Aug. 19, 1947. E. J. RABENDA ET AL 2,426,049

RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

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FIG. 1.

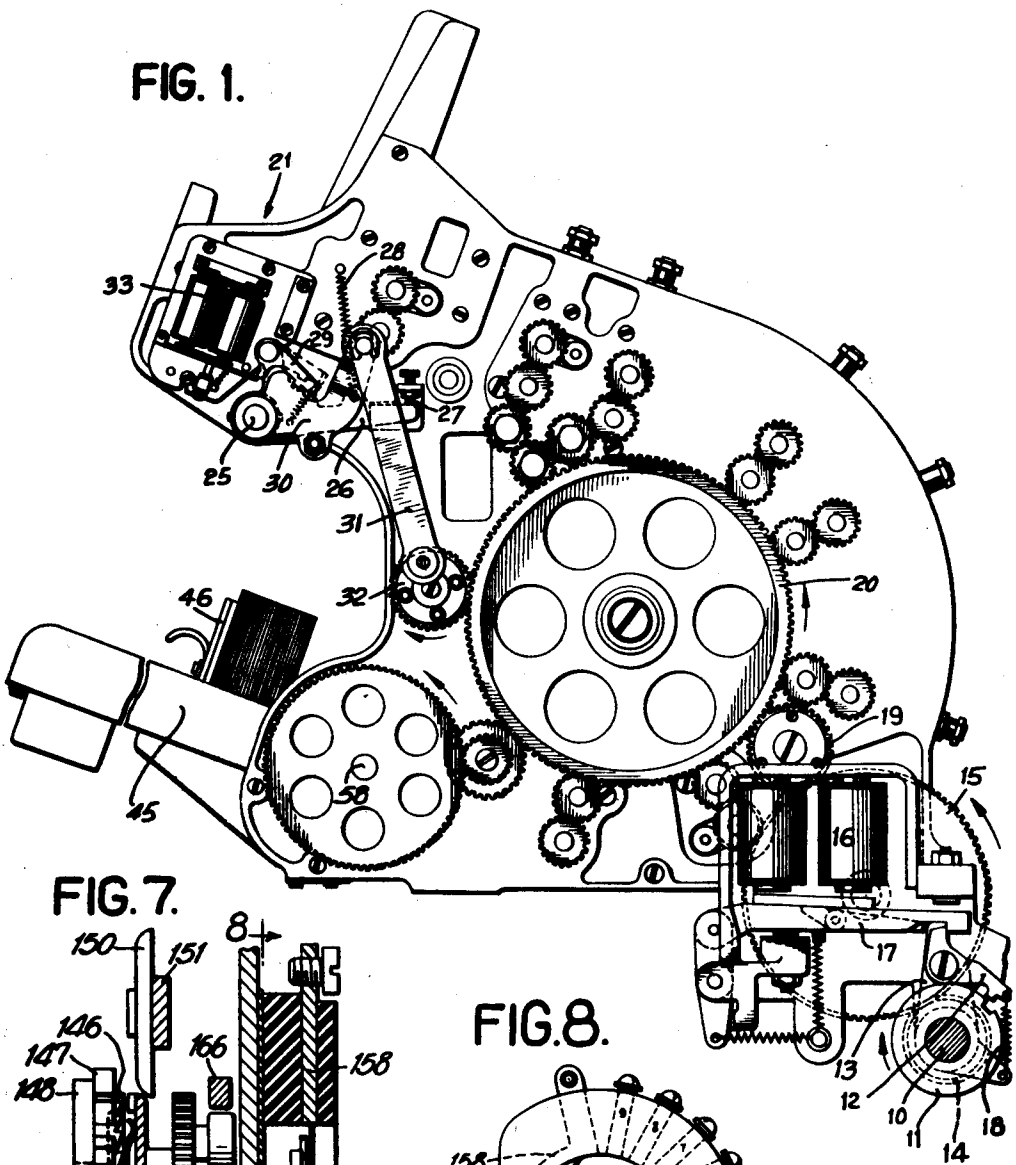


FIG. 7.

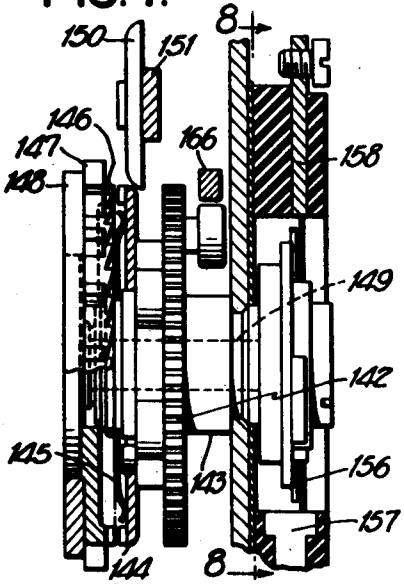
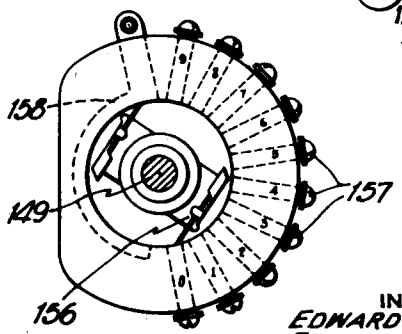


FIG. 8.



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FIG.2.

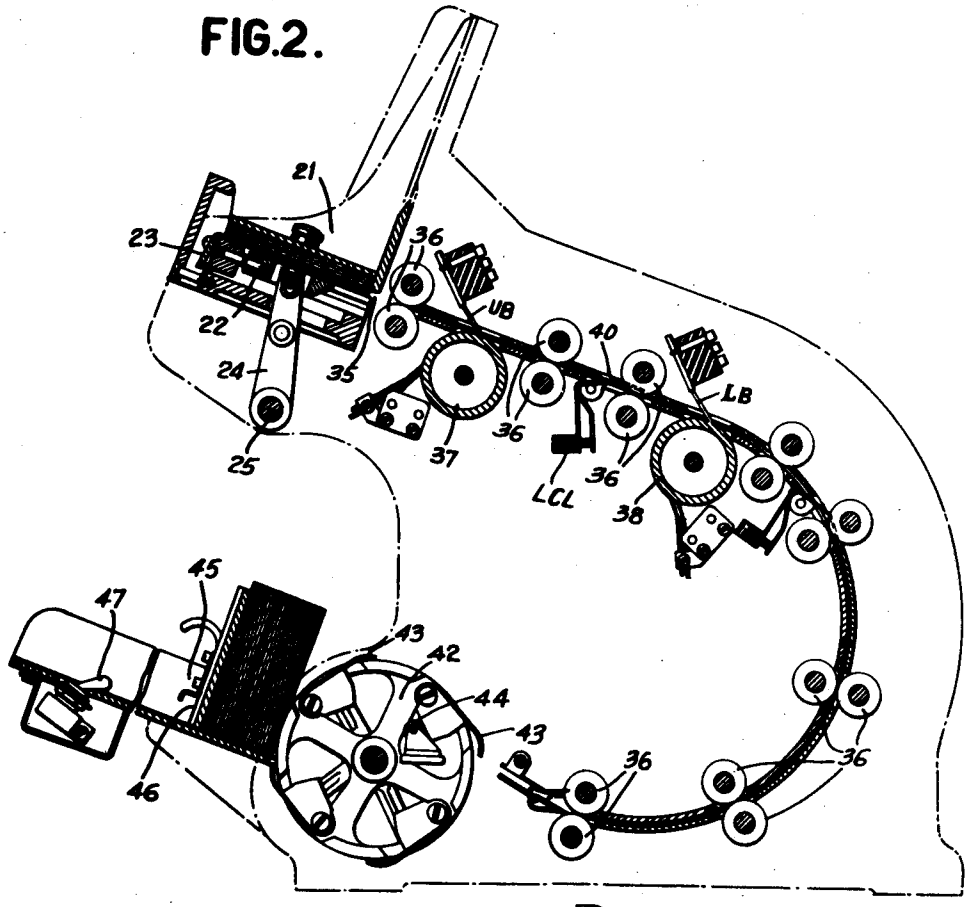
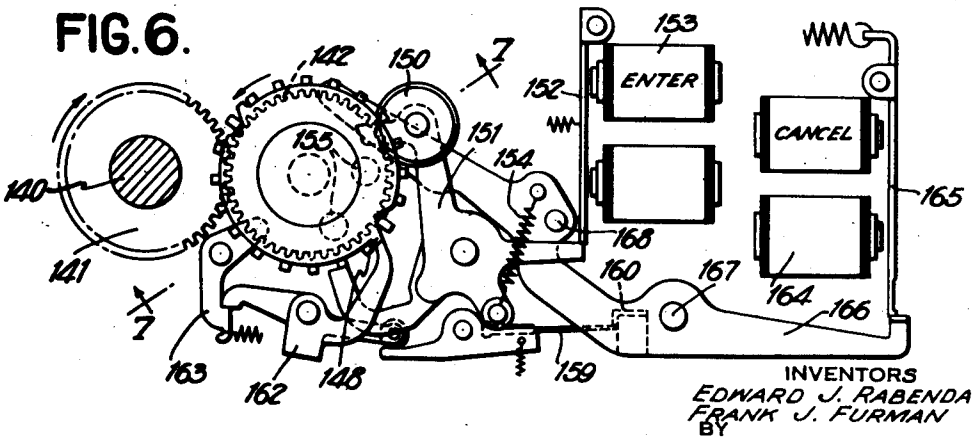


FIG.6.



