

Oct. 4, 1960

H. J. CHALL

2,954,922

SYMBOL PRINTING MECHANISM

Original Filed Jan. 29, 1954

18 Sheets-Sheet 1

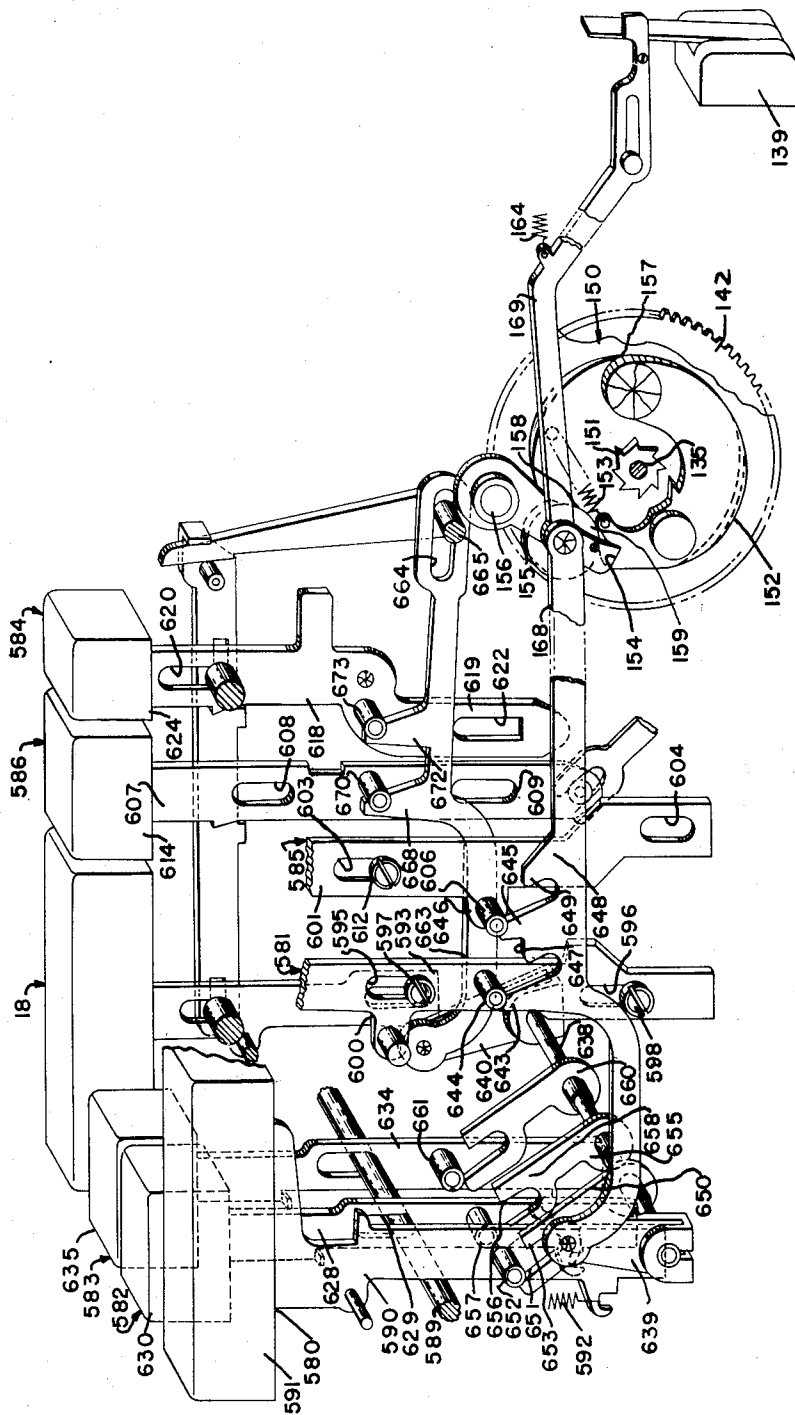


FIG. 1

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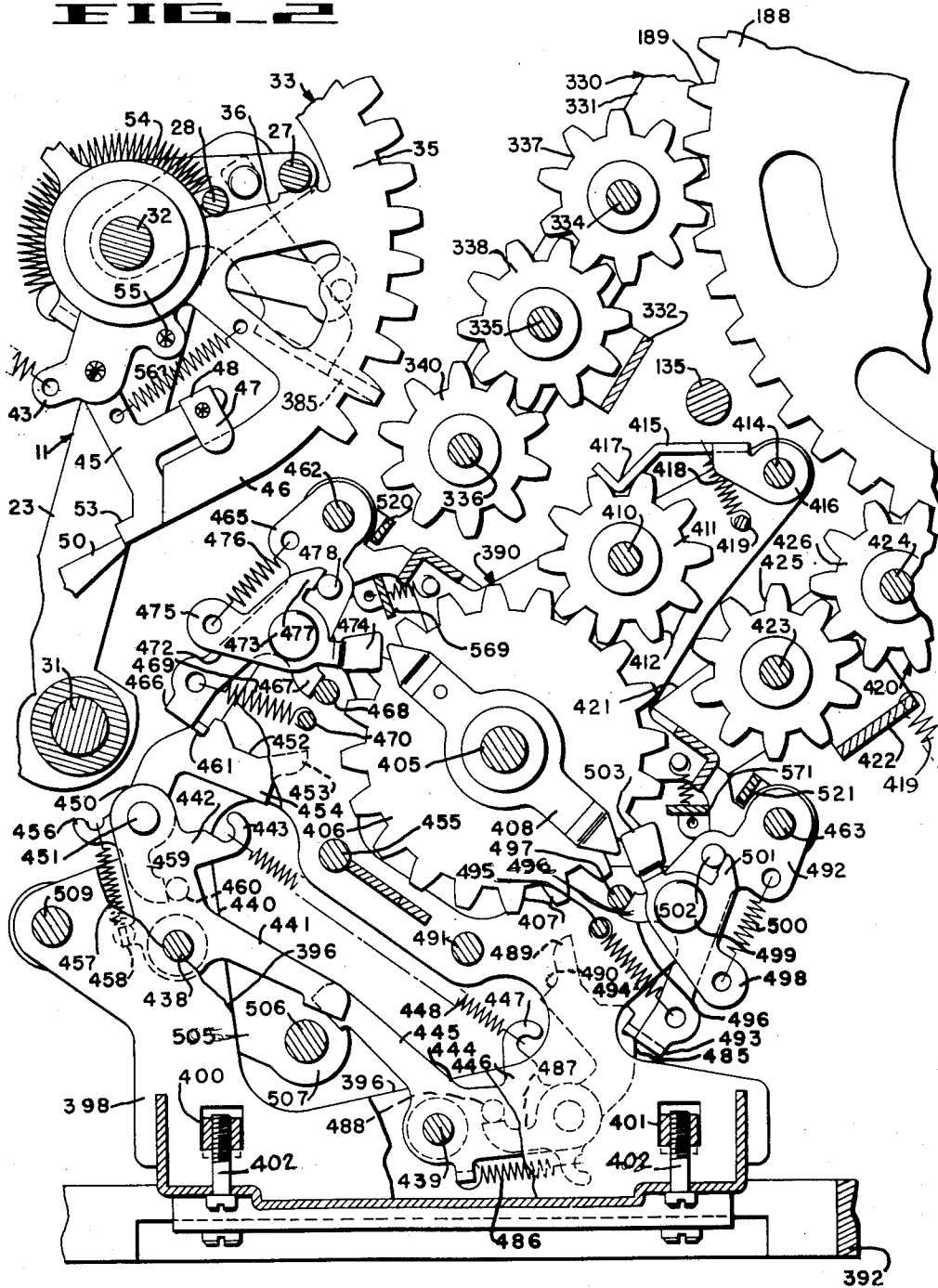
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FIG. 2



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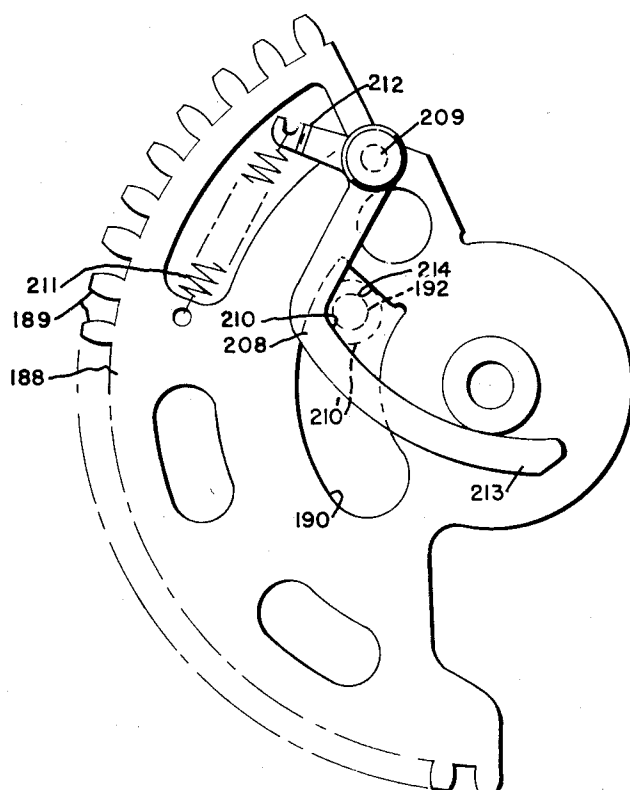


FIG. 3

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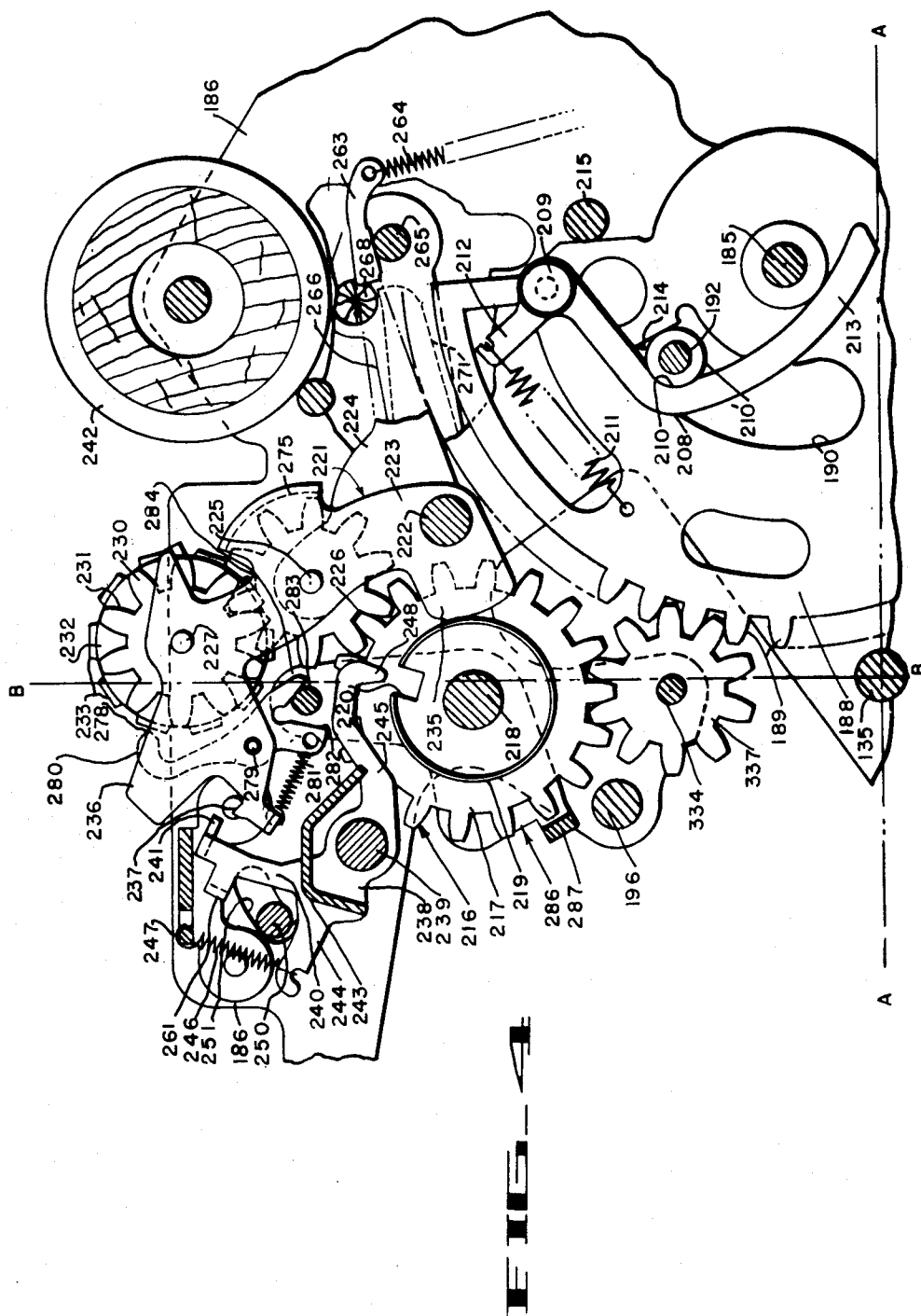
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SYMBOL PRINTING MECHANISM

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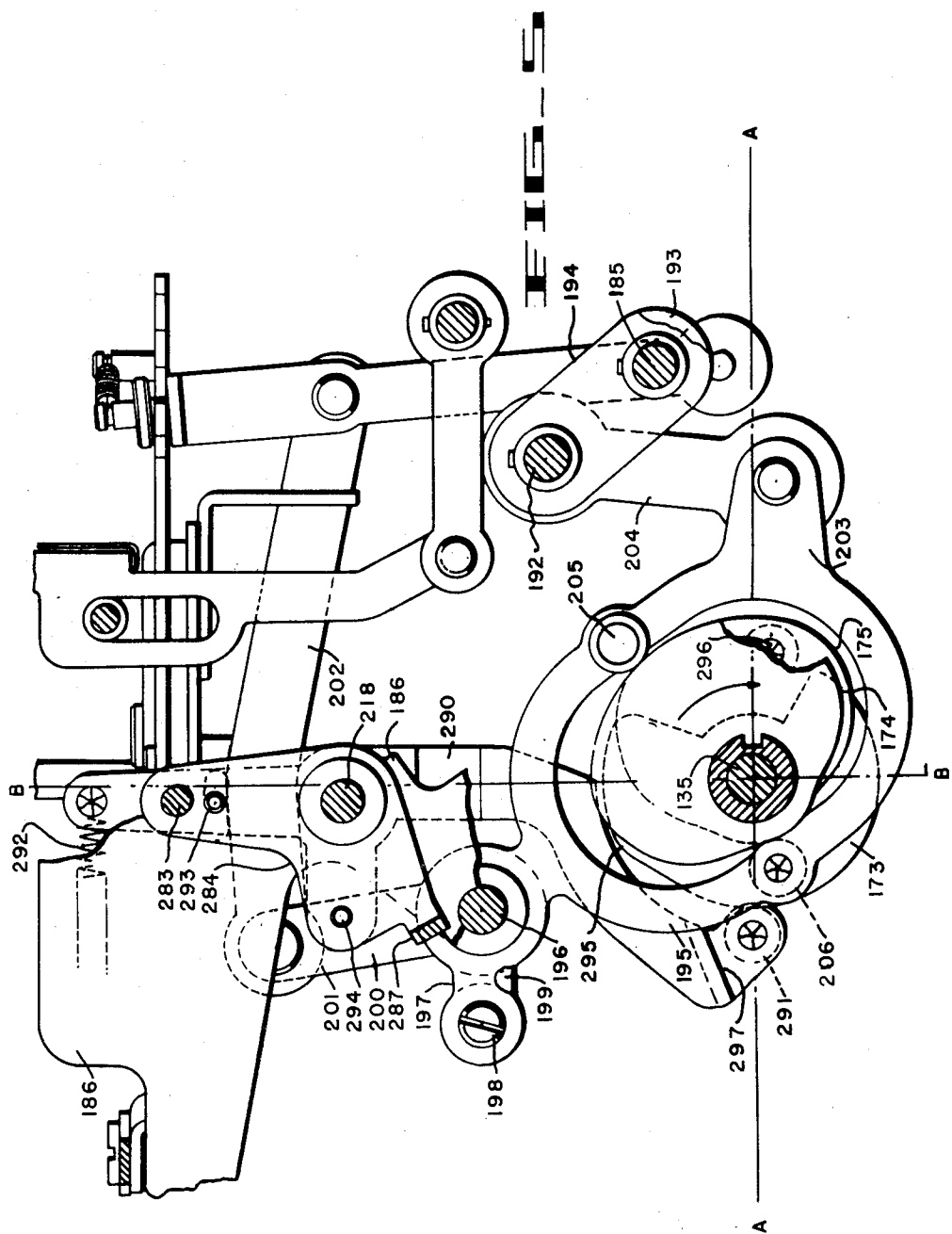
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SYMBOL PRINTING MECHANISM

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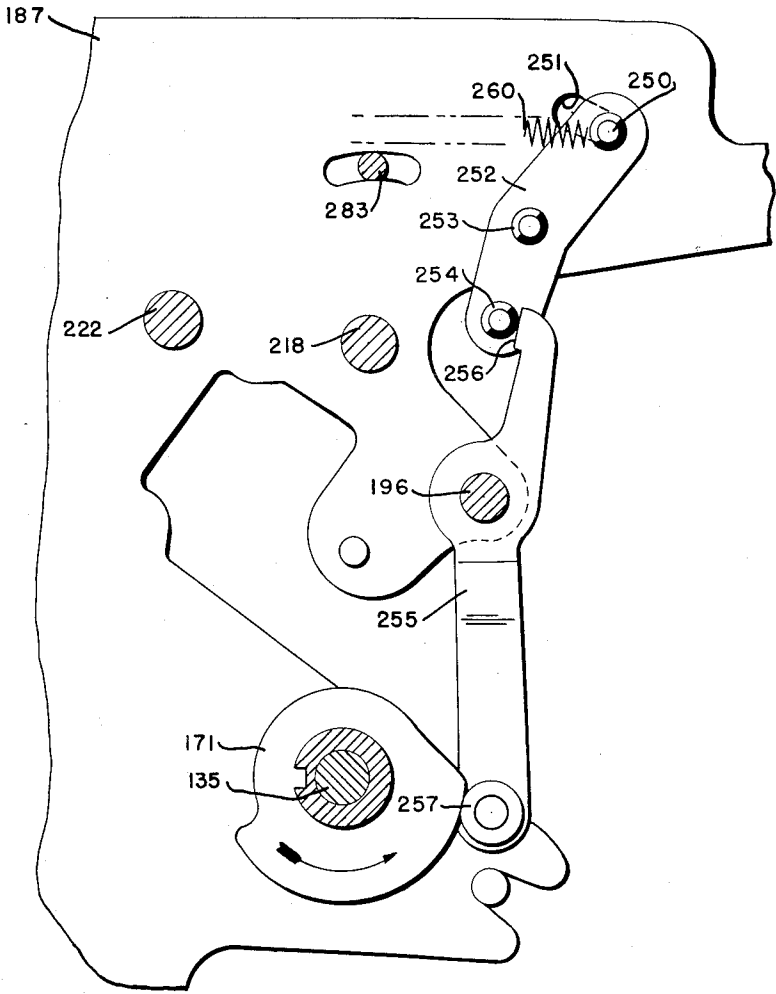
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SYMBOL PRINTING MECHANISM

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FIG. 6



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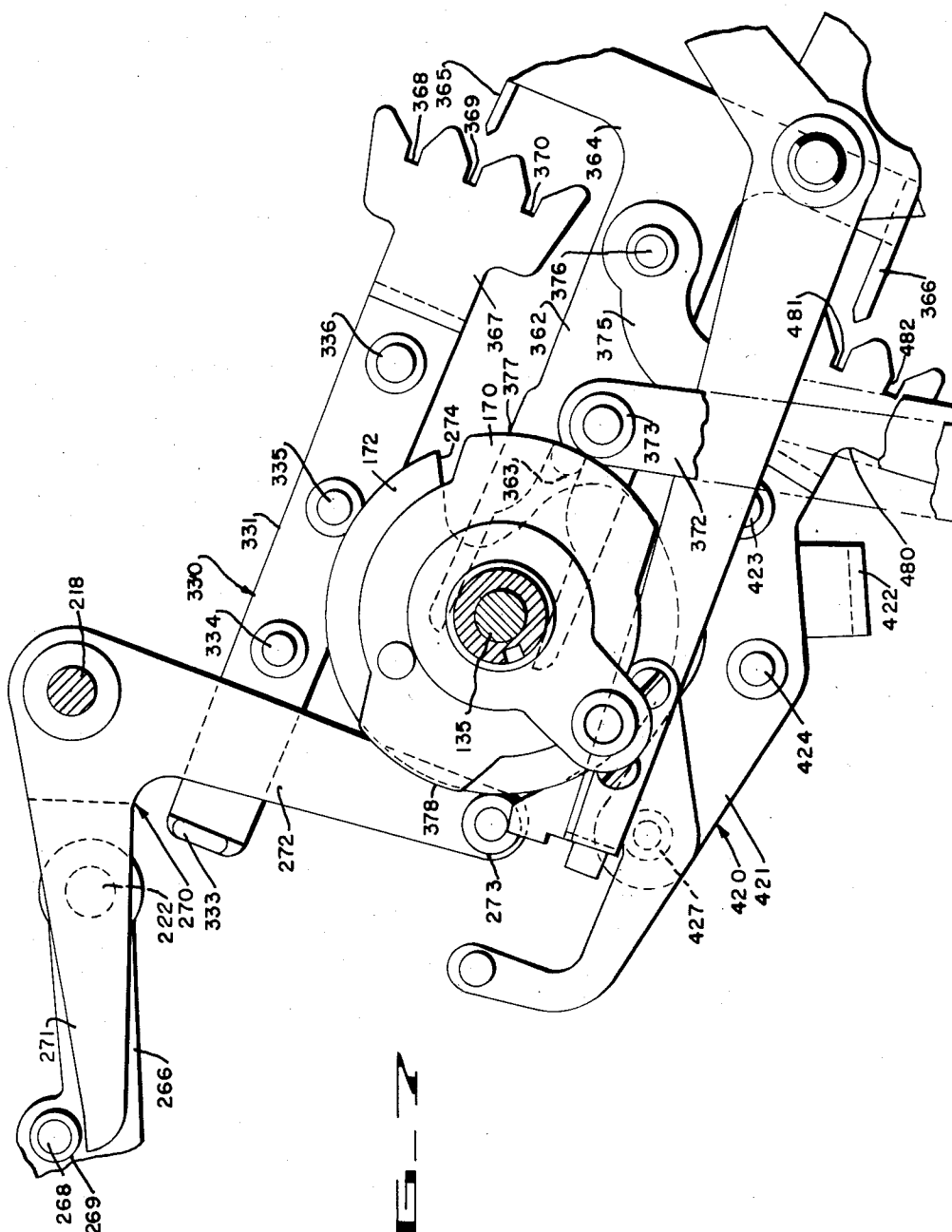


