March 6, 1934. C. M. F. FRIDEN 1,949,740

CALCULATING MACHINE

Filed April 24, 1928 2 Sheets-Sheet 1

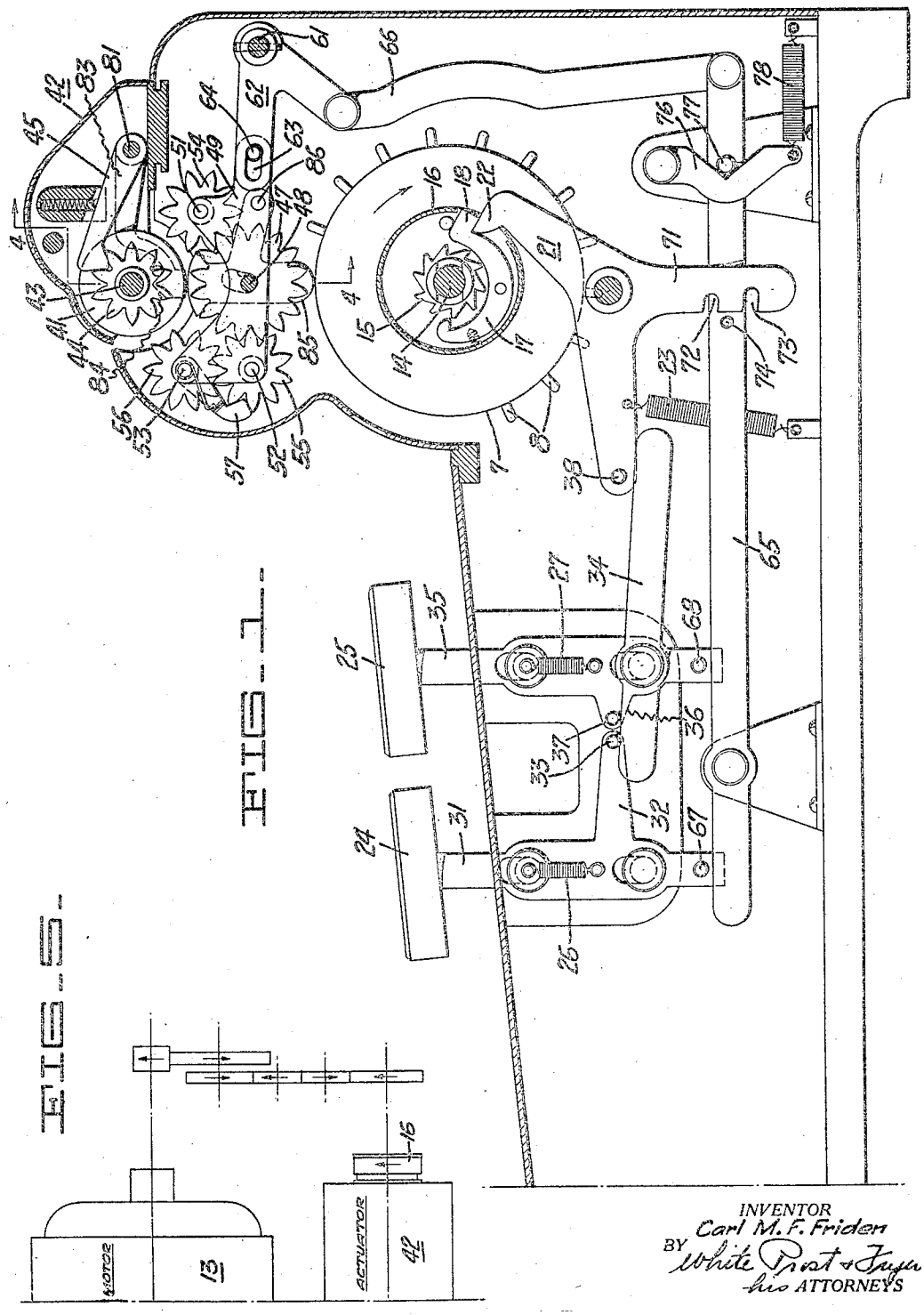

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FIG. 3.

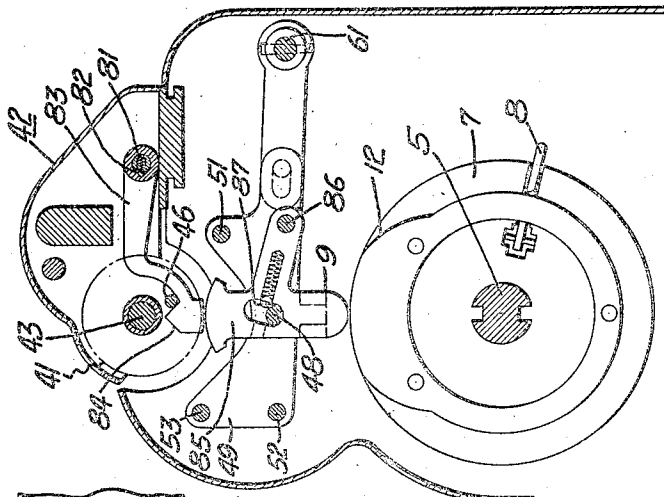


FIG. 4.

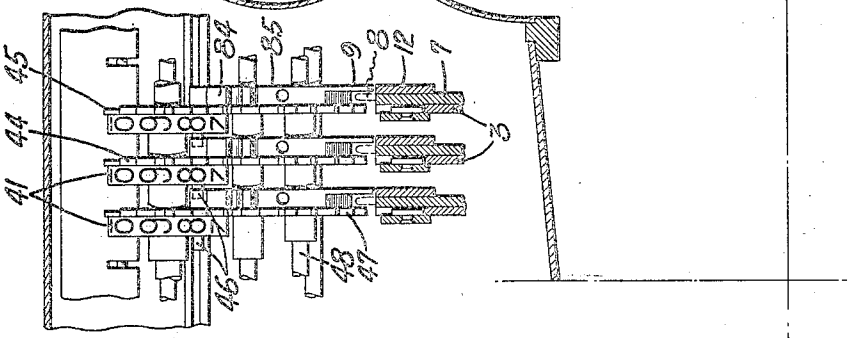
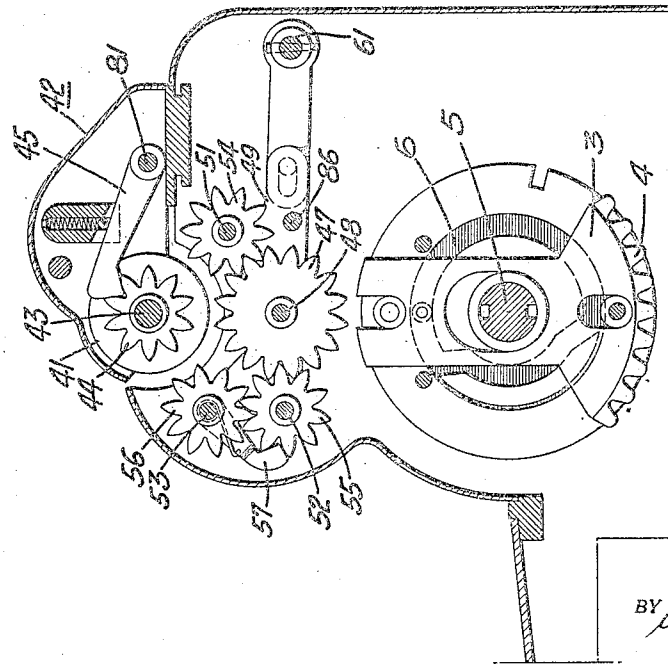


FIG. 2.



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Carl M. F. Friden
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Patented Mar. 6, 1934 1,949,740

UNITED STATES PATENT OFFICE

1,949,740

CALCULATING MACHINE

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Application April 24, 1928, Serial No. 272,403

13 Claims. (Cl. 235—70)

The invention relates to calculating machines of the motor driven type for performing operations in addition, subtraction, multiplication and division.

The calculating machine comprises a rotary actuator and a plurality of keys for introducing values into the actuator. The depression of a key introduces a value corresponding to the numeral on the key into the rotatable actuator and rotation of the actuator serves to transfer these values into the counter or register, to effect the calculating operation. The values introduced into the actuator are transmitted, on rotation of the actuator to the figure discs of the register, which, for the purpose of making direct action of the selected values on the figure discs of highest value possible, is disposed in parallel displaceable relation to the axis of the actuator. The register comprises a series of numeral wheels which are mounted on a carriage which is displaceable transversely of the calculating machine, with respect to the actuator.

The present invention relates to a calculating machine adapted to perform the four rules calculations by the use of a rotary actuator having a uni-directional cycle of operation. Additive or subtractive movement of the numeral wheels in performing calculating operations of different sign is controlled and effected by the manipulation of intermediate gears, disposed between the actuator and the numeral wheels.

An object of the invention is to provide a calculating machine in which positive or negative calculations are initiated and effected by the selective depression of a key, without reversing the direction of rotation of the actuator.

Another object of the invention is to provide a calculating machine provided with an actuator having a unidirectional cycle of operation, with means selectively operable by a single manual stroke to initiate and effect an additive or subtractive movement of the numeral wheels.

A further object of the invention is to provide, in a calculating machine, a rotary unitary actuator having a single series of tens carrying members, operative both on addition and subtractive operations, whereby the number of numerical orders in the actuator may be increased to substantially twice the number possible in a machine having two series of tens carrying members.

The invention possesses other advantageous features, some of which with the foregoing will be set forth at length in the following description, where I shall outline in full that form of my invention which I have selected for illustration in the drawings accompanying and forming part of the present specification.

In said drawings, I have shown one form of mechanism embodying my invention, but it is to be understood that I do not limit myself to such form, since the invention, as set forth in the claims, may be embodied in a plurality of forms.

Referring to said drawings:

Figure 1 is a vertical section through a portion of a calculating machine embodying my invention, showing the means for controlling the rotation of the actuator and the direction of rotation of the numeral wheels.

Figure 2 is a vertical section through a portion of the machine showing the actuator and the mechanism for transferring values from the actuator to the numeral wheels.

Figure 3 is a vertical section through a portion of the machine showing the tens carrying mechanism associated with one numeral wheel.

Figure 4 is a section taken on the line 4—4 Figure 1.

Figure 5 is a diagrammatic representation of the driving mechanism for the actuator.

The invention relates to a motor driven calculating machine and particularly to a calculating machine having an actuator having a uni-directional cycle of operation. The machine is provided with positive and negative operation keys, depression of either key serving to cause rotation of the actuator in the same direction, depression of the positive key serving to cause rotation of the numeral wheels in a positive direction or additive direction and depression of the negative key serving to cause rotation of the numeral wheels in a negative or subtractive direction. The positive key is used primarily in performing problems in addition and multiplication and the negative key is used primarily for performing problems in substraction and division, although in short cut multiplication, the negative key is also used.

The present machine includes a suitable frame, within which the various instrumentalities of the calculating machine are arranged. Many of these instrumentalities are fully disclosed in my United States Letters Patent Number 1,643,710 of September 27, 1927, to which reference is hereby made for a complete disclosure of those features of the calculating machine which are not specifically disclosed in this application. These features relate principally to the arrangement and construction of the keyboard, the means for introducing values into the actuator by the depres-

sion of the keys, the construction of the product register and the quotient register, the means for moving the carriage, the means for resetting the registers to zero and those other features which are required to produce a complete calculating machine.

The present machine includes a rotary actuator, into which values are introduced by the depression of the keys of the keyboard. The actuator comprises a series of units mounted on a driving shaft and these units are of substantially the same construction as disclosed in my aforesaid patent, with the exception, that since the present actuator is unidirectional in operation, only one series of tens carrying pins is required, whereas, in the reversible actuator of the aforesaid patent, two series of tens carrying pins were required. Each actuator unit comprises an ordinal registration member consisting of the slide 3 provided on one end with a toothed rack 4, the slide 3 being mounted on a wheel which is secured to the actuator shaft 5. Rotatably mounted on the shaft 5, and comprising a portion of each actuator unit, is a settable cam member 6 which is selectively set by the depression of a key to determine the time of projection of the slide 3 and thereby the extent of its operation on the intermediate wheels and consequently the value which is introduced into the numeral wheel by the rotation of the actuator unit. The wheel 7 on which the slide 3 is mounted, is provided with a tens carrying pin 8 which is arranged for cooperation with the transfer lever 9, and with a restoring cam 12 for restoring the transfer lever to inoperative position after a tens carry. The series of transfer pins 8 on the successive wheels 7 which comprise the actuator, are successively spaced apart circumferentially, so that they lie in a spiral, so that the successive pins come into operation on the successive numeral wheels during a tens carrying operation of the respective numeral wheels. By virtue of the fact that only a single series of tens carrying pins is required this series may extend around the entire arc of the actuator 7, except that portion occupied by the ordinal registration member 4, so that consequently a larger number of tens carrying pins may be provided on the actuator, than would be possible where it is necessary to provide two separate series of tens carrying pins, as is necessary in a reversible actuator. On account of this fact, it is therefore possible to provide a greater number of transfer pins, and since there is one pin mounted on each actuator unit, it is thereby possible to provide an actuator having a greater number of units, thereby permitting the machine to be made of much greater numerical capacity than machines having a reversible actuator.

The actuator is driven by an electric motor 13, which is connected through suitable speed reducing gearing to the driving shaft 14. Arranged between the driving shaft 14 and the actuator shaft 5 is a clutch, by which the rotation of the actuator is controlled. Secured to the driving shaft 14 is a ratchet wheel 15 and secured to the actuator shaft 5 is a cylindrical clutch housing member 16 which surrounds the ratchet wheel 15. Pivoted within the clutch housing 16 is a pawl 17 which is movable into and out of engagement with the ratchet wheel 15, to cause engagement and disengagement of the clutch. The pawl 17 is provided with a foot 18 which, when the pawl is in engagement with the ratchet wheel, extends through an aperture in the periphery of the cylindrical housing 16. When the actuator is stopped in full cycle position, the foot 18 is pressed into the housing and the pawl 17 removed from engagement with the ratchet wheel 15. Means are provided for controlling the movement of the pawl 17 to engage and disengage the clutch and also to stop the actuator in full cycle position. Pivoted within the machine is a clutch lever 21 having a projection 22 on its rear end which is adapted to engage the foot 18 to disengage the clutch from the actuator in full cycle position. The clutch lever is normally held in clutch disengaging position, as shown in Figure 1, by the spring 23. Means are provided for moving the clutch lever 21 to control the rotation of the actuator. Arranged on the machine, adjacent the keyboard, is a positive registration key 24 and a negative registration key 25, depression of either key serving to move the clutch control lever 21 to cause engagement of the clutch. The keys 24 and 25 are normally held in elevated position by the springs 26 and 27 and are preferably freely retractable so that when pressure thereon is released the depressed key is immediately returned to elevated position. The stem 31 of the key 24 is provided with an extension 32 carrying a pin or stud 33 which overlies one end of the rocking lever 34. Similarly, the stem 35 of the key 25 is provided with an extension 36 carrying a stud 37 which overlies the same end of the rocking lever 34, and is disposed adjacent the stud 33, so that depression of either key 24 or 25 produces substantially the same rocking movement of the lever 34. At its rearward end the lever 34 underlies a pin or stud 38 in the end of the clutch lever 21, the adjacent portion of the rocking lever 34 being spaced somewhat from the stud 38, to provide lost motion, so that the initial downward movement of either key 24 or 25 will not cause movement of the clutch control lever. The reason for the provision of this lost motion will be set forth hereinafter.

Depression of either of the keys 24 or 25 for their full stroke, rocks the clutch control lever 21 to move the projection 22 out of the path of the foot 18 on the pawl 17, when the foot is in its extended position, so that the clutch remains in engagement as long as either of the keys 24 or 25 is held depressed. Upon release of either key, the projection 22 drops back into contact with the periphery of the housing 16, so that it lies in the path of the foot 18 and, when the foot contacts with the projection, due to the rotation of the housing, the projection drops into the aperture in the housing, contacts with the foot 18, and rocks the pawl 17 to cause disengagement of the clutch. The clutch housing 16, being secured to the actuator shaft 5 and the clutch housing being stopped by the projection 22, the projection serves to stop the actuator in full cycle position.

The numeral wheels 41, comprising the product register are mounted in a carriage 42 which is displaceable transversely of the frame of the machine, to bring different numeral wheels into cooperative relation with the respective actuator units. The numeral wheels 41 are mounted on a shaft 43 which is provided with means for resetting the numeral wheels to zero, a suitable means for this purpose being shown in my aforesaid patent. On one side of each numeral wheel is secured a gear or toothed wheel 44 having ten teeth corresponding to the number of figures on the face of the numeral wheel. Each numeral wheel is provided with a detent 45 engaging the

toothed wheel 44 to prevent overthrow of the numeral wheel and to properly position the numeral wheel. On the other side, each numeral wheel is provided with a pin or stud 46, which cooperates with the transfer lever in the usual manner, to transfer values to the numeral wheel of next higher order.

Interposed between the actuator and the numeral wheels is a series of main intermediate gears 47, each gear being independently rotatably mounted on a shaft 48, secured in the frame of the machine. The main intermediate gears 47 respectively lie in the plane of the actuator units or in the planes of the ordinal registration members 4, so that on rotation of the actuator, the selected ordinal registration members engage the respective main intermediate gears. The tooth pitch of the main intermediate gears is the same as the tooth pitch of the ordinal registration member 4 and is the same as the tooth pitch of the toothed wheels 44 associated with the numeral wheels.

Pivoted on the shaft 48 is a rocking frame 49 which includes the three transverse shafts 51, 52 and 53. Freely, rotatably mounted on the shafts 51, 52 and 53 are two sets of subsidiary intermediate gears which serve to transmit movement from the main intermediate gears to the numeral wheels and to determine the direction of movement of the numeral wheels. Mounted on shaft 51 is a series of subsidiary, intermediate gears 54, meshing with the main intermediate gears 47 and normally lying out of the path of the numeral wheels 41 in their movement due to the transverse movement of the carriage. The wheels 54 are adapted, upon rocking of the frame 49, to be moved into mesh with the toothed wheels 44 of the numeral wheels.

Loosely, rotatably mounted on the shaft 52 is a series of subsidiary, intermediate gears 55 meshing with the main intermediate gears 47 and mounted on the shaft 53 is a series of freely rotatable subsidiary intermediate gears 56 which are in mesh with the intermediate gears 55. The intermediate gears 56 normally lie out of the path of the numeral wheels in their movement, due to transverse movement of the carriage, and upon rocking movement of the frame, are moved into mesh with the toothed wheels 44 on the numeral wheels.

The frame 49 is normally held in neutral position, with both series of gears 54 and 56 out of the transverse path of movement of the numeral wheels 41. Upon rocking the frame 49 in one direction, intermediate gears 54 mesh with the toothed wheels 44 and upon rocking the frame in the opposite direction, the intermediate gears 56 mesh with the toothed wheels 44. Due to the fact that one set of subsidiary, intermediate gears contains one series of gears 54 which directly establish driving relation from the gears 47 to the gears 44 and that the other set of subsidiary, intermediate gears comprises the two series of gears 55 and 56, through both of which a driving connection is established between the intermediate gears 47 and the toothed wheels 44, the numeral wheels are rotated in one direction when the frame is rocked in one direction and the numeral wheels are moved in the opposite direction when the frame is rocked in the other direction.

Detents must be provided for preventing free rotation of the gears 47, 54, 55 and 56, and, since all of these gears are always in mesh, the detents may be associated with any one of the series of gears. These detents may be associated with the main intermediate gears 47 but in the drawings, I have shown the detents 57 associated with the series of gears 55. Due to this arrangement, the main intermediate gear 47 will rock with the frame 49, bringing the center line of a tooth on the main intermediate gear 47 into the plane containing the axes of the shafts 5 and 48, so that there will be proper meshing of the teeth on the ordinal registration members 4 with the teeth on the main intermediate gear 47. If the detents are associated with the gears 47, then these gears must be arranged so that in their normal position, the center line of a tooth lies in the plane of the axes of the shafts 5 and 48.

It has been seen therefore, that the direction of movement of the numeral wheels, that is either an additive or subtractive movement thereof is determined by the rocking of the frame 49. This frame normally lies in neutral position, that is, with neither of the gears 54 or 56 in mesh with the toothed wheels 44, and means are provided whereby the initial depression of one of the keys 24 or 25 rocks the frame 49 to establish the selected driving connection, in advance of the engagement of the clutch. Pinned on a shaft 61 is a bell crank lever 62 provided with an elongated eye 63 in which is disposed a pin 64 secured to the frame 49 so that as the lever 62 is rocked, the frame 49 is rocked. Associated with the stems of the keys 24 and 25 and pivotally mounted intermediate the stems of these keys is a rock lever 65 which is connected at its rear end to the bell crank lever 62 by the link 66. The stems 31 and 35 of the keys 24 and 25 are provided on their lower ends with pins 67 and 68 which overlie the rocking lever 65 at equal distances from its fulcrum, so that depression of key 24 rocks the lever 65 to raise its rear end and depression of key 25 rocks the lever 65 to depress its rear end. The spacing of the pins or studs 67 and 68 from the rocking lever 65 and the spacing of the pin 38 on the clutch control lever 21 from the rocking lever 34 is such that the rocking lever 65 is moved to its extreme position in either direction, bringing the selected series of subsidiary intermediate gears into mesh with the numeral wheel gears 44, in advance of the engagement of the clutch.

Means are provided for holding the selected series of subsidiary intermediate gears in engagement with the toothed wheels 44 until the actuator is stopped in full cycle position, or until the actuator reaches full cycle position. For this purpose, the clutch control lever 21 is provided with an extension 71 having two seats 72 and 73 therein which are adapted to receive a pin 74 secured to the rocking lever 65 and thereby hold the lever 65 is selected, adjusted position, in the event that the operating key 24 or 25 has been released, until the clutch lever 21 moves to clutch disengaging position. The rocking lever 65 is normally held in neutral or central position and is returned to neutral position, by the centralizing lever 76 which is provided with a double cam surface pressed into engagement with a pin 77 on the lever 65 by the spring 78.

Due to the arrangement of the intermediate gears with respect to the numeral wheels, and to the fact that the intermediate gears are mounted on the frame and are not movable transversely with the carriage, the construction of the transfer mechanism presented a novel problem. This has been solved by forming the transfer lever in two parts, one part being associated with the numeral wheels and mounted on the carriage and the other part being associated with the actuator

and mounted within the frame of the machine. Since in the present construction, these two parts are superposed, I shall refer to one part as the upper transfer lever and to the other part as the lower transfer lever, but is it to be understood, however, that these two parts will function in the same manner in any oriented position. Mounted on a shaft 81 arranged in the carriage and individually held in raised position by spring pressed balls 82, is a series of upper transfer levers 83, one lever being associated with each numeral wheel. The transfer lever is provided at its forward end with a double cam 84 which is engaged by the pin 46, when a transfer to the numeral wheel of next higher order is to be made, to depress the upper transfer lever. Disposed below each upper transfer lever is a lower transfer lever 85 which is suitably mounted on a shaft arranged within the frame of the machine, in the present instance the series of transfer levers 85 being independently mounted on the shaft 86 carried by the rocking frame 49. The transfer levers 85 are slightly spaced below the transfer levers 83 so that the carriage may be moved transversely. The transfer levers 85 are movable from raised to depressed position by the transfer levers 83 and, after the tens carry, are returned to raised position by the restoring cams 12. The transfer lever 85 is restrained in either its raised or depressed position by a spring pressed ball 87 carried by the transfer lever and adapted to engage opposite sides of the shaft 48 which passes through an elongated aperture in the transfer lever. In operation, the pin 46 presses the transfer lever 83 and consequently the transfer lever 85 to its depressed position, bringing the cam surface 9 on the lower end of the transfer lever into the path of the transfer pin 8. During rotation of the actuator, the transfer pin 8 rides over the cam surface of the transfer lever moving the main intermediate gear 47 of the numeral wheel of next higher order one step and then, the lower transfer lever and consequently the upper transfer lever are both restored to elevated position by the restoring cam 12.

I claim:

1. In a motor driven calculating machine, reversible numeral wheels, actuating means therefor having a uni-directional cycle of operation, clutch means operable to initiate and effect transmission of movement from the motor to the actuator, control means for said clutch, selectively settable transmission members between the actuator and the numeral wheels, means operable by a single manual stroke to set said members and move said clutch controlling member and means cooperating with said controlling member to hold the transmission members in selectively set position.

2. In a motor driven calculating machine, a transversely displaceable carriage, reversible numeral wheels mounted on said carriage, an actuator for the numeral wheels having a uni-directional cycle of operation, two series of intermediate gears disposed between the numeral wheels and the actuator and normally lying out of the transverse path of movement of the numeral wheels, and unitary means for controlling the connection of the motor to the actuator and moving one series of intermediate gears into engagement with the numeral wheels.

3. In a motor driven calculating machine, a transversely displaceable carriage, reversible numeral wheels mounted on said carriage, an actuator for the numeral wheels having a uni-directional cycle of operation, two series of intermediate gears disposed between the numeral wheels and the actuator and normally lying out of the transverse path of movement of the numeral wheels, and selectively operable means for connecting the motor to the actuator and moving a selected series of intermediate gears into engagement with the numeral wheels.

4. In a motor driven calculating machine, a transversely displaceable carriage, reversible numeral wheels mounted on said carriage, an actuator for the numeral wheels having a uni-directional cycle of operation, a series of forward drive intermediate gears and a series of reverse drive intermediate gears disposed between the actuator and the numeral wheels both series of gears normally lying out of the transverse path of movement of the numeral wheels, and selectively operable means for moving either set of intermediate gears into engagement with the numeral wheels.

5. In a motor driven calculating machine, reversible numeral wheels, an actuator therefor having a uni-directional cycle of operation, a clutch between the motor and the actuator, two series of intermediate gears between the actuator and the numeral wheels, a key, means operated by depression of the key for engaging the clutch and moving one set of intermediate gears into operative relation with the numeral wheels and means operative during the time that the actuator is out of full cycle position for holding said set of intermediate gears in operative relation with the numeral wheels.

6. In a motor driven calculating machine reversible numeral wheels, an actuator therefor having a uni-directional cycle of operation, a clutch between the motor and the actuator, reversing motion transmitting devices between the actuator and the numeral wheels, a manually depressible freely retractable key, means operated by depression of the key for engaging the clutch and moving the motion transmitting devices into operative position and means operative upon the stopping of the actuator in full cycle position for returning the motion transmitting devices to inoperative position.

7. In a motor driven calculating machine, numeral wheels, actuating means therefor having a uni-directional cycle of operation, selectively settable transmission members between said actuating means and said numeral wheels, a clutch between said motor and said actuating means, control means therefor operable as an incident to the setting of said transmission members, and means operable as an incident to the operation of said control means for maintaining said members in their selectively set position.

8. In a motor driven calculating machine, numeral wheels, actuating means therefor, selectively settable transmission means for determining the effective direction of actuation of said numeral wheels by said actuating means, control means therefor, a clutch, means for effecting the clutch, and means controlled by said last named means for maintaining said control means in a selective controlling position during operation of said clutch effecting means.

9. In a calculating machine, the combination of a set of numeral wheels, a set of actuators therefor, intermediate gears for transmitting movement from said actuators to said numeral wheels, a transversely movable carriage supporting said numeral wheels, a swinging frame supporting said intermediate gears for movement

into a position in the path of and into a position out of the path of transverse movement of said numeral wheels, spring means for urging said frame into one of said positions, and controllable means for retaining it in the other of said positions.

10. In a calculating machine, a frame, a shiftable carriage carried thereon, registering mechanism mounted in said carriage, driving mechanism including a cyclic clutch mounted in said frame, means for engaging said driving mechanism with said registering mechanism, and means automatically operative upon disengagement of said clutch for disengaging said driving mechanism from said registering mechanism to permit shifting of said carriage.

11. In a calculating machine, a frame, a shiftable carriage carried thereon, registering mechanism mounted in said carriage, driving mechanism including a cyclic clutch mounted in said frame, means for engaging said driving mechanism with said registering mechanism and causing engagement of said clutch, and means automatically operative upon disengagement of said clutch for disengaging said driving mechanism from said registering mechanism, including means for preventing such action until said clutch has completed a cycle of operation.

12. In a calculating machine, a frame, a shiftable carriage carried thereon, registering mechanism mounted in said carriage, driving mechanism including a cyclic clutch mounted in said frame, a clutch control lever movable to lock or unlock said clutch, and means controlled by said lever, upon movement thereof to locking position, for disengaging said driving mechanism from said registering mechanism to permit shifting of said carriage.

13. In a calculating machine, a frame, a shiftable carriage carried thereon, registering mechanism mounted in said carriage, driving mechanism including a cyclic clutch mounted in said frame, a clutch control lever movable to engage or disengage said clutch, and means controlled by said lever, upon movement thereof to clutch disengaging position, for disengaging said driving mechanism from said registering mechanism to permit shifting of said carriage.

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