Nov. 16, 1965 W. M. F. SPAHR ETAL 3,217,985

CALCULATING MACHINES

Filed Aug. 4, 1964 3 Sheets-Sheet 1

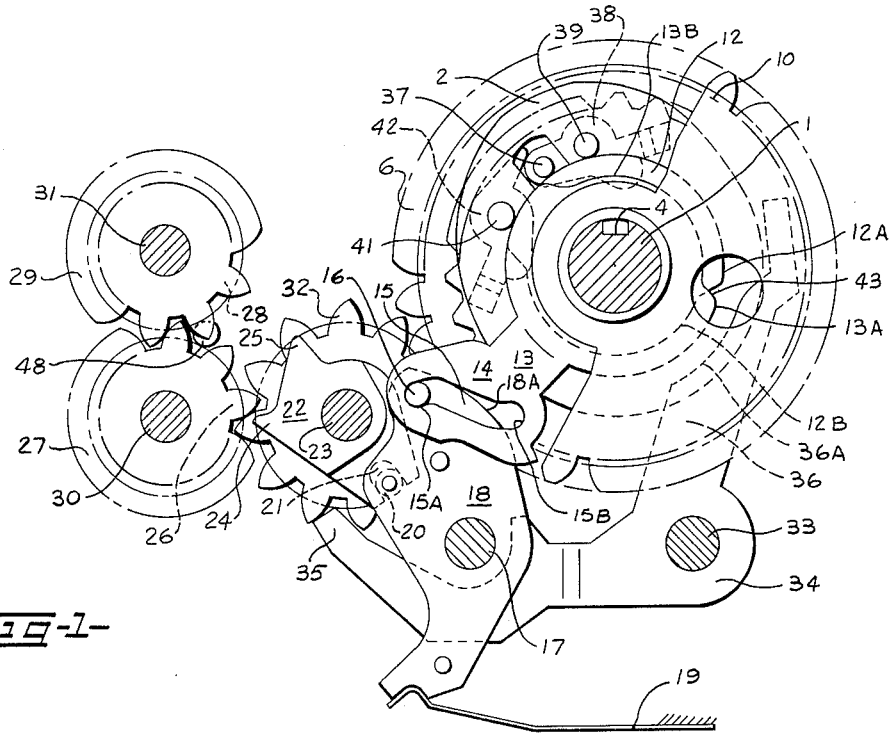


FIG-1-

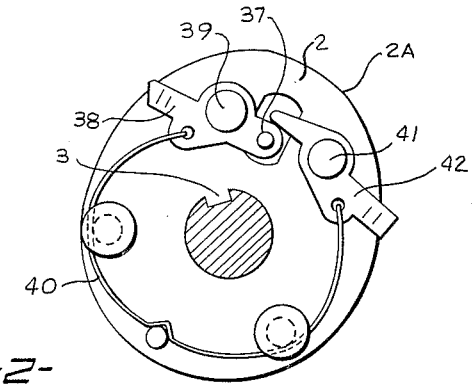


FIG-2-

INVENTORS.

