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BY A. P. C.

R. ANSCHÜTZ ET AL

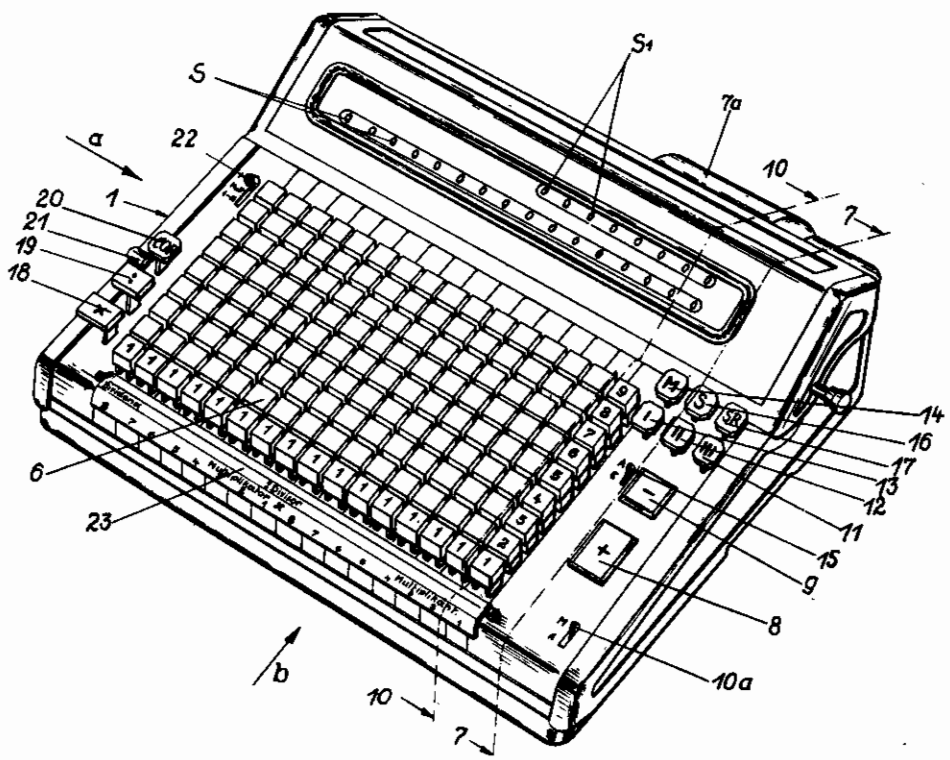
CALCULATING MACHINE

Filed July 13, 1938

Serial No.
219,078

11 Sheets-Sheet 1

Fig. 1



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11 Sheets-Sheet 2

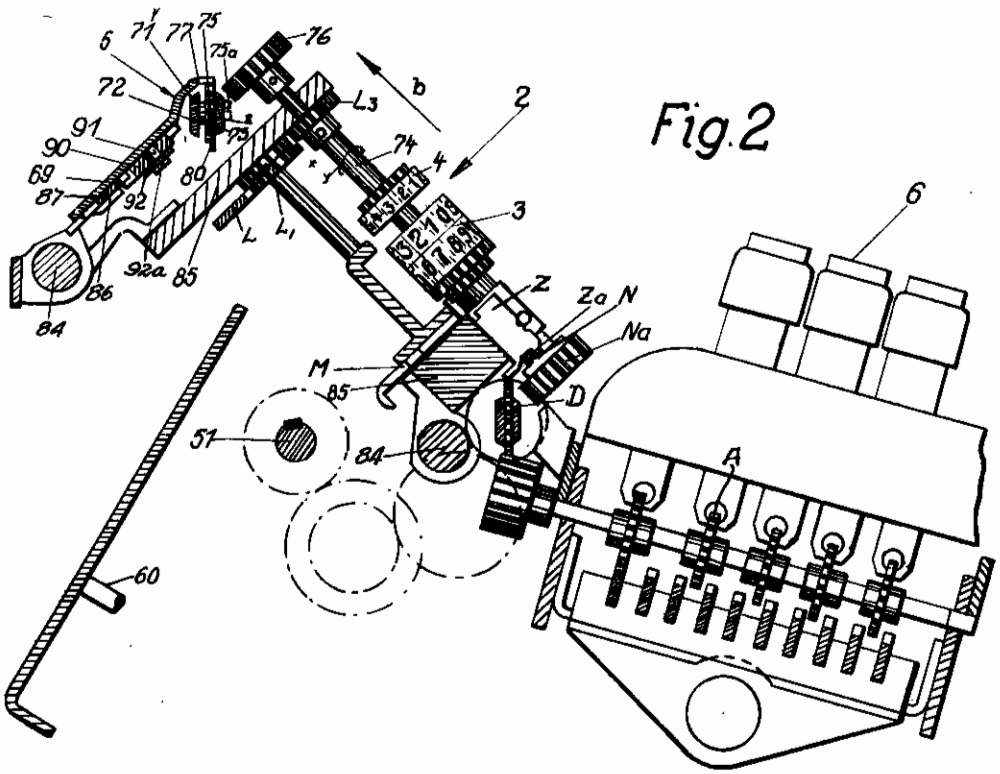

Fig. 2

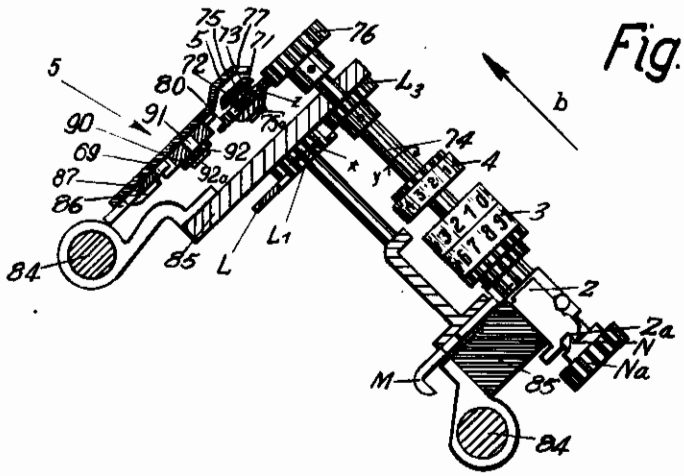

Fig. 3

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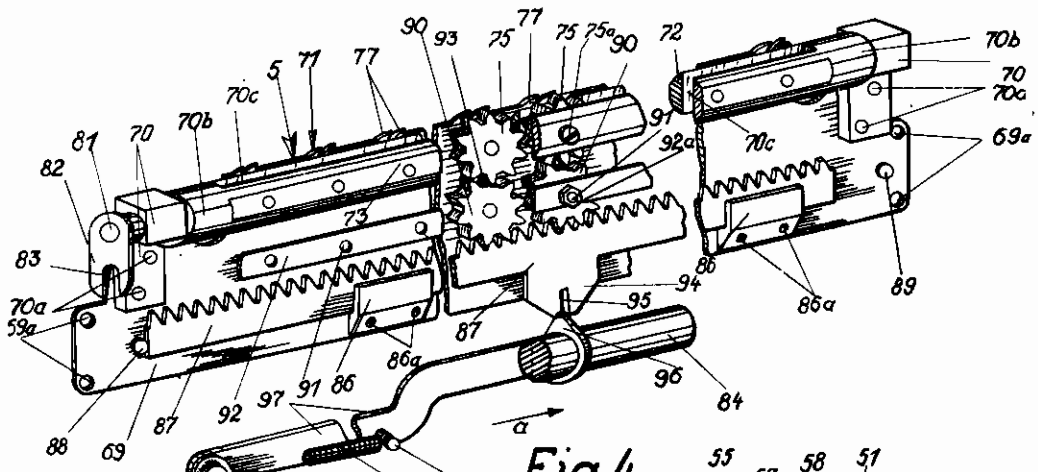

