

Sept. 10, 1940.

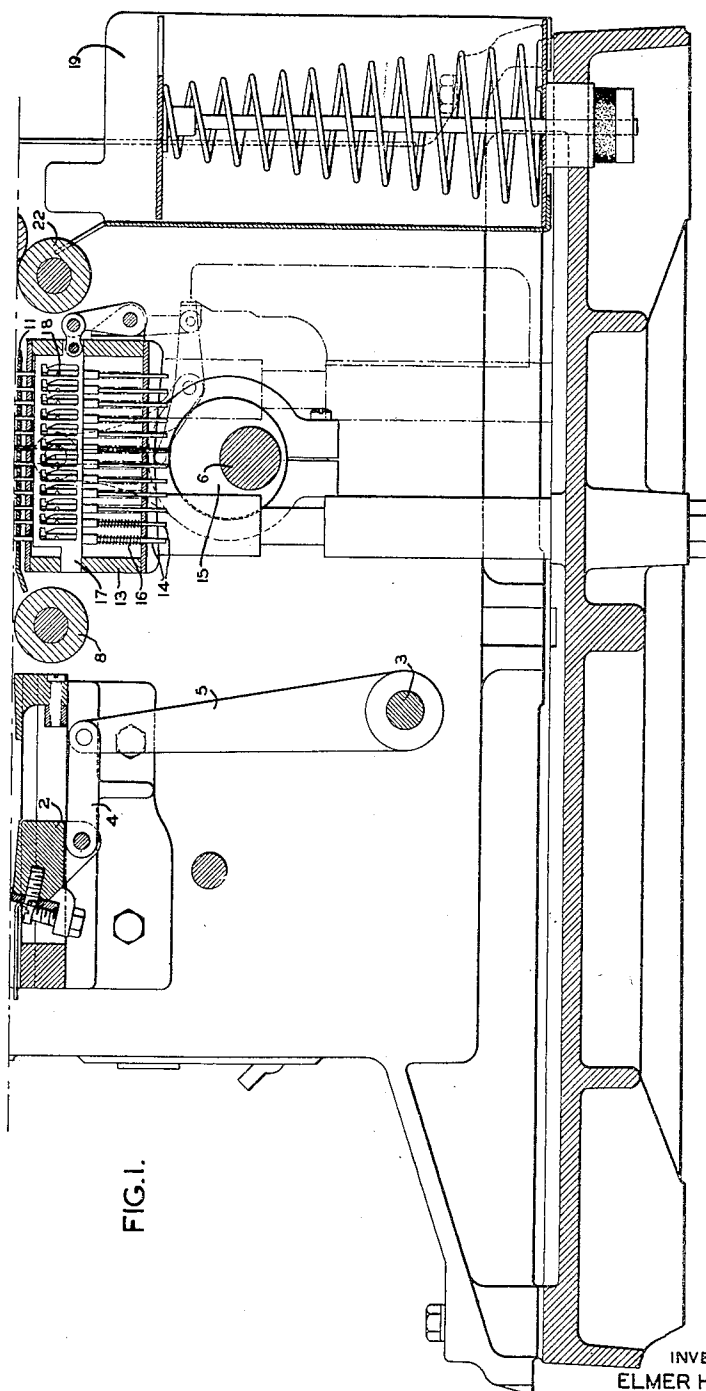
E. H. DREHER

2,214,015

TABULATOR

Filed June 24, 1937

8 Sheets-Sheet 1



INVENTOR
ELMER H. DREHER

BY

H. A. Spark
ATTORNEY

Sept. 10, 1940.

E. H. DREHER

2,214,015

TABULATOR

Filed June 24, 1937

8 Sheets-Sheet 2

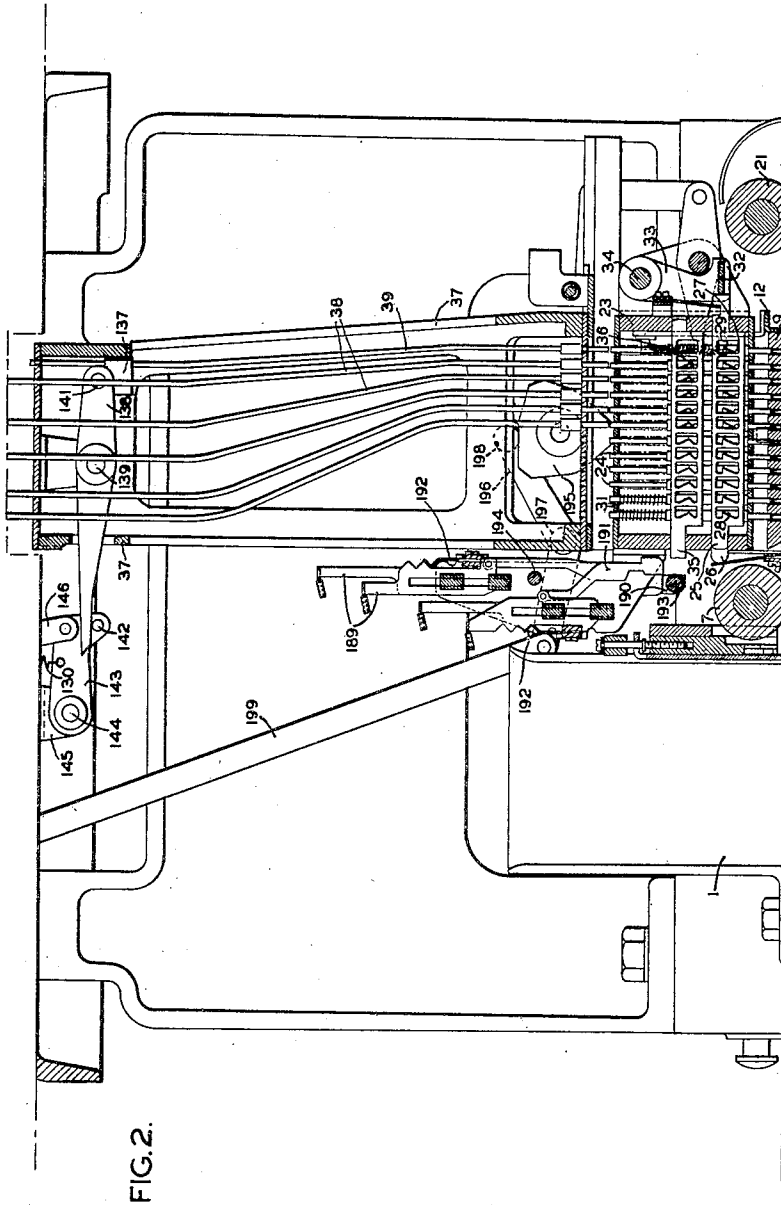


FIG. 2.

INVENTOR
ELMER H. DREHER

BY *D. A. Sparks*
ATTORNEY

Sept. 10, 1940.

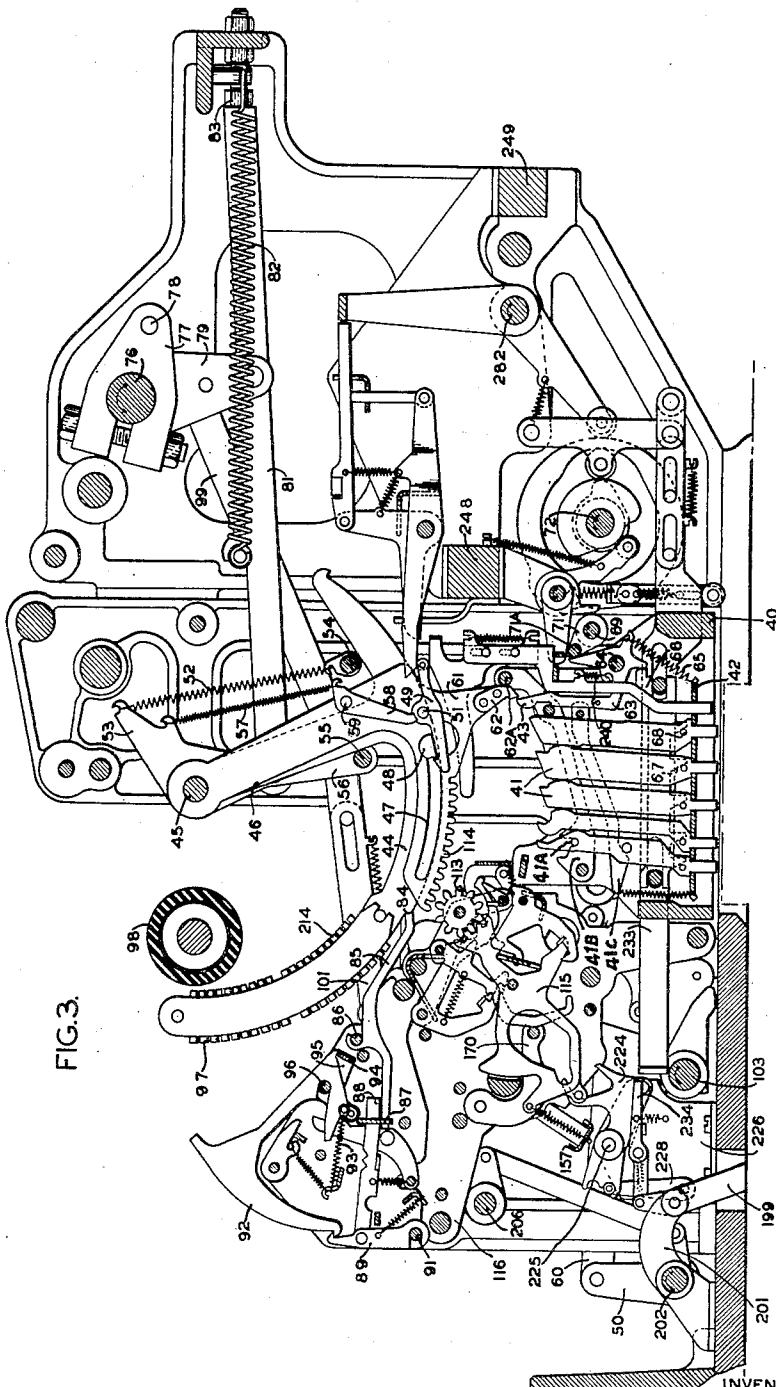
E. H. DREHER

2,214,015

TABULATOR

Filed June 24, 1937

8 Sheets-Sheet 3



INVENTOR
ELMER H. DREHER

BY H. C. Sparks
ATTORNEY

Sept. 10, 1940.

E. H. DREHER

2,214,015

TABULATOR

Filed June 24, 1937

8 Sheets-Sheet 4

FIG. 4.

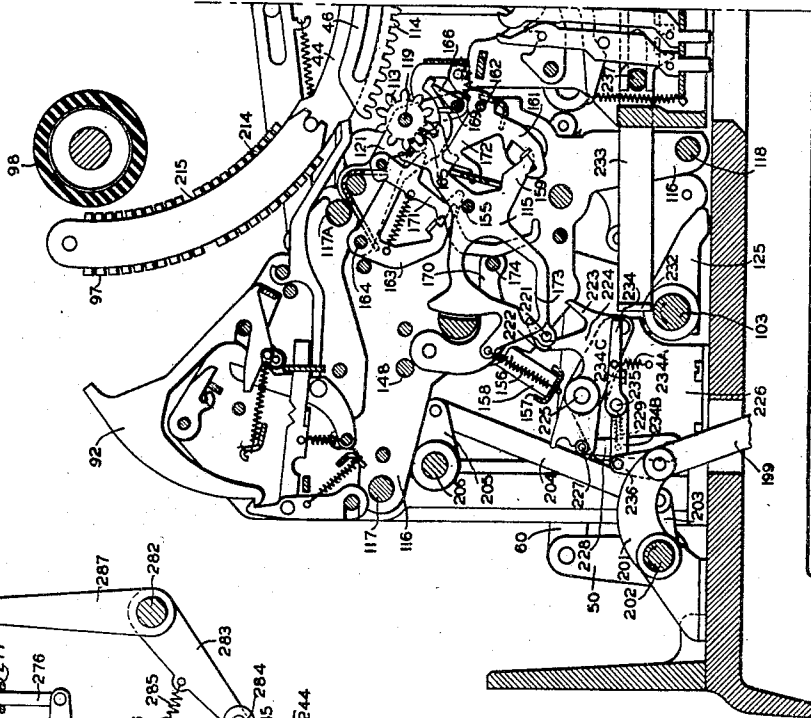


FIG. 11.

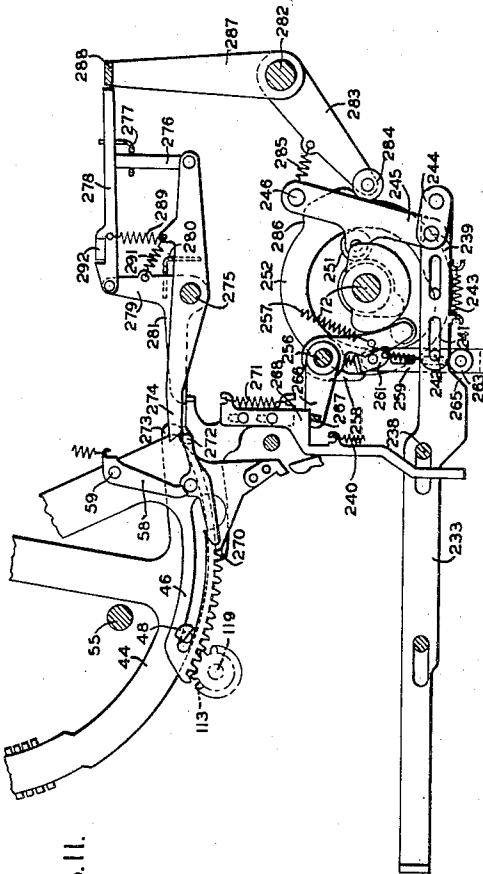


FIG. 12.

