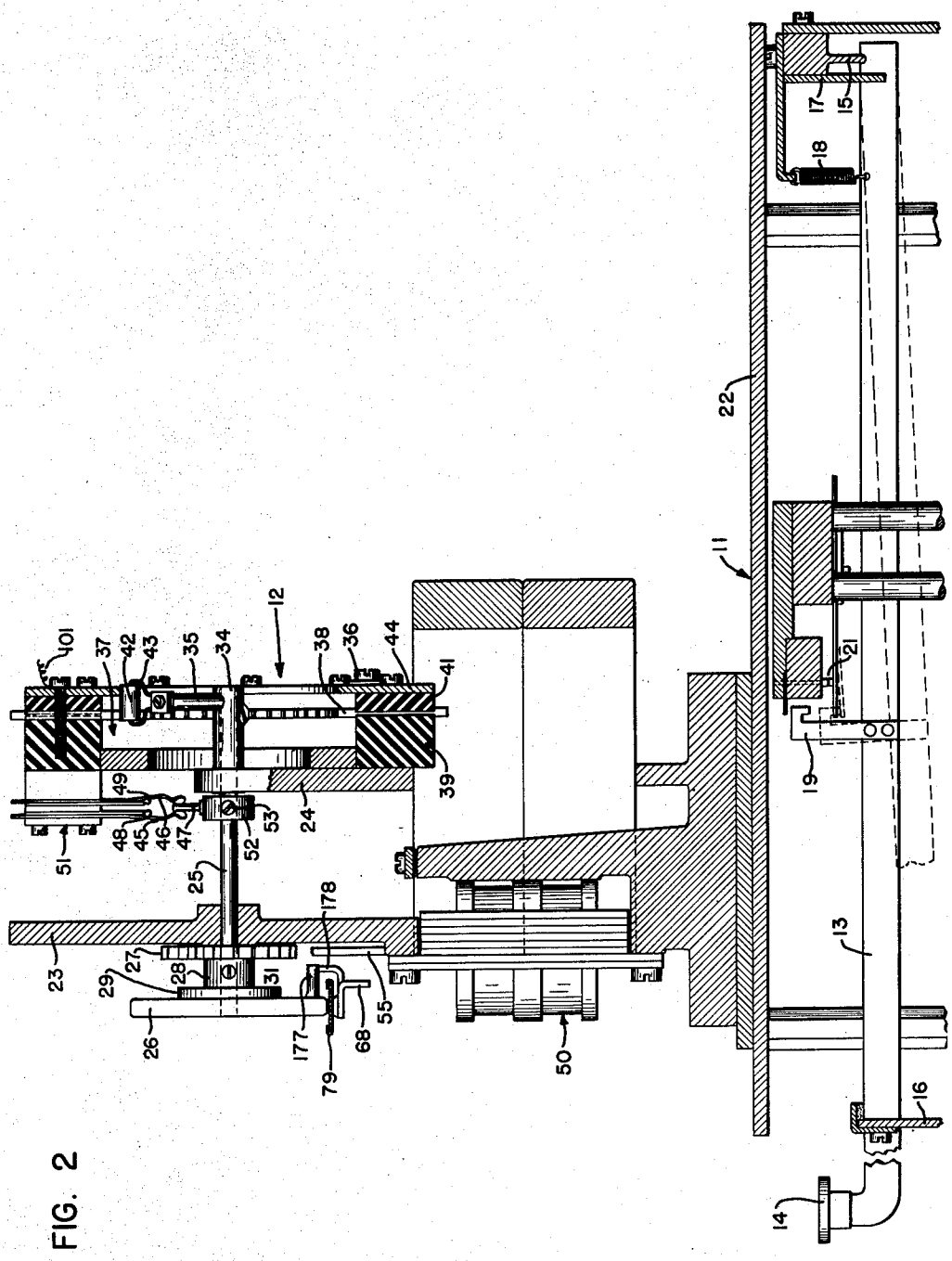


FIG. 2

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PRINTING TELEGRAPH SYSTEM AND APPARATUS

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FIG. 3

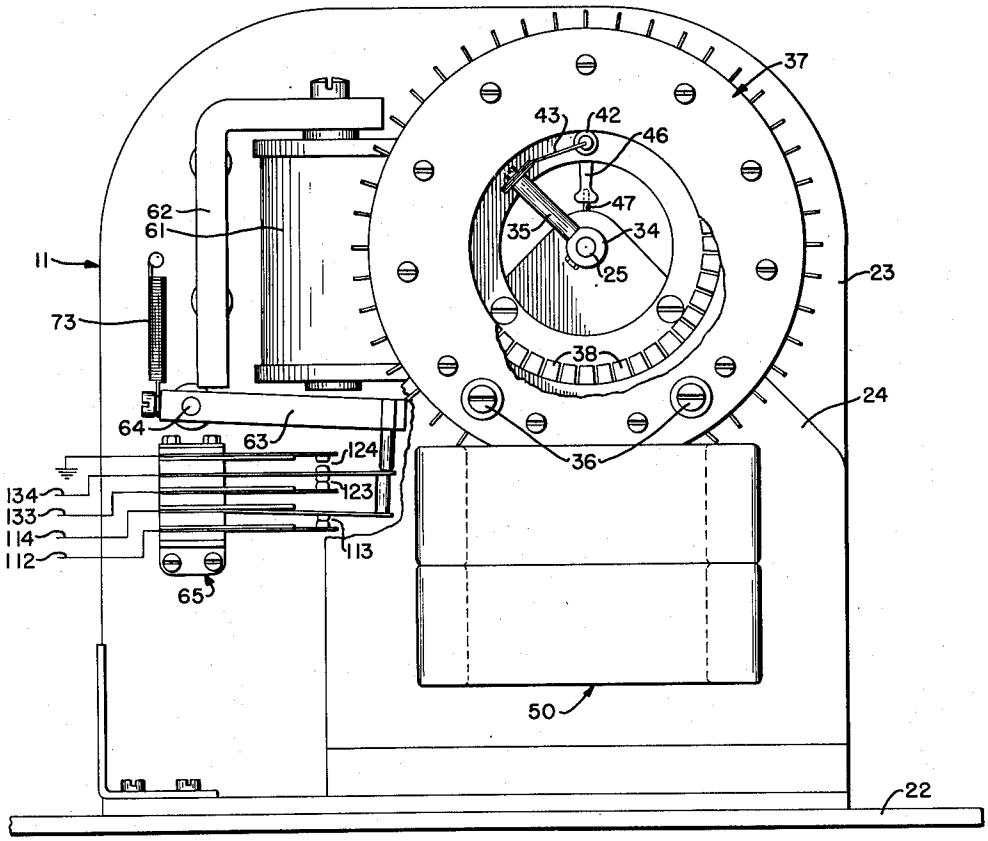
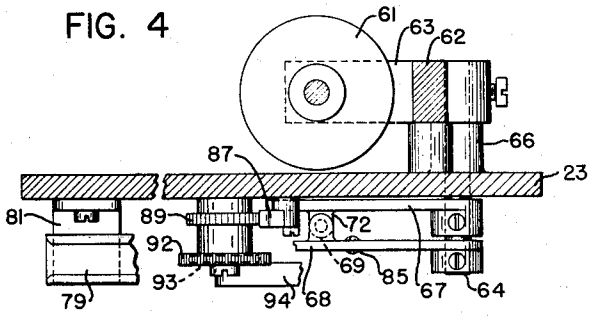


