March 12, 1935. C. M. F. FRIDEN 1,993,834

CALCULATING MACHINE

Filed May 29, 1930 3 Sheets-Sheet 1

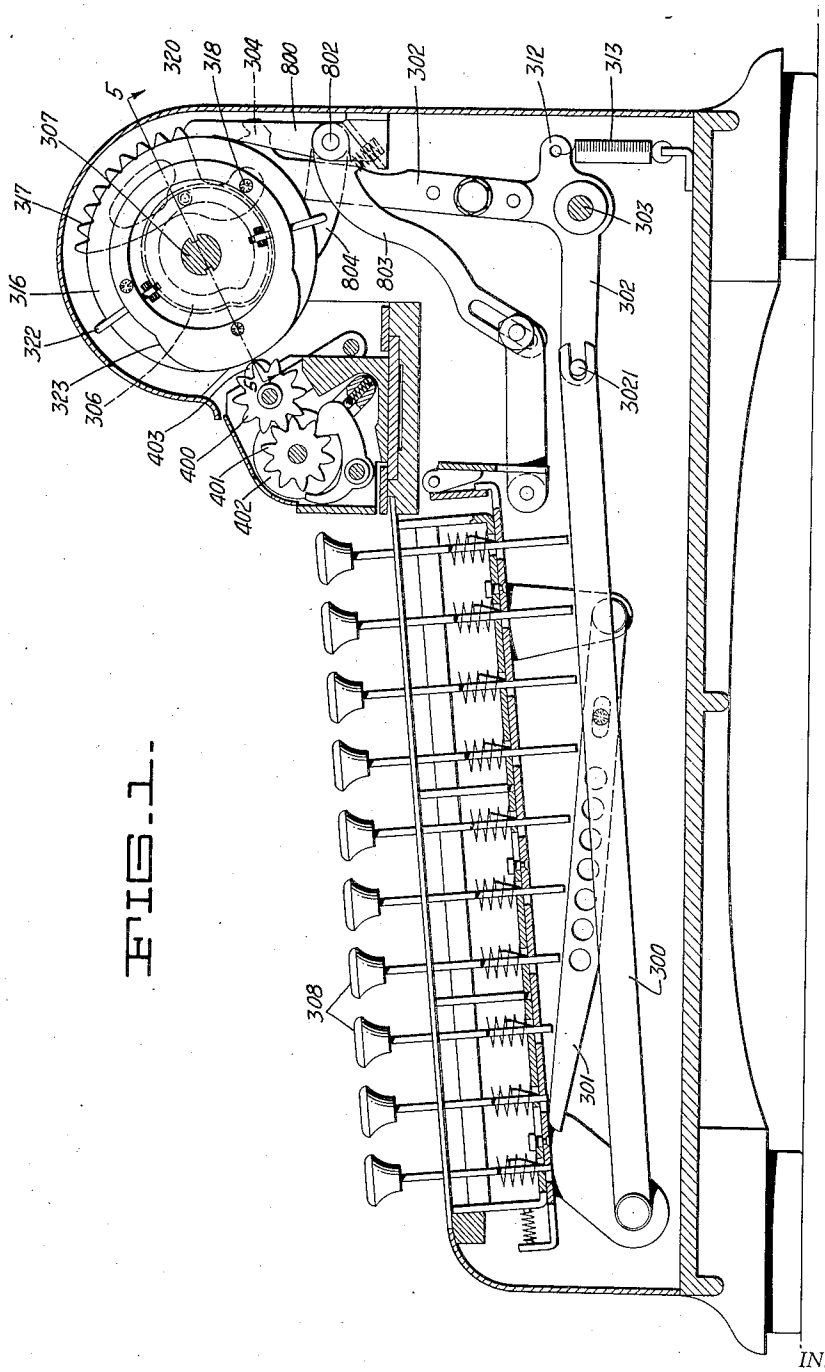

FIG. 1.

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FIG. 2.

