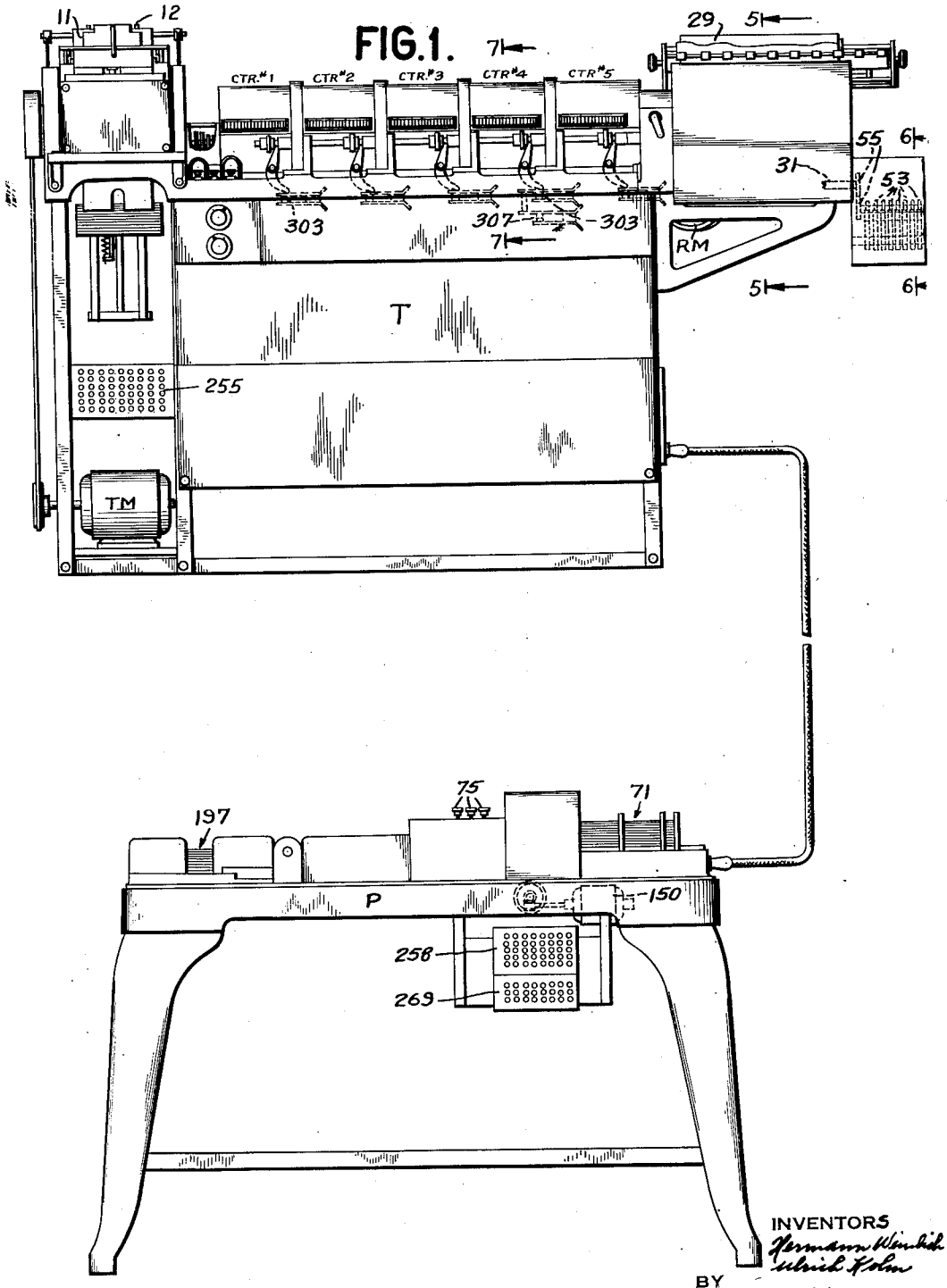
Aug. 9, 1938. H. WEINLICH ET AL 2,126,595

RECORD CONTROLLED TABULATOR TYPE

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FIG. 1.



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RECORD CONTROLLED TABULATOR TYPE

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FIG.2.

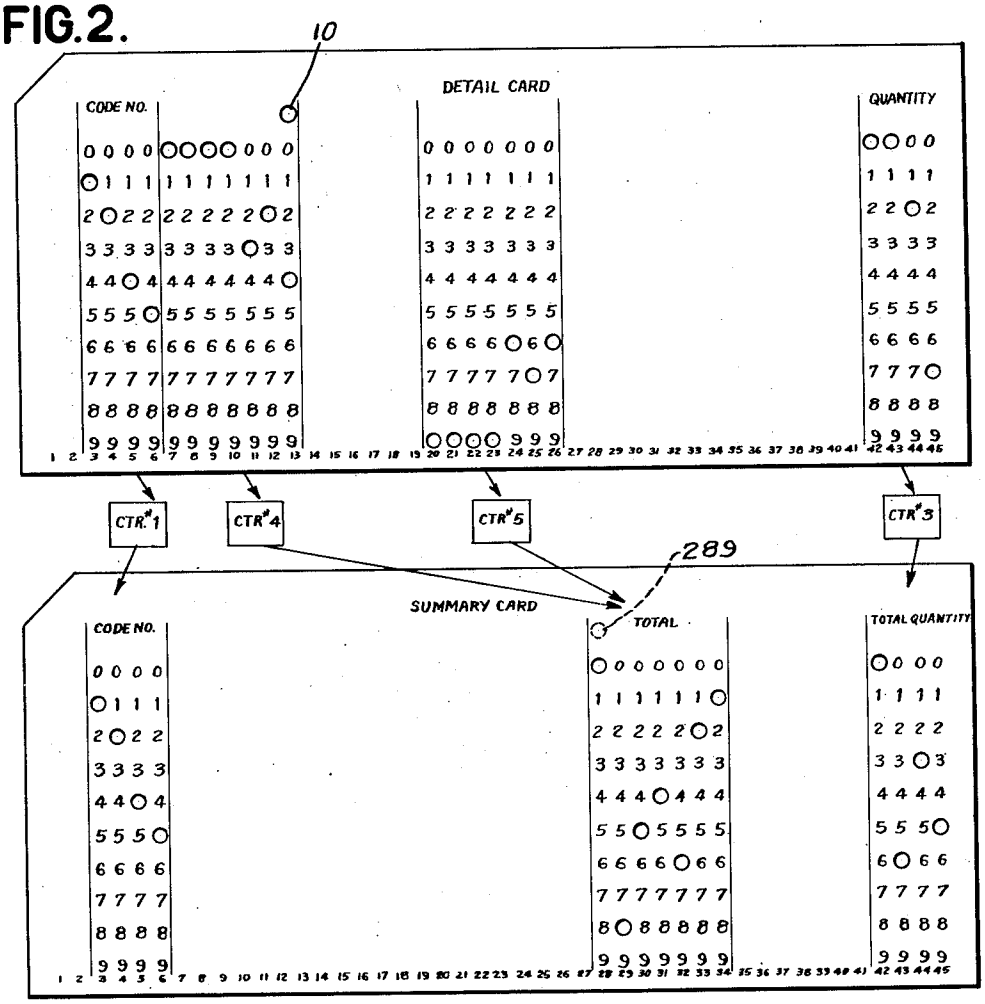


FIG.3.

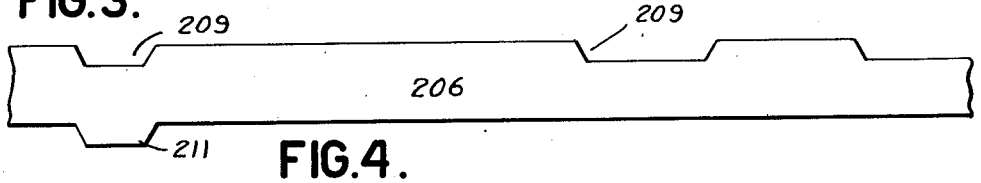


FIG.4.

CODE NO.		QUANTITY	CR. BAL.	DEB. BAL.
1245		635#	854621#	
1246		327#	87431#	
1247		617#		62134#
1248		616#		3174#

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FIG.5.

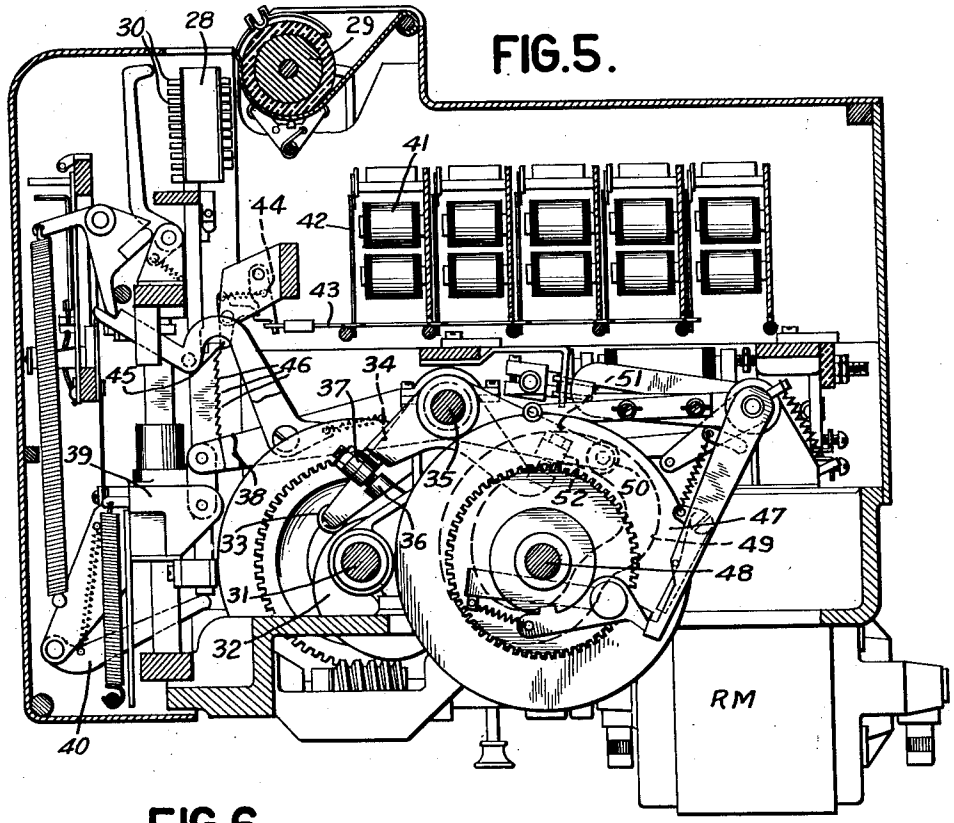


FIG.6.

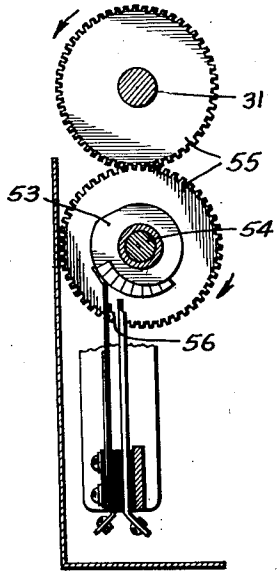
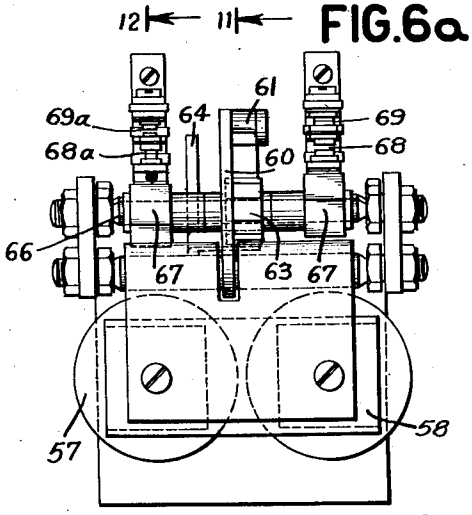


FIG.6a.



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FIG.7.

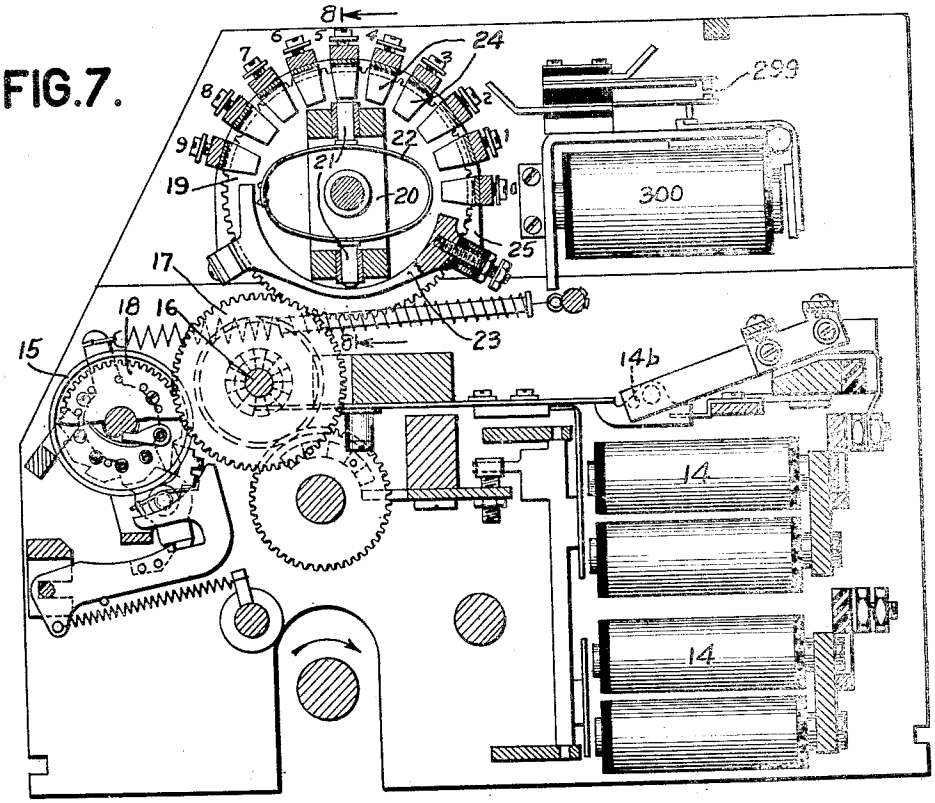


FIG.9.