FIG. 4



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PRINTING TELEGRAPH SYSTEM AND APPARATUS

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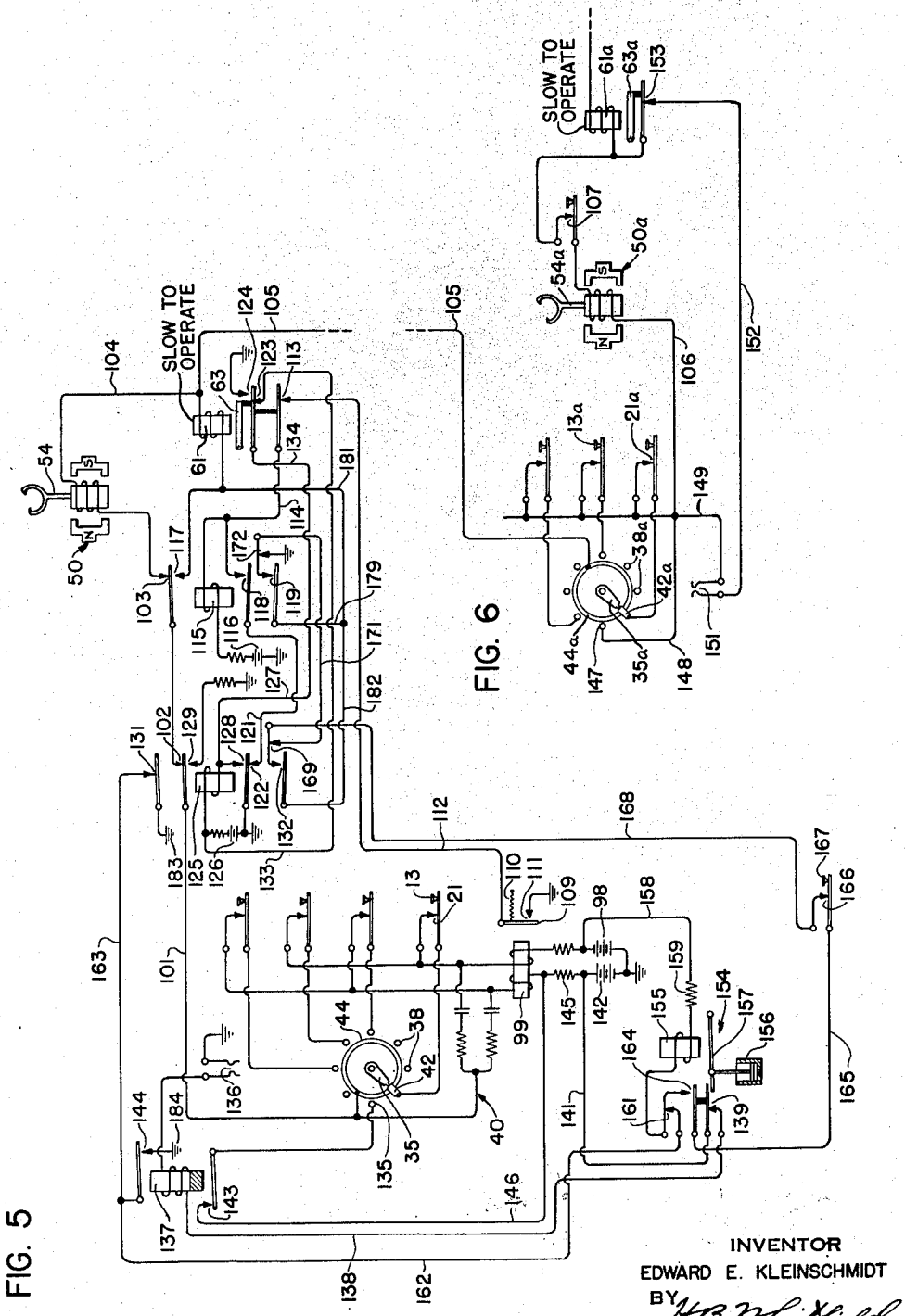


FIG. 5

FIG. 6

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Patented Dec. 21, 1937 2,102,899

UNITED STATES PATENT OFFICE

2,102,899

PRINTING TELEGRAPH SYSTEM AND APPARATUS

Edward E. Kleinschmidt, Highland Park, Ill., assignor to Teletype Corporation, Chicago, Ill., a corporation of Delaware

Application April 25, 1936, Serial No. 76,357

27 Claims. (Cl. 178—35)

This invention relates to printing telegraph systems and apparatus.

An object of the invention is to provide a remotely controlled printing telegraph machine which may be employed economically in localities where the traffic service is light and where it is feasible to operate the apparatus at relatively slow speeds.

Another object of the invention is to provide a simple telegraphic system which is automatic and in which phasing and synchronization of the interconnected printing apparatus is automatically effected cyclically irrespective of the character selecting function of the apparatus at the several stations.

Specifically, the printing machine according to the present invention is operable on the step-by-step principle. In these machines the type wheel, star wheel drive ratchet, synchronizing arm, and the commutator contact arm are all fixed to and rotatable with the same shaft. The star wheel drive or motor magnet is a polar magnet responsive to alternating positive and negative impulses. Normally, the alternate segments of the commutator are impressed with positive and negative current so that when the keys of the transmitter keyboard are unoperated, the circuits are completed alternatively to the polar magnet to oscillate the actuating pawl lever and thus drive the type wheel step by step continuously. However, when a keylever is depressed, the circuit between this particular keylever and its corresponding segment on the commutator is broken so that when the commutator arm arrives at and contacts with such segment, the type wheel will be stopped preparatory to effecting the printing operation. The circuit for the printer according to the present invention provides that when the keylever is depressed and the circuit to the corresponding commutator segment is broken, a printing relay is operated in preparation for the performance of the printing operation, which occurs when the keylever is released and the circuit from the keylever to its corresponding segment is again completed, at which time the printing relay permits the establishment of the energizing circuit to the printing magnet. In other words, printing occurs upon make after break of the keylever contact.

A feature of the circuit for the step-by-step printer according to this invention is the means for effecting synchronization of the interconnected printers once every revolution of the commutator arm, and a further feature resides in the positive stopping of the commutator arm on the synchronizing segment after cessation of message transmission and reception for a predetermined interval of time, for example, a period of ten seconds. In connection with the synchronizing feature, it has been mentioned above that the commutator comprises a series of segments traversed by a contacting arm. One of these segments is identified as the synchronizing segment. Upon the shaft is fixed a synchronizing arm which is adapted, once each revolution of the shaft, to pass through a pair of contact springs making contact therebetween periodically to complete, with the commutator contacting arm simultaneously in contact with the synchronizing segment, a circuit to effect phasing of the printers. If one of the way station instruments is out of phase with the central or main control station instrument (which is provided with identical commutator and synchronizing means) its synchronizing arm will stop between the pair of synchronizing contact springs (with the contacting arm simultaneously on the synchronizing segment) until upon the following revolution of the transmitting synchronizing arm, when it again contacts the pair of synchronizing contacts, all the printers will again be phased, and the succeeding stepping operations will be in unison. A characteristic of the commutator of the printer according to this invention is that the rotational movement of the commutator contacting arm simulates or resembles a start-stop arm, due to the fact that the commutator contact arm steps rapidly from segment to segment until it reaches the synchronizing segment, whereat it is arrested momentarily while the synchronizing function, which is operated over a different circuit from that involving the other segments, is being performed.