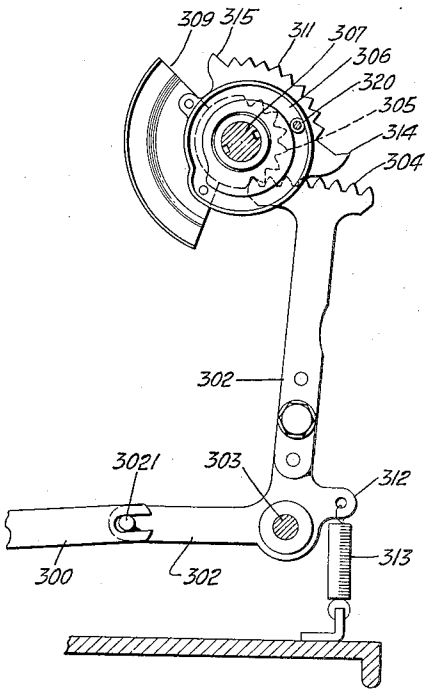


FIG. 3.

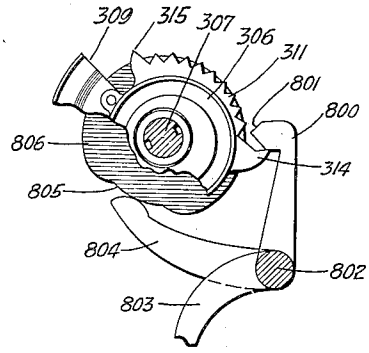
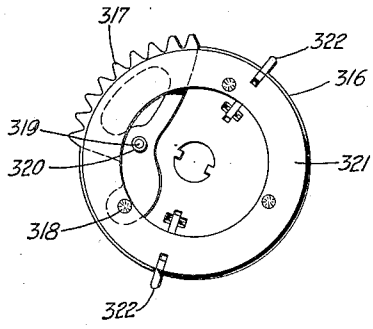


FIG. 4.



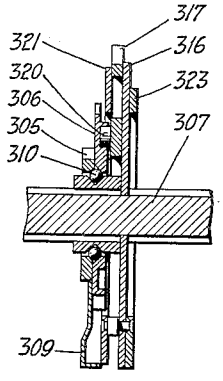


FIG. 5.

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CALCULATING MACHINE

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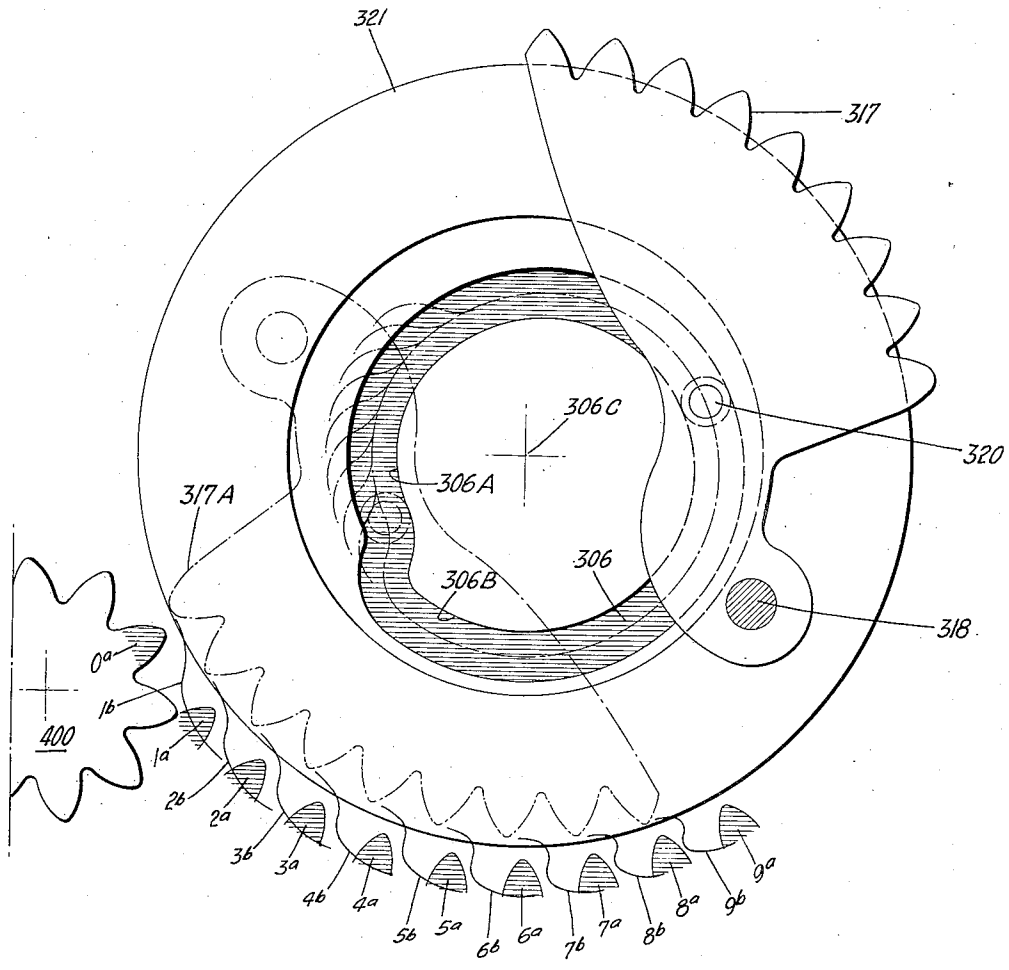
FIG. 6.