WERNER M. F. SPAHR
GÜNTER W. R. HORNAUER
HORST G. G. DENZIN
GERHARD O.W. DENZIN

BY Clarence W. Martin

Nov. 16, 1965 W. M. F. SPAHR ETAL 3,217,985

CALCULATING MACHINES

Filed Aug. 4, 1964 3 Sheets-Sheet 2

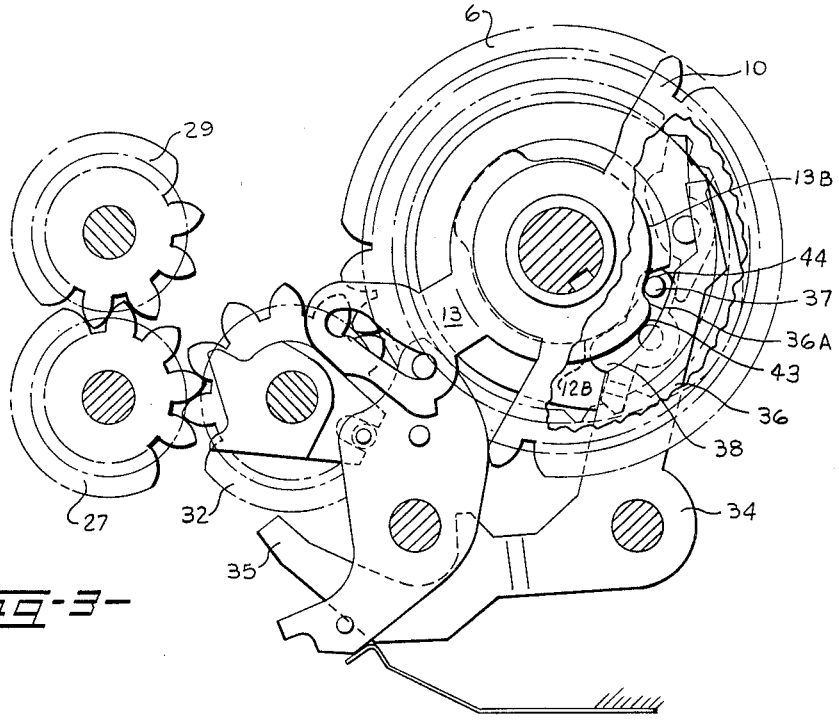


Fig-3-

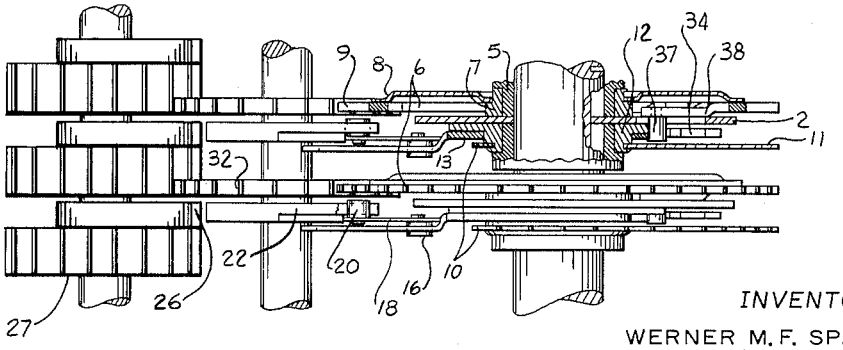


Fig-4-

INVENTORS.
WERNER M. F. SPAHR
GÜNTER W. R. HORNAUER
HORST G. G. DENZIN
GERHARD O. W. DENZIN

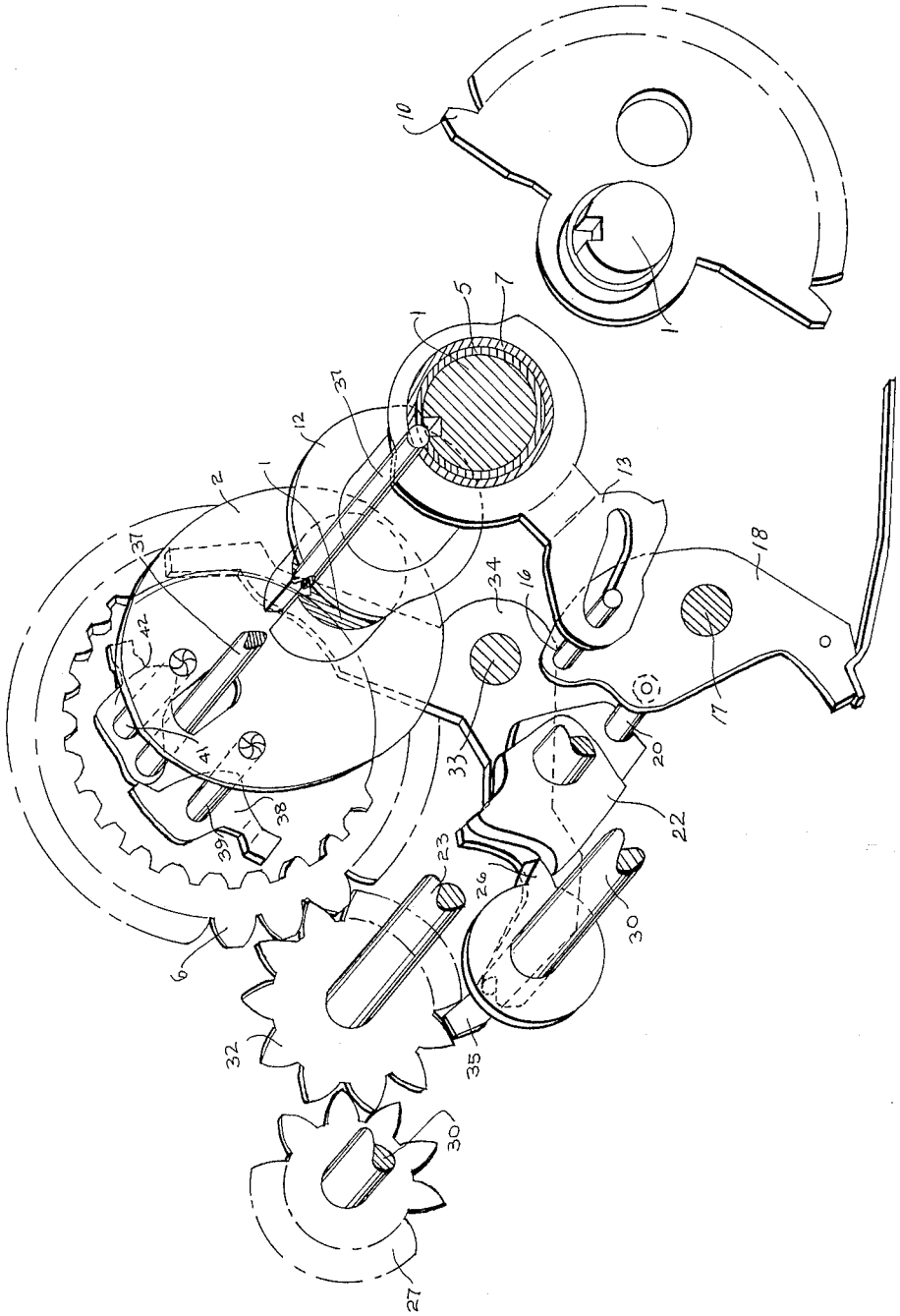
BY Clarence W. Martin

Nov. 16, 1965 W. M. F. SPAHR ETAL 3,217,985

CALCULATING MACHINES

Filed Aug. 4, 1964 3 Sheets-Sheet 3

Fig. 5



United States Patent Office 3,217,985 Patented Nov. 16, 1965

3,217,985

CALCULATING MACHINES

Werner M. F. Spahr, Günter W. R. Hornauer, Georg G. Denzin, and Gerhard O. W. Denzin, Berlin, Germany, assignors to Hamann Rechenmaschinen G.m.b.H., Berlin, Germany, a corporation of Germany

Filed Aug. 4, 1964, Ser. No. 387,441
Claims priority, application Germany, Feb. 2, 1964, H 51,650
6 Claims. (Cl. 235—138)

The present invention relates to rotary drive calculating machines and more particularly concerns improved tens carry mechanisms in which each tens carry increment of drive is transmitted as an extension of the digital actuating drive.

The present invention is disclosed as embodied in a calculating machine such as shown in part in the U.S. Patent No. 1,788,192 issued January 6, 1931. This machine is characterized as being of the polyphase non-reversible type in which the numeral wheel actuators invariably turn in but one direction and wherein a reverse gearing is provided in the gear train between the actuators and the numeral wheels to provide for positive and negative directions of advance. Previously, these machines have characteristically been driven through a digital actuating phase followed by a separate tens carry phase; hence, the name polyphase has been applied thereto. In such machines the digital actuating drive and the tens carry drive have been completely separate from each other with a resultant starting and stopping of the numeral wheels at the beginning and at the end of both the digital and tens carry phases. Such an intermittent drive, occurring twice during each cycle of actuating, has resulted in wear and tear on the parts and has amplified the problems of preventing overthrow of the numeral wheels at the end of the digital actuating and tens carry phases. Furthermore, the provision for intermittent starting and stopping of the drive to the numeral wheels has resulted in extending the time required for the tens carry phase of the machine.