Fig. 4

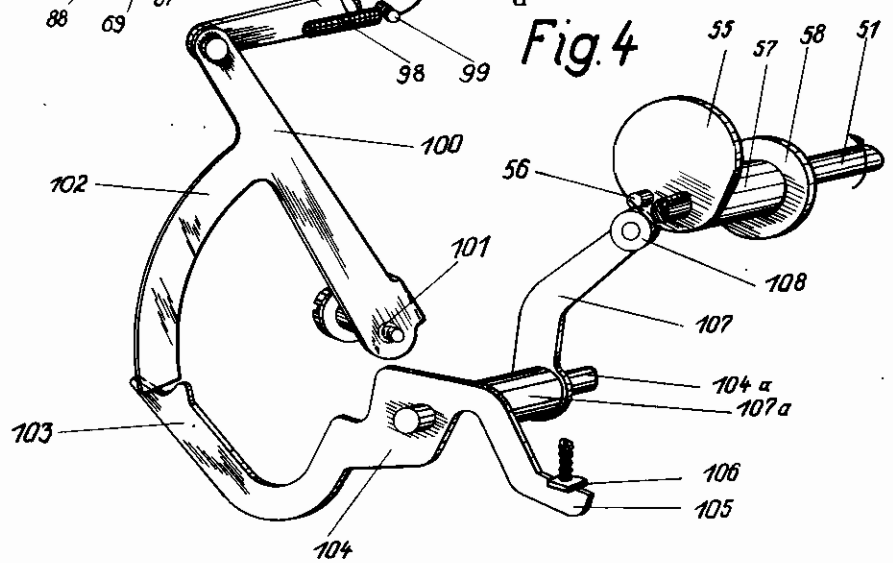

Fig. 5

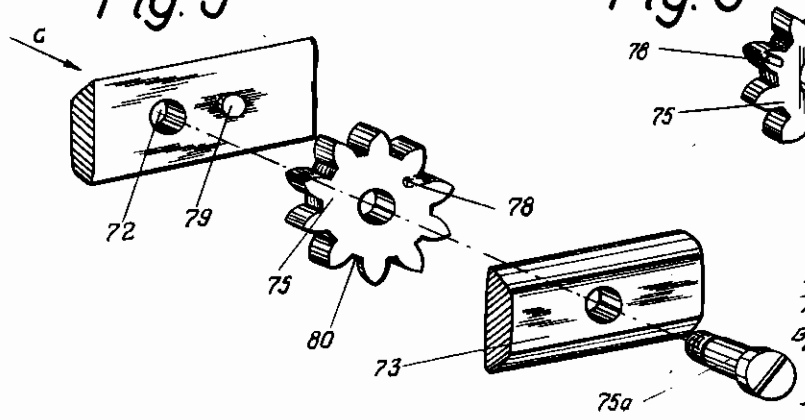

Fig. 6

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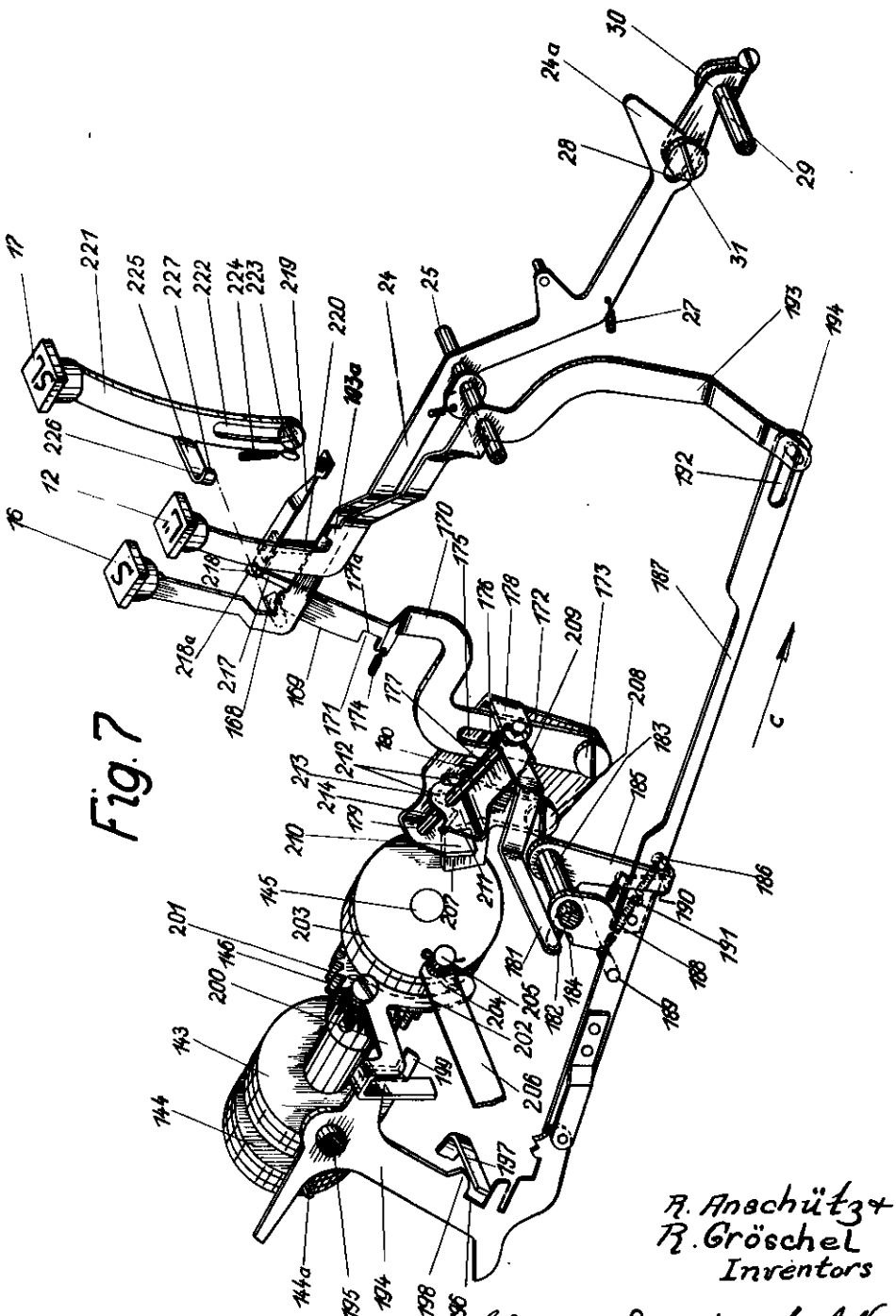

Fig. 7

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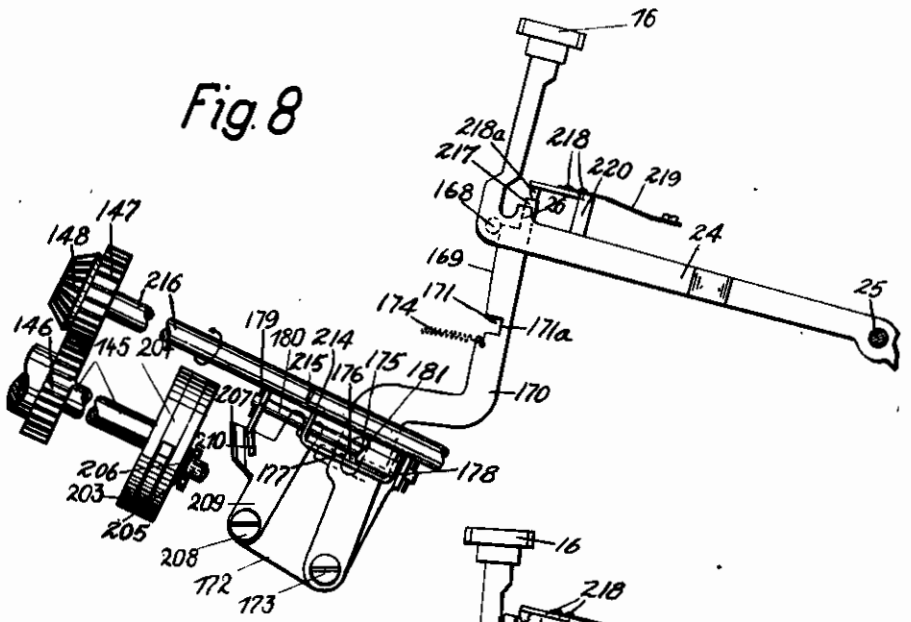
Fig. 8



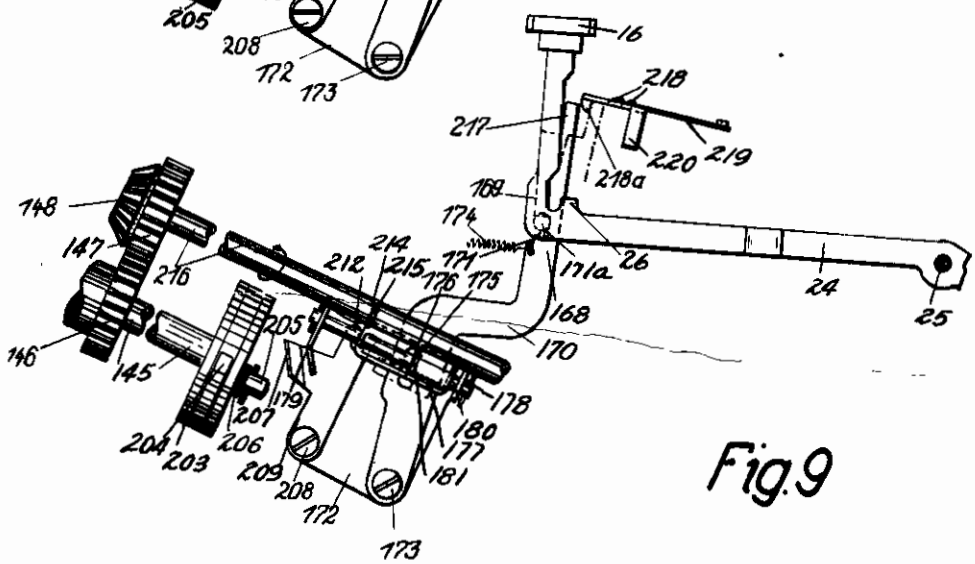


Fig. 9

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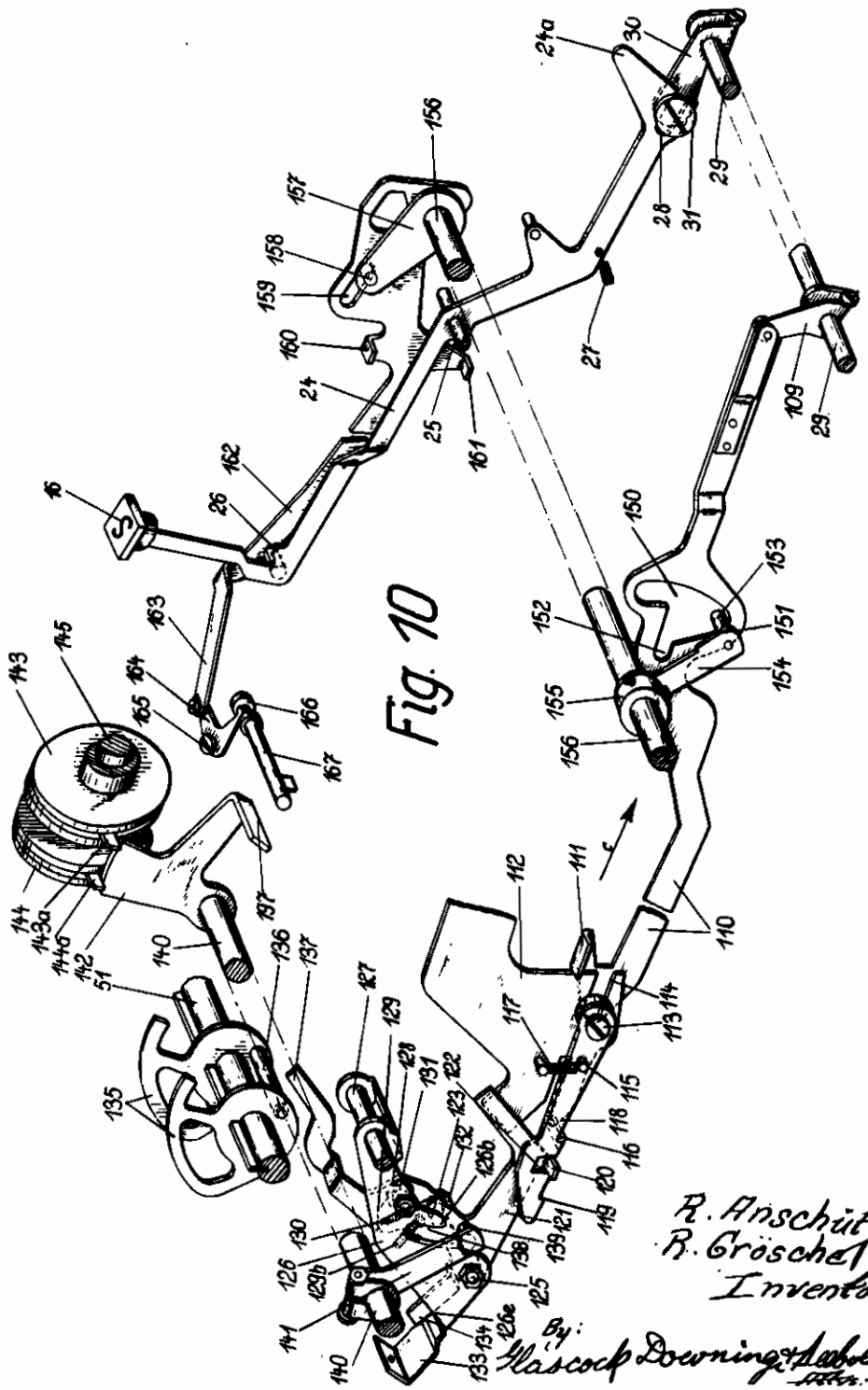