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Patented Mar. 12, 1935 1,993,834

UNITED STATES PATENT OFFICE

1,993,834

CALCULATING MACHINE

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Application May 29, 1930, Serial No. 456,843

1 Claim. (Cl. 235—82)

The present invention relates to calculating machines, and particularly to the type embodying a rotary actuator drum into which the values to be calculated are set, and from which, upon rotation thereof, these values are transmitted to an accumulator register.

The invention is an improvement on that described in the patent to Friden No. 1,524,924, dated February 3, 1925, and is shown embodied in a calculating machine of the type described in the patent to Friden No. 1,643,710, dated September 27, 1927 to which reference will herein be made for the disclosure of a complete calculating machine including mechanisms as are not specifically described herein. Although the accompanying drawings show the invention embodied in a machine of the general type disclosed in the latter patent mentioned above, it is manifest that the invention may be embodied in a calculating machine having any suitable means for differentially controlling the actuator, or any suitable form of accumulator register.

It is an object of the invention to provide an improved, simple, and dependable actuating mechanism for calculating machines.

Another object of the invention is the provision, in mechanism of the class described, of means for eliminating or minimizing undesirable results due to the relative movement of the driving and driven elements at the time they are engaged.

Another object of the invention is the provision of a structure of the class described in which frictional resistance is minimized.

Another object of the invention is the provision of a structure of the class described in which noise incident to the operation thereof is minimized.

Other objects will appear as the description progresses.

The invention possesses a plurality of advantageous features, some of which will be set forth at length in the following description, where that form of the invention which has been selected for illustration in the drawings accompanying and forming a part of the present specification will be described in full. In said drawings, one form of apparatus embodying the invention has been shown, but it is to be understood that the invention has not been limited to such form, since the invention, as set forth in the claim, may be embodied in a plurality of other forms.

In the accompanying drawings forming a part of this specification:

Figure 1 is a longitudinally vertical section through a calculating machine showing one section of keys and the elements associated therewith for setting the value to be calculated into the rotatable actuator.

Figure 2 is a right side view of the differentially settable cam and its associated setting mechanism which is operated by any of a plurality of keys shown in Figure 1.

Figure 3 is a right side view of the differentially settable cam showing the locking means provided therefor.

Figure 4 is a left side view of an actuator disc showing the pivoted gear segment and its associated roller which causes its substantially radial oscillation in respect to the actuator disc by operating in the groove of the aforementioned cam.

Figure 5 is a section through the actuator disc, gear segment, and camming mechanism in their juxtapositional relation on the actuator drive shaft.

Figure 6 is a plan view of the pivoted gear segment and its associated cam showing the plurality of settable positions of said cam and the resultant paths described by each of the gear segment teeth in respect to the operable tooth of its driven accumulator gear while said gear segment is being oscillated radially on its own pivot by said cam, and rotated about the axis of the actuator disc by the actuator drive shaft.

