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3,082,942

COMPUTING ASSEMBLY FOR CALCULATING MACHINE

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3 Sheets-Sheet 1

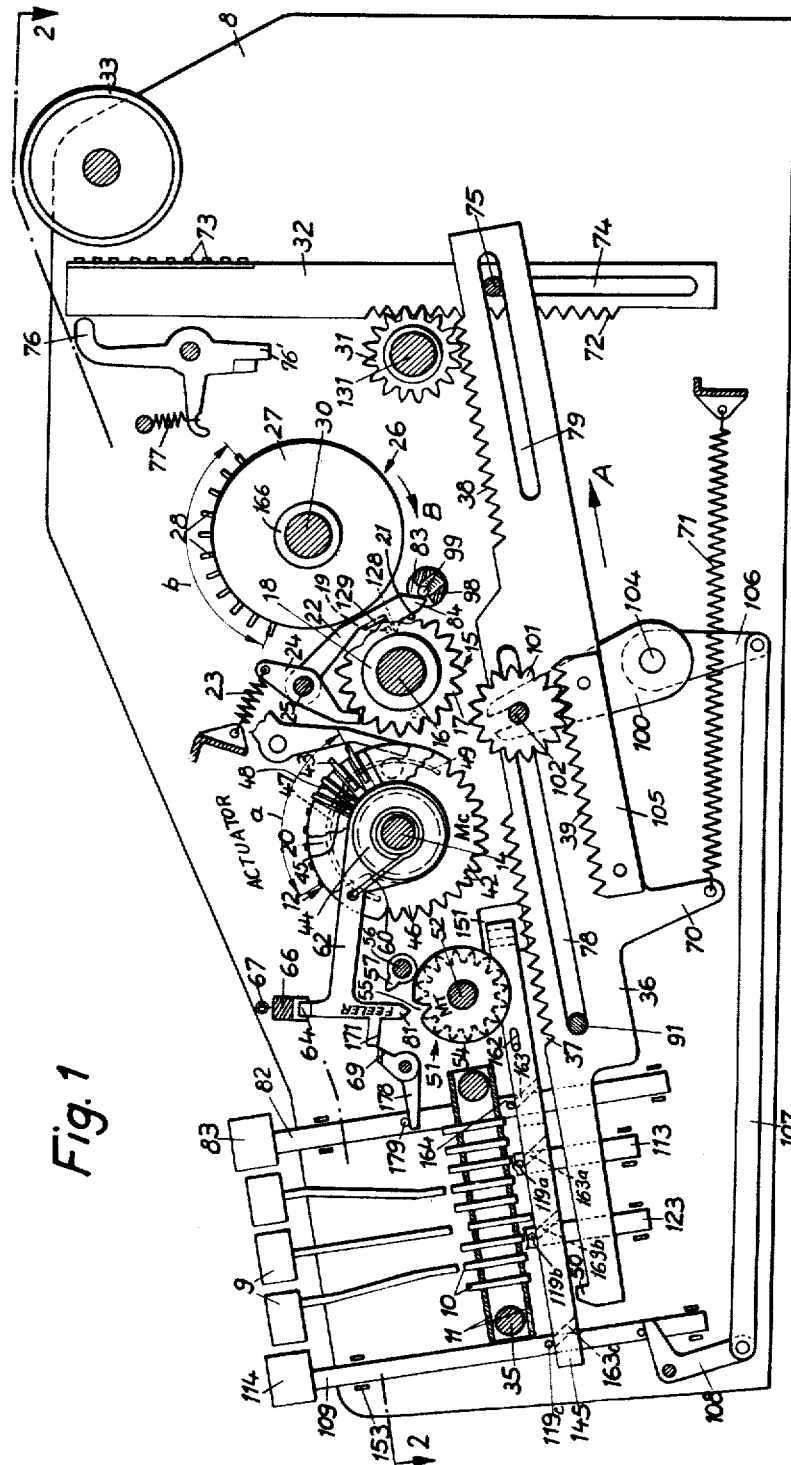
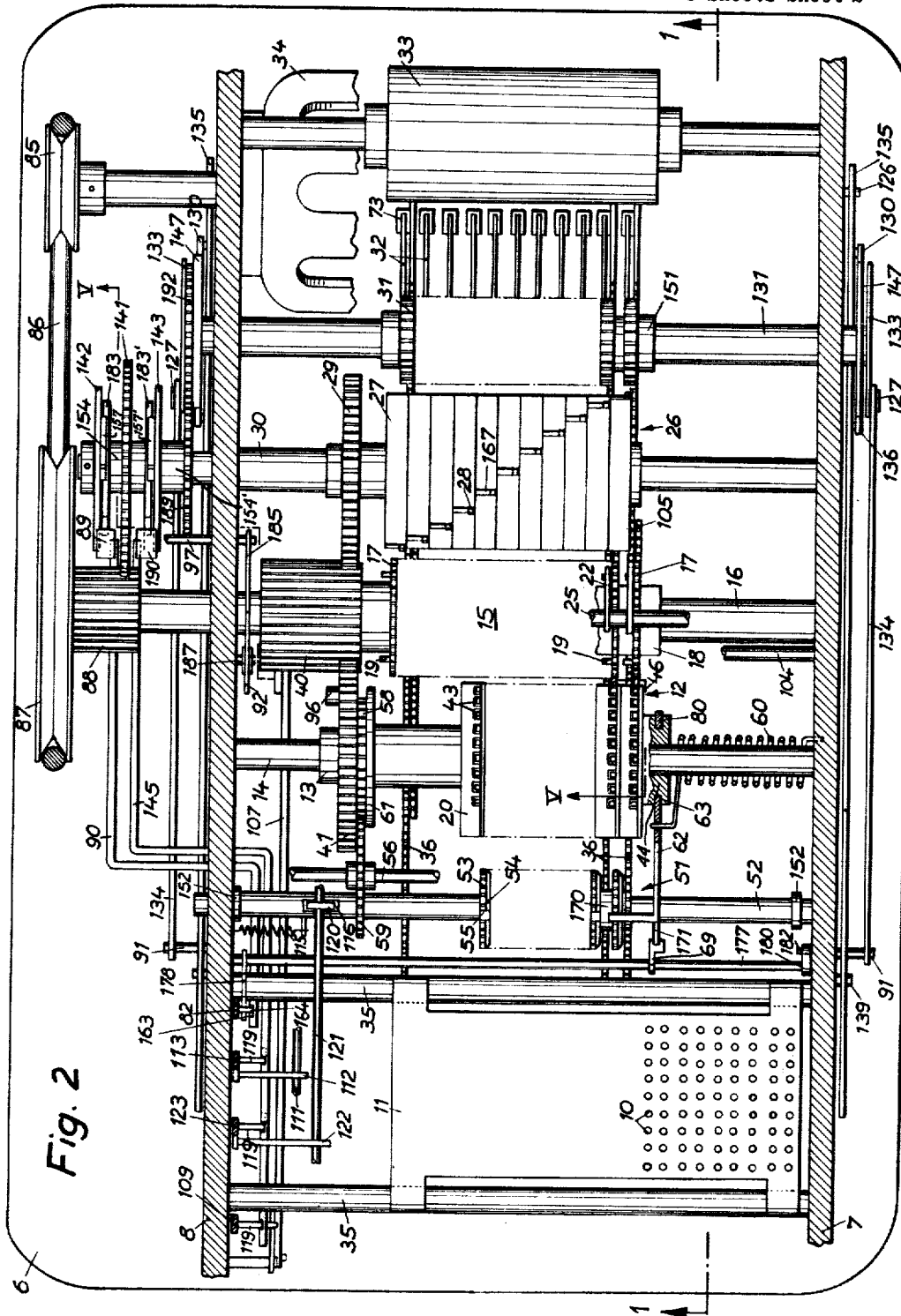


