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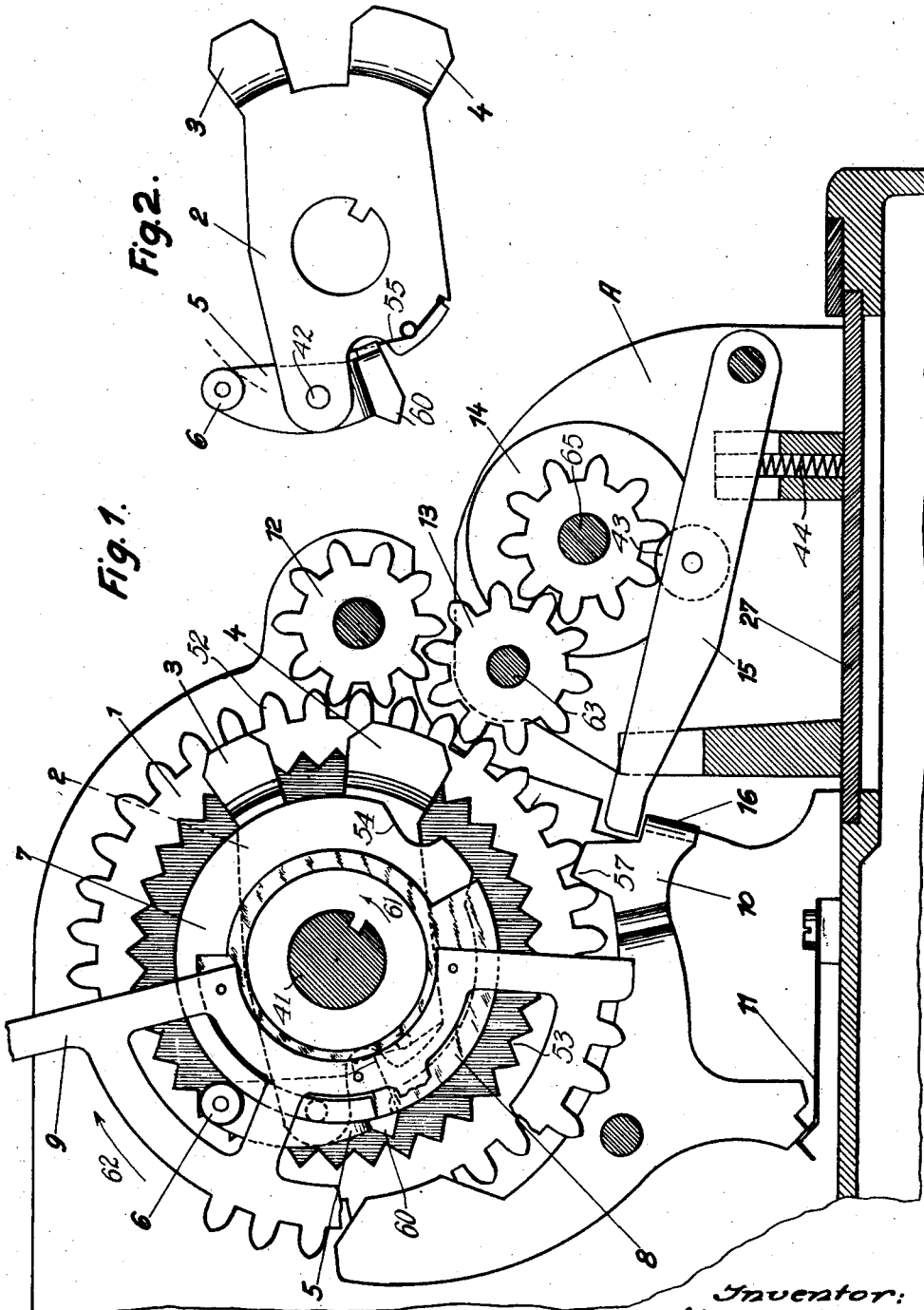
C. HAMANN