Selection mechanism

The calculating machine shown in the accompanying drawings is of the keyboard type, in which the values selected are introduced into the actuator by the depression of keys, as shown in the latter mentioned patent. Obviously, however, the cam comprising part of the present device can be differentially set by any suitable means.

The depression of a key introduces a value corresponding to the numeral on the key into a rotatable actuator, rotation of the actuator being effected to accomplish the calculating operation. The values introduced into the actuator are transmitted, on rotation thereof, to the numeral wheels of the accumulator register, which, for the purpose of making direct action of the selected values on the numeral wheels of highest value possible, is disposed in parallel displaceable relation with the value selecting mechanism axis. As explained in the latter patent mentioned above, the leverage between the selecting bar 300 and its comember 301 is such that a key of a small denomination depresses the bar 300 very slightly while each key of the next higher order adds to the depressed distance of said bar, which motion is transmitted through pin 3021 to bell crank 302, serving to rotate bell crank 302 in a counter-clockwise direction about the axis 303. On the upper end of bell crank 302, (Fig. 2) and concentric with the shaft 303, is a curved rack 304 which meshes with the gear 305 secured to the differentially settable box cam 306. It is obvious that each increase of counter-clockwise rotation of the bell crank 302 is transmitted through the curved rack 304 and gear 305 serving to im-

part in direct ratio a like increase of clockwise rotation to the box cam 306 about the axis of the shaft 307 and on the ball bearings 310 (Fig. 5) provided therefor. Obviously, the successive depressing of the keys 308 in the order of their increasing value from one to nine inclusive, will serve to rotate box cam 306 in a clockwise direction to nine different positions in addition to that normally occupied by it when no key is depressed. Means have been provided for indicating the values which have been entered into the machine by the depression of the keys. Each selecting element is provided with a dial 309 upon which the numerals from zero to nine are successively delineated, and the numeral representing the value of the key depressed is visible through an appropriately positioned aperture in the machine casing.

Selection lock and zero stop

Means have been provided whereby the entire selecting mechanism is free while the machine is in neutral position with all setting and controlling means released. Means have also been provided whereby the selecting mechanism is locked in any one of a plurality of predetermined positions during one or more complete revolutions of the actuator. Means have also been provided whereby the selecting mechanism will be automatically returned to and held at zero or neutral position upon the completion of one or more revolutions of the actuator and upon the release of all setting and operating means.

These operations are accomplished by the provision of a locking mechanism comprising a plurality of vertical lock pawls 800, secured to the shaft 802 which is suitably journaled at both ends. Secured to the shaft 307 is a cam 806 provided on its periphery with a depression 805 into which the arm 804, also integral with shaft 802, is normally held by suitable spring pressure. The rotation of the actuator shaft in either direction will serve to throw the arm 804 out of its normal seat in the depression 805 to the high portion of cam 806 which, in turn, serves to rotate shaft 802 and its integral lock pawls 800 through a limited arc in a counter-clockwise direction. This rotation serves to force the projection 801 of lock pawl 800 in any one of a plurality of depressions 311 in the periphery of box cam 306, dependent on the angular displacement from its normal position, thereby locking the entire selecting mechanism until a full revolution has been completed.

During the calculation of a problem in multiplication or division, it is necessary that the selecting mechanism remain locked during a plurality of revolutions of the actuator. Therefore, means have been provided to accomplish this through an arm 803 integral with the shaft 802 (Fig. 1) which is so connected with the operating means of the machine that the lock pawls 800 are held in locking contact until any number of revolutions of the actuator has been completed, or until the operating means have been released, as disclosed in the latter mentioned patent.