Fig. 1

COMPUTING ASSEMBLY FOR CALCULATING MACHINE

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COMPUTING ASSEMBLY FOR CALCULATING MACHINE

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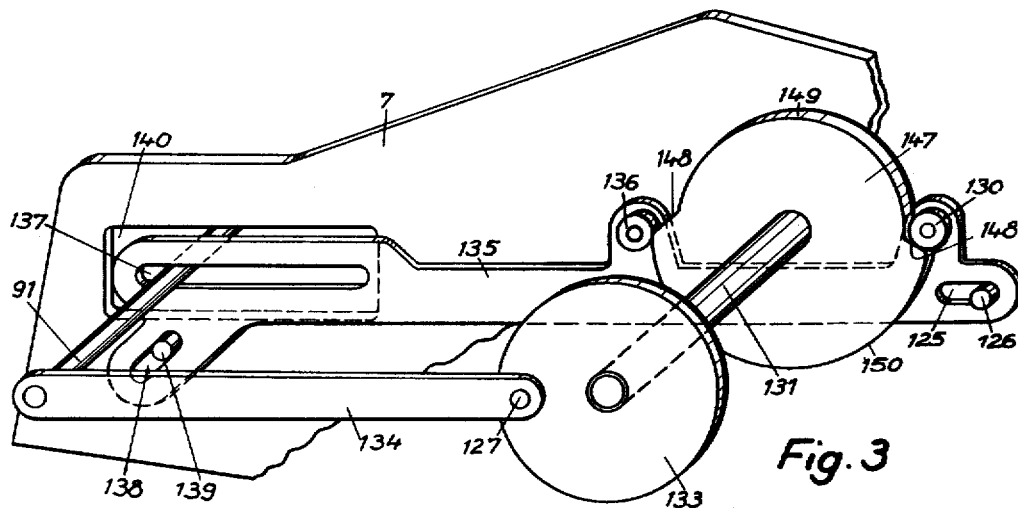


Fig. 3

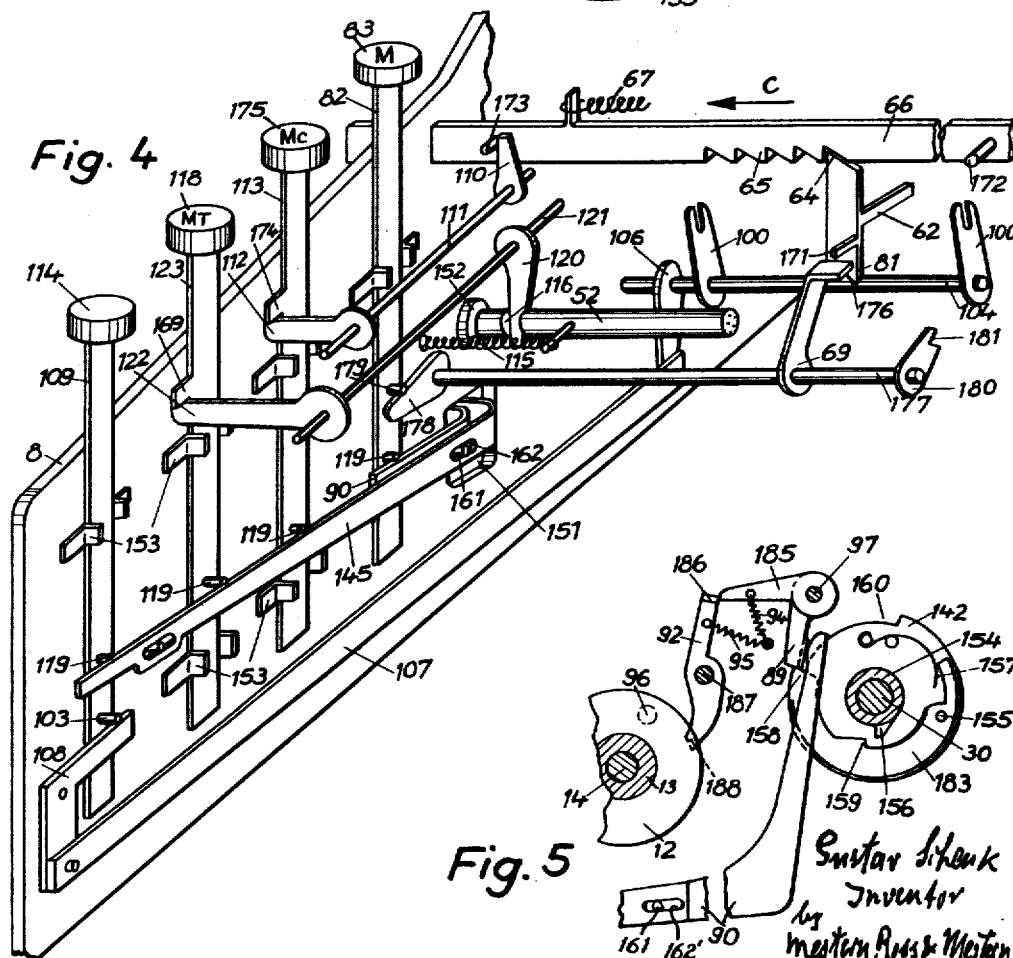


Fig. 5

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COMPUTING ASSEMBLY FOR CALCULATING MACHINE

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6 Claims. (Cl. 235-60)

This application is a continuation-in-part of my application Ser. No. 516,724, filed June 20, 1955, and now abandoned.

