Feb. 24, 1942. E. H. DREHER 2,274,049

CALCULATING MACHINE

Filed Feb. 12, 1937 5 Sheets-Sheet 1

FIG. 1.

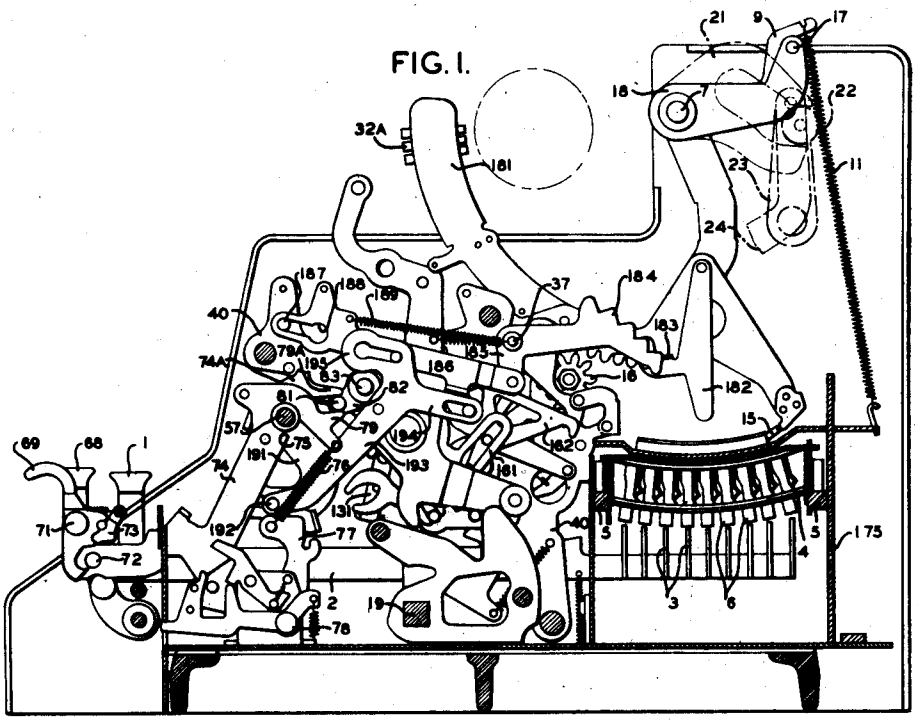
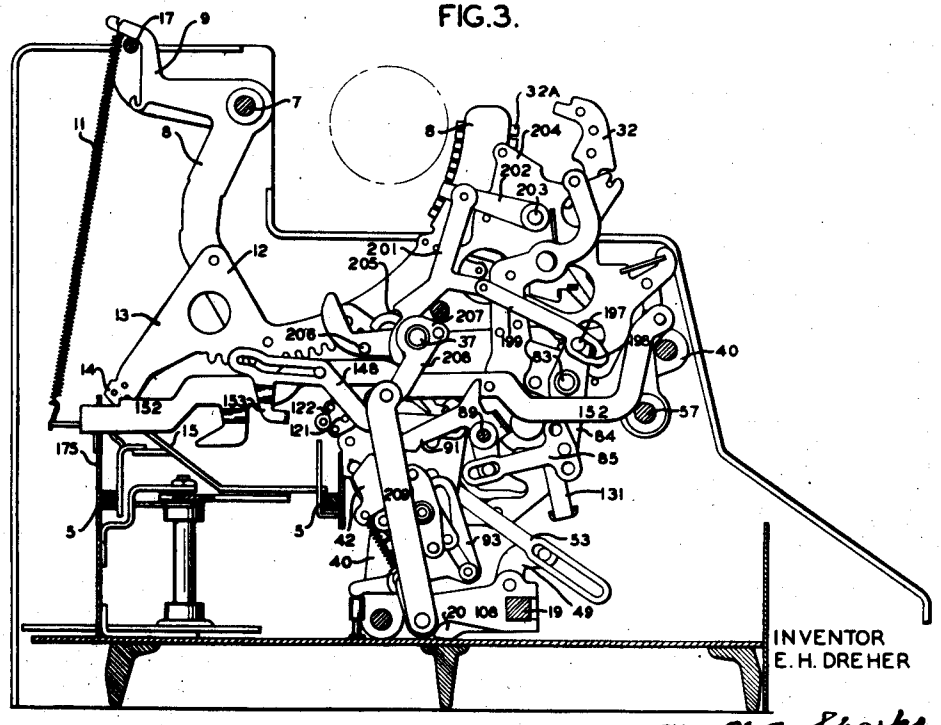


FIG. 3.



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CALCULATING MACHINE

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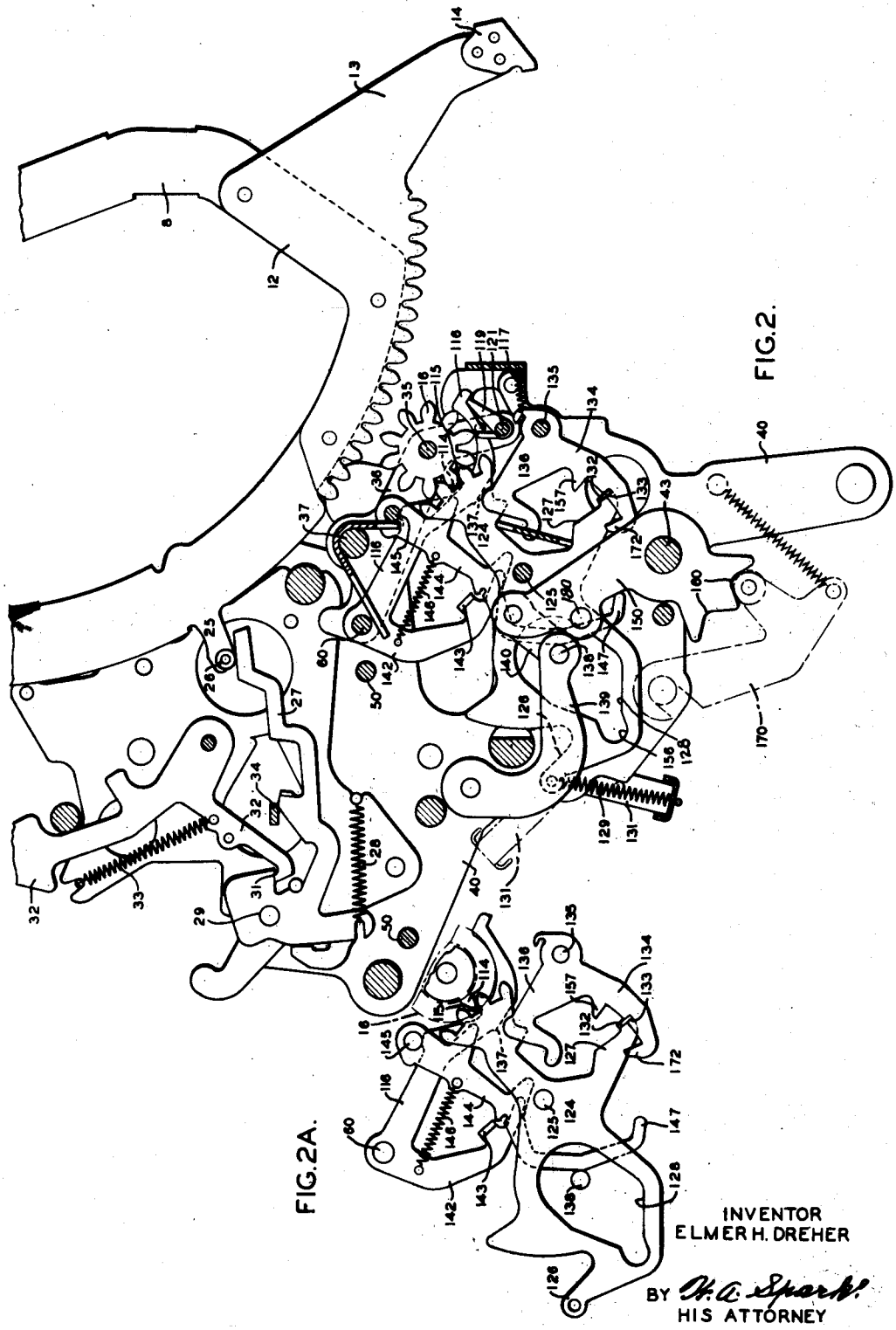


FIG. 2.

