Dec. 2, 1947. E. GRIP ET AL 2,431,930

FULL CYCLE POSITIONING MEANS

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FIG. 2.

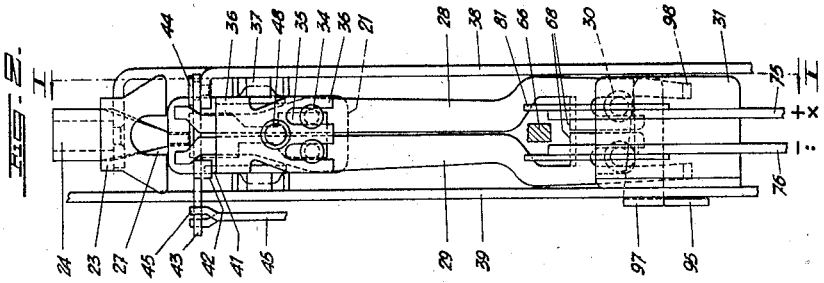
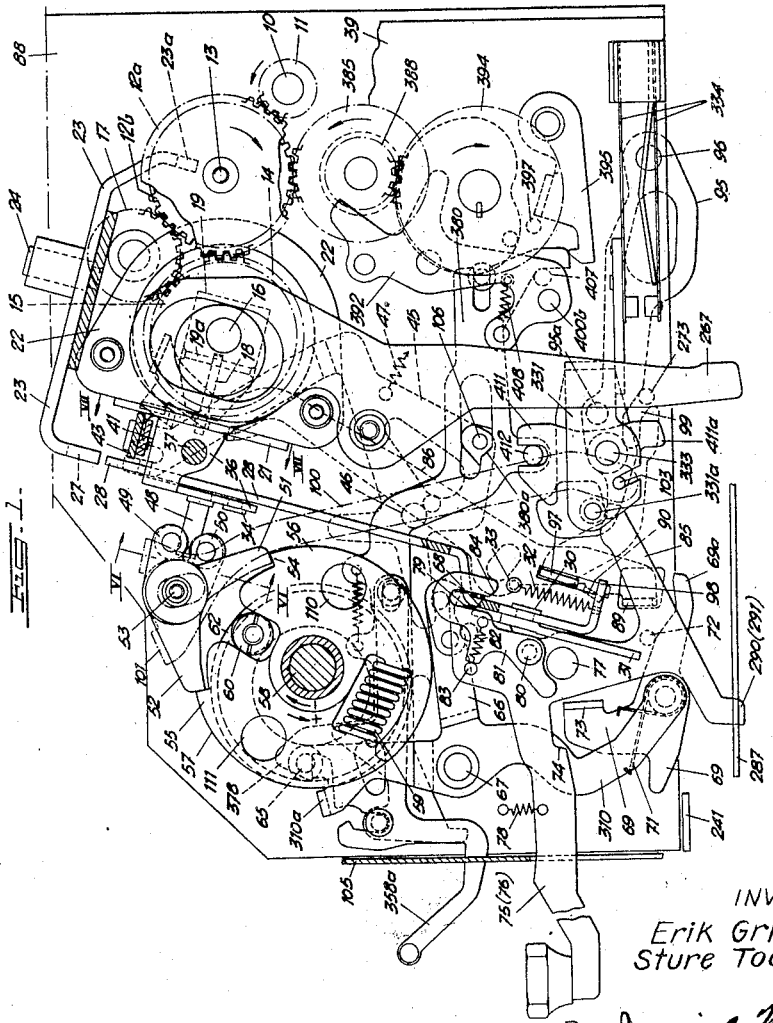


FIG. 1.



INVENTORS,
Erik Grip and
Sture Toorell

By Jarvis C. Marble
Their Attorney

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FIG. 3.

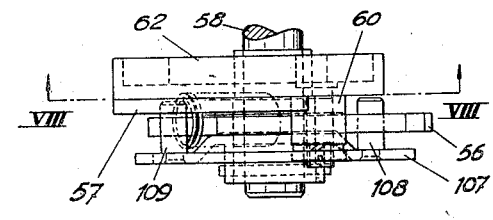


FIG. 6.

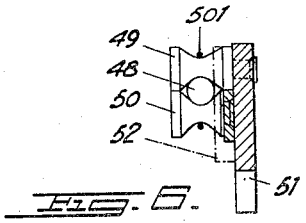


FIG. 4.

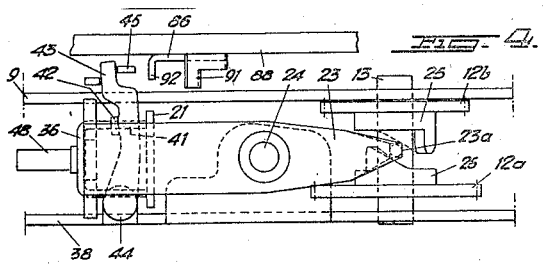
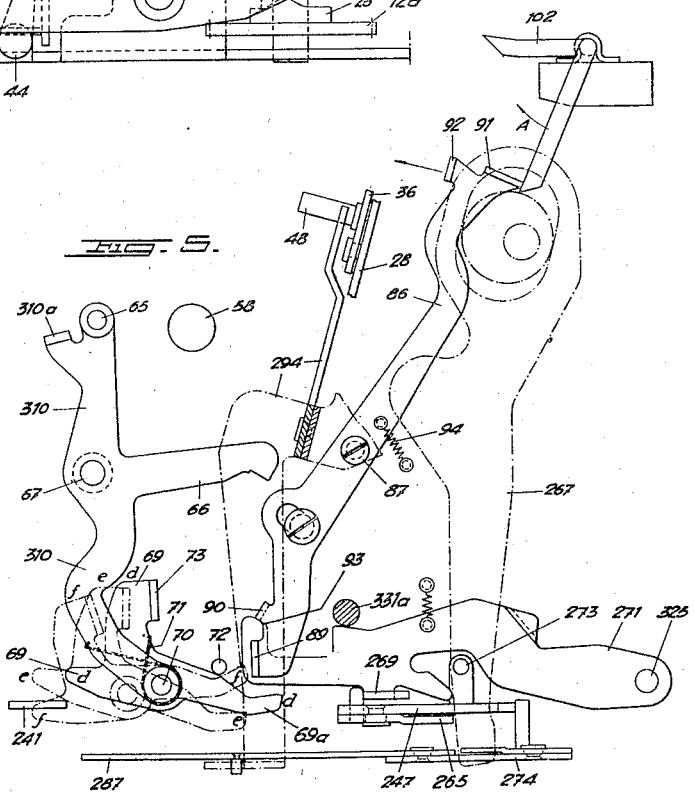


FIG. 5.



