

Feb. 18, 1941.

C. D. LAKE ET AL

2,232,006

ACCOUNTING MACHINE

Filed Dec. 30, 1937

9 Sheets-Sheet 1

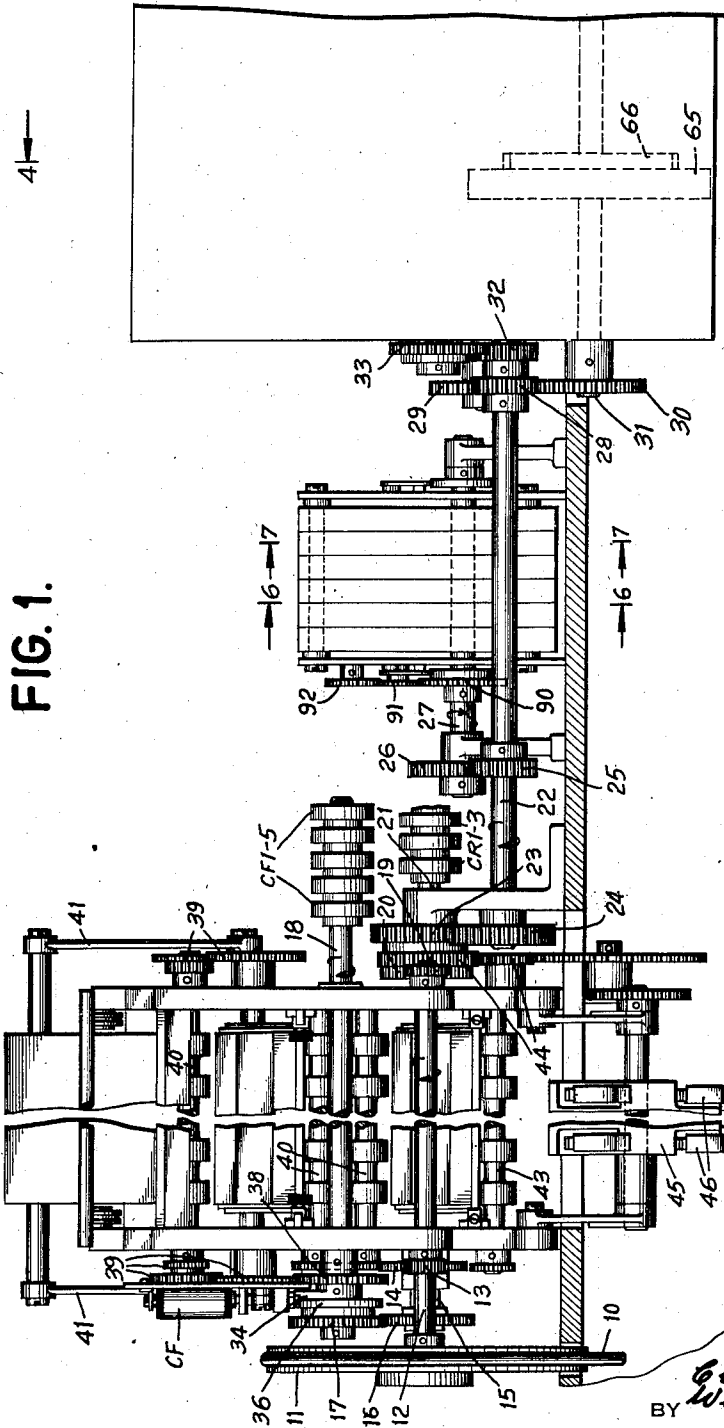


FIG. 1.

INVENTORS
C. D. Lake
Wesley Proff
BY *Wm. W. Wm.*
ATTORNEY

Feb. 18, 1941.

C. D. LAKE ET AL

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FIG. 2.

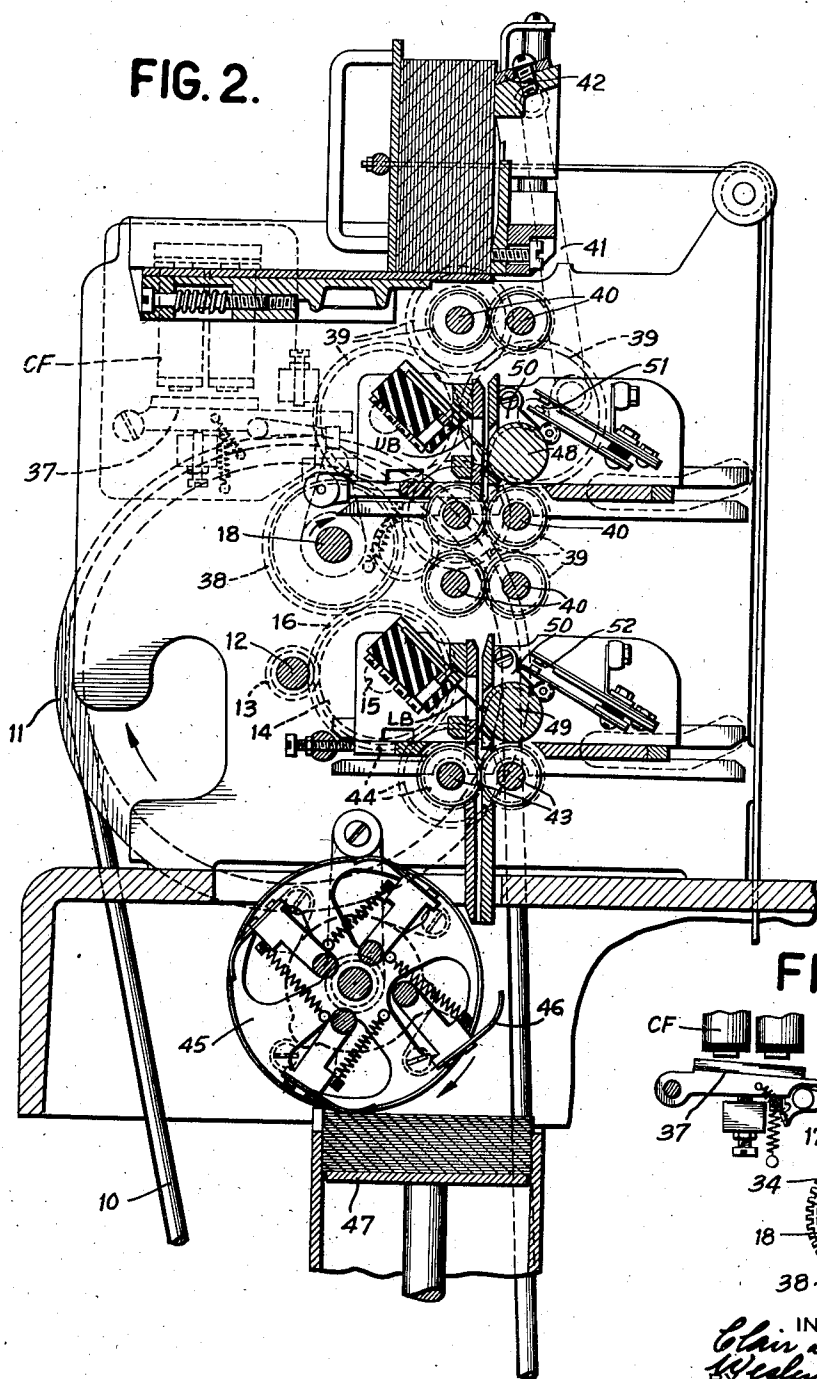
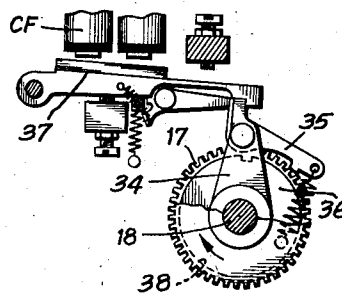


FIG. 3.



INVENTORS
Clair D. Lake
Wesley P. Gaff
BY
W. M. Wilson
ATTORNEY

Feb. 18, 1941.

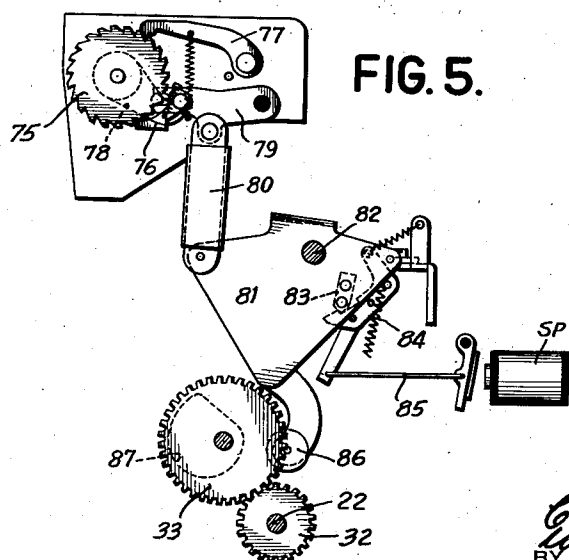
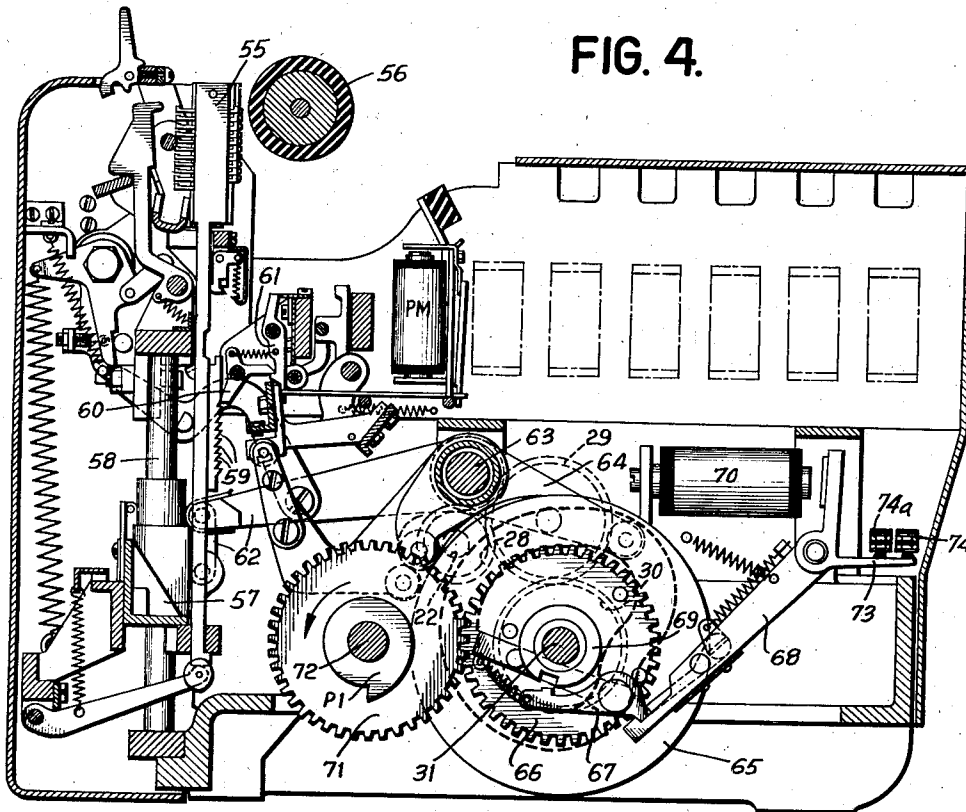
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2,232,006