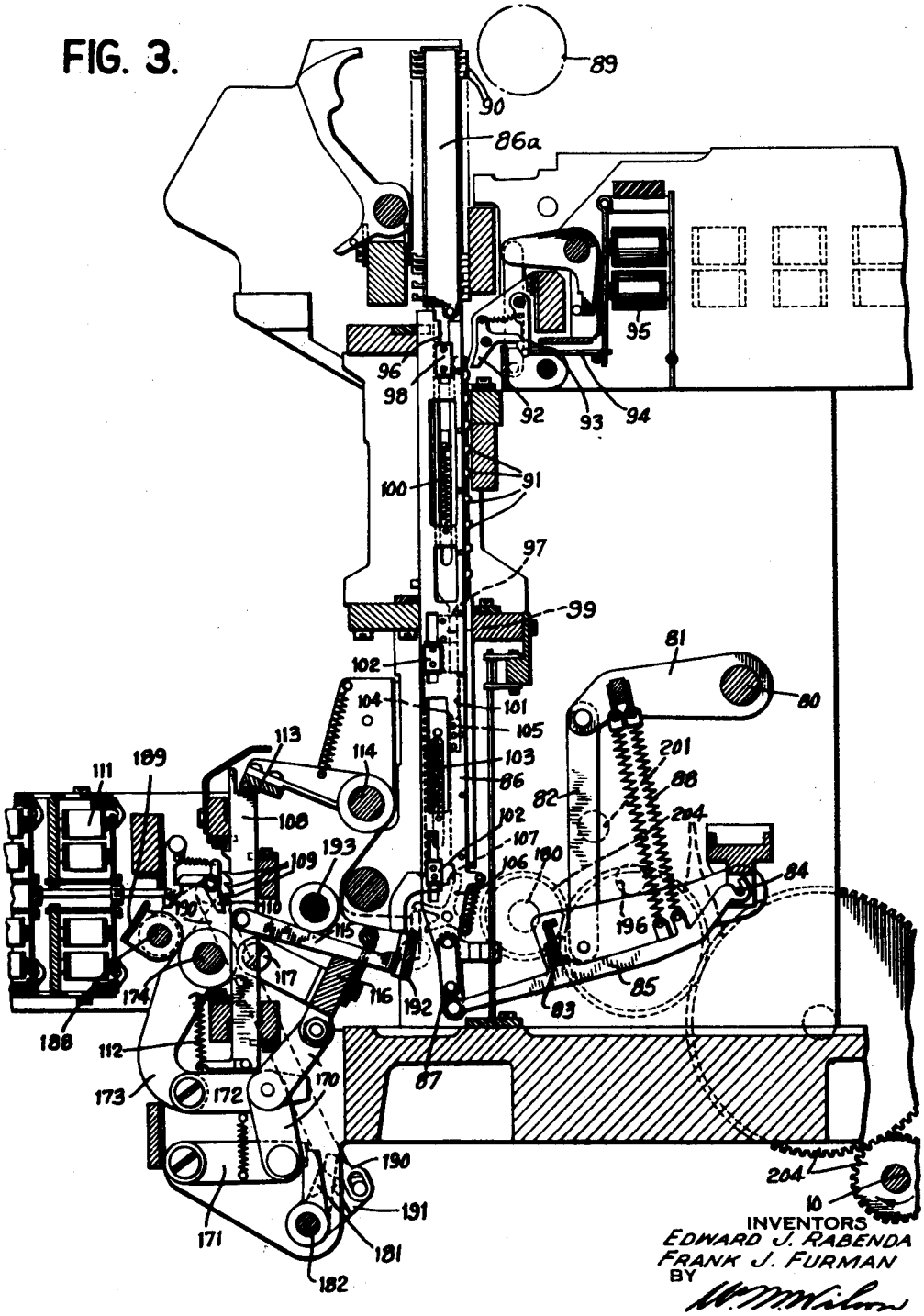
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RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

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FIG. 3.



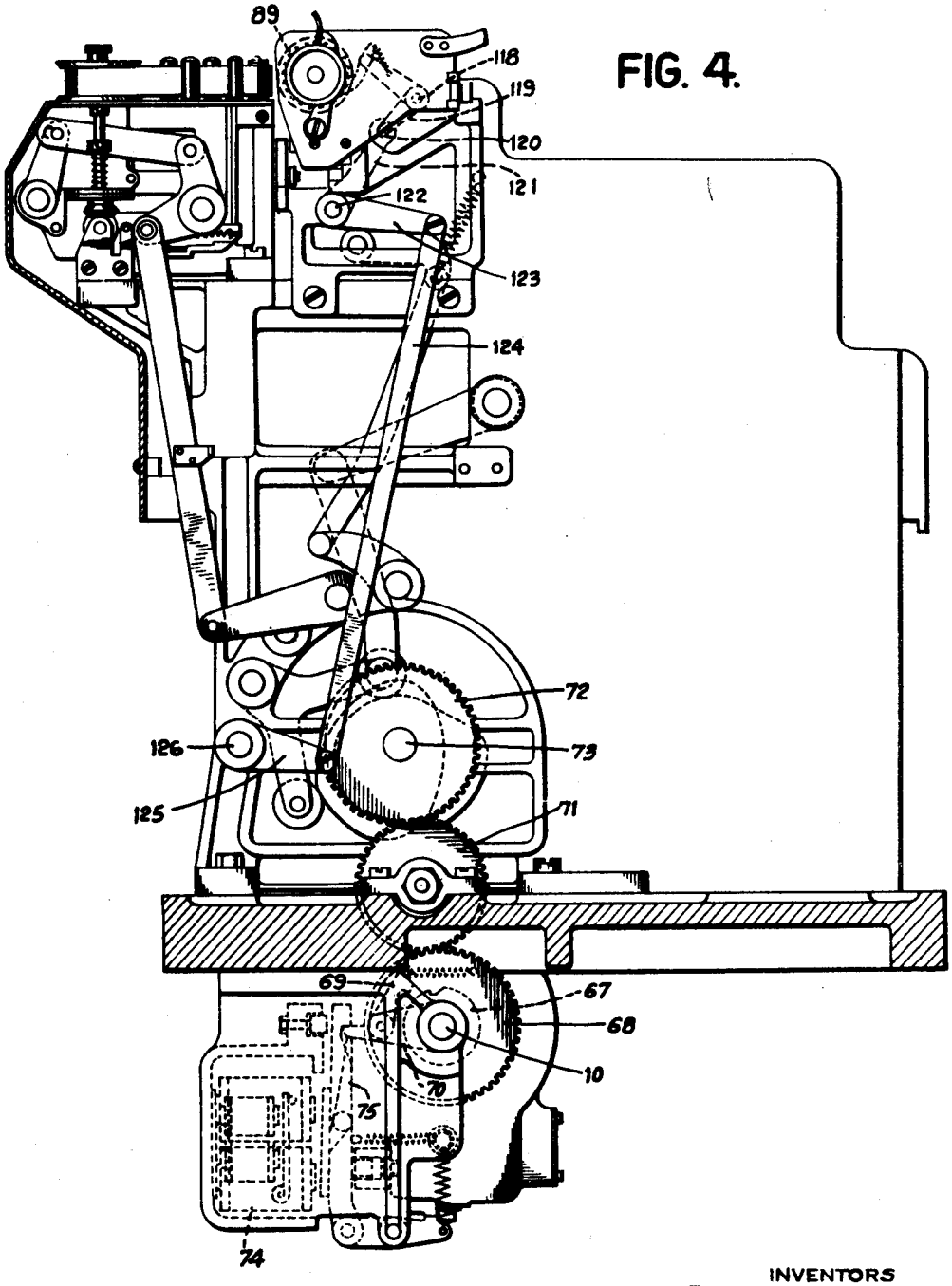
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FIG. 4.



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RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

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FIG. 5.

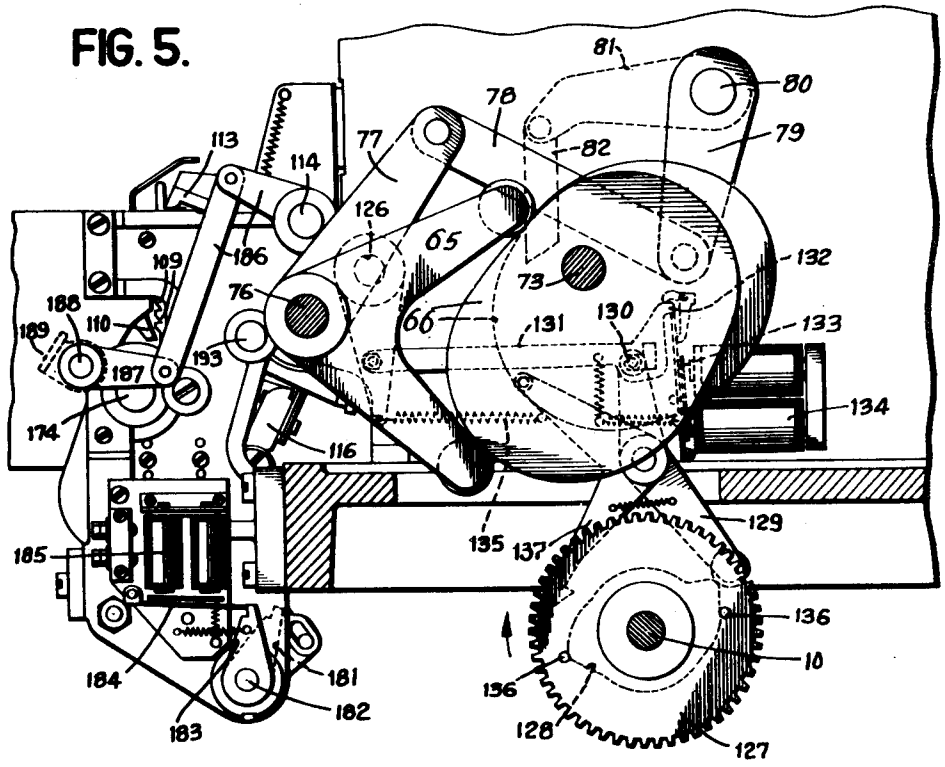
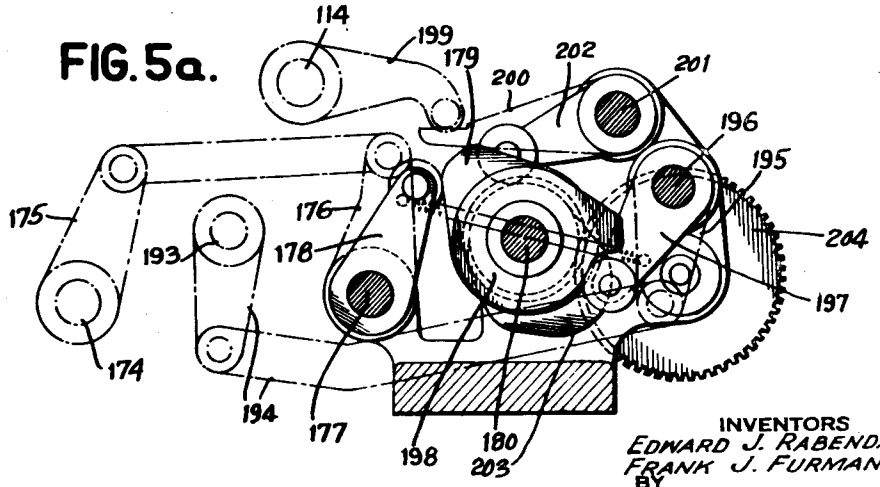


FIG. 5a.



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RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

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FIG. 9.