One advantage of the polyphase non-reversible calculating machine has been that the actuator drive gearing could be so arranged as to start the digital drive in different orders at different selected times each in accordance with the values set therein. The result is that the digital drive terminates in all orders at exactly the same time regardless of the values selected. Accordingly, a common non-overthrow pawl mechanism could be provided for the numeral wheels to prevent overthrow thereof at the end of the actuating drive. However, this arrangement is not applicable to preventing overthrow of the tens carry drive inasmuch as not all orders of the calculating machine receive a tens carry drive at the same time. Therefore, in prior art machines, separate non-overthrow preventing mechanism, if any, was required for prevention of overthrow during the tens carry phase of operation.

According to the present invention the stopping and restarting of the actuator drive train between the digital actuating and tens carry phases is entirely eliminated and in those orders where a tens carry is to occur, the digital actuating mechanism is permitted to remain engaged for a single increment of drive before disengaging the drive from the numeral wheels. Furthermore, each order of the actuating mechanism is provided with a non-overthrow preventing pawl which is rendered operative to stop the rotation of the numeral wheel associated therewith, either at the end of the digital drive, when there is no tens carry, or at the end of the tens carry drive when such drive is transmitted. The provision of the tens carry phase as an extension of the digital actuating phase results in the reduction of wear and noise due to the elimination of one stop and one start of the numeral wheels during each cycle of actuation. Furthermore, operating reliability is increased because the drive to the numeral wheels is engaged only once during each cycle regardless of whether actuation is followed by a tens carry. Finally, since the invention provides for a reduction in the number of parts and since the angle of rotation required in the tens carry phase is reduced, the number of orders of actuation in a given machine may be increased within the same physical space required for the prior art machines, i.e., a machine with the increased capacity is permitted to complete a sequential (chain carry) tens carry operation within a much shorter period of time.

It is, therefore, a main object of the invention to provide tens carry mechanism for calculating machines.

Another object is to provide an improved tens carry mechanism in which the tens carry drive is formed as an extension of the digital actuating drive.

Another object is to continuously drive the numeral wheels throughout the digital and tens carry actuating drive.

A further object is to reduce the number of parts, wear, and noise in a calculating machine.

A further object is to provide an improved digital overthrow preventing means which is required to operate only once in each operating cycle of the machine regardless of whether or not a tens carry cycle follows the digital actuating cycle.

A still further object is to provide a tens carry preparatory mechanism having two selectively set positions and in which the drive transmitting forces which create torsional forces, normally tending to move the tens carry mechanism from either one of its two set positions, merely serves to further lock the conditioning mechanism in either set position thereof.

A preferred embodiment of the invention is described below when taken in conjunction with the following drawings, given by way of example only, and in which:

FIGURE 1 is a view, partially in section, as seen from the right-hand side of the machine, showing the digital drive and tens carry actuating mechanisms;

FIGURE 2 is a right-side view, partially in section, of the main actuator drive shaft and a portion of the actuator drive mechanism;

FIGURE 3 is the same as FIGURE 1 except that the tens carry mechanism is shown in its active position;

FIGURE 4 is a plan view, partially in section, of the actuating mechanism shown in FIGURES 1 and 3, and

FIGURE 5 is an exploded view of the actuating mechanism.

