Oct. 30, 1945. C. M. F. FRIDEN 2,388,209

REVOLUTIONS COUNTER ACTUATOR

Original Filed May 8, 1934 4 Sheets-Sheet 1

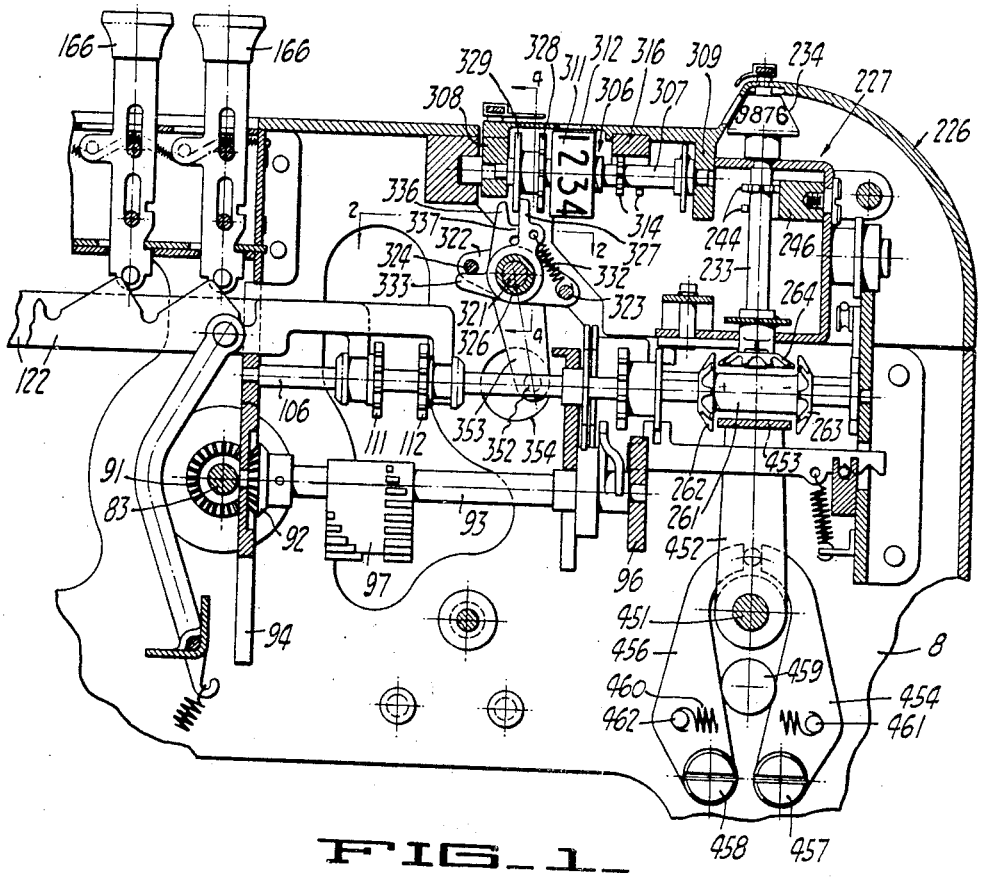


FIG_1_

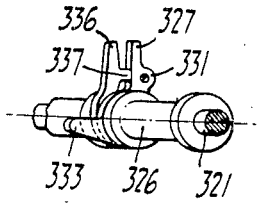


FIG_3_

FIG_2_

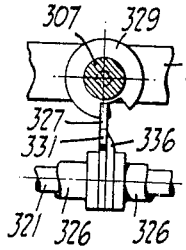
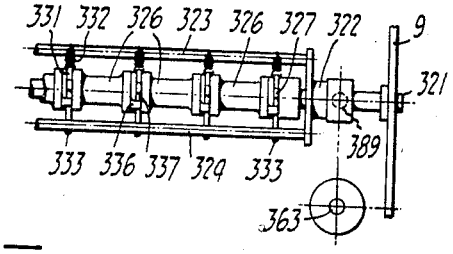


FIG_4_



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REVOLUTIONS COUNTER ACTUATOR