Fig. 10

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Fig. 10a

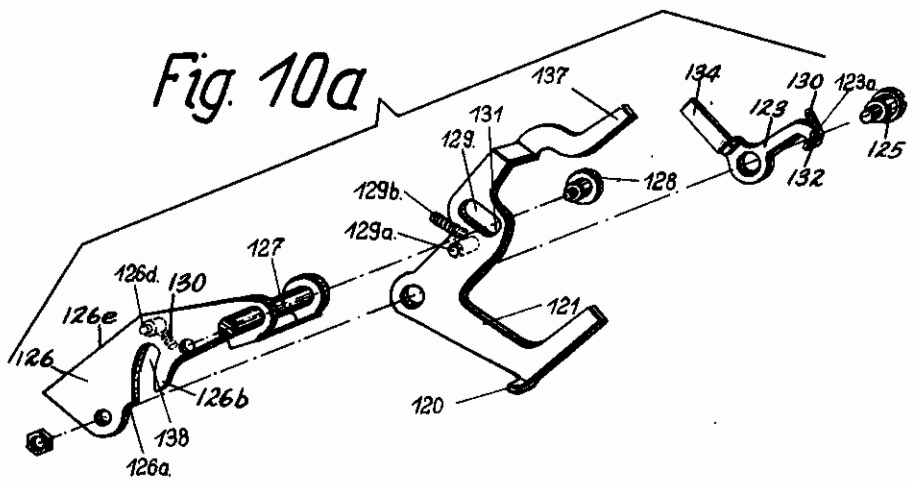

Fig. 12a

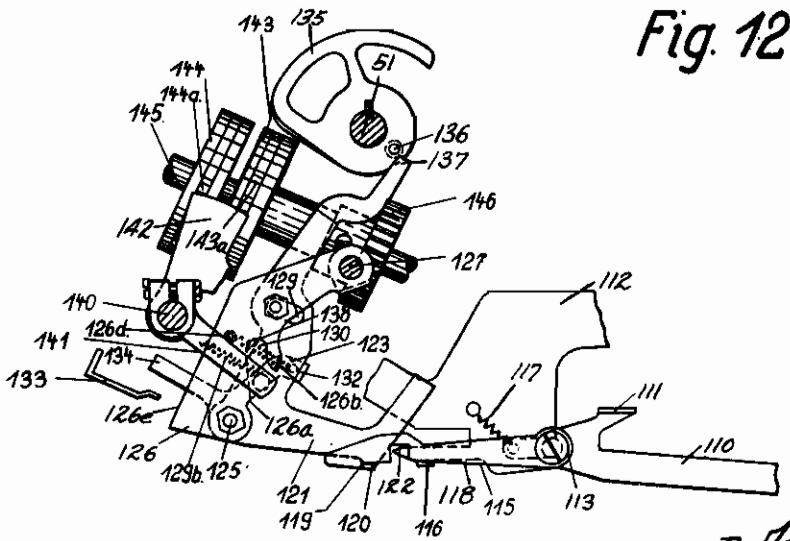

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Fig. 11

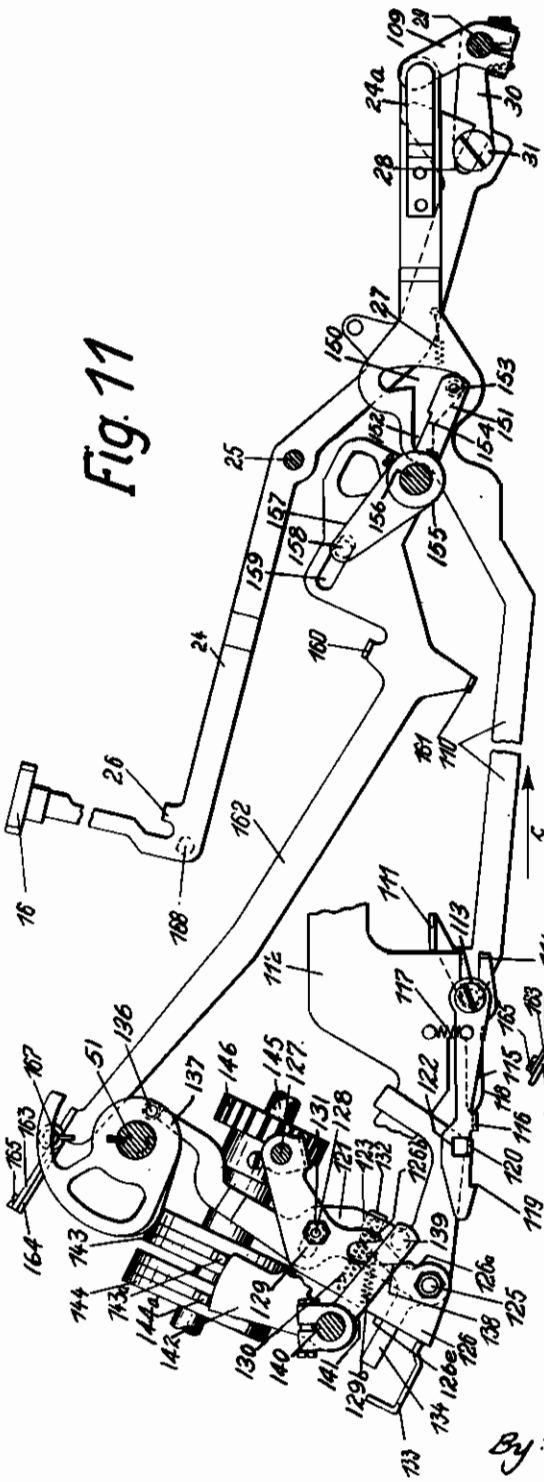
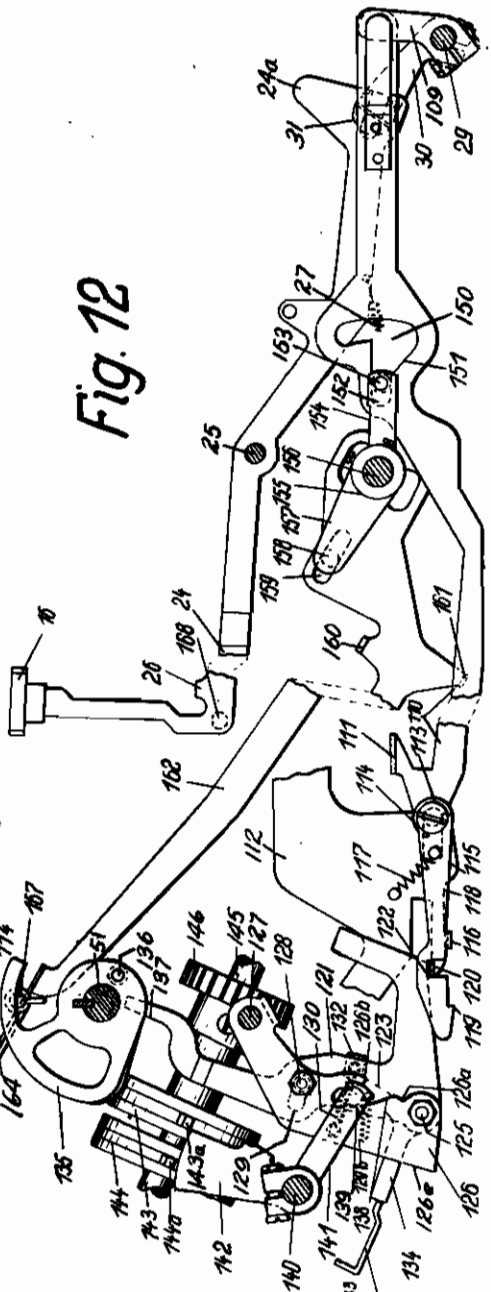


Fig. 12



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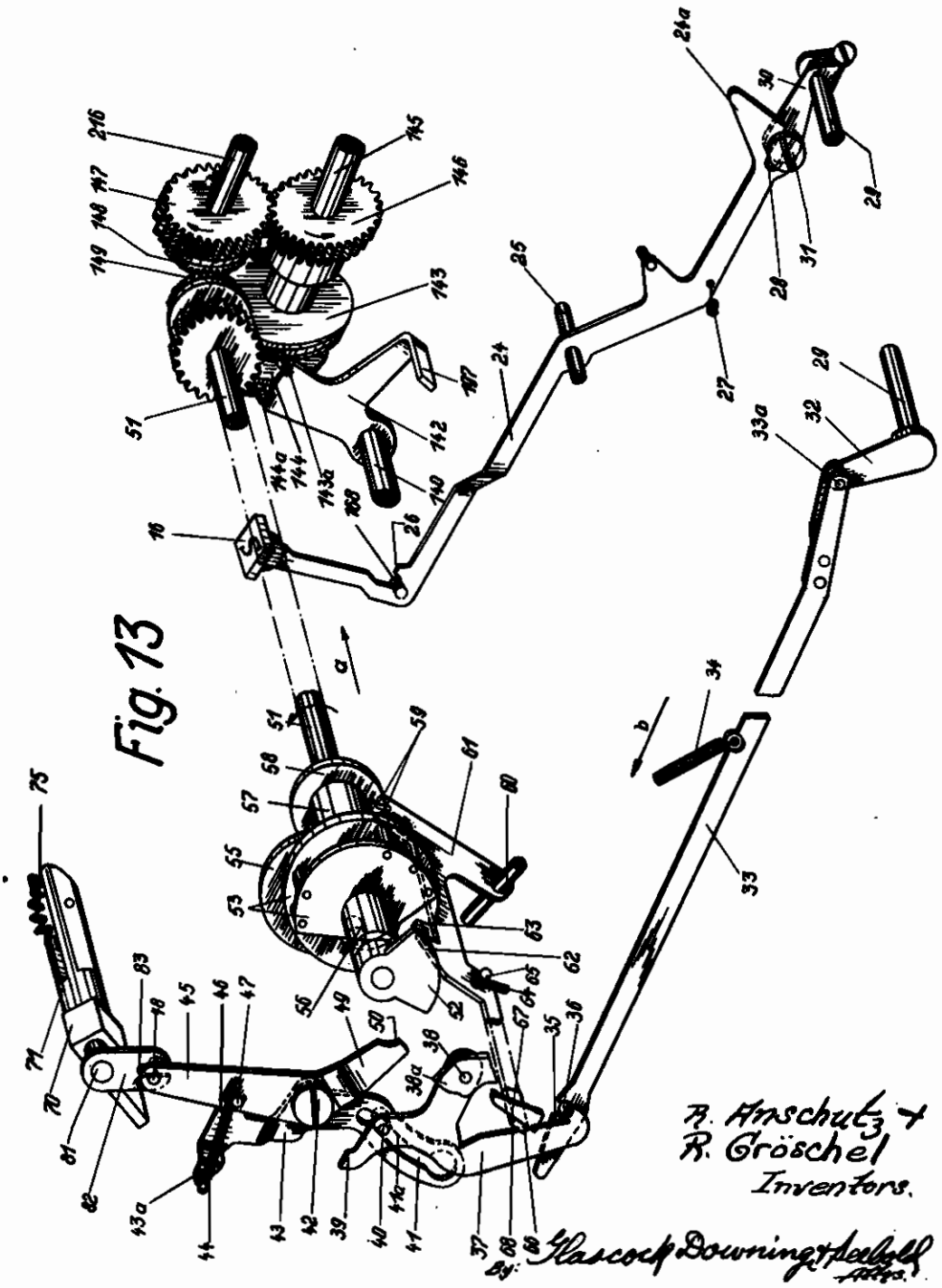