1,788,192

COMPUTING MACHINE

Filed Dec. 17, 1925

4 Sheets-Sheet 1



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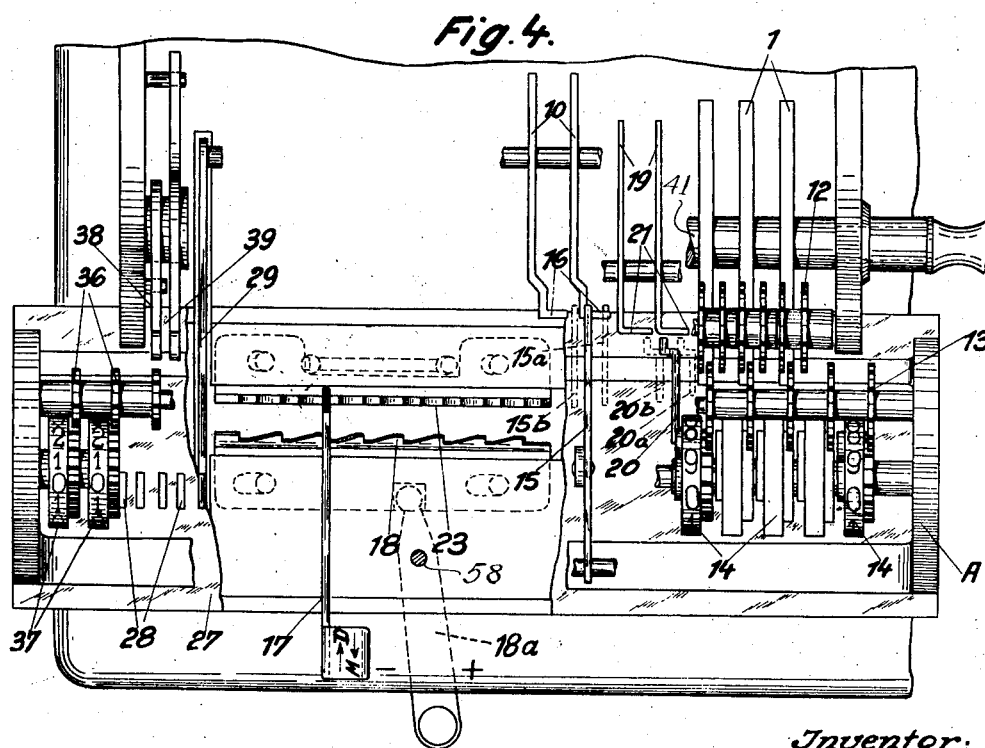
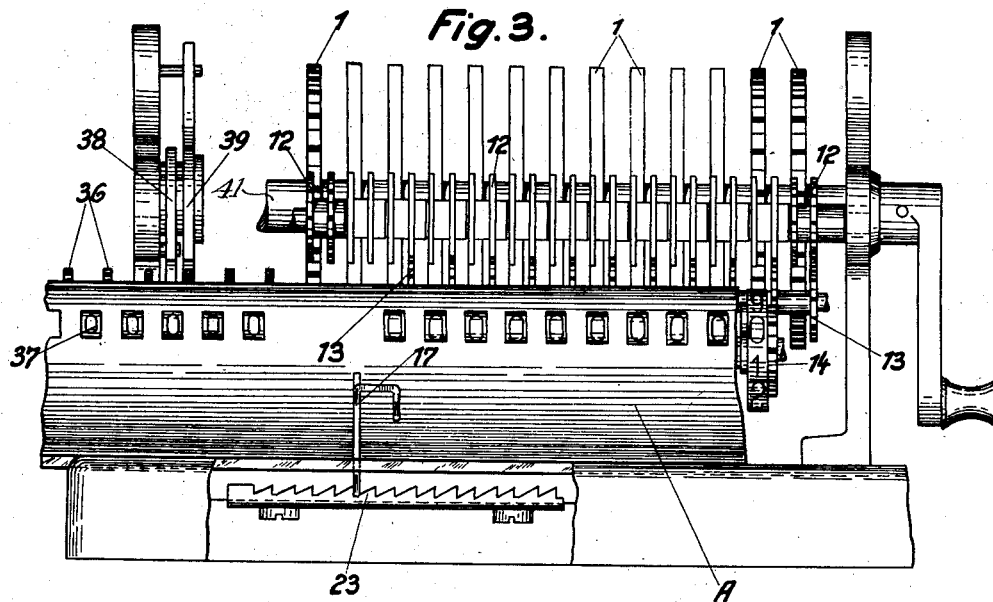
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4 Sheets-Sheet 2



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Fig. 5.

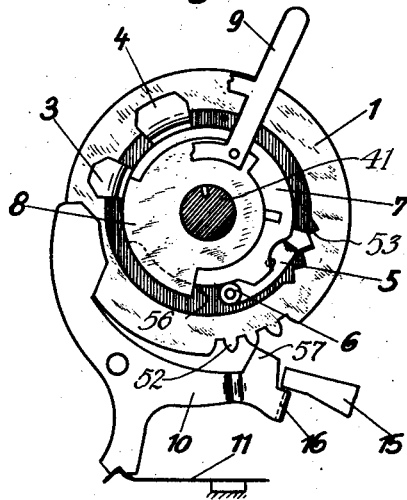


Fig. 6.