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FIG-5

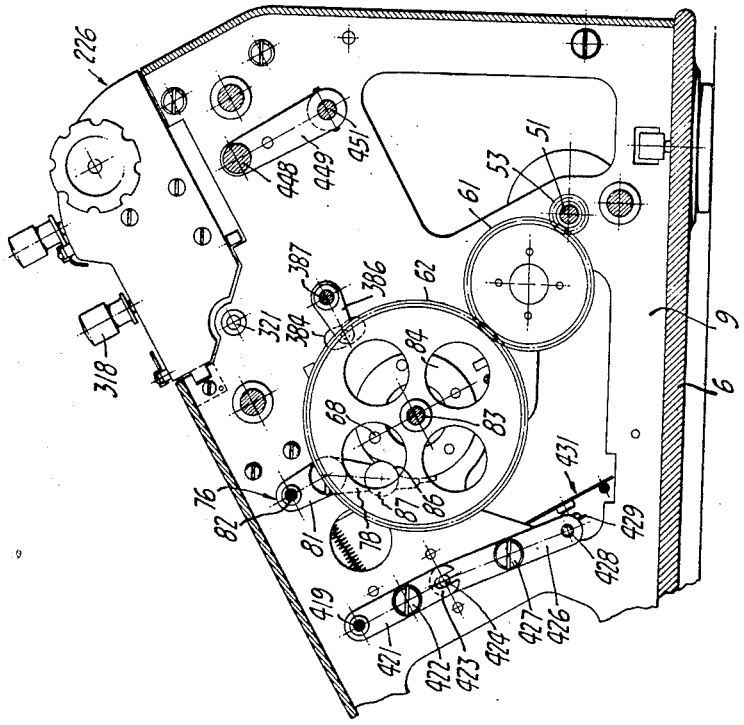


FIG-7

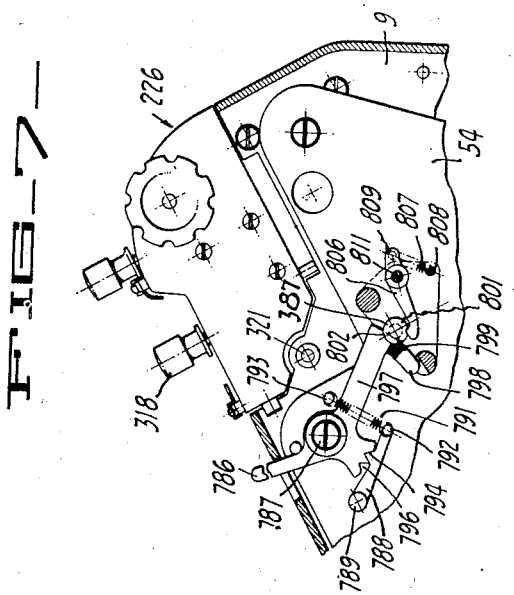
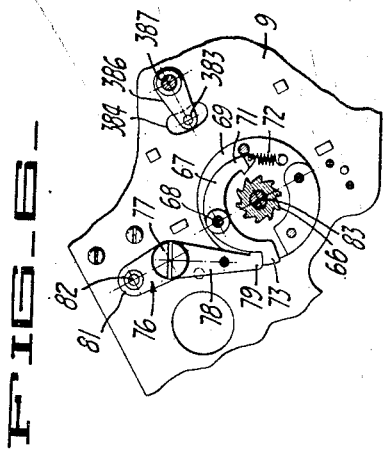


FIG-6



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REVOLUTIONS COUNTER ACTUATOR

Original Filed May 8, 1934 4 Sheets-Sheet 3

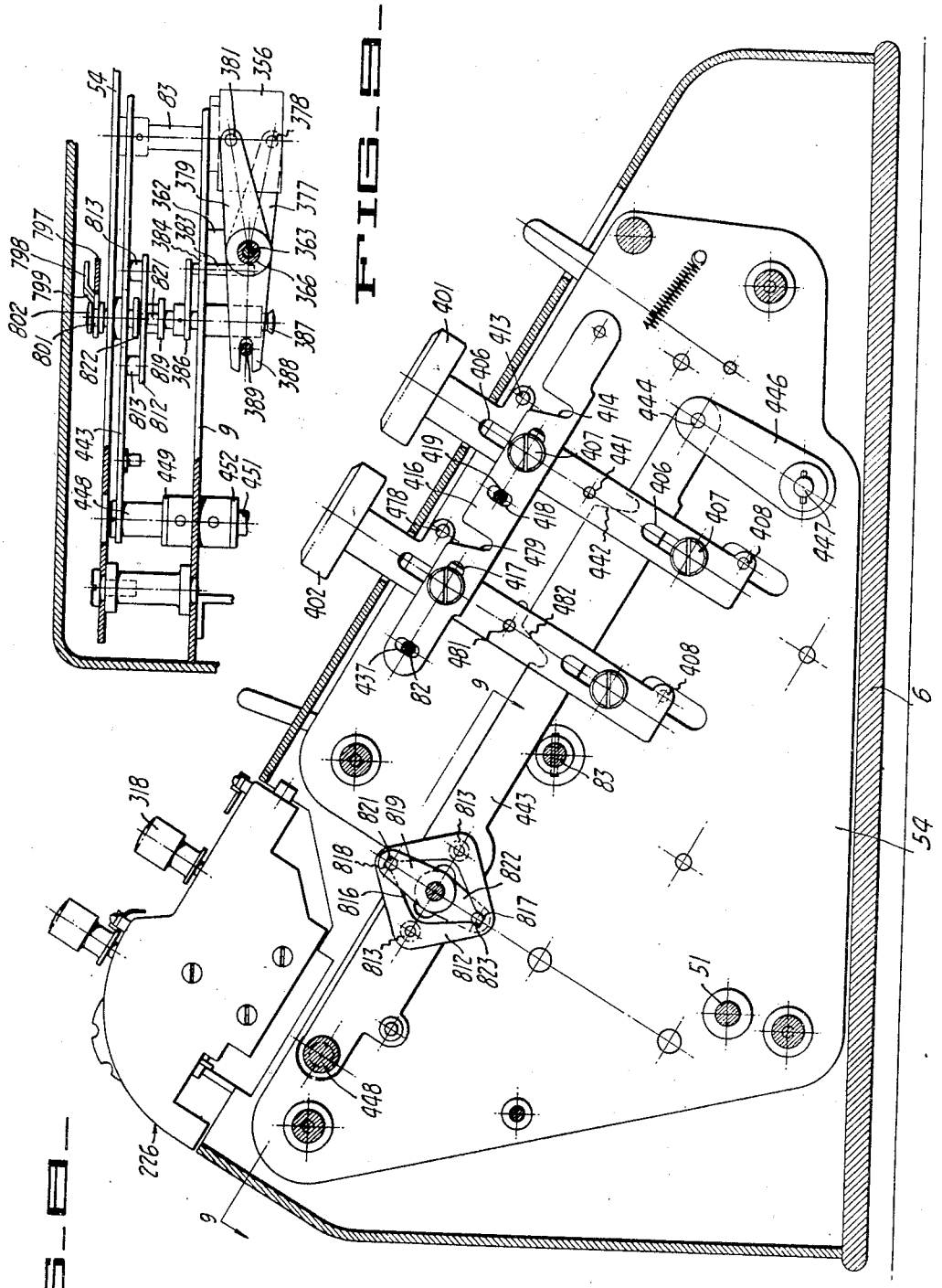

FIG. 9.

FIG. 8.

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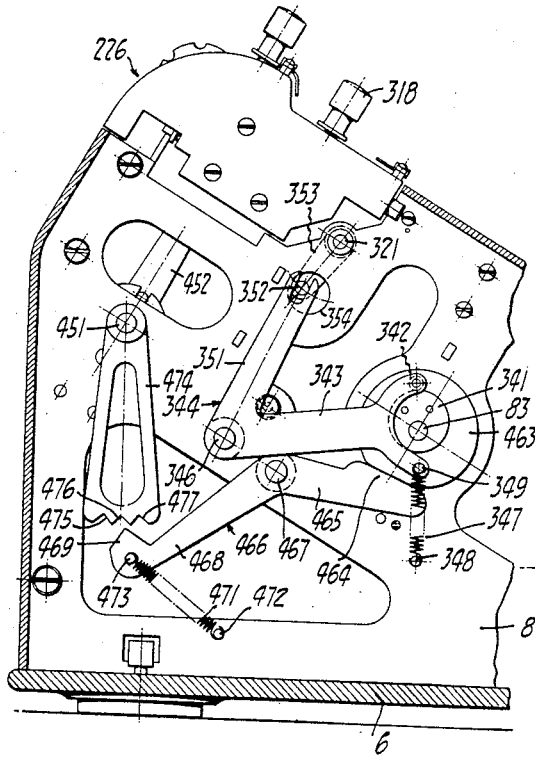