Fig. 13

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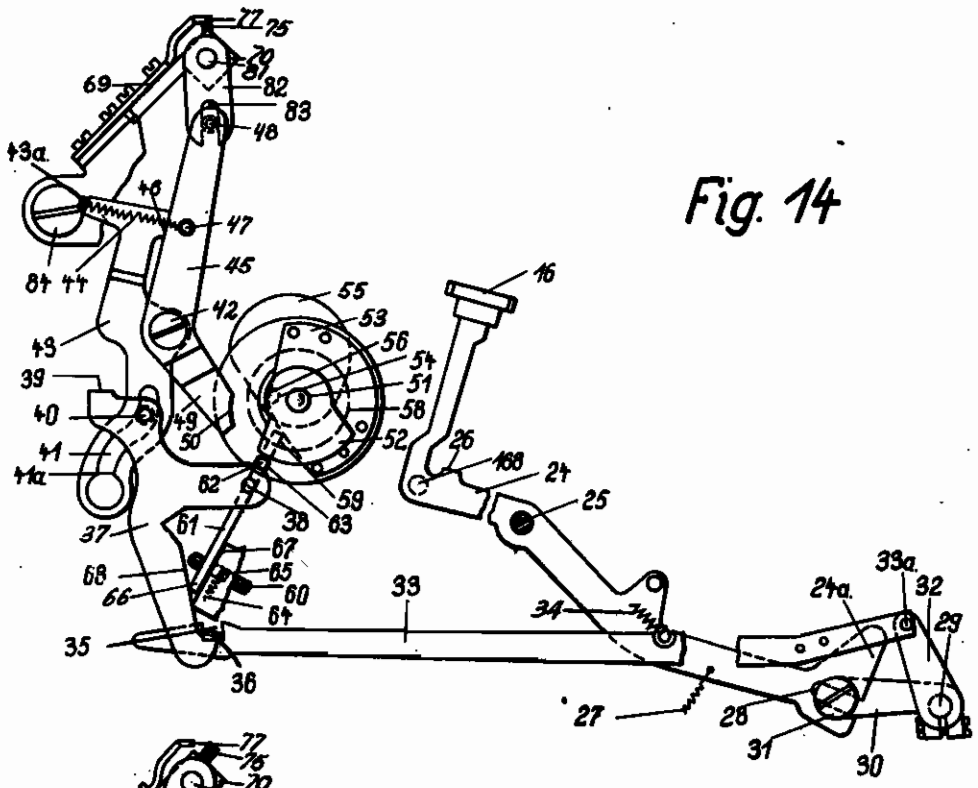

Fig. 14

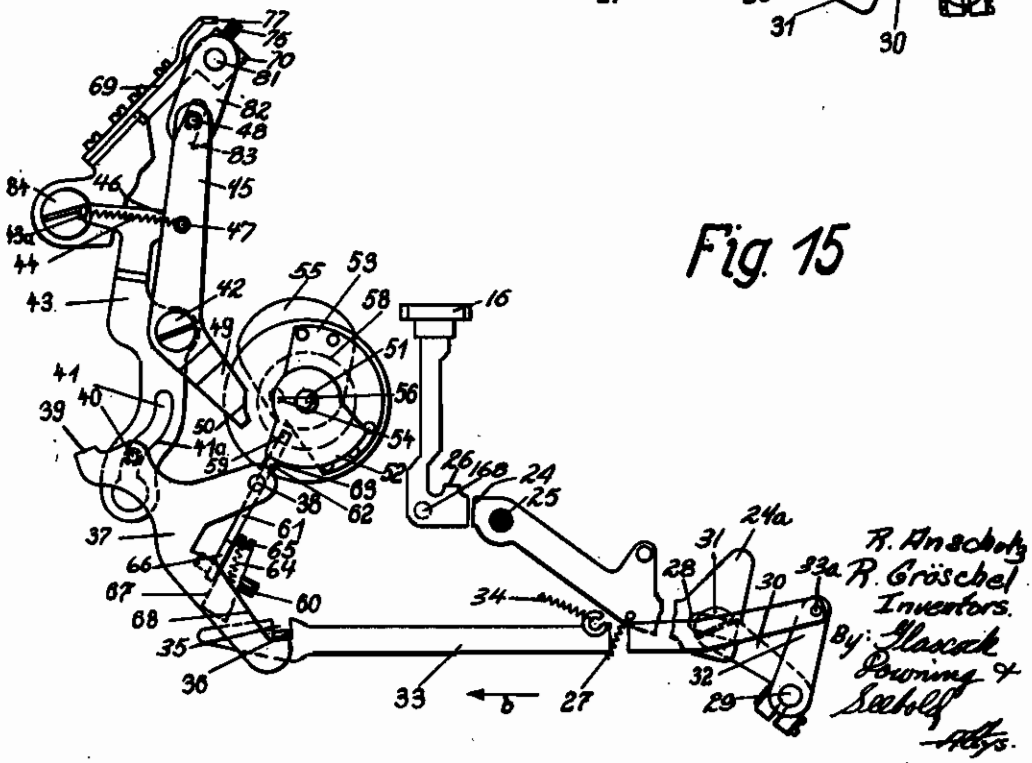

Fig. 15

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Fig. 16

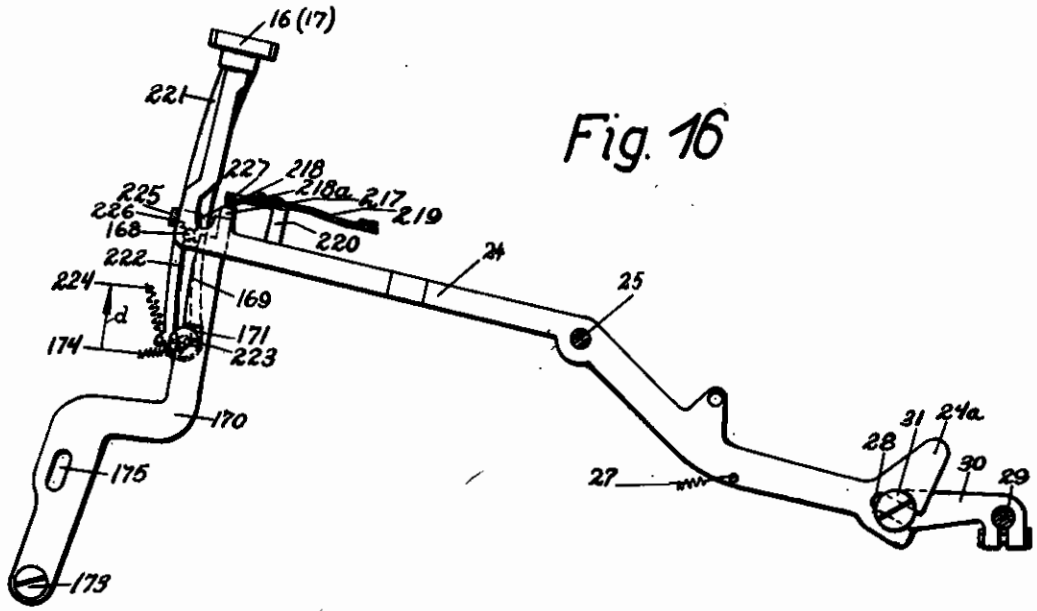
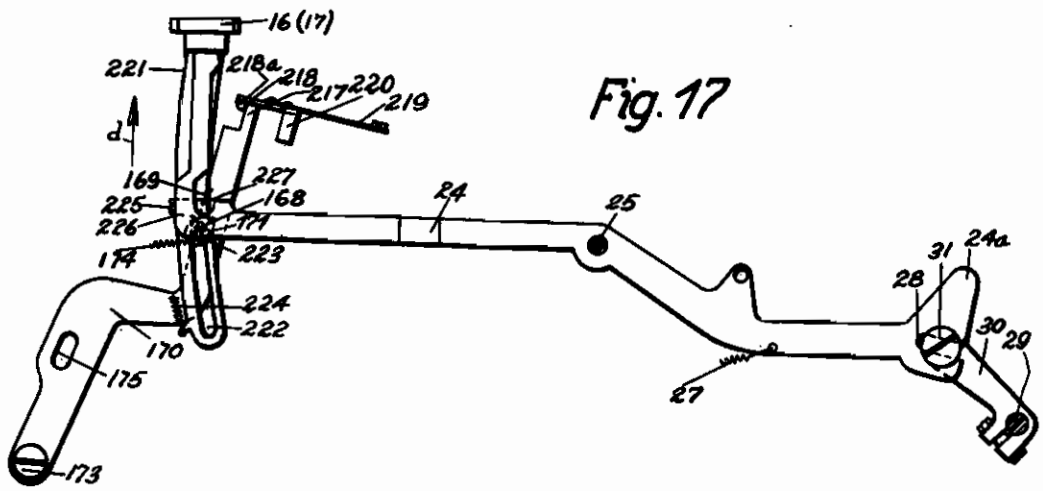


Fig. 17



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ALIEN PROPERTY CUSTODIAN

CALCULATING MACHINE

Robert Anschütz, Zella-Mehlis, Thuringia, and Richard Gröschel, Suhl, Thuringia, Germany; vested in the Alien Property Custodian

Application filed July 13, 1938

This invention relates to a calculating machine with a transfer device between at least one of the totalizers on the carriage of the machine and a value accumulator without tens transfer.