The invention relates to a computing assembly for a calculating machine. One object of the invention is the construction of a calculating machine with certain features which result in a high speed of operation equal or superior to that of the heretofore employed rotating computing devices adapted to carry out multiplications. Machines embodying the invention require a very small space, especially as to width of the computing assembly, so that a printing device can be attached with simple mechanical means, as in normal adding machines. Finally, they make for a very simple type of construction.

According to the invention, I provide a computing device which operates according to the principles of actuators comprising rotating pin wheels. The pin wheels may be of different design depending upon the kind of calculations. If only positive calculations are considered, the pin wheels may be provided with radially settable pins as shown in U.S. Patent No. 952,257, whereas for positive and negative calculations pin wheels with axially rocking pins may be used.

It is a further object of the invention to maintain the pin wheels of the actuator at a uniform speed over a number of operating cycles of the machine during multiplication. Therefore I prefer to transfer the selected numerical values into a register by means of actuators whose pin wheels revolve in one direction only.

It is still another object of the present invention to provide a structurally simple calculator with large capacity.

Other objects and advantages will be apparent from the following specification describing one embodiment and the accompanying drawing in which:

FIG. 1 is a vertical section through the machine according to line 1—1 in FIG. 2;

FIG. 2 is a horizontal section through the machine substantially according to line 2—2 in FIG. 1;

FIG. 3 is an exploded view of parts of the drive of the machine;

FIG. 4 is a perspective view of a control device;

FIG. 5 is a vertical section substantially according to line 5—5 in FIG. 2.

The calculator has a base plate 6 and side walls 7 and 8 rigidly connected thereto. The numbers are inserted by a keyboard having keys 9. These keys operate movable pins 10 of a pin carriage 11, which is displaceably stationary shafts 35 under the keyboard.

The pins 10 operate as stops for parallel reciprocating input racks 36 of which only three are shown in FIG. 2, and of which each is provided with three toothed sections 37, 38 and 39 and a lug 50 at its forward end operating as a stop on the pins 10. The racks 36, equal in number to the number of digits in a register 15 of the calculator, have lower extensions 70. Springs 71, secured to the extensions 70, tend to force the racks 36 in the direction of the arrow A.

A main shaft 131 is journaled in both side walls 7, 8. A sleeve 151, fixed on this shaft, carries a set of gears 31 which are journaled on the sleeve for rotation but are fixed with respect to the axial direction. Each of the gears 31 meshes with a toothed section 38 of one

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rack 36. A type bar 32 is placed adjacent to each rack 36, each type bar being provided with a toothed section 72 at its lower end and with type faces 73 at its upper end. A stationary rod 75 traverses longitudinal slots 74, provided at the lower end of the type bars, and operates as a guide for the latter. Each gear 31 simultaneously meshes with the toothed section 38 of a rack 36 and with the toothed section 72 of the adjacent type bar 32.

By the described arrangement the respective numerical positions of the racks 36 are also transferred to the type bars 32 and the calculation values can be printed onto a roller 33 by pressing the type bars. Adjacent to each of them there is provided a pivoted hammer 76 which is engaged by a spring 77 serving to press the hammer against its type bar. The hammer is provided with a depending arm 76' which may normally be engaged by a latch not shown in FIG. 1. Upon a disengagement of the latch from the hammer this latter will be pressed against the roller 33 by its spring 77.

The racks 36 are provided with longitudinal slots 78 and 79, traversed by rods 91 and 75, respectively; these rods serve to guide the racks 36. The back rod 75 is stationary, while the front rod 91 is movable in the longitudinal direction of the calculator, as well as in a direction normal to this longitudinal direction. As illustrated in FIG. 3 for the wall 7, side walls 7, 8 are respectively provided with two rectangular apertures 140 allowing the rod 91 to move in the said two directions.

To the racks 36 there are attached auxiliary racks 105 which form the toothed segments 39 designed to mesh with intermediate gears 101. These latter are journaled for free rotation on a shaft 102 which traverses the slots 78 of the racks 36. As shown by FIG. 1, the shaft 102 is guided by two forks 100, on opposite sides of the rack assembly, which are fixed on a shaft 104 pivoted in the side walls 7, 8.

A lever 106 (FIG. 4) is fixed on the shaft 104 adjacent to the side wall 8. A two-armed lever 108 is pivoted on the side wall 8, one end of a rod 107 being linked to the free end of the vertical one of the two arms while the other end of this rod is linked to the free end of the lever 106. The other arm of the lever 108 underlies a pin 103 fixed on a bar 109.

The device for moving the racks 36 consists essentially of two slides 135, which are positioned outside the side walls 7, 8. Each slide 135 supports a pair of rollers 130 and 136 engaging a cam disc 147, fixed on the main shaft 131 at diametrically opposed points of this disc. At the rear end of each slide 135 there is a guide slot 125 extending in longitudinal direction of the slide, while at the front end a guide slot 138 inclined to the longitudinal direction of the slide is provided. Pins 126 and 139, attached to the side walls 7, 8, engage these two slots and cause the front ends of the slides, when they are moved in their longitudinal direction, to carry out an up and down movement. This movement is passed on to the guide rod 91, which traverses two further slots 137 in the front ends of the slides 135 and two apertures 140 in the side walls 7, 8, and thereby it is also transmitted to racks 36. On the main shaft 131 there are also fixed two discs 133 with crank pins 127 for two crank rods 134, the front ends of the latter being connected to the guide rod 91. The cams 147 are each subdivided into two semi-circular parts 149 and 150 of different radius which are connected by intermediate sections 148. In the rest position of the main shaft 131 according to FIG. 3 the roller 130 rests on the part 149 of smaller radius, the roller 136 engaging the part 150 of larger radius. Moreover, the crank pin 127, in the rest position of the main shaft 131, occupies its outermost left-hand position, as seen in FIG. 3. Accordingly, the slides 135 and the guide rod 91 will also

take their outermost left-hand position. During one revolution of the main shaft 131 in counterclockwise direction the guide rod 91 is, on the one hand, moved back and forth in longitudinal direction by the crank rod 134. On the other hand, the guide rod 91 is quickly lifted up through the slide 135 at the beginning of this revolution of the main shaft 131 and lowered again at the end of the first half of this revolution. The movement of the guide rod 91 during one revolution of the main shaft 131 is therefore composed of the following partial movements: lifting, forward movement, lowering, and return movement. The racks 36 the front slots 73 of which are traversed by the guide rod 91, and which, owing to the coiled springs 71, tend to follow the longitudinal movement of the guide rod 91, are therefore taking part in the longitudinal movement as well as in the lifting movement. The vertical movement of the racks is most rapid at the beginning of the revolution, i.e. at the instant of engagement with other parts of the calculator, as described later.