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INVENTORS
Clair D. Lake
Wesley P. Gaff
BY
W. M. Wilson
ATTORNEY

Feb. 18, 1941.

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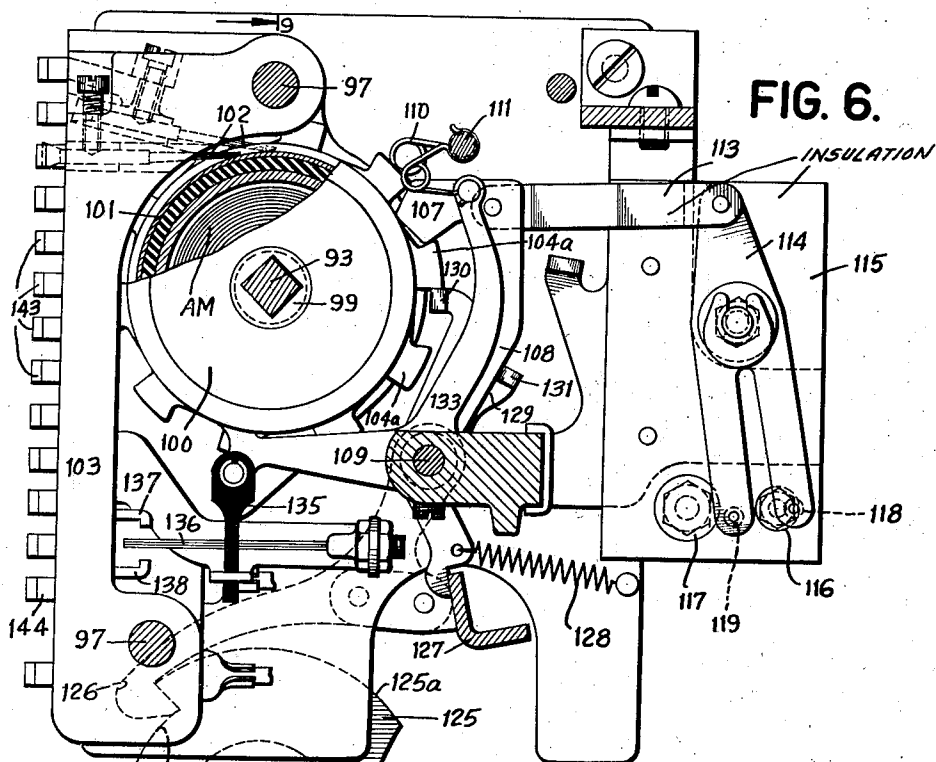


FIG. 6.

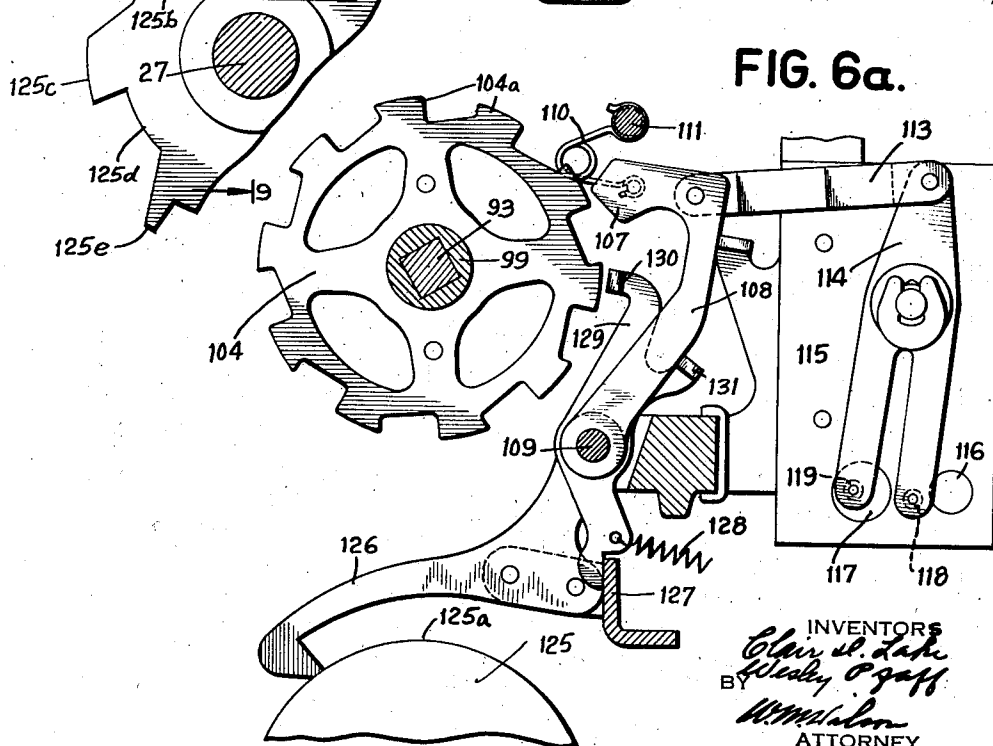


FIG. 6a.

INVENTORS
Clair D. Lake
Wesley O. Gaff
BY
W. M. Malan
ATTORNEY

Feb. 18, 1941.

C. D. LAKE ET AL

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FIG. 7.

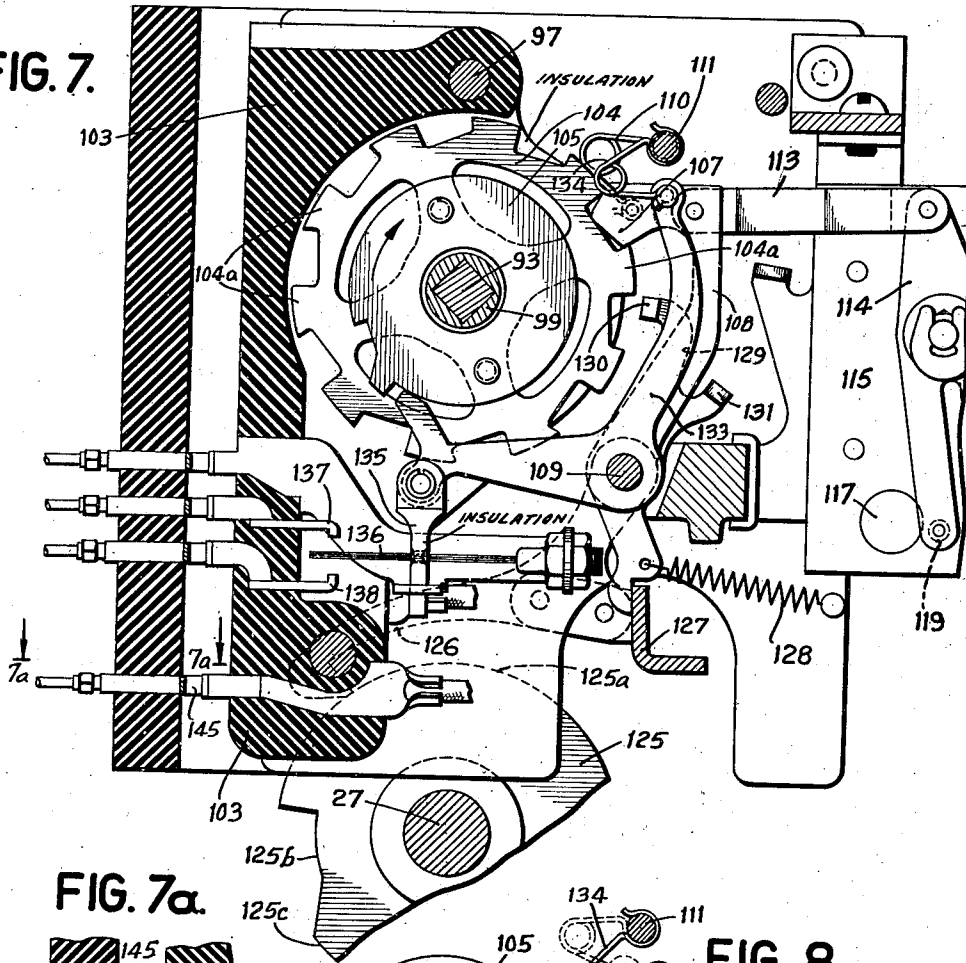


FIG. 7a.