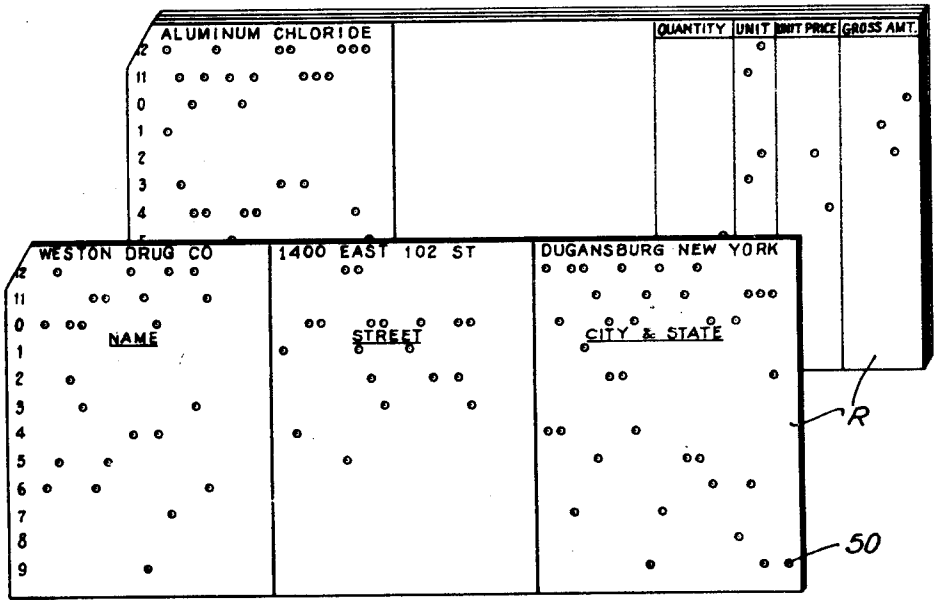
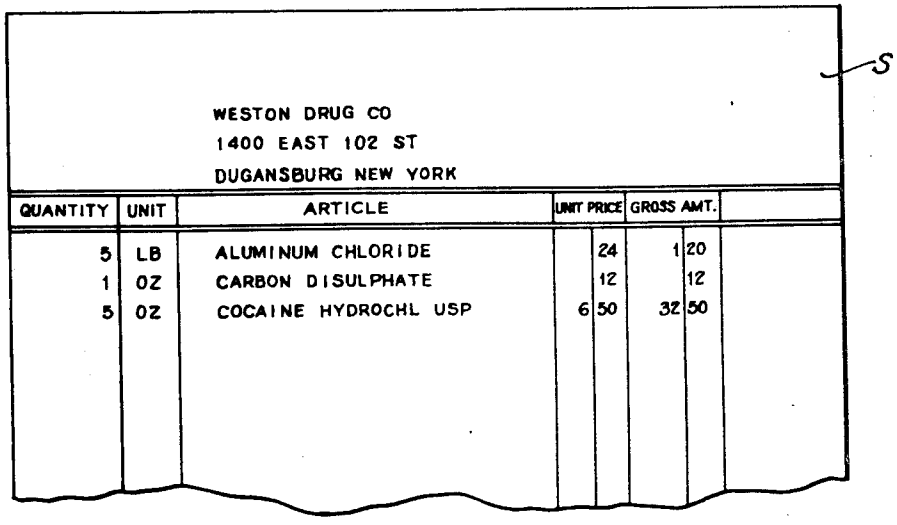


FIG. 10.



QUANTITY	UNIT	ARTICLE	UNIT PRICE	GROSS AMT.
5	LB	ALUMINUM CHLORIDE	24	1 20
1	OZ	CARBON DISULPHATE	12	12
5	OZ	COCAINE HYDROCHL USP	6 50	32 50

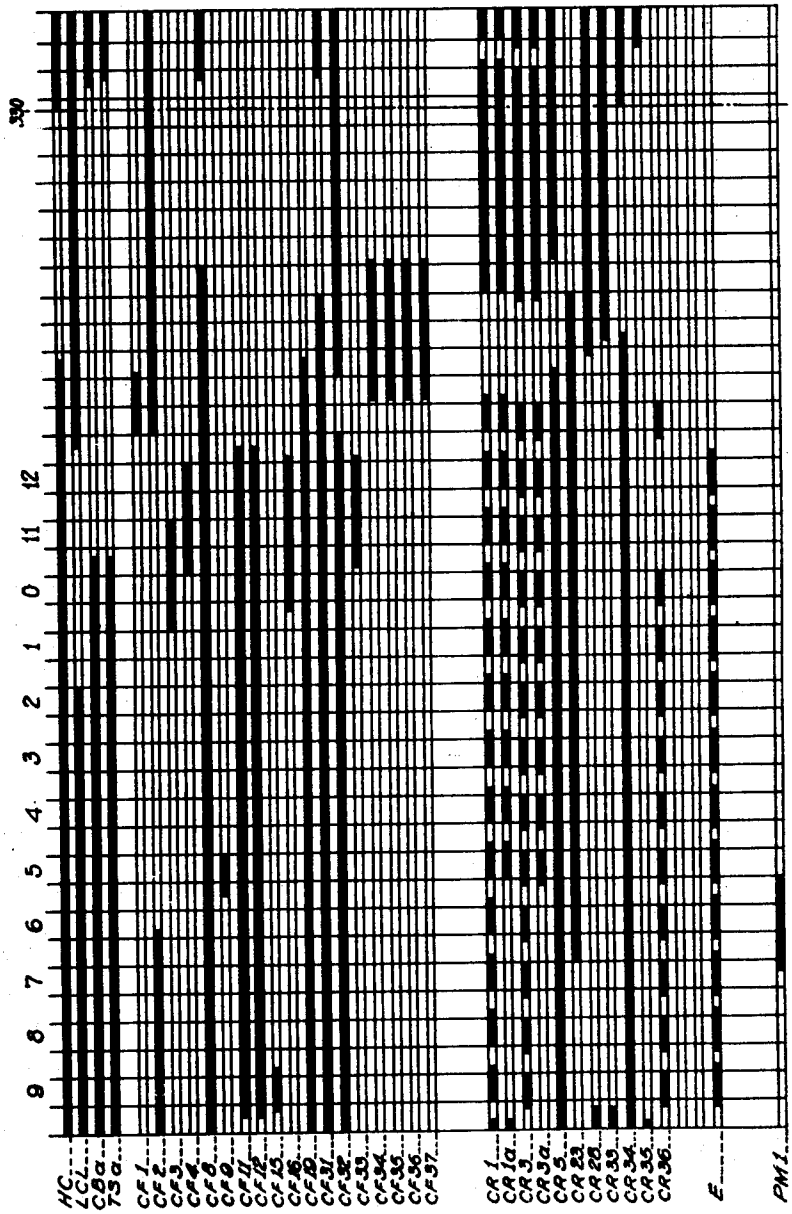
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RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

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FIG.11.



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FIG. 12.

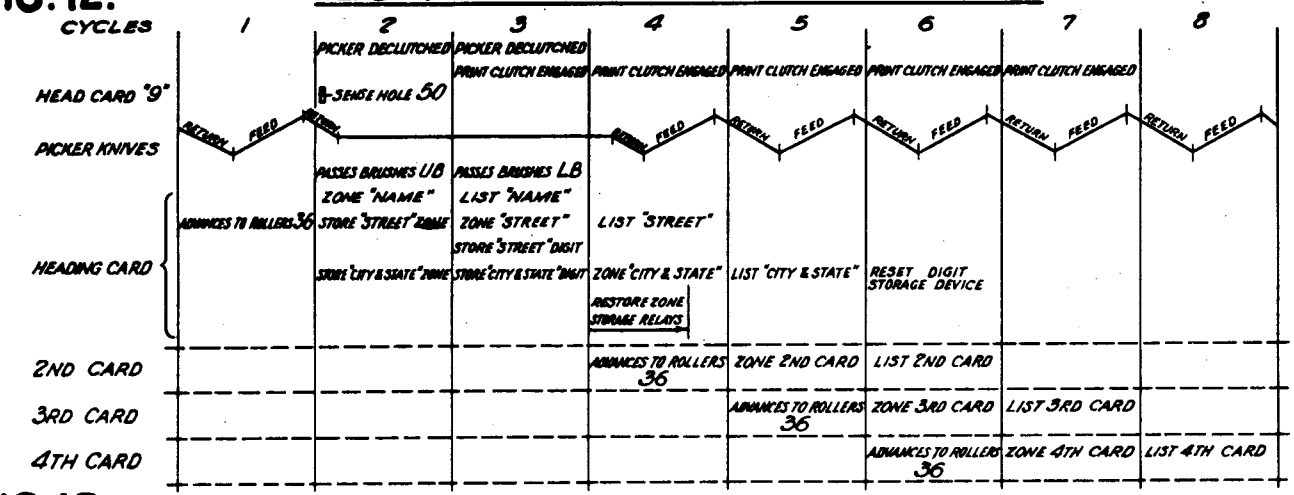
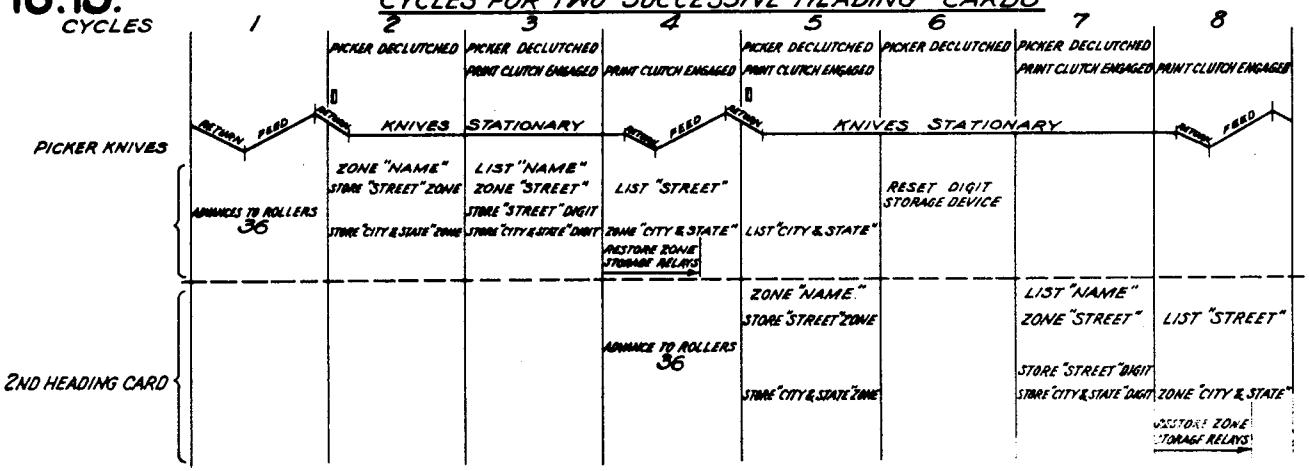


FIG. 13.



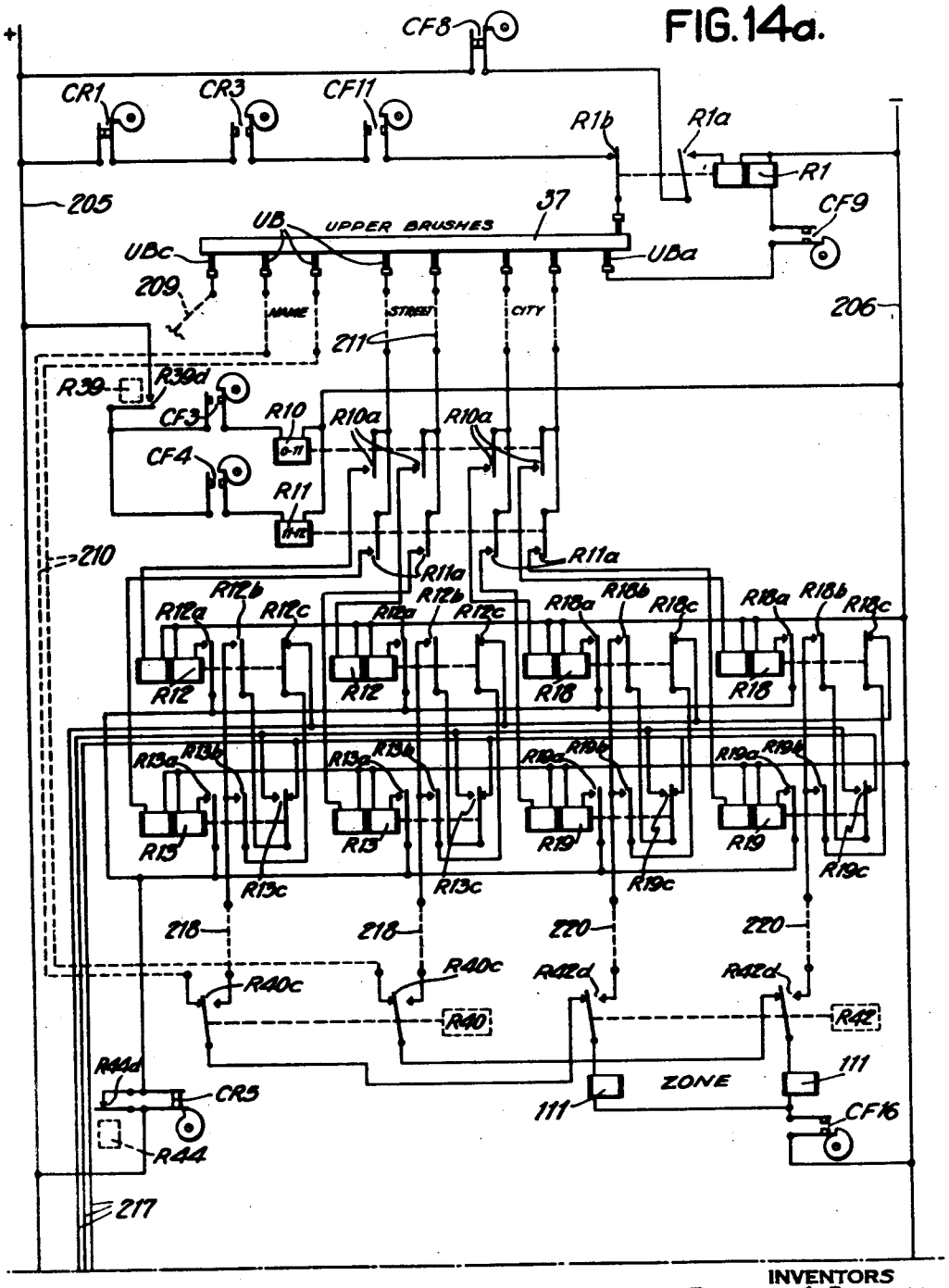
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RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