The actuator 12 is provided for setting the result register 15 and comprises pin wheels 20, fixedly mounted on a bushing 13, and rotatable setting gears 46. In FIG. 1 part of a setting gear 46 is broken away. Each setting gear is journaled on a hub 44 of a wheel 20 and is provided with a curved camming groove comprising a section 47 of smaller radius and a section 49 of larger radius. Actuator 12 is essentially a cylindrical roller axially subdivided into zones constituted by the wheels 20. The setting gears 46 are provided with teeth 42 on part of their circumference, adapted to mesh with the toothed section 37 of the racks 36. The pin wheels 20 are provided with a series of radially extending guideways 48, which are distributed over a sector of less than 180° and in each of which a pin 43 is guided. Each pin is provided with a lug 45 engaging the groove 47, 49. The pins 43 of each pin wheel 20 normally occupy a rest position, as shown in FIG. 2, in which they engage the groove section 47 of smaller radius. By a rotation of a setting gear 46 relative to its pin wheel 20 the lugs of one or more pins are shifted from the section 47 of smaller radius to the groove section 49 of larger radius. Thereby a number of pins, depending upon the angle of rotation between a gear 46 and the adjacent pin wheel 20, are shifted to the off-normal position. In FIG. 1 only two pins are assumed to occupy this later position in which the pins project beyond the circumference of their pin wheel.

The bushing 13 is rotatably and slidably mounted on a shaft 14 secured to the side walls 7, 8. A pair of gears 41, 58 together with a disc 61 are fixed to one end (FIG. 2) of the bushing 13. The gear 41 meshes with an intermediate gear 40 which is freely rotatable on the shaft 16 and shaped as a gear cylinder. The gear 58 meshes with a further gear 59 which is held in place by the gear 41 and the disc 61. The gear 41 of the actuator 12 remains in engagement with the cylindrical intermediate gear 40 when the actuator is axially displaced. The shaft 14 supports a coiled spring 60, one end of which is fastened to the side wall 7. The other end of the spring 60 is fixed to a lever 62 and biases the bushing 13 axially toward the side wall 8. The lever 62 is provided with a ring-shaped end 80 which engages a groove 63 in the bushing 13 so that the lever 62 is freely rotatable relatively to the bushing 13. The spring 60 not only bears upon the bushing 13 but simultaneously biases the lever 62 in a counterclockwise sense as viewed in FIG. 1. The axial shifting of the actuator 12 is controlled by the lever 62, as will be described later on.

The register 15, which together with its tens-transfer device 26 forms a part of a totalizer assembly, is mounted on a shaft 16 secured to the side walls 7, 8. It is composed of gears 17 which are freely rotatable on a bushing 18 fixed on the shaft 16 and are each provided with twenty teeth and two diametrically opposite tens pins 19. The register further comprises stop pawls 24 jour-

naled on a shaft 25 which is fixed in the side walls 7, 8. The pawls 24 are pressed by springs 23 into the gaps between the teeth of the register gears 17 in order to prevent slipping of the latter at high speeds of calculation. As shown by FIG. 2, the gears 17 are arranged in the planes of the auxiliary racks 105 in which are also arranged the intermediate gears 101. The device 26 for the tens transfer comprises the tens levers 22 pivotally supported on the stationary shaft 25. To each gear 17 of the register 15 corresponds one tens lever. In FIG. 2 only two tens levers are shown.

The levers 22 are each provided with a point 84, guided in a slot 83 in a bar 98 which is fixed in the side walls 7, 8. The points 84 rest on a resiliently supported ball 99. The levers 22 are furthermore provided with a cam 128 and a projection 129, the latter extending at a right angle to the plane of the gears 17 toward the side wall 8. In the rest position illustrated in FIG. 1, the lever 22 nearest to the side wall 7 extends between the two lowest-order gears 17, as seen in FIG. 2, i.e. the gears corresponding to the units and the tens respectively, its cam 128 resting on the sleeve 18. Upon rotation of the units gear 17 by 180° in counterclockwise direction out of the zero position shown in FIG. 1, one of the two tens pins 19 will at the end of this rotation come to rest on the lower edge 21 of the cam 128 and swivel the lever 22 counterclockwise in a preparatory position for the tens transfer. The point 84 is thereby moved past the ball 99 and is afterwards held in the preparatory position by the ball.

The device 26 for the transfer of a decimal carry further comprises a series of tens discs 27, constituting a cylindrical body, which are fixed on a sleeve 166 journaled on a shaft 30. This latter is journaled in the side walls 7, 8. A gear 29 is also fixed on the sleeve 166. Each tens disc 27 supports in an axially extending slot 167, a pivoted finger 28, protruding over the circumference of its disc, which is spring-biased to the rest position shown in FIG. 2. The angular position of the discs 27 with respect to each other is such that all fingers 28 form half a turn of a helical line lying on the surface formed by the discs 27. Moreover the axial position of the discs 27 relative to the register 15 is such that upon rotation of the sleeve 166 the fingers 28, when they are in their rest positions shown in FIG. 2, pass between two adjacent gears 17 of the register 15. If, however, one or more fingers 28 are in their working positions, these fingers act as teeth lying within the orbits of the teeth of the gears 17 of the register 15.

Upon one full revolution of one of the gears 17 equaling twenty steps, each one of its two pins 19 will once strike the tens lever 22 associated with this gear, swiveling this lever counterclockwise into its working position. The units lever 22 shown in FIG. 1, associated with the lowest-order gear 17, reaches in its working position the orbit of the tens finger 28 of the lowest-order tens disc 27. If, upon rotation in the direction B (FIG. 1) of the discs 27, the tens finger 28 supported by the lowest-order tens disc 27 strikes the projection 129 of the lever 22, this finger is axially displaced in its slot 167 towards the gear 29 in FIG. 2, thereby reaching the orbit of the teeth of the tens gear 17 of the register 15. Upon further rotation of the discs 27 the tens finger 28 engages this gear momentarily, thus indexing it by one step, and is restored to normal by its biasing spring.