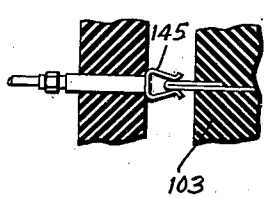
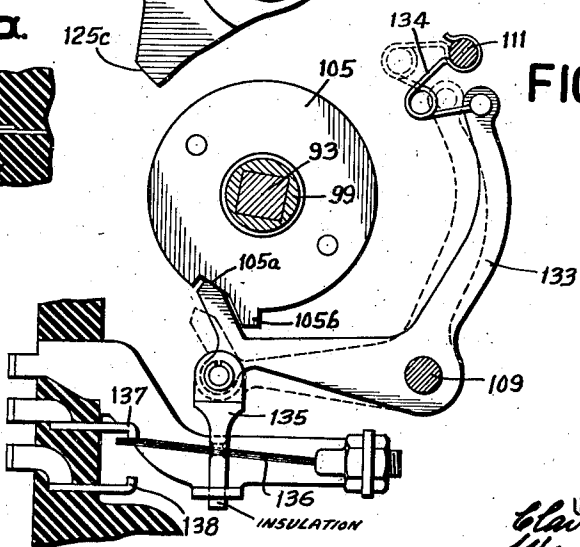


FIG. 8.



INVENTORS
Clair D. Lake
Wesley P. Gaff
BY
W. M. Malcom
ATTORNEY

Feb. 18, 1941.

C. D. LAKE ET AL

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FIG. 9.

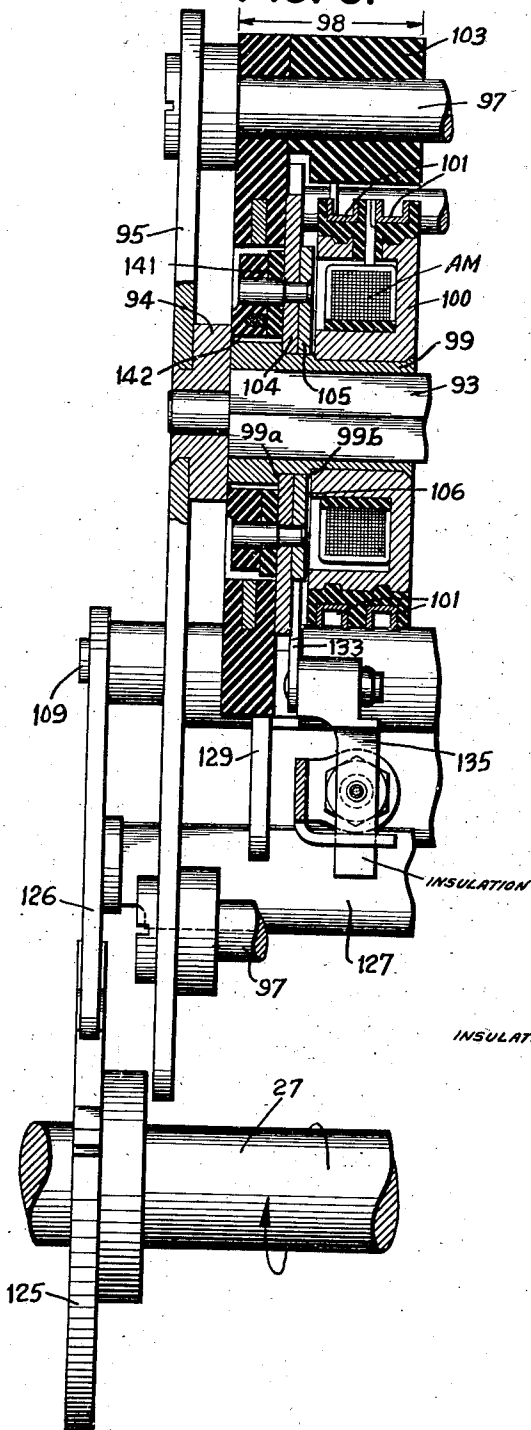
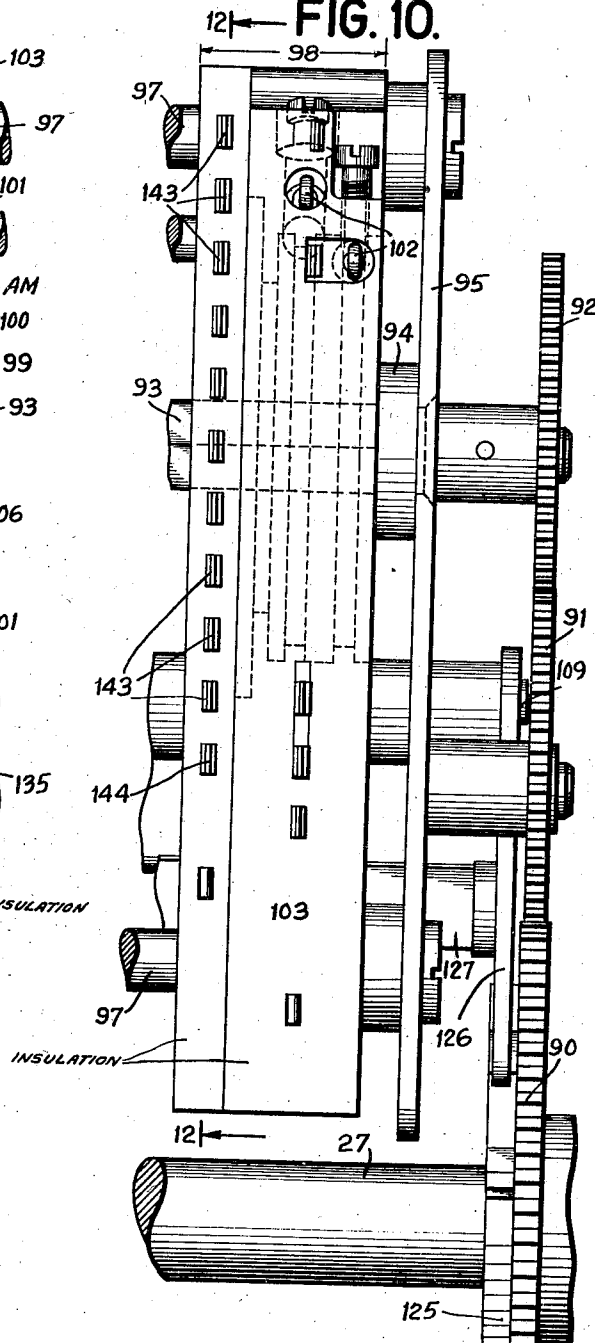


FIG. 10.



INVENTORS
Clair D. Lake
W. M. Lake
BY *W. M. Lake*
ATTORNEY

Feb. 18, 1941.

C. D. LAKE ET AL

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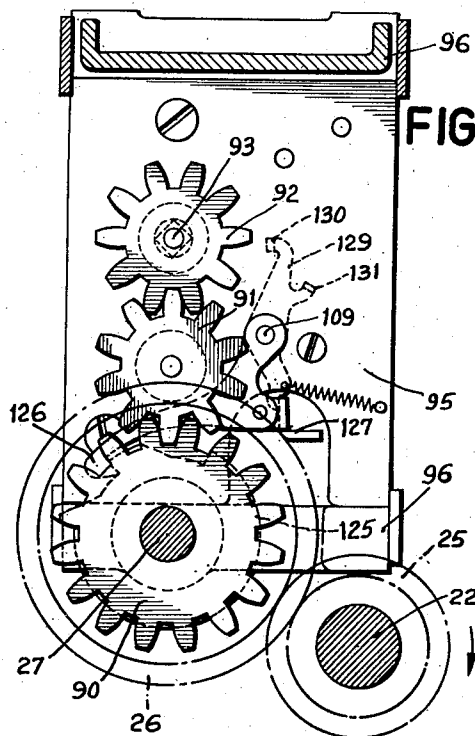


FIG. 11.

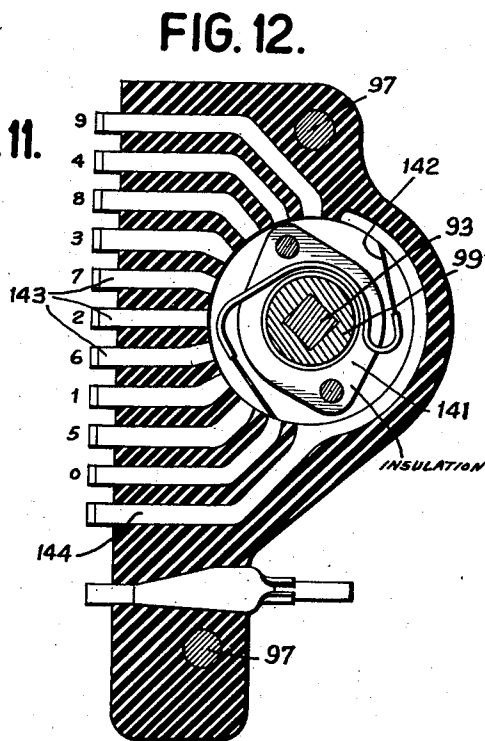
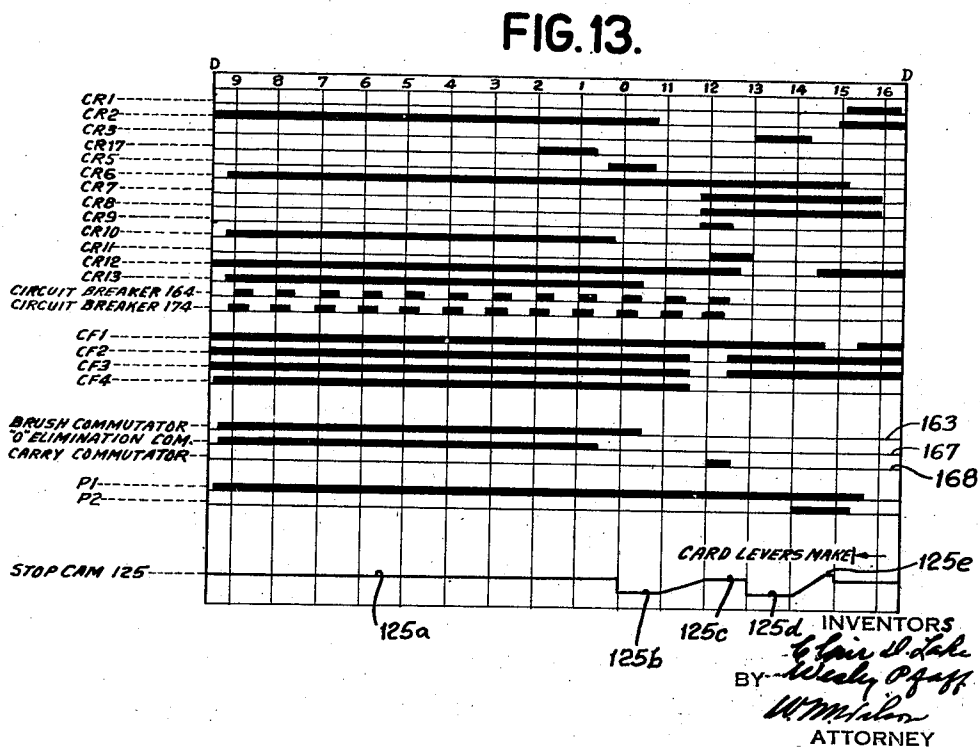


FIG. 12.