This invention is an improvement of the machine described in co-pending application Ser. No. 668,120.

In this machine, the accumulator key must be operated twice for transferring a value which is in a totalizer, to a value which is already in the value accumulator. When the accumulator key is operated for the first time, the value in the accumulator is added to the value in the totaliser and the tens transfer—if any—is effected by the tens transfer mechanism of the totaliser. The machine is then arrested and the accumulator key is operated for the second time. Upon this operation, the total obtained by the addition of the value in the totaliser and the value in the accumulator, is transferred to the accumulator.

It is the drawback of this machine that the accumulator key must be operated twice, for if the operator inadvertently does not operate it for the second time, a miscalculation will result.

This drawback is eliminated according to the invention, as follows:

Upon operation of a key which causes the operation of a transmission driving the totalisers from the value accumulator, a transmission driving the value accumulator from the totalisers is placed in readiness for action and, under the control of the first-mentioned transmission, drives the value accumulator from the totalisers.

In the accompanying drawing the invention is illustrated by way of example as adapted to a calculation machine of the type known as the "Mercedes-Euklid."

In the drawing

Fig. 1 is a perspective illustration of the machine.

Fig. 2 is a central vertical cross section, viewed in the direction of the arrow *a* in Fig. 1 and showing part of the shift mechanism of the machine, one of its totalisers, and the accumulator in its inactive position with respect to the totalisers.

Fig. 3 shows part of Fig. 2, with the accumulator in its active position with respect to the totaliser.

Fig. 4 is a perspective illustration of the accumulator and the mechanism for rotating its wheels, viewed from the front and the left.

Fig. 5 is a perspective illustration showing one of the accumulator wheels, the pin it rotates about, and the means for holding it against axial displacement.

Fig. 6 is a perspective illustration of the wheel, viewed in the direction of the arrow *c* in Fig. 5.

Fig. 7 is a section on the line 7—7 in Fig. 1.

Figs. 8 and 9 are elevations showing certain parts illustrated in Fig. 7 in their inactive and active positions, respectively.

Fig. 10 is a section on the line 10—10 in Fig. 1.

Fig. 10*a* is a perspective illustration showing certain parts illustrated in Fig. 10 remote from each other for the sake of clearness.

Figs. 11 and 12 are illustrations of the parts shown in Fig. 10, in elevation and in the inactive and active positions of the parts, respectively.

Fig. 12*a* shows certain parts illustrated in Figs. 11 and 12, in intermediate positions.

Fig. 13 is a perspective illustration of certain parts arranged at the left hand side of the machine, and viewed from the left in Fig. 1.

Figs. 14 and 15 are elevations of the parts illustrated in Fig. 13, in their inactive and active positions, respectively.

Fig. 16 is an elevation showing the value accumulator and value accumulator canceling keys in their initial positions, as viewed in the direction of the arrow *a* in Fig. 1.

Fig. 17 shows the keys depressed.

1. General description of the machine

The machine, as mentioned, is of the "Mercedes-Euklid" type. The mechanism of the machine is enclosed in a casing 1 whose elevated rear portion contains a carriage on which sixteen totalizers are arranged, and the value accumulator. The number rollers of the totalisers are read through holes S in the front wall of the elevated casing portion, and the indications of revolutions counters, also on the carriage, are read through holes S_1. A motor 7*a*, at the rear of the machine, operates its main driving shaft through a worm gear, not shown.

The machine is equipped with a key board having nine cross rows at sixteen keys 6, for introducing values through a shift mechanism. Special keys are arranged at the right and at the left of this key board. The keys at the right are: An addition key 8 (+), a subtraction key 9 (−), a key board cancellation key 11 (III), a totaliser cancellation key 12 (II); a cancellation key 13 (I) for the revolution counters, a triple multiplication key 14 (M), an accumulator key 16 (S), and an accumulator cancellation key 17 (SL). A controlling handle 16*a* for the addition and subtraction keys 6 and 9 pro-

jects from a slot in the top plate of the casing 1. When this handle is at "M," as shown, the shaft 145 of the shift mechanism rotates while one of the keys 8 or 9 is held in depressed position. When the handle is at "A," the shaft performs one revolution only upon depression of one of the keys. Another handle 15 controls the cancellation of the revolution counters during triple multiplication. Arranged at the left of the keyboard are a multiplication key 18 (×), a division key 19 (÷), and a correction key 20 (COR). A handle 21 is arranged for changing over from multiplication to division, and vice versa, and a handle 22 is arranged for interrupting the multiplication.

An inscription strip 23 is arranged in front of the key board. At its left hand end, the strip bears the inscription "Dividend" and, pitched to the right from this for seven keys, the inscription "Divider," indicating that the dividend must be introduced by depressing the keys 8 in the seven down rows at the left, and that the divider must be introduced by depressing the keys in the nine down rows at the right. At its right-hand end, it bears the inscription "Multiplicand," and, pitched eight down rows to the left, the inscription "Multiplier ×," indicating that one factor in a multiplication must be introduced by depressing the keys 6 in the eight down rows at one side of the key board, and the other factor must be introduced by depressing the keys in the eight down rows at the other side.

Referring now to Fig. 2, a carriage 2 comprising a pair of plates 85 is mounted to slide on a pair of parallel bars 84 in the elevated rear portion of the casing 1 and supports the shafts 74 of sixteen totalisers with number rollers 3, and with a revolution counter 4. A plate 69 is secured in the frame of the machine above the top plate 85 of the carriage and supports a value accumulator 71 whose pinions 75 can be moved into mesh with spur gears 76 at the upper ends of the totaliser shafts 74. The keys 6 operate a shift mechanism A.

2. The mechanism for controlling the connection of the value accumulator and the totalisers

Referring now to Figs. 13, 14, and 15, the lever 24 of the accumulator key 16 (S) at the right of the machine is mounted to swing about a fixed bar 25 secured in the frame of the machine. A spring 27 connected to that part of the key lever 24 which is at the front of its fulcrum 25 turns the lever clockwise and holds a projection 26 on the lever against a fixed abutment—not shown—in the normal position of the key 16. The front end of the key lever 24 has a projection 24*a* arranged to engage an abutment—not shown—and is slotted at 28 to engage a headed screw 31 at the free end of an arm 30 on the right-hand end of a shaft 29 which is mounted to turn in the frame of the machine. Another arm 32 is placed on the opposite end of the shaft 29 and pivotally connected to the front end of a rod 33 at 33*a*. The rear end of the rod is notched at 35 and is held against a hook 36 at the lower end of a T lever 37 by a spring 34 pulling the rod in the direction *b* and upwards at the same time. The T lever 37 is fulcrumed on a bracket 38*a* at 38 with its second arm. The upper end 39 of the third arm engages below an abutment—not shown—on the bracket 38*a* in its initial position, Fig. 14. A pin 48 on this third arm engages in a curved slot 41 in the lower end of a link 43 which is mounted to swing about a headed screw 42 in the frame of the machine. A bellcrank 45, 49 is mounted on the same headed screw and a spring 44 attached to the upper arm of the bellcrank at 47 and to the upper end of the link 43 at 43*a* pulls the arm against a projection 46 on the upper end of link 43.

A pin 48 at the free end of the upper arm 45 engages in a slot 83 in the free end of a crank 82 which is secured on a journal 81. This journal forms part of the accumulator 71 and is mounted to rotate in a bearing 78 on the plate 89.

The lower arm 49 of the bellcrank is crooked at its free end and defines a curved recess 58 for cooperation with a cam sector 52 which is keyed on the tens transfer shaft 51. The drive of the tens transfer shaft is illustrated in Fig. 13 at the right. The main driving shaft 145 which, as mentioned, is driven from the motor 7*a* through a worm gear—not shown—is equipped with a spur gear 148. A spur gear 147 on a shift-mechanism driving shaft 218 meshes with the spur gear 146, their direction of rotation being indicated by the arrows. A bevel gear 148 on the spur gear 147 meshes with a bevel gear 149 on the tens transfer shaft 51 which is rotated anti-clockwise.

A pin wheel 53, with a sector-shaped end plate at the left, and a fully circular end plate at the right, is mounted to turn freely on the tens transfer shaft 51 but held against axial displacement. The pin wheel 53 controls the totaliser coupling D, Fig. 2. A sleeve 57 is splined on the tens transfer shaft 51 at the right of the pin wheel 53 and supports a camplate 55 at the left, and a flange 59 at the right. In the position illustrated in Fig. 13, the camplate 55 is in the immediate vicinity of the pin wheel 53, and a coupling pin 56 on the camplate 55 projects into a hole 54 in the full end plate of the pin wheel 53. The pin wheel now rotates with the tens transfer shaft.

The sleeve 57 is shifted by a coupling lever 61 which is mounted to swing about a pin 60 in the machine frame. The position of this pin with respect to the carriage 2 is shown in Fig. 2. A fork 69 at the right-hand end of the coupling lever 61 engages the flange 59 on the sleeve 57 and a spring 64 which is attached to the coupling lever 61 at 95, turns the lever anti-clockwise so that it pushes the sleeve against the pin wheel 53. A tooth 62 on the coupling lever is arranged to engage in a notch 63 of the full pin wheel disk 53 and to hold the disk against rotation with the tens transfer shaft, but clears the notch in the coupling position illustrated in Fig. 13. The left-hand end of the coupling lever 61 is an extension 66 which under the pull of the spring 64 slides along the inclined edge of a member 67 which is fixed the machine frame, until it is arrested by the edge 68 of the T lever 37. This is the initial position of the coupling lever.

When the accumulator key 16 is depressed for accumulating a value in the accumulator 71, its type lever 24 is swung anticlockwise until its projection 24*a* is arrested by the aforesaid abutment—not shown—the shaft 29 and its arms 30 and 32 are turned clockwise, and the rod 33 is pushed against the direction of arrow *b*. Through the notch 35 in the rod and the hook 36 on the T lever 37, the latter is swung anti-clockwise and its pin 40 acts on the edge 41*a* of the slot 41 in the link 43, turning the link anti-clockwise. The spring 44 turns the upper arm

of the bellcrank 45, 49 which, as described, is mounted to swing on the headed screw 42 with the link 43, anti-clockwise. This, through the pin 48 at the upper end of the arm 45, and the slot 83 in the crank 82, moves the accumulator 71 from its inactive position, Fig. 2, into its active position, Fig. 3.