As can be recognized from FIG. 1, the fingers 43 of the actuator 12 are distributed over a portion corresponding to the arc *a* on the surface of the cylinder formed by the discs 20. The same applies to the fingers 28 of the device 26, which are distributed over a portion corresponding to the arc *b*. Each of these two arcs is not larger than 180°. Via the transmission formed by the gears 29, 40, 41 the actuator 12 and the tens discs 27 are so coupled with the register 15 that, upon rotation of the actuator 12 out of the position shown in FIG. 1 in clockwise direction, first all pins 43 of the actuator 12 and afterwards all fingers

28 of the device 26 will move past the register 15. During a full revolution of the actuator 12 and the discs 27, the setting of the register 15 through the actuator 12 and subsequently the described transfer of the tens from the device 26 to the register 15 takes place.

Since the units and tens transfers do not occur simultaneously but in two steps, the shifting of the actuator 12 from one denominational order or decade to the next, required in multiplications, may be effected while the actuator is continuously rotating. The subsequently described arrangement serves for the performance of this novel non-stop method of computation.

A further section of the calculator, the multiplier accumulator 51 (FIGS. 1 and 2), is supported on an axially shiftable shaft 52 mounted on the side walls 7, 8. Two collars 152 fixed to the shaft 52 limit the axial shifting range of the shaft 52. A spring 115 acting upon said shaft normally draws it into a rest position, in which the collar 152 adjacent to the side wall 8 abuts this side wall. The shaft 52 is provided with a recess 116 engaged by a lever 120. As shown diagrammatically in FIG. 4, a bar 123 with a key 118 is slidably mounted in brackets 153 at the side wall 8 and provided with a projection 169 extending across a lever 122. This lever is fixed to the front end of a shaft 121 carrying at its rear end a lever 120. The shaft 121 is rotatably mounted in the framework of the machine in a manner not shown in the drawing.

The multiplier accumulator 51 comprises a series of gears 53 which are freely rotatable on the shaft 52 and which, by intervening discs 170, are spaced to the same extent as the discs 46 of the actuator 12. To each gear 53 a cam disc 54, provided with a peripheral gap or notch 55, is fixed on the side facing the side wall 7. This notch is similar in shape to the gaps between the teeth of the gears 53 and coincides with one of these gaps.

In the rest position of the shaft 52 the gears 53 of the multiplier accumulator 51 are positioned offset from the tracks of the racks 3. For the introduction of the multiplier into the multiplier accumulator 51, the shaft 52 is to be shifted axially to align the gears 53 with the section 37 of the racks 3. This is effected by lowering the projection 169 through a depressing of button 118.

The cams 54 of the multiplier accumulator 51 cooperate with the lever 62. At its free end this lever is provided with an upper pawl 64 which may engage the teeth 65 of a rack 66. The lever 62 is further provided with a lower pawl or feeler 81 adapted to engage the notches 55 in the cams 54. Finally, the lever 62 carries an extension 171 adapted to rest on a lever 69.

The rack 66 is slidably mounted in apertures of the side walls 7, 8 of the machine. A tension spring 67 tends to shift the rack 66 towards the side wall 7 into a rest position in which a stop pin 172 comes to rest against the side wall 7. The rack 66 is provided with a further pin 173 adapted to rest on a lever 110. This latter is fixed to the rear end of a shaft 111 which is rotatably mounted in the framework of the machine in a manner not shown in the drawing and which carries at its front end a lever 112. The free end of the lever 112 lies under a projection 174 of a bar 113 provided with a key 175 and slidably mounted in guides 153 on the side wall 8.

The gears 53 normally occupy a zero position in which the notches 55 of the cam discs 54 are opposite the lower pawl 81 of the lever 62 so that this pawl may drop to a lower position by entering the notches 55. In this lower position of the lever 62, the upper pawl 64 is out of engagement with the rack 66 and the lever 62 is free to move axially. If a gear 53 is not in its zero position but in a displaced position denoting a finite digital value and the lever 62 is pushed against the cam disc 54 of this gear by the spring 69, the pawl 81, owing to its oblique face 176, will move upwardly until it reaches its upper position in which the pawl 64 engages the rack 66 so that the

actuator 12 is held against axial displacement towards the side wall 8.

The lever 69 is rigidly connected to a shaft 177 rotatably mounted in the side walls 7, 8. A further lever 178 is also rigidly connected to the shaft 177 and lies under a stop pin 179 fixed to a bar 82. The latter is slidably guided on the side wall 8 and carries a key 83. Fixed near the side wall 7 to the shaft 177 is a collar 180 having a stop pin 181. Fixed to the side wall 7 itself is a pin 182. The latter prevents the lever 69 from continuing to turn clockwise beyond the position shown in FIG. 4.

The actuator 12 normally occupies the initial position shown in FIG. 2, in which the extension 171 of the lever 62 rests against the lever 69. As a result, the upper pawl 64, under the action of the spring 60, comes to rest against the first tooth of the rack 66. So long as the key 175 is not pressed, the spring 67 keeps the rack 66 in its rest position, in which the pin 172 abuts the side wall 7. With the actuator 12 in this initial position, the gears 46 are displaced with respect to the associated racks 36 towards the side wall 7, as shown in FIG. 2.

A lug 57 is fixed on the shaft 56 which is journaled in the side walls 7, 8 and which at the same time is shiftable axially. Also fixed on the shaft 56 is the gear 59 which engages the gear 58. Both gears have an equal number of teeth so that during operation of the actuator 12 the lug 57 will revolve at the same speed as the gears 46 and the discs 20 of the actuator 12. The shaft 56 also participates in all axial displacements of the actuator 12 since the gear 59 is axially guided between the gear 41 of the actuator 12 and the disc 61. The axial position of the lug 57 on the shaft 52 is such that, with the actuator 12 and the accumulator 51 in the rest position shown in FIG. 2, the lug 57 is in the same plane as the first accumulator gear 53 nearest the side wall 7. When the shaft 56 is rotated, the lug 57 engages the first gear 53 once for each full revolution of said shaft and thus rotates this gear 53 one step.