FIG. 2A.

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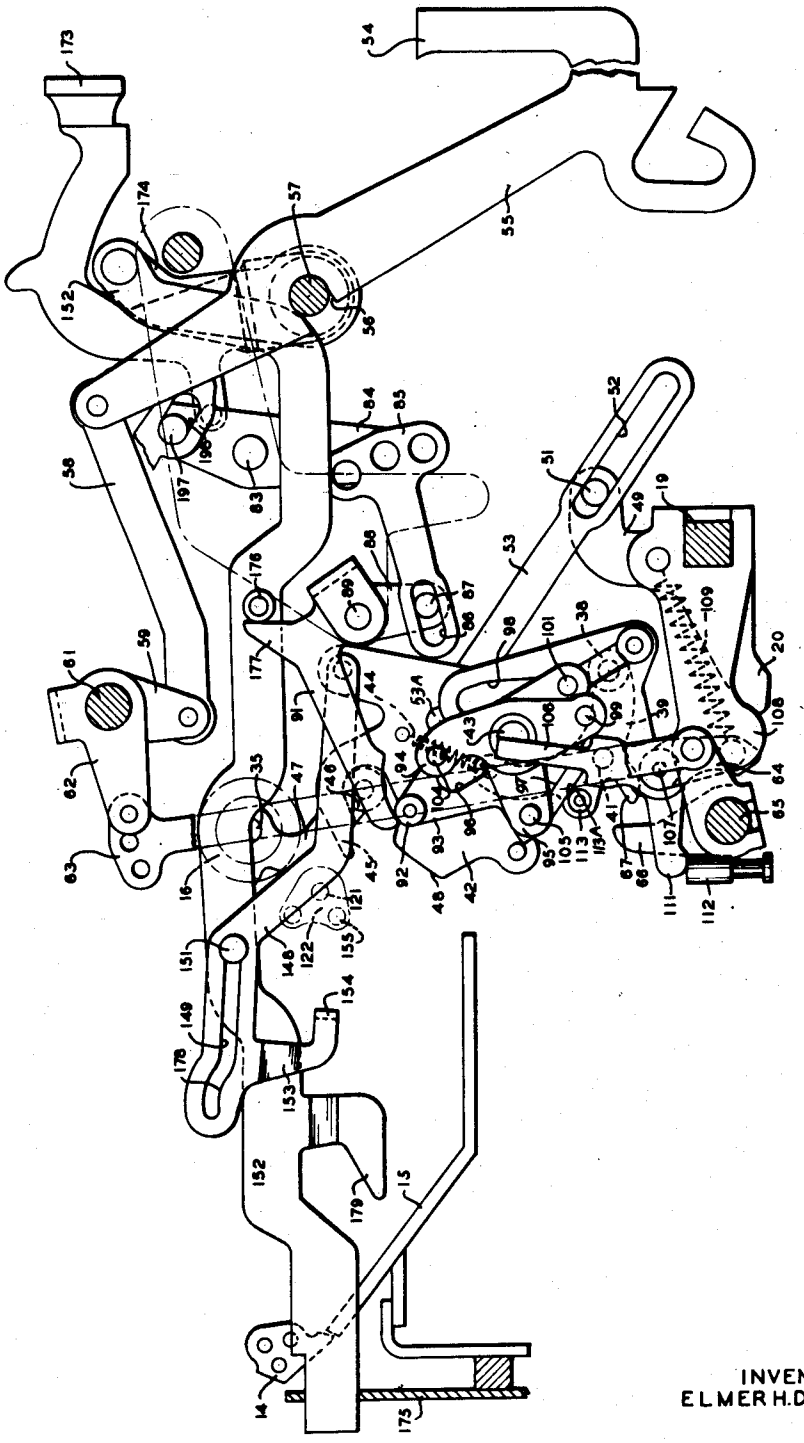


FIG. 4.

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CALCULATING MACHINE

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FIG. 5.

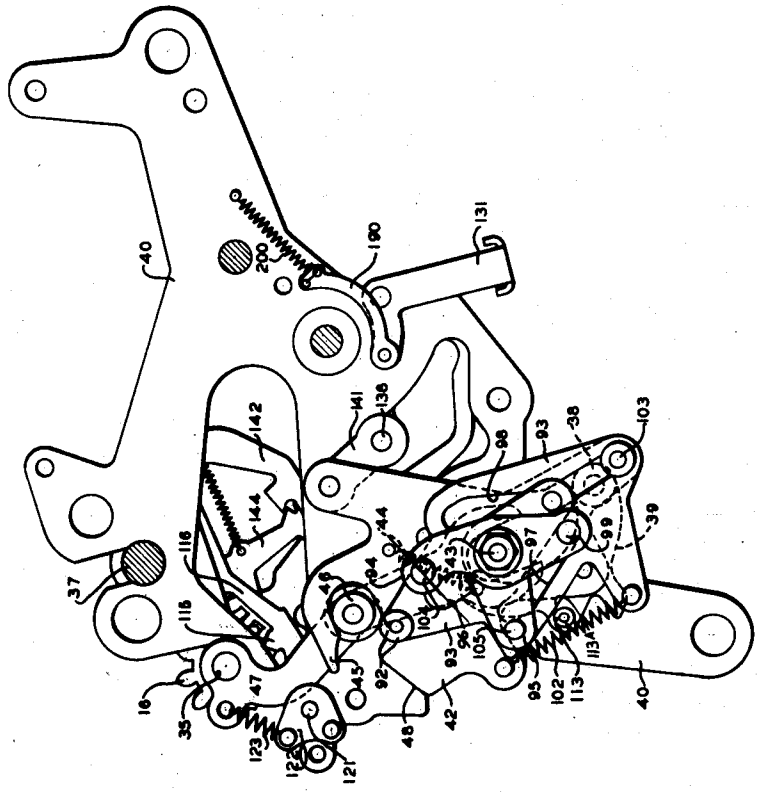
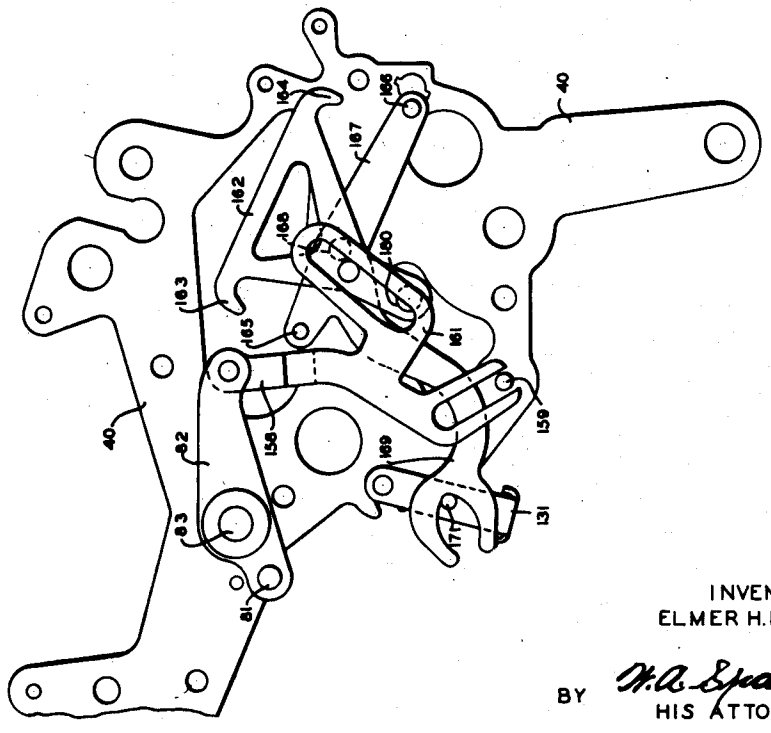


FIG. 6.