FIG-10-

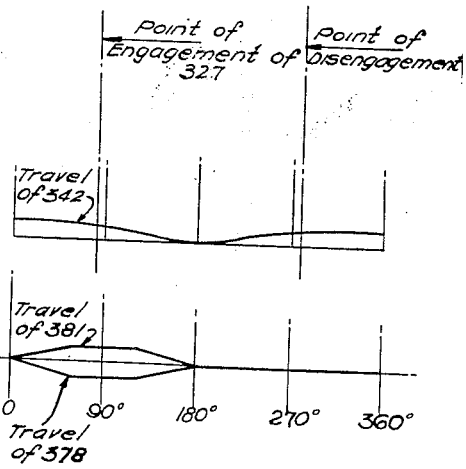


FIG-13-

FIG-11-

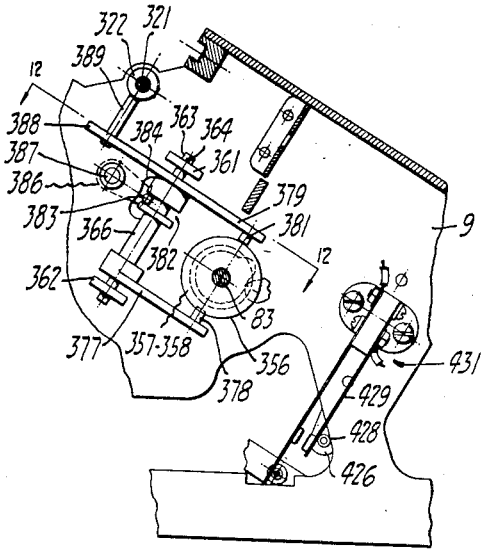
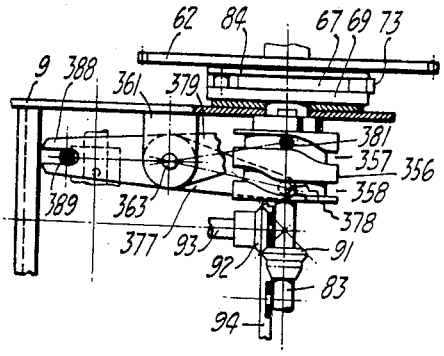


FIG-12-



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Patented Oct. 30, 1945

2,388,209

UNITED STATES PATENT OFFICE

2,388,209

REVOLUTIONS COUNTER ACTUATOR

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Original application May 8, 1934, Serial No. 724,482. Divided and this application December 16, 1940, Serial No. 370,256

6 Claims. (Cl. 235—73)

This invention relates to calculating machines and is concerned more particularly with the provision of improvements in the revolutions counter mechanism and its control.

This application is a division of my copending application, Serial No. 724,482, filed May 8, 1934, for "Calculating machine," now Patent No. 2,229,889.

It is a general object of the invention to provide an improved revolutions counter mechanism for a calculating machine.

Another object of my invention is to provide in a calculating machine of the type having reversible numeral wheels and uni-directionally operable drive means therefor, improved mechanism for controlling the sign character of the registration on the numeral wheels.

A further object of my invention is to provide improved actuator means for the revolutions counter in a calculating machine.

Other objects and advantages of the invention will be apparent from the following description of a preferred embodiment thereof as illustrated in the accompanying drawings, in which:

Figure 1 is a fragmentary sectional view through the upper rear portion of a calculating machine embodying the invention;

Figure 2 is a plan view of the revolutions counter actuator taken in a plane indicated by the line 2—2 in Figure 1;

Figure 3 is a perspective view of a portion of the revolutions counter actuator;

Figure 4 is a fragmentary sectional view taken in a plane indicated by the line 4—4 in Figure 1;

Figure 5 is a fragmentary side elevational view partly in section of a portion of a calculating machine;

Figure 6 is a detail view of the clutch construction;

Figure 7 is a fragmentary elevational view partly in section of a portion of the revolutions counter control mechanism;

Figure 8 is an elevational view partly in section of the plus-minus keys and their associated controlling parts;

Figure 9 is a fragmentary view of a portion of the revolutions counter mechanism, the view being taken in a plane indicated by the line 9—9 in Figure 8;

Figure 10 is a fragmentary elevational view partly in section of the left side of the machine and illustrating a portion of the counter control mechanism.

Figure 11 is a fragmentary sectional view of a part of the revolutions counter control mechanism;

Figure 12 is a fragmentary plan view, partially in section, taken in a plane indicated by the line 12—12 in Figure 11;

Figure 13 is a timing diagram of the drive mechanism for the revolutions counter actuator.

Drive mechanism

The calculating machine disclosed herein includes a base 6 (Figures 5, 8, and 10) which carries at its opposite sides frame plates 8 and 9 which are suitably joined together.

Mounted on the base 6 is a suitable electric motor (not shown). The motor shaft 51 (Figure 5) carries a pinion 53 which meshes with an idler gear 61 suitably journaled in the frame plate 9. The idler gear 61 in turn meshes with a sixty-tooth gear 62 connected to a ratchet 66 (Figure 6) forming part of the main clutch mechanism. Arranged in the same plane as the ratchet 66 is a lever 67 centrally pivoted as at 68 on an adjacent driven disc 69 which is mounted on main shaft 83. One end of the lever 67 is provided with a nose 71 which is urged into engagement with the ratchet by a coil spring 72 fastened to the plate 69. The other end of the lever 67 projects radially, as at 73, from the periphery of the disc 69 under the urgency of the spring 72.

To hold the clutch out of engagement, the nose 71 (Figure 6) must be held away from the ratchet 66 against the urgency of the spring 72, and for that purpose, I provide a lever 76 (Figures 5 and 6) pivoted as at 77 on the frame plate 9. One arm 78 of the lever 76 is provided with a tooth 79 which is co-planar with and normally in the path of the projection 73. The other arm 81 of the lever 76 is provided with a pin 82 for controlling the rotary position of the lever 76. Thus, when the lever 76 is rotated clockwise, as seen in Figures 5 and 6, the tooth 79 is drawn out of the path of the projection 73 and the spring 72 is effective to cause engagement of the nose 71 with the ratchet 66, thus coupling the gear 62 with a main shaft 83 extending transversely of the machine between the frame plates 8 and 9 and journaled therein.