The swinging of the upper arm 45 of the bellcrank in anti-clockwise direction moves the lower arm 49 with its recess 58 into the path of the sector 52. The T lever 37 when turned anti-clockwise raises the extension 66 of the coupling lever 61 by its edge 68 and turns the coupling lever clockwise. This causes the tooth 62 to engage in the notch 63 in the full end plate of the pin wheel 53 so that the pin wheel is now held against rotation, while at the same time the fork 65 shifts the sleeve 57 on the shaft 51 in the direction of the arrow *a* in Fig. 13. This moves the coupling pin 56 out of the hole in the full end plate of the pin wheel 53 so that the tens transfer shaft 51 rotates without being interfered with by the arrested pin disk 53. When the tens transfer shaft has turned through about two thirds of a complete revolution, its sector 52 strikes the recessed lower arm 49 of the bellcrank and turns the bellcrank clockwise against spring 44. The crank 82 is now turned anti-clockwise and moves the accumulator 71 into its inactive position, Fig. 2. This condition continues while the sector 52 slides over the recessed portion 60 of the lower bellcrank arm 49. When the sector has moved off the recess, the spring 44 returns the parts into their initial positions, Fig. 14, and the accumulator 71 is moved into active position again. When the accumulator key 16 is released, the members connected to it also return into their initial position, as shown in Fig. 14.

3. *The accumulator*

Referring now to Fig. 4, the plate 69 is secured to the frame of the machine at the rear by screws inserted in holes 69*a* in opposite ends of the plate. The bearing 70 for the journal 91 at the left has already been referred to, and a similar bearing is provided for the journal at the other end of the accumulator 71. The two bearings 70 are made with plates for securing them to the plate 69 by screws 70*a*. The accumulator shaft 70*b* is solid only at both ends where the journals are and otherwise consists of two parallel bars 72 and 73, with a milled slot between them. The outer faces of the bars are flattened, as best seen in Fig. 5. Sixteen accumulator wheels 75 are mounted to rotate on the shanks of headed screws 75*a* between the bars 72 and 73. A zero stop 78, Fig. 6, projects from the rear face of each wheel 75 and a check 79 is provided on the inner side of the rear bar 72 for cooperation with the zero stop. One tooth of each wheel 75 is cut away for half its depth to form a zero gap 80, Fig. 6. The zero stop 78 and the check 79 define the zero position of the accumulator wheels, the stop abutting against the check from above as the corresponding wheel 75 rotates in the direction of the arrow in Fig. 4. The stop and the check also prevent overthrowing of the wheels 75.

The upper portion of the plate 69 is crooked at 5, Fig. 2, and equipped with a pair of prongs 77 for each accumulator wheel 75 which in the inactive position of the accumulator, that is, when its wheels 75 are not in mesh with the corresponding spur gears 76 at the upper ends of the totaliser shafts 74, engage the two flanks of a tooth in the corresponding accumulator wheel 75 so that the wheels cannot rotate.

As described in chapter (2), depression of the accumulator key 16 causes the accumulator to move into its active position in which the wheels 75 mesh with the totaliser spur gears 76, and, when a value has been introduced in the accumulator, the accumulator returns into its inactive position in which its wheels are blocked by the prongs 77.

4. *The canceling device of the accumulator*

This device which has been illustrated in Fig. 4, is referred to as the "cancelling device" because it serves for canceling a value which has been introduced in the accumulator. But it also serves for adding a value which is introduced in the accumulator to a value which has already been introduced.

Two L-shaped brackets 86 are secured to the plate 69 by screws 86*a* near its lower edge and a canceling rack 87 is mounted to slide in the brackets. In its initial position, the rack 87 bears against a check 88 with its left-hand end, and its movement toward the right is limited by another stop 89. A canceling wheel 90 is arranged below each accumulator wheel 75 in meshing relation on a pin 91. A strip 92 holds the canceling wheels 90 on the pins 91 and is, in turn, secured by nuts 92*a* on the outer ends of some of the pins 91. By these means, the canceling wheels 90 mesh with the corresponding accumulator wheels 75 above, and with the rack 87 below. Each canceling wheel has a zero gap 93, Fig. 4, which, like the gaps 80 in the accumulator wheels 75, extends for half the depth of a tooth.

The canceling rack 87 is operatively connected to the camplate 55 on the sleeve 57 by the following mechanism: A fork 94, with a slot 95, projects downwardly from the canceling rack 87. A flange 96 which is mounted to slide on the lower slide bar 94, engages in the slot 95 and is secured to the right-hand end of a rod 97 whose other end is pivotally connected to a sector lever 100 which is fulcrumed about a headed screw 101 in the rear wall of the machine. A spring 98 attached to the rod 97 at 99 pulls the rod to the left and holds the lower end of the sector 102 on the sector lever 100 against the notched upper end of the rear arm 103 of a double-armed lever 104. This lever is secured to one end of a sleeve 107*a* which is mounted to turn on a bar 104*a* secured in the left-hand side wall of the machine. The front arm of the double-armed lever bears against a headed screw 108 with its end 105, against which it is held by gravity since the rear arm 103 is heavier than the front arm. A roller arm 107, with a roller 109 at its upper end, is held against the camplate 55 on the tens transfer shaft 51 by the weight of its arm 103.

When the accumulator 71 has been moved into its active position, Fig. 3, its wheels 75 engage with the spur gears 76 on the totaliser shafts 74 and with the canceling wheels 90 on the plate 69 and are clear of the prongs 77. At the same time, the coupling lever 61, Fig. 13, has shifted the sleeve 57 to the right in the direction of the arrow *a*, so that the camplate 55 is moved out of coupling relation to the pin wheel 53, and is presented to the roller 109 on the arm 107. When the tens transfer shaft 51 rotates anticlockwise, as indicated by the arrow in Fig. 4, the elevated portion of the camplate 55, through roller 109 and arm 107, swings the lever 104 clockwise, its arm 103 engages below the end of the sector 102

of the lever 100, and the rod 97 and the rack 87 are shifted in the direction of arrow *a*.

If there is no value in the accumulator 71, that is, if its wheels 75 are at zero, their zero gaps 80 are in line with the zero gaps 93 of the canceling wheels 98, as shown in Fig. 3, so that the rotation of the canceling wheels in anti-clockwise direction, Fig. 4, does not influence the accumulator wheels 75. On the other hand, if a value has been introduced in the accumulator 71, solid teeth of the accumulator wheels 75 are in line with the zero gaps 93 of the canceling wheels, and so the canceling wheels rotate the accumulator wheels until the zero gaps 80 in the accumulator wheels 75 are again in line with the zero gaps 93 of the canceling wheels 90. At the same time, the zero stops 76 of the accumulator wheels are arrested by the checks 79, and overthrowing is prevented. Since the accumulator wheels 75 mesh with the spur gears 78 at the upper ends of the totaliser shafts 74, Fig. 3, the shafts are rotated clockwise, as indicated by the arrow *y*, and the value which has been accumulated in the accumulator 71, is added to the value already present in the corresponding totaliser. At this moment, the highest point of the camplate 55 is on the roller 108, and, as the tens transfer shaft 51 continues its rotation and the descending portion of the camplate 55 comes to act on the roller 106, the rack 87 is allowed to return into its initial position against the check 88 at the left under the action of the spring 98.

5. The locking and coupling means for the accumulator key

The functions required for the accumulation of a value necessitate a complete revolution of the tens transfer shaft 51, and the following mechanism is provided for performing this: Referring to Fig. 10, an arm 109 is keyed on the shaft 29 and a rod 110 is pivotally connected to the free end of the arm. At its rear end, the rod is equipped with a lug 111 which is arrested by a recessed intermediate partition 112. A headed screw 113 at the rear end of the rod 110 guides the rod in a slot in the partition 112 and a catch 115 is mounted to swing about the headed screw. A spring 117 whose upper end is secured to the partition 112, holds a lug 116 extending at right angles from the catch 115, against a curved face 118 of the partition 112.

A step 119 is arranged on the rear end of the catch 115 which is arranged to cooperate with a lug 120 of a bellcrank 121 which lug, however, in the inactive position of the mechanism engages in a recess 122 in the catch 115. The bellcrank 121 and another bellcrank 123 are mounted to swing about a headed screw 125 in a lever 126 having a curved slot 136. The slotted lever 126 is mounted to swing about a bar 127—see also Fig. 10*a*—arranged in the machine frame. When the bellcrank 121 is swung, the levers 123 and 126 which are connected to the bellcrank, swing anti-clockwise about the bar 127. A headed screw 128 in the slotted lever 126 engages in a curved slot 129 of the bellcrank 121. The bellcrank is thus enabled to perform a limited swinging movement independently of the slotted lever 126. A spring 130 secured to a pin 123*a* of the bellcrank 123 at one end, and to a pin 128*d* of the slotted lever 126 at the other end, tends to turn the bellcrank 123 anti-clockwise, the initial position of the bellcrank 123 being determined by a lug 132 engaging the bellcrank 121. The bellcrank 121 is pulled with the right-hand end 131 of the slot 129 against a headed screw 128 by a spring 129*b* anchored in the machine frame and attached to the pin 129*a* of the bellcrank 121, with the levers 121 and 126 making up a single unit so that the lever 126 is turned anti-clockwise by the spring 129*b* about the bar 127, its initial position being defined by its edge 126*a* engaging an abutment 133 in the machine frame, Fig. 10.

The arm 134 of the bellcrank 123 is also able to cooperate with the abutment 133, the arm 134 being above the abutment 133 in the initial position of the mechanism.

Two tens transfer cams 135 on the tens transfer shaft 51 are connected by a stay 136 and this stay is in the path of an extension 137 of the bellcrank 121.

The bellcrank 126, Fig. 10*a*, has shoulders 126*a* and 126*b* at the sides of its curved slot 136, and these cooperate with a pin 139, Fig. 10, at the free end of an arm 141 on a shaft 140 mounted to rotate in the frame of the machine. At its right-hand end, the shaft 140 supports a coupling arm 142 which controls the shift mechanism coupling 143 and the carriage control coupling 114 on the main driving shaft 145. The shift mechanism coupling 143 effects a complete revolution of the tens transfer shaft 51 through the gearing 146 etc. illustrated in Fig. 13. In its normal position, the pin 139 at the end of the arm 141 occupies the position illustrated in Fig. 11 with respect to the slotted lever 126 in which the lower edge of the pin 139 is in line with the shoulder 126*a*, and its left edge is below, and in front of, the right-hand edge of the shoulder 126*b*. The arc described by the pin 139 is so determined that the pin, when the pawl 144*a* of the carriage control coupling 144 is released for one step in the feed of the carriage, that is, upon oscillation in clockwise direction, engages before the shoulder 126*a* of the slotted lever 126 and locks the accumulator key 16 since the pin does not permit swinging of the slotted lever 126 anti-clockwise. The pin 139 also locks the accumulator key 16 when the pawl 143*a* of the shift mechanism coupling 143 has been released for a calculating operation by turning the shaft 140, and the arm 141, anti-clockwise, since the pin 138 engages before the shoulder 126*b*.