The calculator is driven by a motor 34 having a shaft carrying a pulley 85. This pulley drives by a belt 86 a pulley 87 freely rotatable on one end of the shaft 16 which extends beyond the side wall 8. The pulley 87 drives a transmission comprising a pinion 88 and a gear 141. The latter is rigidly seated on a hub 154 which is free to rotate on the shaft 30 and which is provided at each side of the gear 141 with a stop 156. As shown in FIG. 2, there is fixed on the shaft 30 a clutch disc 142 to which, as shown in FIG. 5, an arcuate pawl 183 is pivotally connected by means of a pin 155. A flat spring 157 fixed to the clutch disc 142 acts upon one of the ends of the pawl 183 to the effect that said pawl tends to turn clockwise. The other end 158 of the pawl 183 extends as far as the outer periphery of the clutch disc 142 and forms a stop for a lever 89. On its inner side, the pawl 183 carries a dog 159 against which, with the end 158 pivoted inwards, the stop 156 comes to rest when the gear 141 rotates. The clutch disc 142 is provided at its periphery with a recess 160, one end of which also forms a stop for the lever 89.

The lever 89 is rigidly connected to a shaft 97 which is rotatably mounted in the side wall 8 and which, at its end adjacent to the inner side of the side wall 8, carries a further lever 185. A spring 94 engaging the latter tends to turn the levers 89 and 185 counterclockwise. Positioned near the free end of the lever 185 is an end 186 of a further lever 92 pivotally mounted on a bolt 187 fixed to the side wall 8. The other end 188 of lever 92 serves as a stop for a bolt 96 fixed to the gear 41 of the actuator 12. A spring 95 tends to turn the lever 92 clockwise.

To turn the escapement levers 89 and 185 in opposition to the spring 94 a slide 90 is provided. This slide has a slot 162' which is engaged by a bolt 161 fixed to the side wall 8. Said slide 90 further has a recess 163 inclined with respect to its sliding direction and adapted

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to guide a bolt 164 fixed to the bar 82. When the key 83 is depressed, the bolt 164 enters the groove 163 and cams the slide 90 to the left (FIG. 2). The doubly offset slide 90 extends through an aperture 151 in the side wall 8 and thence rises toward the lever 89. When the slide 90 is shifted by pressing the key 83, as described, its end contacting the lever 89 pivots this lever clockwise.

A second clutch disc 143 is journaled on the shaft 30 and is rigidly connected to a gear 189 by a sleeve 154'. This disc is provided with a spring 157' and a pawl 183', similar to spring 157 and pawl 183, which may be engaged by a further lever 190 journaled on the shaft 97. Reaching under the lever 190 is the upper end of a further slide 145 which is also doubly offset and which extends through the aperture 151 while having a slot 162 engaged by the bolt 161. That portion of the slide 145 that is located on the inner side of the side wall 8 extends as far as the bar 109 and, at the point of intersection with the bars 113, 123 and 109, is formed with respective recesses 163a, 163b, 163c each of which is inclined with respect to the sliding direction of the bars. The bars 109, 113 and 123 are each provided with a respective pin 119c, 119b, 119a adapted to engage the respective recesses 163c, 163b, 163a. When any one of the keys 114, 118 and 175 is depressed, the corresponding pin 119a—119c engages the recess 163a—163c located under it and moves the slide 145 to the left (FIG. 1). As a result, the portion of the slide 145 extending outside the side wall 8 engages the lever 190 and pivots it clockwise. The gear 189 meshes with a gear 192, having the same number of teeth, which is rigidly fixed to the main shaft 131 and which is arranged between the two discs 133 and 147 disposed on the outside of the side wall 8.

On the basis of the foregoing description of the driving assembly for the calculator, the action of said assembly is as follows, assuming that the motor 34 is continually running:

When either of the keys 175 and 118 is momentarily depressed, the resulting shift of the slide 145 causes the lever 190 to pivot clockwise so that this lever becomes disengaged from the clutch disc 143 and from the end 158 of the pawl 183' fixed to said disc. The spring 157' fixed on the clutch disc 143 is now able to turn the pawl 183' clockwise, with the result that the dog 159 thereof comes within the range of the associated stop 156. This stop, being driven clockwise by the motor 34, drives the clutch disc 143. When the depressed key is released, a spring, not shown in the drawing and acting upon the lever 190, turns this lever counterclockwise until it comes to rest against the periphery of the clutch disc 143. Consequently, the lever 190 also drops into the recess 160 of the clutch disc 143. Shortly before this disc completes a full revolution, the lever 190 comes up against the end 158 of the pawl 183' and turns it counterclockwise in opposition to the spring 157', so that the dog 159 is disengaged from the stop 156. As a result, the drive of the clutch disc 143 is interrupted so that the latter is arrested in the position shown for the disc 142 in FIG. 5 in which the lever 190 comes to rest against the periphery of the clutch disc both at the pawl end 158 and in a flank limiting the recess 160.

When the key 83 is depressed, the resulting shift of the slide 90 turns the lever 89 clockwise in opposition to the spring 94. As a result, this lever is disengaged from the pawl 183 so that the clutch disc 142 is caused to rotate clockwise, as above described for the clutch disc 143. The pivoting of the lever 89 also entrained the lever 185 which thus became disengaged from the end 186 of the lever 92. Under the action of the spring 95, the lever 92 turns clockwise with the result that its free end 188 moves towards the shaft 14 while its end 186 comes to lie under the lever 185, thus preventing the latter from turning counterclockwise. Accordingly, the drive of the clutch disc 142 continues until the bolt 96 on the

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gear 41 of the actuator 12 knocks against the end 188 of the lever 92, as described below. As a result, its end 186 withdraws from the range of the lever 185 so that this lever, under the action of the spring 94, can return to the rest position shown in FIG. 5. In this position, the lever 185 interrupts the drive of the clutch disc 142 and stops it, as above described for the clutch disc 143.

The operation of the calculator will be described in the following with reference to multiplication:

First the multiplicand is registered on the keyboard of the calculator. Then the key 175 is depressed, causing the rack 66 to slide to the left in opposition to the spring 67 as indicated by the arrow C in FIG. 4. Since, according to the foregoing description, before the beginning of the multiplication the actuator is connected to the rack 66 through the lever 62, the actuator also participates in the shift of the rack 66 when the key 175 is depressed. As previously mentioned, when the actuator 12 is in its initial position, the teeth of the setting discs 46 are out of line with the tracks of the racks 36. Depressing the key 175 moves the actuator 12 into line with the tracks of the racks 36, thus bringing the teeth into a position in which they can mesh with said racks. At the same time, the slide 145 causes the clutch disc 143 to perform a single full revolution in the manner described. As a result, the main shaft 131 driven via the transmission 189, 192 also performs a full revolution. Consequently, the racks 36 are lifted in the manner described and during their working stroke transmit the registered numerical values to the actuator 12 which thus serves as a multiplicand register.