In order that the lever 76 will be held in clutch-engaged position for a complete rotation of the shaft 83, there is arranged a disc 84 (Figure 5) comparable to the disc 69 but having an interruption or irregularity 86 in its peripheral continuity, which is adapted to cooperate with a button 87 mounted on the lever 76. The relationship of these parts is illustrated in Figure 5, with

the clutch in disengaged position and the button 87 within the irregularity 86. This is the "full-cycle" position of the parts. As soon, however, as the lever 76 has been rocked clockwise to cause engagement of the clutch, and as soon as an initial rotation has occurred, the disc 84 rides under the button 87 holding the lever 76 in clutch-engaged position at least until such time as the gear 62 and the ratchet 66 have in unison completed a single cycle or single revolution. At the conclusion of such rotation the button 87 is again free to fall into the irregularity 86, to maintain the parts in their relative positions with the clutch disengaged. Thus, when the clutch is in engagement, the shaft 83 is rotated by the motor.

Actuating and selecting mechanism

The main shaft 83 at suitable intervals of its length, carries bevel gears 91 (Figure 1) each of which meshes with a comparable bevel gear 92 fastened on its respective actuator shaft 93. The shafts 93 are arranged parallel and are journaled in a pair of plates 94 and 96 extending transversely of the machine and in turn mounted in the frame plates 8 and 9. There are as many shafts 93 as there are orders in a particular machine.

Shaft 93 shown in Figure 1, for example, carries an actuator in the form of a segmental gear 97 which is provided with teeth of differential character for entering values in the machine in a well known manner.

Each of the actuators 97 is effective upon an associated shaft 106 (Figure 1) which is preferably of square cross section and carries a pair of pinions 111 and 112 for cooperation with the two sets of teeth on the associated actuator. The pinions 111 and 112 are adapted to be differently positioned with respect to the teeth by respective links 122 operated by means of a suitable series of keys indicated generally at 166. The arrangement is such that a shaft 106 will be rotated for a number of increments corresponding to the value of the depressed keys by means of the relative positioning of the pinions 111 and 112 with respect to the actuator teeth.

Accumulator

The machine includes an endwise shiftable carriage 226 (Figures 1 and 5) containing an accumulator generally indicated at 227 (Figure 1) which is formed of a plurality of numeral wheel shafts 233 each carrying a numeral wheel 234 at its upper end. Numeral wheel shafts 233 at their lower ends carry numeral wheel gears 264 which are adapted for meshing with respective gears 262 and 263 on a spool 261 slidably mounted on square shaft 106. The adjustment of gears 262 and 263 into mesh with the aligned gears 264 is under control of suitable plus and minus keys.

Plus and minus keys

The machine, for the various rules of calculation, is manually under the control of a plus key 401 (Figure 8) and a minus key 402. These keys are identical in shape and each is provided with a pair of elongated slots 406 which guide the key on a pair of headed pins 407 projecting from the control plate 54. Adjacent the lower end, each key is provided with a projection 408 passing through a suitable aperture in the control plate 54 for engagement with a suitable coil spring (not shown) for urging the respective key to its uppermost position.

Plus key 401 (Figure 8) has a pin 413 projecting from the key and adapted to contact with an inclined cam face 414 forming part of a slide 416 having slots 417 engaging supporting pins 407. The slide 416, as the key 401 is depressed, therefore moves correspondingly, being translated toward the left in Figure 8. Between its ends the slide 416 is provided with an aperture 418 into which projects a pin 419. The pin 419 (Figure 5) is at one extremity of a lever 421 pivoted as at 422 on the frame plate 9, and in turn at its opposite extremity provided with a fork 423 to engage a pin 424 at the extremity of a lever 426. This latter lever is pivoted by a headed bolt 427 on the frame plate 9 and at its opposite end carries a pin 428 which extends through an aperture in the frame plate 9 and abuts one of the resilient arms 429 of the motor switch generally designated 431.

Thus, when the slide 416 is translated toward the left, in Figure 8, by the depression of the plus key 401, the pin 419 causes oscillation of the lever 421 (Figure 5) and of the lever 426 to close switch 431 and energize the motor.

Substantially simultaneously with the energization of the motor, the clutch lever 76 is actuated. For this purpose the slide 416 (Figure 8) likewise carries an elongated aperture 437 into which projects the pin 82 (Figure 5) which is mounted, as heretofore described, on the clutch-operating lever 76. Upon the depression of the plus key 401, therefore, not only is the motor energized but likewise the clutch lever 76 is rocked so that pawl 67 is engaged with the ratchet 66, so that the actuating mechanism is set into motion. The slide 416 is held by the cam 84 in clutch-engaging and contact-closing position for a complete rotation of the main shaft, at any time during which the plus key 401 can be released to return to its original position. On the other hand, the plus key 401 can be maintained depressed to cause as many cycles of operation of the machine as desired.

In addition to causing energization of the electric motor and corresponding rotation of the actuators, the depression of the key causes an intermeshing of the pinions 262 and 264 (Figure 1). Thus, the plus key 401 (Figure 8) carries a projecting pin 441 which is adapted to act against a cam face 442 on a plate or slide 443. One end of the plate 443 is pivoted as at 444 to a supporting lever 446 in turn fastened on the control plate 54 by a pin 447. The other end of the plate 443, however, is connected by a pivot 448 (Figures 8 and 5) to a lever 449 (Figure 5) mounted on a shaft 451 passing through the frame plates 8 and 9. The shaft 451 extends transversely of the machine and, adjacent each end, carries an upright arm 452 (Figure 1). Arms 452 support a cross-strap 453 which is situated between the pinions 262 and 263 and is adapted to bear against them whenever the shaft 451 is rotated.

Thus, when the plus key 401 is depressed, the pin 441 abuts the cam face 442 and translates the plate 443 toward the left, as seen in Figure 8. This translation of the plate 443 causes, through the connection of the pin 448 with the lever 449, a rotation of the shaft 451. This in turn simultaneously rotates the uprights 452 and moves the strap 453 toward the rear of the machine. Such movement of the strap 453 is effective to move all of the spools 261 and to mesh the gears 262 of each order with the corresponding gears 264 of the accumulator.