A better understanding of the invention may be had from the following description, taken in conjunction with the accompanying drawings, wherein

Fig. 1 is a front elevation view of the combination sending and receiving apparatus according to the present invention;

Fig. 2 is a sectional view taken on line 2—2 of Fig. 1;

Fig. 3 is a rear elevational view of the printer portion of the apparatus shown in Fig. 1;

Fig. 4 is a sectional view taken on line 4—4 of Fig. 1;

Fig. 5 is a schematic diagram of the electrical circuit at the main control station; and

Fig. 6 is a similar diagram of the electrical circuit at the line station.

Having reference to the accompanying draw-

ings in which like reference characters indicate similar parts throughout, the apparatus according to the present invention, as illustrated in Figs. 1 and 2, comprises a base portion and a printer portion indicated generally by reference characters 11 and 12 respectively. The base portion 11 houses the keylevers 13 which carry at their outer ends individual key tops 14 and which are pivotally articulated at their other ends with a common fulcrum bar 15. Keylevers 13 are operable in front and rear comb or guide members 16 and 17, respectively, and are normally held in their horizontal or clockwise position (as viewed in Fig. 2) by individual springs 18. Carried on each of the keylevers 13 is a contact operating member 19 of non-conducting material which acts, upon the depression of an associated keylever 13 (as indicated by dotted lines in Fig. 2), to open a normally closed contact pair 21 which controls an electrical circuit to effect character selection and printing in a manner to be hereinafter described.

The printing unit or portion 12 is mounted on the top plate 22 of the base portion 11 and comprises a front plate portion 23 and a rear supporting member 24 (Fig. 2). A shaft 25 is journalled in portion 23 and member 24 and carries on its left end a type wheel 26 and a star wheel drive ratchet 27. Ratchet 27 is integral with a sleeve member 28 provided with a flange 29. Sleeve member 28 is secured to shaft 25 by means of a screw 31, and type wheel 26 is adjustably secured to flange 29 by means of slots 32 and screws 33 (Fig. 1). To the right end of shaft 25 is secured a sleeve 34 carrying a commutator contact arm 35. Shaft 25 is thus constrained against endwise or axial movement by sleeves 28 and 34 fixed thereon. Positioned coaxially with respect to shaft 25 and mounted upon member 24 by screws 36 is a commutator, indicated generally by the reference character 37. Commutator 37 comprises a plurality of peripherally arranged and equally spaced contact members 38 (Fig. 3), clamped between rings of non-conducting material 39 and 41, and adapted to be traversed by a contact roller 42 yieldingly carried on a spring 43 secured to the extremity of arm 35. Simultaneously with its traversal of the contacts 38, roller 42 also contacts a metal ring 44 which is electrically connected to the signal line wire.

The commutator 37 also carries a pair of synchronizing contact springs 45 and 46 disposed radially with respect to the axis of shaft 25 and adapted to coact with a conductive synchronizing arm 47 rotatably carried on shaft 25. The springs 45 and 46 are assembled with a pair of rigid spacing members 48 and 49 so disposed as to maintain a distance between the lower extremities of springs 45 and 46 slightly smaller than the diameter of arm 47, so that as arm 47 passes between springs 45 and 46, said springs will be cammed apart to insure proper electrical contact with the synchronizing arm 47. Springs 45 and 46 and spacing members 48 and 49 are carried on the commutator 37. Arm 47 is carried by a collar 52 secured to shaft 25 by a set screw 53.

The shaft 25 is given step-by-step rotation through the instrumentality of a ratchet drive mechanism embodying the ratchet wheel 27 and an actuating pawl lever 54 (Fig. 1). The pawl arms 55 and 56 of the pawl lever 54 are so disposed with respect to the teeth on ratchet 27 as to cause ratchet 27 to be rotated in a clockwise direction (as viewed in Fig. 1) in a manner disclosed in U. S. Patent No. 386,189. Pawl lever 54 is carried on a pivot 57 in the polar motor magnet assembly 50 and is arranged to oscillate between magnetic poles 58 and 59 thereof in well-known manner.

A print magnet 61 is carried by a bracket 62 mounted on the back of front plate 23. The armature 63 of magnet 61 is pivoted at 64 and acts to control a bank of contacts 65 (Fig. 3) as well as the printing arm and tape spacing mechanism (Fig. 1). The control of the contacts of the contact bank 65 will be described in connection with the electrical circuit shown in Figs. 5 and 6. The pivot shaft 64 is journalled in a boss 66 integral with the front plate 23 (Fig. 4). Carried on the outer end of shaft 64 are an actuating lever 67 and a printing arm 68. The actuating lever 67 is fixed to shaft 64 and is provided with a laterally disposed portion 69 which carries an adjustably positionable striker screw 71. Screw 71 cooperates with a laterally disposed flange 72 on the printing arm 68. Actuating lever 67 is normally held in its counterclockwise position (as viewed in Fig. 1) by means of a spring 73 shown in Fig. 3, which spring also tends to urge armature 63 to its clockwise position (as viewed in Fig. 3). With this arrangement, magnet 61 when it is energized upon the reception of a printing pulse, will cause armature 63 to rotate sharply in a counterclockwise direction (as viewed in Fig. 3) against the action of spring 73. This movement due to the fact that armature 63 and actuating lever 67 are fixed to the pivot shaft 64, will cause the actuating lever 67 also to be rotated sharply in a clockwise direction (as viewed in Fig. 1) which, through screw 71, will impart like rotation to printing arm 68. A platen 74 carried at the extremity of printing arm 68 will be thrown sharply against the periphery of the type wheel 26 to effect printing on a tape 75 interposed between the platen 74 and type wheel 26. The tape supply is derived from a tape reel 76 carried by the printing unit 12, which tape extends around guide rollers 77 and 78 through a tape guide 79 carried by brackets 81 and 82 mounted on front plate 23. Printing arm 68 is operable between a pair of eccentric stop screws 83 and 84 which control the extent of its oscillatory movement. The printing arm 68 is held against the lower stop 83 by a spring 85 which is secured at one end to the printing arm 68 and at the other end to an adjustable member 86, so that the tension of spring 85 may be adjusted to control the printing impact. With this form of printing arrangement, overthrow printing is obtained; that is, a sharp blow is imparted by actuating lever 67 to printing arm 68 which, due to its inertia, is thrown against the type wheel 26 against the action of spring 85.

The actuating lever 67 also acts through a pawl 87 pivotally carried at its extremity to effect the spacing movement of the tape after printing. Pawl 87 is urged by a spring 88 into engagement with a spacing ratchet 89, so that upon each oscillation of actuating lever 67, the ratchet 89 will be rotated a distance equivalent to one tooth thereon to impart, in turn, like motion through a pivot shaft 91 to a spacing roller 92. Coacting with the spacing roller 92 is a gripping roller 93 carried on a spring 94 which, through its gripping action, will impart spacing movement to the tape 75 gripped therebetween. A detent lever 95 urged by a spring 96 acts to prevent spacing ratchet 89 from moving in a reversed direction. The en-

gagement between pawl 87 and ratchet 89 is controlled by an eccentric adjusting screw 97.