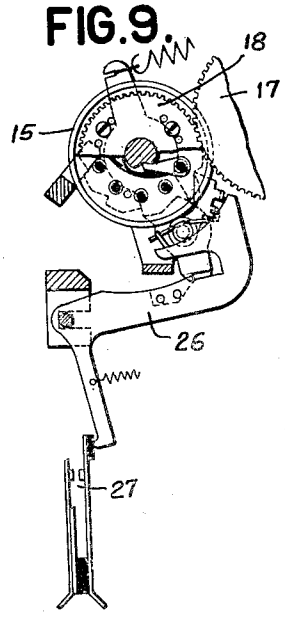
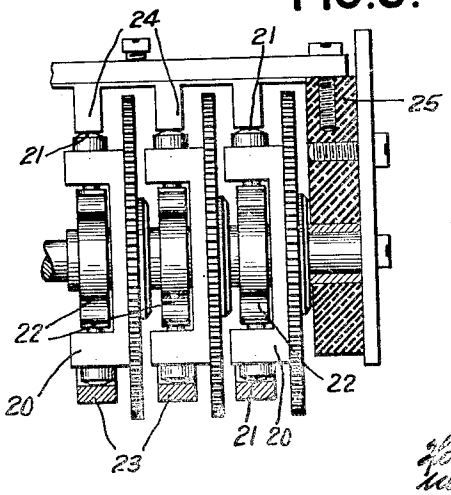


FIG.8.



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FIG. 10.

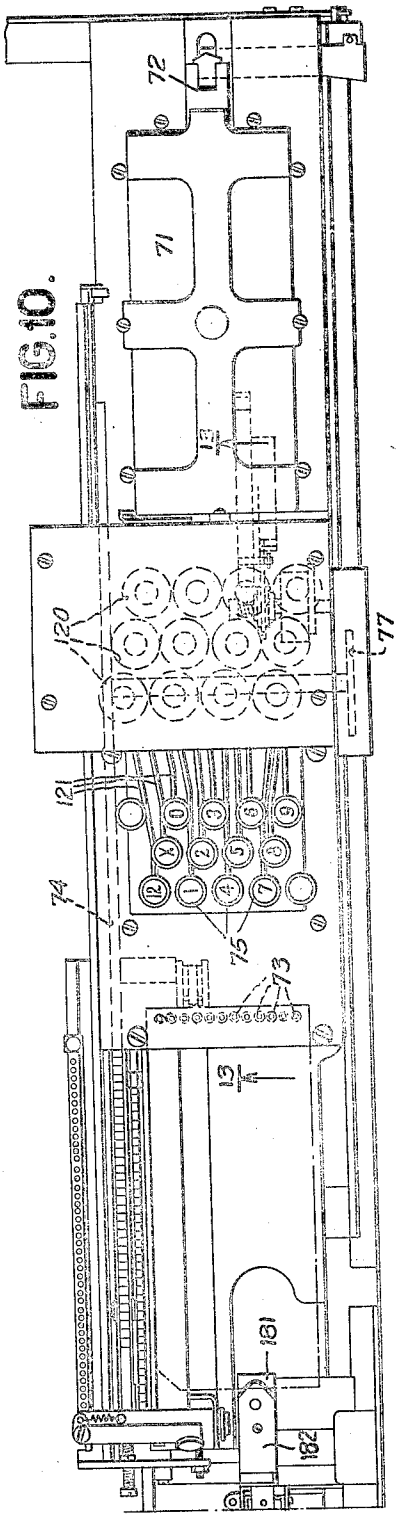


FIG. 12.

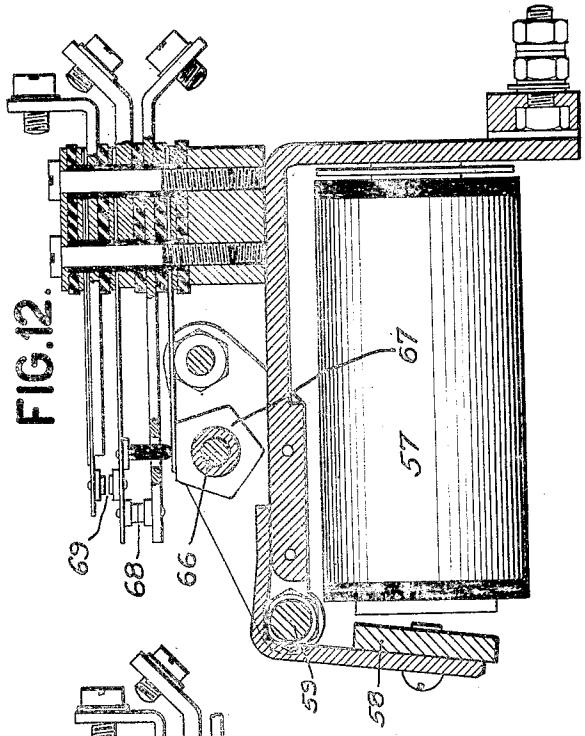
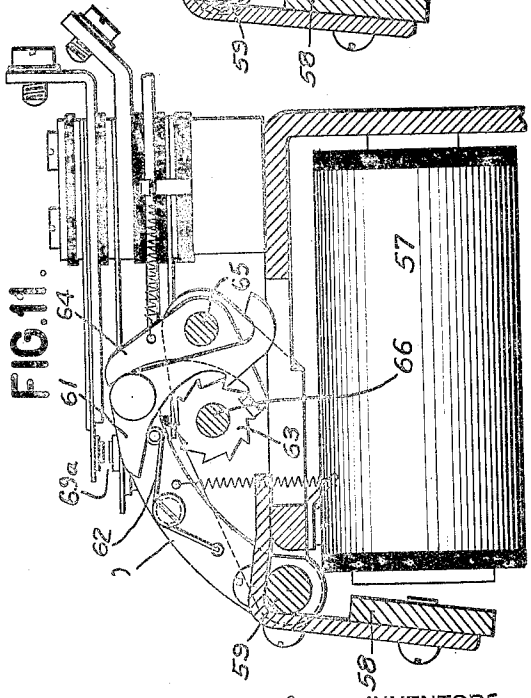


FIG. 11.



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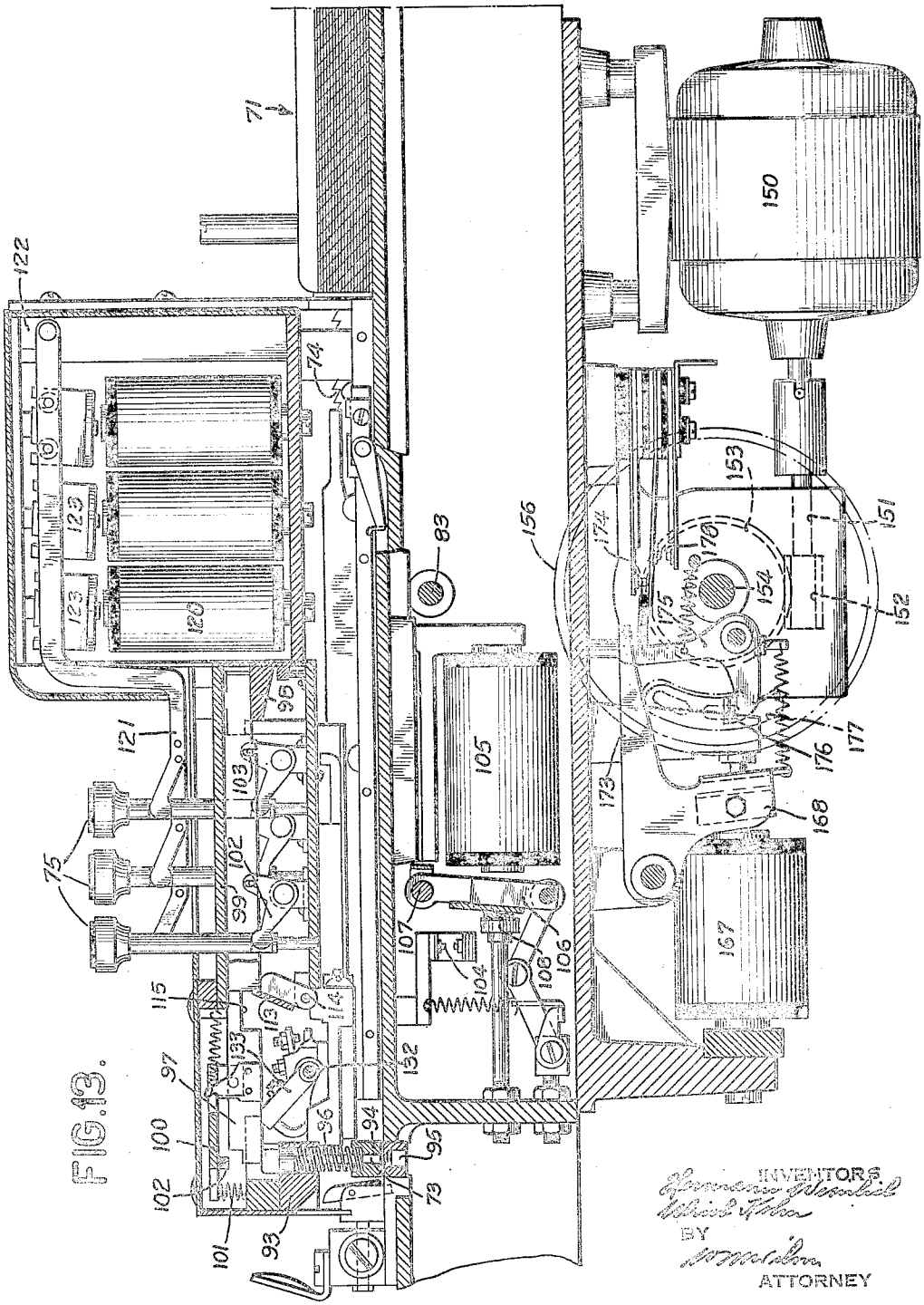


FIG. 13.

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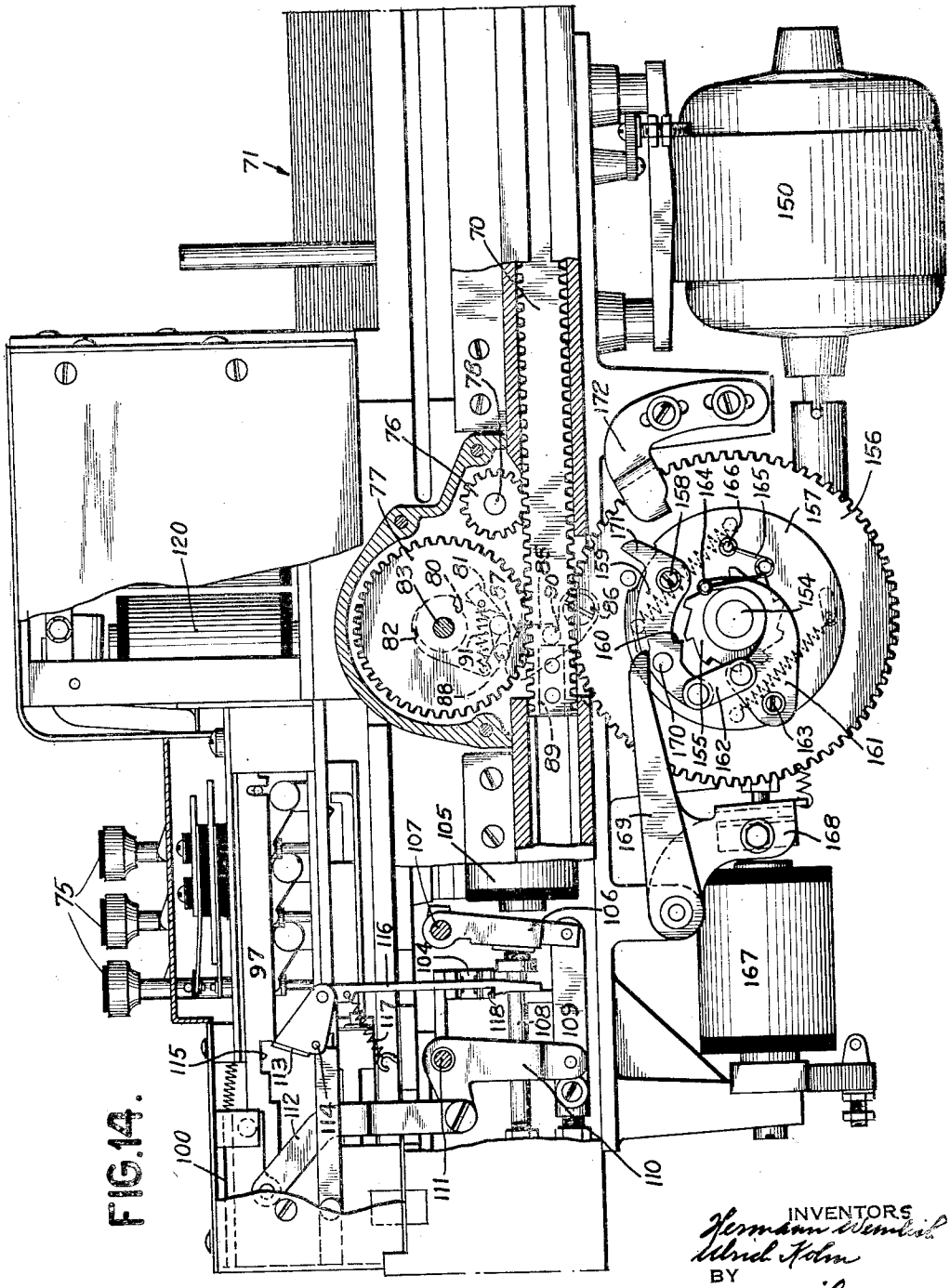


FIG.14.

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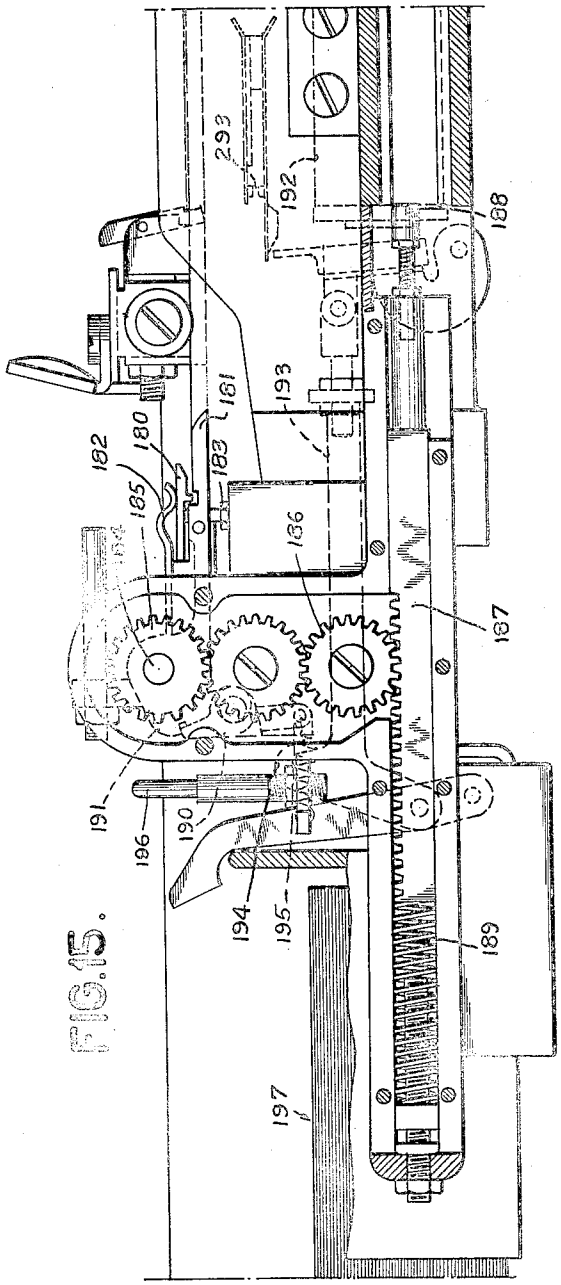


Fig. 15.