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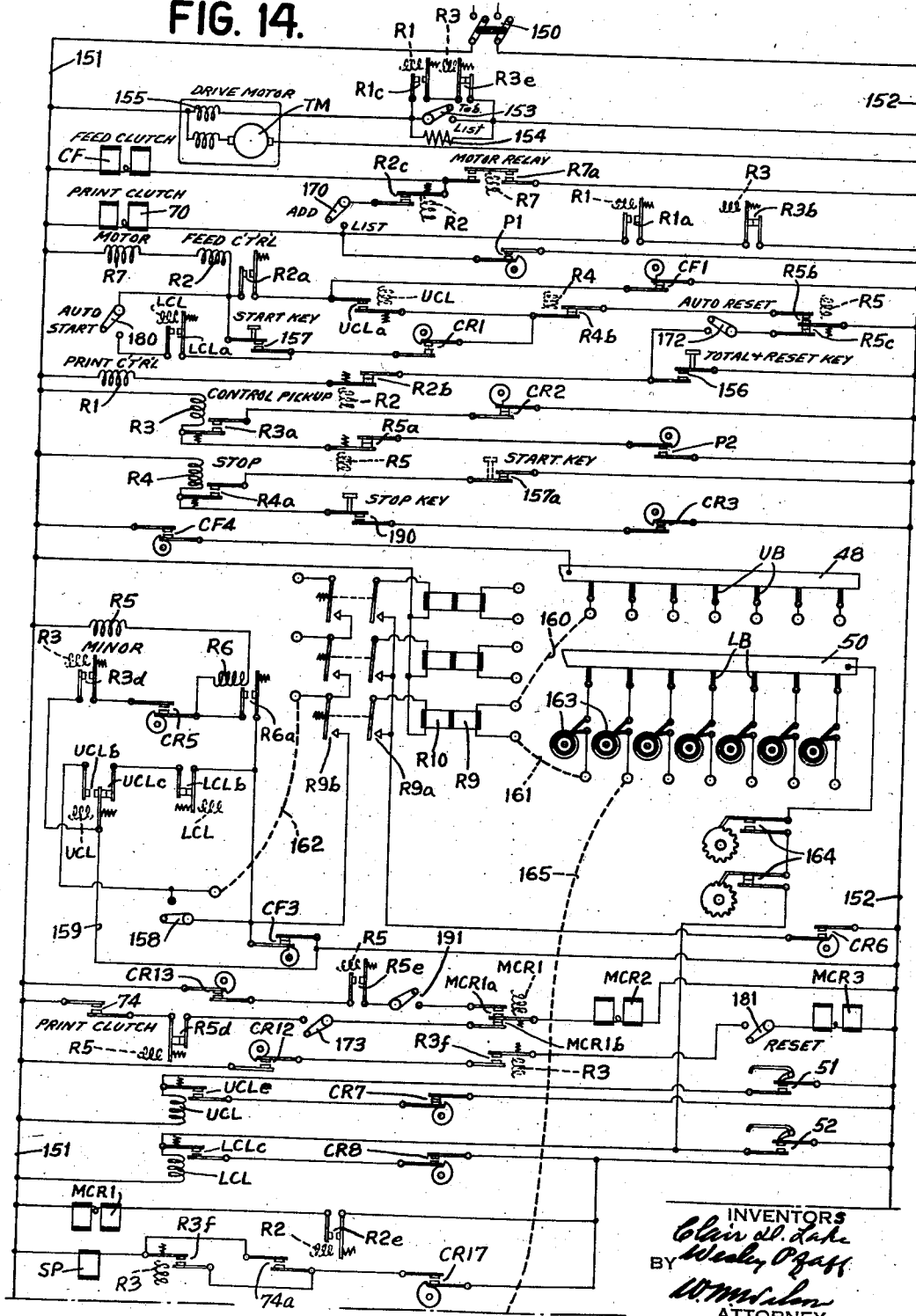
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FIG. 14.



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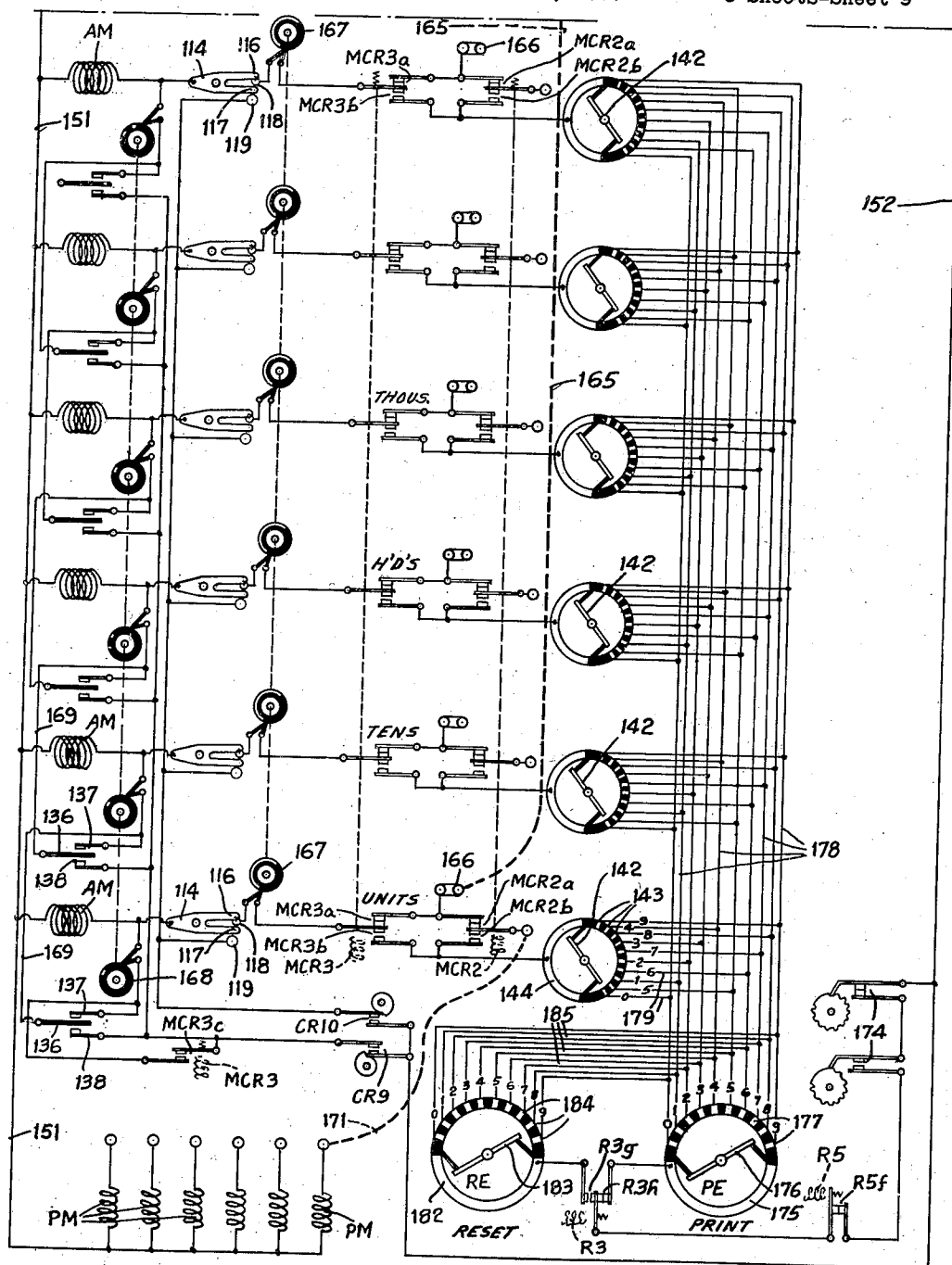


FIG. 14a.

INVENTORS
Clair W. Lake
Wesley P. Gaff
 BY
W. M. Wilson
 ATTORNEY

UNITED STATES PATENT OFFICE

2,232,006

ACCOUNTING MACHINE

Clair D. Lake, Binghamton, and Wesley Pfaff,
Union Center, N. Y., assignors to International
Business Machines Corporation, New York,
N. Y., a corporation of New York

Application December 30, 1937, Serial No. 182,402

6 Claims. (Cl. 235—61.6)

This invention relates to tabulating machines and more particularly to the accumulating mechanism of such machines.

The invention relates more particularly to the simplification of accumulating mechanism for use in high speed, record controlled accounting machines by the elimination of numerous connections and by a compactness of arrangement utilizing a type of accumulating wheel engaging mechanism not heretofore employed in accounting devices.

Heretofore, an electrically controlled denominational order of an accumulator has comprised generally a driving member, a driven accumulating element, a clutching mechanism between the two and a magnet whose energization has brought about a driving engagement between the driving member and the accumulating element. In such constructions the driving and driven members have been located on the same or separate shafts and the operating magnet has been located adjacent thereto and provided with an armature and linkage to effect the clutching action.