INVENTORS,
Erik Grip and
Sture Toorell

By Jarvis C. Marble
their Attorney

Dec. 2, 1947. E. GRIP ET AL 2,431,930

FULL CYCLE POSITIONING MEANS

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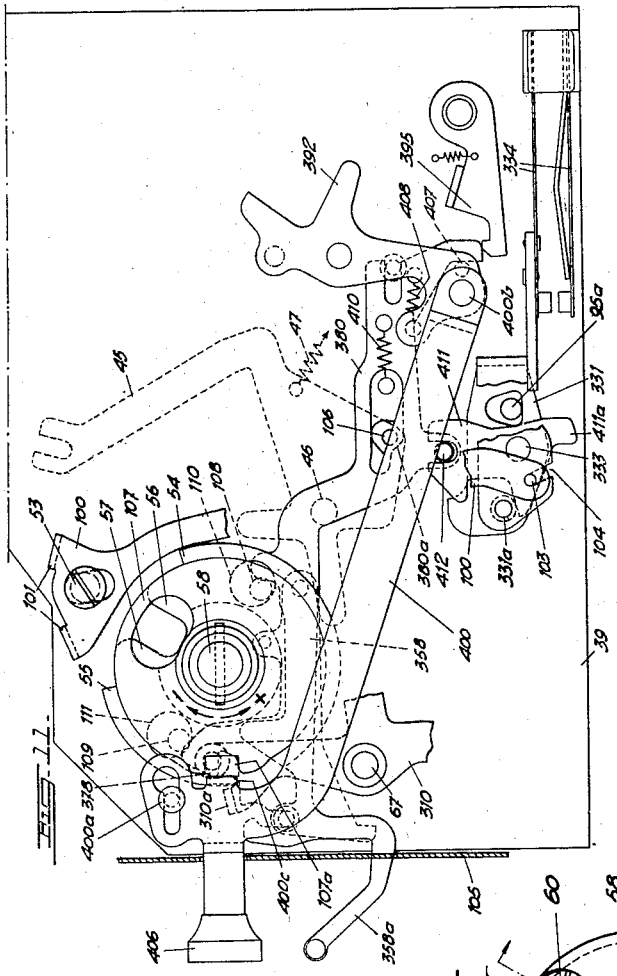

Fig. 1.

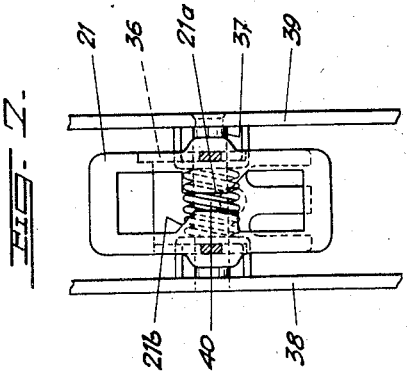

Fig. 2.

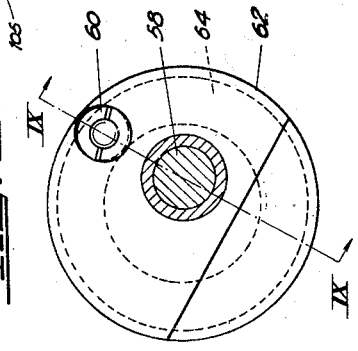

Fig. 3.

INVENTORS,
Erik Grip and
Sture Toorell
By Jamis C. Marble
their Attorney

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Fig. 9.

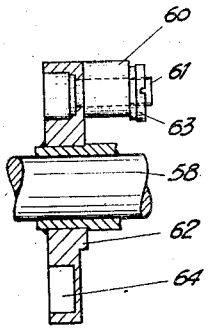
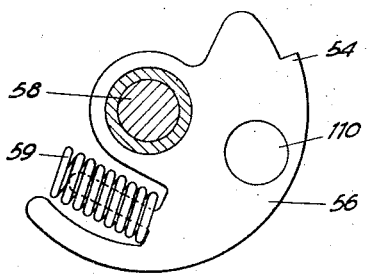


Fig. 10.



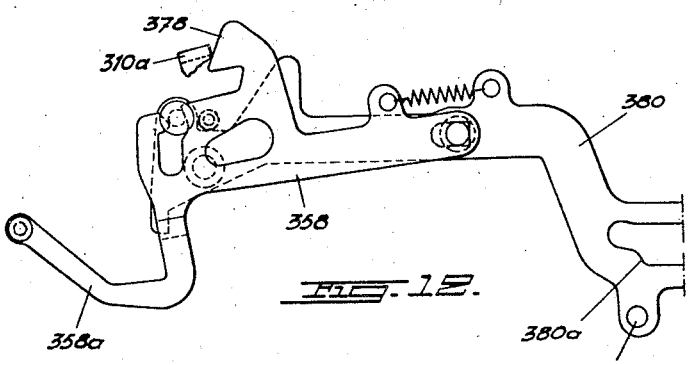


Fig. 12.

INVENTORS,
Erik Grip and
Sture Toorell
By Jarvis, Marble
their Attorney.

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UNITED STATES PATENT OFFICE

2,431,930

FULL CYCLE POSITIONING MEANS

Erik Grip and Sture Toorell, Atvidaberg, Sweden, assignors to Aktiebolaget Facit, Atvidaberg, Sweden, a corporation of Sweden

Application May 5, 1944, Serial No. 534,287
In Sweden May 19, 1943

13 Claims. (Cl. 235—62)

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This invention relates to calculating machines and more particularly to multiplying machines having an actuator to be operated in two directions, that is the + direction and the — direction. It may be applied, for instance, to pin wheel or Odhner machines.