Electrical circuit

In Figs. 5 and 6 are illustrated the electrical circuits at the main control station and line station, respectively. The circuits therein shown are in the condition wherein the keylevers 13 and 13*a* are unoperated and the commutator arms 35 and 35*a* are rotating step-by-step in phase. As the contact roller 42 on commutator arm 35 (Fig. 5) steps along the commutator segments 38, circuits of alternate polarity will be completed through polar motor magnets 50 and 50*a* to effect through the pawl actuating levers 54 and 54*a* the rotation of the type wheel shafts of the interconnected printing machines. For example, as indicated in Fig. 5, a circuit is completed from ground, through battery 98 and one winding of relay 99, through closed contacts 21, associated commutator segment 38, contact roller 42, commutator ring 44, conductor 101, contacts 102 and 103 of relays 125 and 115 respectively, through polar motor magnet 50 (Fig. 5) over conductor 104 and thence over line wire 105, through commutator ring 44*a* (Fig. 6), roller 42*a*, segment 38*a* (corresponding to segment 38), contacts 21*a*, conductor 106, through polar motor magnet 50*a* (Fig. 6), manually operated contact 107 associated with the start key, thence through the winding of print magnet 61*a* and ultimately to a ground or other return. Although the polar motor magnets 50 and 50*a* at the interconnected stations are operated in response to the stepping or signalling impulses, the print magnets 61 and 61*a* being of a slower operating type, will not be operated due to the fact that the stepping impulses are of short duration, the printing impulse being one of much longer duration than the signalling impulses. The circuit path indicated generally at 40 (Fig. 5) functions as a spark quenching shunt around the keylever contacts 21 and commutator segments 38.

When a keylever 13 is depressed at the main control station (Fig. 5), the circuit above described will be opened at contact 21, the effect of which will be to cause the deenergization of relay 99, permitting armature 109 to respond to the action of its spring 110 to close contact 111. The contact arms 35 and 35*a* will continue to be stepped, unaffected by the opening of the contacts 21 by the operated keylever, until rollers 42 and 42*a* reach the segments 38 and 38*a* associated with the depressed and corresponding keylevers, whereupon, the polar motor magnets 50 and 50*a* will cease operating with the type wheels positioned, as hereinafter described, to print the character corresponding to the key operated. The deenergization of relay 99 causes a circuit to be completed from ground through contact 111 and armature 109, over conductor 112, through contact 113, over conductor 114, through winding of printing control relay 115 to battery 116. Printing control relay 115 thus is operated, causing upper contact 103 to be open and the lever contact 117 to close. Also, contacts 118 and 119 of relay 115 will be closed simultaneously, causing relay 115 to be locked up over a circuit from battery 116, through winding of relay 115, through contact 118 (now closed), over conductor 121, through contact 122 to ground. This condition of the circuit which includes conductor 101 and the line wire 105 will exist as long as the keylever 13 is held depressed and the contact 21 remains open. However, when the keylever 13 is released and the associated contact 21 is again closed, the relay 99 will again be operated, opening contacts 111, but inasmuch as relay 115 is now locked up, the opening of contacts 111 will have no effect thereon.

The circuit for transmitting the prolonged printing impulse will extend from battery 98 through winding of relay 99, through contact 21, segment 38, roller 42, commutator ring 44, conductor 101, through contacts 102 and 117, through print magnet 61, thence over line wire 105 to the commutator ring 44*a* at the remote line station (Fig. 6), through roller 42*a*, segment 38*a* and contact 21*a*, over conductor 106, through winding of polar motor magnet 50*a*, through contact 107, and the winding of print magnet 61*a* and ultimately to ground. It is observed that the circuit just traced does not include motor magnet 50, and hence when the prolonged printing impulse is transmitted, this motor magnet will be unaffected by the initial portion of the printing impulse. However, the establishment of this circuit by the printing impulse will cause the polar motor magnet 50*a* and the printing magnets 61 and 61*a* to operate, but since the printing magnets are of the slow to operate type, the motor magnet 50*a* will be the first to respond (to the initial portion of the prolonged printing impulse) to advance the contact arm 35*a*, and hence the type wheel controlled thereby, one step, and immediately thereafter the print magnets 61 and 61*a* will have become operative to effect printing at their respective stations. The operation of printing magnet 61 will, through contact bank 65 (including contacts 113, 123, and 124), affect relay 115 to open contact 117 and close contact 103 in a manner presently described.

The operation of the print magnet 61 (Fig. 5) will cause its contacts 113 and 123 to be opened and its contact 124 to be closed. The closing of contact 124 applies ground to the energizing circuit for relay 125 extending from battery 126, through the winding of relay 125, over conductor 127, through contact 124 to ground. The operation of relay 125 will cause the lower contact 122 to open and the upper contact 128 to close. Simultaneously, contacts 102 and 131 will be opened and contacts 129 and 132 will be closed, the effects of which will hereinafter appear. The opening of contact 122 causes the locking circuit for relay 115 to be broken, thereby permitting contact 103 to again be closed and contacts 118 and 119 to be opened. The closing of contact 103 prepares the circuit for polar motor magnet 50 which shall become operated when contact 102 is again closed. Relay 125 will be locked up by a locking circuit extending from battery 126 through winding of relay 125, thence through contact 128 to ground. The opening of contact 102 interrupted momentarily the printing impulse, and the closing of contact 129 served to maintain relay 99 energized by putting ground on the energizing circuit therefor. This interruption of the printing impulse causes printing magnets 61 and 61*a* to become deenergized. The deenergization of printing magnet 61 causes contacts 113 and 123 to again close and contact 124 to open. The closing of contact 123 short circuits the locking circuit for relay 125 from battery 126, over conductor 133, through contact 123, over conductor 134, through contact 128 to ground. The locking circuit for 125 will thereupon become broken and the contacts associated with relay 125 will again assume the positions indicated in Fig. 5, wherein contact 102 is closed. The closing of contact 102 establishes an energizing circuit for polar magnet 50

and current is impressed on this circuit of the same polarity as the immediately preceding portion of the printing impulse, because contact arm 35 is still resting on the same contact 38 associated with the last operated keylever. Polar magnet 50 will respond to this final portion of the printing impulse, but magnet 50a will not respond (because, as will be recalled, magnet 50a responded to the initial portion of the last preceding portion of the printing impulse which was of the same polarity), thus bringing the magnets 50 and 50a again into phase.

From the foregoing it is observed that in order to compensate for the aforementioned effect of the prolonged printing impulse, the type wheels rotate in a definite out-of-step relationship which consists in arranging the characters on the type wheels (of the stations shown in Figs. 5 and 6) one character out of step. According to this arrangement, a particular character on the type wheel of the line printer (Fig. 6) is one step behind the same character of the type wheel on the main control printer (Fig. 5), and by the initial portion of the printing impulse, whereby the motor magnet 50a is operated and the motor magnet 50 is not operated, the type wheels are brought into exact step or phase (because the type wheel at station Fig. 6 is stepped ahead one step while the type wheel at station Fig. 5 is not stepped) to print the same character. Then after printing, the final portion of the same impulse, being transferred to the motor magnet 50 through contacts 102 and 103, causes the motor magnet 50 to operate to step the type wheel associated therewith one step ahead, which impulse portion (being of the same polarity as the initial portion) will have no effect on the motor magnet 50a, hence bringing the type wheels of the interconnected stations into their predetermined out-of-step relationship.