Then the multiplier is entered on the keyboard and, by depression of the key 113, is transferred to the multiplier accumulator 51. For this purpose the latter has to be axially displaced into the track of the racks 36. When the key 118 is depressed, the accumulator 51 is moved by means of the lever 120 slightly towards the side wall 8 in opposition to the spring 115. As a result, the gears 53 are moved from their rest position into the plane of the section 37 of the racks 36. At the same time the slide 143 is shifted, thus causing the clutch disc 143 to perform a single revolution in the manner described. As a result, the racks 36 are lifted again and during their working stroke transmit the selected numerical values to the accumulator 51.

During the transfer of the multiplicand and the multiplier, the lever 62 is held in the first notch 65 of the rack 66 by the pawl 64, this notch corresponding to the lowest denominational order of the register 15.

Depression of the key 83 starts the multiplication proper. As previously set forth, a driving connection is established between the bar 82 of this key and the lever 69. Depression of the key 83 releases the lever 62 from lever 69 so that, by the action of the spring 60, the lower pawl 81 of the lever 62 contacts the edge of the first cam 54 of the multiplier accumulator 51. Simultaneously depression of the key 83 displaces the slide 90 and thereby lifts the lever 89. As a result, the coupling disc 142 is caused to rotate in the manner described. As it is rigidly connected to the shaft 30, the transmission comprising the gears 29, 40, 41, 58 and 59 is also driven. The gear 41, rotating clockwise as viewed in FIG. 1, drives by means of the sleeve 13 the pin wheels 20 as well as the setting gears 46 which are in resilient driving connection with said pin wheels. Since, according to FIG. 2, the pin wheels 20 and the gears 17 of the register 15 are located in the same plane by pairs, in each pair the pins 43 protruding beyond the surface of the pin wheel 20 engage one after the other the gear 17 of the register 15 and move it counterclockwise by as many steps as there are radially displaced pins 43. If during this process one of the tens pins 19 moves past the associated tens lever 22, it pivots the latter counterclockwise into the preparatory position previously mentioned. When the pin wheels 20 have rotated through the arc α (FIG. 1), all the tens

levers 22 are scanned one after the other by the fingers 28. Such of the tens levers as are in the preparatory position cause one of the fingers 28 to be displaced in axial direction, with the result that this finger comes within the track of one of the gears 17 of the register 15 and rotates the latter by one step. With this, the tens transfer is completed.

The gear 58, with which the gear 41 rotates synchronously, drives the shaft 56 counterclockwise through the gear 59. On each revolution of the shaft 56 the stepping lug 57 rotates the first gear 53 of the multiplier accumulator 51 by one division of its teeth to reduce its digital setting by one. When the zero notch 55 of the first cam 54 is positioned opposite the feeler 81 of the lever 62, the latter is pushed into this notch 55 of the cam 54 by the spring 60. Thus the upper pawl 64 of the lever 62 leaves the first notch 65, and the actuator 12 is released for axial displacement towards the side wall 8. The spring 60 now advances the actuator 12 and the lug 57 to the next-higher denominational order of the multiplier accumulator 51. This axial displacement takes place while the fingers 28 of the device 26 rotate past the gears 17 of the register 15. If a numerical value other than zero has been registered on the second gear 53 of the multiplier accumulator, the lever 62 is cammed upwardly by the inclined surface 176 (FIG. 4) of its lower pawl 81 as soon as it meets the slightly beveled edge of the cam 54 fixed to this gear and engages the next notch 65. The actuator 12 now stays in this axial position until the gear 53 associated with this order has been returned to zero by the stepping lug 57.

This sequence of operations is repeated for subsequent denominational orders until the number registered in the multiplier accumulator 51 has been canceled and the product of the multiplicand and the multiplier has been entered on the register 15. During this time, the actuator 12 has revolved without interruption.

Should there be any zeros in the multiplier and hence in the multiplier accumulator, the corresponding order steps are simply jumped by the actuator 12, since at these positions the zero notches 55 of the cams 54 face the lever 62, and the upper pawl 64 of this lever is forced into the notches 65 of only those orders which contain a multiplier digit different from zero. Here also, therefore, the rotation of the calculator is not interrupted.

After complete restoration of the multiplier accumulator 51 to its initial or zero setting, the actuator 12 has reached its left-hand end position. In this position, as previously described, the drive-stopping bolt 96 on the gear 41 contacts the lever 92, thereby arresting the rotation of the clutch disc 142.

To transmit the setting of the register 15 onto the type bars 32, the key 114 is pressed. By the ensuing shift of the slide 145 the clutch disc 143 is coupled to the motor 34 and rotates through one full revolution, thus moving the racks 36 forward and backward in the described manner. Simultaneously the forks 100 are swiveled clockwise, as viewed in FIG. 1, thereby moving the intermediate gears 101 to a position in which they mesh with the gears 17 of the register 15. During their forward movement the portions 105 of racks 36 mesh with the intermediate gears 101 while the latter also engage the gears 17 of the register 15. By the rotation thus transmitted to the gears 17, the register 15 is cleared. The setting of the type bars is transmitted to the printing roller 33 by swiveling the hammers 76 clockwise.

What I claim is:

1. In a calculator for the multiplication of a multidigit multiplicand by a multidigit multiplier, in combination:

first register means comprising a cylindrical roller rotatable about a first axis, said roller being axially subdivided into a plurality of zones assigned to respective denominational orders of a multiplicand, each of said zones being provided with peripherally spaced

projections individually displaceable thereon between an inoperative and an operative position in groups whose size depends upon the numerical value of a selected multiplicand digit;

second register means comprising a plurality of toothed digit wheels assigned to respective denominational orders of a multiplier and individually rotatable about a second axis parallel to said first axis, said wheels being provided with peripheral gaps aligned with one another in a predetermined zero position thereof, each of said wheels being rotatable from said zero position through a number of angular steps corresponding to the numerical value of a selected multiplier digit;

a totalizer assembly comprising third register means including a plurality of digit gears individually rotatable about a third axis parallel to said first and second axes, said digit gears being assigned to respective denominational orders of a result digit and being each rotatable by the operatively positioned projections of an aligned zone of said roller through a number of angular steps equaling the number of said operatively positioned projections upon each revolution of said roller about said first axis, and transfer means coupled with said digit gears for entering a denominational carry by rotating a higher-order digit gear through an additional step upon rotation of the next-lower digit gear past a predetermined angular position;