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Aug. 9, 1938. H. WEINLICH ET AL 2,126,595

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FIG.16.

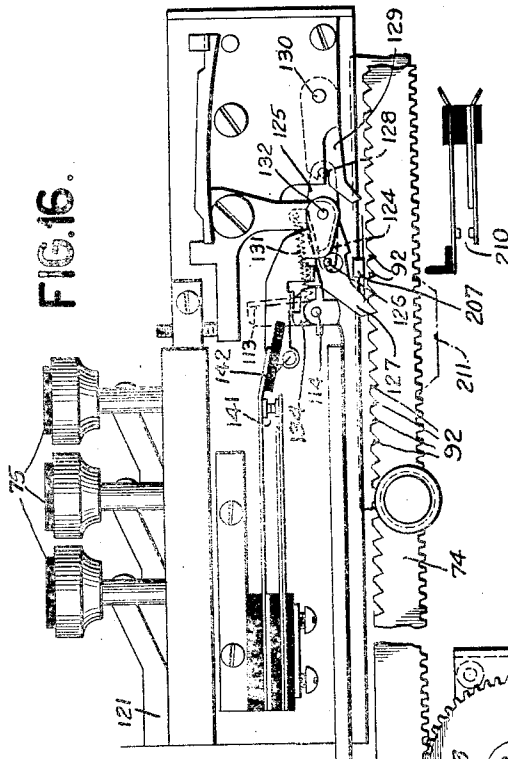
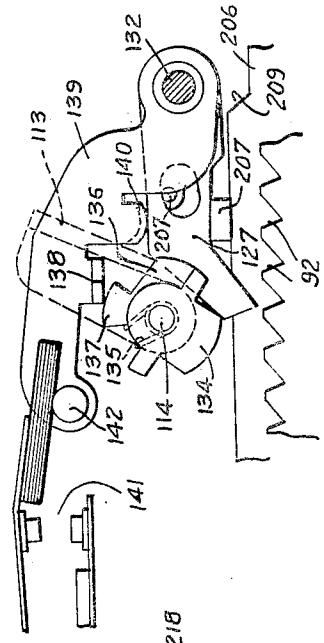


FIG.17.



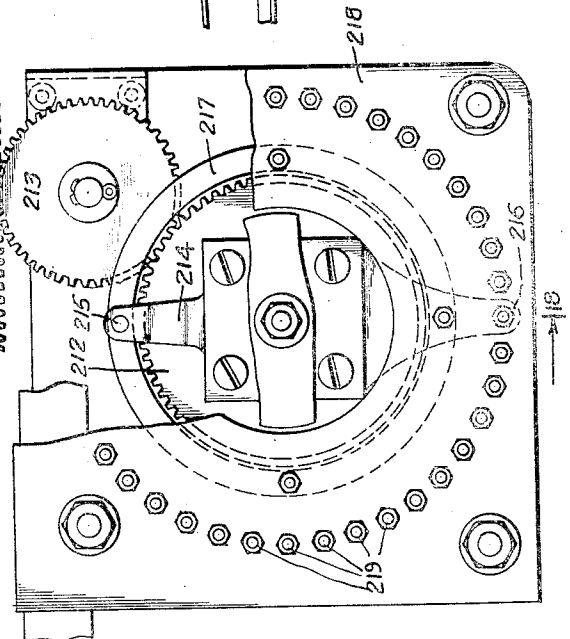
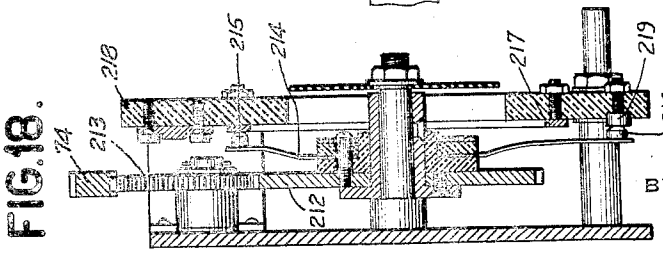


FIG.18.



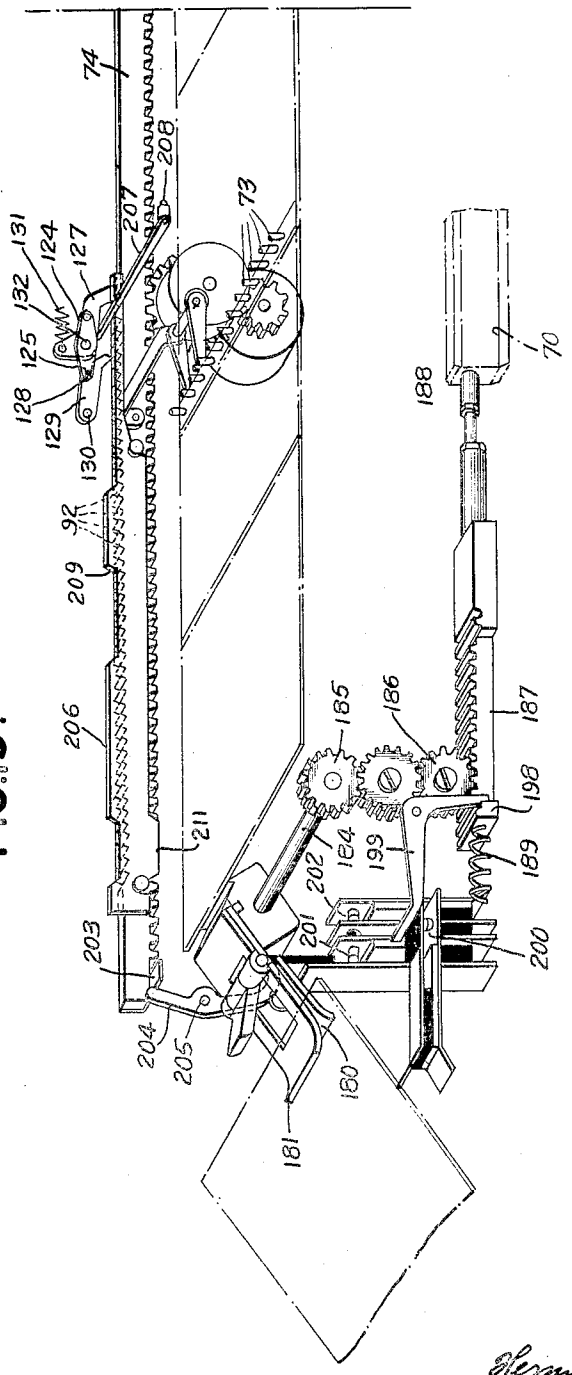
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RECORD CONTROLLED TABULATOR TYPE

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FIG. 19.



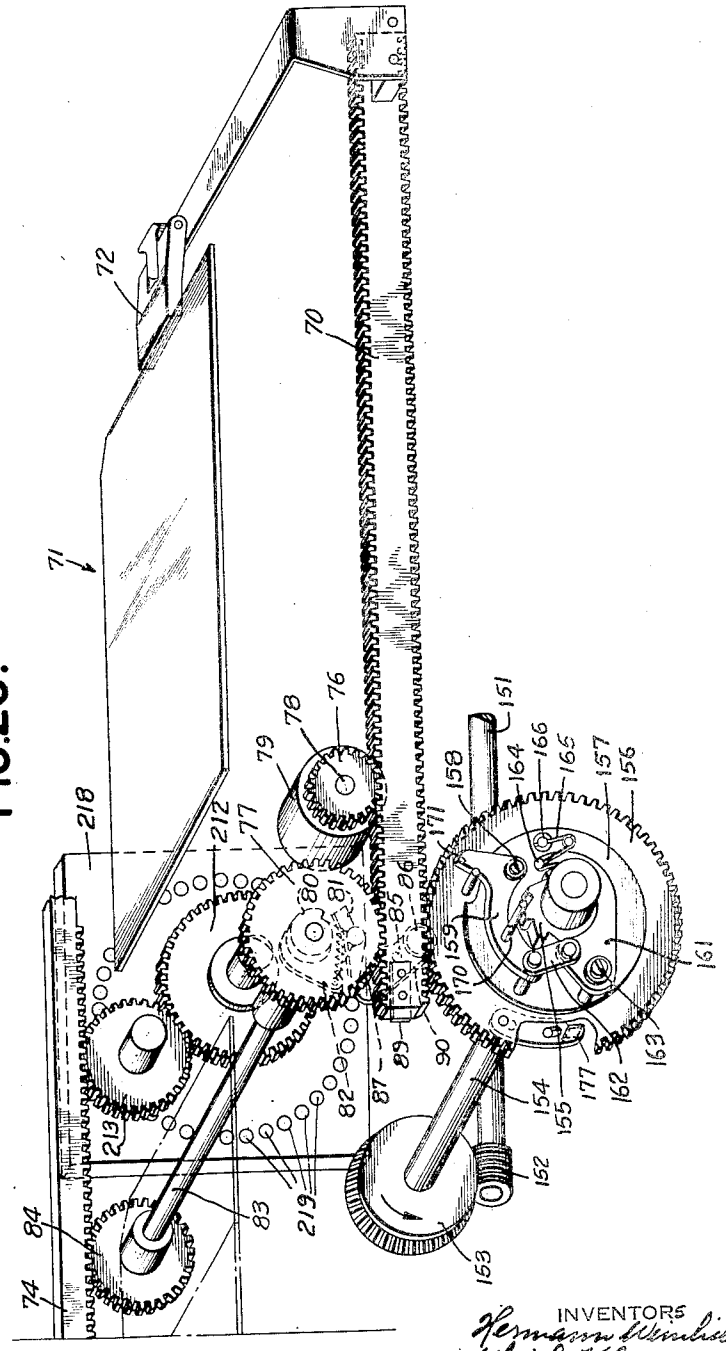
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RECORD CONTROLLED TABULATOR TYPE

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FIG.20.



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RECORD CONTROLLED TABULATOR TYPE

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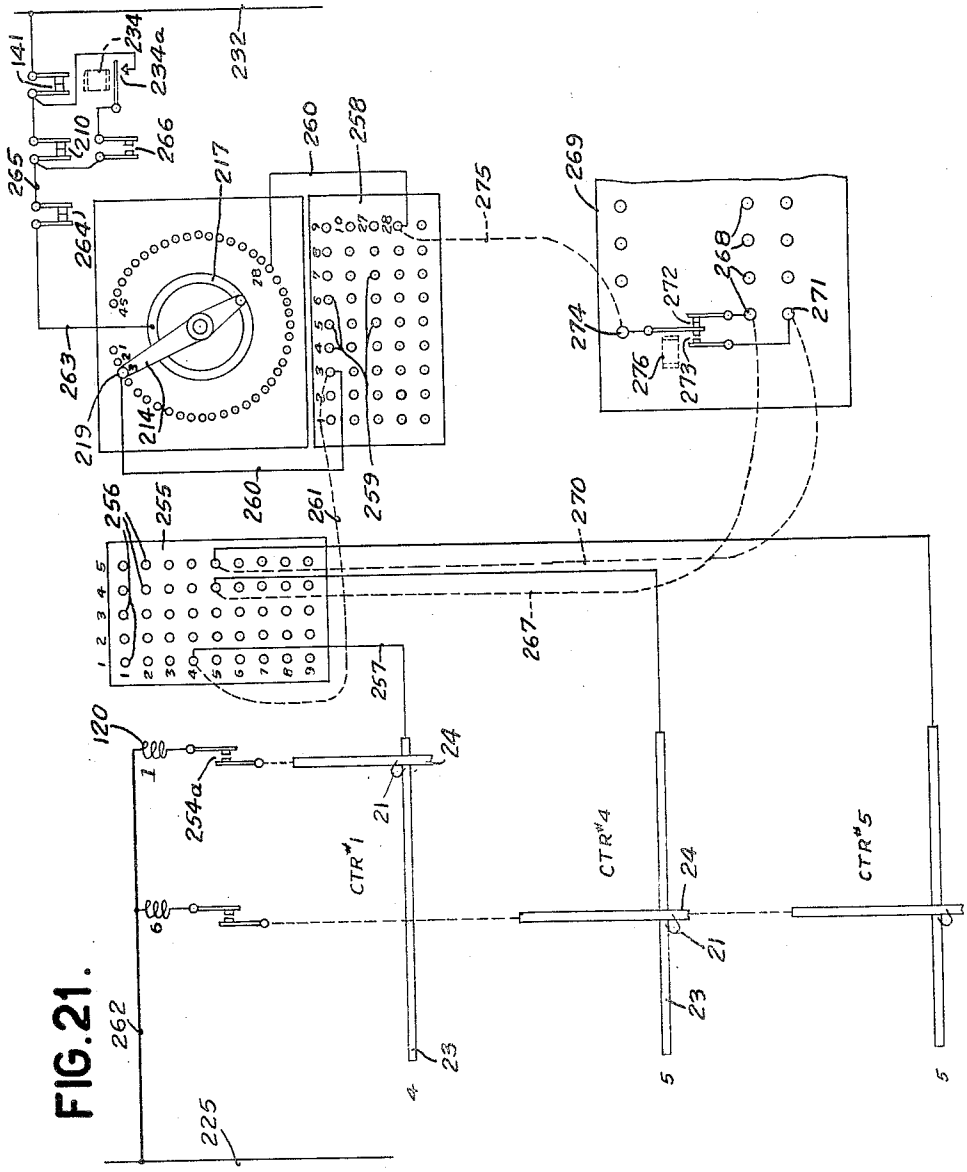


FIG. 21.