The foregoing sequence of operations occurs each time a keylever 13 is operated or depressed to cause the printing of a character corresponding to the keylever operated. However, as previously mentioned, a synchronizing function is performed cyclically, during each rotation of the commutator arm 35, which function will now be described. Assuming that the roller 42 of commutator arm 35 (Fig. 5) is in contact with the synchronizing segment 135 of the commutator, the synchronizing arm 47 (Fig. 2) will be in engagement with the pair of synchronizing contacts 136 comprising the contact springs 45 and 46 (Fig. 2). As the roller 42 leaves the segments 38 and passes onto synchronizing segment 135 the energizing circuit for relay 99 is broken, so that the initiation of the synchronizing function will have the same effect on relay 115 as when the previously described printing function (initiated by the depression of a key 13) is performed. The deenergization of relay 99 will cause contact 111 to close which will cause ground to be applied to relay 115 which, when operated, becomes locked up over a previously described locking circuit, and simultaneously closes contact 117 to prepare a circuit over conductor 101, through print magnet 61 and over line wire 105.

The bridging of contacts 136 by synchronizing arm 47 establishes a circuit from ground through synchronizing contacts 136, thence through the winding of a slow release synchronizing relay 137, then over conductor 138, through contact 139, over conductor 141, to battery 142. The operation of synchronizing relay 137 will effect the closing of its associated contacts 143 and 144. The closing of contact 143 will complete a circuit from battery 142, through resistance 145, over conductor 146, through contact 143 and synchronizing segment 135, over roller 42 and commutator ring 44, conductor 101, through contacts 102 and 117 (now closed) and winding of printing magnet 61 (Fig. 5), over signal line 105, over commutator ring 44a (Fig. 6), through roller 42a and synchronizing segment 147, over conductors 148 and 149, through a pair of synchronizing contacts 151 (assuming the interconnected stations to be in proper phase, the synchronizing arm, not shown in Fig. 6, will be interposed between the pair of contact springs of synchronizing contact 151, at the same time that the synchronizing arm will be interposed between the pair of contact springs of synchronizing contact 136, Fig. 5), over conductor 152, through contact 153 (associated with print magnet 61a) thence through the winding of print magnet 61a, ultimately to ground.

Since the synchronizing signal impulse is one of long duration (the same as the printing signal impulse), the print magnet 61a, which is slow to operate, will become operated, whereupon the contact 153 will be opened and the motor magnet 50a at the station shown in Fig. 6 will be operated by the remaining portion of the synchronizing signal to cause the proper oscillation of pawl actuating lever 54a thereat. It will be observed that the synchronizing impulse is of sufficient duration not only to operate the slow-operating print magnet 61a but also to operate the polar motor magnet 50a after the shunt circuit 152 has been opened at 153, by the operation of armature 63a. In a manner similar to that described in connection with the prolonged printing impulse, the relay 125 when it operates acts, by opening its contact 102, to cut off or terminate the synchronizing impulse. The synchronizing impulse, like the printing impulse, has caused the printing magnet 61 to operate substantially simultaneously with the operation of magnet 61a. However, the last or final portion of the synchronizing impulse has caused the motor magnet 50a to operate, while the motor magnet 50 (Fig. 5) has not yet been operated, thus stepping the arm 35a one step ahead of arm 35. But, similar to the effect produced by the prolonged printing impulse, the operation of the printing magnet 61 will effect the restoration of the circuits including relays 115 and 125 to their normal unenergized condition whereupon contacts 102 and 103 will be closed (as shown in Fig. 5) to establish the circuit for motor magnet 50 which will become energized by an impulse through the last described synchronizing segment, since the roller 42 is still resting on the synchronizing segment 135. This impulse will operate motor magnet 50, but will not operate motor magnet 50a, since the latter was just operated by the synchronizing impulse of the same polarity, thus bringing the synchronizing arms 47 (Fig. 2) again into phase. The operation of the polar motor magnets 50 and 50a at the interconnected stations in this manner causes the commutator arms 35 and 35a at the several stations to be stepped along onto the succeeding commutator segments, whereafter the pawl actuating arms 54a will be actuated by the alternations of current impulses from batteries 98 and 142 through the motor magnets 50 and 50a, as previously described. At this time relay 99 will again become energized.

In the event that the mechanism at the station indicated by Fig. 6 becomes out of phase with

the station indicated by Fig. 5, the present invention provides means for automatically synchronizing the stations. When the commutator arms 35 and 35a at the stations shown in Figs. 5 and 6 respectively are not rotating in synchronism, the commutator arm 35a will rotate up to the synchronizing segment 147 and remain thereat until the commutator arm 35 arrives at the synchronizing segment 135. It is observed that the synchronizing arm 47 and commutator arm 35 are constrained to rotate together, and when it is stated that the commutator arm is in contactual engagement with the synchronizing segment, it is understood that the synchronizing arm is also in contactual engagement with the synchronizing contacts. Asssuming further that the roller 42a on the commutator arm 35a has reached, and remains at, the synchronizing segment 147, and that the commutator arm 35 is in the position shown, the impulse transmitted over the line wire through keylever contact 21 will be received by the apparatus shown in Fig. 6 over the synchronizing segment 147, said circuit being completed over conductors 148 and 149, through synchronizing contacts 151, over conductor 152, through contact 153, and winding of print magnet 61a and ultimately to ground. Since print magnet 61a is slow in operating, the circuit through the motor magnet 50a will be shunted, and the short impulse or impulses transmitted from the station shown in Fig. 5 will have no effect upon the motor magnet 50a. However, when the roller 42 of the commutator arm 35 reaches the synchronizing segment 135 thereat, a long synchronizing impulse will be transmitted over the line wire 105, in the manner previously described, whereupon the print magnet 61a will be operated to open the contact 153 and to permit the current to pass through the polar motor magnet 50a, causing the motor magnets 50 and 50a at the respective stations to be operated thereafter with both commutator arms operating in phase.

As previously mentioned, the present invention also provides means for stopping the commutator arm upon the synchronizing segment after a ten second (or other predetermined period) cessation of transmission. This feature is achieved through the instrumentality of a dash-pot relay indicated generally by reference character 154 (Fig. 5) and comprises an electromagnet 155 and a dash-pot 156. The magnet 155, when energized, tends to attract its armature 157, against the resistance offered by the dash-pot 156. The energizing circuit for magnet 155 extends from battery 98, over conductor 158, through resistance 159 and winding of relay 155, through contact 161, over conductors 162 and 163, through contact 131, to ground 183. This circuit is established while the roller 42 on the commutator arm 35 is traversing the commutator segments 38. However, when the commutator arm 35 contacts the synchronizing segment 135, the ground 184 associated with contact 144 of relay 137 is substituted for the ground 183 associated with contact 131.