A main drive shaft **1** (FIGURE 1) is supported in suitable side frames (not shown) and is rotated once in a clockwise direction either by a hand crank or by conventional cyclic clutch for each adding or subtracting operation. Shaft **1** has a keyway **4** to receive the keys **3** (FIGURE 2) of a plurality of ordinally spaced plates **2**, the arrangement being that the plates **2** rotate with shaft **1**. Each plate **2** has freely pivoted thereon, at **39** and **41** respectively, a pair of drive transmitting pawls **38** and **42**, which pawls normally stand disengaged from the internal teeth of an actuator drive gear **6** (FIGURES 1 and 5). The innermost tails of the pawls **38** and **42** stand adjacent to each other and are spring-urged in clockwise and counterclockwise fashion, respectively by a spring **40** to the extent that a contact follower pin or roller **37** carried by pawl **38** lies adjacent the working peripheries of a pair of cams **12** and **13** (FIGURE 1). Each gear **6** (FIGURE 4) is supported for a rotation about the shaft **1** by a car-

rier disk 8 which is mounted upon a hub 7. Hub 7, in turn, is freely mounted on an ordinal spacer 5.

Also mounted on spacer 5 is a bushing 12 which carries a value entry setting segment 10. The setting segment 10 is well known in the art and may be adjusted, either manually by means of an extension (not shown) projecting through the cover of the machine, or it may be set under the control of a keyboard in known fashion, such setting comprising counter-clockwise movement of a geared segment 10 by a number of increments corresponding to the value selected. The cam 12 is integrally fixed to the selection segment 10 and rotates therewith to a selectively set position. Cam 12 comprises a higher peripheral surface 12A and a lower peripheral surface 12B each of which working surfaces is concentric with the axis of shaft 1. In the initial position of the parts the pin 37 (FIGURES 2 and 1) stands upon the high periphery 12A of the cam thus holding the pawls 38 and 42 disengaged from the internal teeth of the gear 6.

The previously mentioned cam 13 comprises a pair of cam surfaces 13A and 13B and also an extension 14 (FIGURE 1) by means of which the cam 13 is controlled, during tens carry operations, to be adjusted clockwise from the position shown in FIGURE 1 to that shown in FIGURE 3. As shown in FIGURES 1 and 5, with the selection segment 10 set at zero, the high portions of cams 12 and 13 overlap each other so as to present a substantially continuous bearing surface for the pin 37 to hold the pawls 38 and 42 out of engagement from the gear 6. Assuming that the operator selects a value of 7, for example, and adjusts the gear segment 10 seven increments in a counter-clockwise direction, then the cam 12 will likewise be set by a similar number of increments in the same direction, thus creating a gap of seven increments between the ends of the high portions of cams 12 and 13. Then upon rotation of the shaft 1 and its plate 2 in a clockwise direction for one complete cycle, the pin 39, after moving two increments on the high portion 12A of cam 12, will fall to the low portion thereof thus permitting the pawls 38 and 42 to engage the internal teeth of gear 6. Continued rotation of the cam for the next seven increments will cause the gear 6 to be rotated in a clockwise direction and through the external teeth thereof to drive an intermediate gear 32 by a similar number of teeth. Gear 32 is fixed upon a cross shaft 23 and is selectively engaged by one or the other of the plus-minus gears 27 and 29. The latter two gears are freely mounted upon shafts 30 and 31 which shafts, in turn, are fixed to supporting plates (not shown) at the opposite ends thereof and which supporting plates are rocked about a pivot 48. This arrangement comprises a well-known tumbling register, and a disclosure of means for rocking the gears about the pivot 48 is believed unnecessary for an understanding of the present invention. Either one of the two gears 29 and 30 may be thought of as the numeral wheel, or alternatively, a numeral wheel gear may be meshed with one of the two gears 27 or 29 for purposes of display.

After the numeral wheel has been advanced seven increments, as described above, the pin 39 contacts the connecting shoulder 43 between the low portion 13B and high portion 13A of cam 13. At such time the pin 37 is driven outwardly with respect to the shaft 1 thus retracting the pawls 38 and 42 from the numeral wheel gear 6. The outward movement of the pin 37 (FIGURE 3) is effective through contact with a camming surface 36 of a lever 36 to drive the latter clockwise about its supporting pivot 33. A leftmost extension 35 of lever 34 is thereby driven clockwise into engagement between adjacent teeth of the previously mentioned gear 32, thus preventing overthrow of the numeral wheel and centralizing the actuator gear 6 with respect to the drive pawls. Assuming that the numeral wheels originally stood at the registration of zero, then at the end of the above described actuating operation, the numeral wheel register stands at a value of 7.