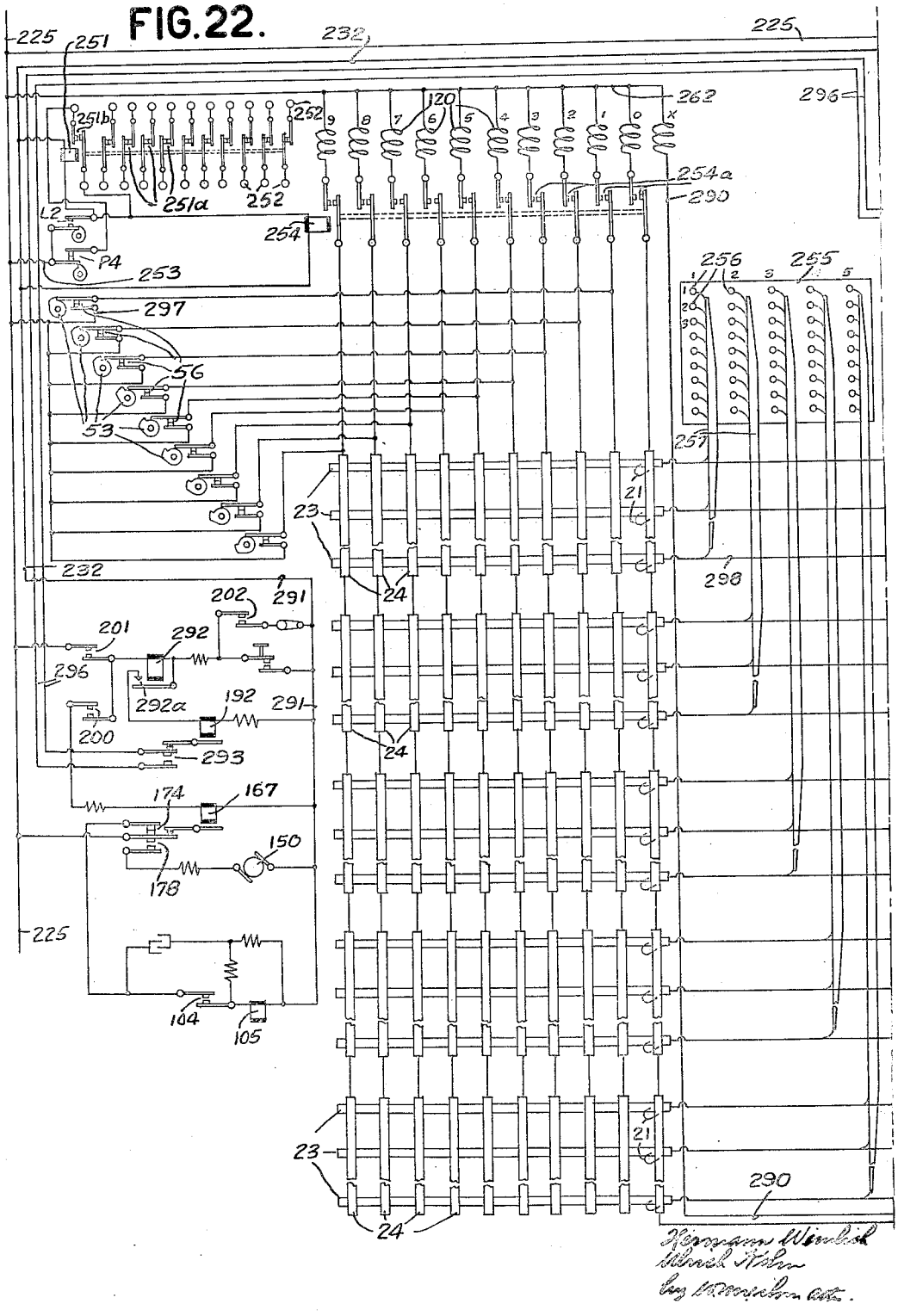
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RECORD CONTROLLED TABULATOR TYPE

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FIG. 22.



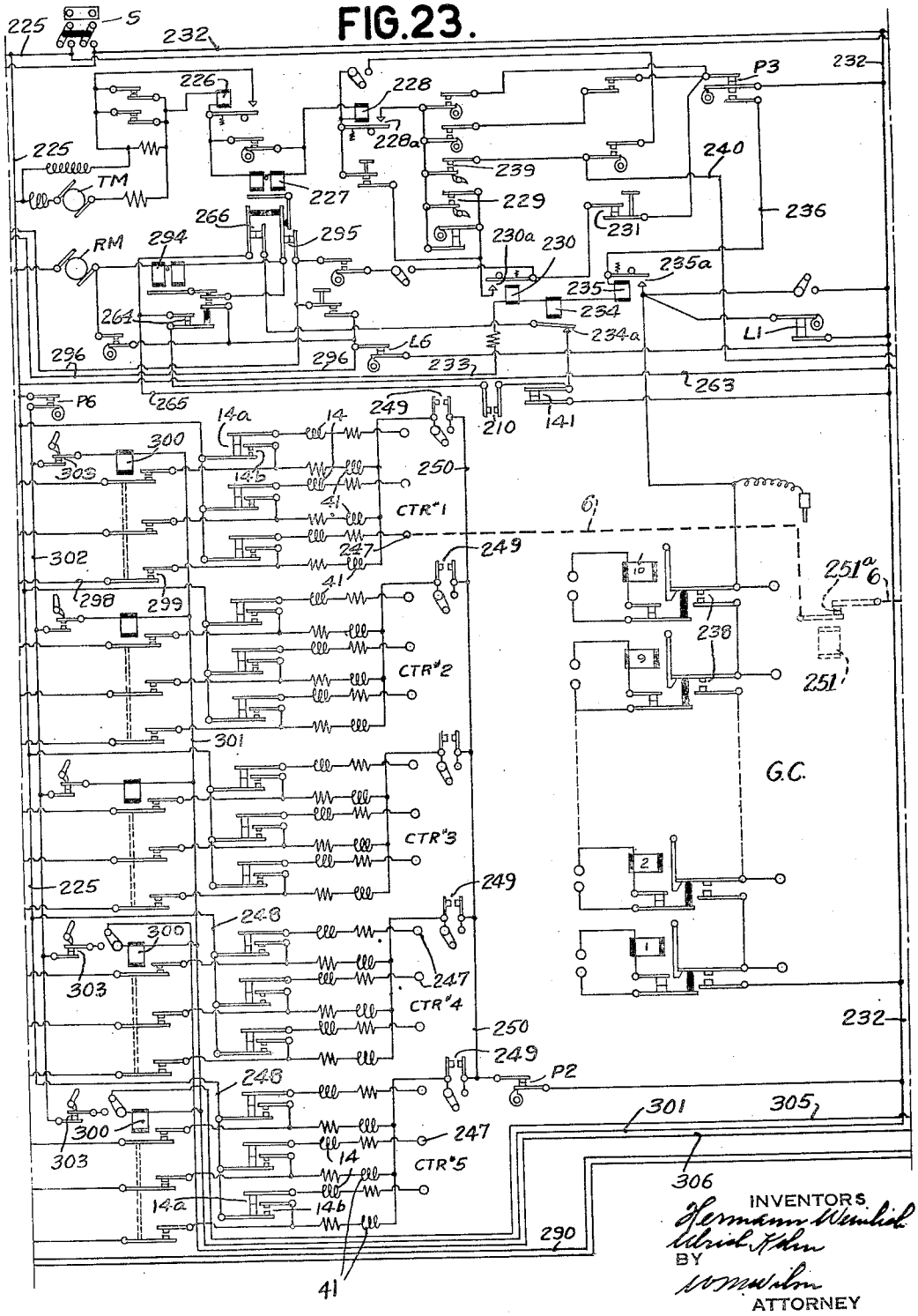
Hermann Weinlich
Ulrich Hahn
by Munn & Co. att.

Aug. 9, 1938. H. WEINLICH ET AL 2,126,595

RECORD CONTROLLED TABULATOR TYPE

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FIG.23.



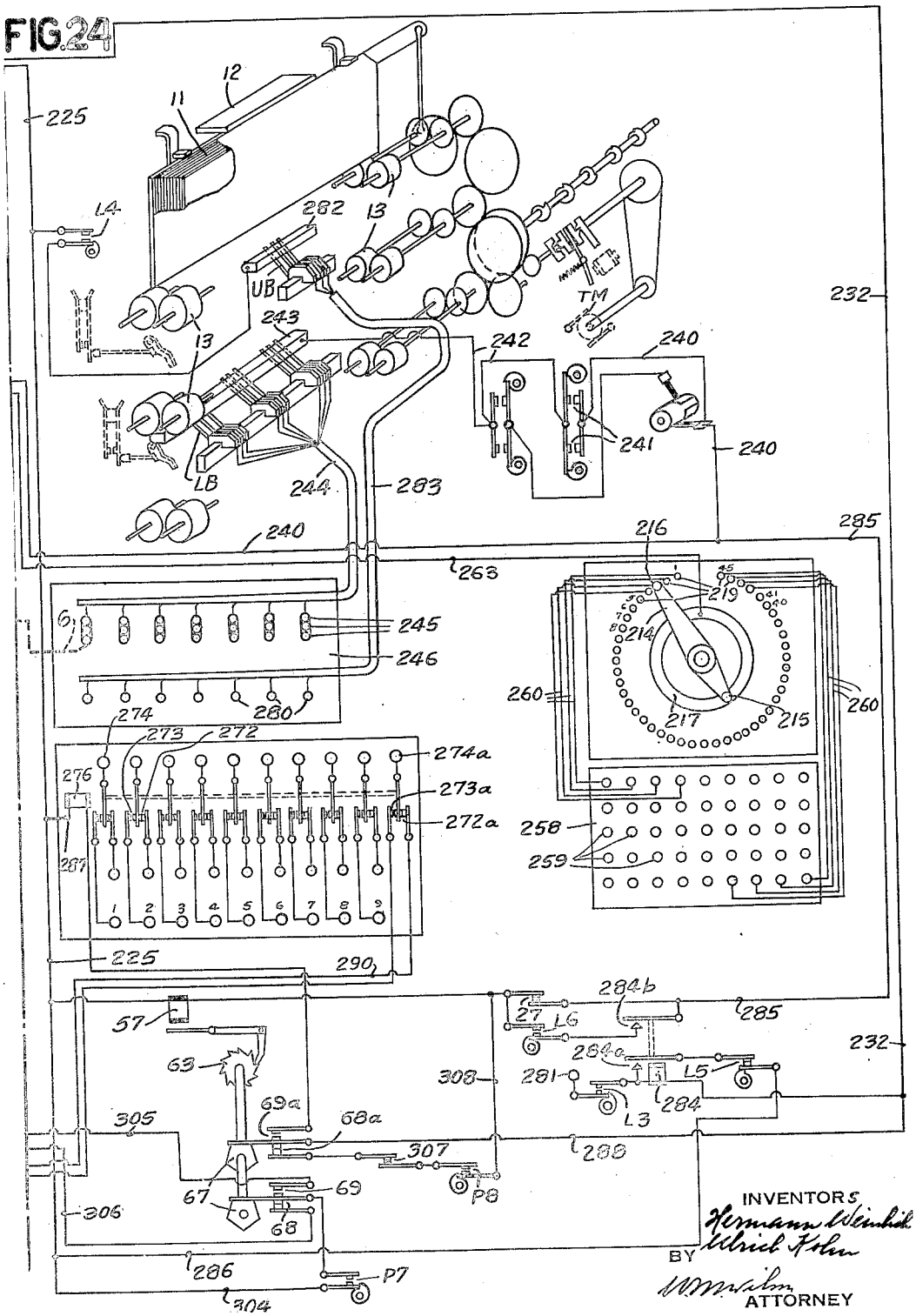
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FIG. 24



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Patented Aug. 9, 1938 2,126,595

UNITED STATES PATENT OFFICE

2,126,595

RECORD CONTROLLED TABULATOR TYPE

Hermann Weinlich and Ulrich Kölm, Berlin, Germany, assignors, by mesne assignments, to International Business Machines Corporation, New York, N. Y., a corporation of New York

Application April 19, 1932, Serial No. 606,092

10 Claims. (Cl. 235—61.7)

This invention relates to accounting machines and more particularly accounting machines of the record controlled tabulator type.

The principal object is to provide an improved accounting system in which a controlling accounting machine may be associated with a punching machine for punching data in record cards under control of the tabulating machine.

Another object resides in the provision of a punching machine which may be remotely controlled by an accounting machine of the tabulator type and in which, through improved mechanism, the machines need not be synchronous in their operation.

The tabulating machine is adapted to analyze groups of record cards and accumulate and print totals in accordance with the analysis of the record cards. The record cards are usually arranged in groups and after the complete analysis of each group a total printing cycle of operations is initiated during which the total for the group is printed and the accumulators reset. In the present invention provision is made for delaying the usual total printing and resetting operations to permit the automatic controlling of a punching machine in accordance with the total in the accumulator to prepare a so-called summary or total card. Following this punching operation the suspended total printing and resetting operations are permitted to automatically resume.

In tabulating machines of the type employed in the present system provision is made for entering designation data into an entry receiving device from the first card of each group. These data are retained in the device until a total printing cycle of operations takes place during which they will be printed together with the totals from other accumulators.

The present invention contemplates automatic punch controlling mechanism which will permit the operation of the punching machine under control of the indicating device without interrupting the operation of the tabulating machine or in other words, while entries are being made into other accumulators of the machine.

A further object of the invention is to provide improved selecting mechanism for determining which of a plurality of accumulators in the tabulator shall control the operation of the punching machine.

Various other objects and advantages of the invention will be obvious from the following particular description of one form of mechanism embodying the invention or from an inspection of the accompanying drawings; and the invention also constitutes certain new and novel features of construction and combination of parts hereinafter set forth and claimed.

In the drawings:

Fig. 1 is a general view of the arrangement of the two units of the apparatus, the tabulating machine being shown in the upper part of the drawings and the punching machine in the lower part, the two being connected with suitable connecting wires.

Fig. 2 is a diagram including a detail card and a summary card and serves to diagrammatically illustrate the distribution of data between the cards and the counters.

Fig. 3 is a diagrammatic representation of a controlling bar in the punch.

Fig. 4 is a fragment of a printed record sheet.

Fig. 5 is a section taken on lines 5—5 of Fig. 1, showing the general arrangement of the printing mechanism.

Fig. 6 is a section taken on the line 6—6 of Fig. 1, showing the arrangement of certain machine controlled cam contact devices.

Fig. 6a is a detail of a double-step relay.

Fig. 7 is a section taken on the lines 7—7 of Fig. 1, showing the accumulating mechanism.

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

Fig. 9 is a detail of parts associated with the highest order indicating wheel of one of the accumulators.

Fig. 10 is a plan view of the punch.

Fig. 11 is a detail of a special relay.

Fig. 12 is a further detail of the relay, showing the contacts controlled thereby.

Fig. 13 is a central section through the punch, the section being taken substantially along lines 13—13 of Fig. 10.

Fig. 14 is an elevational view of the central portion of the punch with certain parts broken away to show the interior mechanism.

Fig. 15 is an elevational view of the left end of the punch, showing the card ejecting mechanism.

Fig. 16 is a detail view looking at the rear of the punch, showing the escapement mechanism and the column selecting device.

Fig. 17 is a detail of parts shown in Fig. 16.

Fig. 18 is a detail section taken on lines 18—18 of Fig. 16.

Figs. 19 and 20, taken together, show in perspective the card feeding devices of the punch.

Fig. 21 is a view of devices shown in the wir-

ing diagram of the machine, showing the plugging connections between the punch and the tabulator.

Figs. 22, 23, and 24, placed side by side with Fig. 22 on the left, Fig. 23 in the center, and Fig. 24 on the right, constitute a wiring diagram of the electric circuits of the entire accounting system.