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FIG. 14a.



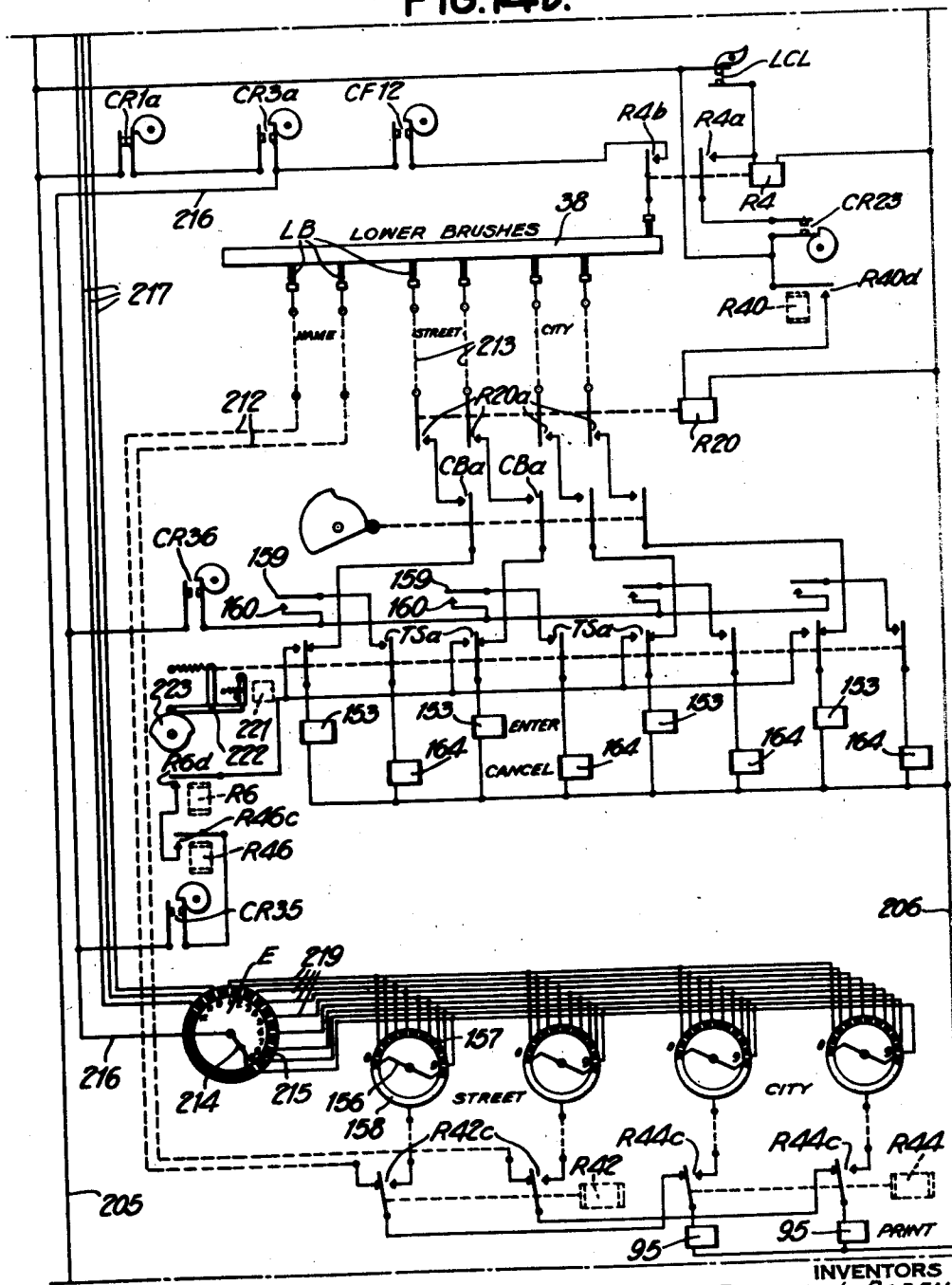
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RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

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FIG. 14b.



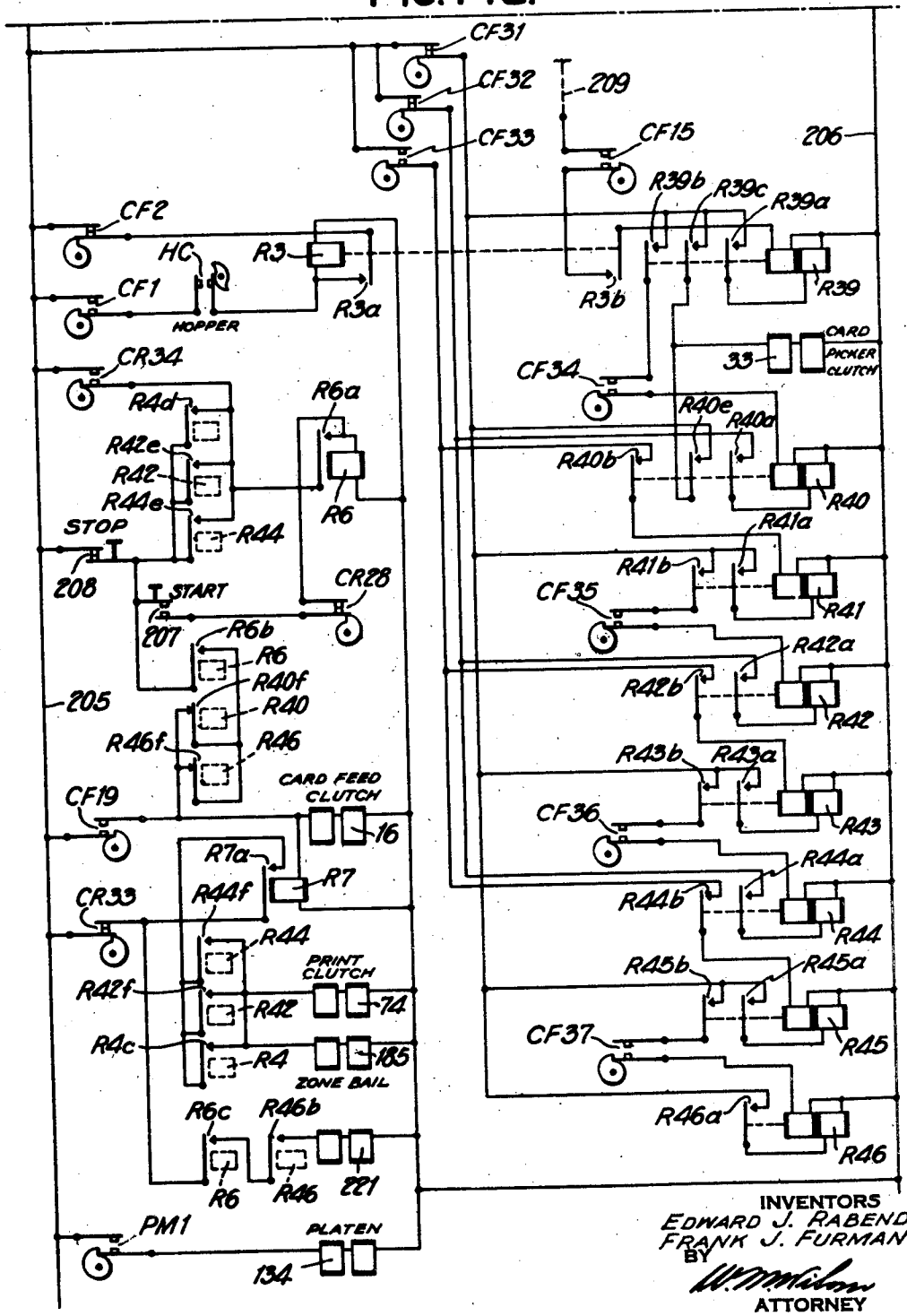
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RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

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FIG. 14c.



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UNITED STATES PATENT OFFICE

2,426,049

RECORD CONTROLLED MULTIPLE LINE PRINTING MECHANISM

Edward J. Rabenda, Binghamton, and Frank J. Furman, Endicott, N. Y., assignors to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application September 16, 1943, Serial No. 502,614

2 Claims. (Cl. 101—93)

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This invention relates to printing machines and more particularly to printing machines of the type controlled by perforated record cards.

The principal object of the invention is to provide a printing machine for preparing statements or invoices in which the name and the address of the addressee are printed at the head of the statement or invoice and various detail items are listed in the body of the invoice.

A further object of the invention is to provide an improved card feeding mechanism for handling groups of cards, each group including at its head a single name and address card followed by detail cards.

A further object of the invention is to provide improved mechanism for causing three different items of information recorded on a single record card to be printed on three successive lines of a statement or invoice.

Other objects of the invention will be pointed out in the following description and claims and illustrated in the accompanying drawings, which disclose, by way of example, the principle of the invention and the best mode, which has been contemplated, of applying that principle.

In the drawings:

Fig. 1 is an outside view of the card feeding and handling mechanism of the machine.

Fig. 2 is a section taken centrally through the card feeding and handling mechanism.

Fig. 3 is a central section of the printing mechanism of the machine.

Fig. 4 is an outside view of the printing mechanism.

Fig. 5 is a detail of the operating mechanism for the printing type bars.

Fig. 5a is a detail of the cams for operating the zoning mechanism.

Fig. 6 is a detail of a device for storing a part of the address data.

Fig. 7 is a section taken along lines 7—7 of Fig. 6.