In the present arrangement, the driving member, the driven accumulating element and the magnet are all concentrically mounted on a common axle or support. The magnet itself is constantly rotated and its metallic casing constitutes the driving element of a magnetic clutch which, when current is passed through the winding of the magnet, will magnetically couple a concentrically mounted accumulating wheel thereto for rotation therewith. Suitable circuit making and breaking devices have been designed to enable the clutching action to take place at a differential time during a cycle of operation dependent upon the time of sensing a perforation in a column of a record card and to cause the clutch to remain in action until a definite point in the cycle whereby various amounts of rotation of the accumulating wheel are obtained in accordance with the value of the digit entered.

A further object of the invention has been to provide a novel form of electrically controlled tens carry mechanism for use in connection with the newly arranged accumulating unit.

A still further object resides in the provision of improved locking devices for insuring the positive positioning of the driven elements throughout the operation of the machine.

Further objects of the instant invention reside in any novel feature of construction or operation or novel combination of parts present in the embodiment of the invention described and shown in the accompanying drawings.

In the drawings:

Fig. 1 is a front view of the machine showing the relationship and driving connections between the card feeding, accumulating and printing sections of the machine.

Fig. 2 is a central section through the card feeding and analyzing section of the machine, the section being taken along the lines 2—2 of Fig. 1.

Fig. 3 is a detail of the card feed clutch devices shown in dotted outline in Fig. 2.

Fig. 4 is a central section through the printing mechanism of the machine, the section being taken along the lines 4—4 of Fig. 1.

Fig. 5 is a detail showing the platen spacing control mechanism for the printing unit looking in the same direction as Fig. 4.

Fig. 6 is a section through the accumulator along the lines 6—6 of Fig. 1. The view is taken along the dividing line between two adjacent denominational orders.

Fig. 6a shows certain parts of Fig. 6 in a different position.

Fig. 7 is a section taken along the lines 7—7 of Fig. 1, taken through the central plane of one of the denominational orders.

Fig. 7a is a detail taken along lines 7a—7a of Fig. 7.

Fig. 8 is a detail of the tens carry controlling cam and related contacts.

Fig. 9 is a sectional view taken substantially along the lines 9—9 of Fig. 6.

Fig. 10 is a view looking from the left of Fig. 6.

Fig. 11 is a view at a reduced scale looking from the right of Fig. 10 showing the gear drive to the accumulator shaft.

Fig. 12 is a detail of the readout device for the accumulator unit, the view being along lines 12—12 of Fig. 10.

Fig. 13 is a timing diagram showing the period of closure of the various cam operated contacts and commutators.

Figs. 14 and 14a taken together and placed one above the other constitute a wiring diagram of the electric circuits of the machine.

GENERAL DESCRIPTION

The separate units of the machine will first be described in detail and their mechanical operation explained. Following this, the circuit diagram will be explained and the complete operation of the entire machine set forth.

Referring to Fig. 1, the machine comprises, generally, a card feeding and analyzing section at the left end thereof, which feeds the well known Hollerith record cards to the analyzing devices

where they are sensed by the analyzing mechanism. The accumulator (which has been limited to a single unit comprising six denominational orders for present purposes) is located in the center of the machine. The printing mechanism is located at the right end of the machine and comprises a number of so-called banks of printing type bars.

10 Main driving connections

The driving motor, represented at TM in Fig. 14 (but not shown in the mechanical views), has suitable driving connection as by a belt 10 (Fig. 1) with a pulley 11 carried by a shaft 12. During the operation of the machine motor TM is in constant operation so that shaft 12 rotates constantly and through a gear 13 mounted thereon drives a gear 14 on a rod 15 which also carries a gear 16. The latter gear meshes with a gear 17 freely mounted on a shaft 18 to which shaft the gear is clutched to operate the card feeding devices, as will be described.

At its right hand extremity, shaft 12 carries a gear 19 meshing with a gear 20 on a shaft 21 from which the accumulator drive shaft 22 is driven by means of gears 23 and 24 so that shaft 22 is also in constant rotation. Through gears 25 and 26 the shaft 27 which operates the accumulator is driven.

To drive the printing mechanism, shaft 22 carries a gear 28 (see also Fig. 4) which through an idler 29 drives a gear 30 secured to the printing shaft 31. Shaft 22 also, through a gear 32, drives a gear 33 (Fig. 5) which operates the paper spacing mechanism of the printing unit.

Thus, through the connections traced the several shafts 12, 21, 22, and 31 are in constant rotation as long as the motor TM is in operation.

40 Card feeding mechanism

Referring to Fig. 3, shaft 18 has secured thereto an arm 34 which carries a spring-pressed dog 35 in the plane of a notched driving disk 36 which is integral with constantly running gear 17. Energization of magnet CF will attract its armature 37 and release dog 35 for engagement with disk 36 whereupon shaft 18 will rotate and through a gear 38 carried thereby will, through gearing generally designated 39 in Fig. 2, cause rotation of card feed roller shafts 40. One of the gears 39 on each side of the card feed section has eccentrically mounted thereon one end of a link 41 whose other extremity connects with the picker 42 mounted for vertical reciprocation so that for each rotation of shaft 18, a card is moved downwardly from the supply magazine to the uppermost pair of feed rollers. The rollers on shafts 40 advance the cards downwardly, in succession, to a pair of feed rollers on the lowermost pair of shafts 43 which are in constant rotation due to direct gear connection designated 44 with shaft 12. From this point the cards are advanced to a stacker mechanism generally designated 45 whose spring-pressed clips 46 grip the leading edges of the cards and deposit them upon tray 47.

Along the line of travel of the cards are located the upper analyzing brushes UB and the lower analyzing brushes LB mounted in insulating blocks and cooperating with contact rollers 48 and 49 respectively. At each of the sets of brushes is a pivoted card lever 50, the upper of which cooperates with a pair of contacts 51 and the lower of which cooperates with a pair of contacts 52. The levers serve to close their respective contacts while a card is passing the brushes and permit

the contacts to open during the interval between cards.

The general operation of the card feeding and analyzing mechanism, in terms of cycles of operation of the machine, is as follows: (A cycle is represented by one reciprocation of the picker 42 or three and a half revolutions of shaft 12.)

With the machine at rest, the picker 42 is in the position indicated in Fig. 2 and during the first cycle, the picker will move upwardly to a position above the first card and then move downwardly to advance the leading card to the feed rollers 40 which advance it to the upper brushes UB. At the end of the first cycle, the leading edge of the card will have slightly passed the upper brushes UB, insulating them from the contact roller 48 and the picker 42 will again be in the position of Fig. 2. During the second cycle, the card will be advanced by the rollers to an exactly similar position with respect to the lower brushes LB; that is, its leading edge will be slightly past the lower brushes LB, insulating them from the contact roller 49. Meanwhile, during this second cycle, a second card will have been advanced to the upper brushes so that there is now a card under the upper brushes and a card under the lower brushes. During the third cycle, the cards will pass the lower and upper brushes concurrently and corresponding index point positions will be analyzed concurrently by the two sets of brushes. At the end of the third cycle, the first card will have been advanced to a position where its leading edge has entered the open jaws of one of the clips 46 and during a fourth cycle, the clips will grip the card and bring it into position upon the discharge stack or tray 47.

The distance between the trailing edge of the first card and the leading edge of the next card is greater than the contacting edge of the card levers (actually $\frac{3}{4}$ of an inch) so that the card levers will rock in and out between the cards.

On shaft 18 (Fig. 1) are carried several cams which control the operation of contacts designated with the prefix CF in the circuit diagram (Figs. 14 and 14a) indicating that they operate only during card feeding operations. On the shaft 21 are similar cams controlling contacts designated CR in the circuit diagram to indicate that they are controlled by constantly running cams.

For a more detailed description of the construction and operation of the card feeding and analyzing mechanism reference may be had to the Patent No. 1,976,617, granted to C. D. Lake et al. on October 9, 1934.

Printing mechanism

The printing mechanism of the present machine is substantially similar to that of the Lake et al. Patent No. 1,976,617 as regards the type bar action so that the same need be but briefly described.

Type bars 55 (Fig. 4) are mounted for vertical reciprocation past a printing platen 56 and are resiliently supported at their lower ends on cross-head 57 which is slidable up and down on rods 58. Each type bar has a series of stopping teeth 59 which, as the type bar rises, pass the toe of a stopping pawl 60, normally latched as shown by a latch 61. The action is such that as the bar rises, energization of print magnet PM when any tooth 59 is passing the toe of pawl 60 will rock latch 61 to release the pawl for engagement with a selected tooth 59 and interrupt further upward movement of the bar. The yieldable connection between the bar and cross head 57 permits the bar to stop

while the crosshead continues on its invariable excursion.

For reciprocating the crosshead there is the usual link and arm connection 62 to shaft 63 which carries an arm 64 upon the free end of which is a roller engaging in the cam groove of a box cam 65, freely mounted on constantly running shaft 31. The cam 65 has secured thereto a gear 66 to which is pivoted a clutching dog 67 normally held in the position shown in Fig. 4 by clutch lever 68, thus holding cam 65 stationary. Lying in the plane of dog 67 is a driving disk 69, secured to shaft 31 so that upon energization of clutch magnet 70, lever 68 integral with the armature of the magnet will release dog 67 to engage in the notch of disk 69 and cam 65 will accordingly be rotated to operate crosshead 57 and type bars 55.

Gear 66 meshes with a gear 71 on shaft 72 to drive the latter on which are mounted contact operating cams whose contacts are prefixed P in the circuit diagram (Figs. 14 and 14a) to indicate that they operate only during printing operations. An extension 73 of lever 68 cooperates with pairs of contacts 74 and 74a to close the same while the magnet 70 remains energized.

At one extremity of the shaft of platen 56 is a ratchet 75 (Fig. 5) with which the usual spacing pawl 76 and detent 77 cooperate. Pawl 76 is carried by an arm 78 which has pin and slot connection with a lever 79 connected by an adjustable link 80 with a plate 81 pivoted at 82. Plate 81 carries a block 83 normally engaged by a latch 84 connected by a link 85 to the armature of a magnet SP. Energization of magnet SP will release plate 81 so that a roller 86 carried thereby may follow the contour of cam 87 carried by the constantly rotating gear 33 and through the consequent oscillation of the plate 81 effect line spacing of the platen.