The two units of the apparatus are shown in Fig. 1 as comprising a tabulating machine T, which is of the general type shown in Patent No. 1,762,145, issued June 10, 1930, to Daly and Page. The punching machine, generally designated P, includes punching mechanism of the type shown and described in Patent No. 1,772,186, issued August 5, 1930, to Lee and Phillips.

The tabulating machine is adapted to feed record cards, such as the detail card of Fig. 2, past sets of upper and lower analyzing brushes which sense the data on the record cards and control the operation of counters accordingly. The tabulating machine includes a plurality of accumulators indicated on the drawings as CTR #1, CTR #2, CTR #3, CTR #4, and CTR #5. Accumulator CTR #1 may be arranged to function as a so-called indicating counter; that is, it may receive a single entry from the first card of a group being fed through the machine, while the remaining accumulators may receive entries from each of the cards of the group. The specific manner in which such entries are made is fully set forth in the patent to Daly and Page, referred to, and only so much of the explanation as is necessary for an understanding of the present invention will be given herein.

Two of the accumulators, namely CTR #4 and CTR #5, may be arranged to accumulate balances of credit and debit data punched on the detail cards. In order to simplify the explanation and clarify the understanding of the problem, the separate detail cards have been represented as being perforated with the amount of a transaction and also with the complement thereof; for instance, in Fig. 2, the detail card is perforated in columns 7 to 13 with an amount 324 and columns 20 to 26 are perforated in accordance with the complementary value of this amount. Where the amount is a debit quantity, it is entered in the field comprising columns 7 to 13 and its complement in the other field. Where a credit quantity is involved in a transaction, the true value of the credit amount is perforated in the field including columns 20 to 26 and the complement thereof in the other field. A special perforation, designated 10, is made in the "eleven" index point position of a predetermined column of the detail card whenever the card contains a debit quantity.

As indicated diagrammatically in Fig. 2, all entries from columns 7 to 13 are made in accumulator #4 and all entries from columns 20 to 26 are made in accumulator #5 so that accumulator #4 will contain all debit amounts and the complements of all credit amounts and accumulator #5 will contain all credit amounts and complements of debit amounts. Consequently, one of these two accumulators will always show a true number and the other the complement thereof.

The summary card of Fig. 2 is adapted to be prepared under control of the various accumulators of the tabulating machine T. The field designated "Total" is adapted to receive perforations under control of either accumulator CTR #4 or accumulator CTR #5, depending upon which of the two contains the true or positive balance. The field headed "Total quantity" will receive an entry directly from accumulator CTR #3 as indicated. The field headed "Code No." will receive its entry under control of accumulator CTR #1.

The various mechanisms of the system will now be separately explained in detail, after which the circuit diagram will be explained and the manner of coordination of the various units pointed out.

Tabulator card feed mechanism

The card feeding mechanism of the tabulator is generally shown in Fig. 1 and diagrammatically in Fig. 24. It comprises a stack 11 from which cards are fed singly by means of a picker 12 to feed rollers 13 which convey the cards past upper analyzing brushes UB and lower analyzing brushes LB. The rollers and picker mechanism are driven through the usual pulley connections by motor TM. Brushes LB and UB are spaced so that a record card feeds past the lower brushes LB exactly one machine cycle after it has passed beneath the upper analyzing brushes UB.

Accumulating units

As the perforated cards pass the lower brushes, their index points instantaneously close circuits through the proper lower analyzing brushes LB to energize accumulator magnets 14 (Fig. 7). As usual, the timed energizations of these magnets control mechanism for entering the data corresponding to the card reading on the wheels 15. The wheels 15 are driven from a clutch shaft 16 to which a gear 17 is coupled upon energization of magnet 14. Gear 17 has driving connection with wheel 15 through a gear 18 fast upon the wheel. Gear 17 also drives a gear 19 upon which is mounted a yoke 20 (see also Fig. 8). Slidably mounted on the yoke is a pair of contact plungers 21 urged outwardly by a looped leaf spring 22. One of the plungers 21 cooperates with an arcuate conductor 23 while the other plunger cooperates with a plurality of segments 24 which correspond in number and position to the several digit indicating positions of the wheel 15. The relationship between the several parts is such that the contact plungers 21 are angularly displaced according to the reading on the wheel. Thus, when the wheel is set to represent "5", one of the plungers 21 will be in contact with the "5" segment 24 and the other plunger will be in contact with the conductor 23. Each group of segments 24 corresponding to the same digit constitutes a common bar of conducting material mounted at its ends upon an insulating block 25.

In Fig. 9 is shown the wheel 15 of the highest order of accumulator CTR #4. This wheel is provided with the usual tens carry mechanism and is so arranged that when the wheel passes through the zero position, the lever 26 is rocked in a clockwise direction to cause closure of contacts 27. The function of these contacts is to assist in selecting the proper accumulator for balance printing in a manner to be more fully set forth in connection with the explanation of the wiring diagram.

Printing mechanism

The printing mechanism is shown in Fig. 5 and is identical with that shown in the Daly and Page patent mentioned above. The type bar 28 is positioned relatively to the platen 29 to bring the proper type 30 into printing position opposite the platen 29. The total shaft 31, driven by

the reset motor RM, is provided with a cam 32 cooperating with a roller 33 carried on arm 34 which is freely rotatable on shaft 35. As the cam rotates, arm 34 rocks clockwise and a lug 36 on arm 34 cooperating with a double-armed member 37 fixed to shaft 35 also rocks the member clockwise. An arm 38 fixed to shaft 35 is linked to printing crosshead 39 which serves to raise the type bar 28 in synchronism with the total taking operation so that the type 30 successively pass printing position opposite platen 29. Owing to spring operated scissors connections 40, however, the type bars 28 may be arrested in any printing position without interfering with the upward movement of the crosshead 39. The type bars are arrested under control of the printing magnet 41. When this magnet is energized, it attracts its armature 42 and pulls a call wire 43 to the right, thereby releasing a latch member 44 normally holding stop pawl 45. When the pawl 45 is so released, it is spring operated to engage ratchet teeth 46 formed on the type bar 28 to prevent further upward movement of the type, thus holding a particular type 30 in printing position.

During listing operations, shaft 35 is rocked to reciprocate printing crosshead 39 under control of listing cam 47 carried by list shaft 48, which is operated from the motor TM in the usual manner during listing and card feeding operations. Cam 47 is provided with a cam slot 49 which cooperates with follower roller 50 carried by an arm 51 loosely mounted on shaft 35. A lug 52 on arm 51 cooperates with double-armed member 37 to rock shaft 35. The configuration of groove 49 is such that the type bars are elevated and the type 30 moved past printing position in synchronism with the passage of the corresponding index point positions of the record cards past the analyzing brushes.

During total printing operations timed impulses are transmitted through the commutator segments 24 of Fig. 7 in a manner to be explained to energize magnets 41 at the proper time to select a type for printing. The device for emitting the timed impulses synchronized with the movement of the type bars 28 is shown in Fig. 6 and comprises a plurality of cams 53 mounted upon a shaft 54 which is driven through gears 55 by total shaft 31.

Cams 53 control contacts 56 and are timed so that one contact will close as each type 30 on type bar 28 is passing printing position. There are nine cams 53 and nine related contacts 56, there being one contact for each of the sets of commutator segments 24 relating to a particular digit. The manner in which these cams and contacts transmit timed impulses to the segments 24 will be more fully set forth in connection with the explanation of the wiring diagram.

The adding and printing mechanism just described are well known in the art and only sufficient thereof has been explained to point out the relationship therewith of the total printing controlling commutator devices which have been incorporated therein for the purposes of the invention.

Double-step relay

A double-step relay is illustrated in Figs. 6a, 11 and 12 whose function is to select the proper accumulator for balance printing when subtracting operations are being performed. The relay comprises a magnet 57 which, upon energization, will rock its armature 58 which is secured to a pivoted rod 59. Rod 59 also carries an arm 60 at the free end of which is pivoted a pawl 61 pressed by spring 62 into engagement with a ratchet 63 having ten teeth. A spring pressed member 64 pivoted at 65 serves as a detent to hold ratchet 63 in position. Rocking of rod 59 will elevate pawl 61 to advance ratchet 63 one tooth. Ratchet 63 is mounted upon a rod 66 which also carries a pair of cams 67 of pentagonal outline.

Cooperating with each cam 67 are contacts 68 and 69 which are adapted to open and close respectively when the high points of their cams 67 lie directly above rod 66. Since ratchet 63 has ten teeth and cams 67 have five low points and five high points, it is obvious that a single operation of magnet 57 will open contacts 68 and close contacts 69 and a second energization will permit them to resume the position they occupy in Fig. 12. The function of contacts 68 and 69 will be fully explained in connection with the circuit diagram.

Punching machine card feed mechanism

The punching machine is provided with a rack 70 (Figs. 14 and 20) having a normal position at the right hand end of the machine and being mounted for movement along the side of the machine. When the rack 70 is moved to the left, a blank card is fed from the bottom of the hopper 71 by the usual picker knife 72 (Fig. 20) attached thereto and advanced to the left to be operated upon by the punching mechanism comprising punches 73 (Figs. 13 and 19).

Such leftward actuation of the rack 70 also serves to move a card carriage 74 (Figs. 19 and 20) to the right to a position to receive the card when the picker 72 reaches the end of its leftward movement. The card is then punched column by column, as required, and the card carriage 74 moved step by step to the left. When the punching of the card is completed and the carriage has reached the end of its movement the punched card according to the present invention is automatically removed and the operation repeated.

The punches 73 may be operated normally by means of numeral keys 75 (Fig. 13) or may be controlled in accordance with the data contained in the accumulators of the tabulating machine.

The rack 70 is also used to actuate the card carriage 74. To this end the teeth along the upper edge of rack 70 mesh with the teeth of a pinion 76 and a gear 77 (Figs. 14 and 20). The pinion 76 is secured to a shaft 78 on which is mounted the usual coil spring barrel 79 for returning the rack 70, when released, to its normal position as more fully shown and described in the patent to Lee and Phillips No. 1,772,186, dated August 5, 1930. The gear 77 is suitably supported for rotation and is fixed to a member 80 having a single tooth in the plane of a pawl 81 pivoted to a disk 82 attached to shaft 83. At its other end shaft 83 is provided with a gear 84 fixed thereon and meshing with teeth in the lower edge of a rack which may be considered as forming part of the card carriage 74.

To control the clutch device 80, 81 provision is made of a cam element 85 pivoted at 86 and having a cam edge 87 cooperating with a pin 88 secured to a tail of pawl 81. The rack 70 has secured thereto a block 89 in the plane of a pin 90 secured to cam element 85 whereby the coaction of the end of block 89 with pin 90 at the extreme rightward position of rack 70 will cause cam edge 87 to rock pawl 81 out of engagement with the

shoulder of disk 80. In this position of the parts, the carriage 74 is freely movable.

When, however, the rack 70 is shifted to the left, it will, through block 89, release cam element 85, permitting a spring 91 to rock pawl 81 sufficiently to pass in front of the shoulder of member 80 which in the meantime has been brought to the necessary position by initial clockwise rotation of gear 77 by the upper teeth of rack 70. It should thus be observed that a leftward movement of rack 70 will transmit through clutch device 80, 81 power to move carriage 74 to the right to receive a card positioned by the picker 72 in the punching mechanism.

The top of carriage rack 74, observing Figs. 16 and 19, is also provided with rack teeth 92 inclining towards the left end of the machine as viewed in Fig. 19 which are provided for the purpose of controlling the stepping of the carriage by increments to provide for successively punching the card in the multiple columns. The description of the escapement mechanism referred to will be given in sufficient detail hereinafter to understand its cooperation with certain improvements incorporated therewith. The escapement mechanism just referred to is of the same general nature as that disclosed in the Schaaff Patent No. 1,426,223, granted August 15, 1922 and reference may be had to this patent for further details of construction and operation.

The escapement mechanism referred to is adapted to hold the carriage 74 when it has reached its extreme limit of its return movement and at this time the first column of the card to be punched will lie beneath the row of the punches 73 (Fig. 13) which have enlarged upper ends guided in a member 93 and lower ends extending through openings in a guide or stripper member 94 and immediately above openings in a die plate 95.

The punches 73 are of the general form disclosed in the patent to Lee and Phillips, No. 1,772,186, and are normally held in raised position by spring 96 interposed between the enlarged heads thereof and the stripper member which is provided with openings to receive the lower ends of said springs. Resting on the upper ends of said punches are interposers 97 supported at their rear ends on a cross member 98 and resting against the lower face of an overlying plate 99 so that they prevent further upward movement of said punches. The interposers 97 are so notched at their forward ends that when they are in normal position depression of an actuating plate 100 against a spring 101 will move a portion 102 of the depressor plate 100 into such notches.

However, when any numeral key 75 is depressed it will actuate a bell crank 102 against the action of suitably connected springs. The forward arm of each bell crank has a rounded head fitting into a notch in the shank of the key, the upright end having a pin 103 in a slot in the lower edge of the corresponding interposer 97. Such interposer will then be advanced to such a position that depression of the plate 100 will effect depression of the interposer and consequently of the corresponding punch.

Upon movement of any of the interposers 97 a pair of contacts 104 is adapted to be closed, thereby closing the circuit to a punch magnet 105 which through intermediate mechanism is adapted to rock the depressor plate 100 to actuate the selected punch 73. Subsequently the circuit of the magnet will be broken allowing the return of the depressed interposer to normal position.

Upon energization of the punch magnet 105 in this manner, the armature 106 will be swung about its pivot 107 away from the abutment or stop 108 and through the link 109 (Fig. 14) will rock a bell crank 110 about the pivot 111 to draw the link 112 downward and rock the plate or depressor 100.

Subsequently the circuit of the magnet 105 will be broken allowing the return of the depressed interposer to normal position. At this time the escapement mechanism will be effective and the card carriage 74 will advance one tooth to permit punching in the next column of the card.

Across the lower edge of all of the interposers 97 is a bail or universal member 113 pivoted at 114 and reaching into notches 115 in the interposers. Attached to the bail member 113 is a depending arm 116 held against a bracket on link 109 by a spring 117. This spring also tends to pull the arm 116 downwardly rocking the bail 113 clockwise into engagement with the right hand shoulder of the slots 115 in the interposers 97.

The arm 116 has a shoulder 118 normally hooked under the lower contact leaf of the pair of contacts 104. When a key 75 is depressed to move one of the interposers 97 to operative position this interposer rocks the bail 113 counterclockwise raising the arm 116 and causing contacts 104 to be closed. This causes energization of magnet 105 as will be pointed out in the wiring diagram to operate the perforating device. As the punch 73 passes through the card and the link 109 moves to the right, the member on the link will push the arm 116 to the right so that the lower contact leaf will be released and contacts 104 will then open, deenergizing the magnet 105 and permitting the punch and its actuating mechanism to return to normal positions.