Fig. 8 is a section taken along lines 8—8 of Fig. 7.

Fig. 9 is a diagram showing a typical group of cards.

Fig. 10 is a sample of an invoice prepared under control of the group of cards of Fig. 9.

Fig. 11 is a timing diagram of certain of the cam controlled contact devices.

Fig. 12 is a diagram illustrating the sequence of operations involved in handling a group of record cards.

Fig. 13 is a further diagram similar to Fig. 12 for a different card arrangement.

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Figs. 14a, 14b, and 14c placed one above the other in the order named constitute a wiring diagram of the electric circuits of the machine.

Before explaining the manner in which the machine operates in its entirety, the various mechanical units will be separately described, after which a typical problem will be considered and the various steps involved in preparing a statement will be explained to set forth the coordination of the separate units.

Card feeding mechanism

Referring to Fig. 1, the main drive shaft of the machine is shown at 10 and this may be driven and maintained in constant operation through any suitable connection to a driving motor or other source of energy. Secured to shaft 10 is a clutch driving disk 11 cooperating with a dog 12 mounted upon an arm 13, to which is fixedly connected a gear 14 to drive the card feeding and analyzing mechanism through an idler gear 15. The engagement of these clutch elements is controlled by a magnet 16 and armature latch 17. The armature latch 17 normally holds dog 12 out of engagement with the driving disk 11 and in the position shown in Fig. 1. Magnet 16, upon energization, rocks armature latch 17, releasing dog 12 so that its spring 18 may bring it into engagement with driving disk 11. Upon deenergization of magnet 16, armature 17 will be moved by its spring into the path of a projecting toe of dog 12 to throw the dog out of engagement with disk 11. Arm 13 will be similarly engaged by armature 17 to prevent further movement of gear 14 in a clockwise direction.

The idler gear 15, through a further intermediate gear 19, drives a large gear 20 from which the feed rollers, picker mechanism, and stacker are driven, as will be explained.

Referring to Fig. 2, the record cards are fed singly from the supply magazine 21 by the usual card picker mechanism comprising a slidably mounted plate 22 carrying a picker knife 23 for cooperation with the record cards. The plate 22 has a pin and slot connection with an arm 24 secured to a rod 25 which has secured at its end (see Fig. 1) an arm 26 which is normally urged in a counterclockwise direction against a stop 27 by a spring 28. Arm 26 has pivoted thereto a dog 29 arranged for engagement in a suitable notch in an arm 30 which is freely pivoted on rod 25. Arm 30 has connected thereto one end of a link 31 whose opposite end is eccentrically connected to a gear 32 driven by the large gear 20.

The arm 30 is thus invariably oscillated once for each cycle of the machine.

If during the counterclockwise or return stroke of arm 30 magnet 33 is energized, the free end of its armature will lie in the path of the short arm of dog 29 so that, when the dog reaches its home position, it will be rocked to the dotted line position shown and, if magnet 33 is held energized, arm 26 will not follow arm 30 on its next operating stroke. Consequently, the picker mechanism will not advance a record card during the next operation of arm 30. Gear 32 is arranged to make one revolution for each card cycle of the machine and, as long as dog 29 remains in engagement with arm 30, a card will be fed for each cycle. When magnet 33 is energized, it will cause the picker mechanism to skip a cycle so that the machine will go through an operation without advancing another card. The manner in which magnet 33 is controlled will be explained in connection with the circuit diagram.

The picker knife 23 advances the record cards singly from the bottom of the stack through throat 35 (Fig. 2) to the first of a series of pairs of rollers 36 which convey the card in an arcuate path between suitable guide plates. The pairs of rollers 36 are driven through the gearing indicated in Fig. 1 from the large gear 20. Disposed in the path of the record cards are two analyzing stations at the first of which upper brushes UB, cooperating with a contact roller 37, sense the perforations; then lower brushes LB, cooperating with contact roller 38, read the card a second time. The brushes are so spaced that, when brushes LB sense a particular index point position of a record card, the brushes UB sense the corresponding index point positions of the next following card.

Intermediate the brushes UB and LB is a card lever 40 which, as a record card approaches the brushes LB, will close card lever contacts LCL. As the cards continue in their travel after having passed the last brush station, they are advanced to the stacker drum 42 upon which are pivoted spring pressed clips 43 which cooperate with a fixed cam roller 44, so positioned that as the clips pass a point tangent to the end of the circular card path they open to permit the leading edge of the card to enter between the periphery of the drum and the clips, which thereafter close upon the card and draw it into the discharge stacker 45. Drum 42 is geared to rotate once every four card cycles. In the discharge hopper the cards are stripped from the clips in the usual manner and, as the cards accumulate therein, the pusher plate 46 is urged toward the left.

Printing mechanism

Referring to Fig. 4, the main drive shaft 10 of the machine carries a notched disk 67 adjacent to gear 68, which disk is adapted to be engaged by a dog 69 pivotally mounted upon an arm 70, which arm is integral with the gear 68. Through an intermediate gear 71 meshing with a gear 72, the printing drive shaft 73 is driven. Driving connection is established upon energization of print clutch magnet 74 which rocks its armature 75 counterclockwise to release dog 69 for engagement with the constantly running notched disk 67. Secured to the shaft 73 (Fig. 5) is a pair of complementary cams 66 which is adapted to oscillate a bifurcated follower arm 65 secured to a rod 76 upon which is also attached an arm 77 which has link connection 78 to an arm 79 secured upon a shaft 80. In Fig. 3, shaft 80 carries arms 81 which have depending link connection 82 with a bail 83 pivoted at 84. Also pivoted at 84 are type carrier actuating arms 85 which are connected at their free ends to the lower extremity of type carriers 86 through link connections 87. Arms 85 are urged in a clockwise direction by springs 88 which are connected at their upper ends to a cross bar extending between arms 81. Thus, as the arms 81 and bail 83 are rocked in a clockwise direction through the action of cams 74, the springs 88 will rock the arms 85 in the same direction and will cause elevation of the type carriers 86 which are suitably mounted for vertical movement.

The type carriers are provided with type elements for printing the letters of the alphabet as well as the digits and is substantially that shown in the Patent No. 2,016,682, granted to A. W. Mills, October 8, 1935, so that a brief description herein will suffice to explain its manner of operation. It includes the usual platen 89 past which the type carriers 86 are reciprocated. The head 86*a* of each type carrier 86 has type elements 90 adapted to print the numerals 1 to 9 and the letters A to Z. The type elements are arranged in nine groups in the following order: 9,I,R,Z; 8,H,Q,Y; 7,G,P,X; 6,F,O,W; 5,E,N,V; 4,D,M,U; 3,C,L,T; 2,B,K,S; 1,A,J. Near the bottom of the type head are two zero type elements. The numerical type elements 90 correspond to the usual numerical type elements of a conventional Hollerith type bar, but are spaced far enough apart to make room for three alphabet type elements between successive numeral type elements which are selected for a printing operation in the same manner as in conventional Hollerith tabulating machines, for instance, as in Patent No. 1,822,594, under control of a perforation in one of the index point positions 1 to 9 of a record column. The alphabetic type elements are selected under control of combinations of perforations, each of which may comprise a perforation in one of the index point positions 0, 11, and 12, with another in one of the remaining nine index point positions.

The selection of the alphabetic type elements 90 is effected by arresting each carrier 86 in the appropriate position corresponding to the value of the perforation in index point positions 1 to 9 of the record card and by further movement of the type head 86*a* relative to its carrier one, two, or three steps, according to whether the other perforation of the combination necessary for a selection is in the 12, 11, or 0 position. The mechanism which effects relative movement between each carrier 86 and its type head 86*a* may be termed the zoning mechanism. Each carrier is provided with a series of stops 91 which represent the corresponding index point positions 0 to 9 on the record card. As the carrier is moved upwardly, the stops 91 move in succession to pass a stopping pawl 92. The latter is held in the position of Fig. 3 by a latch 93 which has connection 94 with the armature of the usual printing magnet 95. When a carrier is used to print numerals only, it will, of course, be controlled by a single perforation in one of the index point positions 0 to 9, inclusive. In such case, each type head and its carrier 86 is maintained in the relationship shown in Fig. 3 and as the card is analyzed, a circuit is completed through a perforation in the card which will energize the magnet 95 in the well known manner and will effect a release of pawl 92, causing it to engage the stop 91 cor-

responding in value to the location of the single perforation in the record card column. This operation results in bringing the corresponding numeral type element to the printing line.

The carrier 86 is provided with a slot 96 and a guide 97 which are adapted to receive a slotted block 98 and the lower end 99 respectively of the type head 86a, the block sliding within the slot 96 and the lower end 99 sliding in the guide 97.

A spring 100, whose lower end is anchored to the carrier 86, is provided at its upper end with a hooked member which engages the lower edge of an opening in the shank of the type head, the spring 100 tending to resiliently hold the head in cooperation with the carrier 86. Mounted upon the lower portion of each carrier 86 is a slide 101 provided with grooved blocks 102 which cooperate with suitable slots in the carrier 86. A spring 103, anchored at its lower end to the carrier and at its upper end to the slide 101, tends to move the slide downwardly to bring a shoulder 104 in the slide into engagement with a block 105 riveted to the carrier 86. With the parts assembled as in Fig. 3, the spring 103 urges the type head 86a in the same direction so that the lower end 99 thereof engages the slide 101. It is plain that, if the slide 101 is moved upwardly relative to the carrier 86, the type head 86a will move likewise. A spring-pressed latch 106 pivoted at the lower end of the carrier 86 is adapted to cooperate with three shoulder stops 107 formed in the lower end of slide 101. When the slide is moved upwardly one or more steps with respect to the carrier, the latch 106 will cooperate with one of the stops 107 to hold the parts in their displaced relationship.

Associated with each alphabetical type bar assembly is a vertically slidable comb 108 which is adapted to be moved downwardly and then upwardly during each cycle of the machine. Each comb has a series of three stops or lugs 109 which, on the upward movement of the comb, pass a stopping pawl 110 in synchronism with the passage of the zone perforations 0, 11, and 12 by the upper analyzing brushes of the machine. Each pawl 110 is controlled by a zone magnet 111, the energization of which operates its armature to release pawl 110, allowing the latter to be moved by its spring into engagement with one of the stops 109. By this action, further upward movement of the comb 108 is prevented for the time being. The combs 108 are moved upwardly by means of springs 112 and moved downwardly by a bail 113 secured to a shaft 114. The bail engages the upper ends of the combs and moves the latter downwardly whenever the shaft 114 is rocked at the proper time.

The comb 108 has pivoted thereto an arm 115 whose free end lies in the path of movement of the associated slider 101 and whose lower edge rests upon a bail 116 which is pivoted at 117. Under control of the zone perforations the pivot point of arm 115 may take one of three positions below that of Fig. 3. In this figure, the parts are shown with the comb in the position it assumes when no zone holes are present in the card, that is, when numerals only are to be printed. When the carrier 86 is in its lowermost position, the bail 116 is rocked in a counterclockwise direction to move the arm 115 in a similar direction into engagement with the lower extremity of slide 101. It will be apparent that the distance which the free end of arm 115 is moved upwardly under control of the bail 116 depends upon the location

of the pivot point of arm 115 at such time. Thus, if the pivot point is located as shown in Fig. 3, the free end of arm 115 will be moved upwardly to a position where it barely touches slide 101. A zone perforation in the zero index point position will result in the movement of the free end of arm 115 three steps upwardly from the position of Fig. 3. A perforation in the 11 position will cause it to move two steps while a perforation in the 12 position will cause it to move only one step above the position in Fig. 3. These steps of movement are, of course, transmitted to the slide 101 and it, in turn, will be moved upwardly 1, 2, or 3 steps in accordance with the setting of the related comb 108, the latch 106 carried by the carrier 86 serving to hold the slide in its displaced position with respect to the carrier.