Accumulator

Referring now to Figs. 10 and 11, the constantly running shaft 27 carries a gear 90 which, through an idler 91, drives a gear 92 carried by a square shaft 93 which is thus in constant rotation. The shaft 93 is supported in bearings 94 of side plates 95 which in turn are supported by the framework 96. Between the plates 95 are cross bars 97 holding them in spaced relationship and aiding in the support of the mechanism of six denominational orders of the accumulator, the entire mechanism of each of which is confined within the space indicated at 98 in Figs. 9 and 10.

Since the several orders are all identical in construction and there being no mechanical interconnections between them except the common supporting and driving shaft, the following detailed description of one order will suffice for all.

On the square driving shaft 93 is a fitted bushing 99 (Fig. 9) upon which a magnet yoke 100 is rigidly secured. This yoke is made of so-called "electric iron." Carried about the periphery of yoke 100 and insulated therefrom and from each other is a pair of channelled collector rings 101 to each of which is connected an end of magnet winding AM positioned within yoke 100. Trailing against each ring 101 is a brush 102 (Fig. 6) slidably mounted and locked in a suitable bore in insulating block 103 carried by rods 97. The yoke 100 carrying with it winding AM and rings 101 constitutes the driving element of the accumulator clutch whose driven element includes the toothed wheel 104 and tens carry-cam 105 which latter is made of cold rolled steel (Figs. 9 and 7). The

wheel and cam are riveted together as indicated in Figs. 7 and 9, and are freely mounted on the section of bushing 99 between its shoulders 99a and 99b (Fig. 9). The combined thickness of the wheel and cam is slightly less than the distance between shoulders 99a and 99b so that there is an air gap 106 between yoke 100 and cam 105. This air gap is very slight and measures about five thousandths (.005) of an inch providing just a working clearance. On the drawings, Fig. 9, the distance is exaggerated to show the gap more clearly.

Wheel 104 (Fig. 7) is provided with ten teeth 104a, between two of which, when the wheel is at rest, there extends the nose 107 of a lever 108 which is freely pivoted on a rod 109 (see Fig. 6a) and held in the position shown in Figs. 6 and 7 by a looped wire spring 110 connected at one end to a rod 111 and at its other end to a pin in nose 107. The spring 110 and lever 108 thus form a toggle with the spring urging nose 107 into contact with wheel 104.

When winding AM is energized, wheel 104 and cam 105 are magnetically clutched to yoke 100 and commence to rotate therewith. That is, wheel 104 and cam 105 are attracted by magnet AM and drawn to the right as viewed in Fig. 9, closing up the air gap 106 and physically engaging yoke 100. As wheel 104 commences to turn with yoke 100 to which it is now magnetically coupled, the edge of one of its teeth 104a bears against the upper inclined edge of nose 107 and cams lever 108 clockwise (as viewed in Fig. 7) about its pivot 109, carrying the end of spring 110 attached to nose 107 to the right of a line between centers 109 and 111 to the position shown in Fig. 6a where it will remain until the wheel 104 is disengaged again.

Lever 108 when rocked by a tooth 104a serves to operate contacts to provide a holding circuit for winding AM. The arrangement is as follows: A link 113 of insulating material connects lever 108 with a lever 114 pivoted to an insulating block 115 in which are embedded metallic contacts 116 and 117. Lever 114 has two contact points 118 and 119. When lever 108 engages wheel 104 as in Fig. 6, contacts 116 and 118 are in engagement and when the levers 108 and 114 are shifted as in Fig. 6a, contacts 117 and 119 are in engagement, the parts being so proportioned that the contacts 117, 119 engage before contacts 116, 118 disengage. In other words, a so-called "make-before-break" action occurs as lever 114 is shifted.

Energization of winding AM and clutching of the accumulating wheel 104 is effected at differential times depending upon the location of the perforation sensed in the record card passing through the card feeding section of the machine and declutching is effected at a fixed point in the cycle so that the amount that wheel 104 is rotated will be proportional to the value of the hole sensed in a particular card column. This declutching is brought about as follows: On shaft 27 is a cam 125 with which a follower 126 cooperates. The follower is integral with a ball 127 which extends across all of the denominational ordered units. Each order has a lever 129 pivoted on rod 109 with its lower extremity bearing against the ball 127 and provided with a spring 128, which spring 128 urges the follower 126 against cam 125. At its upper end, lever 129 has lateral extensions 130 and 131, the former lying in the plane of wheel 104 and the latter extending behind lever 108.

The operation is such that during the entering

period of the cycle, or while the digit representing index point positions of the card are passing the analyzing brushes, the follower 126 rides on the intermediate concentric portion 125a of cam 125 as in Fig. 6a holding bail 127 and through it lever 129 in the position shown in Figs. 6a and 7. At the "0" point in the cycle (see Fig. 13) follower 126 drops quickly to the surface 125b of cam 125 and its bail 127 will free lever 129 to be rocked rapidly in a counterclockwise direction by its spring 128 bringing projection 130 on lever 129 into the space between two of the teeth 104a. At the same time, projection 131 engages lever 108 swinging it back from the position of Fig. 6a to that of Fig. 6, thus causing the holding circuit of winding AM to be broken. This holding circuit will be more particularly pointed out in connection with the circuit diagram. It suffices at this time to state that the circuit is made when contacts 117, 119 engage and is broken when the contacts are separated.

With the current thus interrupted, projection 130 will engage the leading edge of a tooth 104a and positively interrupt further rotation of the now released accumulating wheel 104. At the same time, the trailing edge of the engaged tooth 104a is overlapped by nose 107 to prevent any retrograde movement of the parts. Continued rotation of cam 125 will, through portion 125c thereof, again release wheel 104 for possible tens carry operations and portion 125d will again interrupt the wheel after a single step of movement. Finally, the highest portion 125e of cam 125 will cause lever 129 to rock an additional amount in a clockwise direction to restore the tens carry lever 133, if the same had previously been rocked counterclockwise by the devices now to be described. When magnet AM is deenergized and wheel 104 stopped, the wheel 104 and cam 105 are no longer urged into driving contact with yoke 100 and the wheel is free to move to the left away from the yoke, which it may do due to vibration of the machine. Failure to move back will have no effect on the wheel as it is held against rotation, and with winding AM deenergized only a slight frictional effect would be present which in itself would tend to push the wheel and cam back.

As stated above, wheel 104 has integral therewith carry cam 105 (Fig. 8) which is provided with a notch 105a, and a rise 105b. Carry lever 133 pivoted at 109 has its nose held against cam 105 due to the action of the looped spring 134 urging lever 133 clockwise. Lever 133 carries a depending member 135 of insulating material through which a brush 136 extends to make contact with either of contacts 137 or 138. Normally the parts occupy the position of Fig. 7 with brush 136 lying intermediate contacts 137, 138. When wheel 104 has been advanced to register "9" thereon, cam 105 is in the position shown in Fig. 8 wherein the nose of lever 133 is in the notch 105a, permitting elevation of brush 136 for engagement with contacts 137. When wheel 104 passes through "0," rise 105b on cam 105 will rock lever 133 to its dotted line position indicated in Fig. 8 in which position spring 134 will now hold it since the point of connection between spring 134 and lever 133 is now to the left of the line between centers 111 and 109. As a result, brush 136 is shifted to engage contact 138 and will remain in such position until after the carry portion of the cycle when the high portion 125e of cam 125 causes lever 129 to rock lever 133 back to its position of Fig. 7.

Adjacent to accumulating wheel 104 (Fig. 9)

and carried thereby is a brush structure comprising a holder 141 of insulating material and a wire brush 142 fitted within a groove in the holder (see Fig. 12). In the plane of brush 142 are arranged commutator segments 143 as shown and a common arcuate segment 144. Brush 142 serves to make electrical connection between common segment 144 and each of the segments 143 as the accumulating wheel 104 advances. Since the wheel 104 (Fig. 7) has ten teeth, it moves a tenth of a revolution for each unit entered. Segments 143 are spaced one-twentieth of a circle apart so that brush 142 stops at the segments in the order in which they are numbered in Fig. 12. In the position shown the "0" segment 143 is connected with common segment 144. This device constitutes the so-called readout device by means of which the amount or total standing in the accumulator wheel may be read out.

The segments 143, 144 as well as the brushes 102 of Fig. 6 and the tens carry contacts terminate in beveled contacts as shown in Fig. 7a arranged in the order shown in Fig. 10 so that ready connection can be made to the unit by fixed bifurcated blades 145 as shown in Fig. 7a.

Wiring diagram

The circuit diagram will now be explained with particular reference to the various operations of adding, listing, total printing, and resetting and to the sequence in which the several functions are carried out.

Starting cycles.—With a stack of cards placed in the supply hopper of the machine, Fig. 2, the machine is ready to start. Closure of switch 150 (Fig. 14) puts current on left side of line 151 and right side of line 152, and current will flow through the drive motor TM. If the machine is to "tabulate," that is, add without accompanying printing, switch 153 is left in the position shown so that a resistance 154 is in series with the motor field 155 to obtain high speed operation. When set for "listing," that is, concurrent adding and printing or printing alone, switch 153 is closed, shunting out resistance 154 to obtain a slower operating speed.

The first operation is to depress the total and reset key to close contacts 156 (Fig. 14) which complete a circuit from line 151, print control relay R1, relay contacts R2b and contacts 156 to line 152. Relay R1 closes its contacts R1a to energize the print clutch magnet 70 through a circuit from line 151, magnet 70, contacts R1a, R3b to line 152. The printing mechanism will now go through a cycle of operations during which the P contacts operate and near the end of this cycle contacts P2 close, establishing a circuit from line 151, control pickup relay R3, relay contacts R5a, contacts P2 to line 152. Relay R3 opens its contacts R3b to break the print clutch circuit but contacts P1 hold magnet 70 energized until the end of the cycle. Relay R3 also closes its contacts R3a to provide a holding circuit from line 151, relay R3, contacts R3a, constantly running contacts CR2 to line 152. As seen from Fig. 13, contacts CR2 close when contacts P2 are closed during the aforesaid print cycle and remain closed for the major part of the next cycle during which contacts CR5 close to energize the minor control relay R5 through the following circuit: from line 151, relay R5, relay R6, contacts CR5, contacts R3d (now closed) and wire 159 to line 152. Relay R6 closes its contacts R6a to provide a holding circuit from line 151, relay R5, R6, contacts R6a, contacts CR3, to line 152.