The interposer 97 returns when the key 75 is released and permits bail 113 to turn clockwise to normal position and arm 116 to be lowered so that its shoulder 118 will again snap under the contact leaf and be ready to close the contacts when the next key is depressed. It will be recognized that when the contact leaf is released contacts 104 cannot be closed again until the key 75 which effected their closing has been released and the next key depression effected.

The operation of the punches may also be controlled by means of circuits from the accumulators of the tabulator which cause the selector magnets 120 (Fig. 13) to be actuated in accordance with the amount contained in the accumulators. The selector magnets are twelve in number and operate the ten numeral keys and two auxiliary keys, one being marked "X" and the other "12" (see Fig. 10), and the latter are arranged to operate the two punches at the end of the row farthest from the operator.

Such operation of the keys controlled by the selector magnets may be effected by means of levers 121 (Fig. 13) having at their ends in one direction rounded heads extending into slots in the shanks of the keys 75 to be controlled thereby and extending in the other direction substantially horizontally into a casing for the selector magnets above the cores of the magnets 120. The levers 121 are pivoted to brackets 122 spaced apart and attached to the main frame. Adjustably attached to each of the levers 121 is an armature 123 for cooperation with the corresponding magnet.

The escapement mechanism just referred to is of the same general nature as that disclosed in the patent to Schaaff No. 1,426,223, granted August

15, 1922 but in order to give a better understanding of the operation of the machine a brief description of the mechanism will now be given.

A shaft 132 (Fig. 13) is rocked as an incident to each punching or spacing operation due to the rocking of a member 133 carried thereby, by depression of interposers 97 and has secured at one end oppositely extending arms 124 and 125 (Figs. 16 and 19) of which 124 is provided with a laterally projecting pin 126 for engagement with an enlarged opening in a stepping dog 127 which is loosely pivoted on shaft 132. The opposite arm 125 is provided with a laterally extending pin 128 extending in a slot formed in the locking dog 129 between its pivot 130 and its engaging end.

When the shaft 132 is rocked the arm 124 will, through the pin 126, lift the stepping dog 127 out of one of the notches 92 in the rack 74 and at the same time the arm 125 will depress the locking dog 129 into another notch.

At this time a spring 131 advances the loosely pivoted stepping dog 127 a short distance, sufficient to permit this dog to rest upon the top of the next tooth. When the locking dog 129 is again raised out of engagement with the teeth 92 at the upper edge of the rack bar 74 as an incident to the return movement of shaft 132, the stepping dog 127, due to the movement of the rack 74 will ride down along the tooth on which it rests until the next tooth 92 strikes the end thereof and the said carriage 74 is thereby arrested.

As the shaft 114 upon which universal bail 113 is fixed is rocked from the position shown in Fig. 16 to the position shown in Fig. 17 by a shifting of an interposer 97, a T-shaped element 134 secured to shaft 114 is rocked slightly clockwise.

A spring 135 is coiled about shaft 114 and has its ends abutting a projection of element 134 and a projection 137 of an element 136 loose on shaft 114. The projection 137 (Fig. 16) normally abuts a lug 138 of a contact operating member 139 loose on shaft 132, the result being that spring 135 is coiled about shaft 114 as the element is rocked. When the stepping dog 127 is elevated, the upper edge contacting with an arcuate lug 140 of arm 139 will elevate the latter, permitting the projection 137 to be urged by the spring 135 to ride under the lug 138. An insulating block on the upper blade of contacts 141 contacting with a pin 142 on arm 139 will result in opening contacts 141. The function of these contacts will be pointed out in connection with the circuit diagram.

As the unversal bail 113 is returned to its normal position a projection of T-shaped element 134 will strike a projection of element 136 to rock the latter counterclockwise during a return movement of the bail.

It will be recalled that when the armature 106 (Fig. 14) was shifted the extension on link 109 disengaged the notch 118 of arm 116 from lower blade of contact 104 so that when bail 113 is in the rocked position (Fig. 17) notch 118 will be positioned above the lower contact blade. The arcuate edge of the projection 137 (Fig. 17) is of sufficient length to retain contacts 141 opened until the notch 118 re-engages the lower blade of contact 104. This insures that the arm 116 will be in position to close contacts 104 by the subsequent shifting of a selected interposer prior to the closing of the succeeding circuit, to magnet 105.

Provision is also made of means for automatically returning the carriage 74 and rack 70 to their normal starting positions.

Secured to the underside of the base of the machine is a motor 150 (Fig. 13) coupled to a stub shaft 151 to which is secured a worm 152 in mesh with a worm gear 153 secured to a shaft 154 (see also Fig. 20) one end of which has secured thereto a ratchet shaped clutch element 155 (see Fig. 14). Loosely mounted on shaft 154 is a gear 156 meshing with teeth on the underside of rack 70 and to which gear is secured a disk 157.

Pivoted at 158 to disk 157 is an arm 159 having a clutch tooth 160. The free end of arm 158 is connected to a toggle plate 161 by a link 162, the end of toggle plate 161 distant from its pivot 163 being articulated at 164 to one end of a spring 165. The other end of spring 165 is secured to a pin 166 free to rotate on disk 157. By virtue of this construction spring 165 and plate 161 act as a toggle, spring 165 acting to impositively hold tooth 160 in or out of engagement with the clutch teeth of ratchet wheel 155. It will be noted that point 164 lies above a line drawn between centers 163 and 166 when the parts are in the position of Fig. 14. When tooth 160 is engaged in ratchet 155 point 164 will lie below the line of centers 163, 166.

For the purpose of effecting the clutching action a magnet 167 is provided and when energized attracts an armature 168 so that an arm 169 engaging a pin 170 of arm 159 will rock the tooth 160 into engagement with ratchet wheel 155. Through link 162 the toggle connection will be moved outwardly, spring 165 acting to hold clutch tooth 160 in engagement with the ratchet teeth. Gear 156 will thereupon be driven in a counterclockwise direction substantially a single revolution shifting rack 70 to the left. This will result in moving carriage 74 oppositely to its initial punch controlling position.

At the termination of the counterclockwise movement of gear 156 a tail 171 of arm 159 will strike a projection of a fixed plate 172 to effect the disengagement of the tooth 160 and ratchet wheel 155 by a reverse action. The reverse action of the toggle will cause the tooth 160 to be retained out of engagement with the teeth of the ratchet wheel whereupon the coil spring employed to return the rack 70, fully shown and described in Patent #1,772,186, will act to return the parts to normal position as shown in Fig. 14. As shown and described in the patent just mentioned, a supplemental coil spring is also provided to shift the carriage 74 intermittently under control of the escapement mechanism as an incident to each card punching operation.

Also secured to the pivot of armature 168 is an arm 173 (Fig. 13) the free end of which is adapted to bear upon an insulating block to open contacts 174 when magnet 167 is energized. Contacts 174 are retained opened by a latching bell crank 175 a lug 176 of which is adapted to be struck by a bent up plate 177 (Fig. 20) secured to gear 156 at the termination of the driving movement of the latter. Below contacts 174 are motor control contacts 178 which are latched closed upon an energization of magnet 167 to complete the motor circuit and are unlatched to stop the motor at the termination of the driving operation in the manner just described.

Punched card ejecting mechanism

Means are provided for automatically removing a completely punched card and depositing the same in a receptacle provided for the purpose. This invention is described in detail in the application of J. M. Cunningham, Serial No. 390,755, filed September 6, 1929, now Patent No. 1,916,965,

to which application recourse may be had for details of construction and operation.

Stated generally, the gripper comprises (Fig. 15) a pair of jaws 180 and 181 urged together by a flat spring 182 but the abutment of a pin 183 with the upper jaw 180 separates the jaws in order that the punched card may be received by the slit-like separation. The card occupies a position between the jaws at the termination of the punching of the last columns in the card.

The gripper unit is pivotally mounted on a shaft 184 to which is secured a gear 185 adapted to be driven by a gear 186 through an idler gear. Meshing with gear 186 is a slidably mounted rack 187, the extremity of which terminates in an adjustable plunger 188. During the previous restoration of the carriage the end of rack 70 engaged plunger 188 to shift rack 187 to the left against the tension of a spring 189. This caused a clockwise movement of shaft 184 through the train of gears 185, 186 to bring the gripper unit to the position shown in Fig. 15 whereupon a latch lever 190 will engage a shoulder 191 of the lower jaw 181. At this time a certain amount of compression will be stored up in spring 189.

Shifting of latch 190 is effected by energization of the magnet 192 which attracts its armature when the magnet is energized. This causes a shifting movement of a link 193 to the right and by means of a cam shoulder 194 and arm 195 secured to the pivot shaft of latch lever 190 will shift the latter. This will result in a release of spring 189 to cause the counterclockwise rotation of the gripper unit. As the jaw 180 leaves pin 183 spring 182 will act to cause the latter to close upon the lower jaw 181 thus securely gripping the card and flipping the same in reversed position. A stationary pin 196 may suitably coact with one of the jaws to separate them, permitting the released card to fall in a receptacle 197.

When the card just punched is ejected, shifting of rack 187 (Fig. 19) by release of spring 189 will cause a square shoulder 198 to engage a bell crank 199 to close contacts 200.

In Fig. 19, pairs of contacts 201, 202 are shown. These contacts are adapted to be closed when the card is in position to receive punching in the last column thereof. For this purpose, carriage rack 74 is provided at its left end with an extension 203 adapted when the carriage is in such last column position to rock a lever 204 pivoted at 205 whereby the lower extremity of the lever will engage an insulating block connected to a blade of one of the contacts to cause the same to close.

Detachably secured to carriage rack 74 is the usual skip bar 206 upon the upper edge of which may rest the free end of an arm 207 pivoted at 208. Skip bar 206 may be provided with cut-out portions 209 extending along its upper edge and into which the free end of arm 207 may enter.

As the carriage rack 74 moves back and forth, arm 207 will be rocked up or down accordingly as it cooperates with the high or low portions of skip bar 206. The upper side of arm 207 lies under the stepping pawl 127 and is adapted when in its upper position to raise the stepping pawl out of engagement with the teeth 92 of carriage rack 74, thus permitting the rack to move toward the left with a continuous motion until the arm 207 is again lowered by entering into the depression 209. Raising of arm 207 (Fig. 17) will, of course, also cause opening of contacts 141.

Skip bar 206 is also provided with a depending tab 211 (Figs. 3 and 16) which when the carriage rack 74 is in position to permit punching in the field of the card assigned to receive data from the group indicating counter, will close a contact 210.

Column selecting device

Referring now to Figs. 16, 18, and 20, the column selecting mechanism whose function is to connect the several denominational orders of the accumulators to the punch columns for punching in certain selected columns of the record card will now be described. This device includes a gear 212 connected through an idler 213 to rack teeth cut on the underside of carriage rack 74 so that as the carriage rack moves back and forth, gear 212 will be rotated accordingly. Gear 212 has secured thereto and insulated therefrom a spring brush structure 214 which carries a contact wiper 215 at one end and a similar wiper 216 at the other end. Wiper 215 makes contact with a ring of conducting material 217 mounted on an insulating plate 218. Contact 216 is adapted to contact with a circle of segments 219 of which there is one for each punching position of the carriage rack 74. The operation of the device is such that as the carriage rack 74 moves step by step to present successive columns of the card to the punches, brush structure 214 will also turn step by step to successively connect the segments 219 to the ring 217. Thus when the carriage is in position to permit punching in the first column of the record card, structure 214 will connect the first segment 219 to ring 217 and when the card is in position to receive punching in the last column, the last segment 219 will be electrically connected to ring 217.

Wiring diagram

The various mechanical mechanisms employed in the present invention have now been explained to show their manner of operation. The wiring diagram which is about to be explained, will serve to show how these several elements are coordinated in the operation of the machine. The complete electric circuits for the tabulating machine are included in the circuit diagram shown on Figs. 22, 23, and 24. These circuits are entirely similar to those disclosed in the patent to Daly and Page referred to above, with the exception of the total taking and punch controlling circuits which will be described in detail hereinafter.

During adding and listing operations the machine is driven by the motor TM (Fig. 23) which is kept in operation through the following circuit: from source of current S, line 225, motor TM, relay coil 226, card feed clutch magnet 227, relay 228, points 228*a*, upper card lever contacts 229, points 230*a* of relay coil 230, stop key contact 231, upper points of contact P3, line 232, back to source S. As explained in the patent referred to, relay coil 230 is energized through a circuit established preliminary to the operation of feeding cards. This circuit during the last preceding resetting operation of the machine was completed from line 225, through wire 233, relay coils 230, 234 and 235, wire 236, lower contacts P3, to line 232. Relay coil 235 closed its points 235*a* to establish a holding circuit extending from coil 235, through points 235*a*, cam contact L1, to line 232.

It may be here mentioned that all cam contact devices which operate during listing and adding operations have been prefixed with the letter "L" on the circuit diagram and those which operate during total printing and resetting operations

have been prefixed with the letter "P". These cam contacts are controlled from the listing and total printing shafts 48 and 31 respectively (Fig. 5).

The circuit through motor TM is maintained as long as group designation data on the successively fed record cards continue to correspond. The usual group control mechanism, indicated generally at GC, (Fig. 23) is provided whose control magnets 237 may be connected in series between the upper and lower analyzing brushes in the well-known manner. These magnets control contacts 238 which as long as cards continue to agree will maintain the holding circuit through relays 230, 234 and 235, through relay points 235a, serially through contacts 238 to line 232 so that the holding circuit will be maintained at the time when cam contact L1 opens momentarily to test the group controlling circuit.

If there has been a disagreement in the controlling perforations on successively fed record cards, the series circuit through contacts 238 will not be completed when contact L1 opens and the circuit through relays 230, 234 and 235 will consequently be broken, causing opening of relay points 230a and the breaking of the circuit of motor TM which will cause the machine to stop. The several accumulators of the machine, generally designated CTR #1, CTR #2, CTR #3, CTR #4, and CTR #5, may be connected to lower analyzing brushes LB by the usual plug connections to permit entries to be made therein in the well-known manner.

The tracing of a representative circuit will be sufficient to explain the adding and printing operations involved. This circuit is effective only while the motor TM is in operation and runs from line 232 (Fig. 23) to upper card lever contacts 229 as traced above, thence to lower card lever contacts 239, wire 240 (see also Fig. 24), impulse distributing contacts 241, wire 242, to lower brush common 243, perforation in the record card to brush LB, thence through cable 244 to plug sockets 245 on the plug board 246. From here plug connection may be made to the plug socket 247 of, let us say, the first column of accumulator #5 (Fig. 23). The circuit will continue from here through magnet 14, the usual arcing contact 14a, and wire 248, to line 225. Energization of magnet 14 will cause closure of contacts 14b in the usual manner to complete the circuit to the corresponding printing magnet 41. This circuit flows from the line 225 (Fig. 23), wire 248, contact 14b, printing magnet 41, contact 249, closed during listing operations, wire 250, contact P2, to line 232. In this manner items may be added and listed under control of the lower brushes.