It will be understood from the foregoing description and the more detailed explanation found in Patent No. 2,016,682, that in the case where a perforation occurs in one of the 1 to 9 index point positions only, the mechanism controlled by the zone magnets 111 will not be effective to shift slide 101 relative to carrier 86 and the type bar assembly will be arrested differentially, purely by the operation of print magnet 95, as in former Hollerith tabulating machines.

Bail 116 is actuated through the medium of a toggle mechanism comprising links 170 one of which is pivoted to the bail 116 and the other is pivoted to an arm 171. The point of connection of the links carries an arm 172 which is also pivoted to an arm 173 secured to a shaft 174. Referring to Fig. 5a, shaft 174 also carries an arm 175 which has link connection with an arm 176 secured to a rod 177. A follower arm 178 on rod 177 is actuated by a cam 179 on shaft 180.

Referring to Fig. 3, an arm 181 carried by a rod 182 is adapted to be rocked from its dotted to its full line position prior to the straightening of the toggle links 170 so that, when shaft 174 is rocked in a counterclockwise direction under control of its cam 179, the arm 171 will be restrained against movement and the straightening of the toggle will move the bail 116 upwardly. In Fig. 5, rod 182 carries an arm 183 whose upper end is adapted to be engaged by the free end of an armature 184 of magnet 185. Energization of magnet 185 will permit arm 183 to rock in a counterclockwise direction under the influence of its spring and thereby carry with it rod 182 and the arm 181.

Referring to Fig. 5, the shaft 114 has arm and link connection 186 with an arm 187 on a shaft 188 which carries a bail 189 (see also Fig. 3); through this connection rocking of shaft 114 to restore the combs 108 will also cause clockwise rocking of bail 189 to restore the latches of pawls 110. Shaft 188 has arm and link connection 190 with an arm 191 on rod 182 to cause relatching of arm 183 against the free end of armature 184.

As the type carrier 86 descends from printing position with the slider 101 held in displaced position by latch 106, it is necessary to first restore the slider to its lowermost position before effecting a new zone setting thereon. To this end a bail 192 is provided which is moved to the dotted line position of Fig. 3 before the carrier reaches the lower extremity of its movement. In such position the bail 192 is in the path of an extending arm of latch 106 and as the carrier continues its descent the extension will engage bail 192 and cause clockwise rocking

of latch 106 to release slide 101. Following this action, the bail 102 is lowered and the slide 101 is in readiness to receive a new setting under control of arm 115.

In Fig. 5a, bail 102 is carried by a shaft 193 which through arm and link connection 194 is connected to an arm 195 secured upon shaft 196, which shaft also carries a follower arm 197 cooperating with a cam 198 on shaft 180. Shaft 114 of bail 113 also carries an arm 199 whose free end has a roller in cooperation with an arm 200 secured upon a shaft 201. Shaft 201 also carries a follower arm 202 in engagement with a cam 203 mounted on shaft 180. The shaft 180 is driven from the main shaft 10 of the machine through gearing designated 204 in Fig. 3.

Mounted on the main drive shaft 10 or geared thereto are various cam operated contacts whose timing is indicated in Fig. 11 and which are designated with the prefix CR, indicating that these are contacts operated by constantly running cams making one revolution for each cycle of the machine. A cam operated contact prefixed PM is carried by the print shaft 76 and operated only when the shaft 73 is in operation.

Driven from the gear 15 (Fig. 1) are various other cam operated contacts, whose timing is indicated in Fig. 11 and which are designated with the prefix CF, indicating that these are contacts operated by cams which rotate only when the card feed mechanism is in operation.

Paper line spacing

Referring to Fig. 4, the statement or invoice is carried by the platen 89 supported by the paper carriage frame in the usual manner. Spacing of the platen is effected by the usual pawl and ratchet operated from shaft 118 journaled in the paper carriage. Fixed to shaft 118 is an arm 119 carrying a rod 120 cooperating with a bifurcated lever 121 mounted on stud 122. To this stud is secured an arm 123 connecting through link with an arm 125 on shaft 126.

In Fig. 5 the constantly running gear 127 on shaft 10 has affixed thereto a double cam 128 engaging a lever 129 urged by a spring into contact with the cam. An upwardly extending arm of lever 129 carries a stud 130 which moves in an L-slot of link 131. A nose 132 of link 131 rests upon armature 133 of a magnet 134. The magnet 134, energized at a time when the follower roller of lever 129 is on the lower portion of cam 128 and stud 130 is to the right in the L-slot, will permit link 131 to be drawn down into operating relationship with the stud so that as lever 129 is rocked counterclockwise, shaft 126 will be actuated to cause spacing of platen 89. A spring 135 restores shaft 126 and connected links. Following each paper spacing operation, a pin 136 in the gear 127 coacts with bell crank 137 to positively raise link 131 out of active engagement with the stud in the L-slot and latch it on armature 133. The double rise on cam 128 permits a second paper spacing operation of the above described instrumentalities. Thus, if during the same cycle magnet 134 is energized a second time, an additional paper spacing operation will be effected. The manner in which the magnet 134 is controlled will be explained in connection with the circuit diagram.

Storage mechanism

The machine is provided with a storage device in the form of a well known type of accumulator. Such device is shown in Figs. 6, 7 and 8 and reference may be had to Patent 2,165,288, granted July 11, 1939, for a more detailed disclosure. A brief explanation of its operation will now be given.

Shaft 140 (Fig. 6) is continuously driven from main shaft 10 and makes one revolution per machine cycle. A gear 141 on the shaft drives gear 142 (Fig. 7) freely about a post 143. Driven by gear 142 is a ratchet 144 which is axially movable but normally held in position shown in Fig. 7 by a leaf spring 145. Coaxial with driving ratchet 144 is a ratchet 146 which is part of the storage element comprising adding wheel 147 and tens carry cam 148 which are integral with a rod 149.

Ratchet 144 may be rocked into engagement with ratchet 146 to drive the latter and such rocking is effected by a beveled disk 150 carried by a bell crank 151 which is normally latched in the position shown in Fig. 6 by the armature 152 of entering magnet 153. When magnet 153 is energized, bell crank 151 is released and spring 154 will rock it to move disk 150 toward the axis of ratchet 144, thereby camming the ratchet 144 into driving engagement with the driven ratchet 146.

Gear 142 carries rollers 155 which strike lever 151 and effect uncoupling when the first roller reaches the nose of the lever. As is usual, magnet 153 is energized at differential times, i. e., one, two, three, etc., up to nine so-called cycle points before the first roller 155 effects uncoupling, so that the digital value entered into wheel 147 is dependent on such time of energization of magnet 153. Thus, if a 7 is to be entered, magnet 153 is energized seven points before the knockout position and wheel 147 will have been advanced seven steps.

Secured to shaft 149 (Fig. 8) is a brush structure 156 which is advanced with wheel 147 to successively connect segments 157 with a common conductor 158. Thus, when a 7 is entered, brush 156 is advanced seven steps from its home position of Fig. 8 to a position where one of the brushes contacts the 7 segment 157 and the other contacts the common conductor 158 to form an electrical connection therebetween.

The carry cam 148 controls the usual tens carry contacts comprising movable contact blade 159 and stationary blade 160 which function so that, whenever the wheel passes from 9 to 0, member 162 is rocked clockwise and held by latch 163 as shown in Fig. 6 to hold blade 159 in engagement with blade 160.

The blades 159, 160 do not function as carry contacts in the present case, inasmuch as the device is employed to receive only a single entry which is canceled before another entry is made. The blades are utilized in the canceling operation which is effected as follows. Magnet 153 is energized at a time to cause the wheel 146 to be driven ten steps, during which the wheel will pass from 9 to 0 with the resulting engagement of blades 159 and 160 which will cause energization of the cancel magnet 164. Magnet 164 attracts its armature 165 to release lever 166 for counterclockwise rotation about its pivot 167 under the influence of spring 154. Pin 168 will thereupon engage and rock bell crank 151 clockwise to uncouple the ratchets and leave the wheel 147 in its 0 or home position. The usual rollers are provided to release latch 163 and reset lever 166 and wheel 147 is detented in its positions through devices which are fully explained in the Patent 2,165,288 referred to.

Problem

Before explaining the manner of coordination of the several units that have been separately explained, the problem involved will be explained with particular reference to Figs. 9 and 10.

In Fig. 9 is shown a group of cards designated R of which the first or leading card is known as a heading or address card. On this card there is designated the complete name and address of a customer, which data is to be sensed by the analyzing brushes of the machine and printed on three lines of a bill or invoice as shown on the sheet S of Fig. 10. Heretofore, it has been the practice to employ more than one card for recording the name and address where they were to be printed on successive lines, and such prior practice is disclosed in the patent to A. W. Mills et al. #2,131,919, granted Oct. 4, 1938. Such practice requires care that the several cards comprising an address group are kept in proper sequence and that none are removed from the file. The present arrangement provides that all parts of a name and address remain together through any and all handling of cards. Thus, in Fig. 9 the address card contains the "name" in the left hand field, the "street" in the next field, and the "city" and "state" in the third field.

The data is recorded by combinational perforations in the well known manner, whereby digits are represented by perforations in the corresponding index point positions 9 to 0 and alphabetic characters are represented by a digit perforation 9 to 1 accompanied by a zone perforation in positions 0, 11, or 12. The cards pass through the machine with the 9 index point leading and each heading card is provided with a special identifying designation **50** (Fig. 9) made in the 9 position of a selected card column.

Circuit diagram

The complete operation will now be explained cycle by cycle to point out how the cards of the group of cards of Fig. 9 are fed and sensed to control the printing of the invoice of Fig. 1*e*. In the following, reference is to be made to Fig. 11 for the timing of contacts involved, Fig. 12 for the main operations taking place in the succession of cycles, and Figs. 14*a*, 14*b* and 14*c* for the circuits.

Preliminary operations.—In the circuit diagram, the connections required for only two columns in each of the three address fields are shown to avoid repetition, and plug connections are indicated in dotted lines. A number of relays is employed which have been identified by the prefix R followed by a numeral. Contacts controlled by the relays are given the same reference character followed by a lower case letter for ready identification. In order to simplify the wiring arrangement, the contacts have in some cases been shown remote from their controlling relays, and in such cases the system of identification will serve to associate them and in addition the relays have been dotted adjacent to the contacts which they control.

When the group of cards has been placed in the supply hopper **21** of Fig. 2, so-called hopper contacts HC (Fig. 14*c*) close and remain so as long as there are cards in the hopper. The mechanical construction of these contacts is not illustrated as it is well known.

Current is supplied to main lines **205**, and **206**, and upon closure of start key contacts **207** (Fig. 14*c*) a circuit is completed from line **205**, stop key contacts **208**, contacts **207**, contacts CR**28**, relay R**6** to line **206**. Relay R**6** closes its contacts R**6***b*, completing a circuit from line **206**, stop key contacts **208**, contacts R**6***b*, normally closed relay contacts R**40***f* or R**46***f*, card feed clutch magnet **16**, and relay R**7** in parallel therewith, to line **206**.