Means have been provided whereby the selecting mechanism is automatically returned to and held at neutral or zero position at the end of a calculating operation and when all setting and operating means have been released. The bell crank 302 is provided with a projection 312 opposite its fulcrum point from the operating pin 3021. Tensioned between this projection 312 and a point on the machine base is a spring 313 tending to rotate the rack 304 secured to bell crank 302 in a clockwise direction, which, in the absence of other instrumentalities, would be rotated out of mesh with gear 305. This has necessitated the provision of a zero stop comprising, in the form illustrated, a projection 314 on the periphery of the box cam 306 which rotates in a counter-clockwise direction by virtue of the spring tension already explained, until it contacts and comes to rest against a face of projection 801 on lock pawl 800 (Fig. 3). Similarly, an overthrow stop is provided by the projection 315 on the periphery of box cam 306, which, when the nine key is depressed, has an angular displacement of sufficient magnitude to also engage a face of projection 801 on lock pawl 800, thereby preventing overthrow. Obviously, the box cam 306 is differentially displaceable only through a limited arc, and is locked in any one of a plurality of positions while the shaft 307, rotates the actuator disc 316 and its co-member the pivoted gear segment 317, which are juxtaposed with the box cam 306. The connecting mechanism and mode of operation will be described as this specification progresses.

The pivoted segment

Means are provided whereby any angular displacement of the box cam 306, the magnitude of which is determined by the depression of a key representing the digit delineated thereon, will, when the actuator is rotated, cause the said digit to be added into the accumulator by rotation in one direction, or subtracted by rotation in the opposite direction. This is accomplished by the provision of an actuator disc 316, splined to the shaft 307 (Fig. 5), and upon which is mounted a nine tooth gear segment 317 (Figs. 4, 5, and 6) journaled on a stud 318, and held thereon by any suitable means; in this case, the retainer ring 321. Secured to the segment 317 is a projecting stud 319 which carries a roller 320. The relation of the gear segment 317 (Fig. 5) with the box cam 306 is such that the roller 320 rotatably mounted on the gear segment is confined in the box cam path 306 which has a low portion 306A (Fig. 6), with relation to its axis of rotation 306C, and a high portion 306B. That portion of the cam path from 306A to 306B in a counter-clockwise direction, has a very abrupt radial rise, and, conversely, that portion of the cam path from 306A to 306B in a clockwise direction, has a very gradual radial rise. Obviously, with the box cam 306 locked in any of a plurality of stationary positions, and with the actuator disc carrying the segment 317 around the cam with the segment roller confined within the path of the box cam 306, the segment 317, through the roller 320, will have, when rotated in a counter-clockwise direction, imparted to it an abrupt ejecting oscillation about its pivot point 318 while the roller 320 travels through the short portion of the cam between 306A and 306B, and a gradual retracting oscillation through the long portion of the cam between 306B and 306A. Likewise, a reverse movement is obtained when the actuator disc carries the gear segment in a clockwise direction.

As previously stated in this specification, means have been provided whereby any predetermined digit can be set into the actuating mechanism in such a manner that it is transferred to the accumulator register, either additively or subtractively, upon a revolution of the actuator mechanism. For illustrative purposes, a diagrammatic view (Fig. 6) has been provided showing the resultant paths described by each of the

gear segment teeth with respect to the operable tooth of the driven accumulator gear 400 while said gear segment is being oscillated radially on its own pivot by said cam, and rotated about the axis of the actuator disc by the actuator drive shaft. The positions numbered from zero to nine inclusively, denote the plurality of differentially settable positions taken by the center of the abrupt rise in the cam path which is settable, in this case, from 0 to 9 in a clockwise direction. Obviously, and for explanatory purposes only, the same result is obtained, and the relative positions of the resultant curves to the accumulator gear 400 in any of the plurality of cam positions can be more clearly illustrated, by holding a stationary position of the cam and moving the gear 400 through the same degree of angular displacement in the opposite direction. These positions are denoted by the gear teeth numbered from 1^a to 9^a, inclusively. Gear segment 317 is shown in its neutral or full cycle position on one actuator disc, and is also shown out of its full cycle position in the phantom line figure 317A (Fig. 6). In this latter position, the roller 320 is at the low portion of the cam which places the gear segment in its extreme retracted position radially. Continued rotation in a counter-clockwise direction will result in an abrupt ejection of the roller 320 and the segment 317 rotatable on its pivot point 318 until the roller reaches the high portion of the cam 306B at which time the segment will have attained its extreme radial ejection. It is this abrupt counter-clockwise radial ejection, or conversely, clockwise radial retraction that must be so timed with respect to the gear 400 that any predetermined number of segment teeth will contact the teeth of the gear 400 and result in a like number of circular pitch displacements thereof, each displacement corresponding to a digit on the accumulator numeral wheel.