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CALCULATING MACHINE

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FIG. 8

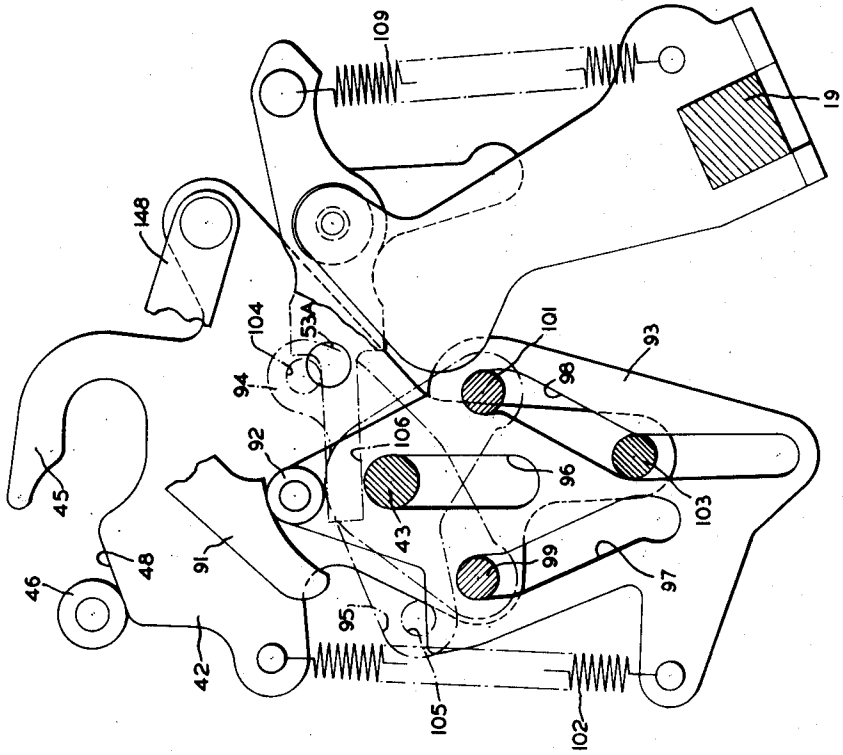
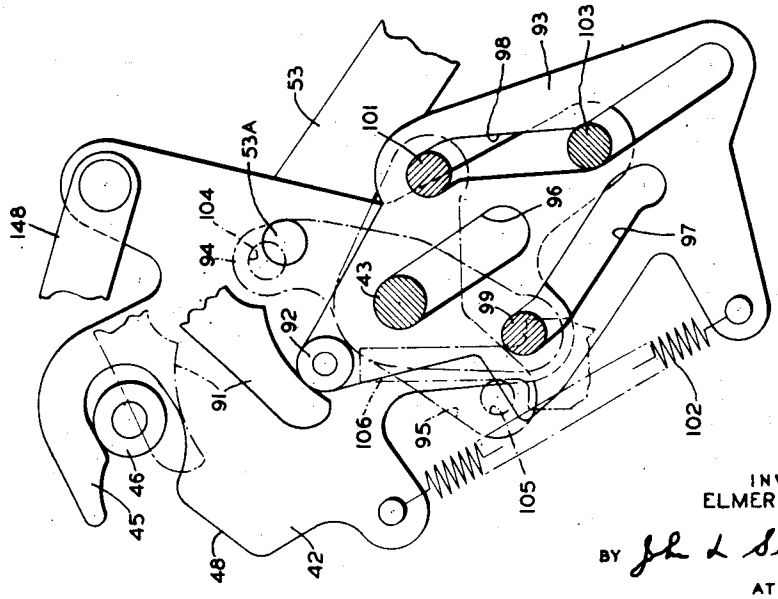


FIG. 7



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Patented Feb. 24, 1942 2,274,049

UNITED STATES PATENT OFFICE

2,274,049

CALCULATING MACHINE

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Application February 12, 1937, Serial No. 125,375

2 Claims. (Cl. 235—60)

This invention relates generally to the tens transfer mechanism for adding and like machines, and particularly to mechanism of this type which is adapted for use in an adding machine capable of direct subtraction wherein a negative total is printed in a form complementary to the true negative balance.

The mechanism of this invention is herein embodied in the well known Dalton adding machine and is a modification of the machine disclosed in the United States patent to Dysart No. 2,014,560 issued September 17, 1935. The machine of the above patent performs problems of addition and subtraction and has its calculating or accumulating mechanism located at the rear of the machine and supported by frame plates which lie outside the regular framework of the machine. It is necessary, therefore, that additional linkage and actuating racks be provided to transmit the motion of the type sectors to the accumulating wheels. Also, in the machine of the above patent, tens transfer mechanism is provided which is adapted to be tripped and to effect a carry as a part of one machine operation but which is not reset until the latter part of the following operation. It is necessary, therefore, to insert a blank stroke between the last accumulating operation and a total stroke, during which blank stroke the tens transfer mechanism is reset and the machine conditioned for totaling.

The mechanism of the present invention comprises a single set of accumulating wheels located near the front of the machine and adapted to mesh with actuating racks integral with the type sectors. The accumulating wheels are controlled by a variable operating means which enables them to engage their actuators at different points in the machine operation and are thus capable of two directions of rotation. When moving in one direction the wheels accumulate positively and when moving in the opposite direction accumulate negatively. Individual tens transfer mechanism is provided for each accumulating wheel and is adapted to be tripped as the wheels pass zero while moving in either direction. The actual carry operation occurs after the wheels are withdrawn from their actuators and before the end of the same machine operation the trip transfer pawls are reset and latched. Therefore, the necessity for a blank stroke is eliminated and the machine is conditioned at all times to effect a total taking operation. If the accumulating wheels are overrun in a negative direction they will contain an amount which is the complement of the true negative amount. If a total is caused to be taken with the wheels in this condition the complementary balance will be printed and must be translated by the operator into the true negative total.

One object of this invention is to record items of either addition or subtraction in an adding machine and, at the same time, to enter these items into a series of accumulating wheels by engaging the wheels with a set of actuating racks on the respective return or forward stroke of the actuators.

Another object of this invention is to effect carry operations from wheel to wheel in a single set of accumulating wheels through the provision of a novel transfer mechanism which is adapted to be tripped each time the wheels pass zero in either direction.

Another object of this invention is to eliminate the necessity for a blank stroke between the last accumulating operation and a total taking operation by providing means whereby the tens transfer mechanism is tripped and reset during a single machine operation.

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

Fig. 1 is a sectional elevation taken from the right hand side of the machine showing the subtraction key and portions of the accumulating and recording mechanism;

Fig. 2 is a detailed sectional elevation taken through the accumulating unit showing the hammer release mechanism and the tens transfer mechanism;

Fig. 2A is a detailed view of certain of the transfer mechanism shown in Fig. 2;

Fig. 3 is a sectional elevation taken from the left hand side of the machine showing the means for restraining the type sectors, the accumulator timing mechanism and part of the subtraction mechanism;

Fig. 4 is a fragmentary detail sectional elevation taken from the left hand side of the machine showing the accumulator timing mechanism and the means for initiating a total taking operation;

Fig. 5 is a view in side elevation of the left hand side of the accumulating unit;

Fig. 6 is a view similar to Fig. 5 showing the opposite side of the accumulating unit;

Fig. 7 is an enlarged fragmentary detail ele-

vational view of the cam plate and the cam slide with said slide in the position assumed after operation of the total or subtract key; and

Fig. 8 is an enlarged fragmentary detail elevational view of the accumulator engaging and disengaging mechanism in the position assumed at the end of the forward stroke of the machine during total or subtract cycles.