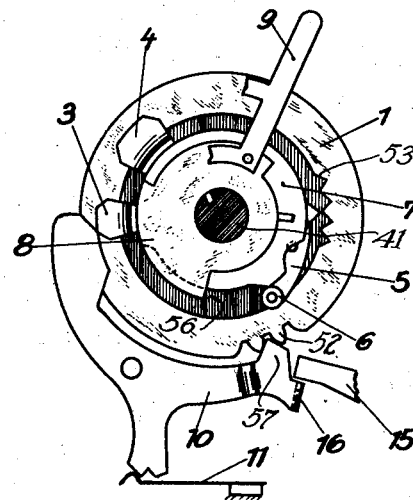
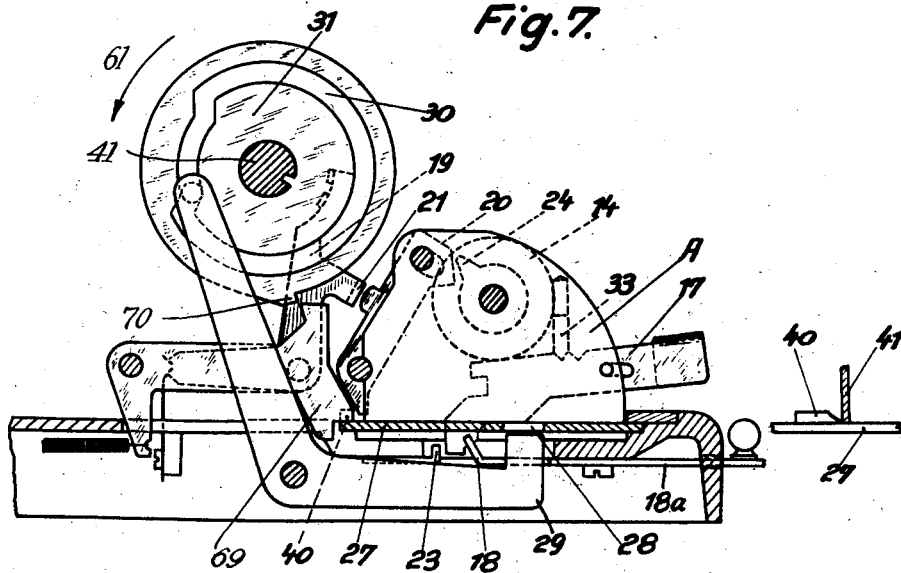


Fig. 7.



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Fig. 8.

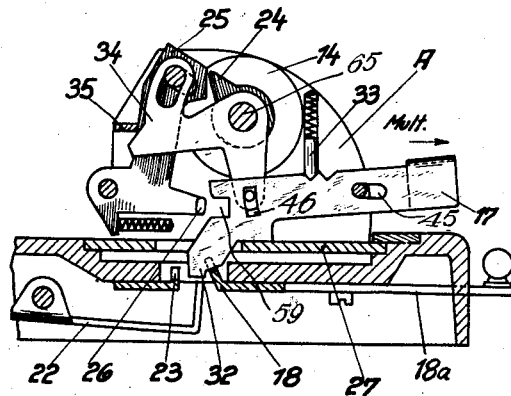


Fig. 9.

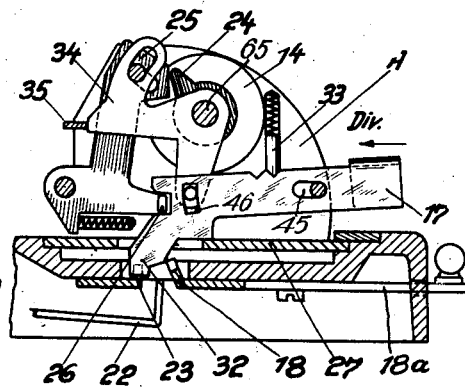


Fig. 10.