FIG. 7

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18 Sheets-Sheet 8

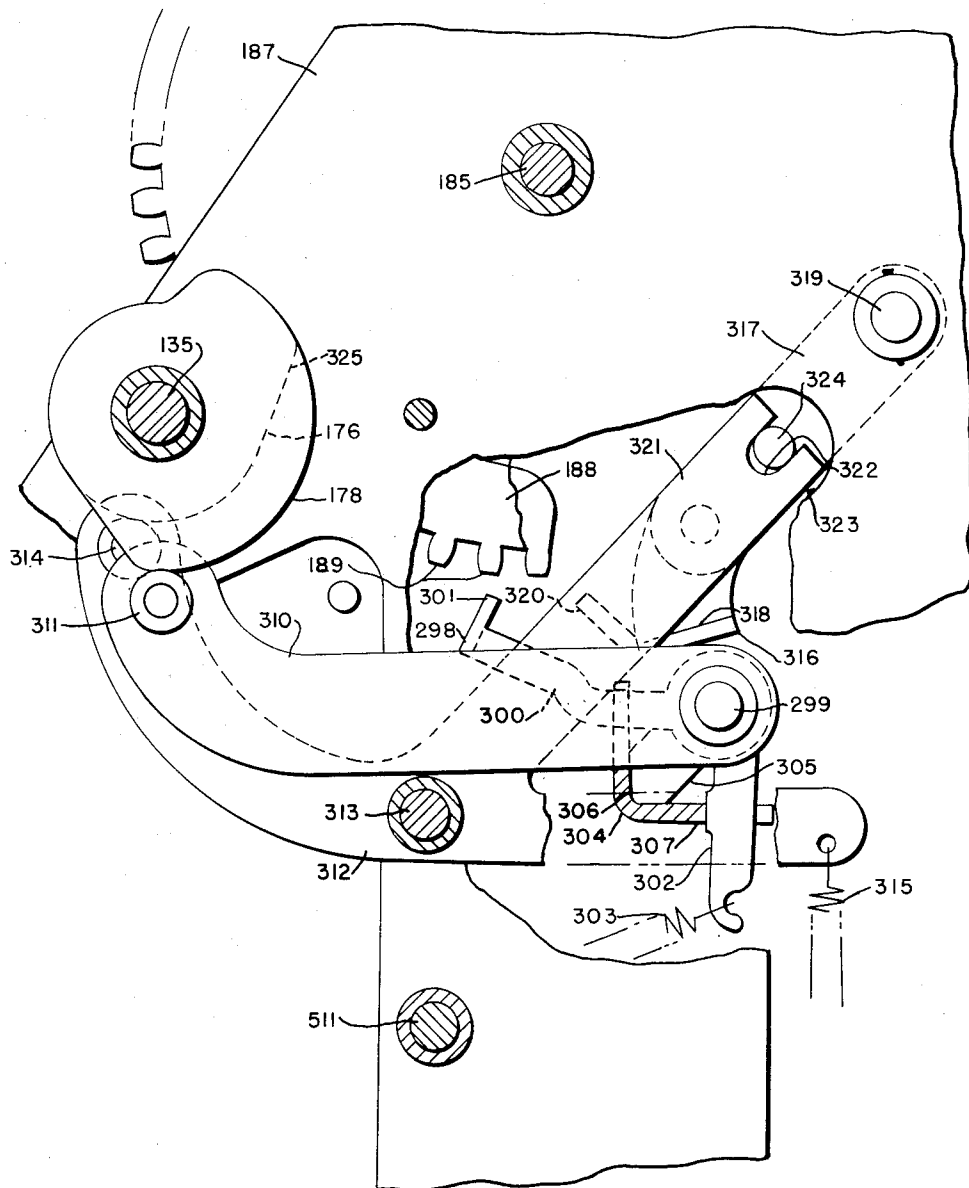


FIG. 8

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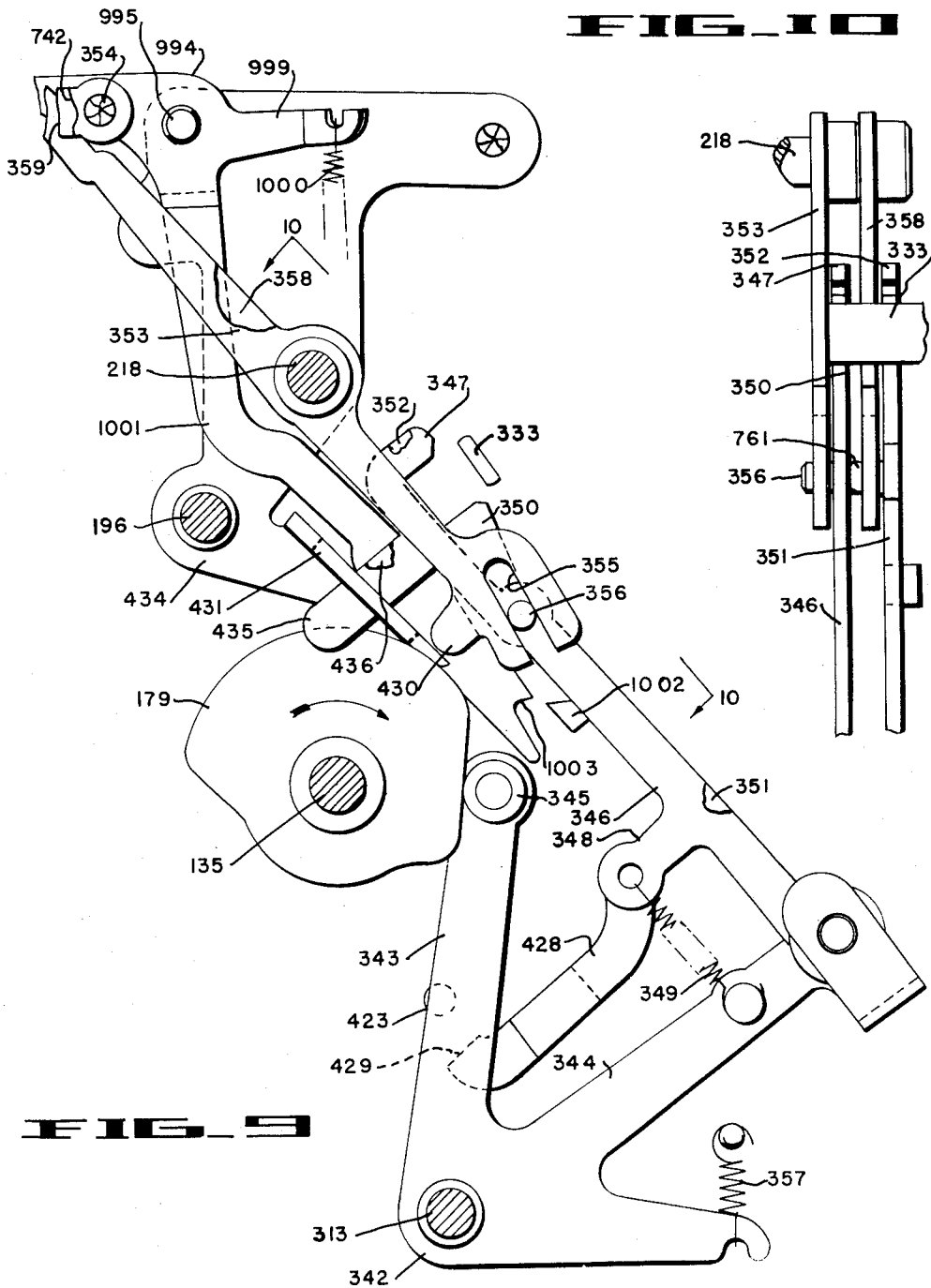
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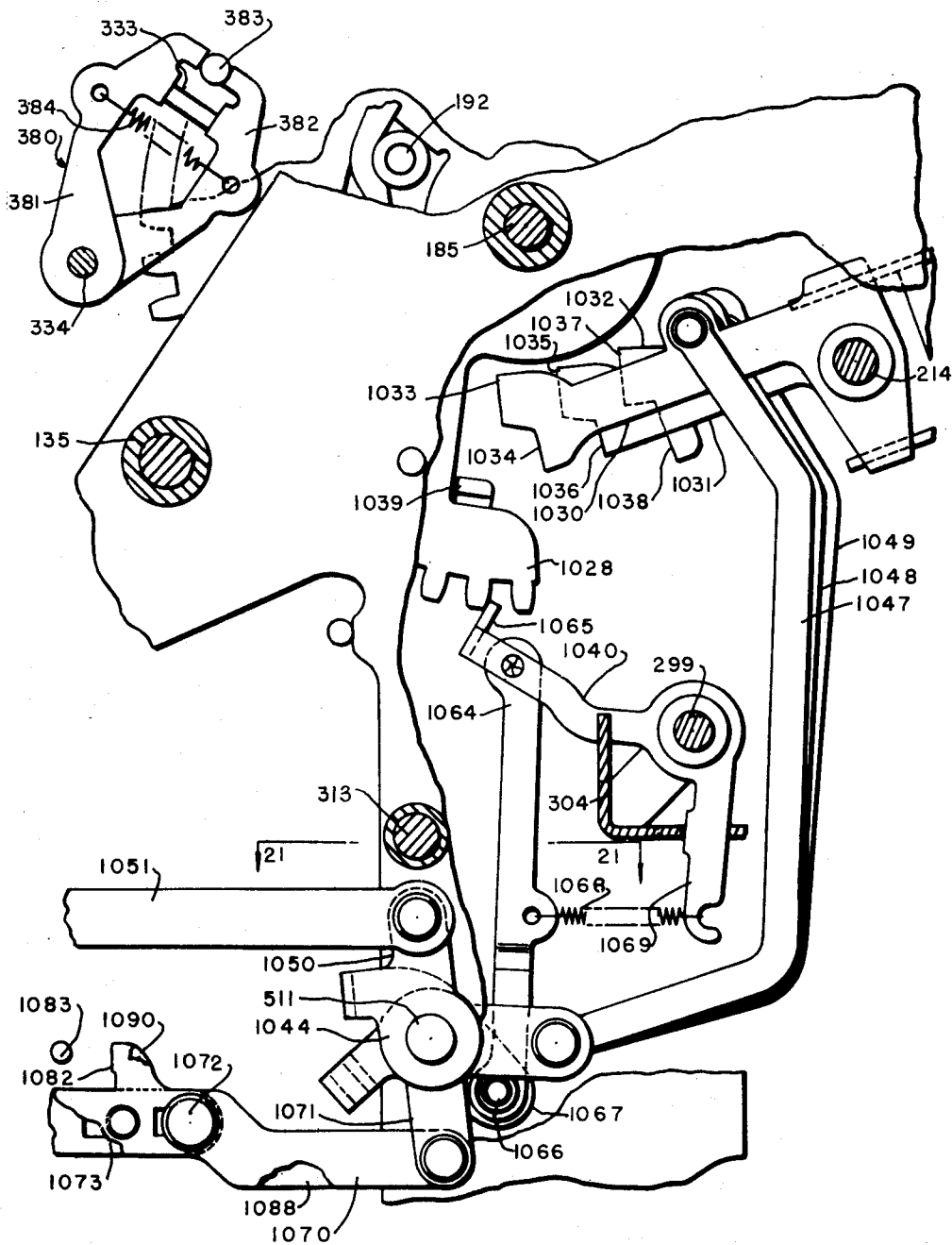


FIG. 11

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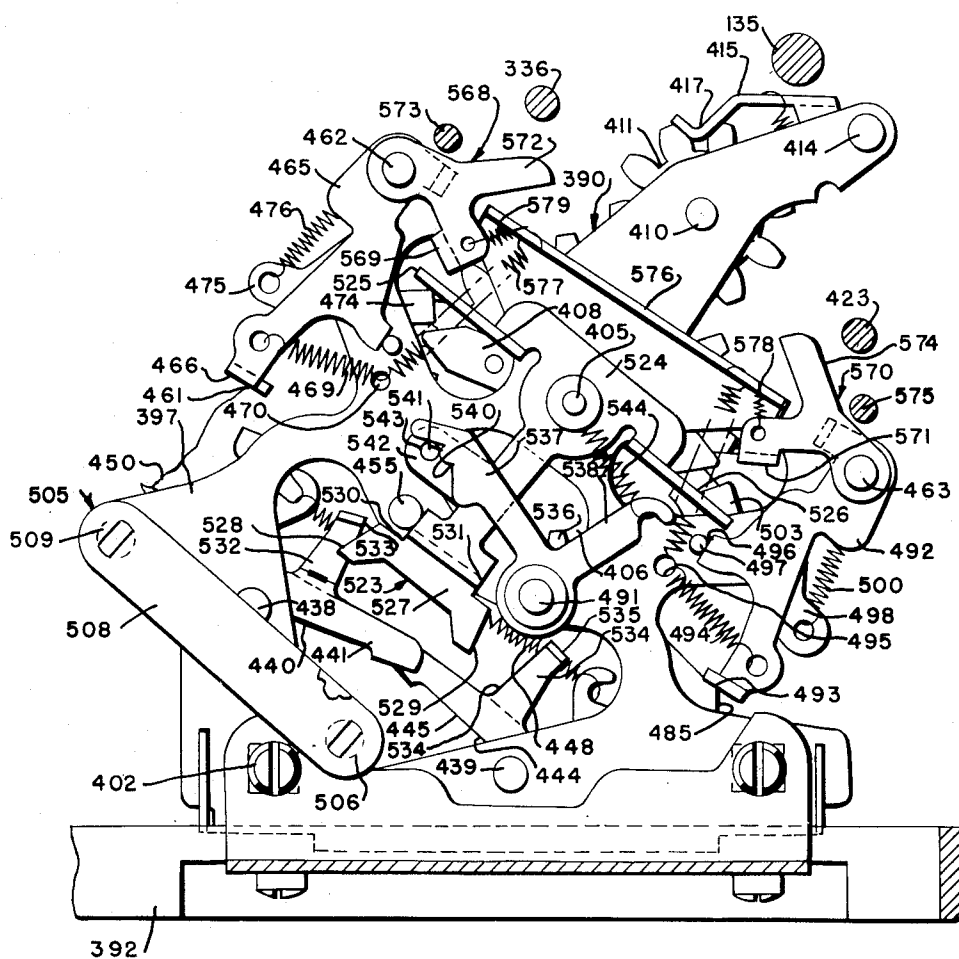


FIG. 12

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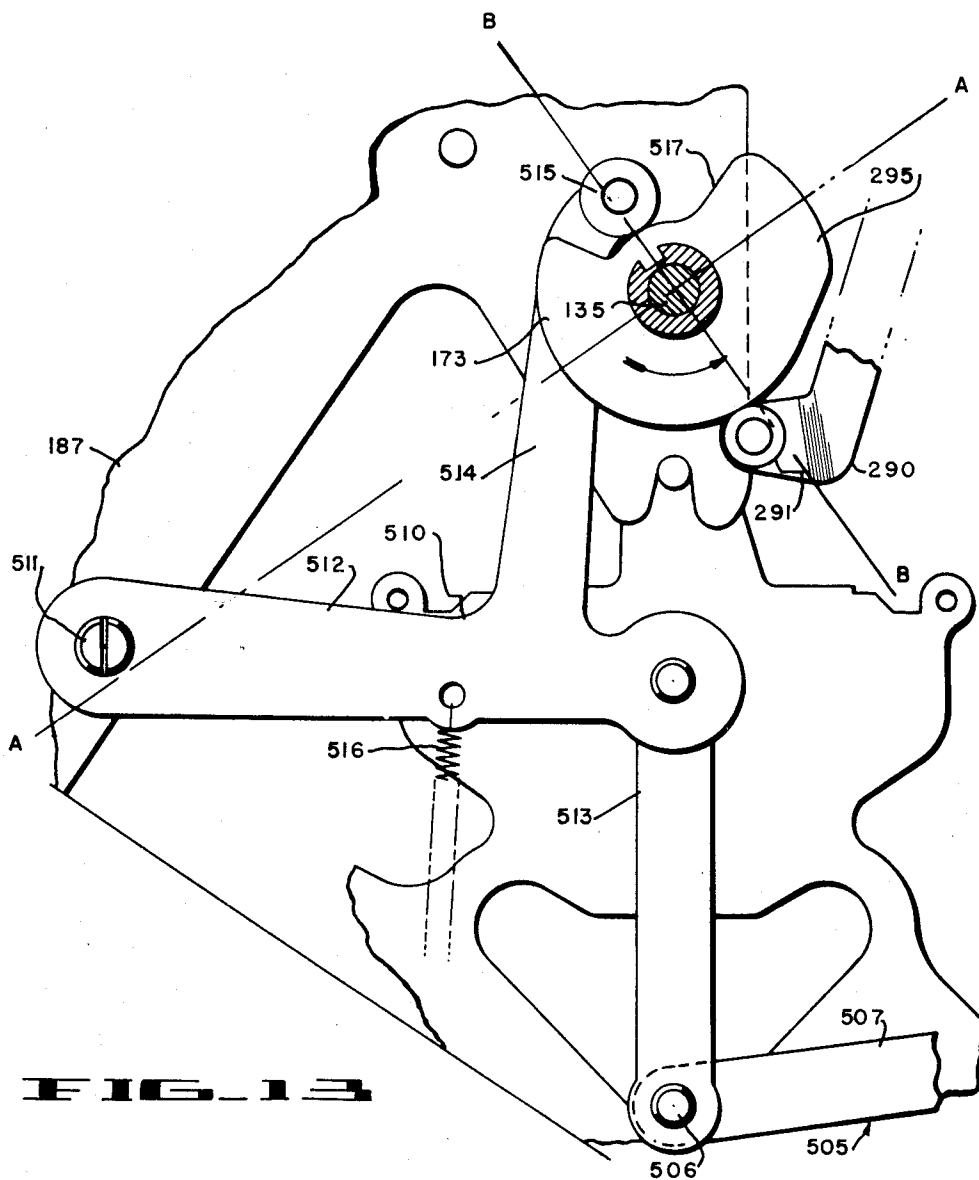
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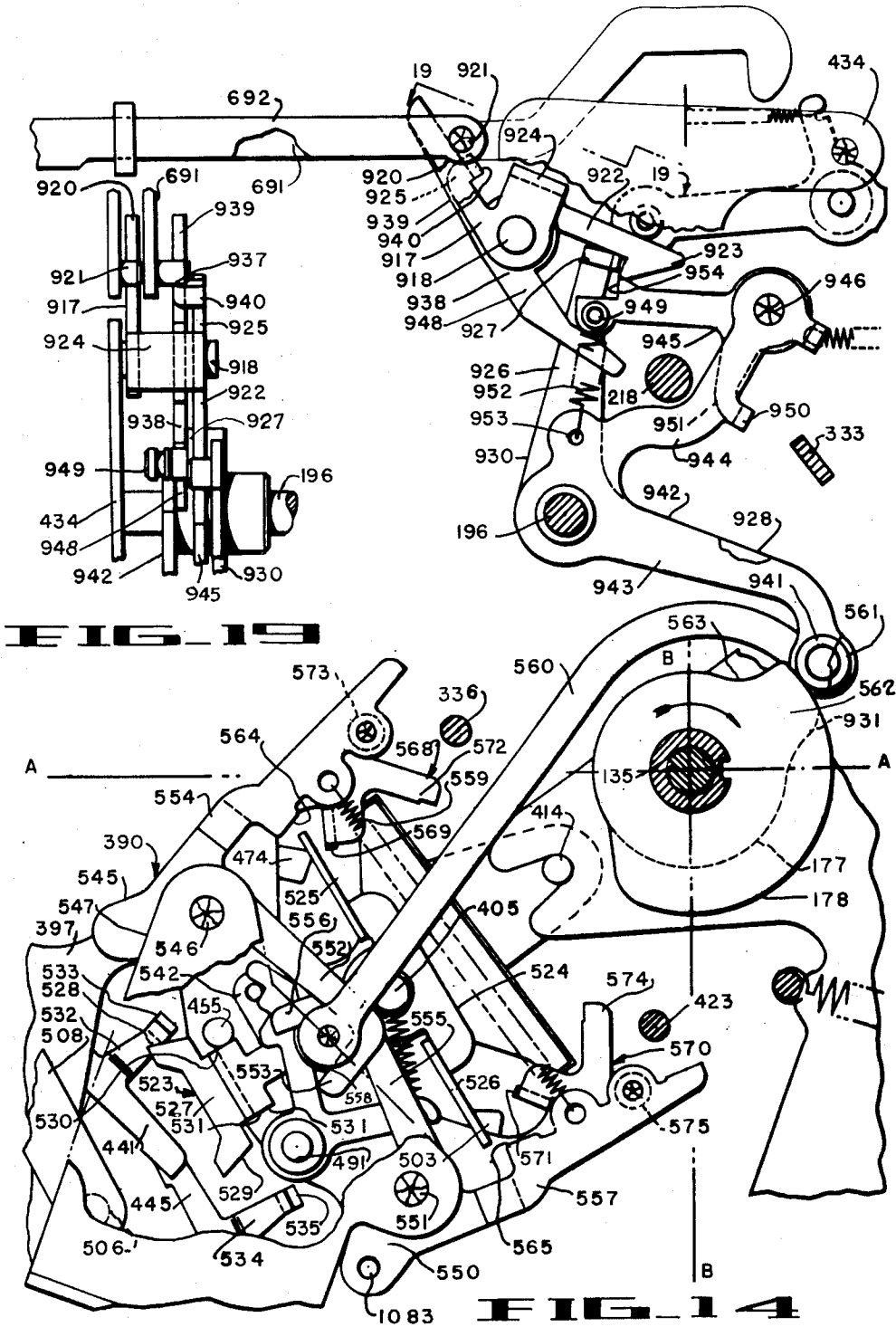
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SYMBOL PRINTING MECHANISM

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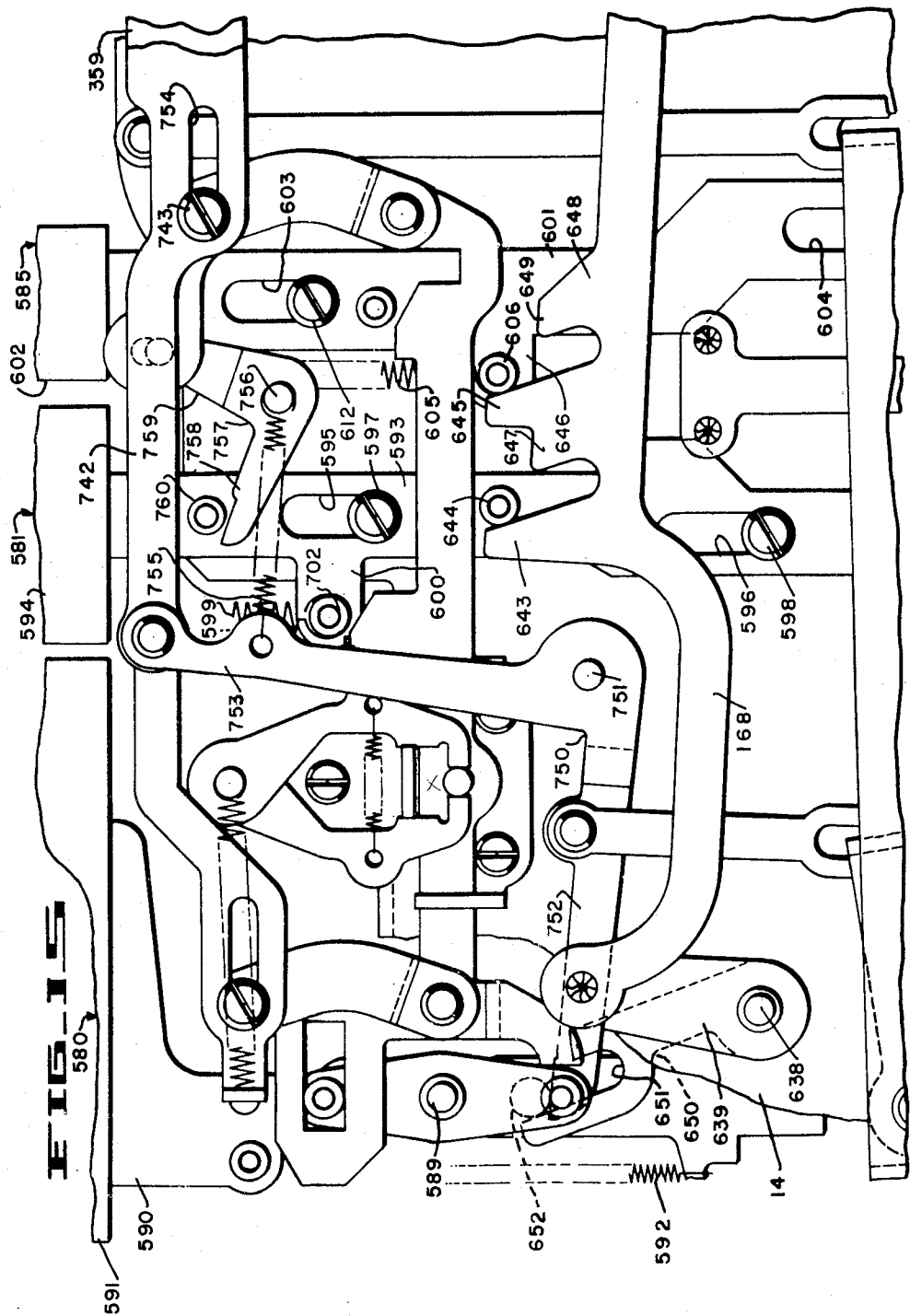
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SYMBOL PRINTING MECHANISM

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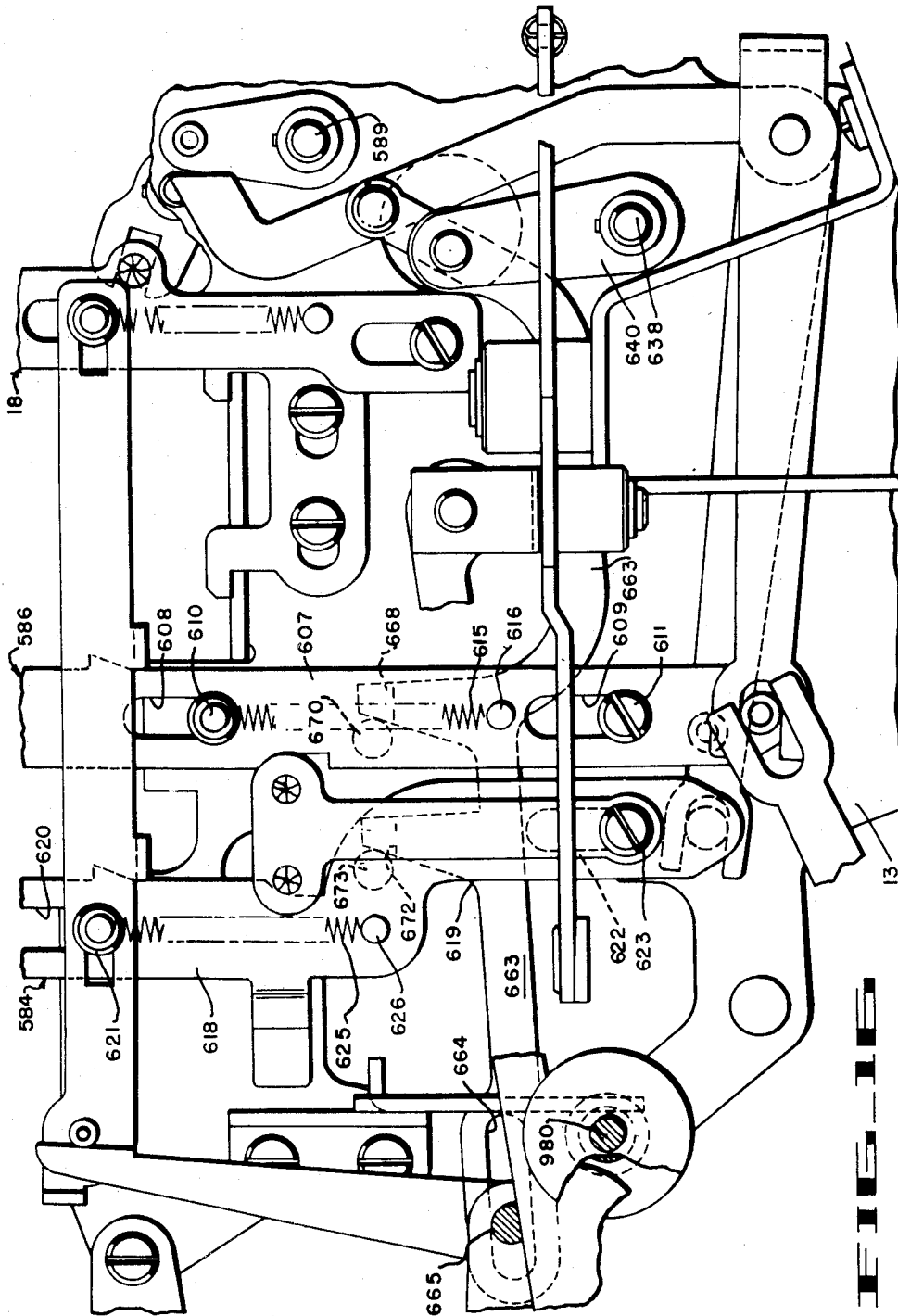
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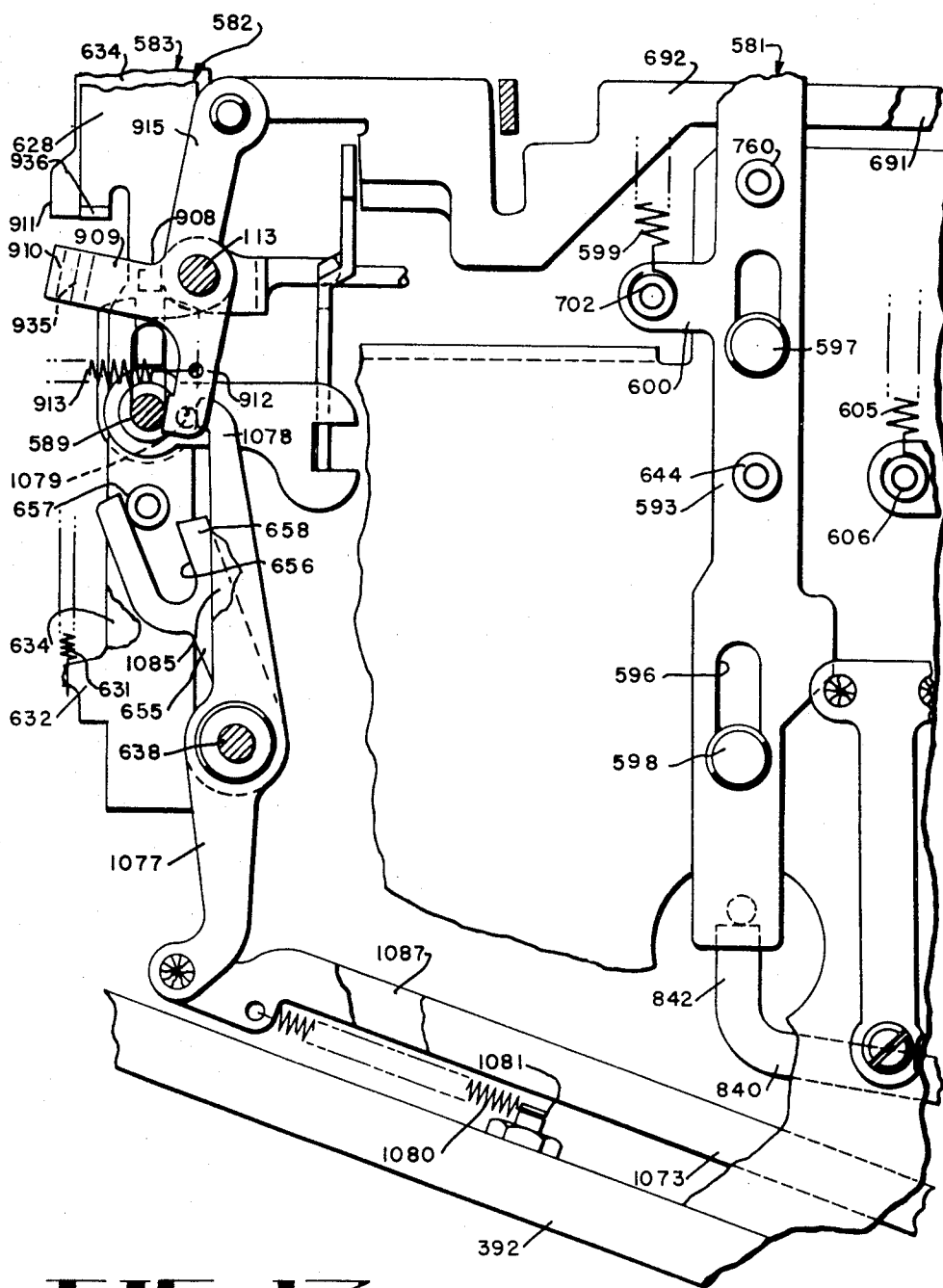