Movement of the strap 453 (Figure 1) from neutral position is opposed by one of a pair of fingers 454 and 456, each of which is pivoted as at 457 and 458, respectively, to the frame

plate 8. A central abutment 459 serves as a stop for the two levers 454 and 456 since the levers are urged thereagainst by a common coil spring 460 joined to the levers by suitable pins 461 and 462. The spring 460 is of sufficient force to restore all of the spools 261 to neutral position at the conclusion of a cycle of operation, providing the plus key 401 is then in released position.

The plus key 401 can be held depressed for any number of cycles desired, but in the event it is released prior to the completion of a complete cycle there is provided mechanism for maintaining the spools 261 in shifted relationship until the completion of the cycle or the return of the machine to full-cycle position. At one extremity, the main shaft 83 (Figure 10) carries a cam disc 463 having a cam flat thereon in what corresponds to the full-cycle location of the disc. Running on the cam 463 is a follower 464 formed integrally with one arm 465 of a lever generally designated 466, which lever is pivoted on a pin 467 on the plate 8. The lever 466 likewise has an arm 468 terminating in a single tooth 469. The follower 464 is urged into contact with the cam 463 by a coil spring 471 at one end hooked to a pin 472 on the frame plate 8 and at the other end hooked on a pin 473 projecting from the lever arm 468. When the machine is in full cycle position, therefore, the spring 471 is effected to hold the tooth 469 in one extreme position, while during the operation of the machine or at an intermediate cycle position the tooth 469 occupies its other extreme position.

To take advantage of this motion, the shaft 451 (Figure 10) passes through the frame plate 8 and carries a depending segment 474 which is peripherally provided with a series of three notches 475, 476, and 477. When the shaft 451 is in neutral position—that is, with the spools 261 in such a location that the gears 264 are not engaged—the notch 476 receives the tooth 469 as soon as the shaft 83 begins a rotation from full-cycle position. If the machine is once energized, therefore, with the shaft 451 in neutral position, the machine is so held or locked in such position until the completion of that cycle. On the other hand, when the plus key 401 is depressed and the shaft 451 is rotated in an anticlockwise direction, as seen in Figure 10, then the tooth 469 is received by the notch 475 when the cycle of operation commences. As soon as the machine returns to full-cycle position, however, the spring 471 retracts the lever 466 and the shaft 451 is free to return to its neutral position under the influence of the centralizing levers 454 and 456.

When the minus key 402 is depressed, a similar sequence of operation occurs. This key 402 carries a projection 478 (Figure 8) designed to engage a cam face 479 on the slide 416 and to translate the slide toward the left, as seen in Figure 8, with the same motion that is caused by depression of the plus key 401, to energize the electric motor and to engage the clutch. Furthermore, the minus key 402 is provided with a projection 481 which is designed to cooperate with a cam face 482 on the plate 443. Since the face 482 is opposite in inclination to the face 442, engagement of the pin 481 with such face is productive of a translation of the plate in an opposite direction, or toward the right, as seen in Figure 8. Through the pin 448 such movement rocks the lever 449 and the shaft 451. This movement, however, is such as to move the strap 453 toward the front of the machine and to translate all of the spools 261 in such a direction that the pinions 263 mesh with the gears 264 of the register mechanism. Such movement of the strap 453 is of course against the urgency of the centralizing lever 456. A negative registration is provided in the accumulator when the gears 263 and 264 are in mesh. While these gears are being meshed, due to the rotation of the shaft 451, the segment 474 is rocked, so that upon the initiation of the cycle the tooth 469 forming part of the lever 466 is received by the notch 477 and the relationship of the parts is maintained until the conclusion of a cycle.

Revolutions counter mechanism

Mounted on the carriage 226, in addition to the accumulator is a revolutions counter, generally designated 306 (Figure 1). This register comprises a plurality of shafts 307 journaled at opposite ends in extensions 308 and 309 of the carriage frame 226. The spacing of the shafts 307 is the same as the spacing of the successive orders in the accumulator. Each of these shafts 307 carries a numeral wheel 311 bearing numerals from "0" to "9" inclusive, spaced apart on the periphery of the wheel and adapted to be seen through a reading aperture 312 cut in the upper face of the carriage shell 226.

The individual numbers of the wheel 311 are properly centralized in line with the aperture 312 by a suitable centralizing mechanism. Also, the shafts 307 are alternately provided with axially offset clearing gears 314 meshing with a multisectional clearing rack 316 of conventional construction. The rack 316, however, is operated against the urgency of a suitable spring (not shown) by means of a knob 318 (Figure 5) projecting from the upper face of the carriage. The revolutions counter is therefore provided with a plurality of numeral wheels 311 arranged in spaced relationship and in any desired number for the capacity of the machine. The individual wheels of this register are all properly centralized and can simultaneously be restored to zero or cleared position by operation of the knob 318.

In order suitably to actuate or introduce values into the revolutions counter, there is provided a suitable actuator. The actuator includes a member 321 (Figures 1 to 4) which has a compound motion having two major components, one a translatory reciprocation and the other an oscillation. That is, the member or shaft 321 is mounted in the plates 8 and 9 to move from end to end to be rocked back and forth. Mounted on the shaft is a pair of collars 322 each of which is extended to support a pair of parallel rods 323 and 324. Disposed on the shaft 321 between the collars 322 is a plurality of actuator spools 326 which in general are identical and are of such size as to be spaced with the same spacing as the shafts 307. The right hand spool 326 as viewed in Figure 2 is only partially complete as compared with other spools, and carries a finger 327 which projects radially between a ten-tooth gear 328 (Figure 1) and a single-notch disc 329 (Figures 1 and 4) both on the shaft 307.

Forming part of the finger 327 is an eyelet 331 to which is hooked a spring 332, the other end of which is hooked on the rod 323. Thus, the spring 332 urges the finger 327 to rotate clockwise, as seen in Figure 1 about the shaft 321 in a direction to engage with gear 328. The point of introduction of finger 327 into gear 328 is con-

trolled by the direction of axial movement of the finger 327 from its normal central position. This initial axial movement of finger 327 occurs while the finger 327 is being rocked toward gear 328 but before it is introduced into the gear. At the end of the initial axial movement of finger 327, a dwell occurs before the return axial movement, and during this dwell the clockwise movement of finger 327 becomes effective to mesh finger 327 with gear 328. Such movement of the finger, however, is normally restrained by a projection 333 likewise forming part of the spool 326 and engaging with the shaft 324. As particularly seen in Figure 1, therefore, as the shaft 321 rotates or oscillates clockwise, carrying with it the frame rods 323 and 324, under the urgency of the spring 332 the finger 327 is moved to introduce itself between successive teeth on the gear 328. At this time the shaft is translated axially to return to its normal central position. Such movement, since the finger 327 remains intermediate successive teeth on the ten-tooth gear 328, is effective to rotate the shaft 307 for one-tenth of a complete revolution, and thus to advance the numeral wheel 311 for one successive digit.