Group indicating circuits

Provision is made for entering the group number contained on the first card of a group into one of the accumulators and suppressing such entries of the other cards from the group. For this purpose a multi-contact relay 251 (Fig. 22) is provided which, upon energization, is adapted to open a plurality of contacts 251a and close a contact 251b. Contacts 251a terminate in plug sockets 252 which may be included serially in the adding circuit of a counter; that is, the lower brush socket 245 (Fig. 24) may be plug connected to one of the sockets 252 (Fig. 22) and the second socket 252 may be plug connected to socket 247 (Fig. 23) of one of the accumulators. During the first card feeding cycle, therefore, the adding circuit may be completed to enter the data from the first card into the selected counter. Contacts 251a may be included in the adding circuit as by connections 6 as shown in Figs. 23 and 24. Toward the end of the first cycle, cam contact L2 (Fig. 22) is adapted to close, completing a circuit from line 225 (Fig. 22) to wire 253, cam contact L2, magnet 251 to wire 232. Magnet 251 will thereupon close contacts 251b and open contacts 251a, the former contacts setting up a holding circuit from line 225, wire 253, cam contact P4, contact 251b, relay coil 251, to line 232. This circuit will be maintained until cam contact P4 opens during a resetting operation of the tabulating machine thus holding contacts 251a open until such time. It will therefore be obvious that no further circuits can be completed to the counter under discussion after the entry of data from the first card of the group.

Connected in parallel with relay coil 251 is a coil 254 which, upon energization, is adapted to close a plurality of contacts 254a, one blade of each of which is connected to a punch selecting magnet 120 of the punching machine. This magnet is likewise included in the holding circuit to contacts P4 and 251b so that contacts 254a will remain closed until a resetting operation of the tabulating machine takes place.

Group indicating punch circuits

Immediately following the entry of the group number into one of the accumulators, the apparatus will be in readiness to punch said group number in a blank card in the punching machine. Before tracing such circuits in detail, the plugging connections whereby the group number may be entered into a predetermined portion of the record card will be explained. In Fig. 22 the plug board 255 is provided with five vertical columns of plug sockets 256, one column for each of the five accumulators of the machine. Each column of plug sockets contains nine individual sockets 256 one for each denominational order of the accumulator. By means of cables 257, the plugs 256 in each column are electrically connected to the conducting segments 23 of the corresponding orders of the associated accumulators. Thus plug socket #1 of column #1 has a wire within cable 257 which connects such socket to segment 23 in the first order of accumulator #1. On the punching machine is a plug board 258 provided with plug sockets 259 one of which is provided for each punching position of the record card carriage 74. Each socket 259 is connected by a wire 260 to the corresponding segment 219 of the column selector. In Fig. 21 there is shown diagrammatically the manner in which a specific order of an accumulator may be plugged to control entry into a specific column of the record card of the amount standing on that order. A plug wire 261 is shown connecting #3 plug socket 259 of plug board 258 to #4 plug socket 256 in the first column of plug board 255 which column corresponds to accumulator #1. Immediately upon closure of contacts 254a a circuit may be traced, in accordance with the plugging on Fig. 21 from line 225, wire 262, #1 punch magnet 120, contact 254a now closed, to connected segments 24, thence through contact plunger structure 21 to conductor 23, cable connection to plug socket 256, plug wire 261 to plug socket 259 on plug board 258, wire 260 to segment 219, connection 214, to ring 217, wire 263, to a contact 264 closed during adding operations, wire 265, to skip bar contact

210, contact 141, to line 232. This circuit may also be readily traced on Figs. 22, 23, and 24.

The energization of magnet 120 will cause the perforation of the record card in the #1 position of the third column following which the escapement mechanism will function in the manner described to space the record card and also move connecting member 214 to the next position in which a further circuit may be completed in the same manner in accordance with the setting in the accumulator order to which the next punch column is connected.

It will be observed in Fig. 22 that the commutator segments 24 which are associated with the index wheels of the accumulators are shown as vertical bars while the common conductors 23 of the individual denominational orders of the accumulators are shown as horizontal bars. The contact plungers 21 which wipe over the segments 23 are represented as curved lines. It will be understood that a line 21 forms connection between a conductor 23 and a column of segments 24 in a position corresponding to the setting of the corresponding denominational order of the accumulator.

The number of columns of the record card to be punched under control of the indicating device is, of course, dependent upon the number of plugging connections made between plug board 255 and plug board 258. A further control over these circuits is exerted by contact 210 which, as previously explained, is closed by the depending portion 211 of skip bar 206 as shown in Fig. 3. 211 is long enough to hold contact 210 closed while the columns in which punching is to take place are in position beneath the column of punches. Following the punching of the last of such selected columns, contact 210 will open preventing the completion of further circuits therethrough. The corresponding cut-out portion of bar 206 will, of course, permit the closure of contact 141 during the same punching period. For example, the bar shown in Fig. 3 has a cut-out portion 209 and a depending portion 211 arranged to permit the closure of contacts 210 and 141 in positions corresponding to columns 3 to 6, inclusive.

It will be appreciated that the position of the summary card in which this group indicating number is perforated is dependent upon the configuration of the skip bar 206. Punching will take place in each of the columns of the record card selected and, in those columns where no significant figure is present, a zero will be punched.

Following the punching of the last column of the field, the high portion of skip bar 206 will cause disengagement of the escapement mechanism and the card carriage will move with a continuous motion until it reaches the next punching position represented by a cut in bar 206. In Fig. 3 this is indicated as being column 28. In such position contact 141 will again be permitted to close but contact 210 will remain open.

Referring now to Fig. 21, it will be observed that with contact 210 open, the common return circuit to line 232 can no longer be completed through such contact. However, a shunt circuit is provided around contacts 210 including a contact 266 and the points 234a of relay 234. Contacts 266, as shown in Fig. 23, are adapted to be opened while the card feed clutch 227, which is included in the circuit of motor TM, is energized; that is, as long as cards are feeding, and adding and listing operations are taking place, contact 266 is open. The relay 234 is included in the group control circuit and remains energized as long as successively fed cards agree in their group designation perforations. As previously pointed out, a disagreement in the record cards will cause failure of the circuit in which relay 234 is included. The consequent deenergization of relay 234 permits points 234a to close. Since the failure of this circuit causes a break in the circuit of the motor TM, card feed clutch magnet 227 will also become deenergized and contacts 266 will close. Therefore, at such time, the closure of both contacts 266 and relay points 234a will provide a shunt circuit around contacts 210. If the punch carriage at this time has already reached its new punching position, contacts 141 will also be closed to complete the circuit to line 232. Punching may now take place under control of such accumulator order connected to the column of the selecting device corresponding to the card column under the punches.

In the example shown in Fig. 2, accumulators #4 and #5 are both connected for controlling the punching in the newly presented field of the summary card. Selecting mechanism to be hereinafter described in detail is provided for determining which of these two accumulators is to control the subsequent punching operations.

In Fig. 21 the fifth denominational order bar 23 of accumulator #4 and the same order bar in accumulator #5 are connected to the proper plug sockets 256 on plug board 255, the manner of connection being identical with that explained in connection with accumulator #1. The socket 256 associated with accumulator #4 is connected my means of a plug wire 267 to a plug socket 268 on a plug board 269 while the socket 256 corresponding to accumulator #5 is connected by a similar plug wire 270 to a socket 271 on plug board 269. Socket 268 is connected to a blade of a contact 272 while plug socket 271 is connected to a blade of contact 273, these two contacts having a central blade connected to a plug socket 274 from which connection may be made through a suitable plug wire 275 to the plug socket 259 on plug board 258 corresponding to the column of the summary card in which the data from the fifth denominational order of accumulator #4 or #5 is to be punched.

With the contacts 272, 273 in the position shown in Fig. 21, the punching circuit may be completed when the card presents its twenty-eighth column to the column of punches 73. The circuit will then run from line 225 to plug board 255, as previously described, and from thence through plug connection 267 to plug socket 268, contact 272, plug socket 274, plug connection 275, to plug socket 259, and thence through wire 260 to segment 219 in the twenty-eighth position, connector 214, contact ring 217, wire 263, contact 264, wire 255, contact 266, relay points 234a, contact 141, to line 232. Contacts 272, 273 are controlled in their position by a magnet 276 which remains deenergized when punching is to take place under control of accumulator #4 and which is energized when punching is to take place under control of accumulator #5, in which case, contacts 272 are open and contacts 273 are closed, thus permitting the aforetraced circuit to extend from plug board 255, through the plug connection 270, to contact 273, and thence back to line 232 as before.

The representative circuits just traced on Fig. 21 may be followed with equal facility on the general circuit diagram, Figs. 22, 23, and 24.

Balance punching selecting mechanism

The particular type of balance selecting mechanism is similar to that shown and described in the copending application of Ulrich Kölm, Serial No. 285,934, filed June 16, 1928, now Patent No. 1,954,054, in which such subject matter is claimed. As much will be described as is necessary for a proper understanding of the present invention.

When balances are obtained by complementary addition in which items of one class are entered in their actual value and those of another class in their complementary value, it is clear that a change in the type of balance, that is, a change from a credit or positive to a debit or negative balance or vice versa, can only occur when an item of the class to which the balance changes is added. If the credit items are entered according to their positive value and the debit items according to their complementary value and a credit balance stands on the accumulator at the time, it can only be changed into a debit balance if a debit entry is made. This will be clearer from a specific example. If a credit value designated by 160 stands on the accumulator and a debit item amounting to 270 is entered in its complementary value of 9730, the character of the balance would be changed thus:

Credit value	160
Complement of debit item 270	999999730
Resulting in a debit balance (complementary)	999999890

In another case, if a credit balance stands on the accumulator and a debit item of smaller value is complementarily added, the character of the balance does not change thus:

Credit value	160
Complement of debit item 29	999999971
Resulting in a balance of	000000131

It will be noted that at the end of the actual entry of the complement the accumulator elements to the left of the significant figures in this case stand at zero and that the nines were disposed of through a transferring operation which takes place in the latter part of the machine cycle after the actual entries.

This transferring operation on the exereme left hand accumulator wheel through which the nine entered from a debit item (complementary) is disposed of is made use of in conjunction with the special debit indicating perforation **10**, shown on the detail card in Fig. 2, to select the proper balance accumulator for punch controlling operation. The selection of the proper accumulator is controlled by the magnet **276** which is energized to select the #**5** or credit accumulator or when deenergized to select the #**4** or debit accumulator for controlling punching of the balance.

The system may be briefly summarized as follows: An entry of one type of item (for example, a debit item) shifts the punch controlling contact connections **272**, **273** from the balance accumulator which is then controlling to the other; a transferring operation after and as a result of an entry shifts the punch controlling connections from the balance accumulator which is controlling just prior to the transfer, to the other. In other words, the punch controlling connections are ultimately shifted as the result of an entry which involves either a debit item or a transfer operation on the extreme left hand accumulator wheel but the punch controlling connections are not ultimately shifted as the result of an entry which involves both a debit item and a transfer operation. The operation of the device will be made clearer by tracing the operation through a plurality of steps during which the several selections are made.

Kind of item	Amount of item	Transfer	Amount entered in CTR #5	Indication on CTR #5
1. Credit	270		270	000000270
2. Credit	110		110	000000380
3. Debit	110	(1)	999999890	000000270
4. Debit	110	(1)	999999890	000000160
5. Debit	270		999999730	999999890
6. Debit	270	(1)	999999730	999999620
7. Credit	409	(1)	409	000000029

The first card carrying a credit item enters this item in its true value into the credit balance accumulator #**5** which is in normal selected position. The second card likewise carries a credit item. There is, therefore, no designating perforation on the cards to select the debit balance accumulator and no transferring operation involved on the left hand accumulator wheel of CTR #**5** so that if it is assumed that the credit balance accumulator is normally in position to control punching, this condition will not be disturbed. The third card carries a debit item whose value, however, is too small to change the character of the balance. In this case the designating perforation on the debit card momentarily selects the debit balance accumulator #**4** for printing but the transferring operation clearing the accumulator wheels to the right re-selects the credit balance accumulator #**5** for punch controlling so that at the end of the entry the accumulator #**5** still remains in condition for punch controlling. The fourth card carrying a debit item operates in like manner as the value of this item is still not sufficient to change the character of the credit balance standing on accumulator #**5**.

The fifth card carries a debit item sufficient in value to change the character of the balance, that is, when its complement is entered there is no transferring action as a nine remains on the left hand counter wheel of CTR #**5**. In this case, as the debit card is analyzed, its designating perforation **10** selects the debit balance accumulator for punching and as there is no subsequent transferring operation of the left hand counter wheel, the selection of the debit balance accumulator persists and, if balance punching is effected after this entry, it will be effected from the debit balance accumulator #**4** in its true value representing a debit balance. The sixth card being another debit card should still select the debit accumulator for punch controlling. The designating perforation shifts the punch controlling connections temporarily selecting the credit accumulator but the ensuing transfer operates to re-select the debit balance accumulator which contains the true debit balance. The seventh item will change the selection to CTR #**4** since a transfer is involved. The circuits involved in these selecting operations will now be traced on the wiring diagram.

Referring to Fig. 24, a plug socket **280** which is connected to the upper brush UB which traverses the column of the detail card in which the special debit item indicating perforation **10** is made in the eleven index point position is connected by a suitable plug wire to a socket **281** in the lower right hand portion of Fig. 24. A cam contact L3 is adapted to close momentarily as this index point position is passing the upper brushes UB so that when a special perforation **10** is analyzed, a circuit

may be completed from line 225, cam contact L4, common 282 of the upper brushes, perforation 10, cable 283, to plug board 246, thence from plug socket 280, through suitable connection to socket 281, cam contact L3, relay 284, to line 232. Closure of points 284a will establish a holding circuit from line 225, wire 286, cam contact L5, now closed, relay points 284a, relay 284, to line 232.

Cam contacts L5 will hold this circuit until after the record card has begun to pass the lower analyzing brushes LB. Points 284b which close with points 284a will permit the completion of a circuit during the time the record card is passing the lower brushes at a time when cam contact L6 closes. This circuit may be traced from line 225, through double-step relay magnet 57, cam contact L6, points 284b, wire 285, wire 240 (Fig. 23), back to line 232 as hereinbefore traced. Energization of magnet 57 when the parts are positioned as in Fig. 24 will rock cams 67 to open contacts 68 and close contacts 69. A corresponding pair of contacts 68a and 69a will be similarly shifted. Closure of contacts 69a will complete a circuit to a line 225 through wire 287, magnet 276, contact 69a, wire 288, to line 232. Energization of magnet 276 will shift the punch controlling circuits from the control of accumulator #4 to accumulator #5 in accordance with the theory of selection outlined above; that is, the entry of any debit item into the balance accumulators will cause the shifting of the contacts 272, 273. If contacts 272, 273 have been in their shifted position during the analyzing of a debit card bearing a special perforation 10, the consequent energization of magnet 57 will have shifted the contacts 68a, 69a, back to their position as shown on Fig. 24, causing the deenergization of magnet 276. In this manner contacts 272, 273 will be shifted for each debit card passing through the machine.