FIG. 17

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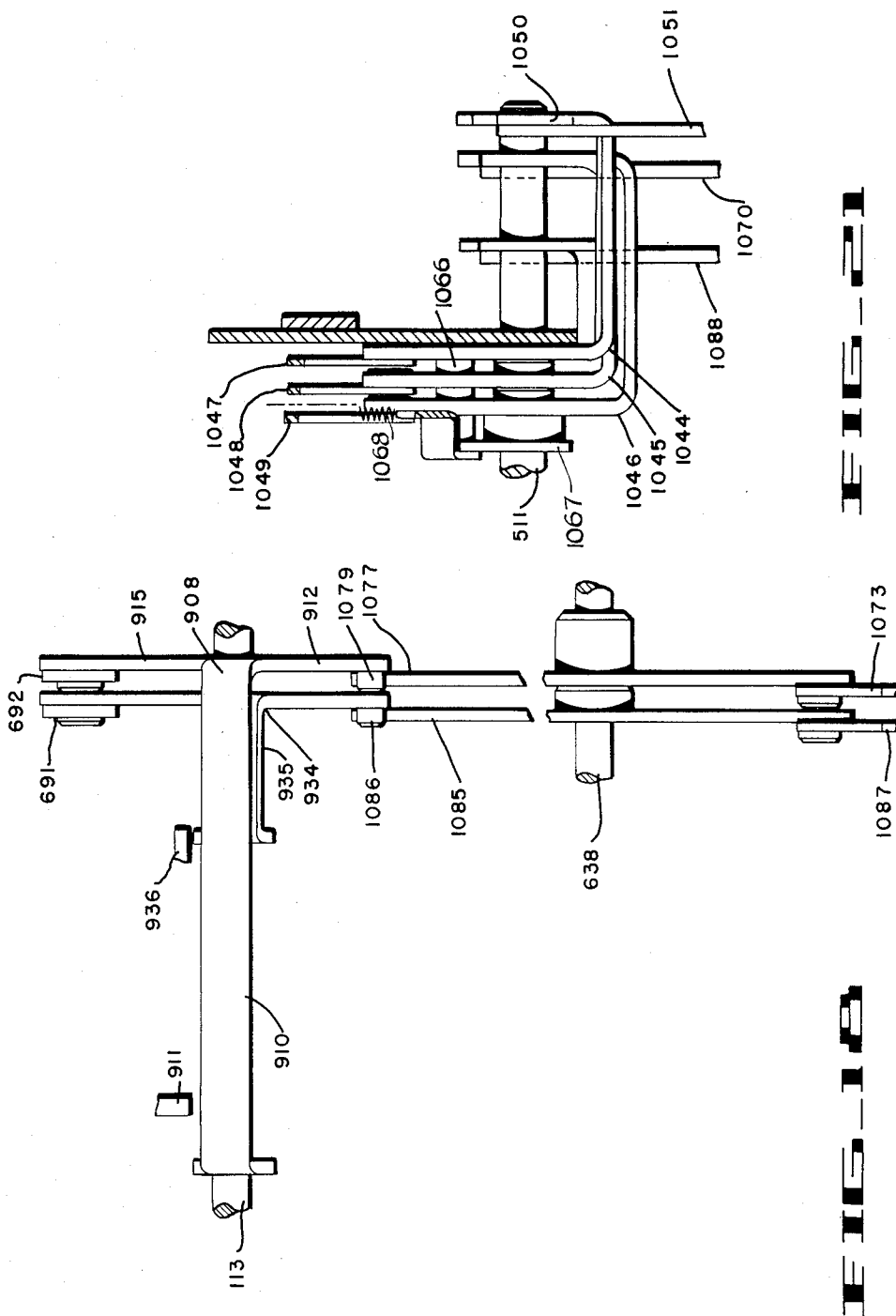
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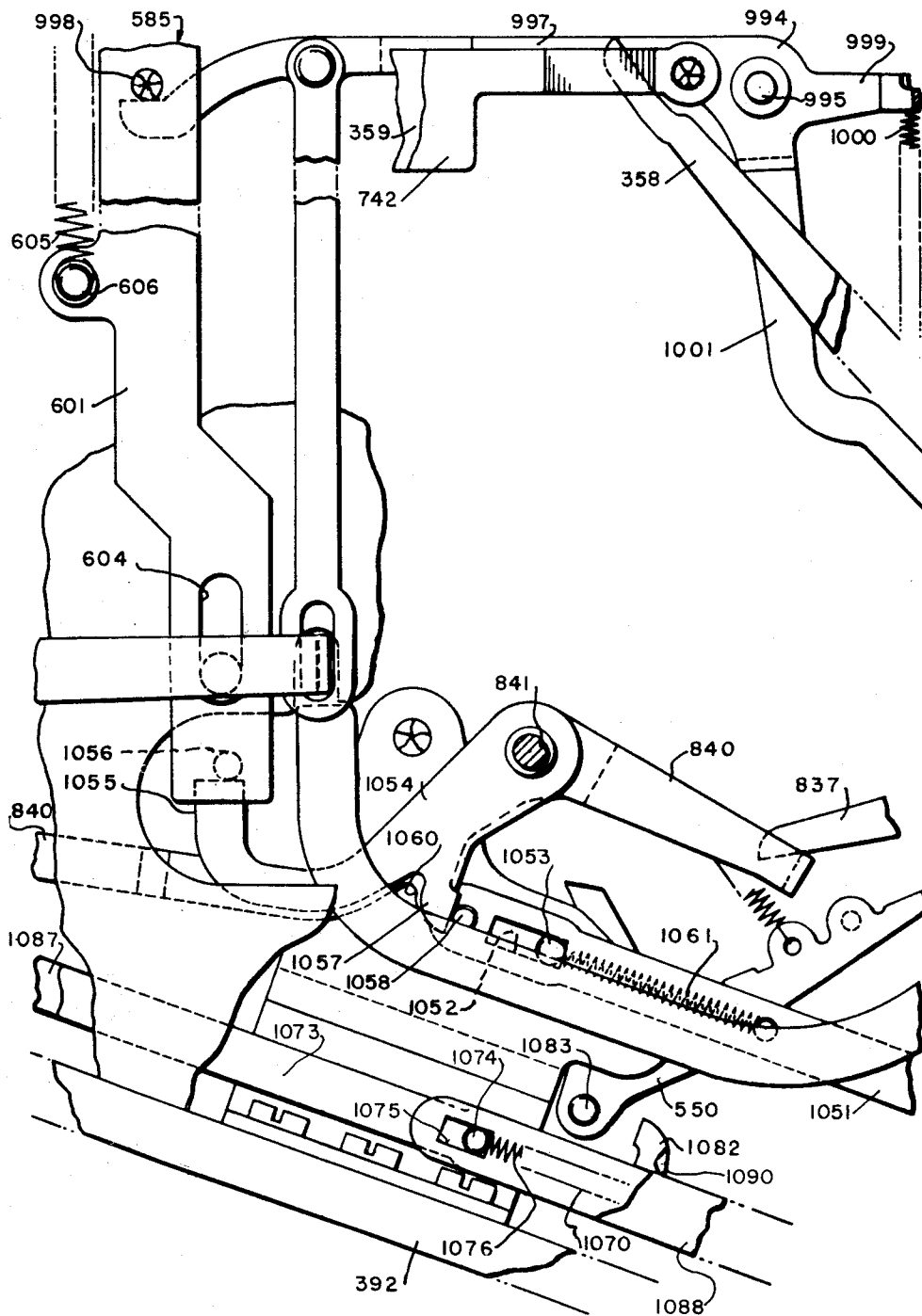


FIG. 20

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SYMBOL PRINTING MECHANISM

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Original application Jan. 29, 1954, Ser. No. 407,016, now Patent No. 2,832,530, dated Apr. 29, 1958. Divided and this application Apr. 12, 1954, Ser. No. 422,571

5 Claims. (Cl. 235—60.18)

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This invention relates to calculating machines such as ten-key adding machines as disclosed in my Patent No. 2,832,530, issued April 29, 1958, for "Value Selecting and Transmitting Mechanism for Listing Adding Machine," of which this application is a division, and more particularly to a symbol printing mechanism for such a machine.

It is among the objects of this invention to provide in a ten-key, listing adding machine of the character indicated, a printing element having type thereon for printing symbols indicating machine operations and the condition of accumulated values in the machine and mechanism effective to automatically set and actuate the printing element during the operating cycles of the machine; which printing element is set by a power operated actuator element of the machine and actuated at the same time the number printing mechanism is actuated to print entry or accumulated values; which prints symbols indicative of a negative entry, a positive or negative subtotal, a positive or negative total, or a print-only entry, separate means being provided to print a symbol indicating a cleared condition of the machine register or accumulator; which printing element setting mechanism is operated by the control keys and accumulator of the machine to adjustably position movable stops for the symbol printing element actuator; and which accurately and automatically prints the selected symbol corresponding to the particular machine operating cycle.

Other objects and advantages will become apparent from a consideration of the following description and the appended claims in conjunction with the accompanying drawings wherein:

Fig. 1 is a somewhat diagrammatic perspective view showing the several control keys, the cam shaft clutch and the motor controlling switch, and the mechanism operated by the control keys for closing the motor switch and conditioning the clutch for a single rotation of the cam shaft whenever any one of the control keys is depressed;

Fig. 2 is a cross-sectional view of the accumulator, the

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positive gear transmission mechanism, the negative gear transmission mechanism, and the immediately associated parts of the machine;

Fig. 3 is a side elevational view of one of the actuator sectors fragmentarily illustrated in Fig. 4;

Fig. 4 is a right side view showing a portion of the printing mechanism and particularly the print wheels, the print wheel drive and the operating mechanism for the print wheels;

Fig. 5 is a right side view of the actuator sector trail and lead cams, a print controlling cam and tens-carrying accumulator operating cam, and the mechanisms operated by these several cams;

Fig. 6 is a left side elevational view of the zero foil releasing cam for the printing mechanism and the mechanisms operated by this cam;

Fig. 7 is an elevational view from the left-hand side of the machine showing the crank for operating the return mechanism of the shiftable selector unit, the positive and negative transmission gear locking cam, the crank pin for releasing the control keys at the left-hand side of the keyboard and the print controlling cam, together with the mechanisms operated by the several cams;

Fig. 8 is an elevational view from the right-hand side of the machine showing the mechanism for aligning the actuator sectors of the machine in proper rotational position for the printing operation and means for releasably locking the actuator sectors in properly aligned condition during the printing operation;

Fig. 9 is a side elevational view looking from the right side of the machine of the means operated by the addition and subtraction keys for controlling the shifting of the positive and negative transmission gear mechanisms;

Fig. 10 is a fragmentary top plan view of the mechanism shown in Fig. 9 looking from a plane indicated by the section line 10—10 of Fig. 9;

Fig. 11 is a fragmentary longitudinal cross-sectional view of the machine showing in elevation the mechanism which controls the positioning of the symbol printing wheel of the printing mechanism of the machine;

Fig. 12 is a side elevational view of the accumulator unit;

Fig. 13 is a left side elevational view of the cam and associated mechanism for operating the accumulator tens-transfer restoring bail and the print wheel detenting mechanism;

Fig. 14 is a side elevational view from the right-hand side of the machine showing the total and subtotal printing cams and the accumulator operated mechanism for sensing the algebraic sign of the total carried in the accumulator and placing the machine in condition to read out either a positive or a negative total or subtotal;

Fig. 15 is an elevational view from the right-hand side of the machine showing the control keys at the right-hand side of the machine keyboard, the machine cycle initiating mechanism controlled by these control keys and the blocking means precluding the depression of more than a single selected control key at one time;

Fig. 16 is a side elevational view from the left-hand side of the machine showing the control keys at the left-hand side of the machine, the mechanism actuated by these control keys for initiating operating cycles of the machine and the mechanism for precluding simultaneous depression of more than one control key;

Fig. 17 is a longitudinal cross-sectional view of the machine showing in elevation the total and subtotal control keys mounted at the front end of the machine keyboard together with the mechanism operated by these keys for initiating operating cycles of the machine and mechanism for blocking the simultaneous depression of two or more control keys;

Fig. 18 is a fragmentary elevational view of a portion

of the mechanism shown in Fig. 17, taken from the front, or left side, of that figure;

Fig. 19 is a fragmentary top plan view of the total and subtotal control mechanism illustrated in Fig. 14 taken from a plane indicated by the line 19—19 of Fig. 14;

Fig. 20 is a fragmentary side elevational view from the right-hand side of the machine showing the print-only control key stem at the right-hand side of the machine keyboard and the mechanism operated by the print-only control key; and

Fig. 21 is a fragmentary cross-sectional view on the line 21—21 of Fig. 11.

As is fully shown in Patent No. 2,832,530, referred to above, the adding machine of the present invention comprises, in addition to a suitable base, a suitable mechanism supporting framework and a mechanism cover, selection mechanism including a ten-key keyboard and a selection device having selector racks which are sequentially set to selected values from the highest to the lowest order corresponding to values entered therein by manual depression of selected keys of the keyboard. It also comprises a printing mechanism, an accumulator, a power-driven actuator controlled by the selection device, power cycling mechanism, a positive transmission gear train which drivingly connects the actuator with the printing mechanism at all times and alternatively connects the actuator with the selector mechanism or the accumulator, a negative transmission gear train which, at times connects the actuator to the accumulator, and a set of control keys including an addition key, a subtraction key, a subtotal key, a total key, a print-only key, a keyboard clearing key and a repeat addition key.

The power cycling device includes a motor driven cam shaft carrying a plurality of mechanism actuating cams and transmission means between the motor and the cam shaft effective to turn the cam shaft through one complete rotation and bring it to a stop each time a control key of the machine is operated.

The positive and negative gear trains each have a neutral position, and one gear train always occupies its neutral position while the other is in its operative position and both are bidirectionally operative to either transmit values from the selection mechanism to the printing mechanism and accumulator or to transmit values from the accumulator to the printing mechanism.

The selection mechanism, or selector, includes, a unit laterally shiftable relative to the actuator and accumulator under control of an escapement mechanism as values are entered therein, so that the digits of a value of any number of digits within the capacity of the selector are simultaneously transmitted through the actuator to the printing mechanism and the accumulator upon the operation of any one of the addition, repeat addition or subtraction control keys.

Before operation of a value transmitting control key, a value can be cleared from the selector by operation of the keyboard clearing key without printing and without changing the total in the accumulator or feeding the printing tape.

The printing mechanism includes a paper tape on which the values are printed and an ink carrying ribbon which is preferably divided longitudinally into two portions of different colors. There is a tape feeding mechanism provided with a spacing adjustment which is effective to feed the tape in single space steps while entry values are being entered into the machine and printed and when a value is printed without entry into the machine accumulator, and to double space the tape feed whenever a "total" or "subtotal" value is printed to thereby clearly offset the total and subtotal figures from the following column of entry value figures on the tape, and to interrupt tape feeding when the keyboard clearing key is depressed. There is also a ribbon shift means which is effective to position the ribbon in one color position

when a positive, or additive, quantity is printed and in a different color position when a negative, or subtractive, quantity is printed, and means are provided for winding the ribbon back and forth between spaced-apart ribbon spools.

The actuator includes a plurality of sectors which are power oscillated to accomplish an advance stroke and a return stroke each time a control key is operated. On the advance stroke the actuators are moved to an extent determined by the positioning of the associated selector elements by the keyboard keys and, on the return stroke, are moved to their home, or full-cycle, position. On their advance stroke the actuator segments transmit the selector values through the positive transmission to the printing mechanism, the printing ribbon being shifted in accordance with whether the addition or subtraction control key is operated, and on their return stroke transmit the value through either the positive or negative transmission to the accumulator in accordance with the operation of the addition or subtraction control key. The accumulator is operated in one direction by the positive gear train and in the opposite direction by the negative gear train and includes tens-transfer mechanism effective to transfer tens from any order to the next higher order in either direction of operation. The accumulator will thus accumulate both positive and negative values to a positive or negative total, as the case may be.

The accumulator will also carry the true total whether the sign be positive or negative.

The accumulator also includes mechanism which senses the sign of the total value in the accumulator and conditions the associated total-taking mechanism to take either a positive or a negative total.

When the total or subtotal control key is depressed, the actuator is drivingly connected with the accumulator through either the positive or negative transmission, depending on the condition of the sign sensing mechanism of the accumulator, and, upon cycling of the machine by the power cycling mechanism, reads out the total in the accumulator and transfers the total to the printing mechanism which prints it on the associated tape near the middle of the machine cycle.

When the total key is depressed, the actuator is connected to the accumulator during the advance stroke of the actuator to read out the total in the accumulator and transfer this value to the printing mechanism, and is disconnected from the accumulator at the end of the advance stroke of the actuator so that the accumulator is not operated during the return stroke of the actuator but is left in its zero setting, or cleared, condition. However, when the subtotal key is operated, the actuator is maintained in driving relationship with the accumulator during both the advance stroke and the return stroke of the actuator, so that the total value read out of the accumulator on the advance stroke of the actuator is returned to the accumulator on the return stroke of the actuator and further entries are added to, or subtracted from, this restored total.

The printing mechanism includes symbol printing apparatus which is driven by a special unit of the actuator and power cycling mechanism but controlled by the control keys and accumulator so that it will print the proper symbol for the operation performed and give the proper sign to the symbol. Thus, the following symbols may be used to indicate the different operations and the sign of the quantity printed:

Addition	-----	No symbol.
Subtraction	-----	(Minus sign in negative ribbon color.)
Subtotal—positive	-----	S.
Subtotal—negative	-----	Š.
Total—positive	-----	T.
Total—negative	-----	Ť.
Print only	-----	N.

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There is also a clear signal printing mechanism which, upon the next additive, subtractive or print-only cycle following a total cycle, prints a clear signal symbol, for example a "C," on the tape to indicate that the accumulator had been cleared before the new entry was made.

The print-only key is used when it is desired to print a number, such as an identifying, or code, number, on the tape without entry of such number as a value into the accumulator. This is accomplished by connecting the selector to the printing mechanism through the positive transmission and actuator during the advance stroke of the actuator and blocking any connection between the actuator and accumulator during the return stroke of the actuator.

The control keys are all connected to the power cycling mechanism in a manner to initiate a cycle or rotation of the power cycling mechanism whenever a control key is operated. The power cycling mechanism is so constructed and arranged that it will automatically complete a full cycle or rotation and come to a stop at a predetermined angular position once a cycle has been initiated by depression of a control key. Blocking means are also provided, so associated with the control keys that only one control key can be operated at a time and no other control key can be operated until after the completion of the cycle initiated by this operated key.

This precludes the possibility of forcing the machine to attempt two or more different operations at the same time and thus avoids probable errors and damage to the machine mechanism.

The machine will thus print positive and negative entries and distinguish between the positive and negative values printed, will accumulate the entry values into positive and negative totals and compensate inherent mechanical errors to provide true total values, will read out and print totals and subtotals and automatically sense the positive or negative nature of such totals, will repeat add the same value any desired number of times, will print numbers without entering such numbers into the accumulator, will clear itself whenever a total is taken but will retain its total when a subtotal is taken, will print appropriate symbols indicating the nature of the entry or the total and can be cleared of an erroneous entry before the entry is printed or accumulated.

Selection mechanism

While the selection mechanism is similar in construction and operation to that disclosed in the Taylor Patent No. 2,628,030 and in the Friden Patents Nos. 2,371,752, patented March 20, 1945, and 2,376,997, patented May 29, 1945, it differs in several respects from these prior art devices and particularly in that, whereas the selector segments of the prior art devices are read out seriatim, in the device of the present invention the value carrying sectors are all read out simultaneously.

The selector assembly is generally indicated at 11 in Fig. 2 and includes a cage having end plates, one of which is indicated at 23, extending longitudinally of the machine substantially perpendicular to the plane of the machine base and held in substantially parallel relationship to each other by spaced-apart tie rods, two of which are indicated at 27 and 28, extending through the cage end plates and transversely of the space therebetween. The end plates are slidably mounted on parallel guide rails, one of which is indicated at 31, which extend transversely of the machine and through apertures in the end plates of the selector assembly, the length of the guide rails being such that the selector unit has a freedom of translational movement substantially equal to its own length transversely of the machine. The end plates support a sector mounting shaft 32 which extends transversely of the space between the end plates substantially parallel to the tie rods 27 and 28. A plurality of ordinarily arranged selector sectors, generally indicated at 33, are journaled on the shaft 32.

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Each selector sector includes a rack element having a hub mounted on the shaft 32, a toothed arcuate rim 35 spaced from the hub, and extending through an angle of approximately 90 degrees, and a spoke structure 36 mounting the rim 35 on the associated hub.

A live pawl 45 is pivotally mounted at one end on the rack element hub extension 43 and bears adjacent its other end against the distal end of a tangential extension 46 of the rack element rim 35. A clip 47 mounted on a lateral extension 48 of the pawl 45, slidably engages the rack element rim 35 to guide the pawl in its rocking movements about its pivotal connection with the hub extension 43. The purpose of the pawl is to limit "bounce" of the selection sectors 33, thus preventing an erroneous entry.

The selector sectors are releasably held in their full-cycle, or home, position by a latch lever 50 pivotally mounted intermediate its length on a latch shaft, not illustrated, which extends across the space between the cage end plates and is secured at its ends to these end plates. Each selector sector is urged to turn about shaft 32 in a clockwise direction, as viewed in Fig. 2, by a tension spring 54 which is wound partly around the sector hub and has one end connected to a sector carried stud 55 and its other end connected to the tie rod 28. Each live pawl 45 is resiliently held against the adjacent end of the corresponding rack element rim extension 46 by a tension spring 56 connected between the live pawl and the spoke structure 36 of the corresponding rack element.

The selector sectors are released from their zero latch levers and stopped at differentially set positions by keyboard operated means fully disclosed in my Patent No. 2,832,530, referred to above, and as the selector segments are set to the selected dial readings, the shiftable selector unit 11 is stepped along the guide rails in a direction from right to left so that selector sectors are successively brought into alignment with the actuator sectors of the machine, later to be described.

Power cycle mechanism

The mechanism of the present machine is driven by a motor, not shown herein, which drives a shaft carrying a small spur gear, likewise not shown, on the outer side of the right-hand frame plate; and that, in turn, drives a cam shaft 135 (Fig. 1) which is journaled in the frame plates of the machine and extends transversely of the machine with its axis in spaced and substantially parallel relationship to the axis of the motor shaft. One end of the cam shaft projects through the right-hand frame plate. A spur gear 142, larger than the motor shaft gear, is journaled on this projecting end of the cam shaft and is driven from the motor shaft gear through a speed reducing gear train, not illustrated.

A one-rotation, or single cycle, clutch, generally indicated at 150, is connected between the cam shaft gear 142 and the cam shaft 135 and includes a ratchet wheel 151 secured to the gear 142, a ratchet pawl 152 pivoted at one end on a cam plate 157 secured on shaft 135 and having intermediate its length a single tooth engageable with the teeth of the ratchet wheel to drivingly connect the gear 142 to the cam shaft 135.

The pawl 152 is urged in a ratchet engaging direction by a spring 153 connected between a stud on the cam disk 157 and the free end of the pawl. A transverse shoulder 154 is provided on the pawl at the free end thereof. A pawl latch dog 155 is pivoted at one end on the right-hand frame plate by a pivotal mounting 156 and is engageable at its free end with the pawl shoulder 154 to hold the pawl out of engagement with the ratchet wheel 151, under which conditions the motor shaft can rotate the gear 142 without rotating the cam shaft 135. When the latch dog is disengaged from the pawl shoulder 154, the pawl engages the ratchet wheel and drivingly connects the motor driven gear 142 to the cam shaft

135 for a single complete rotation of the cam shaft, cam shaft rotation being terminated when the pawl shoulder 154 again comes into engagement with the free end of the pawl latch dog 155 and the pawl is moved out of engagement with the ratchet wheel.

The cam disk 157, which carries the pawl 152, is mounted on the cam shaft adjacent the gear 142 and has a circular periphery interrupted by a single depression, or low 158 of limited angular extent. The latch dog 155 carries a laterally projecting roller 159 which rides on the periphery of the cam disk 157 and holds the latch dog 155 out of its pawl engaging position until the cam shaft has completed a rotation and returned to its home position, at which time the roller 159 drops into the cam depression 158 and frees the latch dog 155 to engage the pawl shoulder 154. This cam disk 157 also serves to hold a depressed control key down until the end of the operating cycle which was initiated by the depression of the control key, as will be presently described.

The clutch pawl latch dog 155 is moved to its pawl releasing position upon operation of a control key of the machine by a link 168 pivotally connected at its rear end to the latch dog 155. An extension 169 of this link extends rearwardly from the rear end of the link 168 to a connection with the motor switch 139 to energize the motor when the cam shaft clutch is engaged. Forward movement of the link 168 and link extension 169 to engage the clutch and close the motor switch is resiliently resisted by a spring 164.

Actuating mechanism

Figs. 2, 3, 4, 5 and 6

The actuator mechanism, Figs. 3 and 4, comprises an axle shaft 185 journaled at its ends in intermediate frame plates 186 and 187 and extends transversely of the machine above and to the rear of, and substantially parallel to, the cam shaft 135. Actuator sectors 188, equal in number to the number of selector sectors plus two, are journaled in side-by-side, or ordinal, arrangement on the axle shaft 185 and extend from the axle shaft toward the shiftable selector unit 11.

Each actuator sector is substantially of the shape of a section of a circle and the axis of the axle shaft 185 extends through the centers of the hypothetical circles of which the corresponding sectors constitute sections. Gear teeth 189 are provided on the arcuate edges of the actuator sectors and each sector is provided with an elongated opening 190 having a longitudinal curvature centered on the axis of shaft 185. The sectors may also be provided with weight reducing openings as shown in Figs. 3 and 4, if desired.

A rod, or bail, 192 extends through the openings 190 in the several actuator sectors. A pair of arms 193 and 194, shown in Fig. 5, rockably support the corresponding ends of the bail 192, which arms are rotatably mounted on the shaft 185 near the correspondingly opposite ends of this shaft, thereby supporting the bail 192 in spaced and parallel relationship to the axle shaft 185.

As shown in Fig. 5, yoke 195 of somewhat elliptical shape surrounds the cam shaft 135 and the actuator trail and lead cams 174 and 175. The yoke has an upwardly and forwardly projecting extension pivotally mounted on a fixed cam follower shaft 196 which extends transversely of the machine above and forwardly of the cam shaft 135, which follower shaft is supported in the side and intermediate plates of the machine frame. An arm 197 extends forwardly from the extension 195 and is pivotally connected by a spacing pin 198 to the distal end of one leg 199 of a ribbon feed actuating bellcrank lever 200 rockably mounted on the cam follower supporting shaft 196. The other leg 201 of bellcrank lever 200 extends upwardly from shaft 196 and is connected at its upper end to the forward end of a link 202 which drives the ribbon feed of the printing mechanism.

An arm 203 extends rearwardly from the rearward end of the yoke 194 and is pivotally connected at its rearward, or distal, end to the lower end of a link 204, the upper end of which is connected to the actuator bail 192.

The yoke carries on its upper side a cam following roller 205 riding on the peripheral edge of the actuator trail cam 174 and on its lower side a cam following roller 206 riding on the peripheral edge of the actuator lead cam 175, the yoke being disposed between the cams 174 and 175 and the roller 205 projecting from the right-hand side of the yoke while the roller 206 projects from the left-hand side of the yoke.

With this arrangement, the bail 192 is positively moved both downwardly and upwardly and, during an operating cycle of the machine, is first moved to its lower position, is maintained in its lower position for a predetermined time interval and is then restored to its upper position.

A corresponding latch lever 208 (Figs. 3 and 4) is disposed adjacent one side of each actuator sector 188 and is pivoted at its upper end to the sector near the upper radial edge of the sector by a pivotal connection 209 and extends from the pivotal connection along the opening 190 in the actuator sector and past the side of the bail 192 remote from the axle shaft 185. The latch lever is angularly bent intermediate its length, to provide at the side thereof adjacent the bail 192 a concave seat 210 which receives a roller 210' rotatably mounted on the bail 192, the roller 210' being received in the corresponding seat 210 when the bail is in its upper limiting position relative to the corresponding sector 188. The latch lever is resiliently held in engagement with the bail by a spring 211 connected between the sector 188 and the distal end of an arm 212 projecting angularly from the pivoted end of the lever 208. The portion of the lever 208 between the seat 209 and the free end of the latch lever constitutes a longitudinally curved tail portion 213 directed from the bail 192 toward the shaft 185.

When the bail is pulled downwardly by the action of the lead cam 175 on the cam follower 206, the engagement of the bail in the latch lever seat 210 pulls the sector 188 down until the sector is positively stopped at an angular position predetermined by the setting of a corresponding selector sector 33, at which time the bail moves out of the seat 210 and along the concave edge of the tail portion 213 of the latch lever to complete the downward movement of the bail. As the bail moves along the tail portion 213, it maintains downward pressure on the sector 188 and the angularity of the tail portion to the remainder of the latch lever is such that this pressure is sustained by the force of spring 211 when the bail starts up again and until the bail positively engages the sector and returns it upwardly to its home, or full-cycle, position, the bail being moved upwardly by the action of trail cam 174 on follower 205.

The actuator unit is fixedly mounted in the machine just to the left of the shiftable selector unit when the latter is in its right-hand, home position and, when the selector unit is stepped to the left by its escapement mechanism, the orders of the selector unit from left to right are successively brought into alignment with the corresponding orders of the actuator mechanism from right to left. Thus the digits carried by orders in the left-hand end portion of the selector will be read out by corresponding orders in the right-hand end portion of the actuator unit.

When the bail 192 moves upwardly relative to the actuator sectors 188, it comes into engagement with abutment formations 214 at the upper ends of the openings 190 in the sectors, simultaneously moving into the seats 210 of the latch levers 208, and then moves the actuator sectors upwardly until the upper radial edges of the sectors abut against a stop bar 215 in the upper, or full-cycle, position of the actuator sectors.

Printing mechanism

(1) PRINT WHEELS AND GEAR MECHANISM

(Fig. 4)

The printing mechanism, generally indicated at 216, is disposed above the actuator mechanism with its orders in alignment with corresponding orders of the actuator mechanism. A plurality of print wheel drive gears 217 are journaled on a drive gear shaft 218 which extends transversely of the machine above, and parallel to, the cam shaft 135 and is mounted at its ends in the intermediate frame plates 186 and 187. The gears 217 are disposed in side-by-side, or ordinal, arrangement along the shaft 218 and the number of the gears is equal to the number of actuator sectors 188. Each gear 217 includes a central hub portion 219 of cylindrical shape provided with a peripheral notch 220, the purpose of which will presently be explained.

A plurality of print wheel carriers 221 are rockably mounted intermediate their length on a fixed shaft 222 which extends transversely of the machine in spaced and parallel relationship to the shaft 218. Each carrier 221 includes a pair of parallel arms 223 and 224 with the pairs of arms arranged in side-by-side, or ordinal, arrangement along the shaft 222 and in alignment with corresponding drive gears 217 and actuator sectors 188. Both arms 223 and 224 extend upwardly from the shafts 222 and near the upper ends of the arms, a pivot pin, or axle, 225 extends transversely through the two arms of each pair and carries an idler gear 226 which meshes with the corresponding drive gear 217. The arm 223 of the carrier pair 221 is extended upwardly and forwardly beyond the upper end of the arm 224 and carries an axle pin 227 spaced above the axle pin 225. A print wheel gear 230 is journaled on the axle pin 227 and includes a spur gear portion 231, the teeth of which mesh with the teeth of the idler gear 226 mounted in the same carrier and which is formed on one side of a print wheel portion 232 having printing bosses 233 projecting from the periphery thereof at uniformly spaced angular intervals therearound. It will be noted that the printing bosses 233 are spaced apart and that the outer surfaces of these bosses are made concave in a direction circumferentially of the printing wheel so that the outer surfaces of the bosses will fit against the cylindrical surface of a printing platen 242 presently to be described.

(2) ZERO FOIL LATCH MECHANISM

(Fig. 4)

Each of the arms 223 is provided with an extension 235 directed forwardly from the pivot shaft 222 and overlying one side of the outer portion of the corresponding drive gear 217 to serve as a guide for maintaining the corresponding drive gears 217 and idler gears 226 in meshing alignment with each other. The arm 223 is also extended forwardly of the print wheel axle pin 227, as indicated at 236, and this forward extension is notched out to provide at its lower portion a latch shoulder 237 facing upwardly and forwardly. A plurality of irregularly-shaped zero foil latch levers 238, equal in number to the number of print wheel drive gears 217 and print wheel carriers 221, are pivotally mounted intermediate their length on a fixed shaft 239 which extends transversely of the machine in spaced and parallel relationship to shafts 218 and 222. Each of these zero foil latch levers 238 has an upwardly directed arm 240 provided at its upper end with a rearwardly directed detent formation 241 which engages the shoulder 237 on the corresponding print wheel carrier arm 223 to releasably latch the corresponding print wheel in nonprinting position in which it is spaced from the associated printing platen 242. The latch levers 238 are received in corresponding transverse notches, or recesses, in a comb bar 243 which extends transversely of the machine

above, and parallel to, the shaft 239 to maintain these latch levers in properly spaced relationship to each other. Each lever has a forwardly directed lever arm 244 and a rearwardly directed arm 245, the rear end portion of which is disposed against the same side of the corresponding drive gear 217 against which the forward extension 235 of the carrier arm 223 is disposed. A spring 246 is connected between the distal end of each forwardly directed latch lever arm 244 and a fixed spring attaching bar 247 extending transversely of the machine above, and substantially parallel to, the shaft 239, these springs urging the corresponding latch levers to rock, in a clockwise direction as illustrated in Fig. 4. Each rearwardly directed latch bar arm 245 has on its rearward end a downwardly directed detent 248 which drops into the notch 220 in the corresponding print drive gear wheel hub 219 to free the latch arm for clockwise rocking movement by the associated spring 246 to a position in which the latching detent 241 at the upper end of the upwardly directed arm 240 of the latch lever engages over the corresponding shoulder 237 on the carrier arm 223.

A latch releasing bail 250 extends through slots, as indicated at 251, in the intermediate frame plates 186 and 187 and across the upper edges of the forwardly directed arms 244 of the latch levers 238. The bail 250 is supported at its ends in the upper ends of a pair of arms, one of which is illustrated in Fig. 6 and designated at 252, pivotally mounted at locations spaced below the bail 250 on the intermediate frame plates 186 and 187, as indicated at 253 for the arm 252, so that the bail 250 can swing forwardly and downwardly or upwardly and rearwardly in the slots.

The arm 252, as shown in Fig. 6, is extended downwardly beyond its pivotal mounting 253 upon the intermediate frame plate 187 and is provided at its lower end with a laterally projecting abutment pin 254. A cam follower lever 255 is pivotally mounted intermediate its length on the transverse shaft 196 and has on its upper end a formation 256 in engagement with the forward side of the abutment pin 254. At its lower end the lever 255 carries a cam following roller 257 which rides on the peripheral edge of the zero foil cam 171 mounted on the cam shaft 135. The zero foil cam 171 is so shaped that during approximately the first 180 degrees of a machine cycle, during which time the actuator sectors 188 are undergoing their downward stroke, the bail 250 is held down on the forwardly directed arms 244 of the latch levers 238, holding the latch lever detents 241 out of engagement with the latching shoulders 237 on the print wheel carrier arms 223. This maintains the latch lever detents 248 out of the notches 220 in the print wheel drive gear hubs 219 and frees the drive gears for rotational movement. Near the end of the first half and beginning of the second half of the machine cycle, while the actuator sectors are being held in their limiting downward positions, the cam follower 257 rides into a low portion of the cam 171 and a tension spring 260 connected between the upper end of the bail supporting arm 252 and the machine frame raises the latch lever bail 250 away from the latch lever arms 244 and thereby conditions the latch levers to move into engagement with the corresponding shoulders 237 under the actuation of the corresponding latch lever springs 246.

During the downward stroke of the actuator sectors and while the latch levers 238 are held out of engagement with the notches 220 in the drive gear hubs 219 by the bail 250, those drive gears in alignment with selector sectors which have been manually set to numeral values will be rotated away from their "0" positions in a manner presently to be described. Then, when the actuator bail 192 approaches the end of its downward movement and the bail 250 is moved to release the latch levers 238, the notches in the drive gears which have been rotated from their "0" positions will be moved out of registry with the

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corresponding zero foil latch lever detents 248 and these detents will not be able to re-enter the corresponding notches 220 and will be held on the cylindrical peripheral surfaces of the corresponding hub formations 219. In that event the corresponding latch lever abutments 241 will be held out of engagement with the shoulders 237 of the corresponding print wheel carriers 221, leaving these carriers free to rock the print wheels 230 carried thereby toward the platen 242 during the printing operation, presently to be described.

The upwardly directed arm 240 of each latch lever 238 has near its upward end a forwardly directed projection 261, the outer end portion of which is laterally directed to the left, as viewed from the front of the machine, and overlies the outer end of the projection 261 on the next latch lever to the left, these forward extensions being omitted from the upwardly projecting arms of the first two latch levers at the right-hand end of the assembly. The arrangement is such that if any print wheel drive gear to the left of the first two gears at the right-hand end of the assembly is moved away from its "0" position, all of the latch levers to the right of such drive gear will be held by the zero foil projections 261 out of latching engagement with the corresponding shoulders 237 on the print wheel carrier arms 223, and the print wheels to the right of the indicated drive gear will be free to move in a printing operation. Since the drive gears to the left of the indicated drive gear have not been moved and still have their hub notches 220 in registry with the zero foil latch lever detents 248, and since the latch levers to the left are not restrained by the projections 261, these latch levers to the left of the indicated drive gear will be moved by their springs 246 into latching engagement with the corresponding shoulders 237 to hold the corresponding print wheels against printing movement, so that the printing mechanism will not print zeros to the left of the highest order of the numeral entry made into the machine by the keyboard and selection mechanism as previously explained.

When the actuator sectors have been returned to their upward position at the end of the machine cycle, the bail 250 will have been moved downwardly by the cam 171 to raise all of the latch lever detents 248 out of the corresponding notches 220 in the print drive gear hubs 219, thereby freeing the print wheel drive gears for rotational movement by the downward stroke of the actuator sectors during the first portion of the next operating cycle of the machine.

The manner in which a driving connection is provided between the actuator sectors 188, the print wheel drive gears 217 and the selector sectors 33 will be described in detail in the next following section dealing with the positive, pendant gear transmission mechanism.

(3) PRINTING OPERATION (Fig. 4)

The lever arm 224 of each print wheel carrier 221 is provided with a rearwardly directed extension, or tail portion, 263. A tension spring 264 is connected between the rear end of each rearward extension 263 and the machine frame, and is effective, when the print wheel carrier is released, to rock the corresponding print wheel carrier 221 about the shaft 222 in a direction such that the associated print wheel 230 is moved rearwardly to strike the adjacent, forward portion of the cylindrical surface of the platen 242.

A bail cross-member in the form of a rod 265 extends transversely of the machine below the rearward extensions 263 of the carrier levers 224 and is supported at its ends in the rearward ends of a pair of bail supporting arms, such as arm 266 shown in Figs. 4 and 7. At their forward ends the arms are pivotally mounted on the carrier supporting shaft 222 and the arm 266 is provided at a location spaced somewhat above, and forwardly of, the bail 265 with a laterally projecting stud 268 which preferably carries a sleeve or roller 269.

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A bellcrank lever 270 is pivotally mounted at its knee on the axle shaft 218 of the print wheel drive gears 217 and has the rearward, or distal, end of one of its arms 271 underlying the stud carried roller 269. The other arm 272 of this bellcrank lever extends downwardly and rearwardly from the shaft 218 and to a location opposite the cam shaft 135 and carries on its lower, or distal, end a cam following roller 273 which rides on the peripheral edge of the print cam 172.

The print cam 172 is so shaped that during the major portion of a machine cycle the bail 265 is supported in its upper limiting position in which it holds the lever extensions 263 upwardly and renders the springs 264 ineffective to move the print wheels 230 toward the platen 242. The cam 172 is provided with a recess 274 of restricted angular extent and having an abrupt leading edge and a sharply sloping trailing edge, into which the cam follower 273 drops during a time interval in which the actuator sectors 188 are retained at the end of their downward stroke, as described above. Such action of bellcrank 270 provides for sharply and momentarily moving the bail 265 downwardly away from the bottom edges of the carrier lever extensions 263 and enabling the springs 264 to rock the carriers 221 which have been freed from their associated latch levers 238 in a direction to strike the print wheels 230 against the platen 242. After the free print wheels have been moved to strike the platen 242, they are immediately returned to their home, or full-cycle, position by reason of the limited angular extent of the recess 274 in the printing cam 172.

A portion of the arm 223 of each print wheel carrier 221 is perpendicularly offset from the edge of the arm and arcuately curved longitudinally to overlie the portion of the corresponding idler gear 226 nearest the platen 242 to provide a dust shield 275 for the idler gear.

When a print wheel carriage 221 is rocked about the shaft 222 to move the corresponding print wheel 230 from its home, or full-cycle, position to its platen engaging position, the teeth of the corresponding idler gear 226 are moved out of mesh with the teeth of the associated print wheel drive gear 217, although they remain in mesh with the teeth of the associated print wheel gear 231. This unmeshing of the idler gear 226 and the drive gear 217 would leave the print wheel free to turn while it is positioned near the platen 242 if some means were not provided to lock the print wheel in its rotational position during this printing movement of the print wheel.

A print wheel locking pawl 278 is pivotally mounted intermediate its length on each print wheel carrier arm 223 by a pivotal connection 279 disposed forwardly of, and somewhat below, the corresponding print wheel axle pin 227. The locking pawl 278 is disposed in substantially upright position at the forward side of the associated print wheel and has on its upper end a hook formation 280, the end of which is double beveled to fit between any two adjacent printing bosses 233 projecting from the periphery of the associated print wheel. A tension spring 281 is connected between the lower end of the locking pawl 278 and the forward extension 236 of the arm 223 below the shoulder 237 and resiliently urges the locking pawl to rock about the pivotal mounting 279 in a direction to engage the end of the hook formation 280 thereof between adjacent printing bosses on the print wheel. At its lower end the pawl 278 is provided with a notch 282 of inverted V-shape and an actuating bar 283 extends transversely of the machine through the notches in the lower ends of all of the print wheel locking pawls 278.

The pawl actuating bar 283 is disposed in spaced parallel relationship to the drive gear axle 218 and is carried at its ends on the distal ends of the legs, such as arm 284 shown in Fig. 4, of a rectangularly-shaped bail 286 pivotally mounted on the axle shaft 218 and near the intermediate, or cross, portion 287 of the bail.

A cam following rocker arm 290 (Fig. 5) is pivotally

mounted intermediate its length on the drive gear axle shaft 218 at the outer side of the intermediate frame member 186 and is disposed in substantially upright position. A cam following roller 291 on the bottom end of the arm 290 rides on the peripheral edge of the tens-transfer cam 173 at the forward side of this cam. A tension spring 292 connected between the upper end of the rocker arm 290 and the machine frame, resiliently holds the cam following roller against the associated cam 173. A spacing pin 293 extending through a slot in the intermediate frame plate 186 connects the rocker arm 290 above the shaft 218 to the leg 284 of the bail 286 and a second spacing pin 294 connects a forward extension of the rocker arm 290 to the forward portion of the leg 284 of the bail 286.

The shape of the tens-transfer control cam 173 is such that the spring 292, which holds roller 291 against the peripheral edge of this cam, will hold the actuating bar 283 in such position, as illustrated in Fig. 4, relative to the lower ends of the locking pawls 278, that the pawls will be held out of engagement with the corresponding printing wheels until the actuator bail 192 nears the end of its downward stroke. At this time the roller 291 rides off of the lobe 295 of the cam 173 and frees the spring 292 to move the bar 283 in a direction to free the springs 281 to force the ends of the hook formations at the outer ends of the locking pawls 278 into engagement between the angularly spaced-apart printing bosses of the associated printing wheels. At the same time the actuator sectors are aligned and latched in position by means presently described, and immediately afterward the print control bail 265 is moved to free the springs 264 to swing the released print wheel carrying arms 221. As the print wheel carrying arms are swung, the print wheel idler gears 226 are moved out of mesh with the print wheel drive gears 217, but, as the idler gears are held against rotation by engagement of the pawls 278 with the print wheels and the actuator sectors and print wheel drive gears are latched against rotation, no relative rotation between the idler gears 226 and drive gears 217 takes place during printing. The print wheels are also held firmly against rotational movement during the printing movement of the print wheel carrying arms, as mentioned above.

When the printing operation has been completed and the print control bail 265 moved upwardly to restore the print wheel carrying arms 221 to their full-cycle position, a pin 296 on the actuator lead cam 175 (Fig. 5) engages an offset shoulder 297 near the lower end of arm 290 and rocks this arm back to the full-cycle position shown in Fig. 4, thereby moving the pawls 278 out of engagement with the print wheels and restoring the rotational freedom of the print wheels so that the print wheels which have been moved away from their "0" position can be restored to their "0" position on the upward stroke of the actuator bail 192. Shortly after the pin 296 has restored the arm 290, the roller 291 again rides onto the lobe of cam 173 and the arm holds the bar 283 in position to maintain the pawls 278 clear of the print wheels 230 until the next printing operation.

(4) ACTUATOR SECTOR ALIGNING AND LATCHING MECHANISM

While the idler gears 226 are out of mesh with the drive gears 217 it is also necessary to hold the drive gears against accidental rotation, so that the idler gears will remesh smoothly with the associated drive gears when the print wheels are returned from their printing to their full-cycle, or home, position. Locking of the drive gears 217 is accomplished by aligning and temporarily locking the actuator sectors 188 during the time that these sectors are retained at the bottom end of their downward stroke, and suitable mechanism for this purpose is illustrated in Fig. 8.

A plurality of bellcrank-shaped, sector locking pawls 298 are pivotally mounted in side-by-side, or ordinal,

arrangement on a pawl supporting shaft 299 which extends transversely of the machine rearwardly of and below the cam shaft 135 and is mounted at its ends in the intermediate frame plates 186 and 187. Each of the locking pawls 298 comprises an arm 300 extending forwardly from the mounting shaft 299 and having on its distal end an upwardly projecting detent 301, and an arm 302 extending downwardly from the shaft 299. A spring 303 is connected between the lower end of each pawl leg 302 and a bail mounting shaft 511 of the symbol printing mechanism, to be described later, and resiliently urges the pawl to rock about the shaft 299 in a direction to insert the corresponding pawl detent 301 between two adjacent teeth 189 of the actuator sector 188 in alignment with the particular pawl. A comb bar 304 of right-angular cross-sectional shape is disposed below, and transversely of, the shaft 299 and is mounted on the shaft for pivotal movement by arms, as indicated at 305, positioned one at each end of the comb. The comb has an upwardly extending leg 306 provided with spaced-apart notches, or slots, respectively receiving the legs 300 of the locking pawls 298 and a substantially horizontally disposed leg 307 having spaced-apart slots, or notches, receiving the downwardly extending legs 302 of the locking pawls. A cam follower lever 310 is mounted at one end on the shaft 299 at one end of the shaft and is drivingly connected to the comb 304. A cam following roller 311 is mounted on the forward end of the lever 310 and rides on the peripheral edge of the total taking cam 178.

When the roller 311 is disposed on the lobe of the cam 178, as shown in Fig. 8, the comb 314 is held in such position that the forward edges of the locking pawl legs 304 engage the inner edges of the corresponding notches in the bottom, or horizontal, leg 307 of the comb and the detents 301 of the locking pawls are held by the comb out of engagement with the teeth of the actuator sectors 188. The locking pawls are held out of engagement with the actuator sectors until the end of the downward stroke of the actuator sectors and are brought into engagement with the sector gear teeth at the end of the downward movement of the sectors by riding of the cam follower 311 off of the lobe of cam 178 to hold the sectors against movement below the positions determined by the corresponding selector sectors 33. In the upward movement of the actuator sectors, the sector teeth ratchet over the pawl detents 301, the cam follower 311 riding upon the lobe of cam 178 to withdraw the pawls from the actuator sectors near the end of the operating cycle of the machine. The locking pawls 300 are made separately, one for each actuator sector, so that the detents 301 thereof can drop into interdenal spaces of the corresponding actuator sectors as the sectors are brought into alignment at the positions in which they are stopped at the end of the downward stroke of the actuator bail 192, as described above.

When the movable selector sectors 33 (Fig. 2) have been brought back to their home position and stopped, the latch levers 208 (Fig. 3) connecting the actuator bail 192 to the respective actuator sectors 188 will yield, so that the bail can complete its downward movement with no further movement of the actuator sectors.

Just prior to the locking of the actuator sectors by the detents 301 of the pawls 300, the actuator sectors are brought into alignment at the end of their downward stroke by suitable aligning mechanism also shown in Fig. 8. This is necessary because the stop bar 27 for the home position of the selector sectors is so positioned that these sectors can move lightly beyond their normal home, or full-cycle, position in order to re-engage the noses 53 of the pawls 45 with the rearward ends of the zero latch dogs 50 when the selector sectors are returned to their "0" position by the downward stroke of the corresponding actuator sectors. This puts the actuator sectors and the print wheels driven thereby

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slightly out of their proper printing position and may leave the print wheels which have been released for printing out of accurate alignment across the print wheel orders.

The mechanism for accurately aligning the actuator sectors and the print wheels, when the sectors reach the end of their downward stroke and just before printing occurs, comprises a cam following rocker 312 pivotally mounted intermediate its length on a cam rocker pivot shaft 313 positioned below the actuator sectors 188 and substantially parallel to the cam shaft 135. At its forward end the rocker 312 carries a cam following roller 314 which rides on the peripheral edge of the actuator aligning cam 176. A spring 315 extends downwardly from the rearward end of the rocker, or lever, 312 and is connected at its lower end to the machine frame to resiliently maintain the roller 314 in engagement with the periphery of the cam 176. A bail 316 of right-angular shape has substantially parallel legs, as indicated at 317 in Fig. 8, spaced apart a distance slightly greater than the length of the actuator mechanism and disposed at the inner sides of the intermediate frame plates 186 and 187. At the open end of the bail these legs 317 are pivotally mounted on a shaft 319 carried by the actuator frame and extend downwardly and forwardly so that the intermediate, or cross-member, 318 of the bail is disposed immediately below the actuator sectors. The cross member 318 carries at its front edge an upwardly and forwardly directed stop rib 320 so positioned that its edge remote from the cross member 318 will engage in approximately aligned interdenal spaces of the actuator sectors 188 and bring these sectors into accurate angular or rotational alignment when the bail 316 is swung forwardly and upwardly about its pivotal mounting on the stop shaft 319.

An arm 321 of the rocker, or lever, 312 extends upwardly and rearwardly from the pivotal mounting of the lever 312 on the shaft 313 and is provided in its upper end with a notch 322. The lever 312 is positioned at the outer side of the intermediate frame plate 187 and this plate is provided with an aperture 323 at the upward end of the lever arm 321. A pin 324 extends from the bail leg 317 adjacent the plate 187 through the aperture 323 in this plate and is engaged in the notch 322 at the upper end of the lever arm 321 so that, when the forward end of the rocker arm 312 is forced downwardly by engagement of the lobe 325 of the cam 176 with the cam following roller 314, the bail 316 will be swung forwardly and upwardly to engage the leading edge of the rib 320 in interdenal spaces of the actuator sectors and bring these sectors into accurate alignment. As is apparent from the shape and relative position of the cams 176 and 178 in Fig. 8, the cam 176 acts first to bring the actuator sectors into alignment and immediately after the sectors have been aligned, the rocker arm 310 is released to move the comb bar 304 in a direction to release the locking pawls 300 so that these pawls may be actuated by their springs 303 into locking engagement with the actuator sectors.

Positive transmission gear mechanism

(Fig. 2)

The mechanism, as mentioned above, which drivingly connects the actuator sectors 188 to the selector sectors 33, comprises a positive transmission gear mechanism disposed between the actuator and selector sectors and generally indicated at 330 in Fig. 2. This gear mechanism 330 comprises a bail including parallel legs, as indicated at 331 in Fig. 2, spaced apart a distance somewhat greater than the length of the actuator mechanism and interconnected by a suitable cross-member 332 and the gear shafts 334, 335 and 336. A top cross-member or transmission shifting member 333 extends perpendicularly from the upper end of one leg above the top gear shaft

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and is used to shift the positive gear transmission mechanism, as shown in Fig. 7.

The bail provides a rigid cage, or carriage, for the transmission gears and the three gear shafts, or axles, 334, 335, and 336 extend transversely of the space between the bail legs 331 in spaced-apart and parallel relationship to each other and are mounted at their ends in the corresponding bail legs at locations spaced apart longitudinally of the legs. A plurality of transmission gears 337 are journaled on the upper gear shaft 334 in side-by-side, or ordinal, arrangement, the number of these gears being equal to the number of actuator sectors 188 and the gears being constantly in mesh with the corresponding actuator sectors and with the corresponding print wheel drive gears 217, as is shown in Fig. 4. A plurality of intermediate, or reversing, gears 338 equal in number to the number of selector sectors 33, are journaled in side-by-side, or ordinal, arrangement on the intermediate gear axle 335 and these gears mesh respectively with the gears 337. A plurality of gears 340 are journaled on the gear axle 336, also in side-by-side or ordinal arrangement, the number of these gears also equaling the number of selector sectors, the gears 340 meshing with the corresponding intermediate or reversing gears 338. The gears 337, 338 and 340 are preferably all ten-tooth gears of the same size with teeth of the size of the teeth on the selector sectors 33 and on the actuator sectors 188.

The upper gear axle 334 is extended beyond the legs of the gear carrying cage and is mounted at its ends in the intermediate frame plates of the machine so that the entire cage can swing about the axis of the axle 334, carrying with it the gear axles 335 and 336 and the gears 338 and 340.

In the addition and subtraction cycles of the machine, as will be later explained, the cage of the positive transmission mechanism is rocked by the cam 179 (Fig. 9) in a manner to bring the transmission gears 340 corresponding to the number of selector sectors which have been stepped to the left during the entry of the figure to be added or subtracted into the selector mechanism, into mesh with the corresponding selector sectors 33 during the first portion of the machine cycle in which the actuator segment bail 192 is given its downward stroke. During the downward stroke of the actuator bail, the actuator segments in alignment with the selector segments, which have been manually set and which are engaged or meshed with corresponding positive transmission gears 340, will be returned to their home, or "0," position at which they are stopped by the stop bar 27. During the downward movement of the corresponding actuator sectors, the print wheels 230 in alignment with these sectors are rotated by the corresponding gears 337, 217 and 226 to bring the numerals embossed on the print wheels, which correspond to the numbers for which the corresponding selector sectors are set, in position to impinge the platen 242 during the printing movement of the print wheels, as described above.

(1) SHIFTING MECHANISM FOR POSITIVE TRANSMISSION GEAR MECHANISM

(Fig. 9)

The positive, or add gear, mechanism 330 is moved into and out of operative engagement with the selector sectors 33 during the addition, subtraction, repeat-addition and print only cycles of the machine and is releasably latched in operative engagement with the selector sectors during the downward stroke of the actuator sectors by mechanism particularly illustrated in Figs. 7 and 9.

Referring first to Fig. 9, a V-shaped bellcrank arm 342 is pivotally mounted at its knee on the rocker arm pivot shaft 313 and has arms 343 and 344 extending from the pivotally mounted knee portion of the arm divergently relative to each other. A cam following roller 345 on the distal end of the arm 343 of this lever

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rides on the peripheral surface of the pendant gear operating cam 179 and the distal end of the other arm 344 of the lever 342 is pivotally connected to one end of a link 346. The link 346 extends upwardly and forwardly from its pivotal connection with the distal end of the bellcrank lever leg 344 and has on its upper end a hook formation 347 positioned to engage the upper edge of the shifting element 333 of the transmission gear mechanism 330. An extension 348 is forwardly directed from the link 346 intermediate the length of this link. A spring 349 is connected between the distal end of the extension 348 and the bellcrank lever leg 344 intermediate the length of this leg and resiliently urges the hooked upper end of the link 346 forwardly and out of position to engage the shifting element 333 of the gear mechanism 330. At a location spaced from the hook formation 347, the link 346 is provided with a shoulder formation 350 projecting in the same direction as the hook formation, with the distance between the opposed edges of the hook formation 347 and the shoulder formation 350 slightly greater than the width of the shifting element 333 so that this element can be received between these opposed edges.

A second link 351 is disposed alongside the link 346 and is pivotally connected at its lower end to the distal end of the bellcrank lever leg 344, this second link 351 having at its upper end a hook formation 352 but having no shoulder formation thereon corresponding to the shoulder formation 350 on the link 346.

Whenever the machine goes through an operative cycle, the cam 179 will, of course, be rotated through an angular distance of 360 degrees or one complete rotation, and brought to a stop. The bellcrank lever 342 will be rocked about its pivotal mounting on the shaft 313 each time the cam 179 is rotated, the cam followed 345 being resiliently maintained in engagement with the peripheral edge of the cam 179 by a suitable spring 357 connected to the bellcrank rocker arm 342.

A lever 353 pivotally mounted intermediate its length on the print mechanism drive gear shaft 218 extends upwardly and forwardly and downwardly and rearwardly from the shaft 218 and has its upper end engaged by an abutment pin 354 on the rearward end of a link 742 connected to the mechanism operated by the addition control key of the machine, so that forward movement of the pin 354 in response to a depression of the addition control key, as will be later explained, swings the lever 353 about its pivotal mounting on the shaft 218 to move the lower end of this lever rearwardly. At its lower end the lever is provided with an elongated slot, or notch, 355 which receives a pin 356 projecting laterally from the link 346 near the shoulder formation 350 on this link.

The lever 353 will be rocked in the manner indicated above not only upon depression of the addition key of the machine, but also upon depression of the repeat-addition key.

A second lever 358, also pivotally mounted intermediate its length on the shaft 218, is disposed alongside the lever 353 and is engaged at its upper end by an abutment pin corresponding to the abutment pin 354 projecting laterally from a link 359 extending rearwardly from the subtraction key mechanism so that the link 359 will be moved forwardly when the subtraction key is depressed, this link being also moved forwardly when the print-only control key of the machine is depressed. At its lower end the lever 358 is provided with a notch similar to the notch 355 slidably receiving a pin projecting laterally from the link 351.

When the addition control key or repeat-addition control key of the machine is depressed, the link 346 is swung by the lever 353 to a position in which the transmission shifting element 333 of the gear mechanism 330 is received between the hook formation 347 and shoulder formation 350 on this link. With the element 333 engaged by the link 346, as the cam 179 is rotated, the link 346 is pulled downwardly to swing the transmission gear

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mechanism in a direction to mesh its gears 340 with the gear teeth of the selector sectors when the lobe portion of the cam 179 passes under the cam following roller 345. This movement of the gear mechanism 330 connects the actuator sectors 188 with the corresponding selector sectors 33 for the downward stroke of the actuator sectors and limits the downward movement of the actuator sectors to the digital positions of the corresponding selector sectors.

After the actuator sectors have been moved downwardly to their terminal position, aligned and locked in position, as described above, the reduced portion of the cam 179 comes opposite the roller 345. Thereupon, the retracting spring 357 connected to the bellcrank lever 342 rocks the lever in a direction to move the link 346 upwardly, thereby swinging the shifting element 333 of the gear mechanism 330 upwardly to move the gears 340 out of mesh with the teeth of the selector sectors, back to a neutral position, and from the neutral position into mesh with the drive gears of an accumulator mechanism, presently to be described. Thus the entry value read out from the selector sectors by the actuator sectors on the downward movement of the actuator sectors and transmitted to the print wheels, will be transmitted to the accumulator on the upward, return stroke, of the actuator sectors.

In a similar manner the lever 358 moves the link 351 to a position such that the hook formation 352 of this link engages the upper edge of the transmission shifting element 333 of the positive gear transmission mechanism 330. When the cam 179 is rotated, the transmission mechanism 330 is first swung to bring the gears 340 thereof into mesh with the selector sectors before the downward stroke of the actuator sectors 188 of the machine. However, since the link 351 has no shoulder formation corresponding to the shoulder formation 350 on the link 346, the link 351 is not effective to move the gears 340 of the transmission mechanism 330 into mesh with the accumulator drive gears but only frees the transmission for a return to its neutral position when the cam following roller 345 rides onto the reduced portion of the cam 179.

(2) LOCKING MECHANISM FOR POSITIVE GEAR TRANSMISSION

(Fig. 7)

The mechanism for locking the positive gear transmission mechanism 330 in each one of its three positions, that is, its position in which its gears 340 are in mesh with the selector sector gear teeth, its neutral position and its position in which its gears 340 are in mesh with the accumulator drive gears, is shown in Fig. 7 and comprises a T-shaped locking bar 362 which inclines downwardly and forwardly from the cam shaft 135. The upper end of the bar 362 is notched out to slidably receive the cam shaft, and this notch is continued longitudinally of the bar at a reduced width to receive a guide pin 363 which insures rectilinear movement of the locking bar. A crosshead 364 on the lower end of the bar extends perpendicularly to opposite sides of the bar 362 and carries at its ends detents 365 and 366 which are directed from the crosshead back along the bar 362 toward the cam shaft 135. The leg 331 of the cage of the positive transmission gear mechanism is provided at its free end with a formation 367 of increased width having spaced-apart notches 368, 369 and 370 in the end of the formation 367, the portions of the formation between and at the outer sides of these notches being provided with inclined edges for camming the detent 365 into the notches.

A cam following rocker arm 372 is mounted at its lower end on the rocker arm pivot shaft 313 (not shown in Fig. 7 but seen in Figs. 8 and 11). The rocker arm 372 carries on its upper end a cam following roller 373 which rides on the peripheral edge of the transmission locking cam 170. A second lever arm 375 disposed in

spaced and almost parallel relationship to the lever arm 372 is also pivotally mounted at its lower end on the shaft 313 and is pivotally connected at its upper end to the slide, or locking bar, 362 by a suitable pivotal connection 376. The lever arm 372 is drivingly connected to the lever arm 375 by a bail, not shown herein, in a manner to permit the upper end of the lever 375 to follow the rectilinear movement of the locking bar 362 and a suitable spring, not illustrated, connected between the machine frame and the lever 372 maintains the cam following roller 373 against the peripheral edge of the cam 170.

The cam 170 has lobe portions 377 and 378 of restricted angular extent disposed in substantially diametrically opposite relationship to each other and effective, when in engagement with the cam following roller 373, to move the locking bar 362 outwardly to retract the detent 365 from the end of the formation 367 on the end of the leg of the positive transmission cage.

While the positive transmission gear mechanism 330 is being swung by the cam 179 to mesh the transmission gears 340 with the selector mechanism sectors, the lobe 377 of the cam 170 holds the detent 365 out of engagement with the end of the cage formation 367. As soon as the shifting of the transmission mechanism is complete, the roller 373 rides off of the cam lobe 377, permitting the detent 365 to engage in the notch 370 and hold the transmission gears 340 firmly in mesh with the gear teeth of the selector sectors. Near the end of the low portion of cam 170, the actuator sectors 188 will be at the end of their downward stroke, and the roller 373 will then ride up on the cam lobe 378, forcing the detent 365 out of the notch 370 and the transmission gear unit is then returned to its neutral position both by the cam 179 and by resilient centering means connected to the gear unit and presently to be described. If the positive transmission gear mechanism is stopped at its neutral position, when the roller 373 rides off of the cam lobe 378, the detent 365 is engaged in the center notch 369 in the free end of the leg 331 of the transmission cage. However, if the transmission gear mechanism is moved past its neutral position by the link 346, as described above, to engage its gears 340 with the drive gears of the accumulator mechanism, the detent 365, when released by the riding of the roller 373 off of the cam lobe 378, engages in the notches 368 to hold the gears 340 of the positive transmission mechanism firmly in mesh with the accumulator drive gears during the upward stroke of the actuator sectors.

The detent 366 on the end of the crossbar 364 remote from the detent 365 operates in a similar manner to lock a negative transmission mechanism in either its neutral, or its operative, position but this negative transmission is reserved for a later description in connection with the subtraction cycle and total taking cycles of the machine.

The mechanism which resiliently urges the positive pendant transmission gear mechanism 330 to its neutral position in which its gears 340 are clear of both the selector sectors 33 and the accumulator drive gears, is illustrated in Fig. 11 and generally indicated at 380. This mechanism comprises a pair of opposed jaws 381 and 382 pivotally mounted at corresponding ends on one end of the positive transmission gear shaft 334 and extending from the shaft 334 past the respectively opposite edges of the transmission shifting element 333 of the positive transmission cage. A stop pin 383 mounted on the adjacent frame plate, is disposed between the free ends of the jaws 381 and 382, when the gear train is in its neutral position. A tension spring 384 connected between the jaws at a location between the gear shaft 334 and the element 333 resiliently urges the jaws 381 and 382 toward each other and the free ends of the jaws against the stop pin 383 to hold the element 333 in its centered, or neutral, position. When the shifting element 333 is moved to one side or the other in consequence of rocking movement of the positive gear transmission mechanism in one direction

or the other from its neutral position, the corresponding jaw 381 or 382 is forced away from the stop pin 383, tensioning the spring 384, which then resiliently urges the jaw back to its position at rest against the stop pin 383 and urges the shifting element 333 back to its position corresponding to the neutral position of the transmission gear mechanism.

Accumulator mechanism

(Figs. 2, 12 and 14)

The accumulator mechanism of the adding machine is generally indicated at 390 and particularly illustrated in Figs. 2, 12, 13 and 14. This mechanism is provided as a unitary structure which is installed in the machine through an opening in the machine base 392. The frame includes left and right end plates 396 and 397, disposed in spaced-apart and parallel relationship to each other, and a plurality of separator plates 398 uniformly spaced apart between the end plates 396 and 397 and disposed in parallel relationship to each other and to the end plates. The end plates and the separator plates are provided with aligned apertures, including one series of aligned apertures near the bottom edges and the front ends of these plates, and one set of aligned apertures near the bottom edges and the rear ends of the plates. A supporting bar 400 of rectangular cross-sectional shape extends through the series of apertures near the front edges of the plates, while a similar bar 401 extends through the series of apertures near the rear edges of the plates. The bars 400 and 401 are secured to the base, or members rigid with the base, by suitable means, such as the screw fasteners 402.

A main axle shaft 405 extends transversely through the plate assembly intermediate the height of the plates and is secured at its ends in the end plates 396 and 397, projecting at its ends beyond the outer sides of these end plates. A plurality of accumulator gears 406 are mounted in side-by-side, or ordinal, relationship on the shaft 405 and are disposed, one gear in each space between the adjacent spacer plates 398, and one gear between each outside spacer plate and the adjacent side plate, there being eleven of these accumulator gears, or one more than the ten selector sectors, as described above. Each accumulator gear 406 has twenty gear teeth 407 uniformly spaced-apart around its periphery and a tens-transfer cam structure 408 is disposed against one side of each accumulator gear and rigidly secured to the gear for rotation therewith.

Each tens-transfer cam structure 408 comprises a bar extending diametrically of the associated accumulator gear. It has an enlarged and apertured center portion through which the shaft 405 extends, and double beveled end portions terminating in blunted points disposed in alignment with interdental spaces at diametrically opposite sides of the gear.

A drive gear shaft 410 extends transversely through the plate assembly above, and parallel to, the shaft 405, and this shaft 410 also extends at its ends outwardly of the outer sides of the end plates 396 and 397 of the plate assembly. Accumulator drive gears 411 are journaled in side-by-side, or ordinal, arrangement on the shaft 410, there being eleven of these gears, disposed one in each space between adjacent plates of the plate assembly and meshing with the corresponding accumulator gear 406. Each drive gear has ten gear teeth 412 so that it requires two rotations of a drive gear to complete one rotation of the associated accumulator gear.

A detent shaft 414 extends transversely through the plate assembly at the upper, width reduced end of the assembly. Detent pawls 415 are rockably mounted on the shaft 414 in ordinal arrangement along the shaft, there being one detent pawl for each of the accumulator drive gears 411. Each pawl has at one end a bearing portion 416 receiving the shaft 414 and at its other end a V-shaped detent formation 417 which engages in the

interdental space at the upper side of the associated drive gear 411 to hold the drive gear and corresponding accumulator gear against accidental rotation. Each pawl is resiliently held in movement resisting engagement with its associated drive gear by a tension spring 418 connected between the pawl at a location intermediate the length of the pawl and a tie rod 419 which extends transversely of the plate assembly below, and parallel to, the detent shaft 414.

With the above-described arrangement it will be apparent that, when the positive gear transmission 330 is rocked, as described above, to mesh its gears 340 with the accumulator drive gears 411 during the upward or return stroke of the actuator sectors 188, the drive gears 411 will be rotated in an additive, or clockwise, direction and will impart an opposite, or counter-clockwise, rotation to the associated accumulator gears 406.

Negative transmission gear mechanism

Means are also provided for rotating the accumulator gears in a negative or subtractive direction during the upward stroke of the actuator sectors. This means includes a negative, or subtractive, gear transmission assembly, generally indicated at 420.

The gear assembly 420 comprises a bail having parallel legs 421 spaced apart a distance at least as great as the length of the actuator mechanism and the accumulator mechanism and connected by a cross portion 422 extending transversely across the space between, and joined at its ends, to the legs 421. Spaced-apart and parallel gear shafts 423 and 424 are mounted at their ends in the bail legs 421 and extend across the space between these legs. A plurality of ten-tooth transmission gears 425 are mounted in side-by-side, or ordinal, arrangement on the shaft 423, while a plurality of similar, ten-tooth transmission gears 426 are mounted in side-by-side, or ordinal, arrangement on the shaft 424 and mesh with corresponding gears 425.

It will be noted that the positive gear transmission 330 has an odd number of gear sets, three such sets being shown in the accompanying drawings, while the negative gear transmission 420 has an even number of gear sets, two such gear sets being illustrated. This provides an arrangement wherein the positive gear transmission will rotate the accumulator drive gear 411 in one direction to add a positive, or additive, value to the accumulator while the negative transmission 420 will rotate the drive gears in the opposite direction to apply a subtractive, or negative, value to the accumulator.

The bail legs 421 of the negative transmission bail extend beyond the gear shaft 423 in a direction away from the gear shaft 424, the bail being mounted on a pivot shaft 427 (Fig. 7) which extends through the bail legs at the ends thereof at the side of the shaft 424 remote from the shaft 423. The ends of the shaft 427 are mounted in the intermediate frame plates 186 and 187 of the machine to provide a pivotal mounting for the negative gear transmission parallel to, but spaced from, both of the gear shafts 423 and 424. The negative transmission mechanism is rocked about its pivot shaft 427 by mechanism shown in Fig. 9 and comprising an arm 428 which projects perpendicularly from the subtraction control link 351 alongside of, and beyond the extension 348 of, the addition control link 346, the arm 428 having its distal end disposed in alignment with a projecting end of the gear shaft 423 of the negative transmission mechanism.

With this arrangement, the depression of the negative control key causes the hook formation 352 of the link 351 to engage the top shifting element 333 of the positive gear transmission. The rotation of cam 179, which follows immediately, pulls link 351 downwardly to rock the positive gear train in a direction to bring its gears 340 into mesh with the selector sectors before the downward stroke of the actuator sectors 188. This arrange-

ment also permits return of the positive gear transmission to its neutral position when the cam follower 345 on the rocker arm 342 rolls off of the lobe of the cam 179, movement of the rocker arm 342 by its retracting spring 357 being ineffective to move the shifting element 333 of the positive gear transmission cage in a direction to mesh the gears 340 of the positive transmission with the accumulator drive gears because of the absence of a shoulder formation on the link 351. However, the rocking of link 351 and its arm 428 (clockwise in Fig. 9) positions the arm 428 so that the distal end portion 429 of this arm engages the projecting end portion of the gear shaft 423, so that the subsequent upward movement of link 351 will rock the negative gear transmission 420 in a direction to mesh the gears 426 with the actuator sectors 188, the gears 425 then being in mesh with the accumulator drive gears.

One leg 421 of the negative gear transmission cage is provided on its free end with a terminal formation 480 (Fig. 7) of increased width and this formation is provided in its distal end with spaced-apart notches 481 and 482, the ends of the portions of the formation 480 at the sides of these notches being beveled to provide cam edges leading into the open, outer ends of the notches. During the cycling of the machine while a positive entry is being made into the accumulator or a positive total abstracted therefrom, the negative transmission unit remains in its neutral position and the detent 366 on the crosshead 364 of the locking bar 362 is moved into the notch 481 to hold the negative gear transmission against movement at the times the positive gear transmission is held in mesh with the selector sectors, in mesh with the accumulator drive gears, or in its neutral position. However, when a negative value is being entered into the accumulator or a negative total being taken therefrom, and the negative gear unit is swung into meshing engagement with the accumulator drive gears, the detent 366 is entered into the notch 482 in the formation 480 to hold the negative transmission gears in mesh with the actuator sectors and the accumulator drive gears during the upward, or return, stroke of the accumulator sectors.

The finger 428 (Fig. 9) is provided at its distal end with a laterally offset nose formation 429 which engages the adjacent end of the shaft 423 when the link 351 is moved by the cam following rocker 342 when the link 351 has been raised by operation of the subtract key, but which misses the end of the shaft 423 when the link 351 is moved by the rocker arm without first having been raised by operation of the subtraction key. Thus the negative gear transmission mechanism will not be rocked to operative position except when the subtraction key is operated or when a negative balance is to be read out of the accumulator, as will be later described.

The link shifting levers 253 and 358 are provided near their lower ends with forwardly directed nose or lug formations, as indicated at 430 for the lever 353. These lug formations rest at their distal ends on the upper surface of a fixed guide plate 431 which extends transversely of the machine immediately above the cam 179, and constitutes a portion of a bracket 434 which carries the shafts 196 and 218. The engagement of noses 430 with the guide plate 431 limits the movement of the lever arms 353 and 358 in a link retracting direction. The links 346 and 351 are provided near their upper ends with downwardly and forwardly extending guide fingers 435 and 436, respectively, which are guided in corresponding slots extending transversely of the plate 431.

From the above description it will be observed that the actuator sectors while undergoing their upward, return strokes, are effective to rotate the accumulator drive gears 411 in either a positive direction or a negative direction depending upon whether the positive transmission gear mechanism 330 or the negative transmission gear mechanism 420 is moved into driving engagement with the accumulator drive gears 411.

For a more convenient understanding of the subsequent description, it will be noted that, when looking at the accumulator mechanism from the right-hand side of the machine as in Fig. 2, the positive rotational direction of the accumulator drive gears 411 is clockwise and that of the associated accumulator gears 406 counter-clockwise and that the direction of negative rotation of the drive gears 411 is counter-clockwise and the direction of negative rotation of the negative accumulator gears 406 clockwise.

Tens-carrying mechanism of the accumulator

As in all mechanical accumulators, it is necessary to provide mechanism which becomes effective when any particular accumulator gear advances past its "9" and to its "0" position to advance the accumulator gear of the next highest order an angular extent corresponding to one gear tooth or a single unit space. This is a tens-transfer mechanism and in the accumulator of the present invention this mechanism is provided in two symmetrical parts located at diametrically opposite sides of the accumulator gears, so that it can accomplish its tens-transfer function in either a positive or negative rotational direction of the corresponding accumulator gears depending upon whether a positive or a negative entry is being stored in the accumulator.

Shafts 438 and 439 (Fig. 2) extend transversely of the accumulator plate assembly below the accumulator gears 406 and in spaced and parallel relationship to each other and the accumulator gear shaft 405. A number of bellcrank levers 440, equal in number to the number of accumulator gears 406, are pivotally or rockably mounted at their knees on the shaft 438 in side-by-side, or ordinal, arrangement. Each of these bellcrank levers has one arm 441 extending downwardly and rearwardly toward the complementary shaft 439 and terminating substantially midway between the shafts 438 and 439 and has an arm 442 projecting upwardly and forwardly from the shaft 438 and provided near its upper end with a rearwardly directed hook formation 443. Bellcrank levers 444 are rockably mounted at their knees on the shaft 439 in side-by-side, or ordinal, arrangement relative to each other and are also equal in number to the number of accumulator gears 406. Each lever 444 has a leg 445 extending upwardly and forwardly toward the shaft 438 and terminating medially of the distance between the shafts 438 and 439, it being noted that the distal ends of the lever arms 441 and 445 overlap between the lever supporting shafts 438 and 439. Each lever 444 also has a rearwardly directed leg 446 provided near its distal end and on its upper edge with an upwardly directed hook formation 447. Tension springs 448 extend between the hook formation 443 and 447, each spring being connected at one end to the hook formation 443 on a bellcrank lever 440 and at its other end to the hook formation 447 on the opposite bellcrank lever 444 and tending to resiliently rock the two bellcrank levers toward each other about their pivotal mountings on the shafts 438 and 439.

A tens-transfer, or feed, pawl 450 is pivotally mounted by a pivot connection 451 on the upper end of each bellcrank leg 442 and has an angularly-shaped arm 452 directed toward the aligned accumulator gear 406 and terminating at its distal end in a nose formation 453 which will engage a tooth of the aligned accumulator gear and rotate the corresponding gear through one unit space in a positive entry direction when the bellcrank lever 440 is rocked about the shaft 438 by the spring 448 in a direction such that the hook formation 443 moves toward the hook formation 447 of the opposite bellcrank lever 444. Adjacent the formation 453, the arm 452 is provided with a terminal shoulder 454 which engages a stop bar 455 extending transversely through the accumulator plate assembly and limits the rotational movement imparted to the accumulator gear by the formation 453 to a single unit space.

The axis of the stop bar 455 is in or adjacent to a plane including the axes of the accumulator gear shaft 405 and the bellcrank pivot shaft 438 intermediate the distance between the shaft 405 and the shaft 438 and this stop bar also serves as a tie rod to reinforce the accumulator plate assembly.

The pawl 450 in addition to the arm 452 includes a hook formation 456 which projects from the pawl radially of the pivotal connection 451 and in a forward direction and which is connected by tension spring 457 to a lug 458 projecting radially from the forward edge of the bellcrank arm 442 adjacent the shaft 438. The spring 457 resiliently urges the pawl 450 to rotate in a direction to raise the nose formation 453 into engagement with the teeth of the aligned accumulator gear 406 when the bellcrank 440 is rocked in a rearward direction by the spring 448. The pawl is also provided with a radially directed stop arm 459, the distal end of which engages a stop pin, or stud, 460 carried by the bellcrank arm 442 to limit rotational movement of the pawl 450 by the spring 457. The arm 452 of the pawl is provided intermediate the length of its upper edge with a latching shoulder 461.

Shafts 462 and 463 extend transversely of the accumulator plate assembly above the accumulator gear shaft 405 and near the front and rear edges, respectively, of the plate assembly. These shafts 462 and 463 are disposed in spaced and parallel relationship to each other and to the shaft 405, and the shaft 462 is above the shaft 438 while the shaft 463 is above the shaft 439.

A plurality of latch levers 465 are rockably mounted at their upper ends on the shaft 462 in side-by-side, or ordinal, arrangement relative to each other. These latch levers depend from the shaft 462 and each carries at its lower end an abutment formation 466 which engages the shoulder 461 on the corresponding feed pawl 450 and holds the pawl in retracted position with its nose formation 453 spaced from the corresponding accumulator gear 406. Each latch lever 465 has intermediate the length thereof, and at the side thereof nearest the accumulator gears 406, a rearwardly extending nose formation 467 which abuts against a stop bar 468 when the lever is in latching engagement with its associated pawl 450 to limit rocking movement of the lever about the shaft 462 in a direction toward the accumulator gears. A tension spring 469 connected between the lower end portion of the latch lever 465 and a tie rod 470 extending transversely through the accumulator plate assembly between the lower end of the latch lever 465 and the accumulator gear assembly, resiliently urges the latch lever to rock toward the gear assembly.

A live pawl, or actuating dog, 472 is disposed against one side of each of the latch levers 464 and is pivotally connected to the corresponding latch lever by a pivotal connection 473 located medially of the length of the latch lever. The actuating dog 472 is provided with an abutment formation 474 which projects radially from the pivotally mounted portion of the dog into the path of the outer end portions of the tens-transfer cam 408 carried by the corresponding accumulator gear. The actuating dog is also provided with a forwardly directed arm 475 connected near its distal end by a spring 476 to the upper end portion of the latch lever 465. The spring 476 resiliently urges the actuating dog 472 to rotate relative to the associated latch lever 465 until a stop arm 477 on the actuating dog is brought to bear against a stud 478 projecting laterally from the corresponding latch lever 465. The stop arm 477 bears against the side of the stud 478 remote from the accumulator gear assembly so that, when the accumulator gear 406 is rotating in a positive, or counter-clockwise, direction, as viewed in Fig. 2, and an end of the tens-transfer cam member 408 engages the abutment formation 474, applying pressure in a downward direction to this abutment formation, the actuating dog will not rock relative to the associated latch

lever 465. Thus, the latch lever will be forced to swing away from the accumulator gear assembly, releasing the abutment formation 466 on the lower end of the latch lever from the latching shoulder 460 on the associated feed pawl 450 to free the feed pawl for rocking movement of this pawl and the associated bellcrank 440 about the shaft 438 in a direction to move the nose formation 453 against a tooth of an aligned accumulator gear and rotate the gear one unit space in the positive or counter-clockwise, direction.

The spring-biased pivotal connection between the feed pawl 450 and the associated bellcrank 440 permits the bellcrank lever and the pawl carried thereby to be returned from a gear moving position to their home, or full-cycle, position, as illustrated in Fig. 2, without imparting any rotation in a reverse, or negative, direction to the associated accumulator gear. The spring-biased, pivotal connection between the actuating dog 472 and the associated latch lever 465 permits the end portions of the corresponding tens-transfer cam 408 to move past the abutment formation 474 of the actuating dog in a negative, or clockwise, direction without moving the associated latch lever 465 to release the corresponding feed pawl 450.

The nose formation 453 on each feed pawl 450 is offset laterally to the left from the abutment formation 474 of the actuating dog 472 mounted on the latch lever 465 holding the particular feed pawl, so that when the latch lever is released from its associated feed pawl by engagement of the tens-transfer cam 408 on the accumulator gear in alignment with the latch lever 465, the nose formation 453 will engage a tooth of the accumulator gear 406 of the next higher order. That is, tens-transfer pawl 450 is released by the latch 465 associated with the tens-transfer cam 408 of one order, and engages the accumulator gear immediately to the left of the gear carrying the tens-transfer cam which released the latch, so that the gear of the next higher order will be advanced one unit space in the positive or additive direction.

A subtractive tens-transfer, or feed, pawl 485 is pivotally mounted on each of the negative bellcrank levers 444 and urged by a tension spring 486 connected between a hook formation on the pawl and a lug on the bellcrank lever to a rotational position in which the stop arm 487 on the pawl engages the stop stud 488 on the arm 446 of the lever 444. Each feed pawl 485 carries a nose formation 489 effective when the arm 444 is rocked by the spring 448 toward the corresponding accumulator gear 406 to move the accumulator gear 406 engaged by the particular formation 489 one unit space in a negative, or clockwise, direction, as viewed in Fig. 2. Each feed pawl 485 is also provided with a terminal shoulder 490 which engages a stop bar 491 extending transversely of the accumulator plate assembly in spaced and parallel relationship to the stop bar 455 to limit swinging movements of the pawl 485 under the influence of spring 448 to an extent such that the nose formation 489 will move the corresponding accumulator gear one unit space only. The assembly of each negative bellcrank 444 and corresponding feed pawl 485 is identical with the corresponding positive assembly, which includes a bellcrank lever 440 and feed pawl 450. The spring-biased pivotal connection between the pawl 485 and the bellcrank 444 permits the pawl and bellcrank assembly to be returned to its home, or full-cycle, position after a gear rotating movement without imparting any rotational movement to the associated accumulator gear.

Negative latch levers 492 are pivotally mounted at their upper ends on the shaft 463 in side-by-side, or ordinal, relationship to each other and depend from the shaft 463 toward the corresponding feed pawls 485. Each latch lever 492 carries on its lower end an abutment formation 493 which engages with the latching shoulder on the upper edge of the corresponding feed pawl 485 to releasably hold the pawl in its home, or full-cycle, position re-

tracted from the corresponding accumulator gear. A tension spring 494 connected between each latch lever 492 near the lower end of the lever and a tie rod 495 extending transversely of the accumulator plate assembly, resiliently urges the latch lever to swing about the shaft 463 to its pawl latching position. A nose formation 496 directed forwardly from the forward edge of the lever 492, medially of the length of the lever, engages a stop bar 497 extending transversely of the accumulator plate assembly to stop the spring induced swinging movement of the latch lever 492 when the lever has been brought by the spring to its latching position.

A latch lever actuating pawl 498 is pivotally mounted on each latch lever 492 medially of the length of the latch lever by a pivotal mounting 499. A tension spring 500 connected between one end of the dog 498 and the upper end portion of the lever 492 resiliently urges the dog to rotate relative to the associated lever 492 until the stop arm 501 on the dog is brought to bear against the outer side of the stop lug 502 extending laterally from the upper portion of the latch lever 492.

The dog 498 carries an abutment formation 503 disposed in the path of the end portions of the tens-transfer cam member 408 carried by the corresponding actuator gear 406. The spring tension on the dog 498 is such that when the gear 406 is rotating in a positive, or counter-clockwise, direction, as viewed in Fig. 2, the ends of the tens-transfer cam will pass the abutment formation 503 and rock the dog relative to the associated latch lever 492 without moving the latch lever out of latching engagement with the corresponding feed pawl 485. However, when the accumulator gear is rotated in a negative, or clockwise, direction, as viewed in Fig. 2, engagement of an end of the tens-transfer cam 408 with the corresponding abutment formation 503 will tend to move the actuating dog 498 relative to the latch lever 492 in a direction in which movement is precluded by the stop arm 501 and stud 502, thereby swinging the latch lever about the shaft 463 in a direction to release the associated feed pawl 485 and free this pawl to impart a single step or unit space rotational movement to the adjacent higher order accumulator gear. The nose formation 489 of the negative gear moving assembly is laterally offset to the left from the position of its associated abutment formation 503, in the same manner as in the positive gear rotating assembly, so that, when the tens-transfer cam on one accumulator gear moves the aligned latching lever 492 to release the corresponding feed pawl 485 and bellcrank lever 446, the nose formation 489 will engage and impart a one-step, or unit space, rotational movement to the accumulator gear 406 of the next higher order.

With the above-described arrangement, the tens-transfer operation will be carried forward in either a positive or a negative direction, but in each case the tens-carry operation will be made from an accumulator gear passing through its "9" to "0" position to the accumulator gear of the next higher order immediately to the left of the gear passing through its "9" to "0" position.

The operation of the tens-transfer mechanism, as described above, is controlled by a bail, generally indicated at 505, the cross, or intermediate, portion 506 of which constitutes an actuating bar extending transversely of the accumulator plate assembly below the distal ends of the legs 441 and 445 of the bellcrank levers 440 and 444. The legs 507 and 508 of the bail 505 are pivotally mounted at the open end of the bail on a shaft 509 which is supported on the end plates 396 and 397 of the accumulator plate assembly parallel to, and forwardly of, the shaft 438. An angularly shaped lever 510 (Fig. 13) is pivotally mounted at one end on the intermediate frame plate 187 of the machine by a pivotal mounting 511 disposed rearwardly of, and below, the cam shaft 135. One arm 512 of this lever 510 extends forwardly from the pivotal connection 511 and is connected at its

forward end to the adjacent end of the bail 506 by a link 513.

A second arm 514 of the lever extends upwardly from the leg 512 near the free, or distal, end of the latter and terminates at a location above the tens-transfer actuating cam 173. A cam following roller 515 is carried on the upper end of the bellcrank arm 514 and rides on the peripheral edge of the cam 173. A tension spring 516 connected to the leg 512 and depending therefrom is connected at its lower end to the machine frame and resiliently urges the bellcrank lever 510 downwardly and the cam following roller 515 into engagement with the edge of the cam 173.

The bail 506 has three operative positions, including an intermediate position (shown in Fig. 2) in which it is slightly below the distal end portions of the bellcrank lever arms 441 and 445, so that, when any one of the feed pawls 450 or 485 is unlatched, the corresponding spring 448 will swing such feed pawl and its associated bellcrank lever about the supporting shaft 438 or 439 an angular extent such that the feed pawl cannot be related by the corresponding latch lever when the tens-transfer cam 408 moves past the abutment formation 474 or 493 which occasioned the unlatching of the feed pawl, a top position in which it is raised sufficiently above its intermediate position to restore any feed pawl which has been unlatched, and a home, or full-cycle, position in which it is disposed below its intermediate position a distance sufficient to permit the tens-transfer action to take place.

After being unlatched and moved to a position at which it cannot be related, the movement of the feed pawl and its carrying bellcrank lever is arrested by the engagement of the distal end portion of the corresponding bellcrank lever arm 441 or 445 with the bail rod 506, with the latter in its intermediate position, so that the tens-carrying operation is delayed until after the entry has been made into the accumulator, and the actuator sectors have returned to their home, or full-cycle, position.

The shape of the cam 173 and its rotational position on the cam shaft 135 is such that the bail 506 is held up in its intermediate position during the portion of the machine cycle in which the actuator sectors accomplish their downward and upward strokes and completely enter the selected value in to the accumulator.

Immediately after the actuator sectors have returned to their full-cycle position, the cam following roller 515 drops from the lobe portion into the recess 517 of the cam 173, moving the bail cross-member 506 downwardly away from the bellcrank lever arms 441 and 445 to its full-cycle position, thereby freeing those bellcranks and feed pawl assemblies which have been unlatched to simultaneously complete their tens-carrying operation under the power of the associated springs 448.

Cam following roller 515 does not ride out of the low portion 517 of the cam 173 before the end of the operating cycle so that the bail 506 is left in its lowered, or full-cycle, position when the operating cycle terminates. At the beginning of the next operating cycle of the machine, the cam following roller 515 rides up on the lobe portion 295 of the cam 173, first raising the bail rod, or cross member, 506 to its top position, somewhat above its intermediate position to restore all of the released bellcrank and feed pawl assemblies to their latched condition and to then lower the bail slightly to its intermediate position, as described above.

The mechanism for adding in the "fugitive 1" comprises the eleventh, or highest, order of accumulator gears and mechanism for stepping the lowest order gear one unit space in the proper direction whenever the highest order gear passes its positive zero location in its positive rotational direction, or its negative zero location in its negative rotational direction.

The mechanism referred to comprises positive and neg-

ative latch levers 465 and 492 (Figs. 2 and 12) rockably suspended from the shafts 462 and 463, respectively, at diametrically opposite sides of, and in alignment with, the eleventh order accumulator gear 406, and latch lever actuating dogs 472 and 498 pivotally mounted on the latch levers 465 and 492, respectively, and spring-urged to predetermined positions relative to the corresponding latch levers in the manner described above.

A positive transfer bail 520 (Fig. 2) extends transversely of the accumulator above the forward portion of the accumulator plate assembly and is secured at its left-hand end to the upper end portion of the positive latch lever 465 of the highest order of the accumulator and at its right-hand end to the upper end portion of the positive latch lever of the lowest accumulator order. A corresponding negative transfer bail 521 extends transversely of the accumulator above the rearward portion of the accumulator plate assembly and is secured at its left-hand end to the upper end portion of the negative latch lever 492 of the highest, or eleventh order of the accumulator, and at its right-hand end to the upper end portion of the corresponding negative latch lever of the lowest order of the accumulator.

When the eleventh order accumulator gear passes through its positive "0" position with a positive rotational direction, the adjacent end of the corresponding tens-transfer cam 408 engages the abutment formation 474 on the actuating dog of the positive latch lever 465 and rocks this latch lever. This rocking of the latch lever 465 rocks the corresponding bail 520 and the bail, in turn, releases the positive latch lever 465 of the lowest order from its associated feed pawl 450 so that the lowest order accumulator gear will be advanced one unit space near the end of the operating cycle when the bail cross-member 506 moves away from the bellcrank lever arms 441 and 445 in the manner described above.

Similarly, when the eleventh order accumulator gear passes through its "0" position with a negative direction of rotation, its tens-transfer cam rocks the associated negative latch lever 492 which, through the negative transfer bail 521, rocks the negative latch lever of the first order accumulator gear, thereby conditioning the tens-transfer mechanism of the first order to add a negative "1" to the lowest order accumulator gear near the end of the operating cycle, as explained above.

Algebraic sign sensing mechanism of the accumulator

Referring particularly to Figs. 12 and 14, a T-shaped blocking member, generally indicated at 523, is pivotally mounted near the cross-member, and centrally of the width thereof, on the right-hand end portion of the accumulator gear shaft 405 projecting outwardly of the right-hand end plate 397 of the accumulator plate assembly. This member 523 is provided on its pivoted end with a symmetrical crosshead 524, the opposite end portions of which are disposed perpendicular to the longitudinal center line of the member and extend substantially equal distances therefrom. The outer portions 525 and 526 of the crosshead are disposed perpendicular to the longitudinal center line of the center, or intermediate, portion thereof so that the outer portions have their greatest cross-sectional dimensions substantially in a plane including the axis of the accumulator gear shaft 405.

The blocking member is provided at its free, or distal, end with a symmetrical formation 527 of a width greater than the width of the intermediate portion of the member. The formation 527 is provided at its outer edges, or ends, with oppositely disposed cam edges 528 and 529 spaced substantially equal distances from the longitudinal center line of the member 523 and symmetrically convergent toward the axis of the shaft 405. Inwardly of the cam edges 528 and 529 the formation 527 provides shoulders 530 and 531 which are substantially parallel to the longitudinal center line of the blocking member and equally spaced from this center line.

The blocking member 523 has two operative positions, in one of which the shoulder 530 at the forward side of the blocking member engages the stop bar 455 to positively position the blocking member in the corresponding operative position. In the alternative operating position the shoulder 531 positively engages the stop bar 491 to positively position the blocking member in this alternative operative position.

The arm 441 of the bellcrank lever 440 of the lowest order of the accumulator is provided intermediate its length with an upwardly and rearwardly projecting arm 532. This arm is provided at its upper end with a laterally offset ear formation 533 which is engageable with the adjacent cam edge 528 of the blocking member 523 to rock the blocking member about its pivotal mounting on the shaft 405 to its operative position in which the shoulder 531 is stopped by the stop rod 491. An arm 534, similar to the arm 532, extends upwardly and rearwardly from the leg 445 of the bellcrank 444 of the lowest order of the accumulator. This arm 534 carries on its distal end a laterally extending ear formation 535 which is engageable with the adjacent cam edge 529 of the blocking member 523 to rock the blocking member about the shaft 405 to the operative position of the blocking member in which the shoulder 530 thereof engages the stop bar 455, this position being illustrated in Figs. 12 and 14.

It will be recalled that when the eleventh order accumulator gear passes through its "9" to "0" position in a positive direction, it rocks the positive latch lever 465 of the lowest order accumulator gear from the associated transfer pawl 450 thereby freeing the pawl 450 and the corresponding bellcrank lever 440 for rocking movement under the influence of the associated spring 448 when the bail cross-member 506 is retracted from the legs 441 and 445 of the levers 440 and 444. This rocking movement of the bellcrank lever 440 about its pivotal mounting on the shaft 438 will swing the blocking member 523 to its alternate operative position, in which the shoulder 531 engages the stop bar 491, as described above. Similarly, when the highest order accumulator gear moves through its negative "0" position in a negative rotational direction, it unlatches the bellcrank lever 444 of the lowest order of the accumulator. When this bellcrank lever swings in its accumulator gear rotating movement, the detent 535 on the distal end of the arm 534 engages the cam edge 529 of the blocking member 523 to move the blocking member to its operative position in which the shoulder 530 thereof engages the stop rod 455.

The position of the blocking member 523 in which the shoulder 531 engages the stop bar 491 will hereinafter be referred to as the positive blocking position of the blocking member, which is the position required for the taking of a negative (true credit balance total); and that position of the blocking member in which the shoulder 530 engages the stop bar 455 will be referred to as the negative blocking position of the blocking member, which is the position utilized for the taking of a positive total.

Detent means are provided for releasably latching the blocking member 523 in its positive and negative blocking positions. This mechanism comprises a bellcrank lever 536 (Fig. 12) pivotally mounted at its knee on the stop bar 491 and having one arm 537 extending past the outer side of the blocking member 523 and a second arm 538 extending rearwardly from the stop bar 491. The arm 537 is provided near its distal end with spaced notches 540 and 541. The intermediate portion of the blocking member 523 has a laterally directed extension 542 carrying a stud 543 which seats in the notch 541 when the blocking member is in its positive blocking position and in the notch 540 when the blocking member is in its negative blocking position. A tension spring 544 connected between the distal end of the bellcrank lever arm 538 and the adjacent end of the actuator

gear shaft 405 resiliently urges the bellcrank arm 537 down against the stud 543 so that the blocking member 523 is releasably latched in its positive or its negative blocking position.

5 A bellcrank lever 545 (Fig. 14) is pivotally mounted at its knee on a stud 546 carried at the upper forward corner of a lever arm supporting bracket 547 mounted on the machine base adjacent the right-hand end of the accumulator. A similar bellcrank lever 550 is mounted
10 at its knee on a stud 551 carried at the upper rear corner of the bracket 547 and is functionally opposed to the lever 545.

The positive total sensing lever 545 has an arm 552 extending from the stud 546 toward the stud 551 and terminating medially of the distance between these studs in a hook formation 553 directed downwardly and forwardly away from the cam shaft 135. The lever 545 has a second arm 554 disposed substantially perpendicular to the arm 552 and extending upwardly and rearwardly to a location at which its distal end is disposed forwardly and in alignment with the right-hand end of the positive transmission gear shaft 336 on which the transmission gears 340 are mounted.

The bellcrank lever 550 has one arm 555 extending
25 from the stud 551 toward the stud 546 and terminating medially of the distance between the studs in a hook formation 556 directed away from the cam shaft 135 and spaced from the hook formation 552 in a direction such that the distal end portions of the arms 551 and 555
30 overlap between the studs 546 and 551. The lever 550 has a second arm 557 extending rearwardly and upwardly substantially perpendicular to the arm 555 with its distal end overlapping the rearward side of the gear shaft 423 of the negative gear transmission mechanism 420.

35 A roller 558 is disposed between the hook formations 553 and 556 at the sides of the bellcrank lever arms 552 and 555 remote from the cam shaft 135. The crosshead 524 of the blocking member 523 is disposed between the bellcrank lever arms 554 and 557 intermediate the length of these lever arms. The positive and negative transmission gear shafts 336 and 423 are disposed between the distal end portions of the bellcrank lever arms 554 and 557. A tension spring 559, disposed between the blocking member crosshead 524 and the transmission gear shafts 336 and 424, is connected at one end to the bellcrank lever arm 554 and at its other end to the bellcrank lever arm 557 and resiliently pulls these lever arms one toward the other.

45 A link 560 is connected at one end to the roller 558 and carries at its other end a cam following roller 561 which is adapted to ride on the peripheral edge surface of the total cycle cam 177.

When the cam follower 561 is free to follow the contour of the cam 177 and drops from the lobe 562 into the restricted portion 563 of the cam 177, the roller 558 will
55 move in a direction away from the cam shaft 135, thereby freeing the bellcrank levers 545 and 550 to rock about their pivot studs 546 and 551 under the influence of spring 559 toward the corresponding transmission gear shafts
60 336 and 423. When the blocking member 523 is in its positive blocking position, as illustrated in Fig. 14, which is the position assumed by the member 523 when the accumulator registers a negative total, or overdraft, and the total will be printed as negative (true credit balance), the end of the crosshead 524 of this member nearest the bellcrank lever arm 554 will engage an abutment formation 564 on the rearward, or inner, edge of this lever arm and stop the movement of the lever arm before it engages the positive gear transmission gear shaft 336. The end
70 of the crosshead 524 nearest the lever arm 557 will, however, be spaced from the corresponding abutment formation 565 on the forward, or inner, edge of the bellcrank lever arm 557, so that this lever arm can move into engagement with the negative gear transmission gear shaft 423 and move the negative gear transmission to its oper-

ative position in which it provides a driving connection between the actuator gear sectors 188 and the accumulator drive gears 411, as described above.

When the blocking member 523 is in its negative blocking position for the taking of a positive total, it holds the bellcrank lever 557 against moving the negative gear transmission shaft 424, but frees the bellcrank lever arm 554 to engage the positive gear transmission shaft 336 and move the positive gear transmission mechanism to a position at which it provides a driving connection between the actuator gear sectors and the accumulator drive gears.

Thus, when the balance in the accumulator is positive in nature, the positive gear transmission mechanism will be connected between the actuator sectors and the accumulator drive gears to read out the positive accumulator total and transmit this total to the printing mechanism; whereas, if the balance in the accumulator is negative, the negative gear transmission mechanism will be activated to provide the driving connection between the actuator sectors and the accumulator drive gears to read out the negative total in the accumulator in the proper direction and transmit this total to the printing mechanism through the actuator sectors and the set of gears 337 of the positive gear transmission mechanism, as described above.

Accumulator conditioning mechanism for total and subtotal printing

The accumulator gear blocking means operated by the total sign sensing mechanism, as described above, comprises two bails: a positive blocking bail, generally indicated at 568, Figs. 12 and 14, the legs of which are pivotally mounted at their distal ends on the ends of the shaft 462 and the cross, or intermediate, portion 569 of which extends across the length of the accumulator immediately above the abutment formations 474 of the latch lever actuating dogs 472; and a negative blocking bail, generally indicated at 570, the legs of which are pivotally mounted at their distal ends on the shaft 463 near the ends of this shaft and the intermediate portion 571 of which extends across the length of the accumulator mechanism immediately above the abutment formations 503 on the actuator dogs 498 for the negative latch levers 492.

The leg of the bail 568 at the right-hand end of the accumulator mechanism is provided with an upwardly and rearwardly extending cam arm 572. A cam actuating roller 573 is mounted on the leg 554 of the positive bellcrank lever 545 in position to engage the cam arm 572 when the lever arm 554 is swung rearwardly and downwardly to engage the adjacent end of the positive gear transmission gear shaft 336 to move the positive transmission gear mechanism into operative association with the accumulator drive gears, as described above. The right-hand leg of the bail 570 is provided with an upwardly and forwardly projecting cam arm 574 and the arm 557 of the negative bellcrank lever 550 carries a cam following roller 575 which rides on the outer edge of the cam arm 574 and rocks the bail 570 downwardly when the bellcrank lever arm 557 is moved to engage the gear shaft 424 of the negative gear transmission mechanism and move the negative gear transmission mechanism into an operative connection with the accumulator drive gears.

When the blocking T-member 523 of the total sign sensing mechanism, described above, is in position to free the positive bellcrank lever 545 for rocking movement about the pivot stud 546 to move the positive gear transmission mechanism into operative connection with the accumulator drive gears, and the bellcrank lever 545 is so rocked in response to a total printing cycle of the machine. The cam following roller 573, riding on the outer edge of the bail cam arm 572, rocks the bail 568 about its mounting on the shaft 462 to bring the edge of the bail cross-member 569 remote from the pivotal mounting into engagement with the upper edges of the abutment formations 474 of the actuating dogs 472 of the positive latch levers 465. This holds the abutments 474 against rocking

upwardly against the force of the corresponding springs 476 when the ends of the tens-transfer cams 408 are brought against the undersides of these abutments during a total or subtotal printing operation. The bail 570 is similarly rocked by the action of the cam following roller 575 carried by the arm 557 of the negative bellcrank lever 550 so that the edge of the cross-member 571 of this bail engages the upper edges of the abutment formations 503 and holds these abutment formations against upward movement.

With the abutment formations 474 held against upward movement by the bail 568, when the accumulator gears are rotated upon the downward stroke of the actuator gear sectors through the positive gear transmission mechanism which is now in operative engagement with the accumulator drive gears, as soon as the accumulator gears have been returned to their positive "0" positions, the ends of the corresponding tens-transfer cams 408 nearest the abutment formations 474 will be brought against the undersides of these blocked abutment formations and rotation of the accumulator gears will be positively terminated. This leaves the actuator sectors in angular position determined by the initial angular position of the several accumulator gears in accordance with the positive total carried in the accumulator and leaving the print wheels in angular position to accurately print the total so taken from the accumulator.

Similarly, when the blocking T-member 523 of the total sign sensing mechanism is in position to free the negative bellcrank 550 for rocking movement under the influence of the spring 559 to swing the negative gear transmission mechanism into operative engagement with the accumulator drive gears, and the negative bellcrank is so swung or rocked in response to a total or subtotal taking cycle of the machine, the blocking bail 570 will be rocked by the cam follower 575 acting on the cam arm 574 to lock the negative abutment formations 503. Thereupon the rotation of the accumulator gears in a negative direction by the downward movement of the actuator bail and actuator sectors will be terminated when the ends of the tens-transfer cams adjacent the abutment formations 503 come into engagement with the bottom surfaces of these abutment formations. This leaves the actuator sectors in angular position corresponding to the rotational movements of the several accumulator gears from their total carrying position to their negative "0" position at which they are stopped, and leaving the print wheels 230 in angular position to print the correct negative total carried by the accumulator.

Since the accumulator gears are rotated with equal facility in either the positive or negative direction, and since the "fugitive 1" is added, when required, to both the positive and negative totals in the accumulator, the accumulator will always carry the true positive or negative total. This true total is accurately read out from the accumulator by the selector sectors through the intermediacy of the positive or negative gear transmission mechanism and transmitted to the print wheels for accurate printing of the true total carried by the accumulator.

At the end of a positive subtotal or total taking operation, the bail 568, when released by the cam following roller 573 on the bellcrank lever arm 554, is returned to its home, or full-cycle, position by a tension spring 579 (Fig. 12) connected between the righthand bail leg near the distal end of this leg and a frame structure 576 of rectangular shape mounted on the accumulator plate assembly between the accumulator gear shaft 405 and the accumulator drive gear shaft 410 and extending longitudinally and transversely of the accumulator. This frame structure has an opening of rectangular shape therein through which the reduced width, upper end portions of the accumulator end and spacer plates extend to support the drive gear shaft 410 and the accumulator drive gears 411.

For convenience in manufacture, the frame structure 576 is placed loosely on shoulder formations of the accumulator plate assembly and is held in operative position by suitable springs, as indicated at 577, connected between the corners of the frame structure and the projecting ends of the tie rods 470 and 495.

The bail 570 is similarly urged to its retracted position by a tension spring 578 connected between the right-hand leg of the bail and the frame structure 576. The retracting movements of the bails are terminated by engagement of the bail cross-members 569 and 571 with the edges of openings in the accumulator end and spacer plates through which the cross-members of the bail extend.

Control key mechanism (control keys)

(Figs. 1, 15, 16, 17 and 18)

The control key mechanism includes seven manually operable keys, namely:

Addition key-----	580
Subtraction key-----	581
Total key-----	582
Subtotal key-----	583
Repeat addition key-----	584
Print only key-----	585
Keyboard clear key-----	586

The control keys 580, 581 and 585 at the right-hand side of the keyboard 10 are mounted for vertical movement on the right-hand frame side plate 14 and the control keys 584 and 586, together with the "0" key 18, at the left-hand side of the keyboard, are mounted for vertical movement on the left-hand intermediate frame plate 13. The total and subtotal keys 582 and 583, disposed in front of the keyboard, are slidably mounted on a shaft 589 extending between the frame plates 13 and 14 near the forward ends of these plates.

The addition key 580 (Fig. 15) is positioned near the forward, right-hand corner of the keyboard and comprises an elongated flat stem 590 disposed against the inner side of the plate 14 and topped by a head, or block, 591. A spring 592 connected between the lower portion of the key stem 590 and the upper portion of the key supporting structure, resiliently urges the key 580 to its upper limiting position.

The subtraction key 581 is disposed immediately rearwardly of the addition key 580 and has an elongated, flat stem 593 disposed against the outer side of the plate 14 and topped by a head, or block, 594. The stem 593 is provided at locations spaced apart therealong with closed slots 595 and 596, and headed studs, or screws, 597 and 598 extend respectively through these slots and are secured to the plate 14 to support the key stem for vertical sliding movement.

A spring 599 connected between stud 702 on a forwardly directed projection 600 on the key stem 593 and the upper portion of the key supporting structure resiliently urges the subtraction key 581 to its upper limiting position.

The print-only key 585 is disposed immediately rearwardly of the subtraction key 581, and this key also has a flat stem 601 disposed against the outer side of the plate 14 and topped by a head, or block, 602. The stem 601 is provided at locations spaced apart therealong with longitudinally extending slots 603 and 604 through which headed studs, as indicated at 612, corresponding to the studs 597 and 598, extend and are secured to the plate 14 to support the key 585 in upright position for vertical movement. A tension spring 605 connected at one end to a cam follower 606 mounted on a forward extension of the stem 601 intermediate the length of the stem, and connected at its other end to the upper portion of the key supporting structure, resiliently urges the print-only key 585 to its upper limiting position.

The keyboard clear key 586 (Fig. 16) is disposed at the left-hand side of the keyboard, immediately rearwardly

of the "0" key 18 and has a flat, elongated stem 607 disposed at the outer side of the plate 13 and provided at locations spaced apart therealong with longitudinally extending slots 608 and 609 through which headed studs, or screws, 610 and 611, respectively, extend and are secured to the plate 13 to support the key 586 in upright position for longitudinal sliding movement. The stem 607 is topped by a head, or block, 614 (shown in Fig. 1), and a spring 615 connected between a stud 616 on the key stem adjacent the upper end of the lower slot 609 and the headed stud 610, resiliently urges the key 586 to its upper limiting position.

The repeat addition key 584 is disposed immediately rearwardly of the keyboard clear key 586 at the left-hand side of the keyboard, and has a flat, elongated stem 618 (shown in Figs. 1 and 16) disposed against the outer side of the plate 13 and provided intermediate its length with a downwardly extending, forwardly directed, offset stem 619. This stem is provided with an upper slot 620 through which a headed stud 621 extends and is secured to the plate 13. The stem 618 is also provided in the forwardly offset lower portion 619 thereof with a lower slot 622 through which a headed screw, or stud, 623 extends and is secured to the plate 13, the studs 621 and 623 supporting the stem 618 in upright position for longitudinal movement. At its upper end the stem 618 is topped by a head, or block, 624 (Fig. 1) and a tension spring 625 connected between a stud 626 mounted on the stem 618 adjacent the forwardly directed offset in the stem and the fixed upper stud 621 resiliently urges the key 584 to its upper limiting position.

The total and subtotal keys 582 and 583 (Fig. 17) are disposed adjacent the front end of the keyboard between the addition key 580 and the "0" key 18, with the total key to the right and the subtotal key to the left. The total key 582 has an elongated, flat stem 628 provided near its upper end with a longitudinally extending slot 629 (Fig. 1) which receives the shaft 589 and this stem is topped by the total key head, or block, 630. The stem 628 is guided at its lower end by a guide finger depending from the lower end of the stem and slidably received in an aperture in the transversely extending guide bar. A tension spring 631 connected between a forward projection 632 near the lower end of the total key stem and the upper portion of the key supporting structure, resiliently urges the total key to its upper limiting position.

The subtotal key 583 has an elongated, flat stem 634 disposed substantially parallel to the total key stem 628 and also provided with a longitudinally extending notch receiving the shaft 589 and a guide finger at its bottom end slidably received in an aperture in the guide bar to support this key stem in upright position for longitudinal movement. A spring corresponding to the total key spring 631, resiliently urges the subtotal key to its upper limiting position and the subtotal key stem 634 is topped by a head, or block, 635.

As shown in Figs. 1, 15, 16 and 17, a shaft 638 extends across the space between the front lower corners of the frame plates 13 and 14 and is journaled at its ends in these plates. An arm 639 is secured at one end to the right-hand end of the shaft 638 and extends upwardly from the shaft, and a similar arm 640 is secured at one end to the left-hand end of the shaft 638 and also extends upwardly from the shaft, the arms 639 and 640 being substantially parallel to each other and rockable together about the axis of the shaft 638.

The control link 168 is pivotally connected at its forward end to the upper end of the right-hand arm 639 and extends rearwardly of the machine to a pivotal connection at its rear end with the control pawl 155 for the clutch mechanism. The extension 169 of this link extends rearwardly of the machine from the pivotal connection with the control pawl 155 to the motor controlling switch 139, as described above in connection with Fig. 1. At the location of the subtraction key stem 593, the link 168 is

provided with an upwardly directed extension 643, having on its rearward edge a downwardly and rearwardly directed cam surface engaged by a cam roller 644 carried by the subtraction key stem 593, so that the link 168 will be shifted in a forward direction relative to the machine when the subtraction key 581 is depressed.

A second cam extension 645 is directed upwardly from the link 168 between the subtraction key stem 593 and the print-only key stem 601, and this extension has on its rearward edge an upwardly and forwardly inclined cam surface engaged by a cam roller 606 on the forward extension 646 of the print-only key stem 601, so that the link 168 is moved forwardly when the print-only key is manually depressed. Forwardly of its cam surface the extension 645 is provided with a shoulder 647 which moves under the cam roller 644 of the subtraction key and blocks depression of the subtraction key when the link 168 is moved forwardly by depression of any control key other than the subtraction key. A third extension 648 is directed upwardly from the link 168 alongside the print-only key stem 601. The flat upper end of this extension constitutes a shoulder 649 which moves under the print-only key cam roller 606 and blocks the print-only key against depression when the link 168 is moved forwardly by depression of a control key other than the print-only control key 585.

A yoke 650 projects upwardly and forwardly from the shaft 638 at the inner side of the plate 14 and is bifurcated at its upper end to provide an elongated notch, or slot, 651 which slidably receives a stud 652 projecting laterally from the stem 590 of the addition key 580. The forward edge of the slot 651 is rearwardly and downwardly inclined, so that depression of the addition key will rock the yoke 650 and turn the shaft 638 in a direction to move the link 168 forwardly to engage the clutch 150 and close the motor switch 139. The rearward prong 653 is shorter than the forward prong of the yoke and, when the link 168 is moved forwardly by depression of a control key other than the addition key 580, the distal end of the rearward prong 653 moves under the stud 652 on the addition key and blocks downward movement of the addition key.

A yoke 655, similar to the yoke 650, extends upwardly and forwardly from the shaft 638 alongside the stem 628 of the total key 582 and has a bifurcated upper end providing an elongated notch, or slot, 656 which slidably receives a cam stud 657 mounted on, and projecting laterally from, the total key stem 628, so that the yoke 655 will be rocked to turn the shaft 638 and move the link 168 when the total key is manually depressed. The rearward prong 658 of the yoke 655 is shorter than the forward prong of the yoke and, when the yoke is rocked by depression of a control key other than the total key 580, the distal end of the rearward prong 658 moves under the cam follower stud 657 and blocks depression of the total key.

A third yoke 660, similar to the yokes 650 and 655, extends upwardly and forwardly from the shaft 638 alongside the subtotal key stem 634 and has a bifurcated upper end providing an elongated notch receiving the yoke operating stud 661 projecting laterally from the subtotal key stem. This yoke also has a shortened prong at the rearward side of the notch therein to engage under the stud 661 and block the subtotal key against depression when the shaft 638 is rocked and the link 168 moved forwardly by depression of a control key other than the subtotal key.

A control link 663 disposed at the outer side of the plate 13 is pivotally connected at its forward end to the upper end of the arm 640 and is provided at its rearward end with a longitudinally extending slot 664 slidably receiving a shaft 665 which extends transversely of the space between the plates 13 and 14 at the rearward end of the control key assembly and is disposed in spaced and parallel relationship to the shaft 638.

The link 663 is provided with an upwardly directed extension 668 alongside the stem 607 of the keyboard clear key 586. The rearward edge of this extension is upwardly and forwardly inclined to provide a cam surface engaged by a cam stud 670 carried by, and projecting laterally from, the key stem 607 to move the link 663 forwardly when the keyboard clear key 586 is depressed. The link 663 is provided with a second upwardly directed extension 672, the rearward edge of which is upwardly and forwardly inclined to provide a cam surface engaged by a cam stud 673 carried by, and projecting laterally from, the stem 618 of the repeat addition key 584, so that the link 663 will also be moved forwardly when the repeat addition key is depressed.

When the link 663 is moved forwardly, it rocks the lever arm 640, shaft 638 and lever arm 639, to move the link 168 forwardly and engage the power cycle clutch and close the motor switch in the manner described above.

The notches in the clutch control link, or slide bar, 168 receiving the stud 644 on the subtraction key stem 593 and the stud 606 on the print-only key stem 601 and the notches in the yokes 650, 655 and 660, respectively, receiving the stud 652 on the addition key stem 590, the stud 657 on the total key stem 628 and the stud 661 on the subtotal key stem 634, are all upwardly and forwardly inclined so that when the slide 168 is moved forwardly by depression of the subtraction key or the print-only key or when the yokes are rocked forwardly by depression of the addition key, the total key or the subtotal key, the key which was manually depressed will be held down by engagement of its clutch operating stud in the corresponding slide bar, or yoke notch, until the cam shaft 135 has completed a rotation and the slide bar is released by the registry of the depression 158 in the clutch cam plate 157 with the cam following roller 159 on the clutch control pawl 155, as described above, the slide bar being moved and the yokes being rocked rearwardly to their home, or full-cycle, position by the spring 164 and releasing the depressed key at the end of the machine operating cycle.

Addition cycle

A bellcrank lever 750 (Fig. 15) of substantially right-angular shape is pivotally mounted at its knee on a stud 751 secured to the right-hand side plate 14. This lever has a leg 752 directed forwardly from the stud 751 and having its forward end portion underlying the stud 652 carried by the addition key stem 590, so that the lever 750 will be rocked in a counter-clockwise direction, as viewed in Fig. 15, upon depression of the addition key. The arm 753 of the lever 750 rises vertically from the stud 751 and is pivotally connected at its upper end to the forward end of the addition key link 742 which extends rearwardly from the upper end of the lever arm 753 past the upper end of the addition lever 353 (Fig. 9) mounted on the print drive gear shaft 218. The link carries at its rearward end the stud 354, the link and bellcrank being resiliently urged in a rearward direction by a spring 755 (Fig. 15) connected between the lever arm 753 and a fixed stud 756. Intermediate its length, the link 742 is provided with a longitudinally extending slot 754 which slidably receives a stud 743.

When the addition key 580 is depressed, it rocks the yoke 650 to move the clutch actuating and switch closing link 168 forwardly to engage the machine clutch and close the motor switch, as described above, and rocks the bellcrank lever 750 to move the link 742 forwardly. Engaging the clutch and closing the motor switch starts the cycle of the machine cam shaft 135 and forward movement of the link 742 swings the lever 353 (counter-clockwise in Fig. 9), about its pivotal mounting on the shaft 218 to raise the link 346 and dispose the shifting element 333 of the positive gear transmission mechanism between the hook formation 347 and the shoulder 350 at

the upper end of the link 346. Now, as the cam shaft 135 rotates, the cam 179 will rock the V-shaped cam following lever 342 to move the link 346 first downwardly and rearwardly to bring the lower set 340 of positive transmission gears into meshing engagement with the teeth of any selector sectors 33 that may have been stepped to the left of the position of the left-hand end of the shiftable selector mechanism when the latter is in its home, or full-cycle, position. As soon as the positive transmission gear mechanism has been moved into engagement with the selector sectors, the transmission latching cam 170, as shown in Fig. 7, will move the latch bar 362 to engage the detent 365 in the notch 370 at the free end of the positive transmission gear cage to positively hold the positive transmission gears in mesh with the selector sectors while the value which has been entered into the selector sectors is set into the actuator sectors 188.

Immediately after the positive gear transmission has been latched in mesh with the selector sectors, the actuator lead cam 175 (Fig. 5) acts on the cam follower 206 of the yoke 195 to move the actuator sectors downwardly. Those actuator sectors to the left of the leftmost selector sector will be held against movement by reason of the engagement of the locking bar 385 (Fig. 2) extending to the left of the shiftable selector unit with the corresponding gears of the positive gear transmission, while those actuator sectors in mesh with corresponding selector sectors will be moved downwardly until the selector sectors are rotated back to their "0" positions, at which time the corresponding actuator sectors will be stopped. The releasable connections between the actuator bail 192 and the actuator sectors are released upon holding, or stopping, of the actuator sectors, permitting the bail 192 to complete its downward movement. Then, at the end of the downward movement of the bail, the actuator sectors are first aligned in position by the aligning bail 320 (Fig. 8) actuated by the cam 176, and are then locked in position by the locking pawls 300 actuated by the cam 178.

During the downward movement of the actuator sectors in mesh with corresponding selector sectors, these actuator sectors will have moved the corresponding print wheels through the gear trains, as illustrated in Fig. 4. These gear trains include the corresponding positive transmission gears 337, the print wheel drive gears 217 and the print wheel idler gears 226, so that the print wheels will be set for printing the value which has been entered into the digitation mechanism, as described above. The print wheels to the left of those which have been rotated to printing position by the corresponding selector sectors are held in nonprinting position by the zero foil mechanism previously described. Also, when the actuator bail reaches the end of its downward movement, the differentially set selector sectors will have been returned to their "0" position and latched in this position by their zero latches.

After the print wheels have been brought to proper printing position and the actuator sectors locked in position to hold the print wheels against rotational movement, the printing bail 265 is dropped by action of the cam 172 on the cam following bellcrank lever 270, as shown in Fig. 7, thereby permitting the print wheels which have been unlatched by rotation of the associated print wheel drive gears 216 to strike the platen 242 and print the value on the paper tape carried around the platen.

The actuator sectors are retained in their actuated position and locked against rotational movement until the print wheels have been returned to their engaged position in which idlers 226 again mesh with gears 217, by rising of the print bail 265. Before the actuator sectors are released by their latches 300, the cam 170 unlatches the positive gear transmission mechanism and the cam 179 swings the positive gear transmission mecha-

nism from its position meshing with the selector sectors, to its position meshing with the accumulator drive gears 411. Thereupon cam 170 (Fig. 7) again operates the latching link 362 to lock the positive gear train 330 in its adjusted position, this time tooth 365 engaging slot 368. The actuator sectors are now released by cam 178 operating latches 300 and the trail cam 174 acts on the cam follower 205 carried by the yoke 195 to return the actuator bail 192 to its uppermost position, the upward movement of this bail returning all of the actuator sectors upwardly to their home, or full-cycle, position, as previously described.

This upward movement of the actuator sectors turns the print wheels which have been moved away from their zero setting back to their zero setting, and also enters the entry value carried by the selector sectors and now determined by the positioning of the actuator sectors away from their home, or full-cycle, position into the accumulator. During the upward stroke of the actuator sectors the print wheels are restored to their "0" position, and after the actuator bail 192 reaches the end of its upward movement and just before the end of the cycle, cam 179 and cam follower 342, together with the centralizing device 380 (Fig. 11) swings the positive transmission gear mechanism back to its central, or neutral, position in which it is out of mesh with both the selector sectors and the accumulator drive gears.

The entry value has now been printed and entered into the accumulator and the machine has been returned to its normal, or full-cycle, position.

Subtraction cycle (Fig. 15)

A bellcrank lever 757 of right angular shape is pivotally mounted at its knee on the stud 756 and has a forwardly directed arm 758 overlying the outer side of the subtraction key stem 593 and an upwardly directed arm 759 pivotally connected at its upper end by a pin-and-slot connection to an intermediate section of the subtraction link, or slide, 359. The slide 359 is provided with a slot corresponding to the slot 754 in the addition link 742 and receives the stud 743 to guide the rear end of the subtraction link 359 for longitudinal movement. The subtraction key stem 590 carries a laterally projecting stud 760 immediately above the forward, or distal, end portion of the bell-crank lever arm 758, which stud engages the arm 758 and rocks the bellcrank lever 757 downwardly and forwardly, imparting a forward movement to the link 359 when the subtraction key 581 is depressed.

The depression of the subtraction key also moves the cam following stud 644 along the rearward edge of the cam extension 643 of the link 168, moving this link forwardly to operatively engage the cam shaft clutch and close the motor switch and thereby initiate a single rotation operating cycle of the cam shaft.

When the subtraction slide, or link, 359 is moved forwardly, a stud projecting laterally from the rearward end of this link and corresponding to the stud 354 (Fig. 9) carried by the addition link 742 engages the upper end of the subtraction lever 358 and rocks this lever about the shaft 218 on which the lever is mounted, so that the lower end of the lever 358 is moved upwardly and rearwardly. The lever 358 is similar in shape to the addition lever 353 and has a bifurcated lower end provided with a slot receiving a stud 761 (Fig. 10) projecting laterally from the subtraction link 351 intermediate the length of this link. When the subtraction lever 358 is rocked in the manner indicated above, the hook formation 352 at the upper end of the link 351 is brought into engagement with the upper edge of the positive transmission shifting element 333. Then the cam 179, acting through the cam following rocker 342, pulls the link 351 downwardly, swinging the positive gear transmission mechanism to a position in which the lower set of gears 340 of this transmission are meshed with the

teeth of the selector sectors which have been stepped to the left of the home position of the left-hand end of the shiftable selector unit 11 by the entry of a digitation value into the digitation mechanism in the manner previously described.

Immediately after the positive gear transmission has been brought into mesh with the selector sectors, this transmission is latched in transmitting position to read out the values on the selector sectors by entry of the detent 365 into the notch 370 in the free end of the positive transmission cage. Immediately after the positive transmission mechanism has been latched in meshing engagement with the selector sectors, the actuator lead cam 174 on the cam shaft 135 engages the cam following roller 206 carried by the yoke 195 and swings the yoke to move the actuator bail 192 downwardly, returning the selector sectors to their "0" position and turning the print wheels to position to print whatever entry has been made in the selector sectors of the digitation mechanism in the same manner as described above in connection with the addition cycle.

Before printing, the actuator sectors are aligned and locked in their downward position where they are maintained during the printing operation, by the mechanism described in connection with the "Addition cycle." Likewise, the further rotation of cam 179 causes the unlatching of the positive transmission mechanism and the movement of this positive transmission mechanism back to its neutral position, as outlined above.

Since the subtraction link 351 has only a hook formation 352 on its upper end and no shoulder formation corresponding to the shoulder formation 350 on the addition link 346, when the cam 179 moves to enable the spring 357 to move the link 357 forwardly, it will not move the positive transmission mechanism past the neutral, or centered, position to which this mechanism is urged by the transmission centering mechanism 330 shown in Fig. 11, and previously described. Since the link 351 has been raised by the subtraction lever 358, however, the nose 429, on the distal end of the downwardly projecting arm 428 of the subtraction link 351, is brought into engagement with the adjacent end of the negative gear transmission shaft 423 when the link 351 moves forwardly, thereby shifting the negative transmission mechanism against the force of spring 419, into meshing engagement with the accumulator drive gears at the sides of the accumulator drive gears opposite the positive gear transmission mechanism, as shown in Fig. 2. When the negative transmission is swung against the force of spring 419, as described above, the negative transmission gears 426 are in mesh with the corresponding actuator sectors and gears 425 are brought into mesh with the corresponding accumulator drive gears 411.

After the positive transmission gear mechanism has been returned to its neutral position and the negative transmission gear mechanism moved into meshing engagement with the accumulator drive gears, the aligner control cam 176 (Fig. 8) releases the rib, or bail, 320 from the actuator sectors. Thereupon, the actuator trail cam 174 (Fig. 5) acting on the yoke 195 through the cam following roller 205, returns the actuator bail 192 to its uppermost position, thereby restoring any actuator sectors that have been moved away from their uppermost position during the downward movement of the bail to their upper, full-cycle, position, the actuator sector teeth ratcheting past the detents 301 during this upward movement of the actuator sectors.

As the actuator sectors are moved upwardly to their full-cycle position, the entry value which determined the lowermost position of the downwardly moved actuator sectors, is entered into the accumulator in a negative direction.

In both the addition and subtraction cycles, the addition link 742 and the subtraction link 359 are returned to their home, or full-cycle, position, moving the addition

link 346 or the subtraction link 351 out of engagement with the positive transmission control element 333 and the negative transmission shaft 423 before the end of the cycle so that, in the case of an addition cycle, the positive gear transmission mechanism will be returned to its neutral position by the centralizing device 380, and, in the case of a subtraction cycle, the negative gear transmission will be swung out of engagement with the accumulator drive gears at the end of the cycle by the spring 419 to a stop on the frame.

As the selector sectors were returned to, and latched in, their zero setting during the downward movement of the actuator sectors, the print wheels were returned to their "0" position during the upward movement of the actuator sectors and the gear transmissions were returned to their home, or neutral, positions before the end of the cycle, at the end of the subtraction cycle the machine will be left in a full-cycle condition ready for the entry of a subsequent value into the digitation mechanism.

Subtotal printing cycle

When the subtotal key 583 (Figs. 1 and 17) is manually depressed, it rocks the corresponding yoke 660 forwardly, thereby rocking the shaft 638 in a direction to move the link 168 forwardly and activate the cam shaft clutch and close the motor switch. This initiates an operative cycle of the machine wherein the cam shaft and the cams carried thereby will be rotated through one complete rotation.

A bail 910 (Figs. 17 and 18) is rockably mounted on the shaft 113 and is supported at its right end by a three-armed lever 908 having a forwardly projecting arm 969 provided at its forward, or distal, end with the bail portion 910 which extends to the left perpendicularly to the arm 909 and underlies a forwardly directed shoulder formation 911 on the subtotal key stem 634. This bellcrank lever has a downwardly directed arm 912, the lower end portion of which is disposed rearwardly of the shaft 589. A spring 913 connected between the downwardly directed arm 912 and a portion of the control key mounting structure forwardly of this arm resiliently urges the bellcrank lever to its home position in which the lower end portion of the arm 912 bears against the shaft 589 to provide a stop for rotational movement of the bellcrank lever by the spring 913 in a clockwise direction, as viewed in Fig. 17.

The bellcrank lever has an upwardly directed arm 915 pivotally connected at its upper end to the forward end of the subtotal actuating link 692. When the subtotal key is depressed, the key stem shoulder formation 911 engages the bail formation 910 on the forwardly directed arm 909 of the bellcrank lever and rocks the bellcrank lever 908 in a counter-clockwise direction, as viewed in Fig. 17, against the force of spring 913 and thereby imparts a forward movement to the subtotal control link 692.

An irregularly-shaped lever 917 (Figs. 14 and 19) is rockably mounted intermediate its length on a stud or pin 918 secured at one end to a bracket 434 carried by the print mechanism frame and spaced to the right from the right-hand side of this frame, the pin projecting to the left from the bracket 434, as shown in Fig. 14. The lever 917 has a forwardly and upwardly directed arm 920 extending past the rearward end of the link 692. The link 692 carries at its rearward end a laterally projecting stud 921 which is opposed to the rearward edge of the arm 920 and is effective to impart to the lever 917 a counter-clockwise rocking movement, as viewed in Fig. 14.

The lever 917 also has a rearwardly directed arm 922 having at its rearward end a downwardly directed hook formation 923, the arm 922 being parallel to the arm 920 and spaced to the left therefrom, the lever 917 including a cross bridge portion, or bail, 924 which extends perpendicularly between the arms 920 and 922 and joins these arms together. The arm 922 has a portion 925 extending upwardly and forwardly from the pin 918 and constituting a tail portion, the purpose of which will be

described in connection with the total printing cycle of the machine.

A cam following, bellcrank lever 930 is rockably mounted on the cam follower supporting shaft 196 and has an upwardly directed arm 926 provided at its upper end with a laterally directed abutment 927 underlying the arm 922 of the lever 917 and engaged at its rearward edge by the hook 923 on the rearward end of the lever arm 922. The cam following lever 930 also has a rearwardly directed arm 928, the rearward end of which carries the cam following roller 561 which is connected to the upper end of link 560 and rides on the peripheral edge of the subtotal printing cam 177.

When the link 692 is moved forwardly by depression of the subtotal control key of the machine, the lever 917 is rocked in a counter-clockwise direction, as viewed in Fig. 14, on the stud 918, raising the rearwardly directed lever arm 922. Raising of the lever arm 922 releases the abutment 927 on the upper end of the arm 926 of the cam following bellcrank 930, so that this bellcrank can rock to permit the cam follower 561 to follow the contour of the subtotal printing cam 177 under the urgency of spring 559.

As neither the addition entry link 742 nor the subtraction entry link 359 has been raised, the gear transmission mechanisms will not be affected by rotation of the transmission shifting cam 179.

At the beginning of the subtotal printing cycle the cam follower rides off of the lobe portion 931 of the subtotal printing cam 177, freeing the link 560 for longitudinal movement in a direction to release the bellcranks 545 and 550 for movement by the spring 559. The positive bellcrank 545 or the negative bellcrank 550 will then be moved by the spring 559, depending upon the total sign sensing position of the blocking member 523. If the total is positive, the positive bellcrank 545 will move to shift the positive transmission gear mechanism into mesh with the accumulator drive gears and swing the positive gear blocking bail 568 into engagement with the positive tens-carry latch abutments 474. If the total sign is negative, the negative bellcrank 550 will move to shift the negative gear transmission mechanism into mesh with the selector sectors and the accumulator drive gears and simultaneously swing the negative gear blocking bail 570 into engagement with the negative tens-transfer latch abutments 503.

The actuator bail 192 will now be moved downwardly and those actuator sectors 188 drivingly connected to the accumulator gears which have been moved away from their "0" position will be moved downwardly until the corresponding accumulator gears are stopped by engagement of their tens-transfer cams 408 with the corresponding tens-transfer latch abutments 474 or 503 which are now locked by the locking bails 568 and 570, as described above. Those actuator sectors drivingly connected to accumulator gears which were already in their "0" position will be held against downward movement by inability of the corresponding accumulator gears to turn.

During the downward movement of the actuator sectors, the total value is read out from the accumulator gears and the corresponding print wheels are turned to printing position corresponding to the positions of the accumulator gears in the corresponding orders. At the end of the downward movement of the actuator sectors, the printing operation will occur, as described above, and the total will be printed on the tape.

The accumulator gears have now been reset to their positive, or negative "0" position, as the case may be, and in order that this operation should be a subtotal operation rather than a total operation, it is necessary to restore the accumulator gears to their original total indicating position during the upward stroke of the actuator sectors. This is accomplished by maintaining the positive or negative gear transmission mechanism, as the case may be, latched in mesh with the accumulator drive gears until

near the end of the operating cycle and the actuator sectors are returned upwardly to their home, or full-cycle, position.

The lobe portion 931 of the subtotal printing cam 177 is of restricted angular extent, the major portion of the circumference of this cam being of such limited radial extent as to release the link 560 and free the bellcrank levers 545 and 550, except at the start and termination of the cycle, for the lobe 931 does not re-engage the cam follower 561 to pull the link 560 and move the bellcrank levers 545 and 550 to their inoperative position until the actuator sectors have been returned to their home position. The positive, or negative, gear transmission is thus left in mesh with the accumulator drive gears during the upward stroke of the actuator sectors and the upward movement of the actuator sectors thus returns the print wheels to their "0" position and places the total read out of the accumulator during the downward stroke of the actuator sectors back in the accumulator during the upward stroke of the actuator sectors.

When the positive or negative gear transmission mechanism is released by the corresponding bellcrank lever 545 or 550 upon re-engagement of the cam lobe 931 with the cam follower 561, the transmission mechanism is resiliently moved out of engagement with the accumulator drive gears and the operating cycle terminates with the print wheels cleared, or in their "0" position, and with the accumulated total still in the accumulator.

Total printing cycle

A bail 935 (Fig. 18), similar to the bail 910, is rockably mounted on the shaft 113 immediately to the left of right-hand arm 908 of the bail. The forwardly extending arm 934 is provided at its distal end with the extension, or bail, 935, which is disposed rearwardly of the bail 910 on the lever 908 and underlies a forwardly extending shoulder formation 936 on the total key stem 628. The lever 934 also has an upwardly directed arm pivotally connected at its upper end to the forward end of the total operating link 691, and has a downwardly directed arm, the lower end of which is disposed at the rearward side of the shaft 589 and urged into engagement with the shaft by a spring similar to the spring 913.

Upon depression of the total key, the shoulder 936 on the total key stem engages the bail 935 of the bellcrank lever 934 and rocks this lever in a counter-clockwise direction, as viewed in Fig. 17, imparting forward movement to the link 691. At its rearward end link 691 is provided with a laterally extending stud 937 (Figs. 14 and 19) which is disposed rearwardly of the upper end portion of a lever 938 rockably mounted on the stud 918 between the arms 920 and 922 of the lever 917.

The lever 938 will be rocked in a counter-clockwise direction, as viewed in Fig. 14, upon forward movement of the link 691. This lever has on its upwardly directed arm 939 a laterally extending ear 940 which overlies the upper edge of the arm 922 of the lever 917, so that the lever 917 will also be rocked in a counter-clockwise direction to release the hook 923 from the abutment 927 on the upper end of the arm 926 of the bellcrank lever 930 when the total actuating link 691 is moved forwardly by depression of the total control key.

A cam following bellcrank lever 942 is rockably mounted at its knee, or angle, on the cam follower support shaft 196 and has a rearwardly directed arm 943 carrying at its rear end a cam following roller 941 which rides on the peripheral edge of the total printing cam 178. This lever 942 also has an upwardly and rearwardly directed arm 944, and a live point lever 945 is pivotally mounted at one end on the upper end of the lever arm 944 by a stud 946 and extends forwardly from this stud. The forward end of the lever 945 overlies the right-hand side of the lever arm 926. The total key actuated lever 938 has a downwardly and rearwardly extending arm 948, the lower end portion of which underlies a stud 949 carried by the

lever 945 at the forward end thereof. Rotation of the lever 945 in a clockwise direction, as viewed in Fig. 14, relative to the lever arm 944 is limited by engagement of the end of a downwardly directed arm 951 of the lever 945 with an ear 950 which projects laterally from the rearward edge of the lever arm 944 below the stud 946. Angular movement of the lever 945 in a counter-clockwise direction, as viewed in Fig. 14, is resiliently urged by a spring 952 connected between the stud 949 and an eye formation 953 on the portion of the lever 942 adjacent the shaft 196.

A forwardly facing shoulder 954 is provided on the upper edge of the lever 945 near the forward end of this lever, and the lever 945 has sufficient freedom of rotational movement in a clockwise direction relative to the lever arm 944 that, when counterclockwise rotational movement is imparted to the lever 938 by forward movement of the link 691, the forward end of the lever 945 will be raised until the shoulder 954 engages the rearward edge of the abutment 927 on the upper end of the lever arm 926.

Raising of the hook arm 922 by the ear 940 on the lever arm 939 raises the arm 922 of lever 917, disengaging the hook formation 923 from the abutment 927 on the upper end of lever arm 926. Since depression of the total key acts through the yoke 655, the shaft 638, and the link 163, to cause a cyclic rotation of the machine cam shaft 135 and the cam 178 carried on the cam shaft, and since the total key is latched down during the corresponding cycle of the machine, the cycle will take place with the bellcrank cam following lever 942 latched to the bellcrank cam following lever 930 by the latch, or live point, lever 945 and with the hook 923 disengaged from the terminal abutment 927 of the lever arm 926.

At the beginning of the rotation of the cam shaft, the cam follower 941 rides off of the lobe portion 562 of the cam 178 and drops into the restricted portion 563 of this cam, thereby releasing the link 560 and the positive and negative bellcrank levers 545 and 550 so that one of these bellcrank levers, depending upon the position of the total sign sensing blocking member 523 will be moved to swing the corresponding positive or negative gear transmission mechanism into meshing engagement with the accumulator drive gears, simultaneously moving the blocking bail 569 or 570 into blocking engagement with the associated tens-transfer latch abutments 474 or 503, as described above.

Immediately after the selected gear transmission mechanism is moved into meshing engagement with the accumulator drive gears, the actuator bail will accomplish its downward stroke, moving those actuator sectors in the orders corresponding to the orders of the accumulator gears which have been moved away from their "0" position, downwardly until the corresponding accumulator gears are stopped by engagement of their tens-transfer cams with the locked transfer latch abutments 474 or 503, as described above.

The lobe portion 562 of the cam 178 extends through approximately 180 degrees of angular extent so that, when the actuator bail has completed its downward movement, the print wheels have been set and the printing operation has taken place, and just before the actuator bail starts its upward movement, the cam follower 941 rides up on the cam lobe 562, thereby moving the link 560 and the bellcrank levers 545 and 550 to release the transmission gear mechanisms. As the transmission latching means are also released at this time, the transmission mechanism which has been moved into engagement with the accumulator drive gears will be moved out of engagement with these drive gears before the actuator bail starts its upward movement and the consequent upward movement of the actuator sectors will not re-enter into the accumulator the total which was read out of the accumulator on the downward stroke of the actuator bail and sectors.

The total printing cycle will thus leave both the print wheels and the accumulator gears in their zero setting and will completely clear the machine.

Print-only cycle

At times it is desirable to print a number, such as a code, or identifying, number, without having such number entered into the accumulator. For this purpose the machine is provided with a print-only cycle controlled by a print-only control key 535, as previously described.

The print-only control key 585 (see Figs. 1, 15 and 20) is mounted at the right-hand side of the keyboard on frame plate 14, and, when depressed, the stud 606 carried on the print-only key stem 601 acts against the rearward edge of the upward extension 645 of the link 168 and directly moves the link 168 forwardly to set the cam shaft clutch and close the motor switch for a cyclic rotation of the cam shaft.

A bellcrank lever 994 (Fig. 20) is pivotally mounted at its knee, or angle, on a stud 995 which is mounted on, and extends to the right from, a bracket 434 mounted on the printing mechanism and spaced from the right-hand end of this mechanism. The bellcrank lever 994 has a forwardly directed arm 997, the distal, forward end of which is disposed alongside the upper portion of the print only key stem 601, as shown in Fig. 20, which key stem 601 carries a stud 998 which bears on the upper edge of the forward end portion of the lever arm 997 and imparts a rocking movement in a counterclockwise direction to the bellcrank lever 994, as viewed in Fig. 20, when the print-only key is depressed.

The bellcrank lever 994 also has a rearwardly directed arm 999 materially shorter than the arm 997. A spring 1000 connected at one end to the distal end of the arm 999 extends downwardly from this arm and is connected at its lower end to the machine frame to resiliently urge the lever 994 in a clockwise rotational direction, as viewed in Figs. 9 and 20, to maintain the distal end portion of the arm 997 against the stud 998. The bellcrank lever 994 also has a downwardly and rearwardly directed arm 1001, the lower end portion of which underlies the subtraction control link 351. The link 351 is provided on its lower edge and intermediate the length thereof with a downwardly and forwardly extending lock ear 1002 and the bellcrank arm 1001 is provided near its lower end with a downwardly and rearwardly facing shoulder formation 1003.

When the print-only key is depressed, and rocks the bellcrank lever 994 in a counter-clockwise direction, as viewed in Fig. 9, the lower end portion of the bellcrank lever arm 1001 is raised into engagement with the lower, or forward, edge of the subtract cycle link 351 and raises the upper end of this link until the hook formation 352 on the upper end of the link 351 is brought into position to engage the actuating cross-member 333 of the positive transmission gear mechanism. Thereafter, the cam following rocker 342 is moved to move the link 351 downwardly and swing the lower gears 340 of the positive gear transmission mechanism into mesh with the activated selector sectors. The positive transmission gear mechanism will be latched in this position in the manner described above, and upon downward movement of the actuator bail 192, the activated selector sectors are returned to their "0" position and the corresponding print wheels are turned to the proper position to print the entry value during the dwell of the actuator sectors at the bottom of their downward stroke, as indicated above. Immediately after the printing operation has been accomplished, the cam 179 reaches an angular position in which it permits the rocker 342 to rock in a counter-clockwise direction, as viewed in Fig. 9, to move the subtraction cycle link 351 upwardly. In the regular subtraction cycle, the spring 357 would move this link upwardly and the nose 429 of the link arm 428 would engage the negative transmission gear shaft 423 and shift the negative trans-

mission mechanism into engagement with the accumulator drive gears to enter the value into the accumulator on the upward stroke of the actuator sectors. In the print-only cycle, however, the ear 1002 on the subtraction cycle link 351 engages the shoulder 1003 on the lever arm 1001 and upward movement of the link 351 is stopped before the negative transmission gear mechanism can be shifted to mesh with the accumulator drive gears to transfer the digitation value acquired by the actuator sectors on their downward stroke to the accumulator during the upward stroke of the actuator sectors, which takes place immediately after the upward movement of the link 351, as described above.

During the second half of the cycle wherein the entry value is normally transferred to the accumulator, the engagement of shoulder 1003 with detent 1002 holds the link 351 against upward movement, the rocker arm 342 being held against the force of the spring that urges the cam follower 345 against the edge of cam 179. This disables the link 351 to move above its full-cycle position and thereby disables the link 351 and link arm 428 to shift the negative gear transmission into mesh with the accumulator drive gears. At the end of the cycle the cam 179 will have been turned to a position at which its edge again engages the cam follower 345, separating the detent 1002 and the shoulder 1003. The print-only key is released, freeing the spring 1000 to swing the bellcrank lever arm 1001 away from the subtraction link 351, so that this link moves away from the positive transmission shifting element 333 and to its full-cycle position.

Since the positive gear transmission was moved out of engagement with the selector sectors at mid-cycle, leaving the selector sectors in "0" position, and since the actuator sectors are restored to their full-cycle position and the print wheels returned to their "0" position during the second half of the cycle, the end of the print-only cycle leaves the machine in condition to receive a new entry value, or to print a total or subtotal value.

Symbol printing mechanism

As explained above, the machine is equipped to print symbols at locations spaced from the right-hand ends of the rows of figures printed on the printing tape to indicate the nature of the value, such as a negative or subtractive entry, a positive or negative subtotal, a positive or negative total, or a code for identifying a number which has not been added into the accumulator. The mechanism for this purpose includes a symbol printing wheel constituting the right-hand wheel of the group of printing wheels 230, an auxiliary actuator sector 1028 (Fig. 11) disposed at the right-hand end of the group of actuator sectors 188, and an additional transmission gear at the right-hand end of the upper set of gears 337 of the positive transmission gear mechanism. As there is no intermediate gear 338 or bottom gear 340 in this right-hand order meshing with the extreme right-hand upper transmission gear 337, the symbol printing actuator sector 1028 cannot at any time be drivingly connected to a selector sector 33, other means being provided for stopping the actuator sector 1028 at the proper positions to print the indicated symbols.

Three forwardly directed stop arms 1030, 1031 and 1032 (Fig. 11) are rockably mounted at their rearward ends on the shaft 214 and are disposed in side-by-side relationship to each other. The arm 1030 is provided on its forward end with abutment surfaces 1033 and 1034 spaced-apart longitudinally of the arm, the arm 1031 is provided on its forward end with transversely extending abutment surfaces 1035 and 1036 spaced-apart longitudinally of the arm and the arm 1032 is likewise provided on its forward end with transversely extending abutment surfaces 1037 and 1038 spaced-apart longitudinally of the arm. It will be noted that both of the abutment surfaces 1037 and 1038 on the forward end of the arm 1032 are spaced to the rear of both abutment surfaces 1035 and 1036 on the forward end of arm 1031, and that abutment

surfaces 1035 and 1036 on the forward end of arm 1031 are spaced rearwardly of the abutment surfaces 1033 and 1034 on the forward end of the arm 1030, the respective abutments being spaced incrementally, one from another, behind abutment 1033.

An abutment bracket, or ear, 1039 is mounted on, and projects inwardly from, the rim of the actuator sector 1028 near the lower end of this rim. The stops, or abutment surfaces, on the arms 1030, 1031 and 1032 are selectively engageable with the stop 1039 to stop the actuator sector 1028 at predetermined locations in its downward stroke, thereby rotating the symbol printing wheel to a position to print the indicated symbol. It will be noted that the actuator sector 1028 is latched in position for printing by a latching dog 1040 of bellcrank shape mounted at its knee on the shaft 299 which carries the latching dogs 300, and has its arms received and guided in corresponding notches in the legs of the angularly-shaped comb structure 304.

Three bails 1044, 1045 and 1046 (Figs. 11 and 21) are mounted near their open ends on the right-hand end portion of the shaft 511 by passing the shaft through mutually aligned apertures in the spaced-apart, and substantially parallel, bail legs. These bails have their left-hand legs rearwardly directed beyond the shaft 511 and pivotally connected at their rearward ends to links 1047, 1048 and 1049, respectively. These links are upwardly directed from the corresponding bail legs and are pivotally connected at their upper ends to the stop levers 1030, 1031 and 1032, respectively, intermediate the length of these levers, so that rocking movements of the bails on the shaft 511 will raise and lower the forward ends of the stop levers.

The right-hand leg of the bail 1044 is provided with an upwardly directed extension 1050. A link 1051, extending longitudinally of the machine, is pivotally connected at its rear end to the extension 1050 above the shaft 511 and extends forwardly from the bail leg extension. This link terminates forwardly below the shaft 841 (Fig. 20) and has near its forward end a longitudinally extending slot 1052 receiving a stud 1053 projecting laterally from the left-hand intermediate frame plate of the machine to guide the forward end of the link 1051 for longitudinal movement of the link. A lever 1054 is pivotally mounted at one end on the shaft 841 and extends downwardly and forwardly from the shaft 841, having at its forward end an upwardly directed end portion 1055 terminating against a stud 1056 projecting laterally from the print-only key stem 601 near the lower end of this key stem. Intermediate its length the lever 1054 has a rearwardly directed abutment formation 1057 which bears against a stud 1058 projecting laterally from the link 1051 near the forward end of this link, the arrangement being such that when the print-only key 585 is manually depressed, the lever 1054 is rocked about its pivotal mounting on the shaft 841 in a direction to impart rearward movement to the link 1051. When the link 1051 is moved rearwardly, it rocks the bail 1044 in a clockwise direction, as viewed in Fig. 11, causing the bail leg connected to the link 1047 to pull downwardly on this link and swing the stop lever 1030 to a position at which the stop formation 1033 at the forward end of this lever is disposed opposite the stop 1039 on the symbol printing actuator sector 1028.

With the stop 1033 positioned in opposition to the stop 1039 on the actuator sector 1028, this sector will be stopped in its downward movement at a position in which it has rotated the associated symbol printing wheel to a printing position to print the symbol corresponding to a print-only operation of the machine.

A bellcrank lever 840, which is rocked by means shown in Fig. 17 when the subtraction key 581 is depressed to release the ribbon shift blocking lever 837, is provided intermediate its length with a rearwardly directed abutment formation 1060 (Fig. 20). The bellcrank lever engages the stud 1058 carried by the link 1051 near the for-

ward end of this link and imparts a rearward movement to the link against the force of the tension spring 1061 connected between the fixed stud 1053 and the link 1051 at a location along the link spaced rearwardly from the stud 1053 to resiliently urge the link in a forward direction to a position in which the stud 1053 abuts the rear end of the slot 1052. As the proportion of the distance from the forward end 842 of the lever 840 (Fig. 17) to the abutment 1060 of this lever over the distance from the abutment 1060 to the shaft 841 is twice the distance from the forward end of the lever 1054 to the abutment 1057 of this lever over the distance from the abutment formation 1057 to the shaft 841, the depression of the subtraction key will move the link 1051 rearwardly only one-half the distance that this link is moved rearwardly by depression of the print-only key 580. Thus, when the subtraction key is depressed, rocking the bail 1044, the bail 1044 will move the lever 1030 through the link 1047 a distance such that the lower abutment surface 1034 of this lever is positioned in opposition to the stop, or abutment, formation 1039 on the actuator sector 1028. The actuator sector will thus move a different distance from its movement in response to depression of the print-only key and will rotate the symbol print wheel to a position to print the symbol indicating a subtractive entry of a value into the machine.

The pawl 1040 locking the print wheel driving actuator sector 1028 in its home, or full-cycle, position is not operated by the comb structure 304 which controls the remaining actuator sector locking pawls, but is guided only by this comb structure and is controlled by a link 1064 (Fig. 11). The upper end of the link is pivotally connected to the locking pawl, or dog, 1040 near the ear 1065 on the end of this pawl. The link extends vertically from the pawl 1040 to a point below the rearwardly projecting leg portions of the symbol printing control bails 1044, 1045 and 1046. At its lower end the link 1064 carries a stud 1066 which projects laterally to the right from the lower end of the link and underlies the left-hand bail legs (Fig. 21). The stud 1066 is pivoted at one end in a guide link 1067 which is also pivoted on the stud 511 to guide the stud 1066 and the lower end of the link 1064. A spring 1068 is connected between the lower end of the depending arm 1069 of the pawl 1040 and the link 1064 intermediate the length of this link.

With this arrangement, when any one of the bails 1044, 1045 or 1046 is rocked in a clockwise direction, as viewed in Fig. 11, to selectively position the corresponding stop lever 1030, 1031 or 1032, the link 1064 is moved downwardly, thereby releasing locking pawl detent 1065 from the gear teeth of the print wheel actuator sector 1028, this sector being locked in its upper, or full-cycle, position when the operation carried out by the machine does not require the printing of a symbol.

A slide bar 1070 (Fig. 11) is pivotally connected at its rearward end to the distal end of a depending arm 1071 of the bail 1046. This link extends forwardly to a position somewhat forwardly of the pivotal mounting of the negative balance sensing bellcrank lever 550, being guided for longitudinal movement by a stud 1072 extending from the machine frame at a location spaced forwardly from the rear end of the bar 1070 and through a slot extending longitudinally of the bar.

A slide bar 1073 (Fig. 20) extends forwardly and rearwardly of the machine and overlaps, at its rearward end, the forward end of the bar 1070. The slide bar 1073 carries near its rearward end a laterally projecting stud 1074 slidably received in a slot 1075 extending longitudinally of the bar 1070 near the rear end of bar 1073. A tension spring 1076 connected between the stud 1074 and the bar 1070 at a location rearwardly of the stud 1074 tends to maintain the stud against the rearward end of the slot 1075. At its forward end the bar 1073 is pivotally connected to the lower end of a lever 1077 (Fig. 17) which is pivotally mounted intermediate its

length on the shaft 638 and extends downwardly and upwardly from this shaft. At its upper end the lever 1077 is provided with a forwardly directed abutment formation 1078 which bears against a stud 1079 projecting laterally from the downwardly directed arm 912 of the right-hand leg of the bail 908 which is rocked by the subtotal key stem 634 upon depression of the subtotal key.

A spring 1080 connected between the front end portion of the bar 1073 and a spring anchoring pin 1081 projecting upwardly from the machine base 392, resiliently urges the interconnected bars 1073 and 1070 in a rearward direction.

When the subtotal key is depressed, the lever 1077 is rocked in a clockwise direction, as viewed in Fig. 17, imparting a forward movement to the interconnected bars 1073 and 1070 which, in turn, imparts a clockwise rotational movement to the bail 1046 (Fig. 11), causing this bail to pull downwardly on the link 1049 and shift the stop lever 1032 downwardly, thereby positioning the upper stop surface 1037 of the lever 1032 in opposition to the stop 1039 on the actuator gear sector 1028. Under these conditions the symbol printing print wheel will be rotated to print the symbol indicating a positive subtotal.

An abutment formation 1082 (Fig. 11) projects upwardly from the bar 1070 at a location adjacent, and to the rear of, the knee, or angle, portion of the total sign sensing bellcrank lever 550 (Figs. 14 and 20). This sensing lever carries below its pivotal mounting on the shaft 557 a laterally projecting pin, or stud, 1083, which, when the bellcrank lever 550 is moved to place the negative gear transmission mechanism in mesh with the accumulator drive gears, as previously described, is disposed in the path of the abutment formation 1082 and limits the forward movement of the bar 1070 to approximately one-half the movement which is obtained when the bar 1070 is not blocked by engagement of the abutment formation 1082 with the stud 1083. Under these conditions the spring 1076 stretches to compensate for the difference in longitudinal movement of the bars 1073 and 1070 and the bail 1046 is moved through an angular distance such that the stop lever 1032 is swung downwardly to position the lower stop surface 1038 opposite the stop ear 1039 on the actuator sector 1028. Under these conditions, the actuator sector will rotate the symbol printing wheel to a position to print a negative subtotal symbol.

A lever 1085 (Figs. 17 and 18), similar to the lever 1077, is mounted on the shaft 638 alongside the lever 1077. The upper end of the lever 1085 is engaged by a stud 1086 projecting laterally from the lower end portion of the downwardly directed arm of the total operated bail 935. A bar 1087 (also in Fig. 17) is pivotally connected at its forward end to the lower end of the lever 1085 and extends rearwardly from the bottom end of the lever 1085 alongside the bar 1073. At its rearward end the bar 1087 (see Fig. 20) is connected by a resiliently resisted, longitudinally slidable connection, similar to the connection between the bars 1070 and 1073, to the front end of a slide bar 1088, the rearward end of which is connected to a depending arm of the bail 1045. The rearwardly directed left-hand leg of the bail 1045 is connected by the link 1048 to the stop lever 1031 and full movement of the bars 1087 and 1088 rearwardly swings the lever 1031 downwardly to bring the stop edge 1035 in opposition to the stop 1039, thereby limiting downward movement of the actuator sector 1028 to a position at which the symbol printing print wheel has been turned to print a positive total symbol.

When a negative total is read out from the accumulator, an abutment formation 1090 on the bar 1088 encounters the stud 1083 carried by the bellcrank lever 550 and forward movement of the bar 1088 is limited to an extent such that the lower stop surface 1036 of the stop

bar 1031 is brought into opposition to the actuator sector carried abutment, or stop, 1039, and the sector 1028 will then be stopped in its downward movement at a position at which the symbol printing print wheel has been turned to print a negative total symbol.

No symbol is provided for the addition key as it is assumed that the absence of a symbol will indicate that the value is positively added into the accumulator, and this is also true for the repeat addition key. Also, no symbol is provided for the keyboard clearing key, as no printing takes place in this operation. The printing actuator sector 1028 is thus held in its uppermost, or full-cycle, position by the locking pawl 1040 whenever the addition key, the repeat addition key or the keyboard clearing key is depressed.

The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiment is, therefore, to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are, therefore, intended to be embraced therein.

What is claimed is:

1. In a listing calculating machine having manually settable selection mechanism, accumulator mechanism including register wheels, a sign sensing element movable from one to another of two operative positions to sense the positive or negative character of the algebraic sign of the balance in the register wheels, and means operated by said register wheels for positioning said sensing element in one or the other of said positions, printing mechanism including a row of ordinally arranged print wheels rotatable about a common axis and each having peripherally disposed type bosses at locations spaced apart therearound, actuator mechanism including a row of ordinally arranged actuator sectors rockable about a common axis and drivingly connected one to each of said print wheels, positive and negative transmission means effective to connect all of said actuator sectors except the actuator sector at the right-hand end of said row of actuator sectors to said selection mechanism and said accumulator mechanism, power means operative in successive operating cycles to move said actuator sectors to differentially set positions as determined by said selection mechanism or said accumulator mechanism and return said sectors to their full-cycle position, and manually operated control means effective to selectively establish different machine operating cycles and including an addition key, a subtraction key, a total key and a subtotal key, a symbol printing mechanism which comprises the right-hand print wheel of said row of ordinally arranged print wheels, said right-hand actuator sector, a plurality of stop arms each having a pair of differentially positioned stops thereon selectively movable to operative positions in which they are effective to stop said right-hand actuator sector at differentially set positions corresponding to the coincident machine operating cycle or the positive or negative character of a balance standing in said register wheels, a resilient linkage means connecting each of said total and subtotal keys to corresponding movable stop arms and normally operated by said total and subtotal keys to move their respective stop arms to an extreme operated position representing the positive character of the algebraic sign of the balance in the register wheels, and blocking means operated by said sign sensing elements to block operation of the said linkages in an intermediate position and thereby position the respective stop arm in an intermediate position representing the negative character of the algebraic sign of the balance in the register wheels when said sign sensing element has been moved to its negative character position.

2. In a listing calculating machine having manually settable selection mechanism, accumulator mechanism in-

- cluding register wheels, sign sensing elements movable from one to another of two operative positions to sense the positive or negative character of the algebraic sign of the balance in the register wheels, and means operated by said register wheels for positioning said sensing means in one position or the other, printing mechanism including a row of ordinally arranged print wheels rotatable about a common axis and each having peripherally disposed type bosses at locations spaced apart therearound, actuator mechanism including a row of ordinally arranged actuator sectors rockable about a common axis and drivingly connected one to each of said print wheels, positive and negative transmission means effective to connect all of said actuator sectors except the actuator sector at the right-hand end of said row of actuator sectors to said selection mechanism and said accumulator mechanism, power means operative in successive operating cycles to move said actuator sectors to differentially set positions as determined by said selection mechanism or said accumulator mechanism and return said sectors to their full-cycle position, and control means effective to selectively establish different machine operating cycles and including manually operable control keys, a symbol printing mechanism comprising the right-hand print wheel of said row of ordinally arranged print wheels, said right-hand actuator sector, a plurality of stops selectively movable to an operative position and effective to stop said right-hand actuator sector at differentially set positions corresponding to the coincident machine operating cycles or the positive or negative character of a balance standing in said accumulator mechanism, and linkage means connecting said control keys to corresponding movable stops, said stops comprising levers mounted each at one end for swinging movement about a fixed axis and each having at its other end abutment surfaces spaced apart longitudinally of the lever, and an abutment formation on said right-hand actuator sector selectively engageable with the abutment surfaces of said levers to stop said right-hand actuator sector and the associated print wheel at angular positions corresponding to the appropriate symbols to be printed, and said linkage means comprising bails disposed adjacent said levers and mounted for rocking movements about a fixed axis, links connecting said bails to said levers, bellcrank members actuated by said control keys, and links connecting said bellcrank members to said bails and each having a resiliently resisted freedom of longitudinal expansion and a shoulder thereon engageable with said sign sensing means to control the extent of rocking movement imparted to said bails by the last-mentioned links when the corresponding control keys are depressed, the freedom of longitudinal expansion of said last-mentioned links providing for full depression of said control keys when the extent of rocking movement of said bails is restricted by said sign sensing means.

3. In a listing calculating machine having manually settable selection mechanism, accumulator mechanism including register wheels, a sign sensing element movable from one to another of two operative positions to sense the positive or negative character of the algebraic sign of the balance in the register wheels, and means operated by said register wheels for positioning said sensing element in one or the other of said positions, printing mechanism including a row of ordinally arranged print wheels rotatable about a common axis and each having peripherally disposed type bosses at locations spaced apart therearound, actuator mechanism including a row of ordinally arranged actuator sectors rockable about a common axis and drivingly connected one to each of said print wheels, positive and negative transmission means effective to connect all of said actuator sectors except the actuator sector at the right-hand end of said row of actuator sectors to said selection mechanism and said accumulator register wheels, power means operative in successive operating cycles to move said actuator sectors to differentially set positions as determined by said selection mechanism

nism or said accumulator mechanism and return said sectors to their full-cycle position, manually operated control means effective to selectively establish different machine operating cycles and including an addition key, a subtraction key, a print-only key, a total and a subtotal key, and means operated by said total or subtotal keys for connecting said accumulator register wheels to their respective actuator sectors and means controlled by said sensing elements for determining whether such connection shall be through said positive or said negative transmission means, a symbol printing mechanism which comprises the right-hand print wheel of said row of ordinally arranged print wheels, said right-hand print wheel carrying type bosses providing appropriate symbols for subtractive and print-only operating cycles and for positive and negative balances for total and subtotal printing cycles so positioned around said right-hand print wheel that appropriate symbols are brought to printing positions by the differentially set positions of said right-hand actuator sector, a plurality of stop arms having a pair of differentially positioned stops thereon selectively movable to operative positions and effective to stop said right-hand actuator sector at differentially set positions corresponding to the coincident machine operating cycle or the positive or negative character of a balance standing in said register wheels, a resilient linkage means connecting at least some of said control keys to corresponding movable stop arms and normally operated by the respective control keys to move their respective stop arms to an extreme operated position representative of one set of symbols, and blocking means operated by said sign sensing element to block operation of the said linkages in an intermediate position representative of another set of said symbols.

4. In a listing calculating machine having manually settable selection mechanism, accumulator mechanism including register wheels, a sign sensing element movable from one to another of two operative positions to sense the positive or negative character of the algebraic sign of the balance in the register wheels, and means operated by said register wheels for positioning said sensing element in one or the other of said positions, printing mechanism including a row of ordinally arranged print wheels rotatable about a common axis and each having peripherally disposed type bosses at locations spaced apart therearound, actuator mechanism including a row of ordinally arranged actuator sectors rockable about a common axis and drivingly connected one to each of said print wheels, positive and negative transmission means effective to connect all of said actuator sectors except the actuator sector at the right-hand end of said row of actuator sectors to said selection mechanism and said accumulator register wheels, power means operative in successive operating cycles to move said actuator sectors to differentially set positions as determined by said selection mechanism or said accumulator mechanism and return said sectors to their full-cycle position, manually operated control means effective to selectively establish different machine operating cycles and including an addition key, a subtraction key, a print only key, a total key and a subtotal key, and means operated by said total or subtotal keys for connecting said accumulator register wheels to their respective actuator sectors and means controlled by said sensing elements for determining whether such connection shall be through said positive or said negative transmission means, symbol printing mechanism comprising the right-hand print wheel of said row of ordinally arranged print wheels, said right-hand actuator sector, a plurality of stop arms of differentially progressive length and each mounted at one end on a fixed axis for rocking movement and having a pair of abutment faces differentially positioned longitudinally of the arms, said arms being selectively movable to operative positions effective to stop said right-hand actuator sector at differentially set positions corresponding to the coincident machine operating cycles or the

positive or negative character of a balance standing in said accumulator mechanism, yieldable linkage means connecting said total and subtotal keys to their respective stop arms, said linkages normally being moved by their respective keys to one operative position representative of one algebraic sign character of the balance in the register wheels and settable to a second position representative of the other algebraic sign character of the balance in the register wheels, auxiliary setting means controlled by said sign sensing element to set said linkages to said second position upon operation of their respective keys, and means actuated.

5. In a listing calculating machine having manually settable selection mechanism, accumulator mechanism including register wheels, a sign sensing element movable from one to another of two operative positions to sense the positive or negative character of the algebraic sign of the balance in the register wheels, and means operated by said register wheels for positioning said sensing element in one or the other of said positions, printing mechanism including a row of ordinally arranged print wheels rotatable about a common axis and each having peripherally disposed type bosses at locations spaced apart therearound, actuator mechanism including a row of ordinally arranged actuator sectors rockable about a common axis and drivingly connected one to each of said print wheels, positive and negative transmission means effective to connect all of said actuator sectors except the actuator sector at the right-hand end of said row of actuator sectors to said selection mechanism and said accumulator register wheels, power means operative in successive operating cycles to move said actuator sectors to differentially set positions as determined by said selection mechanism or said accumulator mechanism and return said sectors to their full-cycle position, manually operated control means effective to selectively establish different machine operating cycles and including an addition key, a subtraction key, a total key and a subtotal key, and means operated by said total or subtotal keys for connecting said accumulator register wheels to their respective actuator sectors and means controlled by said sensing element for determining whether such connection shall be through said positive or said negative transmission means, a symbol printing mechanism comprising the right-hand print wheel of said row of ordinally arranged print wheels, said right-hand actuator sector, a pair of rockable stop arms of differentially progressive length, each having a pair of differentially positioned stops thereon and selectively rockable to either of two operative positions in which they are effective to stop said right-hand actuator sector at differentially set positions corresponding to the coincident machine operating cycles or the positive or negative character of a balance standing in said accumulator mechanism, resilient linkage means connecting said total and subtotal keys to their respective stop arms and normally operative to rock the respective stop arm to the extreme operative position which is effective to position the symbol printing wheel in a position to print a symbol indicative of one sign character, and blocking means controlled by said sign sensing means to block operation of the linkage in an intermediate position to rock the respective stop arm to the other operative position which is effective to position the symbol printing wheel in a position to print a symbol indicative of the other sign character.

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UNITED STATES PATENT OFFICE
CERTIFICATION OF CORRECTION

Patent No. 2,954,922

October 4, 1960

Harold J. Chall

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 14, line 69, for "lightly" read -- slightly --; column 15, line 55, for "geen" read -- been --; column 17, line 34, for "followed" read -- follower --; column 22, line 54, for "253" read -- 353 --; column 25, line 39, after "positive", and after "additive", insert a comma; column 27 line 46, for "in to" read -- into --; column 28, line 20, after "eleventh" insert a comma; column 34, line 52, for "suport" read -- support --; column 52, line 12, after "actuated" and before the period insert -- by said linkage means latching said right-hand actuator sector in differentially set position during the printing operation of said printing mechanism --.

Signed and sealed this 6th day of June 1961.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents

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