At the conclusion of such axial movement toward normal central position the shaft 321 again oscillates but this time in an anti-clockwise direction, so that the finger 327 is rotated positively, due to the contact of the shaft 324 against the finger 333, into the position as seen in Figure 1 in which the finger is out of mesh with the pinion 328. By the described operation, the numeral wheel 311 is advanced one unit.

It is especially pointed out that if, when the shaft 321 rotates to mesh the finger 327 with the ten-tooth gear 328, such meshing is followed by an axial translation of the shaft 321 toward the right in Figure 2, then the numeral wheel is advanced in a positive direction. On the other hand, if, following the meshing of the finger 327 with the gear 328, the axial translation of the shaft 321 is toward the left, as seen in Figure 2, then the direction of movement of the shaft 307 and the numeral wheel 311 is subtractive or negative. The control for the direction of axial movement of the finger 327 is described hereafter.

Tens transfer mechanism for revolutions counter

Now, for each complete rotation of a lower order numeral wheel 311 of the revolutions counter, the numeral wheel of the next higher order must be advanced one-tenth of a rotation. To this end the spool 326 which is arranged intermediate the lowest order and the next higher order, as seen in Figure 2, is not only provided at its left-hand end with a finger 327, but is also provided at its right-hand end with a finger 336 which is bent to be co-planar with finger 327 of lowest order and carries a projection 337 so that the parts are in contact when they bear the relationship illustrated in Figures 1 and 3. Thus, the spring 332 of the "tens" order, for instance, as seen in Figure 2, is effective to urge the finger 336, and particularly its projection 337, into contact with the finger 327 of the "units" order. However, the spool 326 of the "units" order cannot yield because its projection 333 is in contact with the shaft 324. When, however, the shaft 324 rotates about the axis of the shaft 321, the finger 336, under the urgency of its spring 332, tends to follow the finger 327, but can only do so when the notch in the disc 329 (Figure 4) of the units order is in position therefore, which only occurs when the units order counter numeral wheels stands at "9" or "0". Disc 329 is positioned in Figure 4 in its "9" position, i. e., it is conditioned for a positive transfer and the notch is in one of its passing positions for finger 336.

If the notch is out of its passing position for the particular sign character of the registration being performed, i. e., when no tens carry has been determined by the units order counter numeral wheels, the finger 336 cannot pass by the barrier of the disc, then the spool 326 cannot rotate about the axis of the shaft 321 and finger 327 of the tens order is held in inactive position. Correspondingly, due to the similar interlocking relationship of the remainder of the spools 326 for the higher orders, all such higher order spools are maintained stationary. But on the other hand, if the tens-carrying notch in the disc 329 of the units order, for example, is in position to permit passage of the finger 336, associated therewith, during a positive registration as shown in Figure 4 then such finger rotates along with the finger 327 of the units order and causes a corresponding rotation of the spool 326. As a result, the finger 327 of the tens order is effective on the gear 328 and the shaft 307 of the next higher or tens order in the revolutions counter to rotate such shaft through one-tenth of a rotation during return of the finger to its central position and thereby effect the tens-carrying operation.

Operation of revolutions counter actuator

The rotary oscillation of the shaft 321 is produced in synchronism with the rotation of the shaft 83. At the end of the shaft 83 which projects through the frame plate 8 there is mounted an eccentric 341 (Figure 10) against which bears a follower 342 projecting from one arm 343 of a bell crank generally designated 344 and pivoted as at 346 on the plate 8. A coil spring 347 is anchored to the plate 8 at one end by a pin 348 and at the other end is connected to a pin 349 on the arm 343. The bell crank is likewise provided with an arm 351 which is forked to engage a pin 352 on a crank 353 mounted on the opposite side of the plate 8 and fastened on the shaft 321. The pin 352 projects through an aperture 354. Thus, for each complete rotation of the shaft 83 the bell crank 344 is oscillated about the pivot 346 and through the crank 353 causes a comparable complete oscillation of the shaft 321. The timing of the oscillation of actuator finger 327 by cam follower 342 is illustrated in the timing diagram shown in Figure 13 by the line marked "Travel of 342." Thus, at the beginning of a cycle of operation, the rocking movement of finger 327 starts but it is ineffective until the finger 327 meshes with gear 328. This meshing occurs about 80° after the beginning of the cycle and the parts continue meshed until about 80° before the end of the cycle. Thus, the first 80° to the cycle is effectively idle insofar as engagement of the finger 327 with the gear 328 is concerned, and during this time an axial translation of the actuator finger 327 can occur. As explained later, during the time the finger 327 is engaged with the gear 328, a return axial movement of the actuator finger is effected to cause entry of a count in the counter.

The longitudinal or axial translation of the shaft 321 is provided by a mechanism especially illustrated in Figures 11 and 12. On the shaft 83 is mounted a cam drum 356 having a pair of grooves 357 and 358 cut therein. These cam grooves are of identical contour but are polarly or angularly spaced from each other. In order to change the phase relationship of the axial move-

ment of the shaft 321 to the rotary movement thereof, I provide means for optionally engaging either of the grooves 357 and 358. To this end, on the frame plate 9 I provide a pair of projecting ears 361 and 362. These ears mount a cross-shaft 363 which is held in place by suitable pins 364 and on which is mounted a sleeve 366. The lower end of the sleeve is united to a lever arm 377 at the extremity of which is a follower pin 378. Likewise on the sleeve 366 is a lever arm 379 at the extremity of which is a follower pin 381 adapted to extend into the groove 357.

To hold the sleeve 366 in either desired extreme position, I likewise provide on the sleeve a groove 382 in which runs a shifting pin 383 projecting through an aperture 384 in the plate 9 and carried at the end of a lever 386 fast on a shaft 387. Thus, as the shaft 387 is rotated between its two extreme positions, the pin 383 shifts the sleeve 366 along the shaft 363. In this fasnion, either the pin 378 is introduced into the groove 358 so that the sleeve 366 reciprocates in phase relationship with the characteristics of the groove 358, or, conversely, the sleeve 366 is shifted in the opposite direction or downwardly on the shaft 363 and the pin 381 is engaged in the groove 357 so that the sleeve in such circumstances partakes of the reciprocating movement imparted by the cam groove 357.