In actuator mechanisms of this type heretofore, it has been necessary to employ the most abrupt cam rise practicable so that the resultant curve of the segment teeth caused by their concurrent rotation and radial movement would be on a sufficiently radial line to assure the proper meshing of the segment teeth into the accumulator gear without the possibility of an error. Due to the short leverage caused by the operating roller of the segment being nearer to the pivot point than to the segment teeth, the present invention overcomes these disadvantages by causing the majority of the segment teeth to be ejected and retracted rapidly enough against the direction of rotation that the segment teeth enter radially, or better. In the majority of the paths 1^b to 9^b (Fig. 6), it is manifest that the rate of radial movement has been equal to or greater than the rate of rotation even though a comparatively smooth camming action has been used. This more radial movement of the segment teeth assures perfect mesh without working to the close limits heretofore necessary in the manufacture of this type of actuating drum, while the more smooth camming action serves decidedly to decrease noise as well as undue strain on the drive mechanism of the machine in general.

The relative positon of the tooth 0^a on the gear 400 with the cam drop 0 is such that rotation of the actuator in a counter-clockwise direction will eject the segment after all teeth have passed the gear 400, and rotation in a clockwise direction will retract the segment before any tooth can mesh with the gear 400, thus being inoperative in either direction, or zero position with no key depressed.

If the number one key were depressed, the abrupt rise in the cam would be angularly displaced from zero to one position, but for illustrative purposes, the cam will be left in zero position and the operable tooth of the gear 400 will be given a like angular displacement in the opposite direction or position 1^a. Obviously, counter-clockwise rotation of the actuator will now result in a continuous retracted position of the segment until eight teeth have passed the tooth 1^a of gear 400 when the roller 320 strikes the abrupt rise in the cam 306, causing the ninth tooth of the segment to describe path 1^b which serves to rotate the gear 400 a distance of one circular pitch. Rotation of the actuator in the opposite direction results in the segment's meshing with the gear while fully ejected, only to be retracted radially after only one tooth has operated the gear 400.

If the number nine key were depressed, the abrupt cam rise would be angularly displaced from zero to nine position, or, leaving the cam at zero, the gear 400 would be relatively displaced to position 9^a. A counter-clockwise rotation will now serve to eject all of the segment teeth along their respective paths 1^b to 9^b, immediately before meshing with the gear 400 which ejection will be continued until each of the nine teeth has displaced a corresponding tooth of the gear a distance of one circular pitch, thus transmitting nine to the accumulator. A clockwise rotation will result in the segment's meshing the gear 9^a fully ejected only to be abruptly retracted after each of the nine teeth of the segment has performed its operation. Thus, it is obvious how the operation of transmitting any predetermined numeral from the actuator to the accumulator can be followed through by placing the gear in any of its relative positions from 0^a to 9^a.

Means have been provided whereby a tens transfer is effected to the numeral wheel of the next higher order at the necessary time by the provision of tens carrying pin 322 (Fig. 1) transversely displaceable into operative position by the transfer levers 403 which levers are restored to inoperative position by the cam 323 secured to the opposite side of the actuator disk from the segment. Tens transfer mechanism of this type are well-known in the art of calculating machines, so need no further explanation.

Means have also been provided whereby no two of a plurality of the actuator segments placed in axial alinement and composing the actuator drum assembly, can engage the accumulator gears simultaneously, thus suddenly applying a large load to the driving mechanism. This has been accomplished by angularly displacing the neutral position of each gear segment from every other.

I claim:

In a calculating machine, the combination of accumulating mechanism comprising a toothed wheel, differential actuating means therefor comprising an adjustable selecting cam, a member rotatable with respect to said cam having an actuating rack pivoted thereto by a pivot arm of fixed length, and means connecting said rack with said cam for oscillating said rack in the plane of said wheel by moving it about said pivot as said member is rotated.

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