The main features and general operating functions of the Dalton machine have been the subject of numerous patent grants and for this reason, and because of the wide commercial use of this type of machine, have become well known in the calculating machine art. The previously mentioned patent to Dysart No. 2,014,560, may be referred to as an example of standard Dalton construction combined with novel computing mechanism.

In the following description the terms front and rear or forward and rearward, as relating respectively to the front and rear portions of the machine, are freely used to indicate the relative position or motion of the various parts.

According to the usual Dalton construction, and as disclosed herein, there is provided, at the front of the machine, ten numeral keys 1 (Fig. 1) each integral with an associated key lever 2. The key levers 2 are pivoted in any suitable manner near their mid points and extend toward the rear of the machine, each having a lug or upwardly extending projection 3 at its rear end. The projections 3 are positioned as to form a single horizontal line directly under a laterally movable stop carriage 4. The carriage 4 is guided upon rails 5 and moves in a series of step like motions cross ways through the machine. Supported in the carriage is a plurality of rows of vertically movable pins 6 which, in response to the movement of the carriage 4, are positioned one row at a time over the projections 3. Depression of any numeral key 1, therefore, results in the elevation of the corresponding stop pin 6. The stop carriage 4 is spring tensioned to travel step by step toward the left of the machine and any suitable escapement mechanism may be provided to limit such movement and properly adjust the carriage with respect to the projections 3. One type of escapement mechanism which may be used in this machine is shown in the patent to Hopkins No. 1,039,130 issued September 24, 1912.

Pivotally supported on a shaft 7 (Figs. 1 and 3) in the upper section of the machine is a series of type sectors 8 of generally arc like construction and with a rearwardly extending portion 9. Springs 11, attached to the portion 9 tend to swing the sectors 8 upwardly and forwardly about their pivot 7. Secured to each sector 8, in the manner shown in Fig. 3, is an accumulating sector 12 bearing the usual gear teeth along its lower edge and formed with a downwardly extending arm 13 carrying a lug or heel 14 at its lower end (Figs. 1, 3 and 4). The heel 14 lies above the stop carriage 4 and is normally retained just behind the rear edge of a plate 15 pivoted to the frame of the carriage. The gear teeth on the accumulator sectors 12 mesh with the accumulating wheels or pinions 16 in a manner and at a time later to be described.

The type sectors 8 and their associated accumulator sectors 12 are normally prevented from forward movement by reason of a bail rod 17 which rests under the rear extensions 9 of the type sectors. The bail 17 is supported between a pair of arms 18 (see Fig. 1) fast to the shaft 7, and is adapted to be moved downward in response to movement of the main operating shaft 19. With each cross step of the carriage 4 the plate 15 is moved out of the path of a sector 12 (beginning with the extreme right hand sector), so that in those denominational columns in which stop pins 6 have been raised the sector 12 and its associated type sector 8 is free to move forward until stopped by contact of the accumulating sector heel 14 with the raised pin 6. Part of the linkage necessary to rock the shaft 7 is shown in Fig. 1 and comprises a slotted cam member 21, fast to the shaft 7, a roller 22, an arm 23 supporting the roller 22 and fast to a collar on the right hand side frame of the machine, and a link 24 pivotally connected to the upper end of the arm 23. The link 24 is connected, at its other end, to the main shaft in a manner not herein shown. The shaft 19, as before mentioned, is the main operating shaft of the machine and is adapted to be moved in a reciprocal rocking motion either manually, by an operating handle secured to the shaft, or automatically by a motor. In order that superfluous wordage may be eliminated from this description we will assume that an operating handle is fixed to the shaft. The handle is normally in an approximate upright position and is capable of forward and return strokes imparting, of course, a like movement to the shaft 19. Forward motion of the shaft 19, will, therefore, cause a corresponding pulling movement of the link 24 to rock the arm 23 and by reason of the cooperation between roller 22 and cam plate 21 serve to rock said cam plate and the shaft 7 in a clockwise direction as shown in Fig. 1. As the bail 17 is rocked with the shaft 7 all of the sectors 8 which have been released by the cross movement of the carriage 4 will move forward to their respective printing positions under tension of springs 11.

The printing mechanism of the present machine is also of the usual construction and is disclosed in the patent to H. Landsiedel No. 1,395,121 issued October 25, 1921. A portion of the hammer release mechanism is shown herein in Fig. 2. Integral with each type sector 8 is a short arm 25 bearing a stud 26 at its forward end. When the sectors are in normal position and stud 26 contacts the rear extension of a latch 27 and holds it depressed against the tension of a spring 28. The latch 27 is pivoted at 29 and is formed with a nose 31 adapted to engage the printing hammer 32 and hold it in retracted position against the tension of a spring 33. The hammers 32 related to the raised type sectors 8 are released at the beginning of the return stroke of the main shaft 19 by means of a bail 34 which lies above all of the latches 27 and which receives its actuation at the proper time from a cam, not shown herein, on the main shaft.

The hammers 32 operate to drive the type lugs 32A carried by the sectors 8 to effect printing in the usual manner.

The mechanism, briefly described above, for setting up and recording numbers in accordance with the depression of certain numeral keys is believed to be well established both as to principle and practice so that further description herein is deemed unnecessary.

The accumulating mechanism of the invention comprises a single set of ten toothed gear wheels or pinions 16 individually mounted and spaced on a shaft 35 supported between a pair

of arms 36 loosely pivoted to the shaft 37 (Fig. 2). The shaft 37 is supported between a pair of fixed frame members 40 connected by tie rods 50 and various cross shafts. The arms 36 extend forward a short distance beyond the shaft 37 and are rigidly connected by a rod 60 supported between their ends. A spring (not shown) extending between one of the arms 36 at its forward end and one of the fixed frame members 40 tends to hold the wheels 16 in their nonengaging position. The wheels 16 are normally out of mesh with their actuating racks 12 and during the ordinary adding cycle are moved into engagement with the racks at the beginning of the return stroke. As the sectors return to normal the wheels 16 are turned a distance commensurate with the extent of movement of their respective actuating sectors 12 and at the end of the return stroke are withdrawn from engagement and again assume their normal position. A total operation entails a reversal of the above procedure, that is, the gear wheels 16 are moved into engagement with the accumulating sectors 12 at the beginning of the forward stroke and remain in mesh until they have cleared by reaching zero. The wheels are withdrawn at the beginning of the return stroke.