If the value of the card entered into the balance counters during the cycle in which such shifting takes place is of a value such that it causes the highest order wheel of the credit balance accumulator #5 to pass through zero and cause the closure of contact 27, a further shifting circuit will be established from wire 240, wire 285, contact 27, magnet 57, to line 225 to again shift the contacts 272, 273. In this manner accumulators #4 and #5 are alternately connected for punch controlling operations whenever a debit card is analyzed and whenever contact 27 is closed due to the change in the character of the balance on accumulator #5.

Up to this point it has been explained how items may be entered into the accumulators of the tabulator and how after the entry of the first card of a group a punch operation may take place to perforate two group designation data in a field of the summary card under control of a selected counter. It has also been pointed out how after this classification data has been completely punched in the summary card, the card carriage is automatically shifted into position to receive punching under control of another accumulator, which punching will automatically take place upon the change in the classification data of the record cards or will take place immediately upon arrival of the first column of the selected punching field if such classification data change takes place while the summary card is moving to its new punching position. It has also been shown how debit and credit items may be entered into a pair of accumulators and the accumulator having the true balance selected for controlling the operation of the punch.

Means is provided for indicating on the summary card the character of the total punched therein. A special designating perforation indicated in dotted outline at 289 in Fig. 2 may be perforated in a selected column whenever a debit balance is punched. The perforation of this hole is controlled by contact 272a (Fig. 24) which is operated together with contacts 272, 273 and which is adapted to be closed with the contacts 272 when punching is being controlled from the debit balance accumulator #4. This circuit will be completed in the selected column and may be traced as follows: from line 225 (Fig. 22) wire 262, magnet 120 in the X position, wire 290 which extends across Fig. 23, to Fig. 24, contact 272a, to plug socket 274a, and from here suitable plug connection may be made to the selected column from whence the circuit continues to the other side of line in the same manner as the other punch circuits. A perforation in a different location may be made in the same card column when a credit balance is perforated and this circuit may extend in parallel with the above traced circuit and extend through contact 273a to control punching in the zero index point position in the same manner. It will, of course, be apparent that if the credit balance indicating perforation of the zero position is to be made, the column selected to receive this perforation will be one in which amount designations are not to be entered.

Following the punching of the balance, the skip bar will cause the automatic advance of the record card to present the first column of another field which, as indicated in Fig. 2, may then automatically receive punching from one of the other accumulators, as for instance, accumulator #3. The controlling circuits involved in this operation are identical with those involved in punching under control of accumulator #1 and need not, therefore, be repeated. Following the last punching operation the card carriage may be automatically advanced under control of the skip bar 206 to its extreme position if the last punched field has not already brought it into such position.

Operation of the punch card feeding mechanism

It will be recalled that while punching operations under control of the accumulators other than accumulator #1 have been taking place, the tabulating machine is inoperative. Mechanism is included in the punching machine for restarting the tabulator as the punched summary card is being ejected. The circuits controlling this ejecting mechanism will now be described.

In Fig. 22, contacts 201 and 202 which close when the card is in last column punching position complete a circuit at such time from line 225, contact 201, relay coil 292, contact 202, wire 291, to line 232. Energization of relay 292 will close its points 292a to complete a circuit from line 225, contact 201, relay coil 292, points 292a, eject magnet 192, wire 291, to line 232. Energization of eject magnet 192, as has been pointed out in the mechanical description, is adapted to trip the card gripper mechanism which thereupon closes upon the leading edge of the card and flips it over into the receptacle. Movement of armature 192 at the same time causes closure of contacts 293 (see also Fig. 15) which are included in the resetting circuits of the tabulating machine and will, upon closure, initiate a total printing and resetting operation of the tabulating machine which will hereinafter be explained.

When the card is fully ejected, contacts 200 are closed in the manner explained and com-

plete a circuit from line 225, contacts 201, contacts 200, trip magnet 167, wire 291, to line 232. Magnet 167 thereupon causes engagement of the card feed clutch mechanism of the punch and at the same time, through its armature, causes closure of contact 178 which in turn completes the circuit from line 225, contact 178, motor 150, wire 291 to line 232. The motor thus energized and connected to the card feeding mechanism of the punch will return the card carriage rack 74 to its initial punching position and will cause the feeding of a blank card thereto. Opening of contacts 174 will prevent the further operation of the punch operating magnet 105. The normal punching circuit extends from line 225, through contact 174, universal bail contact 104 which is closed for each punch interposer selection, magnet 105, wire 291, to line 232. It will thus be seen that the punch card feeding mechanism will feed a new card into position while the tabulating machine is performing its usual total printing and resetting operations. The resetting circuit initiated by closure of contacts 293 under the influence of the card ejecting magnet 292 may be traced as follows: from line 225 (Fig. 23), reset motor RM, reset clutch magnet 294, contacts 295, closed when the card feeding mechanism is idle, wires 296 which extend to contact 293 in Fig. 22, contact L6, to line 232. This circuit causes the operation of the total shaft 31 and the operation of the various contact devices which are prefixed "P" on the circuit diagram. The usual holding circuit maintains the motor RM in operation until a complete cycle has been effected.

Total printing circuits

Totaling is effected from the several accumulators under control of the emitting cams 53 and contacts 56 of Fig. 22. These cams are timed to close successively as the corresponding type elements pass printing position; that is, as the nine type element passes printing position the contact 56 associated with the #9 column of segments 24, closes momentarily and as the eight element passes printing position, the #8 contact 56 closes, and so on. Thus, as the nine type elements are passing printing position, circuits will be completed through such accumulator orders as have their contact structures 21 standing at nine.

Assuming that column #1 of accumulator #1 has its contact structure 21 set at nine. The circuit may then be traced from line 225 (Fig. 22), through wire 297, #9 contact 56, segment 24 corresponding to the ninth position of accumulator #1, contact structure 21 in this position, to common conductor 23 in the first order of accumulator #1, through a wire 298 (see also Fig. 23), contact 299 closed in a manner to be explained presently, corresponding printing magnet 41, contact 249 now closed, wire 250, contact P2, to line 232. Magnet 41 will therefore be energized to intercept the corresponding type bar with the nine type element in printing position. As the eight type element passes printing position, a similar circuit may be traced through the eight contact 56, and the eight segments 23, to position the type bars to print eight.

Contacts 299 of which there is one for each order of an accumulator are controlled by the magnet 300. A magnet 300 and set of contacts 299 are provided for each of the five accumulators and they are all connected by common wire 301 to one side of line 232 (Fig. 23). These magnets may be energized through a common wire 302 extending to a cam contact P6 which closes at the beginning of the total printing cycle and remains closed while the type elements are passing printing position. Such accumulators as have been selected for resetting, will have their zero button contacts 303 closed so that upon closure of contact P6 such magnets 300 as have their contacts 303 closed will become energized and close their related contacts 299.

Accumulators #4 and #5 when used for balance accumulating have their magnets 300 disconnected from wire 302, through the operation of associated switches as indicated in Fig. 23. It may be mentioned at this time, that prior to the closure of contacts P6, the holding circuit contact P4 (Fig. 22) is adapted to open to break the holding circuit through magnets 251 and 254 whereby contacts 251 and 254*a* are permitted to open. Opening of contacts 254*a* during total printing operations prevents undesirable back circuits while printing, while the contacts 299 prevent undesirable back circuits during punch selecting operations. The printing circuits through accumulators #4 and #5 must be selectively controlled so that the total of the true balance only is selected for printing. This selection is controlled through contacts 68 and 69 (Fig. 24) which, as we have seen, operate identically as contacts 68*a* and 69*a*.

It has been pointed out above that contact 68*a* is closed when punching is to be controlled from accumulator #4. Since contact 68 is also closed when accumulator #4 contains the true balance, it will be in such position at the beginning of total printing operations. A circuit may thereupon be traced from line 225 (Fig. 24) through wire 304, cam contact P7 which is timed identically with cam contact P6, contact 68, wire 306 (see also Fig. 23), magnet 300 of accumulator #4, wire 301, to line 232. When the other accumulator #5 is selected for punch controlling we have seen that contacts 69*a* are closed; consequently, the companion contact 69 is also closed and the print controlling circuit through magnet 300 is completed from line 225 (Fig. 24), wire 304, contact P7, contact 69, wire 305 (see also Fig. 23), magnet 300 of accumulator #5, wire 301, to line 232. In this manner, the accumulator which is selected to control the punching of the true balance is also selected for controlling the printing of such balance during the subsequent total printing operation of the machine. A cam contact P8 is provided for the purpose of setting the contacts 68, 69, 68*a*, 69*a* to their initial starting position for cooperation with the next group of cards.

In series with this contact is a contact 307 associated with the contact 303 of accumulator #4 (see Figs. 1 and 23) which is adapted to be closed by the accumulator reset selecting lever. Thus toward the end of the total print and resetting operations of the tabulating machine, a circuit may be traced from line 232 (Fig. 24) wire 288, contact 68*a*, if such contact is closed, contacts 307, P8, wire 308, magnet 57, to line 225. This will cause the opening of contacts 68 and 68*a* and closing of contacts 69, 69*a* which is their normal starting position. If toward the end of the reset cycle contacts 68 and 68*a* are open due to the selection of CTR #5 or credit balance accumulator this circuit is, of course, ineffective since it is not then necessary to advance the contact stepping mechanism. Following the total printing operations the resetting of the several

accumulators is automatically effected in the well-known manner and if the machine is so set automatic feeding of the next group of cards will take place. These functions are well-known in the art and fully explained in the patent to Daly and Page referred to so that they need not be repeated here.

While there has 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 machine of the class described, a plurality of entry receiving devices, means for feeding a group of record cards, means for entering data from only the first card of said group into one of said entry receiving devices, means for entering data from each of said group of cards into another of said entry receiving devices, a punching mechanism and means for controlling said punching mechanism in accordance with the entry in said first named entry receiving device while the other entry receiving devices are receiving entries from the cards subsequent to the first card.

2. In combination, a record controlled tabulating machine including an accumulator and means for entering data from each card of a group of record cards into said accumulator, punching mechanism and printing mechanism, group control means, means initiated thereby and operative upon completion of the entry of data from a group of record cards for causing said accumulator to control the operation of said punching mechanism, and means controlled by said punching mechanism and operative upon the completion of punching for causing said accumulator to control the operation of said printing mechanism.

3. In combination, a plurality of entry receiving devices having a plurality of denominational orders of readout mechanism associated therewith and positionable in accordance with the setting of the entry receiving devices, a step-by-step punching mechanism, printing mechanism, means for successively connecting the orders of the readout mechanism of the entry receiving devices with said punching mechanism for step-by-step punch controlling operations to punch holes column by column representing said setting, and further means for concurrently connecting said orders of the readout mechanism with said printing mechanism for controlling printing operations from said orders concurrently and means controlled by said punching mechanism to delay the operation of the printing mechanism until punching has been effected.

4. In combination, a record controlled tabulating machine, including an accumulator, means for entering data from each card of a group of record cards into said accumulator, punching mechanism, printing mechanism, group control means, means initiated thereby and operative upon the completion of the entry of data from a group of record cards for causing said accumulator to control the operation of said punching mechanism, means controlled by said punching mechanism to in turn cause said accumulator to control the operation of said printing mechanism, and means controlled by said punching mechanism for delaying the operation of said printing mechanism until punching has been effected.

5. A machine of the class described, including a plurality of entry receiving devices, means for feeding a group of record cards, means for entering data from only the first card of said group into one of said entry receiving devices, means for entering data from each card of said group of cards into another of said entry receiving devices, a punching mechanism, connecting means for successively placing said punching mechanism under the control of said first-named entry receiving device and the other entry receiving device, means including said connecting means for causing said first-named entry receiving device to control the operation of said punching mechanism upon the completion of the first card entry therein and means also including said connecting means for causing the other entry receiving device to control the operation of the punching mechanism upon completion of the entries of the entire group of cards therein.

6. In combination, a tabulating machine including card feeding and analyzing mechanism for feeding and analyzing record cards arranged in groups, automatic group control mechanism and entry receiving devices controlled by said analyzing mechanism; a punching machine including punches, connecting means for successively placing said punching mechanism under the control of said entry receiving devices, means including said connecting means for effecting an operation of said punching machine under control of one of said entry receiving devices after the first card of a group has been fed and analyzed and before the entire group of cards is analyzed and means also including said connecting means and controlled by said automatic group control mechanism for effecting further operation of said punching machine under control of another of said entry receiving devices after an entire group of cards has been fed and analyzed.

7. A machine of the class described, including a plurality of entry receiving devices, means for feeding a group of record cards, means for entering data from only the first card of said group into one of said entry receiving devices, means for entering data from each card of said group of cards into another of said entry receiving devices, a punching mechanism, connecting means for successively placing said punching mechanism under the control of the first-named entry receiving device and the other entry receiving device, means including said connecting means for causing said first-named entry receiving device to control the operation of said punching mechanism upon the completion of the first card entry therein, means also including said connecting means for causing the other entry receiving device to control the operation of the punching mechanism upon completion of the entries of the entire group of cards therein, said last-named means further including means controlled by the punching mechanism for delaying the operation of said last-named means until punching under control of the first card entry has been completed.

8. A machine of the class described, including a plurality of entry receiving devices, means for feeding a group of record cards, means for en-

tering data from only the first card of said group into one of said entry receiving devices, means for entering data from each card in said group of cards into another of said entry receiving devices, a plurality of punches, means for feeding a card to said punches, connecting means for successively placing said punches under the control of said first-named entry receiving device and the other entry receiving device, means including said connecting means for causing said first-named entry receiving device to control the operation of said punches to punch the data therein in one field of the card upon the completion of the first card entry and means also including said connecting means for causing the other entry receiving device to control the operation of said punches to punch the data therein in another field of said card upon completion of the entries of the entire group of cards therein.

9. A machine of the class described, including a plurality of entry receiving devices, means for feeding a group of record cards, means for entering data from only the first card of said group into one of said entry receiving devices, means for entering data from each card of said group of cards into another of said entry receiving devices, a recording mechanism, connecting means for successively placing said recording mechanism under the control of said first-named entry receiving device and the other entry receiving device, means including said connecting means for causing said first-named entry receiving device to control the operation of said recording mechanism upon the completion of the first card entry therein and means also including said connecting means for causing the other entry receiving device to control the operation of the recording mechanism upon completion of the entries of the entire group of cards therein.

10. A machine of the class described, including an entry reeciving device, an accumulator, means for feeding a group of record cards, means for entering data from only the first card of said group into said entry receiving device, means for entering data from each card of said group of cards into said accumulator, a mechanism arranged for control by said device and said accumulator, connecting means for successively placsaid mechanism under the control of said entry receiving device and said accumulator, means including said connecting means for causing said entry receiving device to control the operation of said mechanism upon the completion of the first card entry therein and means also including said connecting means for causing the accumulator to control the operation of the said mechanism upon completion of the entries of the entire group of cards therein.

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