The chief purpose of this invention is to simplify the devices for stopping the rotary actuator (such as a pin-wheel rotor) after completing the desired number of revolutions, and also to improve such stopping devices for rendering them more reliable.

Another purpose of this invention is to lower the costs for manufacturing the stopping devices for the actuator.

Another purpose of this invention is to render the machine more reliable and less sensitive to shocks and rough handling; in other words the risk of machine faults is essentially reduced. This is of course most important in rapidly operating calculating machines driven by electric motors.

When not otherwise expressly stated, the expressions "right," "left," "upwards," "downwards," "forwards," "backwards," "front" and "back" are used in this specification and in the claims as such directions appear to an operator sitting at the key-board of the machine to manipulate it.

One embodiment of an improved calculating machine in accordance with this invention is illustrated in the annexed drawings.

Fig. 1 shows a section on the line I—I of Fig. 2 and is substantially an end view from the right side of the machine, with the right end plate removed.

Fig. 2 shows a front view of the upper part of the driving mechanism proper.

Fig. 3 shows a detail view of the stop disc mechanism, as viewed from above.

Fig. 4 shows a top view of the driving mechanism proper.

Fig. 5 shows an end view of certain details immediately to the left of the driving mechanism proper.

Fig. 6 is a cross-sectional view taken on the line VI—VI of Fig. 1.

Fig. 7 is a cross-sectional view taken on the line VII—VII of Fig. 1, showing a guiding plate.

Fig. 8 is a plan view of a part of the stop disc, and is taken on the line VIII—VIII of Fig. 3.

Fig. 9 is a cross-sectional view taken on the line IX—IX of Fig. 8.

Fig. 10 shows a plan view of one of the buffer discs in the stop disc mechanism.

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Fig. 11 shows an end view of the clearing mechanism and the parts cooperating therewith.

Fig. 12 shows a detail (a side view) of the setting arm for setting the machine to direct subtraction, together with the parts cooperating therewith.

The machine illustrated in the drawings is in its essential features constructed in accordance with U. S. Patents No. 2,108,596, No. 1,927,771, No. 2,243,075 and No. 2,398,286 issued April 9, 1946, though the invention by no means is limited thereto. See also U. S. patent applications Ser. No. 532,961, Ser. No. 534,453 and Ser. No. 543,288 corresponding to Swedish patent applications No. 7448/1942 and 7449/1942 and 3605/43, respectively.

The machine illustrated in the drawings is of the Odhner or pin wheel type and has an actuator or pin wheel rotor arranged in a carriage shiftable along the main shaft 58. For carrying out the calculating operations this shaft together with the actuator is rotated in either direction of rotation, that is + or — direction, that is, counterclockwise and clockwise, respectively, in Figs. 1 and 11, as indicated by arrows correspondingly marked.

A shaft 10 is driven by a motor and carries a toothed wheel 11 driving a toothed wheel 12*a*, which together with another toothed wheel 12*b* (Figs. 1 and 4) is secured to a shaft 13. The toothed wheel 12*a* drives directly a toothed wheel 14, while the toothed wheel 12*b* drives a toothed wheel 15 through an intermediate toothed wheel 17. The two toothed wheels 14, 15 are freely journalled on the shaft 16 and consequently they always rotate in opposite directions as long as the motor runs. One or the other of these toothed wheels 14, 15 may be coupled to the shaft 16 by means of the coupling pawl 18, which is rockable on a pin 19*a*. This pin extends at right angles to the shaft 16, and is secured in the block 19 rigidly attached to the shaft 16 and passes through a slot in said block. Said slot is parallel with the shaft 16 and in it the pawl 18 is thus journalled. When said pawl is rocked in one direction or the other, its lateral projections will engage shoulders or offsets on the sides of the toothed wheels 14 and 15, respectively. This couples the shaft 16 to the toothed wheel 14 or 15, respectively, that is, this shaft is rotated in one direction or the other, because the wheels 14 and 15 rotate in opposite directions. By means of geared transmissions the shaft 16 is in permanent driving connection with the main shaft 58 of the machine, which carries the actuator.

Thus, the actuator is rotated in the + direction or the — direction depending on whether the pawl 18 is coupled to the toothed wheel 15 or 14, respectively.

For guiding the pawl 18 to engage and to disengage the shoulders on gears 14 and 15, said pawl has a point or head at that end which is most remote from the pin 19a. This point enters a guiding slot 21a having oblique entrance edges 21b. This slot is formed in a movable guiding member 21 (Figs. 1, 2 and 7), and the point of the pawl 18 is in the guiding slot 21a, when the shaft 16 is at rest (that is, when the actuator is in its full cycle position). When the shaft 16 rotates, the point of the pawl 18 engages one side or the other of a stationary guiding rail 22 which is curved along a circular arc (Fig. 1). Thus, the pawl 18 is positively guided during that part of the rotation of the shaft 16 during which the point of the pawl is outside of the slot 21a. The guiding rail 22 is preferably resiliently suspended. In other words, the slot 21a and the rail 22 together guide the pawl 18 during the whole revolution of 360°. Normally, the guiding member 21 with its guiding slot 21a is in its middle or central position (Fig. 7) and then the pawl 18 is disengaged from the shoulders on gears 14 and 15. When in the manner described below the guiding member 21 is moved to either side, it rocks the pawl 18 correspondingly to engage the corresponding shoulder on the gears 14 or 15.

A rocking arm 23 is pivotally journalled on the stationary pin 24 and one end 23a (Figs. 1 and 4) of this arm enters the space between two cam discs 25, 26, which are secured to the shaft 13 and consequently rotate when the motor runs. This swings the arm 23 to and fro in a reciprocating or pendulous motion on the pin 24. The opposite end of this arm has a recess 27 (Fig. 2).