As a result, the card feed mechanism is brought into operation and the CF cam contacts function in time with the constantly running CR contacts.

Cycle 1

During the first card feed cycle, identified as cycle 1 in Fig. 12, the address or heading card is advanced up to the first pair of feed rollers **36** (Fig. 2) which bring it up to brushes UB in readiness to pass the same during the next cycle. When cam contacts CF1 close, a circuit is completed from line **205**, contacts CF1, hopper contacts HC, relay R**3** to line **206**. Relay R**3** closes its contacts R**3***a* to establish a holding circuit through contacts CF**2** which will keep relay R**3** energized through the 7 point of the following cycle (see Fig. 11).

During this cycle a further circuit is completed from line **205** (Fig. 14*a*), contacts CR1, CR**3**, CF11, relay contacts R1*b*, the upper brush contact roller **37**, special brush UB*a* (since no card is at brushes UB at this time), which traverses the unpunched margin of the cards, contacts CF**9**, relay R1, to line **206**. Relay R1 closes its contacts R1*a* to set up a holding circuit through contacts CF**8** and the second winding of the relay. It also opens its contacts R1*b* to break the circuit to the common contact roller **37** so that, at the same time in the cycle at which the zone holes are sensed, there is no current on the brushes UB. It is to be noted that in this cycle there is no card between brushes UB and their contact roller.

At the end of this cycle the feed declutches and stops, and it is necessary to again depress the start key or alternatively hold it depressed until a second cycle has commenced.

Cycle 2

At the commencement of this cycle the heading card passes between brushes UB and roller **37**, thus insulating special brush UB*a* so that relay R1 is not energized and contacts R1*b* remain closed. Since this first card is a heading card, it contains the special hole **50** in the 9 position which completes a circuit from line **205** (Fig. 14*a*), contacts CR1, CR**3**, CF11, R1*b*, roller **37**, hole **50**, brush UB*c*, plug connection **209** (Fig. 14*c*), contacts CF**15** (timed to close at the **9** time), contacts R**3***b* (now closed), relay R**39** to line **206**. Relay R**39** closes its contacts R**39***a* to set up a holding circuit through the second winding and contacts CF**31**.

Later in the cycle, the card engages the card lever **40** (Fig. 2) to close card lever contacts LC1 (Fig. 14*b*) which energize relay R**4**, which in turn closes its contacts R**4***a* in series with contacts CR**23**. Contacts CR**23** overlap the open period of the card lever contacts LCL, so that as long as cards continue to be advanced in succession relay R**4** will remain energized. The relay R**4** closes a pair of contacts R**4***d* (Fig. 14*c*) which short circuit the start key contacts **207** and keep relay R**6** energized and in turn the card feed clutch magnet **16** energized through a circuit from line **205**, contacts **208**, R**4***d*, R**6***a*, relay R**6** to line **206**, this circuit being established before contacts CR**34** reopen.

Relay R39 closes its contacts R39c (Fig. 14c) to energize the card picker clutch magnet 33, so that the second card is not advanced during this cycle. In the latter part of the cycle, when cam contacts CF34 close, a further circuit is completed from line 205, contacts CF31, contacts R39b, CF34, relay R40 to line 206. This relay closes its contacts R40a to set up a holding circuit through contacts CF32 and also closes its contacts R40e to complete a circuit from line 205, contacts CF32, R40e, card picker clutch magnet 33, to line 206. Thus, magnet 33 will remain energized throughout cycles 2 and 3 while the heading card passes brushes UB (see Fig. 12).

Zone "name."—As the 0, 11 and 12 positions of the heading card pass brushes UB during this cycle, circuits are completed to the zone magnets 111 to effect a preliminary zoning of the type bars, which at this time are at rest in their lowered position. The circuits completed in response to the sensing of zone holes are traceable from line 205 (Fig. 14a), contacts CR1, CR3, CF11, R1b, roller 37, zone holes in the "name" field of the card, plug connections 210, left hand contacts R40c, left hand contacts R42d, zone magnets 111, contacts CF16, to line 206. Thus, magnets 111 are energized at the 0, 11, or 12 time, depending upon the presence of perforations in such position. At such times, the teeth 109 of bars 108 (Fig. 3) are moving past pawls 110, so that the bars will be displaced according to the zone designations sensed and will adjust the pivot points of arms 115.

Later in the cycle, when cam contacts CR33 (Fig. 14c) reclose, a circuit is traceable from line 205, contacts CR33, R7a (now closed), R4c (now closed), present clutch magnet 74 and zone bail magnet 185 in parallel to line 206. Energization of magnet 185 will act as explained to enable bail 116 (Fig. 3) to rock arms 115 through varying angles and adjust zone bars 101 on the type carriers 86 to thus displace the type heads 86a in accordance with the zoning requirements of the "name" perforations. While the print clutch is tripped at this time, the type bars will not begin to rise until the beginning of the following cycle during which the digit positions of the card pass brushes LB and magnets 95 are energized to complete the selection of the type for printing the "name."

Store "street" zone.—Sensing of the "street" zone positions of the card is concurrent with the sensing of the "name" zone positions, but in the former case the zone data is entered into what may be termed zone storage relays, which will retain a setting of the zone until the following cycle after the "name" has been listed, when the storage relays will control the zone magnets 111.

Referring to Fig. 14a, cam contacts CF3 (see Fig. 11) close during the sensing of the 0 and 11 zone positions and contacts CF4 close during the sensing of the 11 and 12 zone positions, so that with contacts R39d closed a circuit is completed to energize relay R10 and close its contacts R10a, while the 0 and 11 zone positions of the card are being sensed and a parallel circuit is completed to energize relay R11 and close its contacts R11a, while the 11 and 12 zone positions are being sensed.

Accordingly, where a 0 zone hole occurs in a column of the "street," a circuit is traceable from line 205 (Fig. 14a), contacts CR1, CR3, CF11, R1b, roller 37, 0 hole, brush UB, connection 211, contacts R10a, relay R12, to line 206. If the

hole occurs in the 11 position, the same circuit is completed together with a parallel circuit from connection 211, contacts R11a, relay R13, to line 206. Finally, if the hole occurs in the 12 position, only the relay R13 is energized. Relays R12 and R13 close their respective contacts R12a and R13a to establish holding circuits through their second windings traceable from line 206, relays R12 and R13 in parallel, contacts R12a and R13a, normally closed relay contacts R44d to line 205. These holding circuits are maintained until two cycles later.

Store "city and state" zone.—In the same manner as explained for the "street" zone, the zone of "city and state" is set upon relays R18 and R19 and such settings are maintained through contacts R44d.

Briefly, for cycle 2, the sensing of the special hole 50 in the heading card causes energization of relay R39 which acts to cause the zone data of "street" and "city and state" to be stored in the relay storage device. The "name" is directly zoned, that is, the sensing brushes directly energize the zone magnets 111. Card picking is interrupted.

Cycle 3

List "name."—During this cycle the heading card passes brushes LB, while the type bars rise in synchronism therewith, and circuits are completed to the print or list magnets 95 to position the type bars in accordance with the "name" data. A representative circuit is traceable from line 205 (Fig. 14b), contacts CR1a, CR3a, CF12, R4b (now closed), roller 38, digit holes in the "name" field of the card, brush LB, connection 212, left hand contacts R42c, left hand contacts R44d, print magnets 95 to line 206. Later in the cycle the print hammers are tripped as usual to transfer the type bar setting of the "name" to the invoice.

Store "street" digit—Sensing of the "street" digit positions 9–1 is concurrent with the sensing of the "name" digit positions and the former are entered into the storage device of Figs. 6, 7 and 8, where this data is retained for controlling the print magnets 95 in later cycles. Referring to Fig. 14b cam contacts CBa are closed (see Fig. 11) during the digit sensing part of the cycle, so that in the "street" field circuits may be completed from line 205, contacts CR1a, CR3a, CF12, R4b, roller 38, brush LB, connection 213, contacts R20a (closed as will be presently explained), contacts CBa, normally closed contacts TSa, entering magnets 153, to line 206. The timed energization of magnets 153 will position their related readout brushes 156 at segments 157 corresponding to the value of the digits sensed in the "street" columns.

It was previously explained how relay R40 (Fig. 14c) became energized in cycle 1, and is held during this part of cycle 2. A pair of contacts R40d (Fig. 14b) is accordingly closed to energize relay R20 throughout the period indicated by the closure of contacts CF32 (Fig. 11).

Store "city and state" digit.—In the same manner as explained for the "street" digits, the digits of "city and state" are set up in the storage device and represented on the read-out brushes 156 of Fig. 14b.

Zone "street."—During this cycle the zone data for the "street" which is stored in relays R12 and R13 will control the zone magnets 111 in the following manner: An emitter E (Fig. 14b) has a continually running brush 214 traversing segments 215 at the times denoted, so that at the 0,

11 and 12 times in the cycle successive circuits are completed from line 205, contacts CR1a, CR3a, wire 215, brush 214, segments 0, 11 and 12 in succession, to wires 217 which extend to Fig. 14a.

If a 0 zone is stored (in which case relay R12 is energized), the circuit extends from the 0 wire 217 (Fig. 14a), right hand contacts R13c, contacts R12b, connection 218, right hand contacts R40c (now closed), left hand contacts R42d, zone magnet 111, contacts CF16 to line 206.

If an 11 zone is stored (in which case both relays R12 and R13 are energized), the circuit extends from the 11 wire 217, left hand contacts R13c, contacts R12b to zone magnet 111 as before.

If a 12 zone is stored (in which case relay R13 is energized), the circuit extends from the 12 wire 217, contacts R12c, R13b, connection 218 to zone magnet 111 as before.

Thus, during cycle 3 the "name" is listed and the type bars are zoned, preparatory to listing the "street" in the next following cycle, and the paper is spaced. When cam contacts CF33 close during this cycle (see Fig. 11), they complete a circuit from line 205 (Fig. 14c), contacts CF33, contacts R40b (still closed at this time), relay R41 to line 206. Relay R41 closes its contacts R41a to provide a holding circuit through contacts CF31 and also closes a pair of contacts R41b, through which a circuit is traceable from line 205, contacts CF31, R41b, CF35, relay R42, to line 206. Relay R42 in turn closes its contacts R42a to set up a holding circuit through contacts CF32, which will keep relay R42 energized throughout the card sensing portion of the next following cycle. Relay R40 becomes deenergized when contacts CF32 open in the present cycle and opens its contacts R40e, so that the card picker clutch magnet 33 becomes deenergized and permits a card to be advanced from the hopper during the next cycle.

Cycle 4

List "street."—During this cycle, relay R42 is energized while the type bars rise and during this period the digit settings of the "street" will control the positioning of the type bars through circuits traceable from line 205 (Fig. 14b), contacts CR1a, CR3a, wire 216, brush 214 of emitter E, wires generally designated 219, segments 157 of the "street" commutators, brushes 156, conductors 158, right hand contacts R42c (now closed), left hand contacts R44c, print magnets 95, to line 206. The circuits will be completed at differential times corresponding to the digital setting of brushes 156.