Relay R5 when energized remains so until contacts CF3 open during a card feed cycle. It opens its contacts R5a, R5c and R5d and closes its contacts R5b. These two cycles always occur together and are called the "print and reset cycles" or "total and reset cycles." After cards have been run through the machine, these cycles are initiated automatically and during the first or total print cycle actual printing takes place as explained hereinafter under the heading "Total printing operations" and on the next following cycle resetting takes place as explained later under the heading "Resetting operations." At the present time, however, no actual printing takes place and also no resetting, the second cycle serving simply to "set up" the automatic control circuit by the energization of relay R5, which by closing its contacts R5b enables the start key to become effective.

The start key may now be operated to close its contacts 151 so that, when contacts CR1 close near the end of the cycle, a circuit is completed from line 151, relays R7, R2, contacts 151, CR1, R4b, R5b (now closed) to line 152. Contacts R2a close to provide a holding circuit from line 151, relays R7, R2, contacts R2a and CF1 to line 152. Relay R7 closes its contacts R7a through which the card feed clutch magnet circuit is completed from line 151, magnet CF, contacts R7a to line 152.

The first card now commences to feed downwardly toward the set of upper brushes UB (Fig. 2) and during this cycle cam contacts CF3 open to drop the holding circuit of relay R5. However, at the time contacts CF3 open during this first card feeding cycle, there is a shunt path around them so their opening at this time has no effect and relay R5 remains energized.

Near the end of this first card feed cycle, contacts CF1 open to deenergize relays R7 and R2 and card feeding ceases. If the start key contacts 151 are held closed, or again closed, the relays R7 and R2 are immediately energized again as contacts CR1 close shortly after contacts CF1 open (see Fig. 13). Thus, a second card feed cycle will follow immediately after the first. The shunt circuit around contacts CF3 follows from contacts R6a, relay contacts LCLb, UCLc to line 152. The manner in which these contacts are controlled will be explained presently.

Just before the end of the first card feed cycle the leading edge of the first card engages the upper card lever 50 to close contacts 51 which thereupon complete a circuit through relay magnet UCL which in turn closes contacts UCLc to provide a holding circuit for the relay from line 151, relay UCL, contacts UCLc, and CR1 to line 152. The contacts CR1 alternate with contacts 51 to keep relay UCL energized as long as cards are fed to the brushes UB.

During the second card feed cycle, as the first card is advancing to the lower brushes LB, contacts UCLc are open so that, when contacts CF3 open during this cycle, relay R5 will become deenergized, causing in turn deenergization of relays R2 and R7 and magnet CF, thus interrupting further card feeding and leaving the first card in a position where its leading edge is just under the lower brushes LB and the leading edge of the second card is just under the upper brushes UB.

Just before the first card reaches brushes LB, it closed contacts 52 to energize relay LCL which through its contacts LCLc and CR8 provide an alternate circuit to hold the relay energized during the interval between cards.

The foregoing cycles comprising a print cycle,

and reset cycle and two successive card feed cycles are a necessary preliminary to advance cards into the machine when first starting. Adding operations are now ready to commence and in the following the machine will be described as set for tabulating.

Automatic control circuits.—The machine is provided with the usual automatic control devices which serve to keep the machine in operation as long as the control perforations on the successively fed cards are alike. This device may be disabled, however, so that operations continue as long as cards continue to feed. Disabling is effected by closing switch 158, whereby when relays R5 and R6 are initially energized and cards have reached the upper card levers, a holding circuit is established from line 151, relays R5, R6, contacts R6a, switch 158, contacts UCLb to line 152 through wire 159. Therefore, with contacts UCLa also closed the motor relay R7 and feed control relay R2 remain energized through a circuit from line 151, relays R7, R2, contacts R2a, UCLa, R4b and R5b to line 152. When the last card has passed the upper brushes and contacts UCLa open as a consequence, the circuit through relays R7 and R2 is maintained for another cycle by contacts CF1 which shunt contacts UCLa, R4b and R5b and enable the last card to be advanced to pass the lower brushes LB for sensing of the data thereon.

A brief description will now be given of the operation of the automatic control device to show how card feeding is automatically interrupted between card groups. After the four preliminary cycles explained above, another print cycle is initiated by operation of the total key contacts 156 as before and as before contacts P2 energize relay R3 which in turn causes relays R5 and R6 to become energized. If plug connections 160 and 161 have been made as indicated to the corresponding column of the upper and lower brushes and a connection 162 is also made, the machine will continue card feeding as long as the index positions of the selected card column of successive cards agree.

With card feeding restarted as before, a control circuit is traceable serially through the two cards passing the brushes as follows: from line 151, contacts CF4, contact roller 48, hole in the card, brush UB, connection 160, relay winding R9, connection 161, commutator 163, lower brush LB, contact roller 50, circuit breakers 164, lower card lever contacts 52 to line 152. Relay R9 closes its contacts R9a and R9b, the former setting up a holding circuit from line 151, relay R10, contacts R9a and CR6 to line 152 which is held until contacts CR6 open at the end of the cycle. Contacts R9b provide a shunt around contacts CF3 from the contacts through R9b, connection 162, contacts UCLb and wire 159 so that relays R5 and R6 remain energized and cards continue feeding.

When successive cards fail to agree, contacts R9b will not be closed when contacts CF3 open and interruption of card feeding will take place as set forth above.

Adding circuits.—For each column of the card which is to be added a plug connection such as 165 (Figs. 14 and 14a) is made between a lower brush LB and a plug socket 166. Then as the card passes the lower brushes a circuit is completed at differential times, depending on the location of the hole to energize the accumulator winding AM. Assuming a "6" hole to be sensed, the circuit will be completed at the "6" time in the cycle, traceable from line 152, card lever con-

tacts 52 (Fig. 14), circuit breakers 164, contact roller 50, "6" hole in the card, brush LB, commutator 163, plug connection 165 to socket 166 (Fig. 14a); contacts MCR3a, zero elimination commutator 167, contacts 116, 118, lever 114, winding AM to line 151. This causes the accumulator wheel 104 to be started in motion resulting in the opening of contacts 116, 118 and closure of contacts 117, 119, the latter closing before the former open. A holding circuit for the winding AM is thus provided from line 151, winding AM, lever 114, contacts 117, 119, contacts CR10 to line 152. Contacts CR10 open at the time indicated in Fig. 13 just before the stop cam 125 has caused interception of the accumulator wheel 104. Thus, the wheel is intercepted after it has moved six steps to add a "6."

Tens carry.—If during the entering part of the cycle a wheel has passed through zero it will have closed its tens carry contacts 136, 138 so that a carry circuit can now be completed from line 152, contacts CR9, contacts 138, 136 of the units order for example, wire 169, carry commutator 168 of the tens order, winding AM of the tens order to line 151. The duration of the circuit is long enough to advance the tens wheel one step and no extra holding circuit is required. If the tens order stood at "9" at this time, the circuit would have continued from wire 169 through contacts 137, 136 of the tens order through the next higher wire 169 to the carry commutator of the hundreds order, the hundreds order winding AM and to line 151.

Printing operations.—When it is desired to have listing of the items entered as an accompaniment to the accumulating operations, switches 153 and 170 (Fig. 14) are closed, the former causing slower speed operation by cutting out resistance 154 and the latter placing the print clutch magnet 70 in parallel with the card feed clutch magnet CF so that magnet 70 is energized through the circuit from line 151, magnet 70, switch 170, contacts R2c and R1a to line 152. The type bars make a reciprocation during each card feeding cycle. If in the column from which adding takes place a plug connection such as 171 (Fig. 14a) is made, the adding circuit will branch from socket 166, through contacts MCR2 to plug connection 171, printing magnet PM and to line 151 so that the amount added is also listed. Obviously, if a connection is made directly from a lower brush to the magnet PM listing will take place independently of adding.

Total printing operations.—As explained above, the minor relay R5 will be deenergized when a group number change occurs and opening of contacts R5b will cause card feeding operations to stop with the first card of the new group at the lower brushes in readiness to traverse the same when card feeding resumes. If the automatic reset switch 172 (Fig. 14) is closed, a total printing cycle will follow immediately upon cessation of card feeding to print the amount or total standing on the accumulator. A circuit is completed when contacts R5c and R2b close traceable from line 151, print control relay R1, contacts R2b, switch 172, contacts R5c to line 152 resulting as before in energization of the print clutch magnet 70. As a consequence, the type bars begin to rise and contacts P1 close to shunt contacts R1a and R3b in the clutch circuit and keep the magnet 70 energized through the cycle and by breaking the circuit, take the arc.

With switch 173 closed as a preliminary, a circuit is traceable from line 151, contacts 74 (closed

due to energization of magnet 70), contacts R5d (closed due to deenergization of relay R5), switch 173, contacts MCR1b, relay MCR2 to line 152. Relay MCR2 causes closure of its contacts MCR2b (Fig. 14a) and opening of its contacts MCR2a so that the print magnet PM is now connected to the common readout segment 144 through contacts MCR2b and plug connection 171. Total printing circuits can now be completed as follows: from line 152, circuit breakers 174 (Fig. 14a), contacts R5f and R3h (now closed), common segment 175 of the "print" emitter PE, brush 176, segments 177 to impress impulses on the wires 178 in the order 9, 8, 7, etc., as the type bars present the correspondingly valued type to the platen, wire 179 to the readout segment 143 at which brush 142 is set, through the brush 142, segment 144, contacts MCR2b, plug connection 171, print magnet PM to line 151. In this manner the amount set on the accumulator readout devices is printed.

The emitter brush 176 may be mounted on the same shaft that carries the constantly running CR cams so that the brush is in constant rotation.

Near the end of the total printing cycle, contacts P2 (Fig. 14) close to cause energization of relay R3 as explained, which in turn through its contacts R3d causes energization of minor relay R5 and relay R6 during the next following cycle when contacts CR5 close. Thus, total printing will take two cycles during the first of which actual total printing takes place and relay R3 is energized. In the second cycle relay R5 is energized to open its contacts R5c and interrupt the circuit to print control relay R1.