Two coupling rods 28, 29 are displaceably journalled on pins 30 (Figs. 1 and 2) secured to the stationary plate (frame part) 31 and entering oblong slots in the rods. Said rods may, therefore, be displaced in their longitudinal direction, and springs 32 are tensioned between said rods and stationary pins 33 and tend to lift the rods to their uppermost position. At their upper ends, these rods carry pins 34 entering slots 35 of an angular piece 36 which is displaceable laterally, that is parallel with the shaft 16, on a stationary shaft 37 (Figs. 1 and 7) secured between the two intermediate walls 38 and 39 of the machine frame. The angular piece 36 is rigidly connected with the guiding member 21 to form a rigid unit, normally kept in its central position between the walls 38 and 39 by a spring 40, as shown in Fig. 7. When the angular piece 36 and the guiding member 21 are in this central position, the pawl 18 is disengaged from the shoulders on gears 14 and 15, as mentioned above. The angular piece 36 has a projection 41 (Figs. 1, 2 and 4), which rests against the inside of the downwardly projecting part (tongue or offset) 42 of the locking arm 43. At one end said locking arm is rotatably journalled on the pin 44 which is secured to an offset part of the side wall 38. The opposite (outer) end of the locking arm 43 is embraced by the fork-shaped upper end of an arm 45 which is rotatably journalled on the pin 46 on the side wall 39 and is pressed by a spring 47 in such direction (clockwise in Figs. 1 and 11) that the part 42 engages the projection 41.

A pin 48 (Figs. 1, 2 and 6) is riveted to the angular piece 36 and enters the space between

two double-conical pins 49 and 50. The pins 49 and 50 may also be described as having the shape of hyperboloids of rotation. These pins are riveted to the back ends of stop pawls 51, 52, respectively, rotatably journalled on a pin 53 secured to the side wall 39. Around this pin a torsion spring 501 is wound, acting upon the two stop pawls so that the double-conical pins 49, 50 are pressed towards each other to engage the pin 48.

When the machine is at rest and no operation of calculation is being carried out, the two stop pawls 51, 52 engage their respective stop shoulders 54, 55 of two buffer discs 56, 57 (Figs. 1, 3, 10 and 11), said torsion spring 501 pressing the points of the pawls inward against the periphery of said buffer discs which are rotatably journalled on the main shaft 58 of the machine, which carries the actuator. Between the two discs 56, 57 a strong buffer compression spring 59 is arranged which presses those discs to engage an eccentric bushing or sleeve 60 (Figs. 1, 3, 8 and 9). This bushing is either itself non-circular, for instance, oval or elliptic in cross-section, or is eccentrically journalled on a screw or stud bolt 61 which is secured, as by riveting to a cam disc 62 rigidly connected with the main shaft 58. A nut 63 threaded on the screw 61 serves to keep the bushing 60 in its angular position as set on the screw 61. It is to be observed that the cam disc 62 is eccentrically arranged on the main shaft 58 and the circular slot 64 cut in said disc is consequently eccentric in relation to the main shaft 58. A roller 65 (Figs. 1 and 5) enters said slot and is journalled on a three-armed lever or release arm 310 which is rockably journalled on the stationary pin 67. The horizontal arm 66 of said lever extends inwards through the space between the rods 28 and 29 (Figs. 1 and 2) to engage the edges 68 of said rods from above. At this place the arm 66 is broadened so that it can cooperate with the edges 68 of both rods 28, 29, as is shown in Fig. 2. To the lower arm of the release lever 310 a three-arm or three-branched hook 69 is rotatably journalled on the pin 70. A torsion spring 71 is wound around said pin and tends to rock the hook 69 counterclockwise in Figs. 1 and 5.

Under the action of this spring the back arm 69a of the hook 69 engages a pin 72 secured to the intermediate wall 39. In addition, the hook 69 has an angularly disposed portion 73 which extends laterally below the projections 74 (Fig. 1) on the two keys 75 and 76, that is the multiplication or + revolutions key 75 and the division or subtraction key 76, respectively. These keys are rotatably journalled on a stationary shaft 77 and are acted upon by individual springs 78 pressing the back end of the key against the stationary guide 31. In addition, these keys have hooks 79 engaging the edges 68 of the rods 28, 29 from above to normally prevent the spring 32 from lifting said rods, that is when the key 75 or 76, respectively, is not depressed. It is to be observed that the key 75 cooperates with the rod 28 and the key 76 with the rod 29. Each key 75 or 76 has a hook 81, which is rockably journalled on a pin 80 on the key and is pressed by a spring 82 to engage the pin 83 on the key. The points 84 of said hooks are somewhat lower than the striking edges 68 of the rods 28, 29, when said rods are in their position of rest. The keys 75, 76 are integrally formed with the arms 85 and also with the arms 290 and 291, respectively. The arms 85 of said keys engage the pin 331a of an

angular piece or contact lever 331 which is rockably journalled on the stationary pin 333 and controls the electric motor contacts 334. When one of the keys 75, 76 is depressed, the contact lever 331 is rocked to close the motor contacts 334 starting the motor. The arms 290 and 291 of the keys 75 and 76, respectively, enter in well-known manner a recess in a plus-minus-control plate 287 which is arranged below the base plate of the machine, as shown in Figs. 1 and 5. Reference is made to the corresponding parts 290, 291, 287 of U. S. Patent No. 2,398,286, issued April 9, 1946.

A lever 86 (Figs. 1, 4 and 5) is rockably journalled on the stationary pin 87 secured to the frame 88. This lever has four projections 89, 90, 91, 92. The projection 89 (Figs. 1 and 5) extends through a hole in the intermediate wall 39 above the arm 69a of the hook 69. The projection 90 forms a striking edge for the lever 271 which is rockably journalled on the stationary pin 325 and with its surface 93 engages the projection 90. The projection 91 engages the arm 102 which, in a manner shown in U. S. Patent No. 2,398,286 is acted upon by the tens transfer hook or lever for the totalizer wheel of the highest denomination in the results register. When a ten is carried into that totalizer wheel the arm 102 is swung in the direction of the arrow A in Fig. 5, that is clockwise, as is described in detail for the part 102 in U. S. Patent No. 2,398,286. Finally, the projection 92 engages the lever 45 (Figs. 1, 5 and 11) to rock that arm, when the lever 86 is swung counterclockwise. A tension spring 94 presses the arm 86 and its projection 91 into engagement with the arm 102.