input means engageable with said first and second register means for introducing multiplicand and multiplier digits into same by operatively displacing selected numbers of said projections and rotating said digit wheels through selected numbers of angular steps; biasing means bearing upon said roller for axially displacing it relatively to said second and third register means;

feeler means coupled with said roller for axial entrainment thereby under the control of said biasing means, said feeler means upon such axial entrainment describing a path across all of said digit wheels, said gaps being in line with said path in the zero position of each digit wheel whereby a displaced digit wheel blocks the axial advance of said roller and clears said feeler only upon returning to zero position;

drive means connected with said roller for continuously rotating same about said second axis;

stepping means coupled with said roller for joint rotation at a predetermined speed ratio with periodic engagement of the teeth of a digit wheel operatively aligned with said stepping means whereby the digit wheel is progressively returned to its zero position at a rate of one angular step per revolution of said roller, said stepping means being axially entrainable by said roller for successive operative alignment with said digit wheels, said feeler means contacting any digit wheel operatively aligned with said stepping means in the course of its return to zero position whereby upon attainment of said zero position said biasing means axially advances said feeler means and said stepping means relatively to said second register means into engagement with the next displaced digit wheel with concurrent alignment of the lowest-order zone of said roller with the digit gear of said third register means having the same denominational order as said next digit wheel; and

stop means operable by said first register means in a final axial position of said roller for deactivating said drive means.

2. In a calculator for the multiplication of a multidigit multiplicand by a multidigit multiplier, in combination:

first register means comprising a cylindrical roller rotatable about a first axis, said roller being axially subdivided into a plurality of zones assigned to re-

spective denominational orders of a multiplicand, each of said zones being provided with nine peripherally spaced projections individually displaceable thereon between an inoperative and an operative position in groups whose size depends upon the numerical value of a selected multiplicand digit, said projections being distributed over a limited area of said roller spanning an arc substantially less than 360° while leaving unoccupied the remaining surface portion of said roller;

second register means comprising a plurality of toothed digit wheels assigned to respective denominational orders of a multiplier and individually rotatable about a second axis parallel to said first axis, said wheels being provided with peripheral gaps aligned with one another in a predetermined zero position thereof, each of said wheels being rotatable from said zero position through a number of angular steps corresponding to the numerical value of a selected multiplier digit;

a totalizer assembly comprising third register means including a plurality of digit gears individually rotatable about a third axis parallel to said first and second axes, said digit gears being assigned to respective denominational orders of a result digit and being each rotatable by the operatively positioned projected projections of an aligned zone of said roller through a number of angular steps equaling the number of said operatively positioned projections upon each revolution of said roller about said first axis, and transfer means coupled with said digit gears for entering a denominational carry by rotating a higher-order digit gear through an additional step upon rotation of the next-lower digit gear past a predetermined angular position;

input means engageable with said first and second register means for introducing multiplicand and multiplier digits into same by operatively displacing selected numbers of said projections and rotating said digit wheels through selected numbers of angular steps;

biasing means bearing upon said roller for axially displacing it relatively to said second and third register means;

feeler means coupled with said roller for axial entrainment thereby under the control of said biasing means, said feeler means upon such axial entrainment describing a path across all of said digit wheels, said gaps being in line with said path in the zero position of each digit wheel whereby a displaced digit wheel blocks the axial advance of said roller and clears said feeler only upon returning to zero position;

drive means connected with said roller for continuously rotating same about said second axis;

stepping means coupled with said roller for joint rotation at a predetermined speed ratio with periodic engagement of the teeth of a digit wheel operatively aligned with said stepping means during movement of said unoccupied surface portion past said third register means whereby the digit wheel is progressively returner to its zero position at a rate of one angular step per revolution of said roller, said stepping means being axially entrainable by said roller for successive operative alignment with said digit wheels, said feeler means contacting any digit wheel

operatively aligned with said stepping means in the course of its return to zero position whereby upon attainment of said zero position said biasing means axially advances said feeler means and said stepping means relatively to said second register means into engagement with the next displaced digit wheel with concurrent alignment of the lowest-order zone of said roller with the digit gear of said third register means having the same denominational order as said next digit wheel; and

stop means operable by said first register means in a final axial position of said roller for deactivating said drive means.

3. The combination according to claim 2 wherein said stepping means comprises a member rotatable at the same angular velocity as said roller, said member being provided with a single lug engageable with the teeth of an operatively aligned digit wheel.

4. The combination according to claim 2 wherein said feeler means comprises an element movable in a plane transverse to said axis and provided with a first and a second extension, said first extension being engageable with said digit wheels for clearance by said gaps in said zero position and for outward camming displacement by any digit wheel displaced from its zero position, said second register means being provided with a substantially stationary support having a plurality of recesses respectively engageable by said second extension upon outward displacement of said first extension by any of said digit wheels whereby said element is held against movement along said second axis.

5. The combination according to claim 2 wherein said first register means comprises a plurality of setting gears respectively adjoining said zones for camming displacement of a selected number of projections thereof, said input means comprising a set of racks normally disaligned with said setting gears and said digit wheels, said first and second register means being provided with manual operating means for limitedly displacing same along their axes whereby said digit wheels and said setting gears may be respectively aligned with said racks for selective rotary displacement thereby.

6. The combination according to claim 2 wherein said transfer means comprises a cylindrical body provided with a series of axially spaced and angularly staggered transfer pins normally offset from said digit gears but axially displaceable into meshing engagement therewith, said body being rotatable about a fourth axis parallel to said first, second and third axes and being connected to said drive means for rotation about said fourth axis at the same angular velocity as said roller, said third register means being provided with means including a plurality of peripherally spaced tens pins on each lower-order digit gear for axially displacing the associated transfer pins into meshing engagement with the digit gears of the next-higher order in several angular positions of said digit gears.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,082,942

March 26, 1963

Gustav Schenk

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.

Column 1, line 56, after "displaceably" insert
-- mounted on --; column 2, line 71, for "left-rand" read
-- left-hand --; column 3, line 46, for "later" read
-- latter --; column 5, lines 39 and 42, for "racks 3",
each occurrence, read -- racks 36 --; column 10, line 15, for
"asesmbly" read -- assembly --; line 49, for "predetermined"
read -- predetermined --; column 11, line 62, for "returner"
read -- returned --.

Signed and sealed this 19th day of November 1963.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

EDWIN L. REYNOLDS

Acting Commissioner of Patents