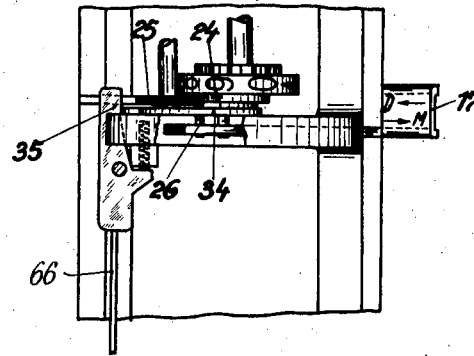
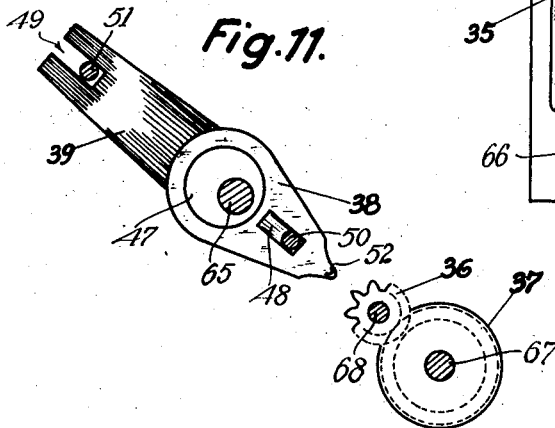


Fig. 11.



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UNITED STATES PATENT OFFICE

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COMPUTING MACHINE

Application filed December 17, 1925, Serial No. 75,948, and in Germany December 18, 1924.

My present invention relates to computing machines of the well-known type (see German Patent 384,150, issued Oct. 27, 1923) in which toothed wheels adjustable by hand are mounted on a shaft common to them which for effecting various calculations is rotated, always in the same direction, either manually by means of a crank or mechanically by an electric motor, a spring, or other suitable means. In prior machines of this kind several ratchet wheels are mounted side by side on the said drive shaft, the number of said wheels corresponding to the highest number to be used in the arithmetical operations of the machine. These wheels are rotatable loosely on the shaft and are carried along by pawls connected with the shaft. Before starting an arithmetical operation, the said wheels are, by means of individual handles or levers, and independently of each other, brought from their initial or zero positions to positions corresponding to the respective digits of the number to be set up in the machine. Thus at each complete revolution of the shaft, the respective pawls will impart to the corresponding ratchet wheels rotations through angles proportional to the relative values of the said digits. These different movements of the several ratchet wheels are transmitted to the numeral wheels of a registering train, which numeral wheels are located side by side similarly to the ratchet wheels, and are mounted on a carriage or totalizer movable in a direction parallel to the drive shaft. The movement of the carriage is employed for multiplication and division. Before beginning the computation, the dividend is set up on the numeral wheels mentioned above, and the divisor or the multiplicand respectively is set up by means of the setting levers mentioned above, which constitute the so-called key-set pawling device, whereas the multiplier does not appear visibly at any point of the machine, but determines the number of revolutions of the drive shaft in each decade position of the carriage. The product or the quotient respectively appears on additional numeral wheels of the carriage. When addition or subtraction is to be performed, the augend or

the minuend respectively is set up by means of the setting levers, and the addend or the subtrahend respectively is set up on the carriage.

In the operation of the machine, a single revolution of the drive shaft is employed for addition or subtraction, the sum or difference respectively appearing on the numeral wheels of the carriage. When multiplication is performed, the drive shaft of the machine is given, in each of the successive positions of the carriage, a number of revolutions corresponding to the respective digit of the multiplier. When performing division, the machine is caused to rotate continuously until arrested by a stop. The shifting or movement of the carriage was effected hitherto by means of a key, the drive shaft being held temporarily stationary during such shifting of the carriage. Multiplication was the only operation which, with a computing machine of a certain type, could be performed in an entirely automatic fashion by a continuous rotation of the drive shaft. As regards division, this was attended with difficulties, for the reason that the number of revolutions in each position (decade) of the registering train is not known beforehand, but is ascertained only by the operation of the machine. The person using the machine was therefore compelled to ascertain by trying, with the aid of the numeral wheels of the registering train, the number of revolutions possible in each decade position, and generally it was found necessary, at the end of each subtraction, to turn the crank in the opposite direction.

The present invention relates to improvements in computing machines of the type indicated above, which improvements enable division to be performed in an entirely automatic manner after the divisor and the dividend have been set up and after the carriage or totalizer has been moved manually to its initial position.