The driving lever 267 (Figs. 1 and 5) drives the swing lever 247, and also the plus-minus control plate 287 in the manner shown in detail in U. S. Patent No. 2,398 286. The lever 247 effects the shifting and the control plate 287 pulls down the keys 75 and 76 during the calculating operations. This control plate 287 is set to its + position and — position by means of the reversal lever 294, depending on the setting of the angular piece 36 to which the reversal lever is directly connected. Depending upon how said angular piece and consequently the control plate 287 are set said control plate engages one of the projections 290, 291 of the multiplication key 75 or the division key 76, as described for the corresponding parts 287, 290, 291 in U. S. Patent No. 2,398,286.

The key holding-down-lever 95 (Fig. 1) which is rotatably journalled on the stationary pin 96 of the wall 39 has a front angular portion 97 extending through a hole in the intermediate wall 39 to engage the angular lower ends 98 (Figs. 1 and 2) of the lifting rods 28, 29 from above. Said lever 95 has a curved cam slot 99 (Fig. 1) engaged by the pin 273 secured to a small standard or tongue on the swing lever 247. In addition, a pin 95a (Fig. 11) is riveted to the key holding-down-lever 95 and enters a slot of the contact lever 331 to swing that lever for closing the contacts 334 when the lever 95 is pressed downwards.

An impulse arm or lever 100 (Figs. 1 and 11) is displaceably journalled at its upper end on the pin 53 for the stopping pawls 51, 52, said impulse lever having an oblong slot through which said pin passes. The upper end of this impulse arm is fork-shaped and has two angular prongs 101 resting on the upper sides of the two pawls 51, 52. At its lower end this impulse lever carries a pin 103 resting in a slot 104 of the contact lever 331.

The slide 241 (Figs. 1 and 5) is controlled by the control lever of the machine as described with reference to parts 241 and 201 in U. S. Patent No. 2,398,286, this lever serving for setting the machine to multiplication and to division with automatic shifting. Depending upon the setting of this lever the slide 241 is in or out of the path of motion of the pawl 69. When the machine is set to multiplication the slide 241 is out of the path of motion of the pawl 69, but when the machine is set for division, the slide 241 enters the path of motion of said pawl.

The release arm 310 (Figs. 1, 11 and 12) acts directly on the hook 358 which is integral with the subtraction setting lever 358a. This lever 358a extends outwards through a slot in the casing 105 of the machine. In the embodiment shown the machine has, in addition to the multiplication or positive multi-revolutions key 75 and the division or negative multi-revolutions key 76 also an addition key, as in U. S. Patent No. 2,398,286, but no subtraction key. Thus, the machine is set to subtraction by pressing the lever 358a downwards manually to its lowermost position, and when the division key 76 is depressed, the machine performs an operation of subtraction as described in connection with Fig. 16 of the patent just mentioned. For this purpose the release arm 310 has an angular projection 310a pressing against the edge 378 of lock 358 when the latter is depressed due to the fact that the operator presses the lever 358a downwards to its lowermost position (for subtraction) or due to the fact that the addition key has been depressed manually. Figs. 1 and 11 show the lever 358a in its uppermost position, while Fig. 12 shows the same in its lowermost position. When the slide 380 is pushed inwards, that is to the right in Figs. 1 and 11, for instance, due to the manipulation of the clearing key 406, the cam 380a of this slide acts on a pin 106 extending through a hole of the intermediate wall 39 and secured to the lever 45. This rocks the lever 45 and moves the locking arm 43 to the left in Fig. 1 and counter-clockwise in Fig. 4 so that the part or offset 42 of that locking arm releases the tongue 41 of the angular piece 36. Under the action of its spring 40, the angular piece 36 with its guiding slot 21a is restored to its neutral, central position so that the coupling pawl 18 is disengaged from the shoulders on gears 14 and 15. If the main shaft 58 rotates, when the clearing is started, such rotation is thus stopped, as soon as the current revolution has been completed. The main shaft 58 cannot be re-started again during the clearing operation due to the fact that the lever 45 keeps the locking arm 43 rocked aside so that its offset 42 does not lock the projection 41. Consequently the guiding slot 21a and the coupling pawl 18 are restored to their inoperative neutral position, before any of the shoulders on the gears 14 and 15 come around to the pawl 18 during rotation of the gears 14 and 15. When the slide 380 is displaced to the right in Fig. 11, the pin 412 thereon rocks the arm 411 clockwise in Fig. 11, said arm being rockably journalled on the pin 333. Consequently, this arm acts on the pin 331a and the contacts 334 are closed for the clearing operation. In clearing operations effected due to the manipulation of the clearing key 406 or when the machine has been set to addition or subtraction and consequently the arm 411 has been swung clockwise in Figs. 1 and 11, the downwardly extending projection 411a of that arm engages the upper side of the angular projection 269 (Fig. 5) of the lever 271. This prevents all shifting of the actu-

ator during operations of addition, subtraction and clearing.

As is described in detail in U. S. Patent No. 2,398,286, the toothed wheels **385**, **388**, **394** (Fig. 1) are driven by the motor under the control of the coupling arm **392**. The clearing key **406** (Fig. 11) is arranged on the link or arm **400** which by means of an oblong slot embraces the stationary pin **400***a* and also by means of the pin **400***b* is articulately connected with the lower end of the coupling arm **392**, the latter being connected with the slide **380** by means of a spring **408**. This slide has a restoring spring **410** and in its backward active position it is locked by a pawl **395** releasable by the pin **397** on the toothed wheel **394** after the clearing of the actuator has been finished. A pin **407** is secured to the coupling arm **392** and engages a projection on the slide **380** so that said slide is drawn backwards (to the right in Figs. 1 and 11) when the coupling arm **392** is rocked counter-clockwise for effecting a clearing operation (zeroizing).