The accumulator shifting mechanism is shown herein in Figs. 3, 4, 5, 7 and 8. Secured to the main shaft 19 (Fig. 4) at the left hand side of the machine is a bail shaped bell crank lever formed with an operating arm 20, the free end of which arm is adapted to contact a roller 38 on one arm of a bell crank 39. The bell crank 39 is pivoted at 41 to the lower portion of a cam plate 42 fast to the shaft 43. Another arm on the bell crank 39 extends upward and bears against the shaft 43. A spring 44, connected at one end to the last mentioned arm of bell crank 39 and at its other end to a stud on the upper portion of the cam plate 42, tends to hold the member 39 in normal position, that is, with one arm bearing against the shaft 43 and with the other arm in a position where its roller 38 may be contacted by the arm 20 on the main shaft. As the arm 20 is rocked upwardly on the forward stroke of the operating handle it bears against the lower face of the roller 38 and by reason of the pivoted connection 41 cams the bell crank counter clockwise out of its path. As the arm 20 continues its upward movement the member 39 is released and immediately returned to normal by its spring 44. At the beginning of the return stroke the arm 20 engages the upper face of the roller 38 and as it continues its return movement forces the bell crank 39, the associated cam plate 42 and the shaft 43 in a clockwise direction, as shown in Fig. 4. As shown in Figs. 4 and 5, the cam plate 42 is formed at its upper end with a hook like portion 45 adapted to engage loosely a roller 46 on an arm 47. The roller 46 is situated approximately midway along the arm 47. The lower end of arm 47 is slotted and fits loosely about the shaft 43 (Fig. 5) while the upper end of the same arm is secured to the shaft 35 which supports the accumulating wheels 16. As the plate 42 is turned clockwise at the start of the return stroke the roller 46 rides out of the recess in which it normally lies and up onto the inclined portion 48 of the cam plate. The upward motion thus imparted to the shaft 35 raises the wheels 16 into mesh with the actuators 12 as they start their return stroke, each wheel receiving a registration determined by the distance required for their respective actuators to return to normal. The wheels 16 are shifted from engagement with their actuators at the end of the return stroke by the following means. Referring now to Fig. 4, an arm 49, also fast to the shaft 19, carries a stud 51 extending through an elongated slot 52 in one end of a link 53. The opposite end of the link 53 is pivoted at 53A to the cam plate 42. As the arm 49 rotates with the shaft 19 on the forward stroke of the shaft the stud 51 on the arm slides ineffectively in the slot 52 and reaches its farthest forward position without effecting a change of position of the plate 42. At the start of the return stroke the cam plate 42 is shifted clockwise, as we have seen, thus moving the link 53 far enough toward the front of the machine so that as the arm 49 nears the end of its return stroke the stud 51 will engage the rear of the slot 52 and as the arm continues its movement will return the link 53 and the cam plate 42 to their normal position. It is evident that counter clockwise movement (Fig. 4) of the plate 42 will cause the hook 45 to again engage the roller 46 and that the roller will move off of the rise 48 and the wheels 16 will move out of engagement with the sectors 12 and return to rest position.

The accumulating mechanism will function in the above manner on each adding operation of the machine. The wheels 16 will be turned in a counter clockwise direction as shown in Fig. 4 a number of tooth spaces corresponding to the amount of movement permitted their respective sectors 8 and 12 so that a complete listing and accumulating operation will take place during one forward and return stroke of the main shaft 19.

Non add mechanism

At some point in the operation of the machine it may be desired to list one or more numbers without entering the number or numbers into the accumulating wheels. Mechanism is provided for this purpose including a key 54 located at the front of the machine and bearing the inscription "Non add" (see Fig. 4).

Integral with the key 54 is a lever 55 extending upwardly and rearwardly in the machine and having a slot or cut out portion 56 in its rear edge. The slot 56 fits loosely about a shaft 57 supported between the side frames of the machine. Connected to the upper end of the key lever 55 is a link 58 extending toward the rear of the machine and connected at its other end to one arm 59 of a bail shaped bell crank loosely mounted on the frame supported shaft 61. The other arm 62 of the bell crank is connected to the top of a T-shaped link 63 which is connected at its lower end to an arm 64 of another bail shaped bell crank loosely mounted on the shaft 65 likewise supported between the side frames of the machine. The other arm 66 of the last mentioned bell crank is adapted to cooperate with a tail or toe piece 67 integral with the member 39. In tracing the operation of the above linkage it will be seen that depression of the key 54 will rock the lever 55 clockwise about its pivot 57 and pull the link 58 forward to turn the bail shaped bell crank composed of arms 59 and 62 counter clockwise about its shaft 61. The link 63, connecting arms 62 and 64 serves to transmit this motion to arm 66 which rocks in a clockwise direction to engage the toe 67 thus rotating the member 39 in an opposite or counter clockwise direction about its pivot 41. The resulting elevation of roller 38 carries it out of the path of arm 20 on both the forward and return strokes

of the arm. The cam plate 42 is not rocked, the roller 46 remains in engagement with the hook 45 and the wheels 16 stay in their normal or rest position during the full operation. It is apparent that the non-add mechanism is effective only so long as the key 54 remains depressed. Any suitable locking means may be employed to hold the key in operative position during several machine operations, or, if desired, it may simply be held down manually.

Subtraction mechanism

In addition to performing the usual adding operations disclosed above, the machine shown in the present invention is also capable of executing direct subtraction operations from the same set of accumulating wheels. When it is desired to enter a number subtractively into the accumulating wheels 16, a subtraction key 68 (see Fig. 1) located at the front of the machine, is first depressed. The number is then set up in the usual manner by depressing the numeral keys 1 and the main shaft 19 is rocked by its operating handle to complete a listing and accumulating operation.

As shown in Fig. 1 the subtraction key 68 bears a latch 69 pivoted at 71 to the right hand side of the key. While the key 68 is held depressed, the latch 69 may be moved counter clockwise about its pivot 71 thus permitting the hook-like lower end of latch 69 to engage the fixed stud 72. A spring pressed detent 73 cooperates with the latch 69 in the manner shown to hold it in either of its two positions. The above latching means is adapted to use principally for the purpose of retaining the subtract key in operative position during a series of successive subtracting operations. A key control lock such as that disclosed in the patent to H. Landsiedel No. 1,537,314 issued May 12, 1925, may be provided herein to hold the subtract key depressed during one machine operation, after which it is automatically released.

A key lever 74 is integral with the subtraction key 68 and extends upwardly in the machine. A slot 75, formed in the rear edge of the lever 74 near its upper end, is passed about the shaft 57 which acts as a pivot for the key lever. A spring 76, tensioned between the upper end of the lever 74 and an arm 77 fast to a shaft 78, tends to hold the key 68 in its normal raised position. The lever 74 is formed at its upper end with a nose 79 bearing against the under side of a stud 81 on a lever 82 secured to one end of a shaft 83. It is evident that depression of the subtraction key 68 will rock the lever 74 counter-clockwise about its pivot 57 (Fig. 1) and that the resulting cooperation between the nose 79 and the stud 81 will cause the lever 82 and its shaft 83 to turn in a clockwise direction. A nose 79A of the lever 74A secured to the lever 74 engages the top of the stud 81 as shown in Fig. 1. The stud 81, therefore, rests in what is, in effect, a slot in the lever 74 so that when the key 68 is released the lever 82 will return to normal position. As shown in Figs. 3 and 4 a lever 84 is secured to the other end of the shaft 83 and is pivotally connected at its lower end to a link 85 extending toward the rear of the machine. A slot 86 is formed in the rear end of the link 85 and is adapted to engage a pin 87 on one arm 88 of a bail shaped bell crank pivoted at 89 to a stud on a fixed frame member. Another arm 91 of the bell crank extends rearwardly with its nose bearing upon the top of a roller 92 on the upper end of a slotted cam plate 93. The cam plate 93 is one member of a cooperating assembly comprising plate 93 and plates 94 and 95, the purpose of which is to rock the previously described cam plate 42 and bring about the engagement of the accumulating wheels 16 with the actuators 12 on their forward stroke. Both plates 94 and 95 are loosely mounted on the shaft 43. As shown in Figs. 4, 5, 7, and 8 the cam plate 93 lies flush against the plate 42 and has cut in its surface three slots 96, 97, and 98. The slot 96 engages the shaft 43 and permits vertical sliding movement of the plate 93. The slot 97 engages a pin 99 on one end of the plate 94 while the slot 98 engages a similar pin 101 on one end of the plate 95. A spring 102 (Fig. 5) tensioned between the cam plate 42 and the lower end of plate 93 normally holds the latter in a raised position with the lower end of the slot 98 engaging a stud 103 on the bottom of the cam plate 42. Therefore, it will be seen, that counter clockwise movement of the shaft 83 (Fig. 4) will rotate the arm 91 counter clockwise through lever 84, link 85 and arm 88 to depress the plate 93 to the position shown in Fig. 7. Upon downward movement of the plate 93 it will be seen that the conformation of the slots 97 and 98 is such as to cause opposite motions of rotation of the plates 94 and 95. The arm 94 will move clockwise about its pivot 43 and the plate 95 will move in a counter clockwise direction. The plate 94 carries a pin 104 on its outer surface and a similar pin 105 is carried by the plate 95. The pins 104 and 105 are adapted to cooperate with a wipe pawl 106 which is raised and lowered on the respective forward and return strokes of the main shaft 19. As shown in Fig. 4 the wipe pawl 106 is pivoted at 107 to an arm 108 secured to the main shaft. A spring 109 tends to rotate the pawl 106 counter clockwise about its pivot 107. An arm 111 of the wipe pawl normally rests on a stud 112 fixed to the bottom plate of the machine so that with the machine in rest position the pawl 106 is held in a generally erect position against the tension of the spring 109. In an ordinary adding cycle, the plates 93, 94 and 95 are retained in normal position. On the forward stroke of the machine the pawl 106 is moved upwardly carried by the arm 108 and under tension of the spring 109 is moved counter clockwise to pivot idly about the pins 105 and 104. As the arm 108 returns to normal the pawl 106 retraces its idle path about the pins 104 and 105 and is restored to the position shown in Fig. 4. During this operation, the wipe pawl does not alter the position of the plate assembly 93, 94 and 95. However, if the plate 93 is depressed as before described, through the operation of the subtraction key 68, or other means later to be described, the pin 105 on the plate 95 will be in a position where it may be engaged positively by a shoulder on the pawl 106 as the pawl rises on the forward stroke of the machine. Further upward movement of the wipe pawl 106 will, therefore, cause the cam plate 42 and plate assembly 93, 94 and 95 to turn as a unit in a clockwise direction to the position shown in Fig. 8 to place the rise 48 on the periphery of the cam 42 under the roller 46 and thus elevate the wheels 16 into engagement with the actuating sectors 12 as the actuators and their type bars 8 begin their forward stroke. With the pin 105 thus displaced, continued upward movement of the pawl 106 will cause it to pivot idly about the pins 104 and 105 to complete its forward movement. When the plate 94 has been thus moved

from normal position, the pin 104 (Fig. 8) thereon is in a position wherein it may be positively engaged by the other shoulder on the pawl 106 at the beginning of the return stroke of the pawl to return the complete plate assembly to normal. As shown in Fig. 4, the spring pressed pivot member 39 carries a roller 113 which lies just under an inclined shoulder 113A an the slotted cam plate 93. The descending cam plate will, therefore, rock the member 39 counter-clockwise about its pivot 41 to raise the roller 38 and, as has been previously described, will render ineffective the arm 20.

Transfer mechanism

It will be apparent from the description as thus far progressed that the accumulating pinions 16 will be turned in a clockwise direction, as shown in Fig. 2 on adding strokes and in an opposite or counter clockwise direction on subtraction strokes. Certain novel transfer mechanism has been provided which is adapted to be tripped by the pinions 16 as they pass zero in either direction in order that a tens carry operation may be effected from one denominational order to the next higher order. The same mechanism is used in transferring additively or subtractively with the exception of certain additional linkage effective only on subtraction strokes and operated by the subtraction key in a manner later to be described. The transfer mechanism for each wheel 16 is identical, therefore a description of one will suffice for all.

As shown in Figs. 2 and 2A, one tooth 114 on each of the accumulating wheels or pinions 16 is so formed as to be of approximately twice the width of the other teeth on the wheel. The portion of the tooth 114 which lies outside the plane of the wheel 16 normally contacts the left hand face of a lug 115 formed in a pawl 116. The pawl 116 is pivoted to the rod 60 supported between the aforementioned arms 36 and is formed with a nose at its far end which is normally engaged and held upward by a bail 119 secured to the shaft 121. The bail 119 is common to all of the pawls 116. The shaft 121 is pivotally supported between rear extensions of the arms 36 and, as shown in Fig. 5, has fast to its outer end a small bell crank 122. Tensioned between one arm of the bell crank 122 and the arm 47, which raises the accumulating wheels, is a spring 123 adapted to retain the bail 119 in the position shown in Fig. 2.

A four toothed gear or carry sector 124 is normally in engagement with each wheel 16 and is pivotally mounted on a shaft 125 rigidly supported between the plates 40. As shown in Fig. 2, the sector 124 is of an odd shape and is formed with two arms 126 and 127 and has a cam slot 128 cut in its surface forward of the pivot 125. Connected to the arm 126 is a spring 129 fastened at its other end to a movable bail 131 pivoted to the frame plates 40 (Figs. 2, 5 and 6). The spring 129 tends to impart a counter clockwise movement to the sector 124 as shown in Fig. 2. The arm 127 of the sector 124 has a lug or projection 132 formed on its outer end adapted to cooperate with a notch 133 cut in one arm of a bell crank 134 associated with the next lower denominational order. The bell crank 134 is mounted loosely on a shaft 135 supported between the frames 40 and has another arm 136 the front end of which rests normally just under a flat undersurface 137 of the pawl 116. The bell crank 134 shown in Fig. 2 is of the preceding denominational order to the sector 124 shown therein. The accumulating wheel 16 and the transfer pawl 116 associated with the bell crank 134 have been omitted from the drawing for the sake of clearness. A spring 117 tensioned between a hook on the upper end of the bell crank 134 and an end plate of the frames 40 tends to hold the arm 136 in the position illustrated in Fig. 2. The cam slot 128 in the sector 124 is adapted to cooperate with a bail rod 138 in a manner and for a purpose soon to be described. The bail rod or shaft 138 common to all of the gear sectors 124 is passed through the slot 128 and is supported at its ends by a pair of rock arms 139 pivoted to their respective frame plates 40. As shown in Fig. 5, the shaft 138 is connected at one end to the cam plate 42 by a link 141 and is connected at its other end through a link 140, to a lever 150 fixed to the shaft 43. At its lower end the lever 150 is formed with two notches 160 adapted to cooperate in the manner shown with a spring pressed arm 170 pivoted to the frame 40. The resilient detent thus provided by the cooperation between the members 150 and 170 acts to hold the shaft 43 and its operating cam plate 42 in either of their two positions.

The previously mentioned pawl 116 is formed with a depending arm 142 carrying a lug or projection 143 at its lower end. The projection 143 is adapted to engage a latch 144 pivoted at its upper end to a rod or shaft 145 fixedly mounted between the arms 36. A spring 146 tensioned between the arm 142 and the latch 144 tends to hold the two in contact but they normally occupy the position in which they are shown in Fig. 2 since a shoulder on the pawl 116 abuts against the lower side of the shaft 145 and a tail 147 on the latch 144 is normally engaged by the shaft 138.

As shown in Fig. 4, a link 148 is pivotally connected at one end to the cam plate 42 and has a slot 149 cut in its surface near its other end. A pin 151 on the link 152 is passed through the slot 149 and acts as a guide for the link 148. The link 148 is formed with a downwardly extending arm 153 which has its lower end 154 bent in the form of a projection. As the cam plate 42 turns clockwise to elevate the wheels 16, the link 148 is drawn forward and near the end of the forward stroke the projection 154 contacts a lug 155 on an arm of the bell crank 122 to rock the shaft 121 and the bail 119 counter-clockwise (Fig. 4) to release the pawls 116.

The operation and timing of the transfer mechanism as thus far described is as follows:

In the light of previous description, it is evident that as the cam plate 42 is shifted in a clockwise direction, on adding strokes (Fig. 4) one immediate effect will be to elevate the arms 36 about their pivot 37, thus causing a similar elevation of the mechanism supported by the arms. Therefore, as the pinions 16 rise into engagement with their respective actuators 12, the relative positions of the pawls 116, the bail 119 and the pinions are retained. As another result of the movement of the cam plate 42, the shaft 138 is moved downward until it occupies a cut-out portion 156 (Fig. 2) of the slot 128. The movement of the shaft 138 will also release the latch member 144 and allow it to swing forward a short distance under the tension of its spring 146 to contact the arm 142. The disabling of the bail 119 occurs in the manner previously described just before the plate 42 reaches the end of its forward movement. As shown in Fig.