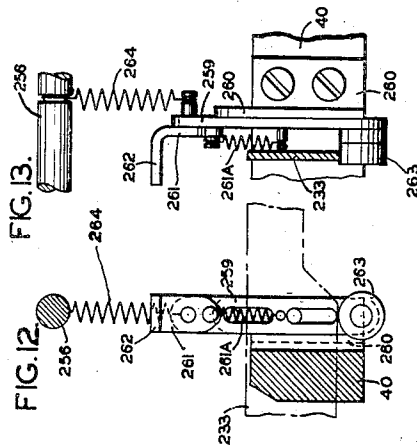
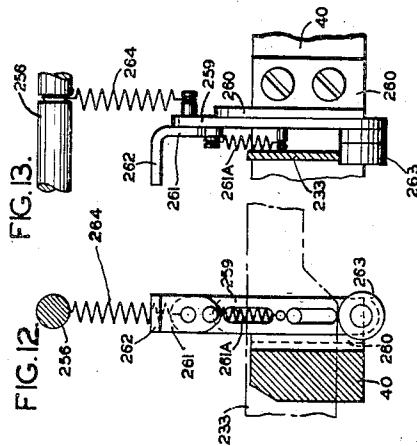


FIG. 13.



INVENTOR
ELMER H. DREHER

BY *H. A. Sparks*
ATTORNEY

Sept. 10, 1940.

E. H. DREHER

2,214,015

TABULATOR

Filed June 24, 1937

3 Sheets-Sheet 3

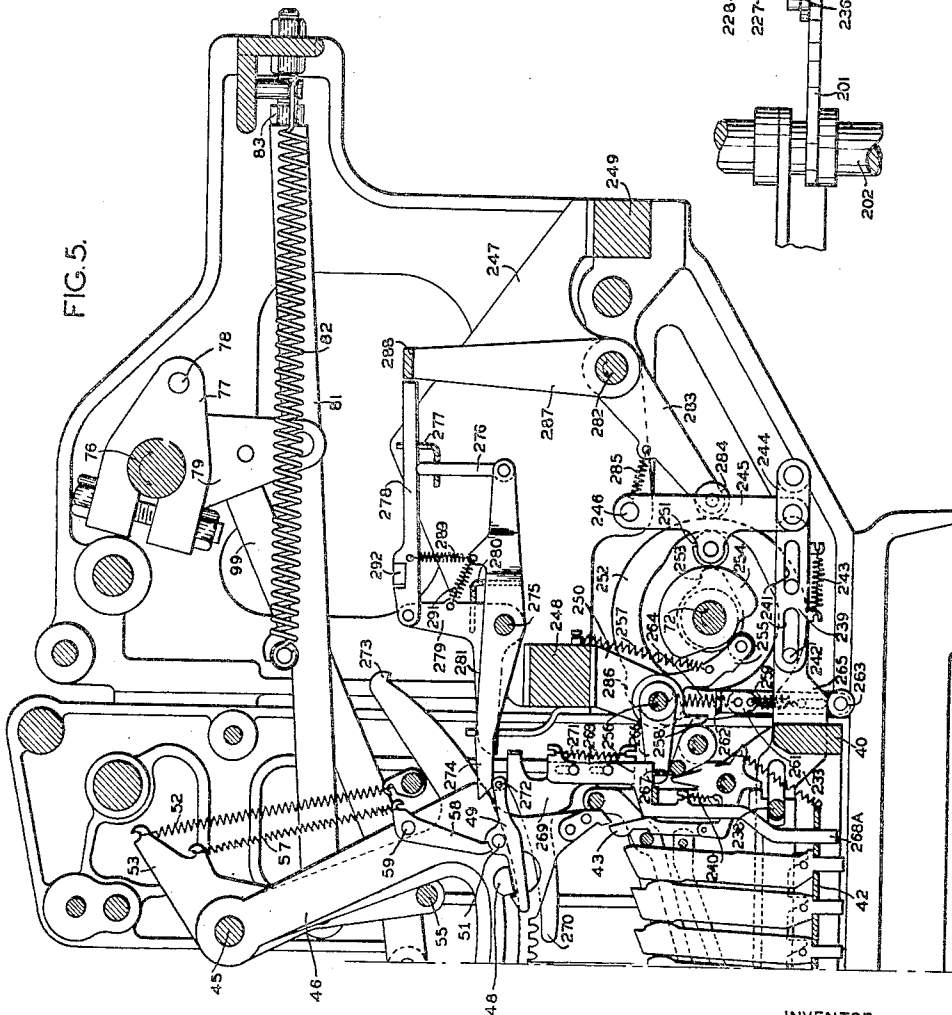
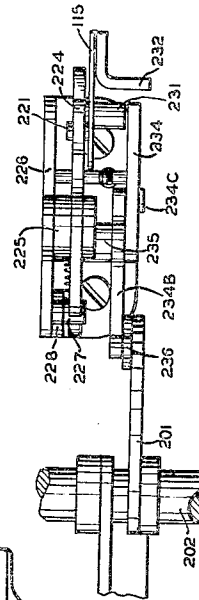


FIG. 5.

FIG. 14.



INVENTOR
ELMER H. DREHER

BY *H. A. Sparks*
ATTORNEY

Sept. 10, 1940.

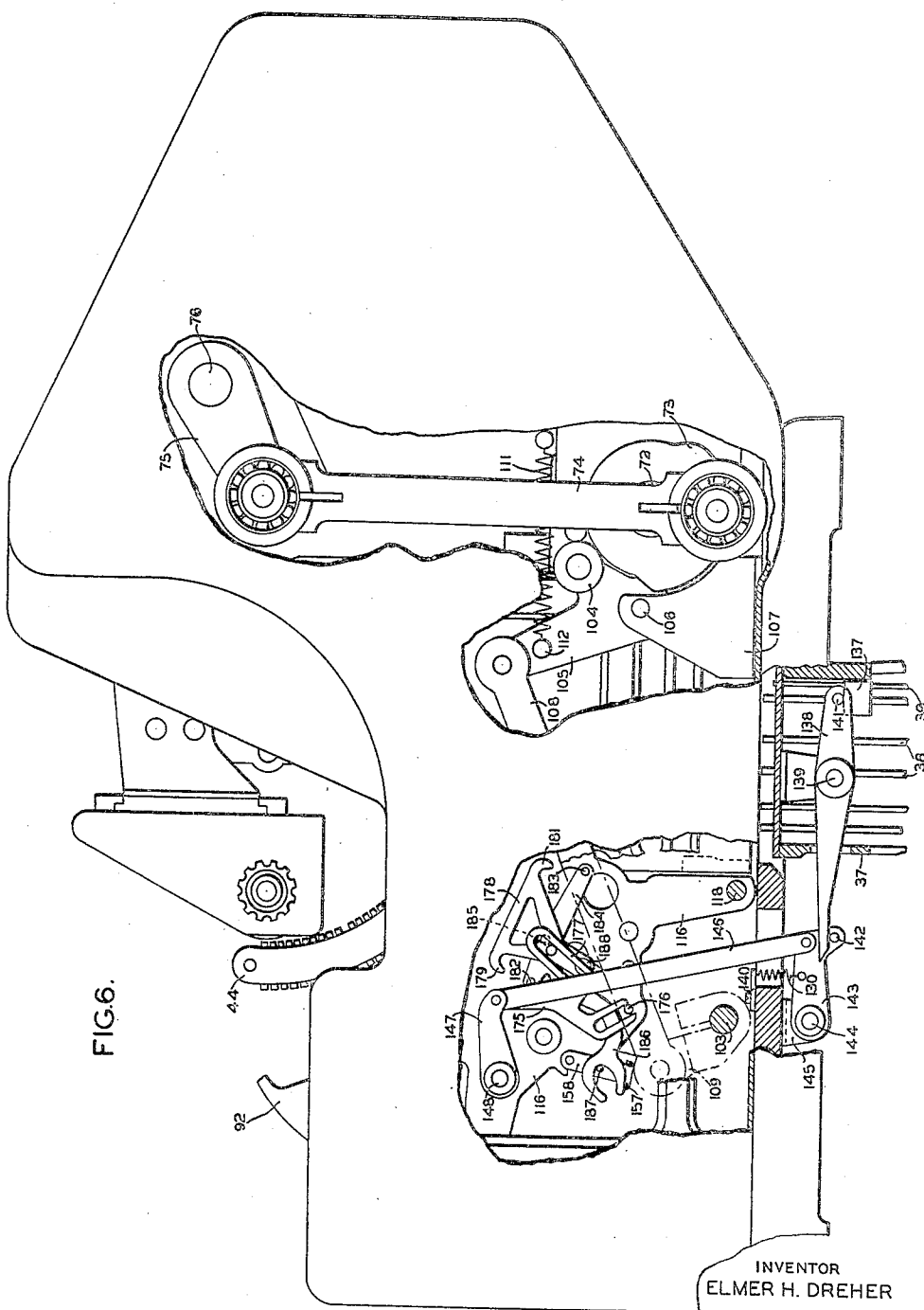
E. H. DREHER

2,214,015

TABULATOR

Filed June 24, 1937

8 Sheets-Sheet 6



Sept. 10, 1940.

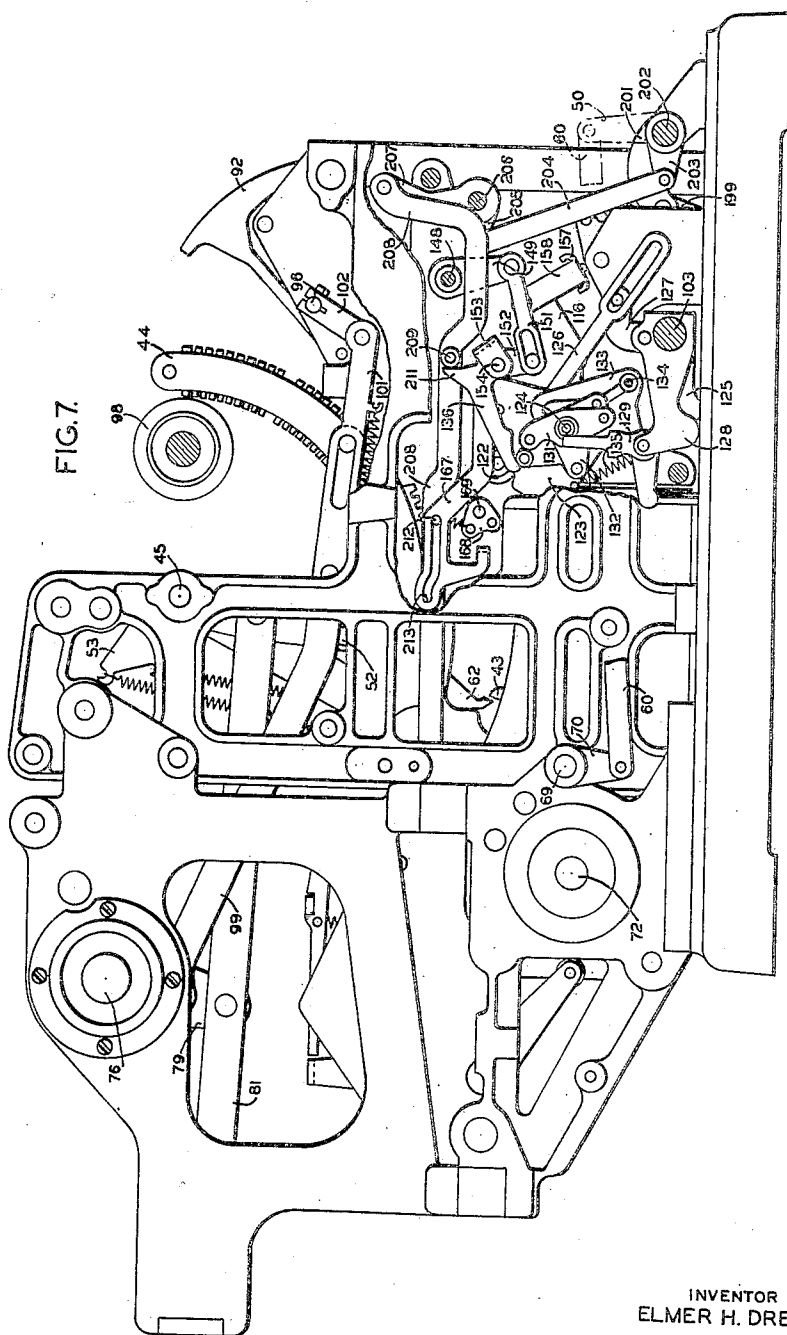
E. H. DREHER

2,214,015

TABULATOR

Filed June 24, 1937

8 Sheets-Sheet 7



INVENTOR
ELMER H. DREHER

BY

W. A. Sparks
ATTORNEY

Sept. 10, 1940.