The operation of this mechanism is as follows: When the accumulator key 16 is depressed, the shaft 28 and its arm 109 are turned clockwise. The arm 109 shifts the rod 110 in the direction of the arrow *c*. The catch 115 which is fulcrumed to the rod 110 is turned slightly about the screw 113 anti-clockwise against the spring 117 by its lug 116 sliding along the curved edge 119. As the slot in the catch 115 engages the lug 120 of the bellcrank 121, the bellcrank is also pulled in the direction of the arrow *c*. The three levers 121, 123, and 126 are swung anti-clockwise about the bar together against the spring 129*b*. The arm 134 strikes the abutment 133 and is swung slightly about the screw 125 in clockwise direction by the spring 130 engaging its lug 132. Immediately after, when the bellcrank 123 has cleared the abutment 133, it is turned anti-clockwise by the spring 130, as shown in Fig. 12, engaging in front of the abutment 133, by which means the accumulator key 16, if released prematurely, is held in its depressed position and the entire mechanism is locked in its active condition.

During the swinging of the lever 126, the pin 139 on the arm 141 slides along the inclined edge

126a and up in the slot 136 of the lever 126 by which the shaft 140 is turned anti-clockwise. The clutching lever 143 releases the pawl 143a of the shift mechanism coupling and the coupling is thrown in.

Through mechanism which is known in the art and has not been illustrated, the circuit of the motor 7a is closed when the accumulator key 16 is depressed and the main driving shaft 145 is rotated anti-clockwise, as viewed in Fig. 13. When the pawl 143a is released the coupling 143 is connected to the main driving shaft and the tens transfer shaft 51 is rotated by the means described and illustrated in Fig. 13. As the tens transfer shaft 51 must perform only a single revolution during the accumulating operation, the clutch 143 must be disconnected after the first revolution. A short time before the tens transfer shaft 51 has completed its first revolution, the stay 136 of the tens transfer cams 135 strikes the edge 137 of the lever 121 and swings this clockwise for about the amount permitted by the slot 129. The lug 120 of the lever 121 now leaves the recess 122 in the catch 115. The lever 121 engages the lug of the bellcrank 123 and swings this clockwise against the spring 130 and its arm 134 leaves the abutment 133. When the pin 136 is on the highest point of the arm 137 of the lever 121, spring 129b swings the three levers 121, 123, and 126 clockwise until the lug 120 of the lever 121 engages the step 119 of the catch 115, Fig. 12a, but the catch and the levers 109 and 110 remain in active position under the action of locking means 168, 170, and 171, Fig. 7, as will be described in connection with the coupling means for the cancelling members of the result totalisers. By the swinging motion of the lever 126 the pin 139 slides out of the slot 138 of the lever 128, turning the coupling lever clockwise so that it returns into the path of the pawl 143a of the shift mechanism coupling 143 and throws this out after one revolution of the tens transfer shaft 51. When the locking of the accumulator key 16 by the means 168, 170, and 171 is released, the spring 27 at the key lever 124 returns the parts 109, 110, and 115 into their initial positions, Fig. 11, as determined by the lug 111 of the rod 110 engaging the intermediate wall 112, and spring 129b returns the levers 121, 123, and 126 into their initial positions.

If the operator holds the accumulator key 16 depressed after the accumulation has been completed, no calculating operations will be performed, since the arm 141 is between the shoulders 126a and 126b of the lever 126 with its pin 139, and in its inactive position.

6. The uncoupling mechanism for the revolution counters

The revolution counters 4 must not be operated when the accumulator key 16 is depressed. The rod 110 has a hole 150, as best seen in Fig. 10, and in this engages a pin 153 at the free end of an arm 154 whose boss 155 is keyed on a shaft 156. The pin 153 is arranged to slide along an incline 151 forming part of the hole 150. At the right-hand end of the shaft 156, another arm 157 is arranged whose pin 158 engages in a slot 159 in a push rod 162 which slides on a guide, not shown, with a pair of lugs 160. The crooked end 163 of the push rod is pivoted to a bellcrank 164 which is fulcrumed about a headed screw 165 and engages between a pair of flanges 166 on a control slide 167 which operates the reversing mechanism, not shown, of the revolution counters 4.

When the accumulator key 16 is depressed, the rod 110 is shifted in the direction of the arrow c and the pin 153 slides along the incline 151 and engages in a slot 152. The shaft 156 is turned anti-clockwise and the push rod 162 is moved into the position Fig. 12. The control slide 167 now assumes an intermediate position and throws out the reversing mechanisms for the revolution counters 4.

7. The coupling means for the canceling members of the result totalisers

When a value is to be accumulated the corresponding totaliser 3 must be canceled. A pin 166 on the key lever 24 of the accumulator key 24, Fig. 7, is arranged to slide along the convex edge 169 of a lever 170 and to engage in a notch 171 at the lower end of the edge. The lever is mounted to swing about a headed screw 173 in a bracket 172 at the right-hand side plate of the machine and a spring 174 pulls the lever anti-clockwise against the pin 166. A lug 176 on a U-shaped frame 177 projects into a slot 175 in the lever 170. The frame is mounted to swing about, and to slide on, a bar 180 secured in two eyes 178 and 179 of the bracket 172. The base plate 177 of the U frame which faces the operator is equipped with an arm 181. The lower edge of the arm engages a pin 182 forming a part of a second frame 184 mounted to swing about a bar 153. A hook 185, 186 on the second frame engages below a connecting rod 187. A spring 188 is connected to the lower end 186 of the hook and to a pin 189 on the connecting rod, pulling the end against an abutment 190 on the rod. Another spring 191 pushes the connecting rod 187 in the direction of the arrow c. A slot 192 in the front end of the connecting rod engages a pin 194 at the lower end of the key lever 193 of the totaliser cancellation key 12. In its upper final position, the key lever 193 bears against an abutment, not shown, with a projection 193a.

The rear end of the rod 187 is pivotally connected to a lever 194 which is mounted to swing about a bar 195. The lever has a projection 198 and a slot 196 below the projection, and a crooked extension 197 of the coupling lever 142 is normally before the slot 196. A lug 199 of the lever 194 controls the coupling lever 200 of a canceling coupling 203. The lever 200 is fulcrumed about a headed screw 201 and its arm 202 cooperates with a pawl 204 on the coupling. A canceling rod 206 is pivoted to the coupling 203 at 205 which, through rack L, pinion L_1, and spur gear L_3, Fig. 2, effects the cancellation of the result totalisers 3.

The pin 205 where the rod 206 is connected to the coupling 203, cooperates with the end 207 of a lever 209 which is pivoted about a headed screw 208 in the bracket 172. The lever 209 which is guided in a notch 211, engages the rear shank 213 of the U frame 177 with a fork 212. The shank 213 has a curved cam 214 arranged to cooperate with a cam 215 on the shaft 216, Figs. 8 and 9.

The lever 170 which is connected to the frame 177 by the pin-and-slot connection 175, 176, has a tooth 217 at its upper end for cooperation with a catch 218a at the free end of a spring 219 to which the catch is riveted at 218. A lug 220 on the spring is arranged to cooperate with the key lever 24 of the accumulator key 16.

When the key is depressed for the distance de-

termined by its projection 24a, its pin 168 enters the notch 171 in the lever 170 and the inner edge 171a of the notch is held against the pin by the spring 174. The movement of the lever 170 in anti-clockwise direction shifts the frame 177 to the left from the position Fig. 8 into that in Fig. 9, through slot 175 and pin 178, and the cam 214 is now presented to the cam 215. The fork 212 moves the lever 209 into its active position, Fig. 9, and its end 207 moves into the path of the pin 215 on the canceling coupling 203. As described, this coupling is turned for a complete revolution, and the shaft 216 is rotated clockwise. When this shaft has performed about three quarters of a revolution, the cam 215 engages the curved cam 214 and swings the frame 177 anti-clockwise. The arm 181 turns the second frame 184 anti-clockwise through pin 182 against the spring 188. This spring is stronger than the spring 191 and pulls the connecting rod 187 in the direction of arrow c until the projection 198 on the lever 194 bears against the extension 197 and turns the coupling lever 142 anti-clockwise. The hook 186 of the second frame now releases the shoulder 190 of the connecting rod 187, and tension is put on the spring 188. When the lever 194 returns from its active position, Fig. 12, into its initial position, Fig. 11, a short time before the tens transfer shaft 51 has completed its revolution, the extension 197 of the coupling lever 142 releases the projection 198, so that now the connecting rod 187 is free to move in the direction of the arrow c under the pull of spring 188 until its shoulder 190 is intercepted by the end 186 of the hook 185. The lever 194 is swung anti-clockwise and its arm 189 turns the lever 200, so that the pawl 204 of the canceling coupling is released and the coupling is connected to the main driving shaft 145. At this moment the shift mechanism coupling 143 and the shaft 216 have turned so far that the cam 215 releases the cam 214, so that the spring 191 returns the frame 177, the frame 184, the rod 187, the lever 194, and the lever 200 into their initial positions.

The canceling coupling 203 rotates anti-clockwise and, through L, L_1, and L_3 (the pinion L_1 rotating in the direction of arrow x, Fig. 2) cancels the corresponding totaliser 3. Before the canceling coupling 203 has completed the first half of its revolution, its pin 205 acts against the end 207 of the lever 209 from below and the lever is turned about the screw 209 clockwise. This movement is transmitted to the lever 178 through fork 212 and the parts connected to it, and the lever now turns clockwise. Its upper end 217, Figs. 8 and 9, acts against an incline on the catch 218a and forces the catch up. When the end of the lever 170 is in the position shown in dot-and-dash lines in Fig. 9, the catch 218a engages over the end 217 and the lever 170 is held against return in anti-clockwise direction.

When the corresponding result totaliser 3 has been canceled all functions required for accumulation have been performed, and the accumulator key 16 can now be released. The lever 170 when turning clockwise as described, releases the pin 168 of the accumulator key 24 which was in the notch 171, allowing springs 27 and 34 to return all parts connected to the key lever, to return into their initial positions. However, before the key lever 24 reaches its upper final, or initial position, it bears against the lug 220 and raises the catch 218a so that the lever 170 is released and the spring 174 pulls it against the pin 168 on the key lever 24, Fig. 8.