A disc **107** (Figs. 3 and 11) is rotatably journalled on the main shaft **58** and carries two pins **108**, **109** which enter into the holes **110** or **111** respectively of the stop discs **56** or **57**, respectively, and are guided in said holes. In clearing operations in connection with operations of addition and subtraction, the projection **400***c* (Fig. 11) of the rod **400** is moved to engage the periphery of the disc **107** when the slide **380** is moved to the right in Fig. 11 and by means of the spring **408** tries to rock the coupling arm **392** counter-clockwise, said coupling arm being articulately connected with the rod **400**. This prevents any clearing operation from being started as long as the main shaft **58** rotates. Similarly, the projection **400***c* engages the periphery of disc **107** when the clearing key **405** is depressed manually for initiating a clearing operation; this prevents any clearing operation from beginning as long as the actuator rotates. Not until after said shaft has been stopped in its full cycle position by the stop pawls **51**, **52**, does the spring **408** pull the projection **400***c* into the recess **107***a* of the disc **107** and this swings the coupling arm **392** counter-clockwise so that the clearing is effected. Thus, said disc **107** is stopped and locked, but nevertheless the main shaft **58** may move slightly beyond its position of rest while compressing the buffer spring **59**. For instance, in an operation of addition the disc **57** may move somewhat counter-clockwise, because the pin **109** can move somewhat in the hole **111**. Thus, the discs **56** and **57** are rocked during a short moment, while the actuator and the main shaft **58** are stopped and their kinetic energy is absorbed by the buffer spring **59**.

Mode of operation

For the various kinds of operation, the device described acts as follows:

Multiplication

The control lever of the machine (see lever **201** in U. S. Patent No. 2,398,286) is set to a position for multiplication, thus causing the slide **241** controlled thereby to be moved out of the path of motion of the hook **69** (Figs. 1 and 5). At this setting, the plus-minus-control plate **287** is locked, as described in detail in said patent, and it is consequently not moved by the eccentric-driven lever **267** in its rocking motion.

After the multiplicand has been entered in the actuator in well-known manner, the multiplication key **75** (Fig. 1) is depressed, causing the

arm **85** of that key to rock the contact lever **331** clockwise in Fig. 1 in such manner that the electric contacts **334** for the motor are closed. When the motor starts, the swinging arm **23** (Figs. 1 and 4) is rocked by the cam discs **25**, **26**. When the operator depresses the key **75**, its oblique edge or hook **79** (Fig. 1) releases the edge **68** of the coupling rod **28** so that said rod is free and displaced upwards by its spring **32**. Then, the upper part of this rod enters the recess **27** (Figs. 1 and 2) of the rocking arm **23** and consequently, the lifted rod **28** is moved by the rocking arm **23** so that said rod is displaced laterally to the left in Fig. 2. During this operation, the pin **34** on the rod acts upon the angular piece **36** causing also that piece to be displaced to the left in Fig. 2 and consequently the guiding slot **21***a* (Fig. 7) rocks the coupling pawl **18** in the same direction. Consequently, the coupling pawl becomes coupled to the shoulder on the gear **15**. This couples the main shaft **58** with the motor to be driven thereby in + revolutions, that is counter-clockwise in Fig. 1. The projection **42** of the locking arm **43** (Figs. 2 and 4) then engages the bent pawl **41** of the angular piece **36**, so that the spring **40** (Fig. 7) cannot restore said angular piece to its neutral central position. When the angular piece **36** is displaced in the manner just described, the pin **48** secured thereto follows and is moved to the left in Fig. 6 to act upon the conical pins **49**, **50** so that they are pressed apart and thus the stopping pawls **51**, **52** are lifted from the shoulders **54**, **55** on the buffer discs **56** and **57**, respectively. The main shaft **58** is now released from the stopping pawls and begins rotating in a + revolution. When the pawls **51**, **52** are lifted, they themselves lift the impulse arm **100**.

When the cam slot disc **62** (Figs. 1 and 8) secured to the shaft **58** begins moving, its eccentric slot **64** rocks the release arm **310** clockwise in Figs. 1 and 11, said release arm engaging the slot **64** by means of a roller **65**. The horizontal arm **66** of the release arm **310** then is lowered towards the striking edge **68** (Figs. 1 and 2) on the coupling rod **28** and thus presses said rod, and also the rod **29**, downwards to its lowermost position, which is somewhat lower than its position of rest shown in Fig. 1.

Because of the depression of the key **75**, the spring **82** (Fig. 1) is able to pivot the hook **81** journalled on that key towards the coupling rod **28** and the oblique surface of the point **84** of that hook now snaps in above the edge **68** of the coupling rod **28** to keep said rod in its lowermost position after the arm **66** of the release arm **310** begins to move counter-clockwise under the action of the eccentric cam slot **64**.

When the multiplication key **75** is kept depressed, its striking surface **74** (Fig. 1) is in the path of motion of the angular portion **73** of the hook **69**, when said hook is rocked by the release arm **310** at the rocking motion of said arm as just mentioned. The arm **69***a* of the hook **69** then is disengaged from the stationary pin **72** and the arm **69***a* slides freely under the tongue **89** of the lever **86** (see position *e* of the hook **69** in Fig. 5) during its reciprocating motion so that said last-mentioned lever is not acted upon. But if the key **75** returns to its position of rest (non-depressed position), the striking surface **74** is moved out of the path of motion of the tongue **73** of the hook **69**. Under the action of the torsion spring **71**, the arm **69***a* is then pressed upwards against the pin **72** and slides along said pin during its motion