In the accompanying drawings, Fig. 1 is a vertical cross section of a typical example of my improved machine, showing particularly the lever-set pawling devices and the parts associated therewith; Fig. 2 is a detail face-

view of one of the pawling devices; Fig. 3 is a front elevation of the machine, with parts broken away; Fig. 4 is a plan view, with certain parts in a different position; Figs. 5 and 6 are vertical cross sections showing two different positions of the lever-set pawling device; Fig. 7 is a vertical cross section showing particularly a safety device or protective device and certain locking and shifting devices referred to hereinafter; Figs. 8 and 9 are vertical cross sections illustrating shifting arrangements for multiplication and division and a signal or warning bell associated therewith; Fig. 10 is a plan view of the parts shown in Figs. 8 and 9; and Fig. 11 is a detail elevation of a revolution counter.

The setting device of the machine (Figs. 1, 3, 5, and 6) is provided with as many ratchet wheels 1 as there are figures to the highest number which may be set up within the capacity of the machine. Each of these ratchet wheels is mounted to rotate independently of the others on a shaft 41 and is provided with external teeth 52 and internal teeth 53. The latter are adapted to be engaged by the respective pawl 5 carried by a plate 2, shown in detail in Fig. 2. It is to be understood that the teeth 52 and 53 in Figs. 5 and 6 in practice extend around the entire circumference of the wheel 1 as indicated in Fig. 1. All the plates 2 are held to rotate with the shaft 41, and each of them is provided with two ears or lugs 3 and 4 respectively. The pawls 5 are under the influence of springs 55, and are pivoted to the respective plates 2 at 42, each pawl carrying a roller 6. The lugs 3, 4 and the pawls 5 are bent in such a manner that the end or point 60 of each pawl will lie in the plane of the internal teeth 53 of the respective ratchet wheel 1, while the lugs 3, 4, will rotate in front of such plane. The shaft 41 rotates in the direction of the arrow 61. During such rotation, the roller 6 will run partly on the edge of a disk 7 secured rigidly to the frame of the machine and having a central opening for the free passage of the shaft 41, and partly on the edge of a segment 8, free to be turned on the shaft 41 by means of a setting handle or lever 9, in the direction indicated by the arrow 62. The segment 8 is thus adjusted or set in a position corresponding to the respective digit of the number to be set up on the machine. When the handle or lever 9 is brought to the zero position, the edges of the stationary disk 7 and of the segment 8 constitute together a continuous or closed track for the roller 6. A notch 54 is provided at the periphery of the disk 7 to operate a tens-carrying mechanism in any well-known or approved manner (see German Patents 384,150 page 3, lines 27 to 32 and 367,726 page 3, lines 17 to 35). When the handle or lever 9 is brought to any one of the positions corresponding to the digits from

1 to 9 inclusive, a gap 56 (Fig. 6) is formed in said continuous track owing to the fact that the edges of the disk 7 and the segment 8 become separated more or less. As soon as, during the rotation of the roller 6 with the shaft 41, such roller comes into registry with the above-mentioned gap, the spring 55 will force the roller 6 inwardly into the gap, thus swinging the pawl 5 on its fulcrum 42 to carry the end or point 60 of the pawl outwardly into engagement with the internal teeth 53 of the respective ratchet wheel 1, and from that moment on such ratchet wheel will rotate in unison with the shaft 41, for a period of time corresponding to the circumferential extent of the gap formed by the separation of the edges of the disk 7 and segment 8.

In its position of rest, the ratchet wheel 1 is locked by the tooth 57 of a pawl 10. As soon as said wheel begins to rotate, the point of the pawl engaging the wheel is forced out, and a spring 11 holds the pawl in this lifted or releasing position, see Fig. 5. After the roller 6 has cleared the gap 56, the lug 3, upon the further rotation of the plate 2, will press the locking lever 10 back to its initial position, in which it again locks the ratchet wheel 1. In this position as well, the lever 10 is held by the spring 11, see Figs. 1 and 6. The lever 10 thus prevents the ratchet wheel from being thrown or whirled beyond its proper final position. During the tens-carrying operation, the second lug, 4, performs the same functions in connection with the lever 10 as just described with respect to the lug 3. This manner of holding or securing the ratchet wheels 1 has the advantage of avoiding noise, wear, and resistance to movement, since the locking lever 10 does not drop into place tooth by tooth.