2, if a pinion 16 is rotated past its zero position on the return stroke of the actuators, the wide tooth 114 will contact the right hand face of the lug 115 and cam the pawl 116 and its arm 142 clockwise a short distance about the pivot 60 in which position it will be latched by the engagement of projection 143 and latching member 144. At the end of the return stroke the pinions 16 are withdrawn from the sectors 12 and return to engagement with the gear sectors 124. It is evident that as the wheel 16 engages the sector 124, the lower flat surface 137 of the pawl 116 will contact the arm 136 and, as the downward stroke continues, will rotate this arm and the bell crank 134, of which it is a part, counterclockwise about the shaft 135, and thus disengage the slot 133 from the projection 132 on the arm 127 of the sector 124 of the next higher order. Due to the tension provided by the spring 129 the sector 124 will then pivot in a counterclockwise direction (Fig. 2) about the shaft 125 until the projection 132 contacts a shoulder 157 formed in the bell crank 134. The pinion 16 which is in mesh with the sector 124 will, therefore, be turned in a clockwise direction a distance of one tooth space which is in proportion to the movement permitted the sector 124. It will also be apparent that as the bail rod 138 returns to normal, the latch 144 will be disengaged from the projection 143, permitting the pawl 116 to move about its pivot 60 and again assume the normal position illustrated in Fig. 2. However, if the above pinion 16 stood at "9" before being turned by its sector 124, the transfer pawl associated with the pinion of next higher order would be tripped against the tension of its spring 146 to effect a carrying into the next higher order. This would occur before the transfer pawl of lower order was fully restored to normal position. In this manner a chain of carry operations is effected during which time the bail 119 is prevented from returning to its normal position by the ends of the tripped transfer pawls 116. When all the pawls 116 are again raised to normal position, the bail 119 will be permitted to assume its usual retaining position under tension of the spring 123. The gear sector 124 is returned to normal on the following operation of the cam plate 42 when the descending rod 138 will engage the cam slot 128 and 156 of the displaced sector and return it to its correct alignment where it will be retained by the cooperation of lug 132 and slot 133 as before explained.

In a previous chapter it was pointed out that subtraction items are accumulated by rotating the wheels 16 in a direction opposite to that in which they are turned during adding strokes. Therefore, the transfer mechanism must be capable of carrying from order to order in a subtraction direction as well as in the manner above described. In order to reverse the usual motion of the gear sector 124, the spring bail 131 pivotally connected to the frames 40 as previously described, is caused to move to the dot-dash position of Fig. 2, so that the sector 124 may be tensioned to move in a clockwise direction. The transfer mechanism is conditioned to operate in the above manner as a consequence of depressing the subtraction key 68.

Referring now to Figs. 1 and 6, it will be seen that the lever 82 which, as has been previously described, is caused to rotate in a clockwise direction (Fig. 1) upon depression of the subtraction key extends toward the rear of the machine and is connected at its far end to a downwardly extending link 158. The link 158 is forked at its lower end and loosely engages a pin 159 on the right hand side frame 40. Formed integrally with the link 158 is an arm 161 connected by a pin and slot connection to a triangular shaped operating member 162. The lower end of the member 162 is loosely connected at 180 to a nose on the detent lever 150 (shown in Fig. 2) so that a downward pulling motion is imparted to the member 162 on each forward stroke of the operating handle in subtraction and each rearward stroke in addition. Formed in the upper end of the member 162 and placed at opposite ends are two hook like portions 163 and 164 each adapted to cooperate respectively with pins 165 and 166 on a lever 167 pivoted at 168 to the right hand frame plate 40. The lever 167 is formed with a forwardly projecting extension 169 which is forked at its forward end and adapted to engage a pin 171 on one side of the spring bail 131. It is apparent that if the triangular member 162 is operated while in the position shown in Fig. 6, the hook 163 thereon will engage the pin 165 without moving the lever 167 and act to retain the spring bail 131 in the position therein occupied which is the adding position previously described. The hook 164 will not engage the pin 166 during this operation. If, however, the link 158 is moved downwardly in response to the operation of the subtraction key, the arm 161 of the link will act to rock the member 162 clockwise about its pivot 180 to place the hook 164 just above the pin 166 and in position to engage said pin upon the operation of member 162. The hook 163 is thus rendered ineffective and on the above mentioned downward movement of the member 162 the lever 167 will be rocked in a clockwise direction about its pivot 168 and through the extension 169 will swing the spring bail 131 upward about its pivot until it occupies the position shown in dot-dash outline in Fig. 2. As shown in Fig. 5 the spring bail 131 has an arm 190 pivoted to its left hand end. Tensioned between one end of the arm 190 and the left hand frame plate 40 is a spring 200 and the resulting cooperation between arm 190 and spring 200 tends to hold the bail 131 in either its add or subtract position. As shown in Fig. 2, with the spring bail 131 thus positioned, it is evident that when the bell crank 134 is operated in the previously described manner to release the gear sector 124, the spring 129 will rotate the sector one tooth space in a clockwise direction to turn its associated pinion 16 a similar distance in a subtract direction, or counter clockwise as shown in Fig. 2. A shoulder 172 on the bell crank 134 limits the movement of the sector 124 in the same manner as the previously mentioned shoulder 157. In all other respects other than the exceptions noted above, the transfer mechanism functions in the same manner on both addition and subtraction operations.

In the above description of the transfer mechanism it was endeavored to limit the description in so far as possible to the operation of one gear wheel 16 and its associated carry sector 124. It should be borne in mind, however, that there is a gear sector 124 for each of the pinions 16 and duplicate mechanisms are provided for effecting a carry from wheel to wheel with the exception that there is no provision for carrying into the wheel of lowest order. Taking the above mentioned wheel of lowest order as an example, it will be readily understood that the pawl 116 asso-

ciated with this wheel is adapted to be tripped as the wheel passes zero and so disable the bell crank latching member 134 which lies below the pawl 116 and approximately in the same plane. The bell crank 134 normally engages and holds ineffective the gear sector 124 which is associated with the pinion 16 of the next higher order. On adding strokes the release of this sector occurs at the approximate end of the return stroke of the machine when all of the pinions 16 have been returned to engagement with their respective sectors 124. In a subtraction operation the pinions are reengaged with their gear sectors 124 at the start of the return stroke. The unlatched sector is now free to turn a short distance about its pivot under the influence of the spring 129, and will effect a corresponding movement of one tooth space of its associated pinion 16 in either an add or subtract direction according to the position of the spring bail 131 which supports all of the springs 129. The means for restoring the sectors 124 to normal is believed to have been made sufficiently clear in the previous description.

Total taking mechanism

In order that the pinions 16 may be cleared and cause the simultaneous printing of their accumulated values, suitable total-taking mechanism, under control of a total key, is provided. Because of the novel transfer operation previously described, wherein the transfer pawls 116 are tripped and reset all in one machine operation, the necessity for inserting a blank stroke between the last accumulating operation and the total stroke itself has been eliminated. Therefore, the machine is conditioned at all times for a total taking operation.