As is observed from the foregoing description, the energizing circuit for magnet 155 is broken periodically by the opening of contact 131 whenever a keylever 13 is depressed and relay 125 is energized during the establishment of the condition set up by the opening of contact 21 associated with the keylever 13. Thus although magnet 155 tends to pull up its armature 157 against the action of the dash-pot relay 156, this function is interrupted periodically by the opening of contact 131. However, should no keylevers 13 be operated for a predetermined period (for example, ten seconds), the magnet 155 remains energized, and during that interval, pulls up its armature 157 sufficiently to open contacts 139 and 161 and to close contact 164. During the ten-second interval, however, the synchronizing function may be performed several times, thus causing contact 131 to be opened each time, to remove ground 183 from the energizing circuit for dash-pot relay 155. Therefore, to compensate for this possibility and to prevent the relay 155 from becoming deenergized prematurely, ground 184 (associated with the synchronizing relay 137) is applied, during the synchronizing interval, in place of ground 183, thus maintaining relay 155 energized. The energizing circuit for magnet 155, previously described, is broken after the ten-second interval and the following circuit is substituted therefor; namely, from battery 98, over conductor 158, through resistance 159 and winding of magnet 155, through contact 164, over conductor 165, through contact 166 associated with the start key 167, over conductor 168, through contact 169 associated with relay 125, over conductor 171, through contact 172 (associated with printing relay 115), to ground. If the commutator arm 35 has not yet reached the synchronizing segment 135, impulses will be transmitted over the line wire 105, through the keylever contacts 21 and contacts 102 and 103 (in series with the conductor 101) through the polar motor magnets 50 and 50a, since the action of the dash-pot relay 154 on contacts 139, 161, and 164 will have no effect upon the polar motor magnets 50 and 50a until the commutator arm 35 has reached the synchronizing segment 135.

When this latter condition is established, the synchronizing contacts 136 (Fig. 5) will have been contacted by the synchronizing arm 47 preparatory to establishing an energizing circuit for the synchronizing relay 137. This energizing circuit will not be established because the dash-pot relay 154 has caused the contact 139 to be opened, thus cutting off battery 142 from synchronizing relay 137. Accordingly, contact 143 associated with synchronizing relay 137 will remain open and no synchronizing impulses will be transmitted over line wire 105, and hence polar magnets 50 and 50a will cease to operate.

The passing of the roller 42 on commutator contact arm 35 from the commutator segments 38 onto the synchronizing segment 135 will cause the deenergization of relay 99, which in turn permits armature 109 to respond to the action of spring 110 to close contact 111 and to apply ground to the previously described energizing circuit for relay 115. The operation of relay 115 causes contacts 117, 118, and 119 to be closed. Relay 115 becomes locked up over its locking circuit extending from battery 116, through winding of relay 115, through contact 118, over conductor 121, through contact 122 to ground. The closing of contact 119 causes contact 172 to open, and the ground for magnet 155 previously applied through contact 172 will be removed and the circuit for magnet 155 will extend through contact 119, over conductors 179 and 181, through winding of print magnet 61, over line wire 105, and ultimately to ground. This is the condition that exists in the system after a ten second cessation of transmission. The function of resistor 159 is to reduce the current over the last described cir-

cuit so as not to operate the print magnets 61 and 61a.

The purpose of the previously mentioned contact 132 is to prevent the accidental deenergization of the dash-pot relay 155 during the period of ten-second cessation of transmission. During this ten second period the dash-pot relay is slowly pulling up its armature 157 to ultimately close contact 164, and also, the synchronizing function is recurring regularly to operate relays 115, 61, and 125 in the order named, as previously described, to transmit the synchronizing signal impulse. While the contact arm 35 is traversing the contacts 38, ground 183 (associated with contact 131 of relay 125) is applied to the energizing circuit for dash-pot relay 155. When the contact arm 35 reaches the synchronizing segment 135, relay 137 becomes energized, closing contact 144 and applying ground 184 to relay 155, thus momentarily, both grounds 183 and 184 are applied to relay 155, after which relay 125 becomes energized to open contact 131 thereby assuring the continued energization of relay 155. Now, when relay 125 operates, contact 169 will open, thus tending to break the aforedescribed circuit including dash-pot relay 155, contacts 164 and 169, and line wire 105. But, if a synchronizing operation occurs at the instant when contact 164 is closed there might occur, but for contact 132, the accidental deenergization of dash-pot relay 155. Thus, if relay 125 operates substantially at the moment when contact 164 closes (and contact 161 opens), then if it were not for contact 132 (which constitutes, with contact 169, a make-before-break contact; that is, when relay 125 operates, contact 132 closes before contact 169 opens) the completion of the energizing circuit for relay 155 will not be effected and hence relay 155 will be deenergized to begin over again its ten-second pull-up. Therefore, it is noted that an overlap of closure of contacts 132 and 169 is essential to insure the continued energization of relay 155 after the ten-second cessation.

The printing apparatuses at all of the interconnected stations will remain in their idle or arrested positions until transmission is again initiated by the operation of the start key 167 to open contact 166 to break the energizing circuit just described for the dash-pot relay magnet 155. The first function automatically performed after the operation of start key 167, and the consequent deenergization of relay 155, is the transmission of the synchronizing impulse. The deenergization of magnet 155 causes contacts 139 and 161 to close again and contact 164 to open. The closing of contact 139 completes the previously prepared energizing circuit for synchronizing relay 137 from battery 142, over conductor 141, through contact 139, over conductor 138, through winding of synchronizing relay 137 and synchronizing contacts 136 to ground. Contact 143 will thereupon close to complete the circuit for the transmission of the synchronizing signal impulse from battery 142, through resistance 145, over conductor 146, through contact 143, segment 135, contact ring 44, over conductor 101, through contact 102, contact 117 (still closed), through print magnet 61, thence over signal line 105.

The synchronizing impulse as previously mentioned, acts to operate print magnets 61 and 61a. The operation of print magnet 61a causes contact 153 to open and to permit the final portion of the synchronizing impulse to pass through and operate the motor magnet 50a as previously described. Magnet 61 is operated by the synchronizing impulse to open contacts 113 and 123 and to close contact 124. The closing of contact 124 applies ground to the previously described energizing circuit for relay 125, which pulls up its armatures and becomes locked up over the locking circuit extending from battery 126, through winding of relay 125, contact 128 to ground. The opening of contact 102 of relay 125 cuts-off or terminates the synchronizing impulse to cause, in turn, the deenergization of printing magnets 61 and 61a. The opening of contact 122 breaks the locking circuit for relay 115 and permits contact 103 to close and contacts 118 and 119 to open. The deenergization of print magnet 61 causes contact 113 to close to short circuit relay 125, as previously described, thus restoring the contacts associated with relay 125 to their position shown in Fig. 5. The contacts 102 and 103 now being closed, the motor magnet 50 will be operated to be brought into phase with motor magnet 50a by a short impulse (of the same polarity as the synchronizing impulse), as hereinbefore described, through the synchronizing segment 135; thus initiating the step-by-step movement of the type wheel shaft and associated elements.

The system is now in its normal operating condition in readiness for the operation of a keylever 13 and should a keylever not be operated for a period of ten seconds, the dash-pot relay 154 will again operate to stop the commutator contact arm 35 on the synchronizing segment 135, as previously described.

Printing may also be controlled over the herein described system by the depression of a keylever 13a at one of the line stations, as shown in Fig. 6. Upon the depression of a keylever 13a, the associated contacts 21a will be opened, the opening of which will have the same effect on relay 99 (Fig. 5) as the opening of a contact 21. The line current for the entire system is derived from batteries 98 and 142 alternatively.

General operation

The printing apparatus according to the present invention is shown in Figs. 1, 2, and 3, with the shaft in its synchronizing position; that is, with the synchronizing arm 47 positioned between the synchronizing contact springs 45 and 46 and the roller 42 of the commutator contact arm 35 contacting the synchronizing segment. This condition, as previously mentioned, obtains either when the apparatus is in its unoperated or idle position upon the cessation of transmission of signals for a period of ten seconds, or at the moment of synchronization during the continuous step-by-step rotation of shaft 25 incident to transmission of step-by-step signals. In this position, the printing magnet 61, Fig. 1, is unenergized and the armature 63 thereof is in its released position under which condition contacts 113 and 123 are closed and contact 124 is opened.

Upon the actuation of the start key for example 167 (Fig. 5), contact 166 will be opened to cause signal impulses to be transmitted over the signal line and through the polar motor magnet 50 to cause the oscillation of pawl actuating arm 54 to effect in turn the rotation of the typewheel shafts step-by-step. Upon the actuation of a keylever 13, the associated pair of contacts 21 will be opened, and when the commutator contact roller 42 reaches the segment corresponding to the keylever depressed

(which segment as noted hereinbefore, has become "dead") the commutator arm **35** will stop thereat and the pawl actuating lever **54** will cease oscillating until the keylever **13** is again released to close contacts **21**. However, before keylever **13** is released to close the contacts **21**, conditions will be set up to cause the energization of the printing relay magnet **115**, as previously described, preparatory to transmitting the prolonged printing impulse simultaneously with the release of keylever **13**.

The transmission of the prolonged printing impulse will, in the manner previously described, effect the energization of print magnets **61** and **61***a* and the consequent attraction or operation of armatures **63** and **63***a*. The operation of armature **63** will cause contact pair **124** to close and the pairs of contacts **113** and **123** to open, the effect of which has already been mentioned. The mechanical effect of the operation of the printing armature **63** (and **63***a*) is through shaft **64**, to operate the actuating lever **67** (Fig. 1) to cause printing arm **68** to be operated. The operation of printing arm **68** is effective to throw the platen **74** against the type wheel to effect printing upon the tape **75**. Simultaneously therewith, the spacing mechanism is rendered operative to space the tape, after printing, by causing (through the operation of lever **67**), the pawl **87** to rotate the tape stepping ratchet **80** one step. Any suitable inking means may be provided; for example, the inking roller **173** carried upon arm **174**, pivoted at **175**, which arm is actuated by a spring **176**.

To prevent the stepping of the tape during the transmission of the synchronizing impulse, which impulse energizes the print magnet **61** and tends to operate the armature **63** in the same manner as a printing impulse, a blocking means is provided for the printing arm **68**, and hence the contacting lever **67** therefor. This blocking means comprises a lug **177** carried on the type wheel **26** and directed inwardly to cooperate with a vertically extending lug **178** integral with the printing arm **68** (Fig. 2). Thus when the synchronizing arm **47** is in contactual engagement with the synchronizing springs **45** and **46**, the lug **177** is presented over the projection **178** of printing arm **68**, so that when the prolonged synchronizing impulse operates print magnet **61**, the printing arm **68** will tend to be thrown toward the type wheel but being blocked by lug **177** this motion will be prevented, and hence spacing pawl **87** will not be moved vertically a sufficient distance to effect the rotation of spacing ratchet **89**, thereby preventing spacing of the tape during the performance of the synchronizing function.

Although the invention has been described in connection with a specific form thereof, it will be understood that it has further applications and it is not intended to be limited in scope by the embodiment shown herein for illustration.

What is claimed is:

1. In a step-by-step synchronous printing system including a series of stations, a combination transmitting and receiving apparatus at each station, each comprising a plurality of character keys, normally closed contacts associated with each key, a shaft carrying a type wheel, commutator arm, and synchronizing arm thereon, an electromagnetic device responsive under certain predetermined operating conditions to alternations of current for rotating said shaft step by step while said contacts remain closed, said shaft rotatable under said conditions until checked by the opening of the contacts by its associated key, and means associated with one of said stations effective cyclically irrespective of the character selecting function to synchronize said apparatus.

2. In a step-by-step synchronous printing system including a series of stations, a combination transmitting and receiving apparatus at each station, each comprising a plurality of character keys, a pair of normally closed contacts associated with each key, a shaft carrying a type wheel, commutator arm, and synchronizing arm thereon, an electromagnetic device responsive under certain predetermined operating conditions to alternations of current for rotating said shaft step by step while said contacts remain closed, said shaft rotatable under said conditions until checked by the opening of a contact by its associated key, means associated with one of said stations effective cyclically irrespective of the character selecting function to synchronize said apparatus, and means effective upon a cessation of operation of said key levers for a predetermined period to arrest the rotation of the shafts at each station in corresponding synchronizing positions.

3. In a telegraph printer, a shaft, a type wheel, driving ratchet, synchronizing arm, and commutator arm carried on said shaft, a polar motor magnet responsive to line signals, a driving pawl magnetically associated with said magnet and acting in response to the line signals to effect through said ratchet the progressive rotative movement of said shaft, contacts controlled cyclically by said synchronizing arm, a commutator coaxially positioned with respect to said shaft provided with segments adapted to be traversed by said commutator arm, and a synchronizing segment cooperative with said contacts to effect phasing operations.

4. In a combination sending and receiving apparatus, a plurality of keys, normally closed contacts associated with each key, a shaft, a type wheel, driving ratchet, and commutator arm carried on said shaft, a polar motor magnet responsive to line signals, a driving pawl magnetically associated with said magnet and acting in response to the line signals to effect, through said ratchet, the progressive rotative movement of said shaft, a commutator coaxially positioned with respect to said shaft provided with segments adapted to be traversed by said commutator arm, each segment being electrically connected individually to one of said contacts, and means effective upon the opening of any one of said contacts to establish a condition to effect printing operations.

5. In a step-by-step synchronous printing system, a plurality of stations comprising a main control station and a plurality of line stations, a line conductor connecting the stations, a rotatable shaft at each station, a synchronizing arm carried by said shaft, a pair of synchronizing contacts cooperably related to said arm, means effective when said shafts are rotating non-synchronously for arresting an out-of-step line station shaft with its synchronizing arm in contactual engagement with its associated synchronizing contacts to prepare a synchronizing circuit, and means for establishing said synchronizing circuit to restart said line station shaft in synchronism with the main control station shaft when said main control station shaft reaches a corresponding position.

6. In a step-by-step synchronous printing telegraph system, a plurality of stations inter-connected by telegraph lines, means at one of said stations for transmitting a synchronizing signal, means at the other stations for responding to the synchronizing signal, and means for causing said one station to undergo normal step-by-step operation until said other stations are conditioned to respond to a synchronizing signal and thereafter until it becomes conditioned to transmit the synchronizing signal.

7. In a step-by-step synchronous printing system, including a series of stations, a combination transmitting and receiving apparatus at each station, each apparatus having a shaft rotatable therein carrying a type wheel and a synchronizing arm therefor, means for arresting the shafts with the synchronizing arms in predetermined positions, and means for causing the shaft of a particular one of said stations invariably to be the last to reach the position of arrestment.

8. In a step-by-step synchronous printing system including a series of stations, a combination transmitting and receiving apparatus at each station, each comprising a plurality of character keys, normally closed contacts associated with each key, a shaft carrying a type wheel, commutator arm, and synchronizing arm thereon, an electromagnetic device responsive to alternations of current for constantly rotating said shaft in a step-by-step manner while said contacts remain closed, said shafts rotatable constantly with said type wheels in a predetermined out-of-phase relationship until checked by the opening of a contact by its associated key, a control circuit, and means effective through said control circuit upon the subsequent closing of said contacts to bring the type wheels at said series of stations in phase during the printing operation and thereafter to reestablish said out-of-phase relationship.