The motion of the sleeve 366, which is an oscillation about its axis, is transmitted by a lever arm 388 which is fixed to the sleeve and at its extremity is forked, particularly as shown in Figures 2 and 12, to engage a radially depending pin 389 projecting from collar 322 encompassing the shaft 321.

If pin 378 is engaged with groove 358, the first half of the axial reciprocation, which occurs before the actuator finger 327 is enmeshed with the gear 328, moves the finger to the left as viewed from the front of the machine, so that a positive registration is effected. From the timing diagram in Figure 13, it is seen that the initial axial movement of pin 378 is completed before finger 327 has engaged gear 328. After this first half of the axial reciprocation, a dwell occurs in such reciprocation to allow engagement of the finger 327 with the associated gear 328. As seen from the timing diagram, after such engagement and during the middle portion of the cycle, the pin 378 is returned to its initial position and the finger 327 being engaged with the gear 328 moves the gear 328 to effect entry of one increment in the aligned numeral wheel of the revolutions counter. After entry of this increment, the finger 327 is subsequently disengaged from the gear 328 so that at the end of the cycle of operation the parts are conditioned for carriage shifting if such an operation is desired.

If pin 381 is engaged with groove 357, the first half of the axial reciprocation is a movement of finger 327 to the right as viewed from the front of the machine, so that a negative registration is effected. The operation of finger 327 under control of the pin 381 with reference to the rocking movement of finger 327 is similar to that described in connection with pin 378 and is also illustrated in the timing diagram shown in Figure 13. Thus, as the main shaft 83 rotates it imparts to the shaft 321 an axial translation in either selected one of two directions to control the sign character of the registration on the numeral wheels 311 in the revolutions counter, as outlined hereinabove.

Revolutions counter control mechanism

As previously described, values can be entered in the revolutions counter in either a positive or a negative sense despite the unidirectional movement of the drive means therefor. There is provided under the control of the operator a settable means which in conjunction with the plus and minus keys determines the sign character of a registration on the revolutions counter. This means takes the form of a lever 786 (Figure 7) projecting from the top of the machine and mounted on a pin 787. The lever 786 is pivotally movable about the pin 787 between two positions, being retained in either position by a detent 788 which is pivoted as at 789 and is urged by a spring 791, fastened to a pin 792 on the detent and a pin 793 on the plate 54, into either of two notches 794 and 796 formed in the lever 786.

The lever is provided with an extended arm 797 which is bent into an axially sinuous and radially arcuate cam 798. This cam, while in one contour (Figures 7 and 9) following the path of a radius about the pin 787, axially of the pin 787 is displaced with an inclined portion 799 leading to the displaced portion. The cam portions operate in a circumferential groove 801 on the shaft 387. Thus, as the handle 786 is moved from one extreme position with the detent 788 in the notch 794 to another position with the detent 788 in the notch 796, the shaft 387 is moved axially between two extreme positions. Due to the length of the pin 383, as seen in Figure 9, such axial movement does not disturb the relationship of the sleeve 366, but since rotation of the shaft 387 does move the sleeve 366 there is mounted at the extremity of the shaft 387 a collar 802 (Figures 7 and 9) which is provided with a pair of peripheral depressions into which a detent lever 806 extends under the urgency of a spring 807, one end of which is connected to a pin 808 on the plate 54 and the other end of which is connected to a pin 809 on the detent which in turn pivots about a pin 811. The shaft 387 is therefore properly maintained in either of its extreme axial positions and centralized in either of its extreme rotated positions.

Between the collar 802 at one end of the shaft 387 and the lever 386 at the other end of the shaft, there is provided a mechanism which in its two different shifted positions provides either a positive or a negative registration on the revolutions counter. To this end the slide 443, particularly as shown in Figures 8 and 9, carries a diamond-shaped frame 812 which is spaced from the slide 443 by a pair of posts 813. The frame is provided with a central aperture 816 which at opposite ends is formed to provide square notches 817 and 818 respectively. On the shaft 387 there is a crank 819 carrying a pin 821 which is adapted to interengage with the notch 818 when the shaft 387 is in one extreme axial position. Likewise carried by the shaft 387 is a comparable crank arm 822 which however is arranged on the shaft axially displaced from the crank arm 819 and at 180° therefrom in an angular direction. The crank 822 carries a pin 823 which is adapted to interengage with the notch 817 when the shaft 387 is in its other extreme axial position.

By the operation of this mechanism, therefore, in the forward position of the setting lever 786, depression of the minus key 402, which translates the slide 443 to the right in Figure 8, for instance, will cause a clockwise rotation of the shaft 387, since the shaft is shifted so that the pin 821 is in engagement with the notch 818. This will cause

a negative registration on the counter. If this relationship, due to the setting of the lever **786**, is maintained when the plus key **401** is depressed, however, the slide **443** will then be translated toward the left in Figure 8 and the shaft **387** will be turned in an anti-clockwise direction, giving a positive registration on the revolutions counter. On the other hand, if the lever **786** is positioned rearwardly as shown in Figure 8 so that the pin **823** is in engagement with the notch **817**, depression of the minus key **402** will still translate the slide **443** to the right in Figure 8, which, however, instead of producing a clockwise rotation of the shaft **387**, as before, will produce an anti-clockwise rotation thereof, so that a positive registration will be effected. Correspondingly, with this setting of the lever **786**, depression of the plus key **401** will produce a translation toward the left in Figure 8 of the slide **443**, and will cause a clockwise rotation of the shaft **387**, so that a negative registration will be effected. Thus, for either positive or negative registration on the accumulator, values can be entered into the revolutions counter in either a positive or negative sense in accordance with the position of the lever **786**.

I claim:

1. In a calculating machine, a revolutions counter comprising a row of numeral wheels, each numeral wheel being operatively connected to a gear, the axes of rotation of said gears being disposed parallel in the same plane, a cyclically operable actuator for said counter mounted for axial reciprocation and for oscillation about its axis, the axis of said actuator being disposed transversely with respect to said axes of rotation of said counter gears, a unidirectionally rotatable driving element, and means for driving said actuator from said element including selectively controllable means for imparting axial reciprocation thereto in one direction or the opposite to effect rotation of said counter gears additively or subtractively, and including means for imparting oscillation to said actuator about its axis to effect movement thereof into and out of engagement with said counter gears.