Zone "city and State."—During the zoning period of the cycle, the zone magnets 111 are energized to set up the zone of the last or third line to be printed, through circuits traceable from line 205 (Fig. 14b), contacts CR1a, CR3a, wire 216, brush 214, segments 0, 11 and 12 in succession to wires 217 which extend to Fig. 14a.

If a 0 zone is stored (in which case relay R18 is energized), the circuit extends from the 0 wire 217, right hand contacts R19c, contacts R18b, connection 220, to right hand contacts R42d (now closed), zone magnet 111, contacts CF16 to line 206.

If an 11 zone is stored (in which case both relays R18 and R19 are energized), the circuit extends from the 11 wire 217, left hand contacts R19c, contacts R18b to zone magnet 111 as before.

If a 12 zone is stored (in which case relay R19 is energized), the circuit extends from the 12 wire 217, contacts R18c, R19b, connection 218 to zone magnet 111 as before.

When contacts CF33 close during this cycle, a circuit is completed from line 205 (Fig. 14c), contacts R42b, relay R43, to line 206. Relay R43 closes its contacts R43a to set up the holding circuit through contacts CF31 so that, when contacts CF32 close later, a circuit is completed from line 205, contacts CF32, contacts R43b, contacts CF36, relay R44 to line 206. Relay R44 closes its contacts R44a to set up a holding circuit through contacts CF32 which keep the relay energized through the entering period of the next cycle.

Relay R44 also opens its contacts R44d (Fig. 14a) and, when contacts CR5 open about the same time, the holding circuits of the storage-relays R12, R13, R18 and R19 are broken, and such relays are deenergized and placed in readiness to receive further zone data.

In the meantime the second card is being advanced to rollers 36 and fed up to the brushes UB in readiness to pass them during the next cycle.

Cycle 5

List "city and state."—During this cycle relay R44 is energized while the type bars rise and during this period the digit settings of "city and state" will control the positioning of the type bars through circuits traceable from line 205 (Fig. 14b), contacts CR1a, CR3a, wire 216, brush 214 of emitter E, wires generally designated 219, segments 217 of the "city and state" commutators, brushes 156, conductors 158, right hand contacts R44c, print magnets 95 to line 206.

Zone second card.—During this period the digit positions of the second card are passing brushes UB and thereafter, as the zone positions pass these brushes, zoning circuits are completed in the same manner as explained for the "name" field of the address card to directly energize the zone magnets 111. A representative circuit is traceable from line 205 (Fig. 14a), contacts CR1, CR3, CF11, R1b, roller 37, zone hole in the card, brush UB in line with the left hand field of the card, connection 210, left hand contacts R40c, left hand contacts R42d, zone magnet 111, to line 206.

During this cycle the third card is advanced by the picker to a position just short of brushes UB. When contacts CF33 close during this cycle, relay R45 (Fig. 14c) becomes energized through contacts R44b and in turn closes its contacts R45a to set up a holding circuit through contacts CF31 so that again, when contacts CF32 close, a circuit is traceable from line 205, contacts CF32, contacts R45b, contacts CF37, relay R46 to line 206. Relay R46 closes its contacts R46a to establish a holding circuit through contacts CF31, which hold the relay energized until the point at which contacts CF31 open in the following cycle (see Fig. 11).

Cycle 6

In this cycle, as the digit positions of the second card pass brushes LB, circuits are completed to the print magnets 95 as for the "name" field of the preceding card, so such circuit need not be retraced. Also, as the zone positions of the third card pass brushes UB, the zone circuits are completed just as for card 2 in the preceding cycle.

From this point on, as long as detail cards (i. e. cards not having the special hole 50 therein) continue to occur, each card will be zoned as it passes brushes UB and listed as it passes brushes LB with zoning of one card and listing of the preceding card occurring in the same cycle in the manner usual in prior alphabetic printing machines.

Reset digit storage devices.—Relay R46 closes its contacts R46*b* (Fig. 14*c*) so that a circuit is completed from line 205, contacts CR33, R6*c* (now closed), R46*b*, magnet 221, to line 206. Referring to Fig. 14*b*, magnet 221 when energized attracts its armature to release a follower 222 for cooperation with a constantly running cam 223 which will then function to shift contacts designated TS*a* at the time designated in Fig. 11. Accordingly, when cam contacts CR35 (Fig. 14*b*) close, a circuit is traceable from line 205, contacts CR35, R46*c*, R6*d*, left hand contacts TS*a*, all of the entering magnets 153, to line 206. These parallel circuits occur in time to initiate rotation of the storage wheels which, if not interrupted, will make a ten step advance and those that stand at 0 will take ten steps and return to 0. Others standing at a significant digit will advance to 0 and will be declutched at such position as will now be explained.

As already explained, when any storage wheel passes from 9 to 0, blades 159 and 160 engage and, when this occurs, a circuit is traceable from line 205 (Fig. 14*b*), contacts CR36, blade 160, blade 159, contacts TS*a*, related cancellation magnet 164 to line 206. In this manner the digit storage device is reset to 0.

Cycles 7 and 8

The operations in these cycles will be apparent from Fig. 12 and during them the card feed clutch magnet 16 is held energized through closed contacts R6*b*, while the print clutch magnet 74 and the zone bail magnet 185 are held energized through the card lever relay contacts R4*c*.

For each cycle of operation of the printing mechanism, there is a paper spacing action so that for the group of cards indicated in Fig. 12 there will be three lines printed under control of the heading or address card and one line each for the following detail cards.

Successive heading cards

In Fig. 13 is illustrated the succession of events occurring where two cards in succession contain the special perforation 50. In such case there will be three lines printed for each of the two cards and for convenience of explanation the data on the two cards will be called address data, although it is apparent that different data may be recorded in the two cards. The arrangement is such that, briefly, all cards with the special hole 50 will print three lines while all others will print only a single line.

With two successive heading cards, the cycles 1 to 4 inclusive of Fig. 13 are the same as for Fig. 12. At the beginning of cycle 5 the special hole 50 in the second heading card is sensed and through the circuits already traced for cycle 2 relay R39 (Fig. 14*c*) is again energized and will declutch the card picker so it remains stationary.

Cycle 5

During this cycle 5, the "city and state" are listed for the first card just as before. The "name" of the second card is zoned directly and the "street" and "city and state" zone data of the second card are entered in the storage relays R12, R13, R18 and R19 as for the first card.

Relay R46 is energized near the end of this cycle just as explained for cycle 5 of Fig. 12 and, when contacts CF34 close, relay R40 (Fig. 14*c*) is also energized. With both relays R40 and R46 energized, the parallel contacts R40*e* and R46*c* (Fig. 14*c*) are open to break the card feed clutch

circuit to magnet 16, so that at the end of cycle 5 card feeding ceases and, of course, the CF cam contacts cease to operate.

Since relay R7 becomes deenergized with magnet 16, its contacts R7*a* also open and as a result the printing mechanism also stops.

Cycle 6

During this cycle resetting of the digit storage devices takes place under control of the contacts of relay R46 in the same manner as for cycle 6 of Fig. 12. There is, however, no accompanying listing or zoning since the print and card feed mechanisms are inoperative. When relay R46 becomes deenergized in the latter part of the cycle, due to opening of the contacts CF31 (Fig. 14*c*), contacts R46*c* reclose to reenergize the card feed clutch magnet 16 and relay R7 in turn reestablishes the print clutch magnet circuit. The feed clutch magnet circuit is traceable from line 205 (Fig. 14*c*), stop contacts 208, contacts R6*b* (closed because relay R4 is energazed due to the presence of a second heading card between the brushes UB and LB where it closes card lever contacts LCL), contacts R46*c* and magnet 16 to line 206. The print clutch circuit is likewise traceable from line 205, contacts CR33, R7*a*, R4*c* (now closed), magnets 74 and 185 to line 206.

This cycle is required to clear the digit storage device in readiness to receive the digit data of the "street" and "city and state" fields during the next cycle, and it will be noted that the picker is held inoperative an extra cycle also.

Cycle 7

This cycle is the same as cycle 3 of Fig. 12 and the subsequent cycles are the same in order as cycles 4, 5, 6, 7, etc., of Fig. 12, so the detailed explanation thereof may be found under the appropriate chapters hereinabove.

Briefly recapitulating, there is provided in accordance with the present disclosure an alphabetic printing machine, in which perforated record cards successively pass first a set of upper brushes and then a set of lower brushes. Certain of the cards called heading or address cards contain three different items of information which is to be presented on three successive lines of a bill or invoice, and such cards are identified by a special designation in the 9 index point position of a selected card column. Other cards contain information which is to be printed on a single line in the usual manner in alphabetic printing machines.

As is customary, the alphabetic information to be printed is recorded by combinational designations in so-called zone and digit positions of the cards, and in passing through the machine the zone designations are sensed by the upper brushes and the digit designations are sensed by the lower brushes. As a heading card passes the upper brushes, the zone position of all the information is read with that of one item directly controlling the printing mechanism, while that of the other two items is entered into so-called storage relays, from which it is read out to control the printing mechanism, one item for each of the next two successive cycles of operation.

As the heading card passes the lower brushes, the digit positions of all the information is read with that of one item directly controlling the printing mechanism, while that of the other two items is entered into an electro-mechanical storage device, from which it is read out to control the printing mechanism, one item for each of the

next two successive cycles of operation. The feeding of the card following the heading card is delayed for the two cycles during which the second and third items of the heading card are printed, and then resumes.

While there have been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

What is claimed is:

1. In a cyclically operable machine of the class described, two record analyzing stations, means for feeding a record card past said stations in succession, said card having alphabetic items represented thereon in the form of combinational perforations arranged in zone and digit index point positions, a zone storage device, a digit storage device, printing mechanism including zoning mechanism controllable by the zone storage device and listing mechanism controllable by the digit storage device which cooperate to control alphabetic printing, means operative during a first cycle of the machine to cause the first analyzing station to directly control the zoning mechanism in accordance with zone data of one item on the card, and to cause the first analyzing station to control two different parts of the zone storage device in accordance with zone data of a second and third item on the card, means operative during the next cycle of the machine to cause the second analyzing station to directly control the listing mechanism in accordance with digit data of said one item, whereby a first line of data will be printed, to cause the second analyzing station to control two different parts of the digit storage device in accordance with digit data of said second and third items on the card, and to cause part of the zone storage device to control the zoning mechanism in accordance with zone data of said second item, means operative during a third cycle of the machine to cause a part of the digit storage device to control the listing mechanism in accordance with the digit data of said second item, whereby a second line of data will be printed, and to cause the other part of said zone storage device to control the zoning mechanism in accordance with the zone data of the third item, and means operative during a fourth cycle of the machine to cause the other part of said digit storage device to control the listing mechanism in accordance with the digit data of said third item, whereby a third line of data will be printed.

2. In a cyclically operable printing machine having record analyzing means, means for feeding record cards past said analyzing means, one card for each cycle of operation, and printing mechanism controlled by said analyzing means to print data from each card as it passes said analyzing means, certain of said cards having a special designation thereon, in combination with a data storage device, means controlled by said analyzing means upon passage thereby of a card having said special designation for controlling said printing mechanism in accordance with part of the data on such card, and for entering the remainder into said storage device, further means controlled by said analyzing means upon passage thereby of said card with a special designation for preventing further feeding of cards to said analyzing means for a predetermined number of succeeding cycles, and means controlled during said succeeding cycles for causing said storage device to control the printing mechanism in accordance with the data entered therein.

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