As shown in Fig. 4 there is provided at the front of the machine a key 173 fast to the shaft 57. Also fast to the shaft 57 is an upstanding arm 174 connected at its upper end to the front end of the previously mentioned link 152. The link 152 or total link as it may be called extends rearwardly the entire length of the machine and is supported at its far end by a plate 175 fixed to the rear frame plate of the machine. Operation of the key 173 will, therefore, cause the link 152 to slide rearwardly through its support 175 and perform the several functions noted below. A pin 176 situated on the side of the link 152 is adapted to cooperate with a nose 177 of the arm 91 to rotate the arm 91 about its pivot 89 to depress the slotted cam plate 93 and so condition the accumulator timing mechanism to bring about the engagement of the wheels 16 with their actuators 12 at the beginning of the forward stroke as previously described. Another function of the total link 152 is to disable the link 148, the purpose of which, as we have seen, is to release the transfer pawls 116 by rocking the bail 119 which normally holds them engaged. When the total link 152 is in operative position the pin 151 which engages the slot 149 lies a farther distance rearward than usual so that when the cam plate 42 is rocked on a total stroke a cam surface 178 formed in the rear of the slot 149 will engage the pin 151, thus forcing the arm 153 downwardly far enough to permit the projection 154 to pass harmlessly under the lug 155 and so retain the bail 119 in its effective retaining position. Formed in the link 152 near its far end is a toe 179 adapted to engage and force down the plate 15 which, as previously described, normally engages the heels 14 of the sectors 12 and restrains them from forward movement.

Keeping in mind these several functions of the total link, it is evident that if the total key 173 is depressed and the operating handle then pulled forward, the pinions 16 will rise into mesh with their respective accumulator racks 12 and all of the sectors 8 and 12 are permitted to move forward to printing position. The printing position of each sector 8 is individually determined by the number of tooth spaces required for each pinion 16 to return to zero. On total strokes the lugs 115 present unyielding surfaces to their respective teeth 114 in order that all of the pinions 16 may be correctly aligned in their original position.

Index sector

As shown in Fig. 1, there is also provided in the machine of the present invention the usual index sector 181 adapted to be raised on total, subtract and non-add operations to print an identifying letter or insignia to the right of the printed item and on the same line. Mechanism of this same general type has been disclosed in numerous other patents, among them the one to Dysart 2,014,560. The sector 181 is similar in shape and operation to the sectors 8 and is provided with a stop arm 182 secured to the rear of the sector and adapted to cooperate through its lug 183 with a stepped bell crank 184. The bell crank 184 is pivoted to a short extension of the shaft 37, and has one arm 185 loosely connected to the rear end of a link 186 supported at its other end by the right hand frame plate 40 through a pin and slot connection 187 and 188. A spring 189, tensioned between a shoulder on the link 186 and the shaft 37 tends to hold the bell crank 184 elevated in the position shown in Fig. 1 so that the sector 181 is normally arrested from forward movement by contact of the lug 183 with the lowest step of the bell crank 184. On a total taking operation the sector 181 is adapted to rise one step to cause the imprint of a familiar insignia which will indicate that the amount just printed is a total and that the wheels are clear. Depression of the total key as previously described causes the rotation of the shaft 57 in a clockwise direction as viewed in Fig. 1. Secured to the shaft 57 is a dependent slotted lever 191 adapted to engage a pin 192 on the lower end of a link 193. At its upper end the link 192 is slidably connected through its arms 194 and 195 to the link 186. It is evident, therefore, that the operation of the total key 173 will cause the bell crank 184 to move in a clockwise direction to enable the lug 183 on the sector 181 to engage the next higher step on the bell crank 184, thus positioning the sector 181 in the printing position mentioned above.

In order that subtraction items and totals may be easily recognized as such after they are printed, mechanism is provided for raising the printing ribbon (not shown) from its normal position and causing the aforementioned subtraction items and totals to be printed in red. As shown in Figs. 3 and 4, the lever 84, fast to the shaft 83, has a pin 197 at its upper end adapted to engage a slot 198 formed in one end of a link 199. At its other end the link 199 is connected to another link 201 loosely connected at its upper end to an arm 202. The arm 202 is one of a pair which is fast to the shaft 203 in the frames 204 and which is adapted, when moved upward, to elevate the printing ribbon in a manner not herein shown. The lower end of the link 201 is formed with a notch 205 adapted on occasion to be engaged by a pin 206 on one arm of a bail

shaped bell crank 207 loosely mounted on the shaft 37. The bell crank 207 is associated with the line space mechanism and is rocked in a clockwise direction about its pivot 37 on each forward stroke of the machine through the other arm 208 of the bell crank and link 209 connected to the arm 108 fast to the main shaft 19. During the regular adding strokes of the machine, the notch 205 lies out of the path of the pin 206 and, therefore, the arms 202 retain their normal position. However, when the lever 84 has been rocked counterclockwise, as viewed in Fig. 3, as a result of either the depression of the subtract key 68 or the total key 173, the link 201 will be moved rearwardly a sufficient distance to permit the pin 206 to engage the notch 205 and thus cause the elevation of the printing ribbon to a point where the hammers 32 will strike the red portion of the ribbon and cause the item to be printed in that color.

Example of negative transfer operation

The mechanism of my invention may be more clearly understood from the following example in which the totalizer is caused to register a negative amount.

Assuming for the sake of brevity that several adding operations have been performed and an amount such as 812 is now in the wheels, or, if it were possible to read the wheels 000000812. It is now desired to subtract an item of 924. The amount will first be set up on the keyboard in the usual manner to elevate corresponding stop pins 6. The subtraction key 68 is then depressed and the operating handle swung forward to release those sectors 8 and 12 associated with the elevated stop pins 6. The operation of the subtraction key has positioned the spring bail 131 in subtract position and has disabled the regular accumulator timing mechanism so that as the main shaft 19 starts its forward stroke the accumulating wheels 16 will be raised into mesh with their respective actuating racks 12. The racks 12 and their associated sectors 8, under tension of their springs 11 follow the forward movement of the printing handle until limited by their stops 6. Referring now to Fig. 2 it will be seen that the wheel 16 of lowest order will be turned in a counter-clockwise direction a distance of four tooth spaces. The wheel of next higher order will turn two spaces in the same direction and the next wheel 9 spaces. During the operation each of these wheels 16 will pass its zero position to trip its associated pawl 116 and condition the transfer mechanism for operation. At the completion of the forward stroke, the operating handle will be permitted to start on its return stroke back to normal. At the beginning of the return stroke the printing hammers 32 will be released to print and the accumulating wheels will be withdrawn from engagement with their actuators 12 and returned to engagement with their gear sectors 124. Immediately after the reengagement of the pinions 16 and sectors 124 the latter are released from their latches 134 and a transfer operation occurs which is effective in all of the pinions 16 except, of course, the wheel of lowest order. At the conclusion of the return stroke, therefore, the wheels will contain a negative amount of 999999888 which is the complement of the true negative amount 000000112.

Assuming now that a total is desired to be taken immediately after the above operation, the total key 173 is first depressed. The operating handle is then pulled forward and all of the sectors 8 and 12 swing forward, engaging as they do so their respective pinions 16 returning them to zero and causing the amount represented therein, or 999999888 to be printed in the usual manner. As mentioned above, this amount is the complement of the true negative total and must be translated into the correct negative balance by the operator.

A negative total may be easily recognized by the series of nines which are caused to be printed to the left of the first significant digit.

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 an adding or like machine, the combination of a plurality of register wheels, actuators therefor, a main operating mechanism, means including an oscillating member operable by said main operating mechanism for moving said register wheels into and out of cooperative relation with said actuators, a plurality of transfer pawls associated with said register wheels, locking means normally holding said pawls in positive engagement with said wheels, and an operating element connected to said oscillating member and operable thereby to disable said locking means after said wheels are moved into cooperative relation with said actuators.

2. In an adding or like machine, the combination of a plurality of register wheels, actuators therefor, a main operating mechanism, means including an oscillating member operable by said main operating mechanism for moving said register wheels into and out of cooperative relation with said actuators, a plurality of transfer pawls associated with said register wheels, locking means normally holding said pawls in positive engagement with said wheels, an operating element connected at one end to said oscillating member and operable thereby, said operating element being guided at the other end by a cam slot formed therein and a pin normally engaging a portion of said slot whereby movement of said operating element is guided in a manner to disable said locking means after said wheels are moved into cooperative relation with said actuators, a key, and means operable upon the depression of said key to shift said pin into another portion of said slot whereby movement of said operating element is guided in a manner to permit said locking means to remain in locking position.

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