and with its point strikes the tongue **89** of the lever **86** (as shown in the position *f* of the hook **69** in Fig. 5, in which the position *d* is the position of rest of that hook). This swings said arm **86** counter-clockwise in Fig. 5 so that its tongue **92** strikes the arm **45** and rocks it counter-clockwise in Fig. 1, that is to the left in Fig. 4. The locking arm **43** follows in that motion and its part **42** is moved out of the path of motion of the part **41** of the angular piece **36** which now is restored to its inoperative central position by the spring **40** (Fig. 7). This restores the pin **48** secured to that angular piece, to its central position shown in Fig. 6 and the stopping pawls are released. Their torsion spring **501** now presses them downwards against the periphery of the buffer discs **56**, **57**. During its continued rotation the coupling pawl **18** is acted upon by the oblique surface **21***b* of the guide member **21** (Fig. 7) now in its central position and, consequently, this pawl is drawn out of its engagement with the shoulder of the gear **15** so that the main shaft **58** is disconnected from the motor. When the stopping projections **54**, **55** of the buffer discs **56** or **57**, respectively, are just in front of the points of the stopping pawls **51**, **52**, the torsion spring **501** presses these stopping pawls into engagement with said stop projections **54**, **55**. Because the main shaft **58** now is rotating in + revolutions, that is counter-clockwise in Fig. 1, the stop projection **54** strikes the stop pawl **51**. The kinetic energy of the rotating actuator on the main shaft **58** is absorbed by the buffer spring **59** so that the rotating parts are gently and reliably stopped. It is to be observed that during the whole bouncing action, the stopping pawls **52**, **51** engage the stopping projections **55**, **54** permanently and without any relative motion. This means that there is no risk that the stopping pawls will swing out and be disconnected, but on the contrary, the rotation is rapidly and reliably stopped. It is to be observed that for example in a + revolution the stop pawl **51** may be depressed to its lowermost stopping position almost one half revolution before the main shaft **58** is stopped. As is shown in Fig. 10, the disc **56** has substantially the shape of a half-circle and permits the stopping pawl **51** to swing down to its stopping position approximately one half revolution of the main shaft **58** in advance. Thus the stopping projection **54** strikes the stopping pawl **51**, the disc **57** continues rotating somewhat counter-clockwise, so that the stop pawl **52** can easily be rocked down against the stop projection **55**.

When in the manner just described the lever **86** is rocked counter-clockwise in Figs. 1 and 5 under the action of the hook **69**, the lever **271** is released from the tongue **90** and is lifted upwards by its spring. This releases in the manner described in U. S. Patent No. 2,398,286 a shifting impulse, because the pawl **265** (Fig. 5) is thus released and enters the path of motion of the driving lever **267**, which then drives the swinging lever **247** carrying the pawl **265** with which the step-shifting mechanism of the actuator may be coupled. When thus the swinging lever **247** begins moving to the left in Fig. 5 the pin **273** secured to said lever acts upon the arm **271** and presses it downwards in Fig. 5 so that the tongue **90** of the lever **86** again engages the surface **93** and locks the arm **271** in its lowermost position shown in Fig. 5. During this operation, said pin **273** moves in the slot **99** (Fig. 1) of the key depresser or key holding-down member **95**, which is consequently also pressed downwards so that its angular portion **97** presses the bent lower ends **98** of the coupling rods **28**, **29** downwards. Consequently, said rods cannot be released and cannot be lifted upwards to engage the rocking lever **23**. Thus, the main shaft **58** and consequently also the actuator thereon cannot be started, as long as a shifting operation is being carried out.

When the multiplication key **75** returns to its position of rest, the contact lever **331** is still kept in its operative position and keeps the contacts **334** closed, because the pin **103** of the impulse lever **100** (Figs. 1 and 11) presses on the contact lever, said impulse lever being now raised to its uppermost position by the lifted stop pawls **51**, **52**. Not until after the stop pawls **51**, **52** fall down to engage the stop projections **54**, **55** does the impulse arm **100** move downwards, that is, not until after the main shaft **58** and the actuator thereon have reached their position of rest or full cycle. The electric contacts **334** are consequently kept closed. This is very important for a rapid and reliable action of the machine.

Division

For division the control lever of the machine, which corresponds to lever **201** in U. S. Patent No. 2,398,286 is set manually to its position for division. Thus, the slide **241** is moved into the path of motion of the hook **69** (Figs. 1 and 5). As is described in detail in U. S. Patent No. 2,398,286, the plus-minus-control plate **287** is now free and can be displaced, when a shifting impulse is applied thereto.

The dividend is now entered in well-known manner in the actuator and is transferred to the results register. The actuator and, if necessary, also the revolutions counter is cleared and then the divisor is entered in the actuator, which is now in the usual manner tabulated to its extreme left position, that is to the highest decimal denominations of the results register. To start the machine the operator now depresses the division key **76** which then causes the contact lever **331** to close the electric contacts **334**. In a manner analogous with that described above under the heading "Multiplication," the rod **29** is lifted and the main shaft **58** is started to rotate clockwise in Fig. 1, that is in a — revolution.

When now the cam slot disc **62** rocks the release arm **310**, the hook **69** (Fig. 5) follows and with its edge engages and slides on the slide **241**, as shown in position *e* in Fig. 5. The slide **241** thus prevents the hook **69** from moving to its position *f* after the division key **76** has been restored to its position of rest. In other words, the hook **69** will not act upon the part **89** of the lever **86**. Said lever remains thus unactuated and the main shaft **58** with the actuator thereon continues rotating in — revolutions until the capacity of the results register is exceeded and, consequently, a ten is carried to the highest denomination of that register. This swings the arm **102** in the direction of the arrow A in Fig. 5 and this motion is transferred to the lever **86** which is consequently swung counter-clockwise. As described above under the heading "Multiplication" this causes the striking surface **92** to swing the arm **45** (Figs. 1 and 4) and consequently also the locking arm **43**. Consequently, the angular piece **36** is now free and it is restored to its inoperative, central position so that the main shaft **58** is disengaged from the motor and the actuator is resiliently stopped by the stopping pawls **51**, **52**.

When the lever **86** in the manner just described is rocked counter-clockwise in Figs. 1 and 5 under the action of an impulse from the arm **102** at the

tens transfer, the arm 271 is released from the projection 90 and this releases in the manner described in U. S. Patent No. 2,398,286 shifting impulse, because the pawl 265 is released and springs out into the path of motion of the driving lever 267. Consequently said lever now drives the swinging lever 247 carrying the pawl 265 to shift the actuator one step. When the angle piece 36 is moved to its outermost position (— position) it acts in well-known manner on the plus-minus-coupling arm 294, and said arm then sets the control plate 287 to pull down the multiplication key 75 by means of its projection 290. The driving lever 267 by means of the plus-minus-driving lever 274 now acts on the control plate 287 to displace it and to cause it to pull down the multiplication key 75.

Thus, the automatic division is continued in well-known manner.

Addition

When the item (addend) has been set in the actuator in well-known manner, the actuator upon the depression of the addition key performs one single + revolution in the manner described above under the heading "Multiplication" and is stopped. Then the actuator is automatically cleared in the manner described in U. S. Patent No. 2,398,286 due to the fact that the slide 360 is displaced to the right in Fig. 11, when the hook 358 is moved downwards (counter-clockwise) at the depression of the addition key.

Subtraction

Subtraction is carried out similarly as an operation of addition. The minuend is set in the actuator, the setting lever 358*a* for subtraction is moved downwards by the operator and the division key 76 is depressed. The actuator therefore performs a — revolution, is stopped and automatically cleared.

Certain modifications may be made in the device shown and described within the scope of this invention. Thus, the distance between the striking edges or stopping shoulders 54, 55 may be adjusted by substituting exchangeable cylindric rollers on the stud bolt 61, for the eccentric 60. The striking surfaces or edges with which the discs 56, 57 engage the eccentric 60 may be made oblique, instead of parallel. This renders it possible to adjust the distance between the shoulders 54, 55 still more, because in such case the eccentric, in its different angular positions, sets said distance to different values.

What we claim is:

1. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating said actuator in opposite directions, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders, resilient means for opposing rotation of said members relative to said actuator, and a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator.

2. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating said actuator in opposite directions, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders, a single buffer spring for opposing rotation of both of said members relative to said actuator, and a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator.

3. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating said actuator in opposite directions, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders facing each other, resilient means for opposing rotation of said members relative to said actuator, means for adjusting the space between said shoulders in their position of rest, and a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator.

4. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating said actuator in opposite directions, a projection rotatable with said actuator, a pair of members rotatably mounted coaxially with said actuator and having substantially radial surfaces engaging opposite sides of said projection, a buffer spring between said members for urging said faces into contact with said projection, said members having shoulders, and a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator.

5. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating said actuator in opposite directions, a projection rotatable with said actuator, a pair of members rotatably mounted coaxially with said actuator and having substantially radial surfaces engaging opposite sides of said projection, a buffer spring between said member for urging said faces into contact with said projection, said members having shoulders, said projection comprising an eccentric element, means for adjusting the eccentricity of said element to thereby vary the space between the shoulders on said members, and a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator.

6. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating said actuator in opposite directions, a projection rotatable with said actuator, a pair of members rotatably mounted coaxially with said actuator and having substantially radial surfaces engaging opposite sides of said projection, a buffer spring between said members for urging said faces into contact with said projection, said members having shoulders, said projection comprising a cylindrical element, means for removably mounting said element whereby it may be replaced by an element of different diameter in order to vary the space between the shoulders on said members, and a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator.

7. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating said actuator in opposite directions, a projection rotatable with said actuator, a pair of members rotatably mounted coaxially with said actuator and having arcuate peripheries of not more than 180°, each member having a shoulder formed adjacent to one end of its periphery, a buffer spring between said members for urging the members into contact with said projection, and a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator.

8. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating said actuator in opposite directions, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders, resilient means for limiting rotation of said member relative to said actuator, a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator, and means for simultaneously disengaging both said pawls from said shoulders.

9. In a power actuated calculating machine, a rotatably mounted actuator, means for rotating

said actuator in opposite directions, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders, resilient means for opposing rotation of said member relative to said actuator, a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator, said pawls having adjacent concave surfaces, and a member movable between said surfaces to simultaneously move said pawls out of engagement with said shoulders.

10. In a power actuated calculating machine, a shaft, an actuator carried by said shaft, means for rotating said shaft and actuator in opposite directions, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders facing each other, resilient means for limiting rotation of said members relative to said actuator, a pair of arresting pawls cooperating with said shoulders for stopping rotation of said actuator, a disc rotatably mounted on said shaft, a clearing key operable only when said disc is in its full-cycle position, each of said members being formed with an aperture, and a pair of pins of smaller diameter than said apertures extending from said disc into said apertures, for limiting relative rotation between said members and said disc.

11. In a power actuated calculating machine, a shaft, an actuator carried by said shaft, means for rotating said shaft and actuator in opposite directions, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders facing each other, resilient means for limiting rotation of said members relative to said actuator, a pair of arresting pawls cooperating with said shoulders for stopping rotation of said actuator, a disc rotatably mounted on said shaft, each of said members being formed with an aperture, a pair of pins extending from said disc into said apertures, said disc being formed with a notch in its peripheral surface, and a clearing key cooperating with said peripheral surface and engageable with said notch when said disc is in its full cycle position determined by engagement of said pawls with said shoulders.

12. In a power actuated calculating machine, a rotatably mounted actuator, an electric motor for rotating said actuator in opposite directions, an electric switch in the circuit of said motor, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders, resilient means for opposing rotation of said members relative to said actuator, a pair of arresting pawls cooperable with said shoulders for stopping rotation of said actuator, and means operative by said pawls for maintaining said switch closed when the pawls are disengaged from said shoulders.

13. In a power actuated calculating machine, a rotatably mounted actuator, an electric motor for rotating said actuator in opposite directions, an electric switch in the circuit of said motor, a pair of members rotatably mounted coaxially with said actuator and formed with shoulders, resilient means for opposing rotation of said members relative to said actuator, a stationary shaft, a pair of arresting pawls pivotally mounted on said shaft and cooperable with said shoulders for stopping rotation of said actuator, an arm movably supported on said shaft, projections on said arm and engaging said pawls so that disengagement of said pawls from said shoulders moves said arm, and means responsive to the movement of said arm for maintaining said switch closed.

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