The external teeth 52 of the several ratchet wheels 1 are in permanent mesh with one of a pair of twin reversing pinions 12 (Figs. 1, 3, and 4), the other pinion of such pair being adapted to be brought into engagement, by a longitudinal movement of the totalizer carriage A, with intermediate pinions 13 mounted independently and loosely on a common shaft 63 supported on said carriage. The two pinions 12 are connected with each other so as to be operated in unison. The carriage or totalizer is provided with as many intermediate pinions 13 and numeral wheels 14 as there are figures to the highest number which may be set up within the capacity of the machine. The numeral wheels 14 are mounted independently of each other and loosely on a common shaft 65. In the addition position of the totalizer A (Fig. 4), the intermediate pinions 13 are in mesh with the external teeth 52 of the respective ratchet wheels 1, while in the subtraction position of said totalizer (Fig. 3) they mesh with one member of each pair of twin pinions 12. Each of the twin pinions 12

and each of the intermediate pinions 13 is half as thick as a ratchet wheel 1.

In the position of rest, locking levers 15 (Fig. 1) secure the numeral wheels 14 and the intermediate pinions 13, in pairs, against accidental rotation, a spring 44 urging each lever 15 upward to press a roller 43, journaled in said lever, into a tooth space of the respective numeral wheel 14. The locking lever 10 previously mentioned is provided with a bent end portion 16 adapted to support the free end of the corresponding locking lever 15. Thus the lever 10 assists in keeping the lever 15 in its locking position.

The totalizer or carriage A is connected in the well-known manner with a propelling spring (not shown) which has a permanent tendency to shift it toward the left in Figs. 3 and 4. Normally, however, movement in that direction is prevented by a stepping member or latch 17 secured to the totalizer carriage and engaging a rack 18 mounted on the frame of the machine. This rack may be moved lengthwise by means of a shifting lever 18^a fulcrumed on said frame at 58. The totalizer carriage A may thus be set in either one of two positions, so that the registering train pinions 13 will, as described above, mesh either with the ratchet wheels 1 (for addition, Fig. 4), or with the twin pinions 12 (for subtraction, Fig. 3).

When it is desired to employ the machine for multiplication, the totalizer carriage is pulled to the right manually a distance corresponding to the number of figures in the multiplier, and then released, the lever 18^a having been swung to the right, toward the + sign shown in Fig. 4, thus bringing the rack 18 to the addition position. The latch 17 will drop behind one of the teeth of said rack, and thus hold the totalizer carriage against return movement. By means of the crank shown in Fig. 3, or by other suitable means, the shaft 41 is then given a number of revolutions corresponding to the first figure of the multiplier. Then the latch 17 is temporarily lifted from the rack 18, as by moving one end of a releasing lever 22 upward against said latch (Figs. 8 and 9), said lever being provided with a key (not shown) for depressing its other end. This will momentarily release the totalizer carriage A so that under the influence of its propelling spring such carriage will jump one space toward the left, in readiness for the corresponding operation in the next decade, where the shaft 41 is given a number of revolutions corresponding to the second figure of the multiplier. The bent-up end of the releasing lever 22 is formed in the well-known manner as a rack which extends longitudinally of the totalizer. At every rise of the forward end of lever 22 and the rear end of latch 17 the latter is held in raised position by the adjacent tooth of the lever 22. As soon as the lever 22 drops, the latch 17

drops into the next space between the teeth of rack 18. In this way the totalizer is allowed to advance only by a step by step movement. By successive steps the escapement mechanism described above will bring the totalizer carriage to the proper positions for the other stages of the multiplication to be performed.

As the latch 17 is readily accessible, it may also be lifted by hand to release the carriage entirely and enable it to be adjusted manually to any desired position.

When division is to be performed, the latch 17 will co-operate with a rack 23 in substantially the same manner in which it co-operates with the rack 18 during multiplication. This rack 23 (Figs. 3, 4, 8, and 9) is mounted slidably in the frame of the machine and is constantly urged toward the right of Figs. 3 and 4 by means of a suitable spring (not shown). The rack 23 may be moved a short distance toward the left, and is provided with twice as many teeth as the rack 18, in other words, the rack 23 has two teeth for each decade. The purpose of this arrangement is to enable the totalizer carriage to be brought, in each decade, alternately into the addition position and the subtraction position. It is immaterial what position the shifting lever 18^a occupies at this time, since this lever co-operates only with the rack 18, which at that time is inactive.

For the performance of division, the latch 17 is pushed into the machine, the slot 45 (Figs. 8 and 9) being provided to permit such movement. The carriage A is then moved by hand to the extreme right, when it will be in a subtraction position. By means of the handles or levers 9, the divisor is set up, while the dividend is set up by a proper rotation of the numeral wheels 14 by hand. The shaft 41 is then rotated to effect repeatedly a subtraction of the divisor from the dividend, until the last numeral wheel 14 to the left changes from zero to 9. This indicates that the divisor has been subtracted once too often. As the said numeral wheel passes from zero to 9, a projection 24 on said wheel (Figs. 7, 8 and 9) will strike the beveled or inclined end of a lever 25 provided with a bent end 26 adapted to extend laterally into a notch 59 of the latch 17 when the latter is in the division position, Fig. 9.