F. H. DREHER

2,214,015

TABULATOR

Filed June 24, 1937

8 Sheets-Sheet 8

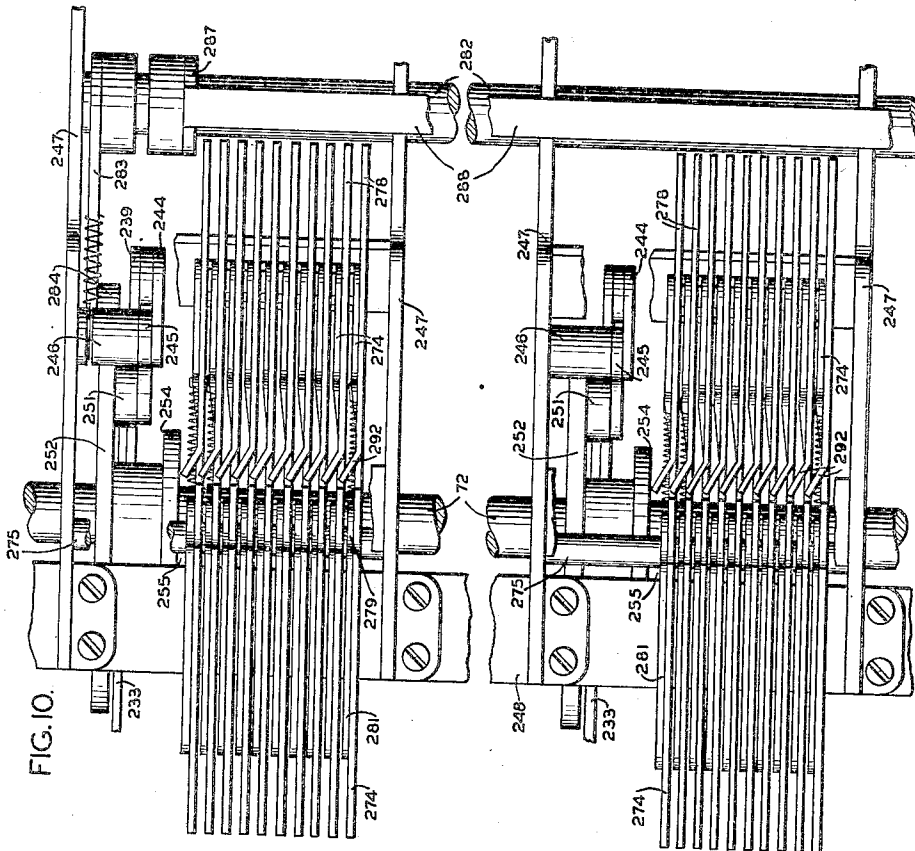


FIG. 8.

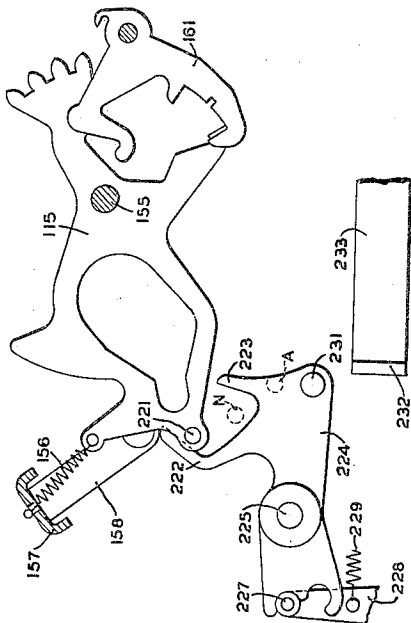
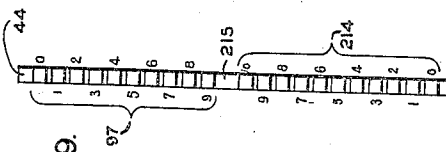


FIG. 9.



INVENTOR
ELMER H. DREHER

BY

O. A. Sparks
ATTORNEY

UNITED STATES PATENT OFFICE

2,214,015

TABULATOR

Elmer H. Dreher, Rockville Centre, N. Y., assignor
to Remington Rand Inc., Buffalo, N. Y., a corporation of Delaware

Application June 24, 1937, Serial No. 150,073

14 Claims. (Cl. 235—60)

This invention relates generally to mechanism, in accounting and like machines, for printing true negative balances, and more particularly to mechanism of this type employing a single accumulator and novel transposition means for effecting correct printing of a negative balance from a complementary amount stored in the accumulator.

The mechanism of the present invention is directed primarily towards an improvement of the machine disclosed in the U. S. application of Dreher S. N. 125,375, filed February 12, 1937. A portion of the above application discloses an accumulator capable of performing problems of addition and subtraction, and has special reference to transfer mechanism therein for effecting tens carry operations of either a positive or negative character. Mechanism is also provided for extracting totals from the accumulator and causing them to be printed on a tally roll or record sheet. A positive total is printed in its correct form whereas a negative total is printed in complementary form and must be translated by the operator into the true negative total.

The machine of the previous application, therefore, is unable to print a true negative total and it is with the means for overcoming this disability that the present application is concerned. In conjunction with the accumulating unit noted above, the machine of the present invention provides printing mechanism adapted to be controlled by the accumulator on total cycles. Included in the printing mechanism are printing or type-carrying sectors each of which bears the usual series of type elements zero to nine on its upper portion, and in addition to these bears, beneath the first set, a second series of elements of opposite numerical progression, that is, from nine to zero. The two sets of elements are in vertical alignment and an extra zero element is interposed between them. Normally effective latching means causes the upper set of type elements to be effective on all listing operations and positive totals. The lower set of elements is used only on a negative total taking operation. Mechanism is provided for disabling the above mentioned latching means, the disabling mechanism being automatically conditioned for operation when the accumulator contains a negative amount. If a total cycle is initiated while the accumulator is in a negative condition, the disabling mechanism will be rendered effective and a total will be printed through the second set of type elements. Additional mechanism, also effective only on negative total taking operations, is provided for

causing all of the printing sectors to the left of the lowest significant denominational order to move one additional space in order that a true negative total may be printed. It should be understood, however, that this extra or fugitive one is not entered into the accumulator and is associated solely with the printing mechanism.

The invention is shown in the present disclosure as embodied in a Powers tabulator. As is well known in the art, the Powers machine operates on perforated record cards and is adapted for use in a great variety of accounting problems. The accumulating and printing mechanisms are card controlled on both listing and total taking operations and are divided into a plurality of individually operable units. In the particular embodiment shown herein an accumulator of the type disclosed in the application S. N. 125,375 is provided for each unit in the tabulator and negative total printing mechanism is associated with each accumulator. The normal function of the accumulator is to accumulate all items positively so that it is necessary to provide a special control hole for all fields of the card which contain a negative item. A more detailed discussion of the main operating features of the tabulator, as they relate to the mechanism of the invention, will be entered into later in the specification.

One object of my invention is to print the true total of a series of positive and negative entries in a single accumulator even though the amount represented in the accumulator is not the true algebraic total thereof.

Another object of my invention is to insure the printing of a true negative total from a complementary negative amount stored in a single accumulator.

Another object of my invention is to combine with a single accumulator, capable of direct subtraction, novel printing mechanism including printing sectors having two sets of type elements, one set of which is effective on all listing and positive total taking operations, and the other set of which is effective only on negative total taking operations.

Other objects and structural details of my invention will be apparent from the following description, when read in connection with the accompanying drawings, wherein:

Figs. 1, 2, and 3, when read together, comprise a composite view in right-hand cross section of the entire machine. The three sheets are drawn to a scale of approximately one half size and should be arranged vertically with Fig. 1 at the

bottom, Fig. 2 directly above it and Fig. 3 at the top.

Figs. 4 and 5 comprise a composite view of the head section of the tabulator as viewed in right-hand cross section, and disclose the detailed construction of the true negative total printing mechanism. The composite view Figs. 4 and 5 is an enlarged view of Fig. 3.

Fig. 6 is a view in elevation of the right-hand side of the tabulator head. A portion of the outside casing is broken away to disclose some of the drive mechanism and the means for initiating a subtraction operation in the machine.

Fig. 7 is a view in side elevation of the left-hand side of the tabulator head with the outside casing removed. Shown in the view is a portion of the accumulator, some of the total taking mechanism and the operating means for releasing the printing hammers.

Fig. 8 is a detail view of the carry sector of highest denominational order in subtract position with its associated blocking latch raised out of effective position.

Fig. 9 is a detail front view of one of the type sectors showing the novel arrangement of type thereon.

Fig. 10 is a plan view of certain of the negative total printing mechanism.

Fig. 11 is a detail view of the negative total printing mechanism in operative position.

Fig. 12 is a detail view in front elevation of an interponent connected with the negative total printing mechanism.

Fig. 13 is a right-hand side view of the mechanism shown in Fig. 12.

Fig. 14 is a detail plan view of the negative total control mechanism.

The mechanism with which this invention is chiefly concerned, namely, the printing and computing mechanism, is located in the head section of the tabulator and, therefore, a major portion of the following description will be directed towards a disclosure of that portion of the machine. The main operating features of the tabulator itself are old, well known in the art, and have been disclosed in numerous patents and previous applications. In the present instance reference is made to the patent to William W. Lasker, No. 2,044,119, issued June 16, 1936 for all controlling mechanisms not herein specifically indicated.

MACHINE OPERATION

Situated at the front of the machine in its base section is a card hopper 1 (see Figs. 1 and 2) adapted to receive a stack of sequentially arranged perforated record cards. The cards are ejected from the hopper 1 seriatim by a picker knife and block 2 connected to a rock shaft 3 through a link 4 and an arm 5 fast to the shaft 3. The shaft 3 is given a reciprocable rocking motion once for each machine cycle by a cam (not shown) on the main cam shaft 6, so that, unless otherwise interrupted, the picker knife 2 will feed the bottom card of the stack out of the hopper 1 and into position for sensing each revolution of the shaft 6. The main cam shaft 6 is a constantly driven rotating shaft geared to an electric motor in a manner not herein shown. For the operation of shaft 6 and all other base mechanisms reference should be made to the previously mentioned Patent 2,044,119. The main operating mechanism of the base in the present machine is identical with that shown in the above patent. After the ejection of the card

from the hopper 1 it is picked up by a pair of constantly driven feed rolls 7 and 8 and thereby fed into a sensing chamber comprised of a pair of perforated plates 9 and 11. A card stop 12, driven from a cam (not shown) on the main cam shaft 6, operates at this time to block the exit of the sensing chamber and retain the card in sensing position. Immediately beneath the sensing chamber is a pin box 13 in which is supported a plurality of sensing pins 14. The pins 14 are arranged in forty-five columns of twelve pins to a column so that the entire card may be sensed with one operation. The pin box 13 is given a vertical reciprocable motion once for every cycle of the cam shaft 6 by an eccentric disc 15 secured to the shaft 6. The pins 14 are urged upwards by springs 16 and are adapted, as the pin box 13 rises on a sensing operation, to pass through the perforations in the plate 11 of the sensing chamber, and also through whatever perforations may be present in the card held in the chamber. Those pins 14 which find no perforation in the card merely press against its lower surface and are ineffective. Cooperating with each column of pins 14 is a locking slide 17, the purpose of which is to impart a positive upward movement to those pins 14 which have passed through a perforation in the card. The locking slide 17 reciprocates horizontally through the pin box 13 and cooperates with the extrusions 18 on the pins 14 in a manner more completely disclosed in the Lasker Patent 2,044,119. After the card has been sensed, the card stop 12 is withdrawn and a pair of spring-pressed rollers (not shown herein) causes the ejection of the card from the sensing chamber into a receiving pocket 19 by way of feed rollers 21 and 22. At the time one card is leaving the sensing chamber another card is being fed in to take its place so that card analyzing may proceed without interruption.

Positioned directly above the sensing chamber is another pin box 23 (Fig. 2) in which is supported a plurality of intermediate pins 24 equal in number and arrangement to the pins 14 of the lower pin box 13. The lower ends of the pins 24 lie just above the sensing chamber and are in alignment with the upper ends of the sensing pins 14. Any pin 14, therefore, which passes through a perforation in the card, will also pass through the perforated plate 9 to contact and elevate its corresponding intermediate pin 24. Associated with each column of pins 24 is a pair of locking slides 25 and 26 adapted to cooperate with extrusions 27 on the pins 24. The locking slides 25 and 26 shown herein are of the type adapted for use with 90-column cards and their construction and operation is briefly as follows: As viewed in Fig. 2 the outer slide 25 is formed with six cam slots 28 on its left-hand side and six open slots 29 on its right-hand side. The inner slide 26 is immediately adjacent the slide 25 and is formed with similar slots 28 and 29, arranged in reverse position to the slots in the outer slide 25. Each column of pins 24 has six extrusions 27 extending in one direction and has the other extrusions extending in the opposite direction. The resulting cooperation between slides 25 and 26 and pins 24 enables both sets of six pins to operate independently of one another. The slides 25 and 26 are spring urged in a right-hand direction (Fig. 2) and serve to engage the elevated pins 24 and retain them in that position until the slides are retracted, at which time the pins will restore to normal through the action of springs 31 on the pins 24. For a more compre-

hensive disclosure of the locking slides 25 and 26 reference is made to the U. S. Patent to Lasker No. 2,151,406 issued March 21, 1939. The retract mechanism comprises in part, a bail 32, a pair of arms 33 (one shown) supporting the bail 32 and a rock shaft 34 to which the arms 33 are secured. The shaft 34 is rocked once for each machine cycle by a cam on the main cam shaft 6 in a manner not herein shown. As viewed in Fig. 2 if the shaft 34 is rocked in a clockwise direction, the bail 32 will force the slides 25 and 26 leftward against the tension of their retaining springs and cause the release of the elevated pins 24. Also associated with each column of pins 24 is a pair of so-called "change-of-designation slides" indicated in Fig. 2 by the single reference numeral 35. The slides 35 are similar in construction to the slides 25 and 26 with the exception that the cam slots cut therein are not of the locking type, that is, their function is not to lock the pins 24 but to coact with extrusions 36 on the pins 24 to cause the displacement of the slides in a leftward direction (as viewed in Fig. 2). The function of these slides 35 is disclosed in the previously mentioned Patent No. 2,151,406 and will be entered into in somewhat greater detail further on in the present description.