2. In a calculating machine, a revolutions counter comprising a series of numeral wheels, each numeral wheel having a gear for receiving increments of movement and a disc mounted for movement with said gear, said disc having a notch therein, and an actuator for said revolutions counter, means mounting said actuator for both axial movement and oscillation about its axis, the axis of said actuator being disposed transversely to the axes of rotation of said gears, means for operating said actuator including selectively controllable means for imparting axial reciprocation thereto in one direction or the opposite to effect rotation of said numeral wheel gears additively or subtractively and including means for imparting oscillation to said actuator about its axis to effect movement thereof into and out of engagement with said gears, said actuator having a tooth in the lowest order for actuating the gear opposite thereto upon operation of said actuator, a series of transfer elements mounted on said actuator for reciprocation therewith and individually urged resiliently to oscillate therewith, each of said elements having a finger cooperating with one of said discs and blocked thereby except during a transfer operation, each of said elements also having a tooth cooperating with the gear in the next higher order, the said notches in said discs being disposed so that in additive actuation of said counter upon initial oscillation of said actuator a finger enters the notch of its associated disc when the numeral wheel stands at "9" to permit the transfer tooth in the next order to engage its gear and so that in negative actuation of said counter upon initial oscillation of said actuator a finger enters the notch of its associated disc when the numeral wheel stands at "0", and means effective upon blocking of an element of lower order by the associated disc for restraining the similar elements of higher order.

3. In a calculating machine, a revolutions counter comprising a series of numeral wheels, each numeral wheel having a gear for receiving increments of movement and a disc mounted for movement with said gear, said disc having a notch therein, and an actuator for said revolutions counter, means mounting said actuator for both axial movement and oscillation about its axis, the axis of said actuator being disposed transversely to the axes of rotation of said gears, means for operating said actuator including selectively controllable means for imparting axial reciprocation thereto in one direction or the opposite to effect rotation of said numeral wheel gears additively or subtractively and including means for imparting oscillation to said actuator about its axis to effect movement thereof into and out of engagement with said gears, said actuator having a tooth in the lowest order for actuating the gear opposite thereto upon operation of said actuator, a series of transfer elements mounted on said actuator for reciprocation therewith and individually urged resiliently to oscillate therewith, each of said elements having a finger cooperating with one of said discs and blocked thereby except during a transfer operation, each of said elements also having a tooth cooperating with the gear in the next higher order, the said notches in said discs being disposed so that in additive actuation of said counter upon initial oscillation of said actuator a finger enters the notch of its associated disc when the numeral wheel stands at "9" to permit the transfer tooth in the next order to engage its gear and so that in negative actuation of said counter upon initial oscillation of said actuator a finger enters the notch of its associated disc when the numeral wheel stands at "0," said transfer elements having an interlocking connection whereby blocking of an element of lower order by the associated disc will restrain all similar elements of higher order.

4. In a calculating machine, a revolutions counter comprising a series of numeral wheels, each numeral wheel having a gear for receiving increments of movement and a disc mounted for movement with said gear, said disc having a notch therein, a cyclically operable first tooth for engaging one of said gears opposite thereto to advance the associated numeral wheel one step for each tooth cycle, transfer means for said counter, comprising a series of transfer elements mounted on a cyclically operable actuator, means mounting said actuator for both axial movement and oscillation about its axis, the axis of said actuator being disposed transversely to the axes of rotation of said gears, said transfer elements being mounted on said actuator for reciprocation therewith and individually urged resiliently to oscillate therewith, each of said elements having a finger cooperating with one of said discs and a tooth cooperating with the gear in the next higher order, the tooth of an element

being restrained from engaging the associated gear when the finger of said element is blocked by the disc in the next lower order except when a transfer is to take place when upon initial oscillation of the actuator the finger enters the notch of the lower order disc permitting the transfer tooth to be positioned to engage the higher order gear so that upon axial reciprocation of the actuator the numeral wheel in the higher order is moved one step to effect the transfer, means effective upon blocking of an element of lower order by the associated disc for restraining the similar elements of higher order, and means for operating said actuator and for operating said first tooth to advance the associated numeral wheel one step after all unrestrained transfer element teeth are positioned to engage their respectively associated gears.

5. In a calculating machine, a revolutions counter comprising a series of numeral wheels, each numeral wheel having a gear for receiving increments of movement and a disc mounted for movement with said gear, said disc having a notch therein, and an actuator for said revolutions counter, means mounting said actuator for both axial movement and oscillation about its axis, the axis of said actuator being disposed transversely to the axes of rotation of said gears, means for operating said actuator including selectively controllable means for imparting axial reciprocation thereto in one direction or the opposite to effect rotation of said numeral wheel gears additively or subtractively and including means for imparting oscillation to said actuator about its axis to effect movement thereof into and out of engagement with said gears, said actuator having a tooth in the lowest order for actuating the gear opposite thereto upon operation of said actuator, a series of transfer elements mounted on said actuator for reciprocation therewith and individually urged resiliently to oscillate therewith, each of said elements having a finger cooperating with one of said discs and a tooth cooperating with the gear in the next higher order, the said notches in said discs being disposed so that in additive actuation of said counter upon initial oscillation of said actuator a finger enters the notch of its associated disc when the numeral wheel stands at "9" to permit the transfer tooth in the next order to engage its gear and so that in negative actuation of said counter upon initial oscillation of said actuator a finger enters the notch of its associated disc when the numeral wheel stands at "0," said transfer elements having an interlocking connection whereby blocking of an element of lower order by the associated disc will restrain all similar elements of higher order, and the lowermost transfer element having a similar interlocking connection with said tooth.

6. In a calculating machine, a revolutions counter comprising a row of numeral wheels, each numeral wheel being operatively connected to a gear, the axes of rotation of said gears being disposed parallel in the same plane, a cyclically operable actuator adapted to actuate said counter additively or subtractively, means mounting said actuator for axial reciprocation and for oscillation about its axis, the axis of said actuator being disposed transversely with respect to said axes of rotation of said counter gears, cyclically operable means for controlling engagement of said actuator with said gears by oscillating said actuator about its axis, means for controlling actuation of said counter gears by said actuator by reciprocating said actuator, and selectively operable means for controlling the direction of reciprocation to determine additive or subtractive registration.

CARL M. F. FRIDEN.