When the projection 24 engages the lever 25, the latter will yield and by means of its end 26 will temporarily withdraw the latch 17 from the rack 23. The latter will then be drawn toward the right by its spring, but only the distance of one tooth, since the latch 17 will at once drop back into engagement. The carriage A will then be in the addition position, and by turning the shaft 41 the divisor, which has been subtracted once too often, will then be added in the same decade position, thus effecting the required correction. During this operation, the numeral

wheel previously referred to will go back from 9 to zero, and the projection 24 will again pass in engagement with the lever 25, but in the opposite direction; the lever, being actuated by said projection, will again move the latch 17 to release the carriage A, to allow the latter to jump (under the influence of its propelling spring) into the subtraction position of the next decade. The operations described above are then repeated in this new position, without interrupting the rotation of the shaft 41.

At the time the latch 17 is lifted as described, the shaft 41 has not yet reached its normal position. In order to avoid injury to the machine, the carriage must be prevented from jumping ahead immediately. For this purpose, the carriage base 27 which is guided in the frame of the machine, is provided with a series of slots or openings 28 (Figs. 4 and 7), the spacing of which corresponds to the distance between the teeth of the rack 23. Into these slots is adapted to project one end of a lever 29 (Fig. 7), the other end of which is controlled by a cam groove 30 in a disk 31 held to rotate with the shaft 41. In the initial position (position of rest), the lever 29 does not project into any one of the slots 28, and the cam disk 31 is in the position shown in Fig. 7. Only when the lever 29 is in this position (shaft 41 in its position of rest) can the carriage jump. The time necessary for this jump is allowed by making the cam groove 30 with a short concentric portion of smaller radius than the main portion of the groove, see Fig. 7. For the same purpose, the pawls 5 are so arranged that they can engage the internal teeth 53 of the ratchet wheels 1 only after the shaft 41 has been rotated to a certain extent from its position of rest.

In the two positions (pushed in and pulled out) which the latch 17 may assume, it is secured by a spring-pressed pin 33 (Figs. 7, 8 and 9) which also throws said latch into engagement with the teeth of the racks 18, 23. Into a transverse slot 46 of the latch 17 extends a pin projected from a bell-crank lever 34 mounted loosely on the shaft 65. The approximately horizontal member of said lever 34 has an inclined face for lifting the arm 35 (Figs. 8, 9 and 10) of the bell hammer 66 whenever the latch 17 is pushed into the machine for the purpose of division. In the other position of the latch 17 (multiplication position), the arm 35 lies in contact with the lever 25 (Fig. 8) and will therefore be actuated and cause the bell to be run, whenever the capacity of the machine is exceeded, that is, whenever the last numeral wheel to the left passes from 9 to zero. In the division position of the latch 17 (Fig. 9), the arm 35 is lifted off the lever 25 so as not to be actuated under the conditions just referred to. Thus there will be no misleading ringing of the

bell whenever a division is completed and the correction described above is made.

For registering the number of revolutions of the shaft 41, a revolution counter is provided on the carriage A in any well-known or approved manner. In the embodiment illustrated, this counter comprises numeral wheels 37 (Fig. 11) and intermediate pinions 36 adapted to mesh therewith, said wheels and pinions being mounted loosely (each independently of the other wheels or pinions) on the shafts 67 and 68 respectively. This counting mechanism is operated in one direction or the other according as addition or subtraction is being performed. The said mechanism registers the number of revolutions of the shaft 41 and therefore will indicate the quotient in the case of a division, or the multiplier in the case of a multiplication. The change from forward drive to reverse, or vice versa, is effected by means of fingers 38, 39 mounted loosely and independently of each other, upon an eccentric 47 rigid on the shaft 65. The fingers 38 constitute one-armed levers, and the fingers 39 are two-armed levers. They are provided with longitudinal slots 48 and 49 respectively into which extend stationary pins 50 and 51 respectively. Since these pins are located on opposite sides of the shaft 65, the fingers 38, 39 will perform elliptical movements in opposite directions, the points 52 of said fingers (which points are in registering position in Fig. 11, so that the point 52 of the finger 38 covers the similar point of the finger 39) will engage the corresponding pinion 36. This will move the wheels 36, 37 of the counting mechanism either forward or rearward.