Automatic start circuit.—If the automatic start switch 180 is closed, card feeding will automatically resume under control of contacts CR1 which close at the end of the cycle and establish a circuit from line 152, contacts R5b, R4b, CR1, and LCLa, switch 180, relays R2 and R7 to line 151. Relay R7 again causes energization of the card feed clutch magnet CF and, if switch 170 is closed, the print clutch magnet 70 is concurrently energized for listing the subsequently sensed cards.

Resetting operations.—Resetting of the accumulators is effected by entering into the accumulator the nines complement of the amount standing therein under control of the readout device and then adding a "one" into the units order during the tens carry time to advance all the wheels from nine to zero. This operation takes place during the second of the two total taking cycles and is only effective if reset switch 181 (Fig. 14) is closed. As explained, relay R3 is energized near the end of the total printing cycle and opens its contacts R3b so that the print clutch will not be energized during the second or what may be termed the "reset cycle," and its contacts 74 are accordingly open during this reset cycle so that relay MCR2 is deenergized. Closure of contacts R3f under control of contacts CR12 will complete a circuit from line 151, contacts CR12, R3f, switch 181, relay MCR3 to line 152.

This relay will thereupon cause opening of its contacts MCR3a and closure of its contacts MCR3b (Fig. 14a).

Relay R3 also causes closure of its contacts R3g (Fig. 14a) one blade of which is connected to the segment 182 of "reset" emitter RE, whose segments 184 are connected by wires 185 to wires 178 in inverted order. That is, "9" segment 184 is connected to the "0" wire 178; the "8" segment

is connected to the "1" wire 178; etc. Thus, as emitter brush 183 rotates, circuits will be completed which are traceable from line 152, circuit breakers 174, contacts R5f, R3g, segment 182, brush 183, segments 184, wires 185, 178 and 179 to the segments 143 and to brushes 142 at times representing the nines complement of the amount indicated by the setting of brushes 142, thence through segment 144, contacts MCR3b, commutator 167, contacts 116, 118, winding AM to line 151. Again contacts 117, 119 will be closed upon movement of accumulator wheel 104 to set up the holding circuit for the winding. At the carry time contacts CR9 close to complete a circuit from line 152, contacts CR9, contacts MCR3c (now closed), the units order carry commutator 168 and units order winding AM to line 151. This circuit also branches through the units order nines contacts 137, 136 and thence serially to all the other windings and nines contacts to add a unit to each thereby advancing all orders to zero.

Stop key operation.—Card feeding and printing may be interrupted at any time during their operation by depression of the stop key to close contacts 190 (Fig. 14) which cause energization of relay R4 when contacts CR3 close. Contacts R4a then set up a holding circuit through the normally closed start key contacts 157a and this circuit remains held until the start key is again operated. Relay R4 opens its contacts R4b breaking the holding circuit through relays R7 and R2 so these relays become energized when contacts CF1 open, resulting in the opening of contacts R7a to deenergize magnets CF and 70 at the proper time to stop the operations at the end of a cycle.

List control switch.—A multicontact relay MCR1 (Fig. 14) is provided which is energized due to closure of contacts R2e whenever cards are feeding and causes closure of the contacts MCR1a, during the period that the cards are passing the brushes. A switch 191 is provided which, when closed, will enable the completion of a circuit from line 151, contacts QR13, R5e, switch 191, contacts MCR1a, relay MCR2 to line 152. When this switch is closed, listing of the data sensed is prevented, even though the plug connections 171 (Fig. 14a) are made, due to the fact that relay MCR2 causes opening of its contacts MCR2a so the circuit from the brushes LB cannot branch to the printing magnets PM. As explained hereinbefore, however, total printing circuits may be completed if switch 173 is closed to permit energization of relay MCR2 during a total cycle, in which case connection 171 is connected to the readout common 144 through contacts MCR2b.

Paper spacing.—The paper space magnet SP is energized each time the print clutch magnet 70 is energized and the circuit is traceable from line 151, magnet SP (Fig. 14), contacts 74a (closed by the armature of magnet 70), contacts CR17 to line 152. During total printing operations an additional impulse is given to magnet SP to obtain an extra space after the total. As explained above, there are two cycles following a group change during the first of which the total is printed and magnet SP is energized due to closure of contacts 74a. Also, during this cycle relay R3 is energized, closing its contacts R3f so that during the second or reset cycle, magnet SP may be energized again when contacts CR17 close and spacing again takes place.

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 an accumulating unit for an accounting machine having an accumulating wheel which is to be advanced different extents to accumulate amounts, including in combination, differential advancing mechanism for said wheel, said mechanism comprising a continuously driven magnet coaxial with said wheel, said wheel having ten rotative positions, means normally holding said wheel in any one of its rotative positions, means for energizing said magnet at differential times during its rotation to cause said wheel to be magnetically coupled thereto for rotation therewith, means integral with said wheel and effective upon rotation thereof for causing release of said holding means, means controlled by the holding means and effective upon said release to cause maintenance of the energization of the magnet, means for deenergizing said magnet at a fixed point in its rotation to uncouple said wheel and magnet and means operative upon said uncoupling of the wheel and magnet to cause said holding means to reengage and hold said wheel.

2. In an accumulating unit for an accounting machine having an accumulating wheel which is to be advanced different extents to accumulate amounts, including in combination, differential advancing mechanism for said wheel, said mechanism comprising a continuously driven magnet coaxial with said wheel, said wheel having ten rotative positions, a member normally holding said wheel in any one of its rotative positions, means for energizing said magnet at differential times during its rotation to cause said wheel to be magnetically coupled thereto for rotation therewith, means integral with said wheel and effective upon rotation thereof for causing release of said holding member, means controlled by said member upon release for establishing a holding circuit for the magnet, means for deenergizing said magnet at a fixed point in its rotation to uncouple said wheel and magnet means operative upon said uncoupling to momentarily engage and hold said wheel, and machine controlled operating means therefor, said last named means also causing said member to reengage the wheel to hold the same.

3. In an accumulating unit for an accounting machine having an accumulating wheel which is to be advanced different extents to accumulate amounts, including in combination, differential advancing mechanism for said wheel, said mechanism comprising a continuously driven magnet coaxial with said wheel, said wheel having a plurality of rotative positions, a member normally holding said wheel resiliently against forward movement and positively against retrograde movement in any one of its rotative positions, means for energizing said magnet at differential times during its rotation to cause said wheel to be magnetically coupled thereto for rotation therewith, means integral with said wheel and effective upon rotation thereof for causing release of said holding member, means controlled by said member upon release for establishing a holding circuit for the magnet, means for deenergizing said

magnet at a fixed point in its rotation to uncouple said wheel, machine controlled means momentarily operative to positively engage and hold said wheel against further forward movement upon
 5 said uncoupling, and means integral with said engaging means for causing said holding member to reengage the wheel during said positive engagement.

4. In an accumulating unit for an accounting
 10 machine having an accumulating wheel which is to be advanced different extents to accumulate amounts, including in combination, differential advancing mechanism for said wheel, said mechanism comprising a continuously driven
 15 magnet co-axial with said wheel, said wheel having ten rotative positions, a member normally holding said wheel in any one of its rotative positions by engagement therewith, means for energizing said magnet at differential times during its
 20 rotation to cause said wheel to be magnetically coupled thereto for rotation therewith, camming surfaces on said wheel effective upon rotation thereof for camming said member out of engagement therewith, a circuit for holding said magnet energized, means controlled by said member
 25 for establishing said circuit, means for breaking said holding circuit at a fixed point in the rotation of the magnet to cause uncoupling of said wheel and magnet, and a single machine
 30 controlled means momentarily operative to engage and hold said wheel upon said uncoupling, said last named means acting upon said member to cause the same to reengage the wheel.

5. In an accumulating unit for an accounting
 35 machine having an accumulating wheel which is to be advanced different extents to accumulate amounts, including in combination differential advancing mechanism for said wheel, said mechanism comprising a continuously driven magnet
 40 co-axial with said wheel, said wheel having ten teeth, a member engaging one edge of one of said teeth to prevent advance of said wheel, a lever engaging another edge of said tooth to prevent retrograde movement of said wheel, a cam rotatable with the magnet, a follower controlled by
 45 the cam to remove said member from engagement with said tooth, means for energizing said mag-

net after said member is removed to cause said wheel to be magnetically coupled thereto for rotation therewith, said tooth on said wheel being effective upon rotation to cause disengagement of
 5 said lever, a pair of contacts, means controlled by said lever upon disengagement for closing said contacts to establish a holding circuit for the magnet, said cam operating at a fixed point in its operation to cause the follower to return the member into engagement with another tooth on
 10 said wheel, a part of said member causing said lever to also reengage said other tooth whereupon the lever will cause the means controlled thereby to reopen said contacts.

6. In an accumulating unit for an accounting
 15 machine having an accumulating wheel which is to be advanced different extents to accumulate amounts, including in combination, differential advancing mechanism for said wheel, said mechanism comprising a continuously driven magnet
 20 co-axial with said wheel, said wheel having ten rotative positions, a spring biased lever restraining said wheel against advance, a pair of normally closed contacts, a pair of normally open contacts, means for energizing said magnet at dif-
 25 ferential times during its rotation to cause said wheel to be magnetically coupled thereto for rotation therewith, said energizing means including circuit connections through said normally closed pair of contacts, means integral with said
 30 wheel and effective upon rotation thereof for causing release of said restraining lever, a connection between the lever and said pairs of contacts to cause reversal of their open and closed positions, the one pair closing before the other
 35 opens, a holding circuit completed by the normally open pair of contacts to maintain said magnet energized, means for breaking said holding circuit at another point and at a fixed time to release
 40 said wheel, and means for causing said lever to reengage and hold said wheel upon said release whereby said wheel will be advanced to another rotative position depending upon the time of its initial coupling to said rotating magnet.

CLAIR D. LAKE.
 WESLEY PFAFF.