9. In a step-by-step printing system, a line circuit, a main control printer and a plurality of line printers in said circuit, means for transmitting current reversals over said line circuit, and a motor for each of said printers, said current reversals being the sole source of power for operating the printers and motors.

10. In a signaling system, a line circuit, a main control printer and a plurality of line printers in said circuit, a motor for each printer, means including a sole source of power for transmitting current reversals over said line circuit to operate the printers and motors, and means under the control of any of said printers for operating all of said printers.

11. In a signaling system, a line circuit, a main control station and a plurality of line stations in said line circuit, combination sending and receiving apparatus at each of said stations, a motor for each apparatus, means including a sole source of power for transmitting current reversals over said line circuit to operate the motors and apparatuses, and means effective under the control of any one of said apparatuses for operating all of said apparatuses.

12. In a signaling system, a line circuit, a main control station and a plurality of line stations in said line circuit, a printer at each of said stations, a motor for each printer, means including a sole source of power for transmitting current reversals over said line circuit to operate the printers and motors, and means under the control of any of said stations for operating all of said printers.

13. In a step-by-step synchronous printing system, a line circuit, a main control station and a plurality of line stations in said circuit, combination printing and receiving apparatus at each of said stations, a motor for each apparatus, means including a sole source of power for transmitting current reversals over said circuit for operating the apparatuses and motors, and means under the control of any of said stations to effect stepping before printing at said line stations and stepping after printing at said main control station.

14. In a signaling system, a line circuit, a main control station and a plurality of line stations in said circuit, telegraph apparatus at each station, a motor for each apparatus, means including a sole source of power for transmitting current reversals over said line circuit for operating the apparatuses and motors, and means effective cyclically for synchronizing said apparatus, said last recited means effective to arrest the further actuation of the motor of an out-of-phase apparatus for one cycle and to thereafter cause said printer to operate in proper phase.

15. In a step-by-step printing system, a line circuit, a main control station and a plurality of line stations in said circuit, printers at each station, a motor for each printer, means for transmitting current reversals over said line circuit, said current reversals being the sole source of power for operating the printers and motors, and means effective cyclically for synchronizing said printers, said means acting to prevent further operation of the motor individual to each out-of-phase printer until said printer is in phase with the main control station printer.

16. In a signaling system, a line circuit, a main control printer and a plurality of line printers, a motor for each printer, means including a sole source of power for transmitting current reversals over said line circuit to operate the printers and motors, means under the control of any of said printers for operating all of said printers, and means effective under certain predetermined conditions to render said first recited means ineffective.

17. In a signaling system, a line circuit, a main control station and a plurality of line stations in said circuit, a printer at each of said stations, means including a source of power for transmitting current reversals over said line circuit, means under the control of any of said stations for operating all of said printers, and means comprising a slow-acting instrumentality to render said first recited means ineffective.

18. In a signaling system, a line circuit, a main control station and a plurality of line stations in said circuit, a printer at each of said stations, means including a source of power for transmitting current reversals over said line circuit, means under the control of any of said stations for operating all of said printers, and means effective after a predetermined period of inactivity of said last recited means to render said first recited means ineffective.

19. In a signaling system, a line circuit, a main control station and a plurality of line stations connected to said circuit, a printer at each of said stations, means including a source of power for transmitting current reversals over said line circuit, means under the control of any of said stations for operating all of said printers, and dash-pot relay device to render said first recited means ineffective.

20. In a step-by-step printing system, a line

circuit, a main control printer and a plurality of line printers connected to said circuit, means for transmitting current reversals over said line circuit, a motor for each of said printers, said current reversals being the sole source of power for operating the printers and motors, and slow-acting means to render said first recited means ineffective.

21. In a printing system, a line circuit, a main control printer and a plurality of line printers connected to said circuit, means for transmitting current reversals over said line circuit, a motor for each of said printers, said current reversals being the sole source of power for operating the printers and motors, and a dash-pot relay device to render said first recited means ineffective.

22. In a signaling system, a line circuit, a main control printer and a plurality of line printers connected to said circuit, a motor for each printer, means including a sole source of power for transmitting current reversals over said line circuit to operate the printers and motors, means under the control of any of said printers for operating all of said printers, and means comprising a slow-acting instrumentality to render said first recited means ineffective.

23. In a step-by-step printing system, a line circuit, a main control printer and a plurality of line printers connected to said circuit, means for transmitting current reversals over said line circuit, a motor for each of said printers, said current reversals being the sole source of power for operating the printers and motors, means under the control of any of said printers for operating all of said printers, and means effective after a predetermined period of inactivity of said last recited means to render said first recited means ineffective.

24. In a telegraph printer, a shaft, a type wheel, driving ratchet, synchronizing arm, and commutator arm carried on said shaft, a polar motor magnet responsive to line signals, a driving pawl magnetically associated with said magnet and acting in response to the line signals to effect through said ratchet the progressive rotative movement of said shaft, contacts controlled cyclically by said synchronizing arm, a commutator coaxially positioned with respect to said shaft provided with segments adapted to be traversed by said commutator arm including a synchronizing segment cooperative with said contacts to effect phasing operations, and means effective under certain operating conditions to render said magnet ineffective.

25. In a combination sending and receiving apparatus, a plurality of keys, normally closed contacts associated with each key, a shaft, a type wheel, driving ratchet, and commutator arm carried on said shaft, a polar motor magnet responsive to line signals, a driving pawl magnetically associated with said magnet and acting in response to the line signals to effect, through said ratchet, the progressive rotative movement of said shaft, a commutator coaxially positioned with respect to said shaft provided with segments to be traversed by said commutator arm, each segment being electrically connected individually to one of said contacts, means effective upon the opening of any one of said contacts to establish a condition to effect printing operations, and means effective after a predetermined period of inactivity of said last recited means to render said magnet ineffective.

26. In a step-by-step synchronous printing system including a series of stations, a combination transmitting and receiving apparatus at each station, each comprising a plurality of character keys, normally closed contacts associated with each key, a shaft carrying a type wheel, a commutator contacting arm, and a synchronizing arm thereon, a commutator comprising a series of segments including a synchronizing segment, all traversed by said contacting arm, a pair of synchronizing contacts cooperable with said synchronizing arm, an electro-magnetic device responsive to alternations of current for rotating said shaft in a step-by-step manner while said contacts remain closed, said shaft normally rotatable until checked by the opening of the key controlled contacts by its associated key, and circuit means cooperating cyclically with said synchronizing arm, synchronizing segment, and synchronizing contacts for automatically effecting the synchronizing function irrespective of the character selecting function.

27. In a step-by-step synchronous printing system, a plurality of stations connected together including a phase-controlling station, a motor at each station, a rotatable shaft in each station controlled by the motor thereat, a synchronizing arm carried by said shaft, means for transmitting current reversals over said line circuit, said current reversals being the sole source of power for operating the printers and motors, means acting when the shafts are rotating out of predetermined phase relation to prevent further operation of the motor individual to each out-of-phase printer until said printer is in phase with the main control printer by arresting the shaft of the out-of-phase printer with its synchronizing arm in a predetermined position, and means for reoperating the motor of the out-of-phase printer for restarting the shaft thereat in proper phase with the shaft at the phase controlling station.

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