At the end of a computation the latch 17 causes an additional shifting of the totalizer carriage A to the left, whereby the locking members 15 come in the position 15^b (Fig. 4), wherein they are freed from the levers 10. The numeral wheels can now be revolved by hand one complete revolution, for the purpose of zero-setting in the well known manner. In order to prevent the numeral wheels 14 from being thrown beyond the zero position, in the case of a quick zero-setting operation, there are provided levers 20 (Fig. 7) engaged by the projections 24 of the numeral wheels 14, in the zero position of a numeral wheel. In this position each lever 20 is held against accidental movement by lateral lugs 21 of levers 19, the latter yielding and permitting a yielding of the levers 20 when the shaft 41 is revolved. Fig. 4 indicates three positions 20, 20^a, 20^b of a lever 20 corresponding with the three possible positions of the associated numeral wheel.

When performing division, the shaft 41, or the crank operating it, is locked after the quotient has been fully formed on the totalizer A. This is effected in the following manner: In the above-mentioned last additional shift-

ing of the totalizer carriage A a lug 40 projecting from the carriage base 27 (Fig. 7) will pass under, and lift, one arm of a spring pressed locking lever 69, thereby bringing the upper end of such lever into the path of a lug 42 on the cam disk 31 and blocking the further rotation of the shaft 41 and of its operating crank. The operator thus becomes aware that the division has been completed.

Various modifications may be made without departing from the nature of my invention as set forth in the appended claims.

I claim:

1. In a calculating machine, the combination of a series of actuator wheels mounted on a common shaft and freely rotatable thereon, a slidable totalizer provided with numeral wheels engaging with the said actuator wheels either directly or by interposed reversing wheels, two toothed bars, a stepping member mounted on the totalizer and adapted to engage either of said bars to control the sliding movement of the totalizer, and means operable to bring the said stepping member into engagement with one of said bars when the machine is to perform addition, subtraction, or multiplication, and with the other of said bars when the machine is to perform automatic division.

2. In a calculating machine, the combination of a series of actuator wheels mounted on a common shaft and freely rotatable thereon, a slidable totalizer provided with numeral wheels engaging with the said actuator wheels either directly or by interposed reversing wheels, two toothed bars, a stepping member mounted on the totalizer and adapted to engage either of said bars to control the sliding movement of the totalizer, and means operable to bring the said stepping member into engagement with one of said bars when the machine is to perform addition, subtraction, or multiplication, and with the other of said bars when the machine is to perform automatic division, the totalizer moving by half-steps in the case of division.

3. In a calculating machine, the combination of a series of actuator wheels mounted on a common shaft and freely rotatable thereon, a slidable totalizer provided with numeral wheels engaging with the said actuator wheels either directly or by interposed reversing wheels, two toothed bars, a stepping member mounted on the totalizer and adapted to engage either of said bars to control the sliding movement of the totalizer, and means operable to bring the said stepping member into engagement with one of said bars when the machine is to perform addition, subtraction, or multiplication, and with the other of said bars when the machine is to perform automatic division, the latter bar having twice as many teeth on the same length as the other said bar and therewith

securing the totalizer when dividing, in alternate adding and subtracting positions.

4. In a calculating machine the combination of a series of actuator wheels mounted on a common shaft and freely rotatable thereon, a slidable totalizer provided with numeral wheels engaging with the said actuator wheels either directly or by interposed reversing wheels, two toothed bars, a latch key arranged on the totalizer and adapted to engage either of said bars to control the step-by-step movement of the totalizer, said latch key being shiftable by hand to bring the same into engagement with one of said bars when the machine is to perform addition, subtraction or multiplication, and with the other of said bars when the machine is to perform automatic division.

5. In a calculating machine, the combination of a series of actuator wheels mounted on a common shaft and freely rotatable thereon, a slidable totalizer provided with numeral wheels engaging with the said actuator wheels either directly or by interposed reversing wheels, two toothed bars, a latching member arranged on the totalizer and adapted to engage one of said bars to control the step-by-step movement of the totalizer, the totalizer being latched to one of said bars when the machine is to perform addition, subtraction and multiplication and to the other of said bars when it is to perform division, a shifting-lever adapted for being moved by a projection in passing the last number wheel of the totalizer from 9 to 0 (or vice versa), the said hand-shiftable latch-key being coupled in its divisional position with the last named shifting lever for being by this lever disengaged from the division-bar and for stepping the totalizer.

In testimony whereof I have affixed my signature.

CHRISTEL HAMANN.

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