Positioned in the mid section of the tabulator is the usual translator 37 in which is supported a plurality of rigid wires 38 for the purpose of transmitting the sensing represented by the elevated pins 24 to the head section of the machine where it is accumulated and printed. The lower ends of the wires 38 lie directly above their respective pins 24 so that the elevation of any pin 24 will cause a corresponding elevation of the associated wire 38. The six wires illustrated in Fig. 2 represent one column of a card. The first five wires from the left represent the numerals 1 to 9 while the extreme right-hand wire, designated by the numeral 33, is a control wire the purpose of which is later to be explained. For the sake of clearness only one column of translator wires is shown in Fig. 2, but it should be understood that the translator is capable of supporting 90 individual columns of wires and that, therefore, the six left-hand pins 24 are adapted to operate a separate column of wires 33-39 (not shown) positioned to the left of the set illustrated and in the same row. Referring now to Figs. 2, 3, 4, and 5 it may be seen that the upper ends of the wires 38 lie just beneath the bars 41 of a stop basket 42. The stop basket may be of the same construction as that disclosed in the patent to Lasker No. 1,780,621, issued November 4, 1930, but the one illustrated herein differs slightly from the basket of the patent although both use the same principle of operation. A stop basket 42 is provided for each computing unit of the tabulator and a stop tray 40, secured between the side frames provides a common support for all of the baskets. In the present instance each basket supports ten denominational columns of stop bars 41. There are five stops 41 to each column plus a normally effective zero stop 43. The essential points of difference between the present basket and that of the Patent No. 1,780,621 lies in the control of the zero stop and the nine stop of each denomination. The nine stop is the extreme left-hand bar 41 (as viewed in Fig. 3) and corresponds generally, in function, to the bar shown in Fig. 2 of the cited patent and indicated therein by the reference numeral 106. As described in the above patent the five digit stops 41 repre-

sent, in order from left to right, the odd numerals 9, 7, 5, 3, and 1. To obtain an even number the odd numbered stop of next lower value is raised in combination with the nine stop of the same denomination. As a result of this operation the digit stops in this denomination are permitted to move a step forwardly to set the differentially settable racks, which they control, to the representation of an even number. As shown in Fig. 3 the nine stop of each denomination is formed with a pin 41A which is normally seated in a notch cut in an arm 41B rigidly supported between the side walls of the basket 42. While the nine stop is thus held all of the stops in that denomination are prevented from shifting forwardly. Elevation of the nine stop will move the pin 41A out of the notch in arm 41B and the stops are free to shift a measured distance in a forward direction. A spring-pressed arm 41C bears upon a second pin formed on each nine stop 41 and serves to restore the stops to normal position. The operation of the zero stops will be considered in a later paragraph. Associated with each column of stops 41 is a type carrying sector 44 pivoted loosely to the shaft 45. Also mounted loosely on the shaft 45, and associated with each type sector, is an actuating sector 46 formed with a slot 47 in its lower horizontal surface. A stud 48 on the sector 44 is passed through the slot 47 and is normally engaged by a latch 49 pivoted at 51 to the actuating sector 46. During normal machine operation, therefore, the sectors 44 and 46 retain the relation shown in Fig. 3 and operate as a unit. Latch 49 and stud 48 may, however, be disengaged during certain conditions of machine operation later to be described. Each sector 44 is urged to move in a clockwise direction (Fig. 3) about its shaft 45 by means of a spring 52 tensioned between a rear extension 53 of the sector 44 and a spring anchor 54. The sectors 44 are, however, normally retained in retracted position against the tension of their springs 52 by a bail rod 55 individual to each unit in the machine. As shown in the drawings, in the extreme retracted position of the sectors 44 the studs 48 thereon are positioned slightly to the rear of the engaging shoulders of the latches 49 in order that the latches may be easily rocked into disengaged position. The bail 55 is supported between a pair of arms 56 (one shown) secured to the shaft 45. The arms 56 and the shaft 45 are rocked in a clockwise direction, and returned, once for each machine cycle, to permit the sectors 44 to move forward to their respective printing position. The amount of movement permitted each type sector 44 on listing operations is individually determined by its associated column of stop bars 41, as previously noted. As shown in Fig. 3 a spring 57 is tensioned between the rear extension 53 of each type sector 44 and one end of a pawl 58 pivoted at 59 to the actuating sector 46. The other end of the pawl 58 engages a notch formed in the previously mentioned latching member 49 so that the tension exerted by the spring 57 provides a resilient force for keeping the latch 49 and the stud 48 engaged, and in addition to that causes the sector 46 to assume a normal position slightly to the rear of the type sector 44. The actuating sector 46 is formed with a downward extension 61 to which is secured a heel 62 which, in the normal position of the sector, lies slightly behind the upraised zero stop 43 and abuts against a tie rod 62A. It is evident, therefore, that while a zero stop 43 is up the pair of sectors 44 and 46

associated with that particular column of stop bars cannot move from normal position. In each separate unit of the machine mechanism is provided for lowering the zero stops 43 either individually, during listing operations, or as a group during total taking operations. As shown in Fig. 3 the zero stop 43 is connected, at its lower end, to one arm of a bell-crank 63 loosely mounted on a shaft 64. A spring 65 tensioned between another arm of the bell-crank 63 and the base plate of the stop basket 42 tends to rotate the bell-crank in a clockwise direction about the shaft 64 and retain the zero stop 43 in its raised position. A third arm of the bell-crank 63 bears against one end of a slide 66 which extends horizontally through the stop basket 42. Each slide 66 is formed with a plurality of cam shoulders 67 (one for each bar 41) which cooperate with pins 68 on the lower portion of each bar 41. The elevation of any bar 41, therefore, will cause the slide 66 to the right (as viewed in Fig. 3) to rotate the bell-crank 63 counter-clockwise (Fig. 3) and cause the withdrawal of the zero stop 43 from its upraised position thus freeing the heel 62 of the sector 46. A rock shaft 69 is rotatably mounted in the side frames of the machine and occupies a position immediately behind the bell-cranks 63. The shaft 69 is known as the rear total shaft and is adapted to be rocked, in a manner later to be described, only during a total taking operation. For each unit of the machine there is provided a pair of arms 71 (one shown) secured to the shaft 69 and supporting between them a bail 71A which normally contacts the rear edge of all the bell cranks 63 in the unit. During a total taking operation the shaft 69 will rock in a counter-clockwise direction (Fig. 3) and the motion thus imparted to the arms 71 and their supported bail 71A will rotate the bell cranks 63 also counter-clockwise to free all of the sectors 44 and 46, as above.

Referring now to Figs. 3 and 6 there is shown therein a portion of the hammer release mechanism and certain drive mechanisms of the head, including the means for reciprocating the bail rod 55. The shaft 72, positioned between the side frames near the rear of the machine, is the main drive shaft of the head and is continuously driven in a clockwise direction (Fig. 3) by a chain of gearing, not shown herein, which has its origin in the base of the machine. As shown in Fig. 6 a cam 73 is secured to the shaft 72 at its extreme right-hand end, and pivotally connected to the outside surface of the cam near its lower edge is a pitman 74 connected at its upper end to an arm 75 secured to a shaft 76. Rotation of the shaft 72, therefore, causes a reciprocatory rocking motion of the shaft 76. Referring now to Fig. 3, a lever 77 is also secured to the shaft 76 and bears on its outer end a stud 78 adapted to cooperate with the rear edge of an arm 79 loosely mounted on the shaft 76. The lower end of the arm 79 is connected to a longitudinal link 81, the front end of which is fastened to one of the arms 56 supporting the bail rod 55. It is apparent from the linkage just described that the shaft 76 will rock in a clockwise direction (Fig. 3) during the first 180° of rotation of the shaft 72 and that during that period the stud 78 will pick up the arm 79 and through the connecting link 81 will cause the bail arms 56 to move forward about their pivot 45 to release the sectors 44 and 46. During the second 180° of rotation of the shaft 72, the shaft 76 returns to normal position thus

permitting the bail 55 to restore the type sectors under tension of spring 82 connected at one end to the link 81 and anchored at its other end to the rear frame of the machine. As shown in Fig. 3 the link 81 extends rearwardly of the arm 79 and limits against a set screw 83 in order to prevent an overthrow of the restoring bail 55. In order to insure an even positive driving action of the bail rod 55 there is provided a pair of levers 77, a pair of arms 79 and a pair of links 81 for each unit of the machine, each link 81 being connected to a separate bail arm 56.

The hammer release mechanism operates as follows: Each of the type sectors 44 is formed with a cam shoulder 84 (Fig. 3) cut in its lower edge and adapted to cooperate with one end of a lever 85 pivoted at 86 to a fixed frame plate. The other end of the lever 85 rests in a comb plate or bracket 87 and lies just under an arm 88 also guided in the comb plate 87. The front end of the arm 88 is pivotally connected to a latch member 89 pivoted at its lower end to a rod 91. The upper end of the latch 89 normally engages a lip on a printing hammer 92 and holds the hammer in ineffective position against the tension of a spring 93. The hammer 92 is further prevented from moving from normal position by a bail 94 supported between a pair of arms 95 (one shown) secured to a shaft 96. The hammer 92 pivots on this shaft 96 and a short extension of the hammer engages the bail 94. The shaft 96 receives a reciprocable rocking motion once for each cycle of the main shaft 72 and thus causes the bail 94 to swing away from the hammer 92, which continues to be held ineffective by the latch 89. It is evident that with the parts positioned as shown in Fig. 3 bail 94 will pass idly over the arm 88. However, if a type sector 44 is permitted to move forward at about the same time the bail 94 begins its forward motion the cam shoulder 84 will rotate the lever 85 a short distance clockwise (Fig. 3) about its pivot 86 and cause a corresponding elevation of the arm 88 and so position the said arm as to enable the bail 94 to strike its rear edge and force the latching member 89 out of engagement with its hammer 92. The spring 93 is then free to exert its tension to swing the hammer 92 about its pivot 96 and causes the hammer to strike whichever type element 97 has been moved to printing position. The type elements 97 record their impression upon a record sheet surrounding a platen 98 in the usual manner. The mechanism for rocking the shaft 96 is shown in Figs. 3 and 7. A longitudinal link 99 is pivotally connected at one end to the arm 79, loosely mounted on the shaft 76, and is resiliently connected at its forward end to another link 101 (Fig. 7) which is in turn connected to an arm 102 fast on the shaft 96. Rotation of the arm 79, therefore, results in movement of the restoring bail 55, as previously mentioned, and also causes the rocking of the bail 94 to release the hammers 92. The bail 94 is common to all of the hammers 92 in one unit and there is also provided a second arm 102, on the opposite end of the shaft 96, and a second set of links 99 and 101 motivated in the previously described manner by the second arm 79.

As shown in Fig. 6 mechanism is also provided for rocking a third operating shaft 103, which is situated near the front of the machine and controls the accumulator timing mechanism. The cam 73, secured to the shaft 72 as previously described, is adapted to cooperate with a roller 104 on one arm of a bell crank 105. The

bell crank 105 is pivoted at 106 to an upstanding bracket 107 secured to the base plate of the head. Pivotaly connected to the other arm of the bell crank 105 is a link 108, which extends towards the front of the machine and is connected at its other end to an arm 109 fast on the shaft 103. With the above linkage positioned as shown in Fig. 6, which is its normal position, the roller 104 is resting on the low dwell of the cam 73 and hence is inactive. During the course of rotation of the shaft 72 the rise on the cam 83 will move under the roller 104 to rock the bell crank 105 counter-clockwise (Fig. 6) and so cause a corresponding rocking motion of the shaft 103. A spring 111 tensioned between a stud 112 on the bell crank 105 and the frame work of the machine serves to maintain the roller 104 in constant contact with its cam 73.

ACCUMULATING MECHANISM

The description of the machine as thus far progressed has been confined to the means for sensing and recording items from a perforated record card. Mechanism is also provided for storing these items in a set of accumulator wheels 113 (Figs. 3 and 4) and for releasing their accumulation during total taking operations. The accumulator employed in the present machine is identical in construction and mode of operation to the accumulator disclosed in the previously mentioned application S. N. 125,375 and is capable of accumulating items of either a positive or negative character. The several units of the machine each contain their own accumulator which is individually operable from a respective field in the card, so that, while a positive item is being accumulated in one unit, a negative item may be accumulated at the same time in another unit. During a total taking operation all of the units clear simultaneously and effect printing of their respective balance, which may be either positive or negative. As shown in Fig. 4, the actuating racks 46 are formed with gear teeth 114 adapted to mesh with and rotate the gear wheels 113. The wheels 113 are normally disengaged from the racks 46 and occupy the position shown in Fig. 4 enmeshed with carry sectors 115. During adding cycles of the machine, the wheels 113 are permitted to remain out of mesh with the teeth 114 during the forward stroke of the sector racks 46 and are caused to engage the teeth at the beginning of the return stroke. At the end of the return stroke they are again disengaged and resume their normal position. During subtracting and total taking cycles the procedure is just the opposite, that is, the accumulating wheels 113 are moved into engagement with the racks at the beginning of their forward stroke and out of engagement at the beginning of the return stroke. The normal function of the accumulator is to operate additively and it will alter its operation only when a special control hole is sensed in a card. A total taking operation is initiated automatically upon a change in the designatory matter of a card.

The shaft 103, which, as previously mentioned, is given a reciprocable rocking motion for every cycle of the main shaft 72 is the equivalent of a similar shaft disclosed in Figs. 1, 3 and 4 of the previous application S. N. 125,375 and indicated therein by the reference numeral 19. Each unit of the present machine is separately controlled by operating mechanism, mounted on the shaft 103, which is identical to that shown in the above application as mounted on the shaft 19. The construction and operation of the accumulator unit

is, briefly, as follows: A pair of frame plates 116 (Figs. 3, 4, and 6 herein) support the mechanism of the accumulator and these plates are themselves supported by cross shafts 117, 117A, and 118 mounted between the side frames of the machine. The accumulator wheels 113 are loosely mounted on a shaft 119 supported between a pair of arms 121 (one shown), one of which is pivotaly mounted on the inner surface of each side frame 116. A downwardly extending arm (not shown) is connected to the left-hand side of the pivoted frame comprising the arms 121 and shaft 119 and bears a roller 122 (Fig. 7) midway along its surface. The roller 122 rests on the upper edge of a cam plate 123. The cam plate 123 is secured at its middle to a shaft 124 and is adapted to be rocked in a manner not completely shown herein by an arm 125 secured to the shaft 103. The motion of the cam plate 123 as it is rocked from normal is clockwise, as viewed in Fig. 7, the arm 125 being ineffective on the forward stroke of the shaft 103. Clockwise motion of the cam plate 123 causes a rise formed thereon to move under the roller 122, thus forcing upward the roller, the arm supporting the roller and the arms 121 which support the shaft 119. The above operation causes the engagement of the wheels 113 with the racks 46 at the beginning of the return stroke of the racks which, as explained above, is its adding operation. The wheels 113 are withdrawn from engagement with their racks at the end of the return stroke by a link 126 connected at one end to the cam plate 123 and connected at its other end, by means of a pin and slot connection, to an arm 127 secured to the shaft 103. As explained more fully in the above mentioned previous application, the arm 127 engages the link 126 positively at the end of the return stroke of the racks 46 and causes the cam plate 123 to rock in a counter-clockwise direction (Fig. 7) to permit the roller 122 to descend from its raised position and so disengage the wheels 113 from the teeth 114. During subtraction operations the mechanism described above is disabled and a separate chain of actuating mechanism is rendered effective to engage the wheels 113 and the racks 46 at the beginning of the forward stroke and to cause their disengagement at the beginning of the return stroke. The arm 125 comprises one arm of a bail-shaped rock lever, the other arm of which is indicated at 128 in Fig. 7. A wipe pawl 129 is pivotaly connected to the rear end of the arm 128 and is adapted to cooperate with an assembly of plates comprising two pin carrying plates 131 and 132 loosely mounted on the shaft 124 and a third plate 133 which is slotted to engage pins on the plates 131 and 132 and a stud 134 on the cam plate 123. A spring 135 tensioned between the upper portion of the cam plate 123 and an arm (not shown) of the slotted plate 133 tends to retain the plate assembly 131, 132, and 133 in the position shown in Fig. 7. With the plates thus positioned, the wipe pawl 129 will pivot idly about the pins on the plates 131 and 132 and will move from and return to its normal position without altering the position of the cam plate 123. If, however, the slotted plate 133 is moved downwardly by means of a lever 136, against the tension of the spring 135, the pin plates 131 and 132 will pivot from their normal position and enable the pins carried thereon to be positively engaged by shoulders on the wipe pawl 129, on both the forward and return stroke of the shaft 103. Downward motion of the plate 133 serves to disable the first mentioned actuating means, including the arm 125, in a manner not

shown herein, but which is fully disclosed in the application S. N. 125,375. Operation of the lever 136, therefore, will render ineffective one train of accumulator timing mechanism and render effective another train of mechanism. The lever 136 is adapted for operation only during subtract and total taking cycles.

As mentioned earlier in the specification each subtract item which is punched in a card, must also have punched in the same field a special control hole, the ultimate function of which is to cause the operation of the lever 136 and so permit the accumulator timing mechanism to function subtractively.

As shown in Figs. 2 and 6, the special control wire 39 is located at the extreme right-hand side of the translator 37 and is provided with a block 137 secured to the wire 39 near its upper end. A lever 138 (Fig. 6) pivoted at 139 to the inner frame of the translator 37, is provided with a stud 141 at one end which overlies the block 137. The forward end of the lever 138 extends through the frame of the translator and overlies a stud 142 on an arm 143 loosely mounted on a shaft 144 supported by brackets 145 fastened to the underside of the base plate of the head. A spring 130 tensioned between the arm 143 and a fixed plate 140 tends to retain the arm 143 in normal elevated position. Pivotally connected to the right hand end (Fig. 6) of the arm 143 is a link 146 extending upwardly through an opening in the base plate of the head and connected at its upper end to an arm 147 secured to the right hand end of a shaft 148 loosely supported between the frame plates 116. An individual shaft 148 is provided for each accumulator in the machine. In tracing the above linkage through an operation it is apparent that, when a special control hole is sensed in a card, the wire 39 and the block 137, integral therewith, will be moved upward to rotate the lever 138 about its pivot 139 a short distance in a counter-clockwise direction, (Fig. 6) thereby depressing the arm 143 against the tension of spring 130, and, through the connecting link 146, rock the shaft 148 in a clockwise direction (as viewed in Fig. 6). Individual subtract mechanism, including a wire 39 and associated linkage, is provided for each computing unit of the machine. As shown in Fig. 7 an arm 149 is secured to the left hand end of the shaft 148 and one end of a link 151 is connected to the lower end of the arm. The link 151 extends rearwardly and is operatively associated, through a pin and slot connection, with one arm 152 of a bail shaped member 153. The member 153 is pivoted at 154 to a stud in the frame member 116 and is formed with another arm 136, which, as previously described, is the operating medium for depression of the plate 133. As viewed in Fig. 7, the direction of rotation of the shaft 148, as it moves from normal position, is counter-clockwise so that actuation of lever 138, as previously described, will operate lever 136 in the desired manner.

In the accumulator of the previous and present application there is provided a single wheel-delayed carry transfer mechanism adapted to function during both adding and subtracting operations of the machine. The construction and operation of the tens carry mechanism employed herein is fully disclosed in my previous application S. N. 125,375 so only a brief description of the mechanism will be included in this specification. As previously mentioned, the accumulating wheels 113 are normally in mesh with a set of

four toothed carry sectors 115 (see Figs. 3 and 4). The carry sectors 115 are loosely mounted on a shaft 155 rigidly supported between the frame members 116. Fastened to the forward end of each of the carry sectors 115 is a spring 156 connected at its other end to a movable spring tensioning bail 157. The spring bail 157 is supported by arms 158 pivotally connected to the side frames 116 (see Figs. 4, 6, and 7), and normally occupies the position shown in Fig. 4 wherein it tends to impart a counter-clockwise motion of rotation to the carry sectors 115. In order to retain the sectors 115 in normal position, against the tension of springs 156, an arm 159 of each sector 115 is normally engaged by a latch 161 associated with the accumulating wheel 113 of the next lower denominational order, and pivoted on a rod 162 supported between the frames 116. Also associated with each wheel 113 is a trip pawl 163 pivoted to a rod 164 and formed with an upstanding cam tooth 165 which normally engages a wide tooth (not shown) on the wheel 113. The tooth 165 and the wide tooth on the wheel 113 are normally held in positive engagement by a bail 166 which extends under the rear edge of all the trip pawls 163. The bail 166 is supported between rear extensions of the pair of arms 121, which support the shaft 119, so that the trip pawls 163, the bail 166 and the wheels 113 all retain the same relative position as the wheels are moved into engagement with the racks 46. As shown in Figs. 4 and 7, the bail 166 is moved out of its retaining position, at about the same time the wheels 113 reach engaging position with the teeth 114, by a slide 167 pivotally mounted on the cam plate 123, and a bell crank 168 operable by slide 167. The bell crank 168 is secured to the same shaft to which the bail 166 is fastened. The shaft is indicated in the drawings at 169. The motion of cam plate 123 as it moves from normal, therefore, will disable the retaining bail 166 and free the trip pawls 163, although the pawls 163 and the wheels 113 will retain their same relative position for the moment. When, however, one of the wheels 113 is caused to rotate beyond its zero position, in either direction, the wide tooth on the wheel 113 will strike the cam tooth 165 and force the tooth out of the path of the wheel thereby rotating the entire pawl 163 a short distance in a clockwise direction (Fig. 4), about its pivot 164 in which position it will be retained by a latch member 171. Now, as the wheels are returned to normal, out of engagement with the rack 46, the lower edge of the displaced trip pawl 163 will strike a forwardly extending arm 172 of the latch 161 of next higher denominational order to cause the disengagement of the latch 161 and the arm 159 thus freeing the sector 115 and allowing it to rotate under the tension of the spring 156 a distance limited to one tooth space by shoulders cut in the latch 161. The wheels 113 are fully restored to normal just prior to the release of the sectors 115 so that the carry motion of any sector 115 is transmitted directly to its associated accumulator wheel 113. A cam slot 173 is cut in each of the carry sectors 115 and a shaft 174, supported between arms 170 (one shown) pivotally mounted on the side frames 116, cooperates with the slots 173 to return the sectors 115 to normal and to release the trip pawls 163. The shaft 174 is connected by a link (not shown) to the cam plate 123 and is moved thereby into the lowermost portion of the slot 173, and returned, once for each

cycle of the main shaft 103. The trip pawls 163 are reset during the same machine cycle in which they are tripped while the carry sectors 115 are not reset until the accumulating wheels 113 move from normal position on the following cycle. The spring tensioning bail 157 is, as before stated, pivotally mounted on the side frames 116 and is adapted, during subtracting cycles, to be shifted to the position shown in Fig. 8. When the bail 157 is in subtract position, the tension imparted to the carry sectors 115 is clockwise (as viewed in Fig. 4). Referring now to Fig. 6, mechanism is provided for shifting the spring bail 157 from add to subtract position automatically when a negative control hole is sensed in a card. As previously described the elevation of special control wire 39 causes the arm 147 and the shaft 148 to which the arm 147 is secured to rock in a clockwise direction and alter the timing of the accumulator actuating mechanism. Pivotaly connected to the rear end of the arm 147 at the same point where the link 146 is connected is a downwardly extending slide 175 slotted at its lower end to engage a stud 176 fixed on the outside of the right hand frame member 116. A rearwardly extending arm 177 of the slide 175 engages, through a pin and slot connection, a triangular shaped operating member 178. The upper end of the member 178 is formed with a hook 179 on its left-hand end and a similar hook 181 on its right-hand end adapted to cooperate with pins 182 and 183 respectively, on a swinging lever 184 pivoted at 185 to the frame member 116. The lever 184 is formed with a forwardly extending arm 186 which is slotted at its forward end to engage a pin 187 on one arm 158 supporting the spring bail 157. The operating member 178 is connected at 188 in a manner not herein shown, to the shaft 174, and through it receives a downward pulling motion once for every complete operation of the shaft 103. When the above linkage occupies its normal adding position (Fig. 6) the hook 179 on the member 178 and the pin 182 on the lever 184 are in effective cooperative position while the hook 181 and the pin 183 are in ineffective position. When the operating member 178 is actuated while in its adding position, therefore, the hook 179 will engage the pin 182 at about the end of its (the hook's) stroke and serves no purpose other than to retain the bail 157 in the position it now occupies. If, however, a subtract item is to be entered into the accumulator, the arm 147 of that unit will be rocked, as previously described, the slide 175 will be depressed and through its arm 177 shift the member 178 rearwardly about its pivot 188 to a point where the hook 181 lies just above the pin 183 and at the same time render the hook 179 and the pin 182 ineffective. Now, if the actuating member 178 is pulled, the lever 184 is given a positive actuating movement about its pivot 185 and the arm 186 rises upward carrying with it the spring bail 157 to shift it to subtract position. The spring bail shift mechanism just described is returned to normal after each subtract operation by the previously mentioned spring 130.

With the exception of the controlling means for instituting a subtract operation, the accumulating mechanism of the present machine is the same as that disclosed in the previously mentioned application S. N. 125,375.

TOTAL TAKING MECHANISM

The machine of the present invention is adapted

to take totals automatically from a change in the designatory matter on a card. The mechanism for performing this function is old and well known in the Powers machine and is fully disclosed in the patent to Lasker 2,044,119. The total taking mechanism comprises, briefly, a normally inactive cam and ratchet unit under the control of a cam on the main cam shaft 6 (Fig. 1) and adapted to be tripped and thus made active through movement of the change of designation slides 35. When it is desired to take totals by this method all of the cards to be fed through the machine are punched with a designating number. Any column or columns on the card may be used for this purpose, but the same columns must be used throughout one set of cards. In the usual accounting problem, the items to be listed and accumulated will fall into a plurality of separate groups or divisions and ordinarily it is desirable to clear the accumulators after each group has been tabulated and to print that total on the record sheet. Each group may be designated by a different serial number and each card of a group will bear the number assigned to that group. Before tabulation the cards must first be sorted according to serial numbers in order that all the cards belonging to one group will be arranged together. As previously stated each time a pin 24, of the upper pin box 23, (Fig. 2) is raised the change of designation slide 35 associated with the same column as the raised pin will be cammed leftward or toward the front of the machine. Positioned above and to the front of the pin box 23 is a plurality of hand settable slides 189 each of which pivotally supports a dependent interponent 191. A slide 189 and an interponent 191 are provided for each column of the card. The normal position of each slide 189 is the position shown in Fig. 2 with the lower end of the interponent 191 just above and in front of the nose of its respective slide 35. When the operator of the machine has determined in which columns of the card the group serial numbers appear, he selects and depresses the corresponding slides 189. The interponent 191 for each of the depressed slides is thus lowered from its normal position and lies directly in the path of its slide 35. A spring detent 192 serves to retain the slide 189 in either of its set positions. Also in the path of the slides 35, but beyond their scope of movement, is a bail 193 supported between a pair of arms 190 (one shown) secured to the shaft 194. The interponent 191 is lowered between the slide 35 and the bail 193 so that motion of the slide 35 will be imparted directly to the bail 193 and through its supporting arms to the shaft 194. The slides 189 are set to lowered position before the machine is started so that as the sensing pins rise on the first card, the slide 35 is cammed out of its normal position to trip a total and, when the pins 24 reach their extreme elevated position, returns to normal. As fully explained in the Patent 2,044,119 the retraction of the locking slides 25 and 26 occurs at a time when the sensing pins 14 are in approximately their highest elevated position. It is apparent, therefore, that, in sensing for a designating number, if the same sensing pins 14 are permitted to pass through successive cards, then the original pins 24 will not be permitted to descend and the extrusions 36 on each elevated pin 24 will remain in the upper portion of its associated cam slot in the slide 35. As soon as all the cards of one group have been listed the first card of a new group, bearing a new serial number, will appear. A new set of pins 14 will pass through the card, a

new set of pins 24 will be elevated and the old pins 24 will descend to normal. Either the ascent of the new pins or the descent of the old pins may cam the slide 35 leftward and in either case the result is the tripping of a total, as described above.

A complete view of the mechanism of the total unit is not included in this application, only one cam of the complete assembly being shown here. The cam 195 shown in Fig. 2 is the total pull cam of the total unit and it is adapted to cooperate with an arm 196 pivoted at 197 and bearing, at one end, a roller 198 which is spring urged to follow the contour of the cam. A link 199 is connected to the other end of the arm 196 and extends upwardly and forwardly in the machine (see Figs. 2, 3, and 4) where it is connected to an arm 201 secured to a rock shaft 202 pivotally supported between the side frames of the head. It is apparent that when a high point of the cam 195 passes under the roller 198 on the arm 196 the arm 196 will pivot in a counter-clockwise direction (Fig. 2) to pull the link 199 downward and so rock the shaft 202 a short distance in a clockwise direction (Fig. 4). One arm 201 is secured to the shaft 202 for each unit of the machine, for a purpose later to be described. There is, however, but one link 199 for the purpose of rocking the shaft 202. The shaft 202 may be called the total shaft of the machine since the rocking motion thus imparted to it is employed to clear the accumulators and condition the machine for a new series of listing operations. As shown in Fig. 7, the motion of the shaft 202 is also used to rock the previously mentioned rear total shaft 69 to depress the zero stops 43 during total strokes. An upstanding arm 50 is secured to the shaft 202 near its left-hand end and the upper end of the arm is pivotally connected to a long rearwardly extending link 60, the rear end of which is connected to a downwardly extending arm 70 fast on the shaft 69. Counter-clockwise rocking motion (Fig. 7) of the shaft 202, therefore, will be transmitted through arm 50, link 60 and arm 70 to the shaft 69 to rock the latter shaft a short distance in a clockwise direction. As shown in Figs. 4 and 7 a short rearwardly extending arm 203 is also secured to the shaft 202, near its left-hand end, and is connected at its free end to an upwardly extending link 204. The link 204 is connected, at its upper end to an arm 205 fast on another rock shaft 206. The shaft 206 is loosely supported between the main side frames of the machine. Also secured to the shaft 206 is an upstanding arm 207 pivotally connected at its upper end to a long rearwardly extending link 208 supported at its rear end by a fixed bracket (not shown) in such a manner as to permit horizontal sliding movement of the link. As viewed in Fig. 7 a counter-clockwise motion of the shaft 202 will rock the shaft 206 in the same direction (through link 204) to force the slide or link 208 rearwardly. Positioned on the side of the slide 208 is a stud 209 which is adapted, when the slide 208 is actuated, to contact an arm 211 formed on the lever 136 and to rotate the said lever 136 counter-clockwise about its pivot 154 to depress the plate 133 and render the wipe pawl 129 effective, as previously described. The above operation results in the engagement of the wheels 113 with their actuating racks 46 at the beginning of the forward stroke of the racks. An additional function of the slide 208 is to prevent the disabling of the locking bail 166 in order that the wheels 113 may be returned to a positive zero position

and thus accurately position their associated type sectors 44. This is done through a pin 212 positioned on the side of the slide 208 and a cooperating cam slot 213 cut in the previously mentioned slide 167. When the slide 208 is shifted rearwardly the pin 212 is moved into position where it may be engaged by a raised portion of the slot 213 and so force downward the slide 167 to a point where its operating arm is unable to contact the bell crank 168, and, therefore, cannot rock the shaft 169. The shaft 206, as previously noted, extends between the side frames of the machine and for each computing unit there is provided an arm 207 and slide 208. Each unit is identical in its operation to the one described above.

TRUE NEGATIVE TOTAL PRINTING MECHANISM

The accumulating mechanism thus far described is the same as that disclosed in the previously mentioned application S. N. 125,375 with the exception that subtract and total taking operations are initiated automatically from perforated record cards instead of manually through the depression of a key. However, the machine of the earlier application was not particularly well adapted for the printing of negative totals. In the above application, if a total was caused to be taken while a negative balance was in the accumulator, the amount printed would not be the true algebraic total but the complement of the true amount. Mechanism was provided whereby a negative total could easily be recognized as such, and then it had to be visually translated by the operator into the true algebraic representation. In the present machine novel printing mechanism has been evolved which operates without a change in the old accumulator and which operates effectively to print a true algebraic total upon every total taking operation of the machine, regardless of whether the balance contained in the accumulator is of a positive or negative character.

As shown in Figs. 4 and 9, herein, each of the type sectors 44 carries two separate sets of type elements 97 and 214. The upper set of elements 97 is arranged in the usual order from zero to nine, while the lower set of elements 214 is arranged in opposite numerical progression, that is, from nine to zero. A blank space 215 separates the two sets of elements and an additional zero element precedes the nine element of the second set. The type sectors shown in Fig. 9 illustrates the exact arrangement of all of the above mentioned elements 97 and 214. In all listing and positive total taking operations printing is effected through the upper set of type elements 97 while the lower set 214 is latched in ineffective position. However, if a total is taken while the accumulator contains a negative balance, printing will be effected through the lower set of type elements 214 while the upper set 97 will be raised beyond the range of the printing hammers 92 and hence rendered ineffective.

Referring now to Figs. 4 and 8, the carry sectors 115 are, as previously described, under the control of the shiftable spring tensioning bail 157 and the latches 161. The carry sectors, therefore, have three different positions. They have, first, a normal position at which time the latches 161 are effective and the springs 156 ineffective, second, with the latches 161 ineffective and the spring bail 157 in add position, and third, with the latches 161 ineffective and the spring bail 157 in subtract position. It should be understood that the latches 161 operate independently

of one another, as do the carry sectors 115. It should also be understood that when the accumulator wheels 113 are overrun in a negative direction all of the carry sectors to the left of the highest significant order will move in a subtract direction and assume the third position noted above. In Fig. 8 hereof the carry sector 115 of highest denominational order is shown in the position it assumes immediately following an operation which causes the wheels 113 to overrun in a negative direction. The dotted circles N and A in the same figure represent respectively the normal and add positions of the same carry sector 115. The carry sector 115 of highest denominational order bears a stud 221 (Figs. 4, 8, and 14) on its lower front surface which is adapted to cooperate with a pair of fingers 222 and 223 formed in a latch 224. The latch 224 is pivoted near its mid-point at 225 to a small frame member 226 fixed to the base plate of the head. The front edge of the latch 224 is formed with a pair of detent notches adapted to cooperate with a roller 227 on the upper end of an arm 228 pivoted to the frame 226. A spring 229 tensioned between the arm 228 and the frame 226 serves to retain the roller 227 in constant contact with the front edge of the latch 224. As viewed in Fig. 4 the carry sector 115 is in its normal position with the finger 222 resting directly on the stud 221. If, however, the spring bail 157 is shifted into subtract position and the accumulator "goes negative" then the latch 161 associated with the sector of highest order will be disabled and permit its sector 115 to move in a clockwise direction about its pivot 155 until it reaches its full carry position (Fig. 8). The latch 224 is thus caused to rotate, with the sector 115, in a counter-clockwise direction (Fig. 4) about its pivot 225 until the roller 227 on the arm 228 engages the upper detent in the front edge of the latch (Fig. 8). The latch 224 will remain in its raised position until the accumulator changes its registration from negative to positive, at which time the stud 221 on the last sector will lie in the position marked A in Fig. 8. In moving from N to A the stud 221 will pick up the arm 223, rocking it downward and thus restore the latch 224 to normal. Positioned on the lower rear surface of the latch 224 is a stud 231 which normally lies in the path of a bent-over lug 232 formed at the front end of a horizontally movable slide 233 (see also Fig. 14). Also normally in the path of the lug 232 is an arm 234 pivoted at 235 to the frame plate 226, and urged to retain its normal position by a spring 234A. A lever 234B is also pivoted at 235 and is formed with a rearwardly extending bent over portion 234C which lies under the arm 234. The forward end of the lever 234B is pivotally connected to an upstanding arm 236 connected to the rear end of one of the previously mentioned arms 201 secured to the total shaft 202. It is apparent that the rocking of the total shaft 202 (clockwise as viewed in Fig. 4) will rotate the lever 234B in a counter-clockwise direction, about its pivot 235, thus elevating the arm 234 in the same direction out of the path of the slide 233. As shown in Figs. 4 and 5 the slide 233 extends rearwardly through the machine and is loosely supported by rods 237 and 238 which form a part of the stop basket 42, and by cross bars of the stop tray 40 (not shown in full) which supports all of the stop baskets 42. Resiliently connected to the rear end of the slide 233 is a link 239 formed with two slots 241 each of which is adapted to

cooperate with studs 242 formed on the side of the slide 233. A spring 243, tensioned between dependent arms of the slide 233 and the link 239 normally serves to maintain the studs 242 in the forward end of the slots 241. The rear end of the link 239 is connected to a short forwardly extending arm 244 the front end of which is, in turn, connected to an upstanding lever 245 (see Figs. 5 and 10). The lever 245 is pivotally connected at its upper end to a stud 246 (Fig. 10) secured to an auxiliary frame member 247 fastened to a pair of cross bars 248 and 249. As shown in Fig. 10 there are two auxiliary frame members 247 for each computing unit of the machine. Both are fastened to the cross bars 248 and 249. Referring again to Fig. 5 the lever 245 bears a roller 251 which rides in a grooved box cam 252 secured to the main head shaft 72. The normal position of the cam 252 is shown in Fig. 5 with the highest portion 253 bearing directly on the roller 251. When the shaft 72 begins to rotate, however, the roller 251 rides off of the rise 253, causing the lever 245 to move in a clockwise direction about its pivot 246 to draw the link 239 forward. The spring 243, connecting the link 239 and the slide 233, will tend to carry the slide 233 forward also, but, if either the arm 234 or the latch 224 are in their normal blocking positions, the slide 233 will be held in its original position, against the tension of the spring 243. This attempted reciprocation of the slide 233 occurs once for every cycle of the shaft 72. It is apparent, however, that the only time at which the slide 233 will be permitted to complete a full forward stroke is when the latch 224 has been raised to subtract position (at which time the stud 231 will be out of the path of the lug 232) and the total shaft 202 rocked while the latch 224 is held out of blocking position.

Also secured to the shaft 72 is another cam 254 adapted to cooperate with a roller bearing arm 255 loosely mounted on a rock shaft 256 supported between a pair of brackets 259 (one shown) dependent from the cross bar 248. A spring 257 tensioned between the arm 255 and a stud on the cross bar 248 serves to maintain the roller on the arm 255 in constant contact with the cam 254. The arm 255 is reciprocated about its pivot 256 by the cam 254, once for each cycle of the shaft 72. Rigidly secured to the shaft 256 is a short, downwardly extending finger 258 lying in approximately the same plane as the arm 255 but with a distance separating the two members that about equals the distance moved by the arm 255, when the high point of the cam 254 engages its roller. The purpose of the arm 255 is to rock the finger 258 and hence the shaft 256, on negative total taking operations. During all listing and positive total taking operations the arm 255 reciprocates ineffectively and the shaft 256 remains motionless. As shown in Fig. 5 a slide 259 is mounted on a bracket 260, (shown in Figs. 12 and 13), fixed to the rear of the stop tray 40, in such a manner as to permit the slide 259 to move vertically with respect to the bracket 260. Pivoted to the upper end of the slide 259 is an interponent 261 which has its upper end bent over in the form of a lug 262. A spring 261A, tensioned between the lower end of the interponent 261 and a stud on the slide 259 tends to maintain the interponent in vertical alignment with the slide. Positioned on the lower end of the slide 259 is a roller 263 which is urged into contact with the lower edge of the slide 233 by a spring 264 tensioned between a stud on the rear

of the slide 259 and the shaft 256. The lower edge of the slide 233 is formed with a cam surface 265 along which the roller 263 is permitted to ascend only during a negative total taking operation. When the slide 233 moves forward and the roller 263 ascends the cam surface 265, the interponent 261 will rise and position its turned over lug 262 between the arm 255 and the finger 258 so that clockwise motion (Fig. 5) of the arm 255 will be transmitted through the interponent 261 to the finger 258 and result in a similar (clockwise) motion of the shaft 256.

Also secured to the shaft 256 is a pair of arms 266 (one shown) which support between their forward ends a bail 267 positioned directly under a plurality of slides 268. There is one slide 268 for each denominational order of a computing unit, that is, one for every type sector 44. The slides 268 are formed with downward extensions 268A guided in the stop basket 42, each extension being connected to an arm on the bell crank 63 by a spring 240. Each slide 268 is resiliently associated with an elevating member 269 through pin and slot connections and a spring 271. Clockwise rocking motion of the shaft 256, therefore, will elevate all of the slides 268, and also the elevating members 269, through springs 271. The upper edge of each member 269 is normally positioned just under a stud 272 on the previously mentioned latch 49. Elevation of each member 269 will, therefore, cause its associated latch 49 to rock counter-clockwise about its pivot 51 and move out of engagement with the stud 48 on the type sector 44. The type sectors 44 are thus free to move forward, without the actuating racks 46, under tension of their springs 52. Each type sector 44 is formed with a rearwardly extending portion 273, the rear end of which is formed as a cam-like book. The computing unit in which the above operation has taken place is now conditioned to print a true negative total, and it will be seen that as the restoring bail 55 swings upward, as previously mentioned, all of the sectors 44 will follow in the usual manner and the studs 48 of the released type sectors 44 will move forward in the slots 47 of the stationary actuating sectors 46 until they reach a point just short of the forward end of the slots. At this point the hook-like ends of the extensions 273 will engage the studs 272 of the latches 49 and each pair of sectors 44 and 46 will move forward together a distance determined by the number of tooth spaces required for their associated wheel 113 to return to normal. The zero stops 43 have, in the meantime, been withdrawn in the previously described manner. As shown in Fig. 5 each of the members 269 is formed with a forwardly extending arm 270 along which the stud 272 rides and which acts to retain the stud 272 and the book on 273 in positive engagement. At the time the extensions 273 engage the studs 272 the type sectors 44 have progressed upward to such an extent that the lower sets of type elements 214 are in printing position and the upper sets of elements 97 are ineffective. If an actuating sector 46 were to be held immovable at this time, the first type element (zero) of the lower set would be aligned in printing position. One step of movement would bring the nine element into printing position, two steps, the eight element, and so on.

In considering the above linkage it is evident that if this were the only mechanism provided for printing a true negative total, the printed balance would still be inaccurate in nearly every case, since each sector 44 would print the tens

complement of the amount in the accumulator, whereas the true negative total must be represented by a nines complement in all denominational orders to the left of the lowest significant order. It is evident that in a negative total operation which involved the printing of just one significant numeral, and that one numeral appeared in the highest denominational order, then the balance would be represented as a full tens complement and the above mechanism would be adequate for the operation. The number 1,000,000,000, for example, would be printed as a full tens complement. However, in order to insure the printing of a true balance upon every negative total taking operation of the machine, mechanism is provided for permitting all of the type sectors 44 to the left of the lowest significant order to move one additional space when printing a negative total. Positioned just above each of the studs 272 is the forward end of a lever 274 (Figs. 5 and 10) pivoted to a shaft 275 secured between the auxiliary frames 247. The lever 274 extends rearwardly of the pivot 275 and has connected at its rear end a vertical arm 276 guided in a bracket 277. Resting on the upper end of each of the arms 276 is a carry link 278 also guided in slots in the bracket 277. The forward end of each link 278 is connected to one arm 279 of a bell crank pivoted on the shaft 275. The other arm 281 of the bell crank overlies a rear extension of the elevating member 269 associated with the next higher denominational order and is adapted to depress it through the following means. Secured to a shaft 282, loosely supported between the side frames of the machine, is an arm 283 bearing a roller 284 on its lower end which is constrained through a spring 285 to contact the outer surface of the box cam 252. The outer surface of the cam 252 is formed with a rise 286 adapted to pass under the roller 284, and, in so doing, rock the shaft 282 in a counter-clockwise direction (Fig. 5). Also secured to opposite ends of the shaft 282 is a pair of arms 287 (one shown) which support between their upper ends an actuating bail 288. Under normal conditions of operation, the actuating bail 288 is positioned directly behind the rear edges of the carry links 278 and is adapted when reciprocated by the shaft 282 to propel the links 278 forward and rotate the bell cranks 279 and 281 counter-clockwise about their pivots 275 to depress the members 269. This motion occurs with every cycle of the main shaft 72 but if no members 269 are raised the motion is, of course, ineffective.

A spring 289 tensioned between the lever 274 and the link 278, acts to maintain the link and the arm 276 in contact. Another spring 291, tensioned between the arm 279 and the lever 274 maintains the bell crank 279 and 281 and the carry link 278 in normal position, and also serves to keep elevated the rear end of lever 274. A comb plate 280, supported between the frames 247, guides and limits both the lever 274 and the bell crank 279—281.

Returning now to the previously described operation involving the elevation of the members 269 and the consequent disabling of the latches 49, it is apparent that as the studs 272 are raised the levers 274 will pivot in a clockwise direction (Fig. 5) about the shaft 275 and thus lower the arms 276 and the carry links 278 which the arms support. The links 278 are thus placed below the range of the actuating bail 288 and as long as the studs 272 remain below the forward end of their respective levers 274, and in elevated position, 75

restoration of slide 233 through the action of its spring 234A.

True negative total printing mechanism, identical to that just described, is provided for each computing unit of the machine. Each unit is individual with respect to both its controls and its operation and all units are adapted to clear simultaneously during a total taking operation. The balance printed in each unit may be either negative or positive and in either case the operation of one unit will not affect the operation of another.

Example of true negative total printing operation

In order that the essential purpose and function of my invention may be easily understood the following specific example of a negative total taking operation is included in the specification.

Assume that a series of algebraic items have been entered into an accumulator and that the amount now contained therein is a positive five hundred and seventy-nine (579). Now assume that another card is fed into the sensing chamber and a negative amount of six hundred and twenty-five (625) is entered into the same accumulator as above. Since the amount subtracted from the wheels is greater than the amount already contained therein it is evident that the accumulator will register a negative balance and if a total taking operation is initiated at this point the above described true negative total printing mechanism will automatically be rendered effective. The problem to be performed may be represented as follows:

579	Positive amount	35
625	Negative amount	
999999954	Complementary balance set up in accumulator	
000000046	True negative total	40

During the carry operations incident to the entry of the above negative amount, the carry sector 115 of highest denominational order will rotate to subtract position and thereby elevate its associated blocking latch 224 out of the path of the slide 233, in which position it will be retained by the detent 228. Now, when the total shaft 202 is rocked and the blocking arm 234 moves out of normal position, the slide 233 is free to complete a full horizontal stroke and so permit the roller 263 on the vertically movable lever 259 to ascend along the cam surface 265 and position the interponent 261 between the arm 255 and the finger 258. Actuation of the arm 255, by the cam 254, follows immediately and causes the shaft 256 to rock and elevate all of the members 269 associated with that particular computing unit. All of the latches 49 will consequently be rendered ineffective and when the bail rod 55 swings upward, the type sectors 44 will follow under tension of their springs 52. Extensions 273 will finally engage the studs 272, on the latches 49, thereby picking up the actuating sectors 46, so that all of the sectors 44 and 46 will move forward together to position the proper type elements 214. The actuating sector 46 of lowest denominational order will be permitted to move four tooth spaces before the carry lug on its associated accumulating wheel 113 reaches zero. By referring to Fig. 9 and counting down four spaces from the top zero position of the lower group of elements it will be seen that the above four spaces of movement will position the type element six (6) at the printing line. Forward motion of the lowest

the links will remain in this ineffective position. Now, as the sectors 44 swing forward with the bail 55, the extensions 273, thereof, will engage the studs 272 and, in all those denominational orders which are not forced to remain at zero, the sectors 44 and the racks 46 will move forward together. Considering now the lowest significant order, it will be seen that, as the stud 272 leaves its normal position, under the lever 274, the lever will rock back to normal under the tension of spring 291 and thus elevate its associated link 278 again into the path of the bail 288. Immediately following this movement the bail 288 is actuated to propel the link 278 forward and rock the bell crank 279 and 281 counter-clockwise (Fig. 5) about its pivot 275 to depress the next higher order elevating member 269. Depression of this elevating member 269 will cause its associated latch 49 to rock in a clockwise direction about its pivot 51 (through spring 57 and pawl 58) to release the hooklike extension 273 and permit the stud 48 on the type sector 44 to move to the full extent of the slot 47, thus providing the extra necessary step of movement to the sector 44 which will enable it to print a nines complement of the amount contained in the accumulator. It is evident that the sector of lowest significant order will not be released in the above manner and it will print a tens complement in the manner previously described. The actuation of the bail 288 is in such timed relation to the actuation of the bail 55 that the link 278 is propelled forwardly immediately after its elevation to effective position. Therefore, by the time the stud 272, of the next higher order, has moved one tooth space, its supporting member 269 will be forced down and the sector 44 released. Fig. 11 hereof shows the true negative total printing mechanism in operative position just prior to the actuation of the bail 288. As shown in Figs. 5 and 10 each of the carry links 278 is formed with a bent over ear 292, the forward end of which lies directly behind an open shoulder of the link 278 of next higher order. Forward motion of any link 278, therefore, will be imparted through the ear 292 to all of the links 278, to the left of the first operated link. The ear 292 and the shoulder of each link 278 are so arranged that even if a link is out of effective relation with the bail 288, the link may still receive and transmit the above described carry motion. All of the sectors 44 to the left of the lowest significant sector, therefore, will print a true nines complement, even though the normal function of some of those sectors would be to remain at zero. At the end of each negative total taking operation the enabling mechanism therefor is restored and completely reset through the operation of cams 252, 254 and the restoring bail 55. The bail 55 picks up all of the sectors 44 and 46 and returns them to normal, permitting the latches 49 to reengage their studs 48 and causing the sector heels 62 to again assume their normal position just to the rear of the upraised zero stops 43 (Fig. 5). The elevating members 269 are returned to normal through springs 240, just prior to the complete restoration of the sectors 44 and 46, when the roller on arm 255 rides off of the rise on its cam 254. A short time after the release of members 269 the high point 253 of the box cam 252 engages the roller 251, causing the slide 233 to be retracted and forcing down the interponent slide 259. The blocking arm 234 will, of course, return to its original position immediately upon the

order sector 46 will re-establish lever 278 in effective position and permit its actuation by the operating bail 288. In the present example all of the sectors 44 will have moved forward so that all of the levers 278 will be in effective position, and an operation of the carry lugs 292 is unnecessary. All of the bell cranks 279-281 will be rotated counter-clockwise (Fig. 5) about their pivot 275, against the tension of springs 291, and all of the elevating members 269 to the left of the lowest order member will consequently be depressed against the tension of springs 271. The studs 272 associated with the depressed members 269 are thus moved out of engagement with the hook-like extensions 273 and the studs 48 on the sectors 44 will move to the extreme forward end of the slots 47 before picking up their sectors 46. Thus an extra step of movement is provided for all sectors to the left of the lowest order sector. In the present example we have seen that the units order sector will print a six. The tens order sector will move five tooth spaces under the control of its wheel 113 and this plus the extra step of movement just described brings the four (4) element to printing position (Fig. 9). The hundreds order sector and all of the sectors to the left of this order will move nine spaces under the control of their respective accumulating wheels 113 and the extra step of movement imparted to them results in a series of zeros being aligned in printing position. The printed balance, therefore, is 000000046 which is the true negative total.

Unless the negative total itself occupies all ten denominational orders, a string of zeros will always precede the highest significant digit so that a negative balance may be easily recognized as such. In order to be certain of prompt recognition of a negative total, however, special distinguishing signs such as a different style of type for the elements 214, or a red printing ribbon, may be employed, if desired.

While I have described what I consider to be a highly desirable embodiment of my invention, it is obvious that many changes in form could be made without departing from the spirit of my invention, and I, therefore, do not limit myself to the exact form herein shown and described, nor to anything less than the whole of my invention as hereinbefore set forth, and as hereinafter claimed.

What I claim as new, and desire to secure by Letters Patent, is:

1. In a machine of the class described, the combination of an accumulator including accumulator wheels adapted to register a positive balance in its true form and a negative balance in its complementary form, actuating racks reciprocable from and to a normal position to enter items into said accumulator wheels, mechanism for causing a total taking operation during which operation said actuating racks reset said wheels to zero, type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks, a set of type elements mounted on each of said type carriers and arranged to print the number representative of the numerical position of a respective rack, a second set of type elements mounted on each of said type carriers and arranged in reverse order to the first said set for printing the complement of the numerical position of a respective rack, latching devices between each of said type carriers and its respective actuating rack whereby each type carrier is caused nor-

mally to move in unison with its rack and whereby the second said set of type elements is normally held out of printing position, normally ineffective means for disabling said latching devices, means acting in the operation of taking a negative total for conditioning said disabling means for operation to permit said type carriers to advance a determined distance relatively to said racks to bring the second said set of type elements into printing position, a set of feelers operating during a negative total taking operation and controlled by said actuating racks, each of said feelers being set in one position under control of its respective rack when the latter has not advanced from normal position and in another position when its rack has so advanced, and means controlled by each feeler whose rack has so advanced to permit all of the type carriers of higher denomination to advance one additional type space.

2. In a machine of the class described, the combination of an accumulator including accumulator wheels adapted to register a positive balance in its true form, and a negative balance in its complementary form; actuating racks for said accumulator wheels; type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks; two separate sets of type elements of opposite numerical progression mounted on each of said type carriers; three means for arresting the independent advance of said type carriers, one of said means acting to hold said type carriers in such position relative to said racks as to place in printing position the sets of type elements representing the numerical positions of the racks, the second of said means acting to arrest said type carriers in such positions relative to said racks as to place in printing position the set of type elements representing the ten complements of the numerical positions of the racks, and the third said means acting to arrest said type carriers in positions to print the nine complements of the numerical positions of the racks; means for disabling said first arresting means; mechanism for causing a total-taking operation during which operation said actuating racks reset said accumulator wheels to zero; means controlled jointly by said accumulator and said mechanism and effective when a total is taken with a negative balance in said accumulator for conditioning said disabling means for operation; a separate disabling means for said second arresting means; and means controlled by the lowest order rack which advances to reset its associated accumulator wheel during a negative total-taking operation for conditioning said separate disabling means for operation.

3. In a machine of the class described, the combination of an accumulator, actuating racks therefor advanceable differentially to numerical positions, type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks, two separate sets of type elements of opposite numerical progression mounted on each of said type carriers, latching devices between said type carriers and said actuating racks whereby said type carriers are normally held in such position relative to said racks as to place in printing position the set of type elements representing the numerical position of said actuating racks, means for disabling said latching devices whereby said type carriers are permitted to advance independently of said racks and move said normally effective set of elements

out of printing position, means for arresting the independent movement of said type carriers when they have moved a determined distance to place in printing position the set of type elements representing the ten complements of the numerical positions of the racks, means for releasing certain of said type carriers from their said arresting means to permit thereby an additional movement of these carriers independently of their respective racks, and means for arresting these certain type carriers in position to print the nine complements of the numerical positions of their respective racks.

4. In a machine of the class described, the combination of an accumulator including accumulator wheels adapted to register a positive balance in its true form and a negative balance in its complementary form, actuating racks for said accumulator wheels, type carriers operatively connected to said actuating racks, and spring-urged to advance independently of said racks, a set of type elements mounted on each of said type carriers for effecting printing of positive and negative items and of positive totals, a second set of type elements on each of said type carriers for effecting printing of negative totals, said second set of elements being arranged in complementary order to the first said set, latching devices between said type carriers and said actuating racks whereby said type carriers and said actuating racks are caused normally to move in unison and whereby said second sets of type elements are held normally out of printing range, normally ineffective means for disabling said latching devices whereby said type carriers are permitted to advance relatively to said actuating racks to move the second said sets of type elements within the printing range and the first said sets of elements out of printing range, mechanism for causing a total taking operation during which operation said actuating racks reset said accumulator wheels to zero, and means controlled jointly by said accumulator and said mechanism and effective when a total is taken with a negative balance in said accumulator for conditioning said disabling means for operation.

5. In a machine of the class described, the combination of a pair of accumulator wheels of successive denominational order; actuating racks for said accumulator wheels; type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks, two separate vertically aligned sets of type elements mounted on each of said type carriers; means comprising a stud integral with each of said type carriers and cooperable with a latch mounted on each of said actuating racks whereby said lower sets of type elements are normally held out of printing range; individual yielding means adapted to retain said latches in engaging position; a resiliently operable disabling member for each of said latches, said disabling members being adapted when operated to displace said latches whereby said type carriers are permitted to advance relatively to said actuating racks to place the lower sets of said type elements within the printing range and the upper sets of said type elements out of printing range; means for operating said disabling members; means for arresting the movement of said type carriers relative to said actuating racks, said means consisting of an extension on each of said type carriers cooperable with a stud on an associated latch; and means conditioned for operation by said actuating rack of lower order for permitting the

type carrier of higher order to move an additional step beyond its previous point of arrestment and relatively to its actuating rack, said means comprising a bell-crank lever adapted to depress said disabling member of higher order to permit the disengagement by said yielding means of said latch of higher order from the extension on said type carrier of higher order, a positively driven actuating element for said bell-crank lever, a link intermediate said lever and said actuating element and movable relatively to said actuating element for transmitting the positive action of said element to said lever, and means for retaining said link in effective position relatively to said actuating element, said means being normally held disabled by the displaced latch on said rack of lower order and released for operation by a movement of said rack of lower order in resetting its associated accumulator wheel to zero.

6. In a machine of the class described, the combination of an accumulator including accumulator wheels, actuating racks for said accumulator wheels; type carriers operatively connected to said actuated racks and spring-urged to advance independently of said racks; two separate vertically aligned sets of type elements mounted on each of said type carriers; means comprising a stud integral with each of said type carriers and a cooperative latch mounted on each of said actuating racks whereby said lower sets of type elements are normally held out of printing range; individual yielding means adapted to retain said latches in engaging position; a resiliently operable disabling member for each of said latches, said disabling members being adapted when operated to displace said latches against the tension of said individual yielding means whereby said type carriers are permitted to move relatively to said actuating racks to place the lower sets of said type elements within the printing range and the upper sets of said elements out of the printing range; means for operating said disabling members; means for arresting the movement of said type carriers relatively to said actuating racks, said means consisting of an extension on each of said type carriers cooperable with a stud on an associated latch; means for permitting certain of said type carriers to move an additional distance relatively to their actuating racks, said means comprising a train of mechanism individual to each denominational order of the accumulator for moving said disabling members out of cooperative relation with said latches to permit the disengagement by said yielding means of said latches from the extensions on said type carriers, a common actuating element of all of said trains of disabling mechanism, individual conditioning devices controlled by each of said actuating racks for rendering said actuating element effective with respect to the next higher order chain of disabling mechanism, each of said conditioning devices being released for operation by a movement of its associated actuating rack, and means comprised in each of said chains of disabling mechanism for transmitting the motion imparted thereto by said actuating element to all the higher order chains of mechanism irrespective of the position of the conditioning devices in said higher orders.

7. In a machine of the class described, the combination of an accumulator, actuating racks therefor, type carriers on each of which is mounted two separate vertically aligned sets of type elements through which printing is effected, means

comprising a stud integral with each of said type carriers and a cooperative slot formed in each of said actuating racks for permitting said type carriers to move with and relatively to said actuating racks, a latch mounted on each of said actuating racks and cooperable with an associated type carrier stud to retain said stud in the rear portion of said slot whereby said type carriers and said actuating racks are caused normally to move in unison and whereby the lower of said sets of type elements are held out of printing range, individual yielding means for retaining said latches in engaged position, means for displacing all of said latches against the tension of their yielding means whereby said type carriers are permitted to move relatively to said actuating racks to place the lower of said sets of type elements within the printing range and the upper of said sets out of printing range, means for arresting the relative movement of said type carriers before the studs thereon reach the forward end of their respective slots, said means consisting of a rear extension on said type carriers adapted to engage a stud on said displaced latches, and means for disengaging certain of said latches from their associated extensions whereby these type carriers are permitted to move beyond their previous point of arrestment until the studs thereon reach the forward end of their respective slots.

8. In a machine of the class described, the combination of an accumulator including accumulator wheels adapted to register a positive balance in its true form and a negative balance in its complementary form, actuating racks for said accumulator wheels, mechanism for causing a total taking operation during which operation said actuating racks reset said accumulator wheels to zero, type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks, two separate vertically aligned sets of type elements on each of said type carriers, each of said sets being arranged in complementary order to the other, latching devices between said type carriers and said actuating racks whereby said type carriers are held in such position relative to said actuating racks as to place the upper of said sets of elements within the printing range and the lower of said sets out of the printing range, means for disabling said latching devices whereby said type carriers are permitted to advance relatively to said actuating racks to place the lower of said sets of type elements within the printing range and the upper of said sets out of the printing range, means controlled jointly by said accumulator and said mechanism for causing the taking of totals and effective when a total is taken with a negative balance in said accumulator for rendering said disabling means effective, individual means for arresting the movement of said type carriers relative to said actuating racks when said latching devices are disabled, and means for disabling certain of said individual means to permit their respective type carriers to move an additional step beyond their point of arrestment to effect printing of the true negative balance.

9. In a machine of the class described, the combination of an accumulator including accumulator wheels adapted to register a positive balance in its true form and a negative balance in its complementary form, actuating racks for said accumulator wheels, type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks, two separate vertically aligned sets of type elements on

each of said type carriers, each of said sets being arranged in complementary order to the other, latching devices between said type carriers and said actuating racks whereby said type carriers are held in such position relative to said actuating racks as to place the upper of said sets of elements within the printing range and the lower of said sets out of the printing range, means for disabling said latching devices, whereby said type carriers are permitted to move relatively to said actuating racks to place the lower of said sets of elements within the printing range and the upper of said sets out of the printing range, mechanism for causing a total taking operation during which operation said actuating racks reset said accumulator wheels to zero, means controlled jointly by said accumulator and said mechanism and effective when a total is taken with a negative balance in said accumulator for rendering said disabling means effective, individual means for arresting the movement of said type carriers relative to said actuating racks when said latching devices are disabled, and means conditioned for operation by the movement of any one of said actuating racks in resetting its associated accumulator wheel to zero during negative total taking operations for disabling all of the individual means in the higher denominations to permit their respective type carriers to move an additional step beyond their previous point of arrestment to effect printing of the true negative balance.

10. In a machine of the class described the combination of an accumulator including accumulator wheels and tens transfer devices for effecting carrying operations within said accumulator in either an add or subtract direction, actuating racks for said accumulator wheels, mechanism for causing a total taking operation during which operation said actuating racks reset said accumulator wheels to zero, type carriers operatively connected to said actuating racks and adapted to be set thereby to permit printing of positive and negative items and of positive and negative totals, a set of type elements on each of said type carriers for effecting printing of positive and negative items and of positive totals, a separate set of type elements on each of said type carriers for effecting printing of negative totals, said second sets of type elements being arranged in complementary order to the first said sets, individual yielding means adapted to urge said type carriers to advance independently of said actuating racks, latching devices between said type carriers and said actuating racks whereby said type carriers and said actuating racks are caused to move in unison and the second of said sets of type elements are normally held out of printing range, normally ineffective means for disabling said latching devices whereby said type carriers are permitted to move a certain distance relatively to said actuating racks to place the second of said sets of elements within the printing range and the first of said sets out of printing range, means for conditioning said disabling means for operation, a blocking means for preventing the operation of said conditioning means, a second blocking means for preventing the operation of said conditioning means, means operable by the tens transfer devices associated with the highest order accumulator wheel for disabling the first said blocking means when the total of the negative items subtracted from said accumulator exceeds the total of the positive

items entered therein, and means operable by said mechanism for causing the taking of totals for disabling the second said blocking means.

11. In a machine of the class described, the combination of a pair of accumulator wheels of successive denominational order, actuating racks for said accumulator wheels, type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks, two separate vertically aligned sets of type elements mounted on each of said type carriers, latching devices between said type carriers and their associated actuating racks whereby said type carriers and said actuating racks are caused to move in unison and the lower of said sets of type elements are normally held out of printing range, means for disabling said latching devices whereby said type carriers are permitted to move relatively to said actuating racks to place the lower of said sets of elements within the printing range and the upper of said sets of elements out of printing range, individual means for arresting the movement of said type carriers relative to said actuating racks when the first type element of said lower sets reaches the printing line, and means conditioned for operation by the movement of the actuating rack of lower order in resetting its associated accumulator wheel to zero for disabling the individual means of higher order to permit the type carrier of higher order to move an additional step beyond its point of arrestment and relatively to its actuating rack.

12. In a machine of the class described, the combination of an accumulator, actuating racks therefor, type carriers on each of which is mounted two separate vertically aligned sets of type elements through which printing is effected, means comprising a stud integral with each of said type carriers and a cooperative slot formed in each of said actuating racks for permitting said type carriers to move with and relatively to said actuating racks, a latch mounted on each of said actuating racks and cooperable with an associated type carrier stud to retain said stud in the rear portion of said slot whereby said type carriers and said actuating racks are caused normally to move in unison and whereby the lower sets of type elements are held normally out of printing range, individual yielding means for retaining said latches in engaging position, a resiliently operable disabling member for each of said latches, said members being adapted to displace said latches when operated whereby said type carriers are permitted to move relatively to said actuating racks to place the lower sets of type elements within the printing range and the upper sets of type elements out of printing range, means for operating said disabling members, means for arresting the movement of said type carriers relative to said actuating racks, said means consisting of a rear extension on said type carriers adapted to engage a stud on said displaced latches, and means conditioned for operation by a movement of any one of said actuating racks for moving the disabling members in the denominational orders higher than that of the moved rack out of contact with their respective latches thereby permitting the disengagement of these latches from their associated type carrier extensions by said yielding means and a conse-

quent additional movement of these type carriers beyond their previous point of arrestment and relative to said actuating racks.

13. In a machine of the class described, the combination of a pair of accumulator wheels of successive denominational order; actuating racks for said accumulator wheels; type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks; two separate vertically aligned sets of type elements mounted on each of said type carriers; means comprising a stud integral with each of said type carriers and a cooperative latch mounted on each of said actuating racks whereby said type carriers and said actuating racks are caused to move in unison and the lower sets of type elements are normally held out of printing range; individual yielding means adapted to retain said latches in engaging position; a resiliently operable disabling member for each of said latches, said disabling members being adapted when operated to displace said latches whereby said type carriers are permitted to move relatively to said actuating racks to place the lower sets of said type elements within the printing range and the upper sets of said type elements out of printing range; means for operating said disabling members; means for arresting the movement of said type carriers relative to said actuating racks, said means consisting of an extension on each of said type carriers cooperable with a stud on an associated latch; and means conditioned for operation by a movement of said actuating rack of lower order for permitting the type carrier of higher order to move an additional step beyond its point of arrestment and relatively to its associated actuating rack, said means including positively driven actuating mechanism adapted to force the disabling member of higher order out of its operated position to permit the disengagement by said yielding means of said latch of higher order from the rear extension of its associated type carrier.

14. In a machine of the class described, the combination with an accumulator including accumulator wheels adapted to register a positive balance in its true form and a negative balance in its complementary form, of actuating racks for said accumulator wheels advanceable differentially to numerical positions; type carriers operatively connected to said actuating racks and spring-urged to advance independently of said racks; two separate sets of type elements of opposite numerical progression mounted on each of said type carriers; and three means for arresting the independent advance of said type carriers, one of said means acting to limit the advance of said type carriers relative to their respective racks so as to place in printing position the type elements representing the numerical positions of the racks, the second of said means acting to arrest the type carriers in such positions relative to their respective racks as to place in printing position the type elements representing the ten complements of the numerical positions of the racks, and the third said means acting to arrest said type carriers in position to print the nine complements of the numerical positions of the respective racks.

ELMER H. DREHER.