Assuming now that a value of 24 is to be added thereto, the lower order selection segment 10 will be set at a value of 4 and the adjacent higher order value selection 10 will be set a a value of 2. Further assuming that the shaft 1 is rotated as described to enter the value 24 into the calculating machine, the addition of the 4 to the 7 previously accumulated will cause a tens carry to be into the adjacent higher order, which higher order numeral wheel should then be driven to a registration of 2 rather than 1. During the rotation of the units order gear 27 through a registration of from 9 to 0, a wide tooth 26 (FIGURE 4), integral with the gear 27, contacts a tens carry tooth 24 on a tens carry element 22 associated with the adjacent higher order numeral wheel. Element 22 is freely mounted on supporting shaft 23, and the lower rightmost end thereof is forked as at 21 to receive a roller 20. The latter is mounted upon a plate 18, the plate being freely mounted upon cross shaft 17. The wide tooth 26 rocks the tooth 24 counter-clockwise and through the forked connection 21–20 rocks the plate 18 in a clockwise direction. Plate 18 carries a pin 16 which engages within a modified "S" shaped slot 15 formed within the extension 13 of the cam. Clockwise movement of the pin 16, acting upon the confines of slot 15, drives the extension 14 and cam 13 one increment in a clockwise direction from that shown in FIGURE 1 to that shown in FIGURE 3. A detent spring 19 holds the plate 18 in either adjusted position thereof.

After the higher order numeral wheel (which was digitally driven to a value of 1 in accordance with the selection previously made) has reached the end of its digital drive, the pawls 38 and 42 are not disengaged from the gear 6 due to the cam 13 having been rocked one increment clockwise. Therefore, the gear 6 is driven one more increment, corresponding to the tens carry drive, before the pin reaches the high portion of cam 13. Thus, the digital increments of drive and the single tens carry increment of drive are continuous and uninterrupted, thereby eliminating one of the faults of previously known intermittent drive machines.

It will also be observed that the cam surface 36A of lever 36 is extended in such fashion as to be actuated by the pin 37 when the latter is moved in a disengaging direction following the tens carry drive. This results in driving the lever 36 and its extension 35 clockwise into overthrow preventing relationship with the gear 32, in the same manner as previously described. Thus, a single overthrow preventing mechanism is provided in each order of the present machine for preventing overdrive of the numeral wheels either as a result of termination of digital actuation or the termination of the tens carry drive.

During subtracting operations the gear 29 (FIGURE 1) is engaged with the gear 32 and gear 29 has a wide tooth 28 fixed thereon in the same manner that the wide tooth 26 is fixed to the gear 27, the only difference being that in a subtractive direction the wide tooth 28 cooperates with tooth extension 25 of the element 22 during the passage of the gear 29 from a nine to a zero registration, in a manner well known in the art.

Since the plate 18 is held in either rocked position thereof by the detent 19, means must be provided for restoring the plate 18 and the tens carry mechanism to its initial position. For this reason the plate 2 carries a raised cam surface 2A thereon and after the tens carry operation is completed, surface 2A contacts surface 18A on plate 18 thus rocking the latter in a counter-clockwise direction back to the position shown in FIGURE 1. When the shaft reaches the position shown in FIGURE 1, all the parts are restored to the initial positions thus completing the addition of the value 24 to the value 7.

In order to eliminate torsional moments which might be created by the contact of pin 37 with the rise and fall

of the cam **13**, the respective ends **15A** and **15B** of the "S" shaped slot **15** are so formed that in the two set positions of the cam **13** the forces are absorbed by the shaft **17** through the mediacy of the pin **16** and the lever **18** without detrimental effect on the latter.