If the operator holds the accumulator key 16 depressed after the accumulation has been completed, no calculations can be performed for the reasons stated in the last paragraph of chapter (5). On the other hand, the catch 218a allows the key lever 24 of the accumulator key 18, and the parts connected to it, to return into their initial positions immediately when the key 16 is released.

8. Mechanism for canceling the accumulator

The bar 221 of the accumulator cancelation key 17, Fig. 7, is curved and has a slot 222 at its lower end with which it is guided on a headed screw 223. A spring 224 pulls the bar up in the direction of the arrow d in Fig. 17. The bar 221 has a lug 225 with an angular tooth 226. The lower edge of the tooth bears against the pin 168 on the key lever 24 and its concave front edge 227 cooperates with the convex edge 188 of the lever 170.

When the accumulator cancelation key 17 is depressed, its tooth 226 turns the key lever 24 of the accumulator key anti-clockwise through the pin 168. The length of the slot 222 is so determined that the final position of the key 17 is also the active position of the accumulator key 16, as shown in Fig. 17. The mechanisms connected to the accumulator key 18 are now operated as described, and the accumulator is canceled by transferring the accumulated values to the result totalisers 3. The totalisers 3 cannot be canceled by the means described in Chapter 7 as the lever 170, notwithstanding the juxtaposition of its notch 171 and the pin 188, cannot turn under the pull of the spring 174 because it is arrested by the concave edge 227 of the tooth 226 engaging its convex edge 189.

9. The operation of the machine

Assume that the products 11×11, 12×16, and 13×15 are to be added, and that the product 25×5 is to be subtracted from the total of the three products. The result totalisers 3 and the accumulator 71 are in their zero positions.

The calculation keys 9 are depressed in the seventh and eighth down rows from the left, Fig. 1, for introducing the multiplier 11, and the multiplicand is introduced in a similar manner at the right, the multiplication key 18 is depressed, and the first product $11\times11=121$ is indicated by the corresponding result totaliser 3, the revolution counter 4 indicating "11." The first product, 121, must now be transferred to the accumulator 71 by depression of the accumulator key 10. Shaft 29 is turned clockwise and the parts 32, etc., are moved from their initial positions, Fig. 14, into the active positions, Fig. 15, as described. The end 50 of the lower arm 48 of the bellcrank 45, 48 is presented to the sector 52 on the tens transfer shaft 51, the pin disk 53 for the totaliser coupling D is disconnected from the transfer shaft 51 by the lever 61 shifting the sleeve 57 in the direction a, Fig. 13, and moving the camplate 55 into active relation to the roller 108 at the upper end of the roller arm 107, Fig. 4. At the same time, the accumulator 71 is moved into its active position, as shown in Fig. 15, so that its wheels 75 mesh with the totaliser spur gears 76, Fig. 3, and, if the number rollers of the totalisers 3 are returned to zero, the first product 121 is transferred to the accumulator 71 by the totaliser 3.

Upon depression of the accumulator key 16, the parts 109, etc., are moved from the position

in Fig. 11 into that in Fig. 12, and the same occurs with the parts 153, etc., connected to the shaft 156, by which means the totaliser 4 is rendered inactive.

Lastly, the pin 168 on the key lever 24 of the accumulator key 18, through lever 170, moves the frame 177 from the inactive, or initial, position, Fig. 8, into the active position Fig. 9, in which the curved cam 214 of the frame is presented to the cam 215 on the shaft 216, and the end of the lever 208 is presented to the pin 205 of the canceling coupling 203.

When the said preliminary adjustments subsequent upon the depression of the accumulator key 18 have been completed, as described, the circuit of the motor 7a is closed by automatic means, not shown, and the main driving shaft 145 is rotated anti-clockwise. The shift mechanism coupling 143 which has been thrown in by its lever 142, rotates with the main driving shaft and the tens transfer shaft 51 is rotated through the gearing which has been described. The first operation performed by the rotating tens transfer shaft is the cancelation of the accumulator 71 by the elevated portion of the cam plate 55 depressing the roller 108 on the arm 107 and, through the means described, shifting the rack 87, Fig. 4, to the right so that the canceling wheels 90 are rotated anti-clockwise. However, as there is as yet no value in the accumulator wheels 75, their zero gaps 80 are presented to the canceling wheels 90 and they do not rotate the accumulator wheels 75.

When the canceling operation in the accumulator 71 has been completed, that is, when the roller 108 is engaged by the lower portions of the camplate 55, which occurs after about two thirds of a revolution of the tens transfer shaft 51, as described, the sector 52 engages the lower arm 48 of the bellcrank whose upper arm moves the accumulator 71 into inactive position by means of the crank 82. In the present instance, this disconnection of the accumulator wheels 75 and the totalizer spur gears 76 has no function. When the sector 52 releases the arm 49, the spring 46 returns the bellcrank 45, 49 into the position shown in Fig. 15 in which the accumulator 71 is returned into active position and its wheels 75 reengaged with the totalizer spur gears 76. At this moment, the cam 215 on the shaft 216 engages the cam 214 of the U frame 177 and tension is put on the spring 189, as described.

Shortly before the tens transfer shaft 51 has completed its revolution, the stay 136 of the tens transfer cams 135 engages the arm 137 of the lever 121 and turns the lever clockwise, so that, as described, the arm 134 of the lever 123 again leaves the abutment 133, and the spring 129b swings the levers 121, 123, and 126 until the lug 120 engages the step 119 in the catch 115, the parts occupying the intermediate positions illustrated in Fig. 12a. At the same time and under the action of the slot 138 in the lever 126, the coupling lever 142 returns into its initial position in which it throws out the shift mechanism coupling 143 after one revolution, and releases the lever 184, as described, so that it couples the canceling coupling 203 with the main driving shaft 145 under the pull of the spring 188, by the means described.

Since the accumulator key is still locked in its depressed position and holds the accumulator 71 in active position, the accumulator wheels 75 still are in mesh with the totalizer spur gears 76. The rod 206 which is connected to the canceling coupling 203 at 205, cancels the totalizer 3 which contains the first product 121 through members L_1, L, and L_2 in the manner described, the accumulator wheel 75 being rotated for the amount introduced into the totalizer during the first half revolution of the canceling coupling 203. The totalizer shaft is rotated clockwise until its tens transfer cam N, Fig. 2, engages the tooth Za of the tens transfer slide Z. Thus, the accumulator 71 receives the first product 121 while the corresponding result totaliser 3 is returned to zero. After in this manner the value 121 has been transferred into the accumulator 71 from the totaliser 3, the accumulator key 16 is unlocked by the pin 205 of the canceling coupling 203 engaging the end of the lever 208, and all parts operated by the accumulator key 16 return into their initial positions. The factor "11" which is still in the revolution counter 4, is canceled by depressing the key 13.

The second product, 12×16, is now introduced by means of the keys 6, as described, and the multiplication key 18 is depressed whereupon the value 192 is indicated by the totalizer 3, and the value 6 by the revolution counter. To obtain the total 121 + 192, the accumulator key 16 is depressed again, but the product 192 is not transferred to the product 121 already in the accumulator 71 but the product 121 in the accumualtor 71 is added to the product 192 in the totalizer 3 by canceling the accumulator 71 and the total 313 thus obtained in the totalizer 3 is transferred to the accumulator 71.

When the accumulator key 16 is depressed, the accumulator 71 is canceled in the manner described above, its canceling wheels 90 rotating anti-clockwise. This, however, applies only to the three wheels 75 at the right, as the value 121 was introduced only in these by the first accumulation and so a solid tooth of the three wheels is in line with the zero gaps 83 of the allotted canceling wheels 90. These wheels 75 are now rotated clockwise until their zero stops 78 engage the checks 79. By the rotation of the three wheels 75 at the right, the three totalizers 3 at the right are rotated anti-clockwise through spur gears 76, in conformity with the accumulated value 121. However, since the totalisers already indicate the value 192, the accumulated value 121 is added to 192, but only "213" is indicated by the totalisers, since the tens transfer has only been prepared for the present since the tens transfer cam N of the spur gear Na, Fig. 2, engages the tooth Za of the tens transfer slide Z and shifts the slide in the direction of the arrow b. At this moment, the tens transfer shaft 51 has been rotated so far that its sector 52 acts on the end 50 of the bellcrank arm 49 and thereby disconnects the accumulator 71 from the gear wheels 76. This is necessary for the tens transfer, because the accumulator wheels 75 which are already at zero could not rotate clockwise as required for tens transfer, being arrested by the checks 70. The tens transfer is effected immediately after the accumulator has occupied its inactive position, Fig. 2, in manner per se known, by the tens transfer cams 135 on the tens transfer shaft 51 which elevate all tens transfer slides M. As, however, only the tens transfer slide Z of the tens place was shifted in the direction b, the corresponding tens transfer slide M is turned to the right when the slide Z rises, turning the number roller of the 100 place of the totalizer for one place so that now the correct amount 313 is now indicated by the totalizers. After this has been effected, the

sector 52 releases the arm 49, and the spring 44 returns the accumulator into active position.

When the tens transfer shaft 51 has completed its revolution, the shift mechanism clutch 143 is thrown out and the canceling coupling 203 is thrown in, so that the totalizers are now canceled. As the value accumulator is still in the active position, Fig. 3, the total of the two products 121+192=313, is transferred to the value accumulator 71. The third product 13×15=195 is now introduced and appears in the totalizers. For adding the value 313 in the accumulator 71 to the value 195 in the totalizers, the accumulator key 16 is depressed again, and the product 195 is now transferred to the accumulator 71 in the manner described. The value 508 is now in the accumulator 71. The product 25×5 must now be subtracted from the total 508. The handle 21, Fig. 1, is placed on "division", or negative multiplication. The two factors 25×5 are now introduced by means of the keys in the manner described and the multiplication key 18 is depressed. The product now appears negative, 999 999 999 999 9875. To find the final result, 508—125=383, the accumulator cancelation key 17 is depressed and thereby the value 508 in the accumulator 71 is transferred additively to the value in the totalizers, and the machine now performs the following calculation:

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  999 999 999 999 9875
+ 000 000 000 000 0508
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  000 000 000 000 0383
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The value "1" found at the left of the sixtenth place, by tens transfer, is not indicated since there is no number roller at this point, and so the correct result 383 is indicated by the totalizers.

To cancel the value 383 from the totalizers, the totalizer cancelation key 12 is depressed, the cancelation coupling 203 is thrown in and the value 383 is canceled from the totalizers through the mechanism L, L_1, L_3. The accumulator and the totalizers are now at zero again.

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