From the foregoing, it will be apparent that we have provided an improved tens carry mechanism, which mechanism not only is simpler in parts, requiring less space in the machine, and rendering the tens carry cycle more compact, but more effectively permits extension of the number or orders to which a tens carry operation may be carried out without extending the operating cycle of the machine. Furthermore, we have provided a new overthrow pawl which is operative either at the end of the tens carry cycle, or at the end of the digitation actuating cycle (in those cases where a tens carry does not occur). The provision of a simple overthrow preventing pawl permits increased operating speed of a numeral wheel drive actuating mechanism. The invention is applicable to adding machines, bookkeeping machines, etc., as well as calculating machines, and in the following claims, the term "calculating machines" is meant to cover all of such applications of the invention.

We claim:

1. In a rotary calculating machine having an ordinally arranged numeral wheel register, an actuator drive shaft, means to selectively drive said numeral wheels comprising in each order a drive gear, a selectively settable first cam having high and low surfaces thereon, a second cam also having high and low surfaces and lying adjacent said first cam, said second cam normally standing in a predetermined position, a cam follower carried by said drive shaft and spring urged to contact the high and low surfaces of said two cams during rotation of the follower relative to the cams to thereby cause an arm of said follower to engage said actuator gear and drive the same a predetermined amount; in combination with means responsive to movement of a numeral wheel through a predetermined value registration to move the second cam of an adjacent higher order by one increment whereby the drive transmitted by the follower to the numeral wheel in the adjacent higher order is equal to one digital increment.

2. A calculating machine as defined in claim **1** in which digital increments and tens carry increments are both transmitted to a numeral wheel by a common drive mechanism.

3. A calculating machine as defined in claim **1** in which the second cam comprises an extension thereon

having a modified "S" shaped cam slot cut therein; a control pin engageable in said slot and moveable by the advance of an adjacent lower order numeral wheel from a first to a second predetermined position, said pin, during said movement, moving the extension and said second cam to said second position, and the ends of said "S" shaped slot being so formed that in either one of the two operating positions of said pin torsional forces transmitted to said second cam by the follower tend to lock the pin in either set position of said slot.

4. A calculating machine as defined in claim **1** having a pawl engaging the numeral wheel drive train to prevent overthrow thereof, said pawl being operable by said drive transmitting cam follower in moving to drive disengaging position either upon conclusion of digitation without tens carry or at the conclusion of a digital drive followed by a tens carry.

5. A calculating machine as defined in claim **1** including means carried by said drive shaft and operable after a tens carry drive has been transmitted to a numeral wheel to return said pin and said second cam to the first respective positions thereof.

6. In a calculating machine having a main drive shaft, numeral wheels, and polyphase non-reversible actuators therefor, value entry mechanism comprising a first cam freely mounted for rotation about said shaft and settable from an initial zero value representative position to any one of a plurality of value representative positions 1 to 9, said cam having a high peripheral and a low peripheral working surface, said actuators each comprising an internal gear freely mounted for rotation about said shaft, a member fixed to said shaft, and carrying at least one pawl spring urged for engagement with said internal gear, a second cam mounted adjacent said first cam and having a working surface thereon, a follower contacting the working surfaces on said cams whereby with said first cam set in a value selected position the rotation of said shaft and said follower along said cams permits the pawl to engage and then disengage from the internal gear to advance the numeral wheel a selected amount, in combination with tens carry mechanism responsive to a numeral wheel passing a predetermined value registration for moving at least one of said cams of the adjacent higher order numeral wheel actuating mechanism in a direction to maintain the follower on the low periphery of said cam for transmitting an additional increment of digital movement to said higher order numeral wheel.

No references cited.

LEO SMILOW, *Primary Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,217,985 November 16, 1965

Werner M. F. Spahr et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, line 2, and in the heading to the printed specification, lines 3 and 4, for "Georg G. Denzin", each occurrence, read -- Horst G. G. Denzin --.

Signed and sealed this 27th day of September 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents