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MAY 25, 1943.
BY A. P. C.

K. B. W. KIEL

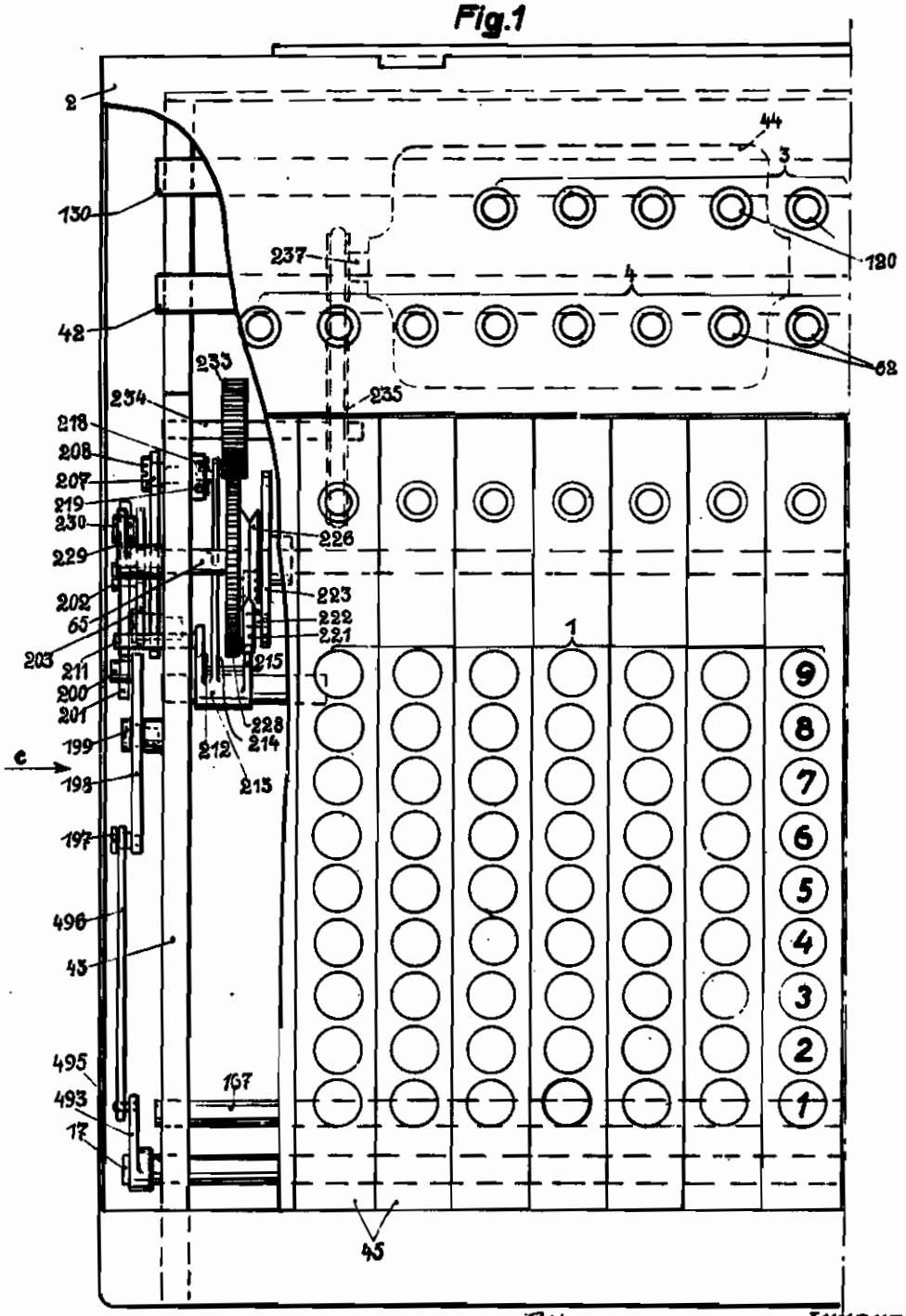
CALCULATING MACHINE

Filed March 17, 1939

Serial No.
262,552

14 Sheets-Sheet 1

Fig.1



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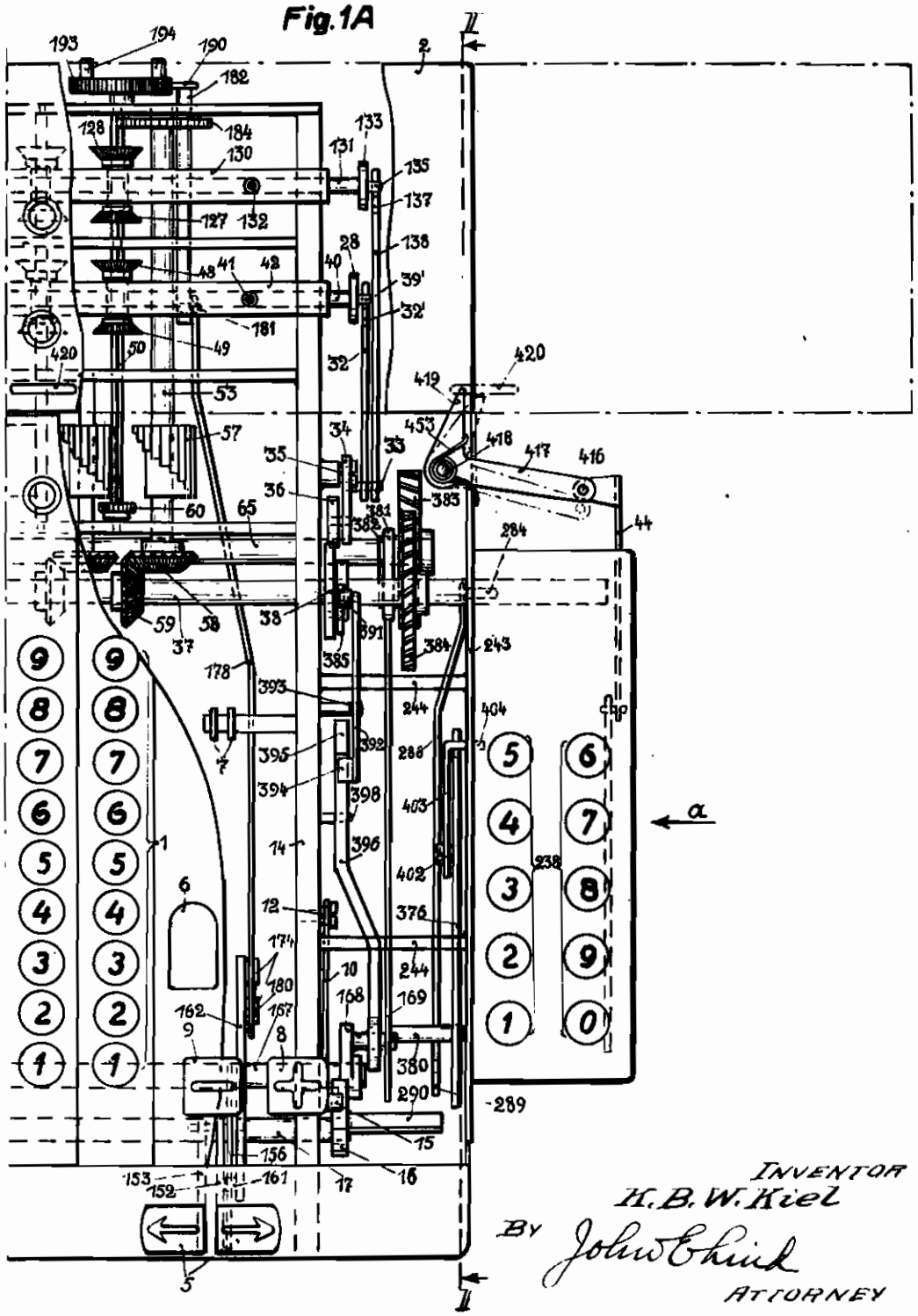
262,552
14 Sheets-Sheet 2

Fig.1A



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Serial No.
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Fig.5

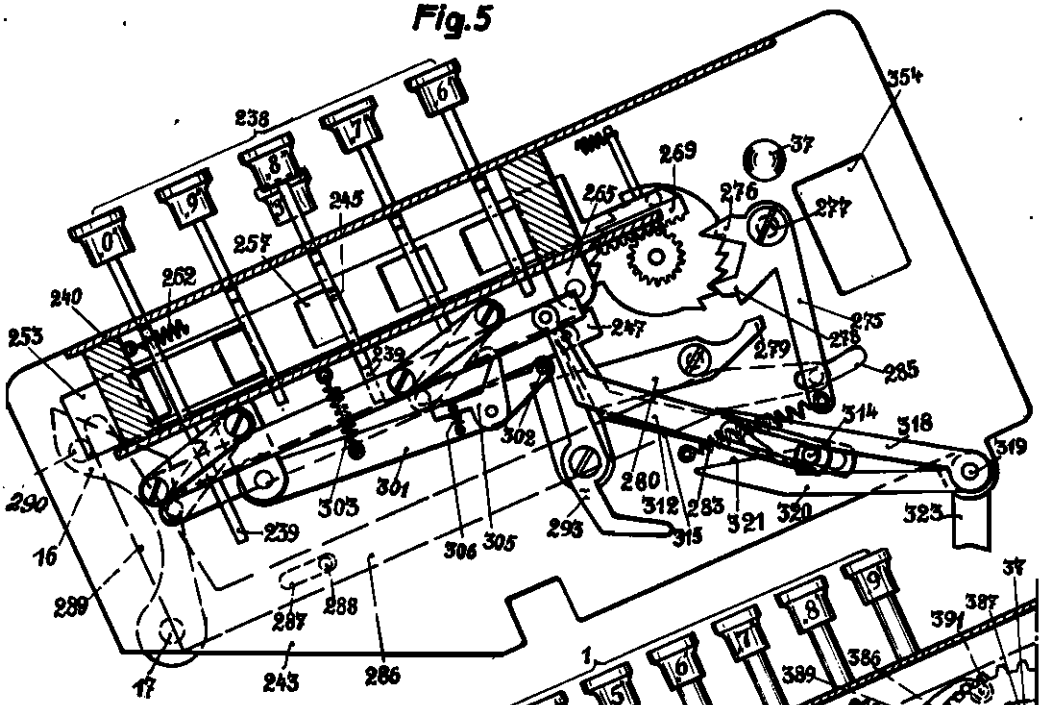
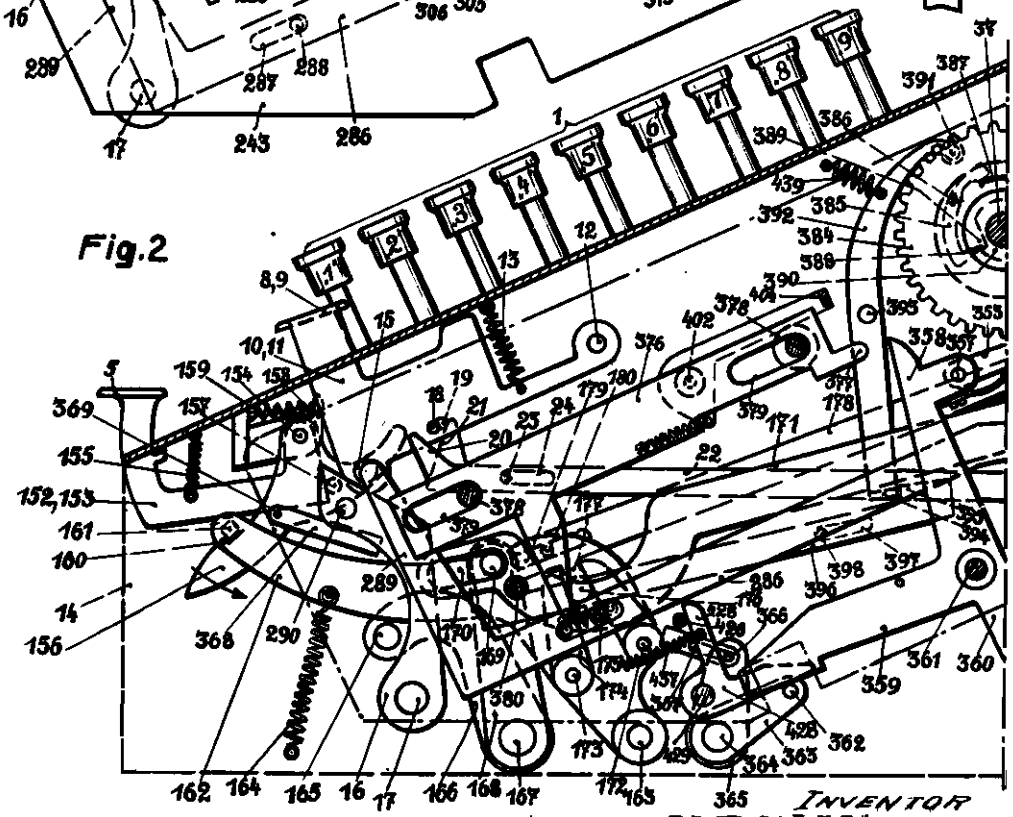


Fig.2



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CALCULATING MACHINE
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Serial No.
262,552
14 Sheets-Sheet 4

Fig.1B

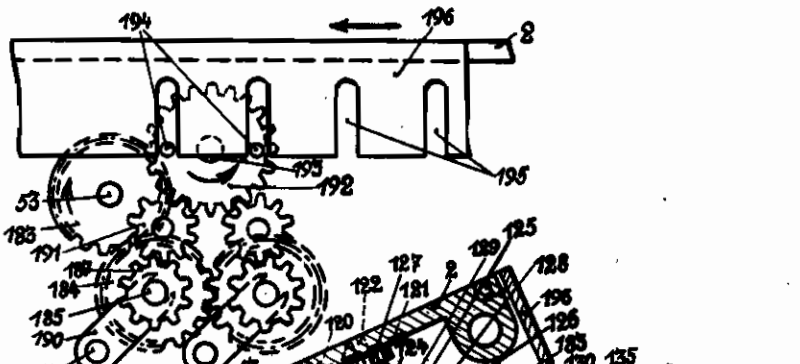
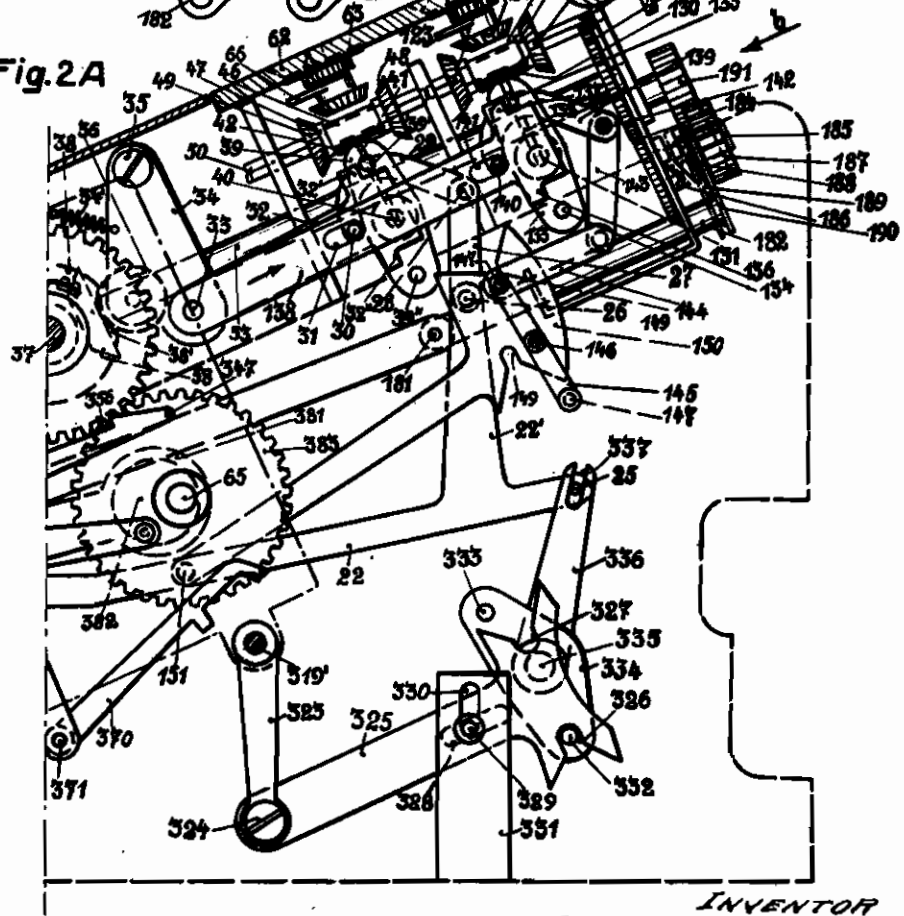


Fig.2A



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CALCULATING MACHINE
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262,552
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Fig. 3

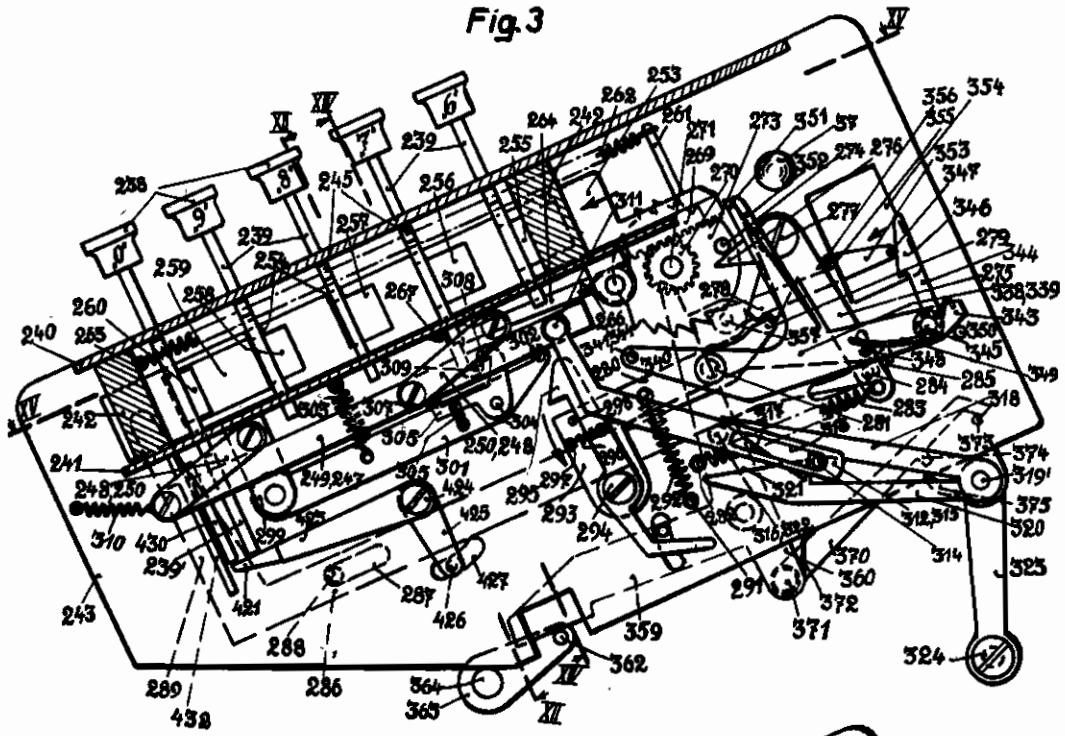
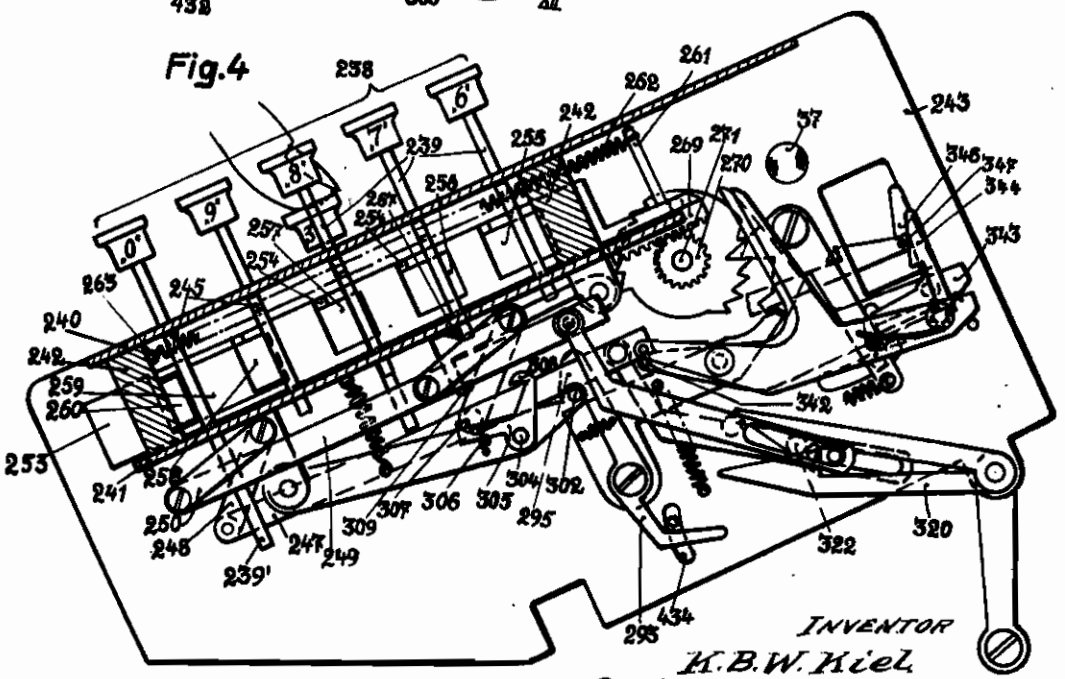


Fig. 4



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CALCULATING MACHINE
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262,552
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Fig.6

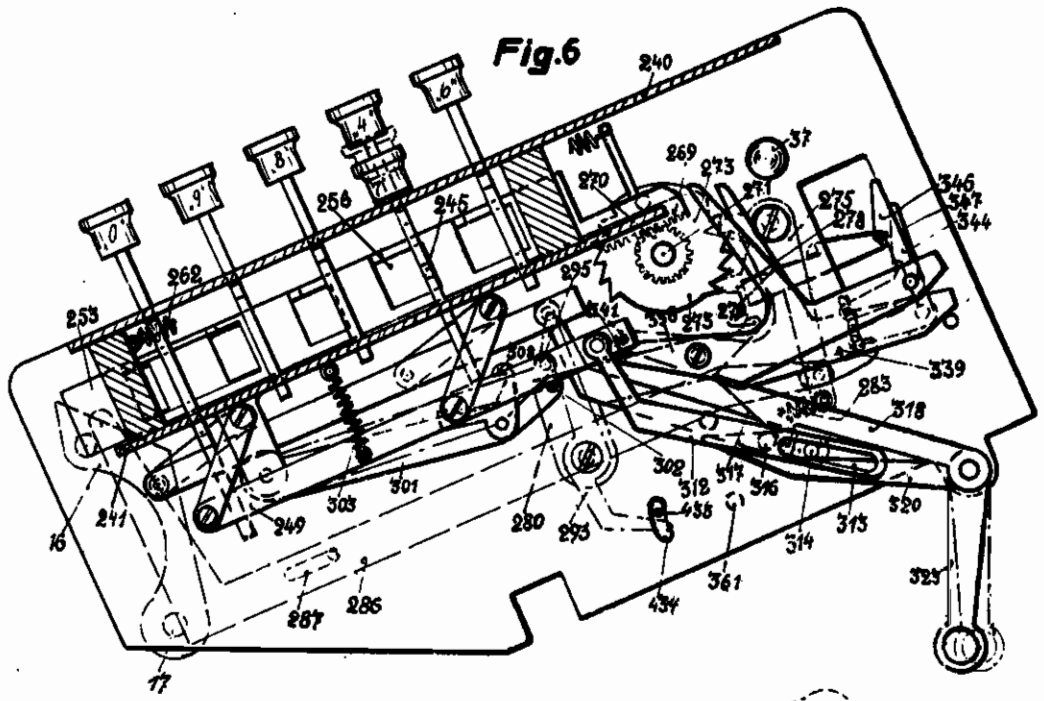
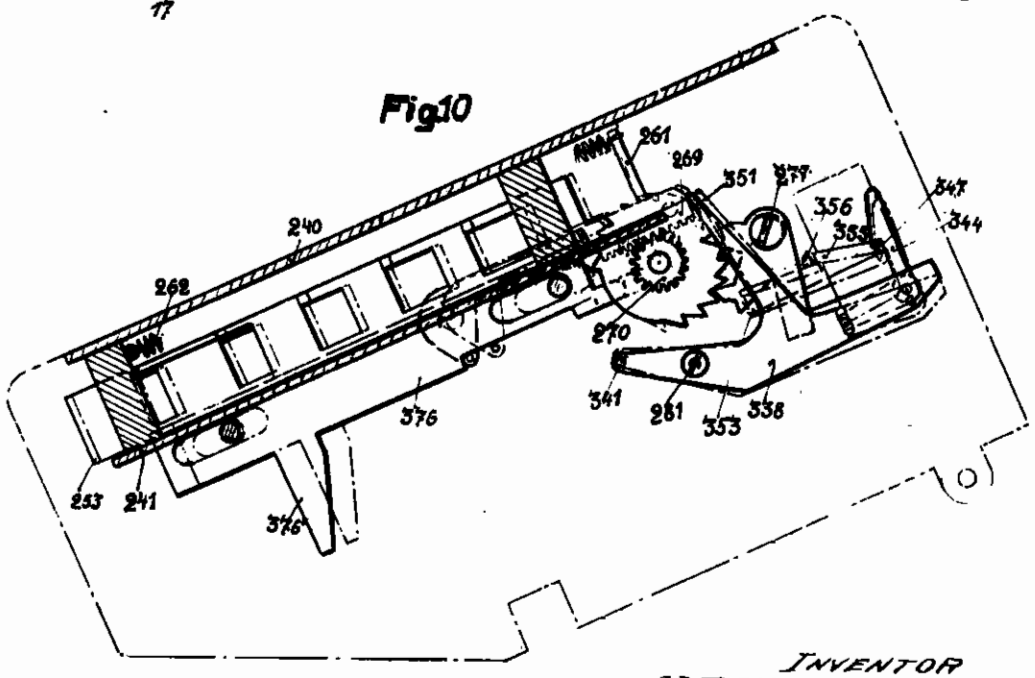


Fig.10



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CALCULATING MACHINE
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Serial No.
262,552
14 Sheets-Sheet 7

Fig. 12

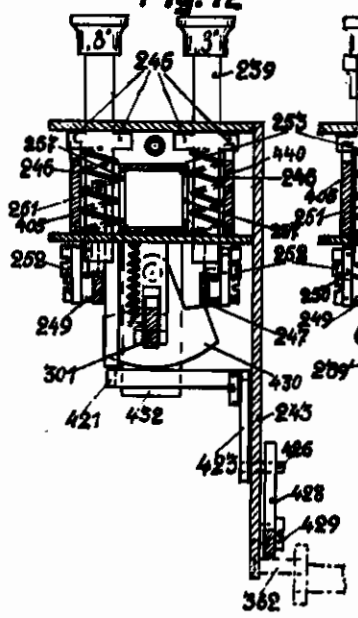


Fig. 13

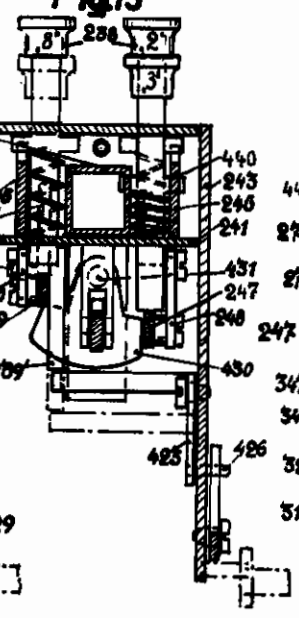


Fig. 14

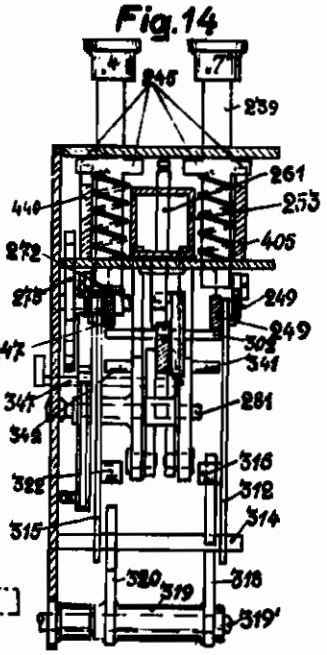
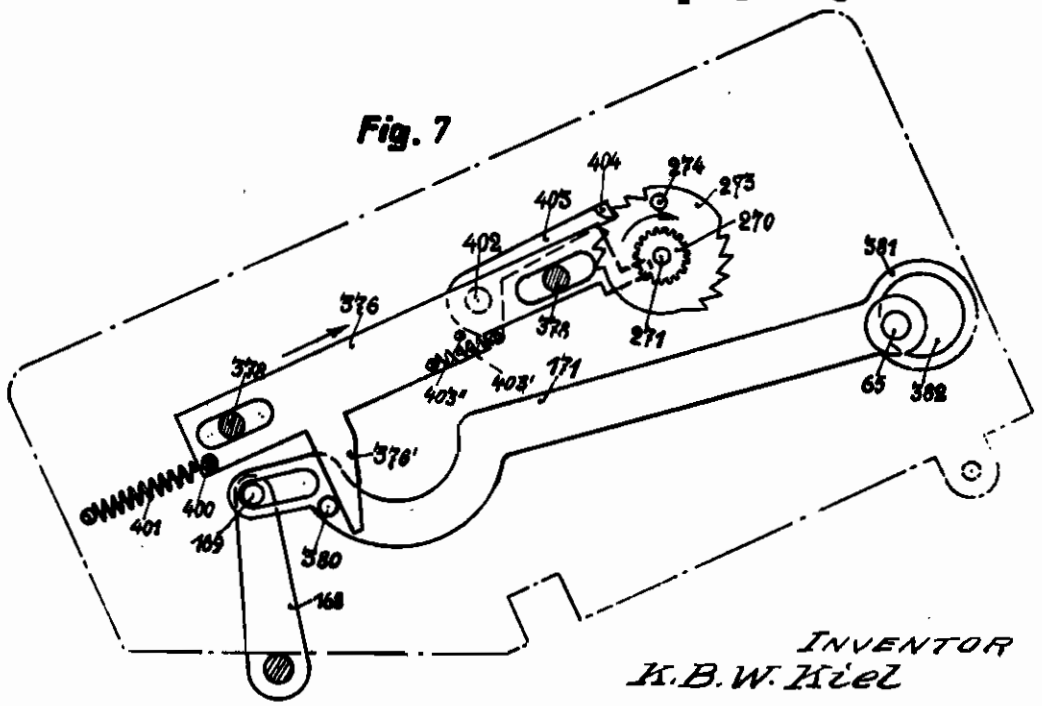


Fig. 7



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CALCULATING MACHINE
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262,552
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Fig. 8

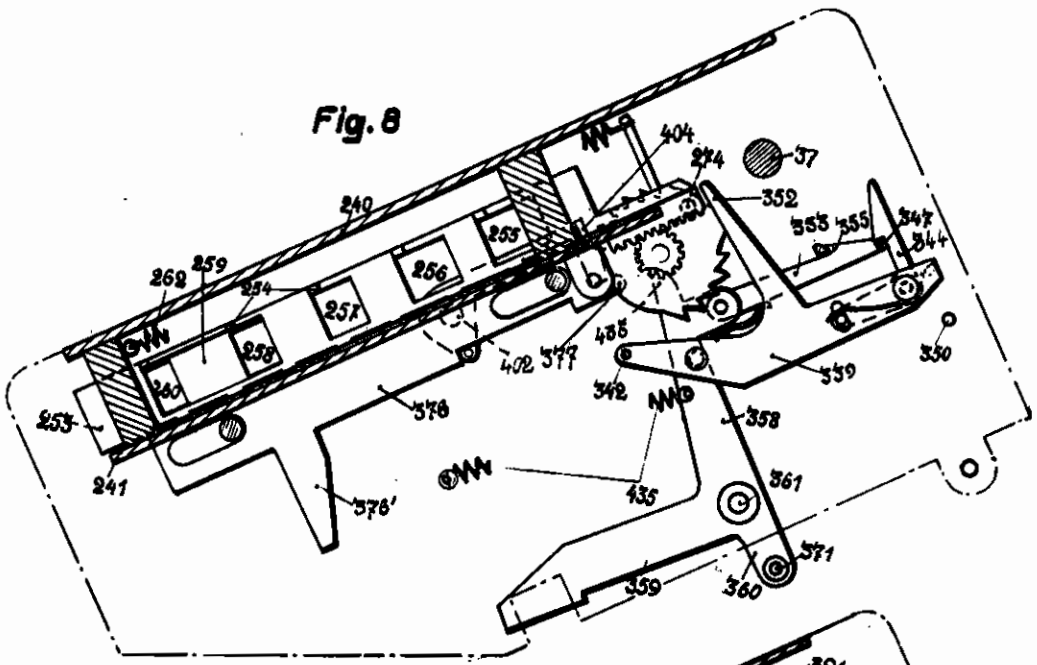
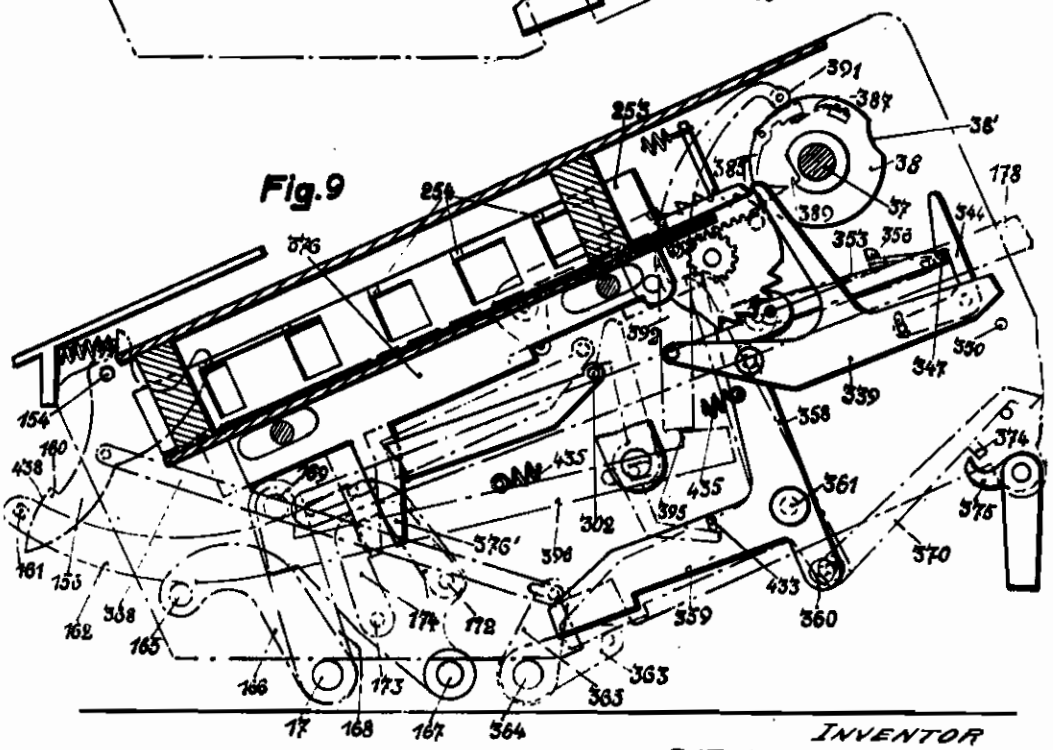


Fig. 9



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CALCULATING MACHINE
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Serial No.
262,552
14 Sheets-Sheet 9

Fig. 22

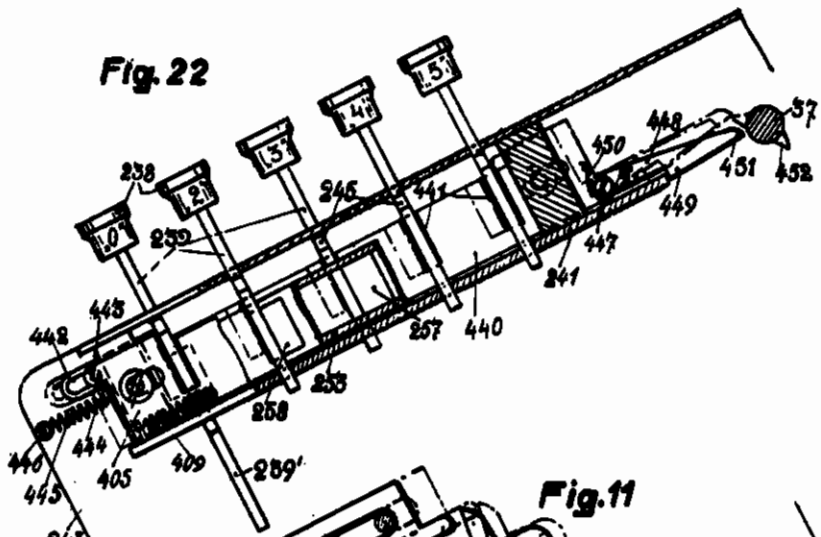


Fig. 11

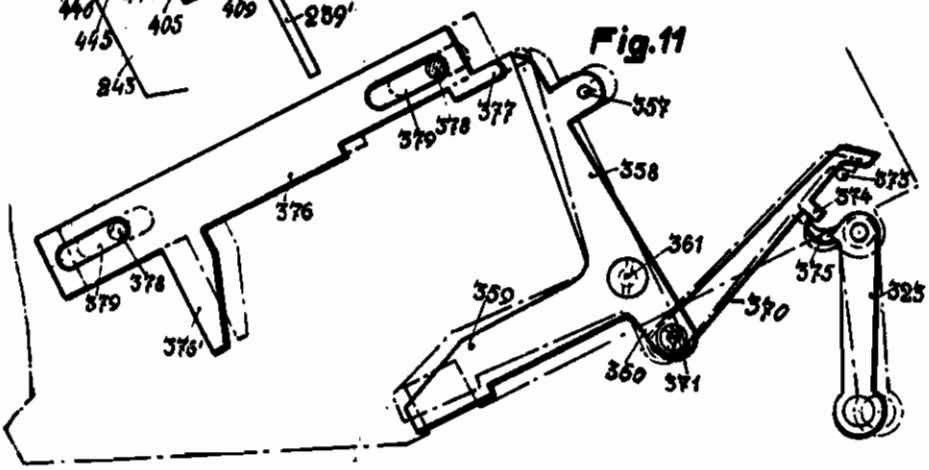
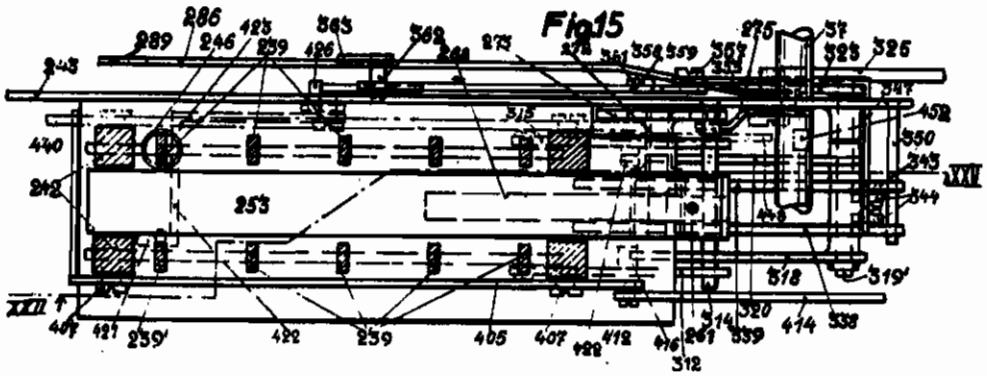


Fig. 15



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CALCULATING MACHINE

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Fig.17

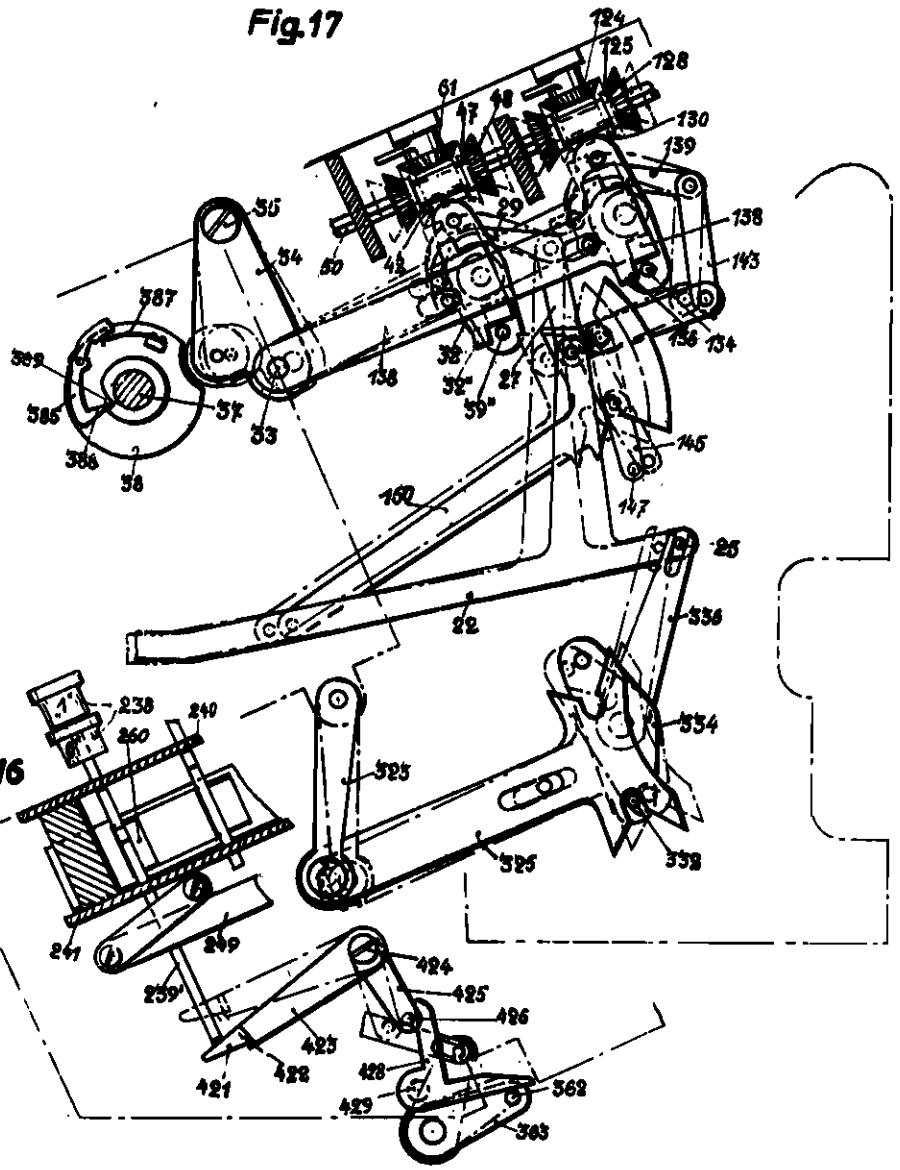

Fig.16

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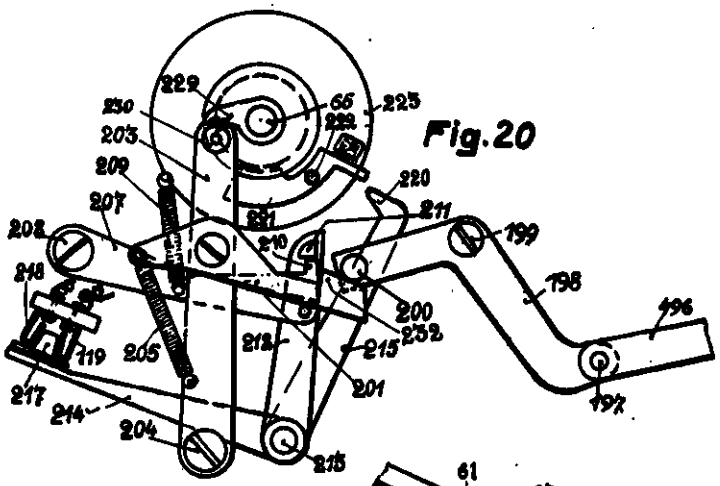

Fig. 20

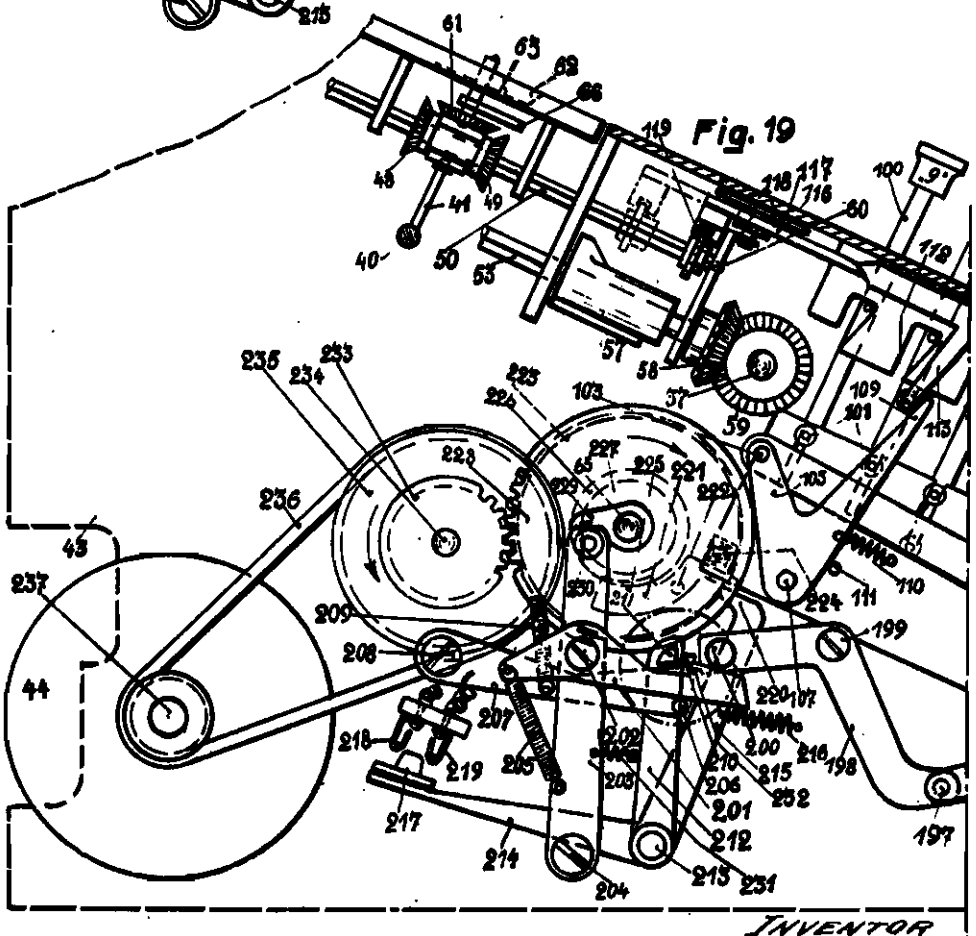

Fig. 19

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Serial No.
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14 Sheets-Sheet 12

Fig. 21

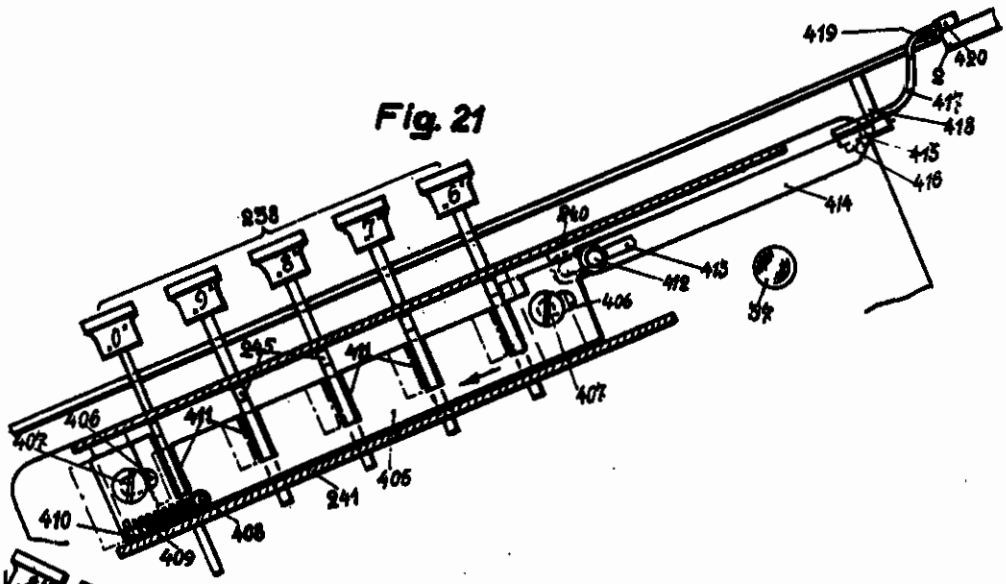
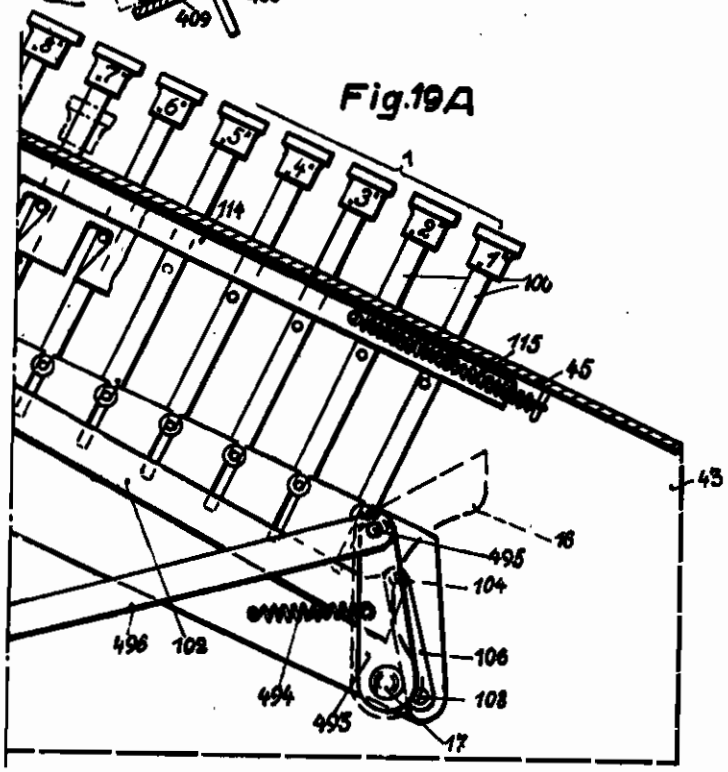


Fig. 19A



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CALCULATING MACHINE

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Fig. 23

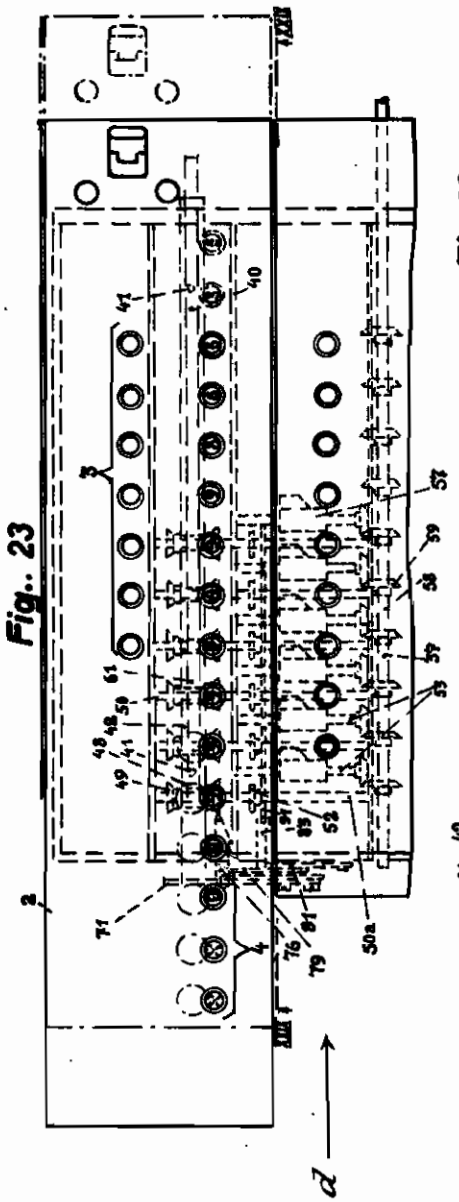


Fig. 29

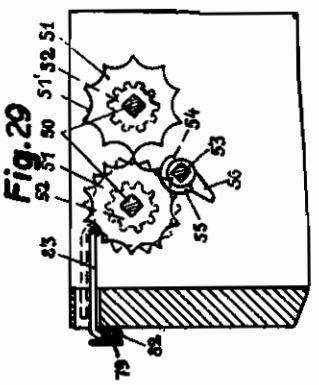
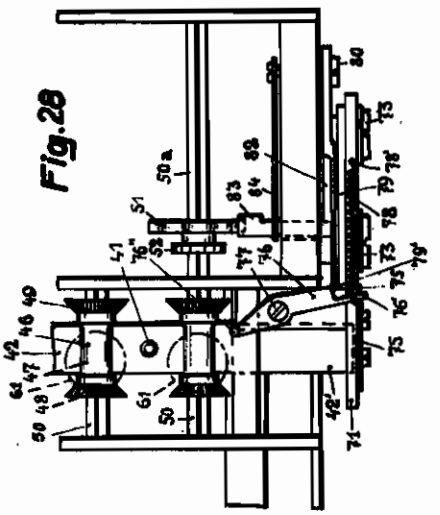


Fig. 28



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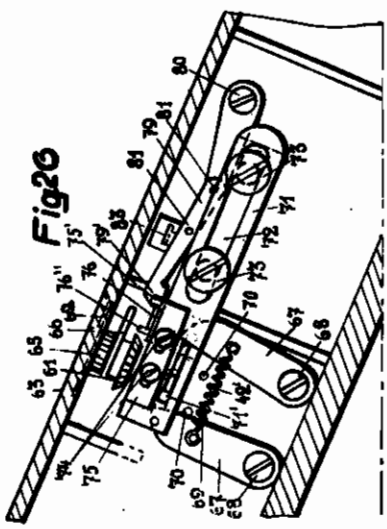
Fig. 26

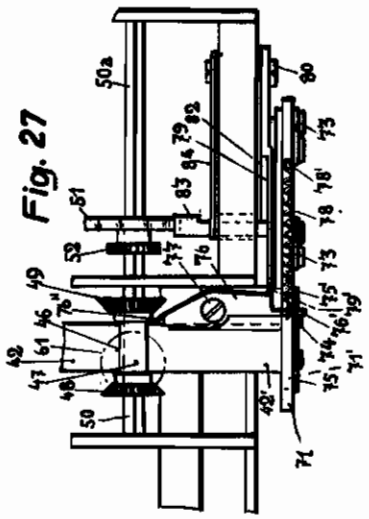
Fig. 27

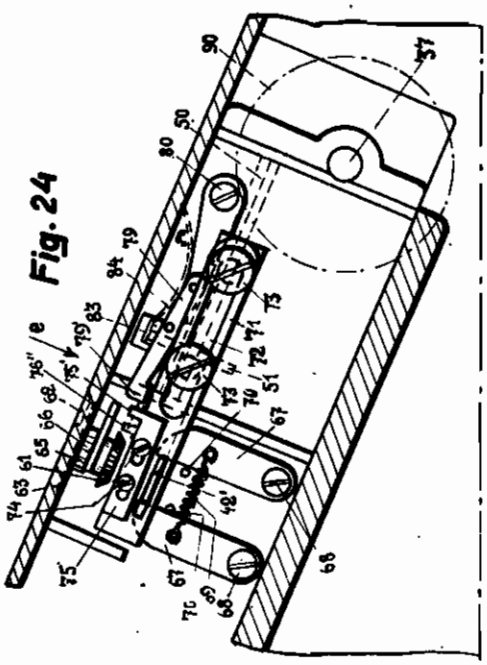
Fig. 24

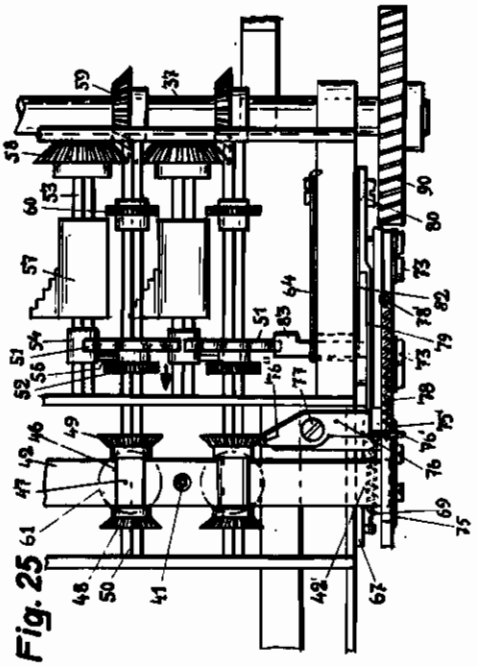
Fig. 25

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ALIEN PROPERTY CUSTODIAN

CALCULATING MACHINE

Karl Berthold Wilhelm Kiel, Glashutte, Germany; vested in the Alien Property Custodian

Application March 17, 1939

Calculating machines provided with short-cut multiplication arrangements are known in the most widely varied forms. A large number of this type of calculating machine is provided with a multiplier setting mechanism in which the multiplier must be completely set up and the machine then set in operation by actuating a so-called starter key. A defect of these machines is that the total multiplier must first be set up in the calculating machine before the latter can begin operation. The present invention does not relate to this type of machine, but rather to calculating machines provided with multiplier keys "0"–"9". By pressure on one of these keys a number of calculating shaft revolutions corresponding to the value of the key takes place and a subsequent carriage shift to the next higher decimal place occurs. Arrangements heretofore proposed are defective in that, on termination of the multiplication, it is necessary to see whether the machine has operated by the short-cut method in the highest decimal place in the multiplier and, if such is the case, a key must be again actuated. With careless operation, this requirement leads to incorrect results.

An object of the invention is to avoid this defect and to provide means whereby the multiplier keys, for short-cut multiplication, are subdivided into two groups and one group, that comprising the keys "6"–"9", is connected with a mechanism which initiates a number of calculating shaft revolutions in the minus or negative direction corresponding to the supplement of the key value and then causes the machine to make a plus or positive revolution, after the carriage shift. The group comprising the keys "1"–"5" operates in the usual manner.

An object of the invention, therefore, is to provide an arrangement in which a preliminary setting up of the multiplier is not necessary. On the contrary, the machine begins to operate at once with the first multiplier decimal position. In addition, after the multiplier has been keyed, the correct result appears in the totaliser, whether the highest decimal place of the multiplier has been considered negatively or positively in the machine.

Also calculating machines are known which are provided with a row of multiplier keys "0"–"9" and in which these keys, for the purpose of short-cut multiplication, are divided into two groups, one of which, the group "6"–"9", is connected with a mechanism which initiates negative or minus revolutions corresponding to the supplement of the key value. However, in these machines it is necessary to begin with the setting up of the highest decimal place of the multiplier and therefore a preliminary setting of the carriage is necessary. This preliminary setting is not only troublesome but, also, often causes calculating errors through carelessness of the operator.

An object of the invention is to provide a setting member provided with shoulders or abutments which control the revolutions of the calculating machine shaft and such setting member being shifted stepwise, and the multiplier keys cooperating therewith. According to the invention the setting member abutments cooperating with the keys "6"–"9" are made so that they allow two shift advances more than the supplement of the key value, of which one advance is employed in the usual manner to shift the calculating carriage into the next higher decimal place and the other serves for a plus rotation in such next higher decimal place. In this manner a constructively simple shift drive is provided in which all necessary actuations are initiated from a single setting member. As the setting member serves at the same time as a key check the result is that all keys can be checked until the movements initiated by the preceding key depression are completely terminated.

In accordance with the invention the complete totaliser must be in the range of the tens carrying-over mechanism provided by the machine or the totaliser must itself be provided with such a mechanism extending entirely therethrough. If these constructions are absent in the machine, it is preferable to provide an arrangement which, when the machine is set for negative or subtractive multiplication will release a correcting member so that on the tens carry-over into the highest acting operative dial it will move into the path of the gears connected with the dials and on the following carriage shift will cause the necessary rectifying movement. It is thus possible, to provide the arrangement of the present invention on calculating machines in which the calculating mechanism on the carriage has no tens carrying-over mechanism extending entirely therethrough and in which the carriage extends beyond the calculating machine frame proper.

It is an object of the invention to provide means whereby the key "0" of the multiplier keys may act through a rod device directly on the rod mechanism controlling the carriage shift. In this manner it is possible, by a single, long-continued pressure on the "0" key, to make a number of successive shifts of the carriage uninterruptedly, which may be suitable for example when the

multiplier has a number of zeros in adjacent decimal positions.

A further object is to provide a key stop for the multiplier key bank "6"–"9", which is carried into operative position when the highest decimal position of the revolutions counter is shifted opposite the lowest decimal position of the calculating mechanism, or when the carriage reaches its extreme right position. Errors in calculation caused by depression of one of the keys the value of which has already been supplementarily considered, are thereby prevented.

A further object is to provide means whereby after a key has been pressed in the last or highest position of the revolutions counter, in order to prevent errors by additional unintentional pressure on the multiplier keys, a check member is coordinated with the multiplier keys which prevents further depression of these keys, when the carriage is in its extreme right end position.

With these and other objects in view which will become apparent from the detailed description below, the invention is shown in the drawings in which:

Fig. 1 is a plan view of a Thomas calculating machine having the arrangement of the present invention.

Fig. 2 is a partial vertical cross section on line II—II of Fig. 1.

Fig. 2A is a continuation to the right of Fig. 2.

Fig. 3 is a partial lateral elevation viewed in the direction of the arrow *a* in Fig. 1 with the side plate removed.

Fig. 4 is a similar view to Fig. 3 showing the elements in a different operative position and with certain elements removed for greater clarity.

Fig. 5 is also a similar view to Fig. 3 showing the elements in a still different operative position and with certain parts omitted for greater clarity.

Fig. 6 is still another view similar to Fig. 3 with certain elements omitted to show the parts in a still further operative position.

Fig. 7 is a side elevational view showing the means for shifting the setting member operated from the main calculating shaft.

Fig. 8 is a side elevational view showing particularly the setting member and certain elements cooperating therewith.

Fig. 9 is a side elevational view of the setting member and various elements cooperating therewith in another operating position.

Fig. 10 is a similar view to Fig. 9 with certain portions omitted illustrating the parts in a different operative position.

Fig. 11 is a detailed view of certain elements shown in Fig. 9 with the parts in a different operative position.

Fig. 12 is a vertical cross sectional view on the section line XII—XII of Fig. 3 looking in the direction of the arrows.

Fig. 13 is a view similar to Fig. 12 with the parts in a different operative position.

Fig. 14 is a vertical cross sectional view on the section line XIV—XIV of Fig. 3 looking in the direction of the arrows.

Fig. 15 is a cross sectional view on the section line XV—XV of Fig. 3.

Fig. 16 shows a portion of Fig. 3 with the parts in a different operative position.

Fig. 17 shows a portion of Fig. 2A with the parts in a different operative position.

Fig. 18 is a partial rear elevational view looking in the direction of the arrow *b* in Fig. 2.

Fig. 19 is a partial lateral elevation viewed in the direction of the arrows *c* in Fig. 1 with the side plate removed and parts broken away for greater clarity.

Fig. 19A is a continuation of Fig. 19 to the right.

Fig. 20 shows a portion of Figs. 19 and 19A with the parts in a different operative position.

Figs. 21 and 22 are detailed showings of portions of Fig. 3.

Fig. 23 is a partial plan view of a calculating machine in which the carriage projects at one end beyond the machine frame.

Fig. 24 is a partial lateral elevation viewed in the direction of the arrow *d* in Fig. 23 with parts broken away.

Fig. 25 is a partial plan view looking in the direction of the arrow *e* in Fig. 24 with the cover and the carriage removed for greater clarity.

Fig. 26 is a view similar to Fig. 24 with the parts in a different operative position.

Fig. 27 is a partial plan view of Fig. 26 with the cover and carriage removed.

Fig. 28 is also a partial plan view of Fig. 26 with the cover and carriage removed showing the parts in a different position.

Fig. 29 is a partial cross sectional view on section line XXIX—XXIX of Fig. 23.

The calculating machine shown is driven by an electric motor and 1 designates the keyboard on which the multiplicand is set up in multiplying operations. The carriage 2 mounted slidably on the machine frame carries the revolutions counter 3 and the totaliser 4. 5 designates the two carriage shift keys. The clearing key is shown at 6, the quotient and division shift lever at 7, the addition key at 8 and the subtraction key at 9.

General features of calculating machine

As shown in Figs. 1, 2 and 2A, the keys 8 and 9 are mounted on the parallel adjacent levers 10 and 11, respectively. These levers are pivoted at 12 on the machine frame wall 14 and are each subject to the action of a spring 13, which hold the levers in the position shown in Fig. 2. Attached to the lever 10 is a pin 15 which extends within range of a lever 16. The latter is attached to a shaft 17 which is rotatably journalled in the machine frame.

Provided on the lever 10 is also a pin 18 which extends within range of the movement of an inclined surface 20 provided on a bar 22. A similar pin 19 is attached to the lever 11 and extends into the path of movement of the inclined surface 21 also provided on the bar 22. A slot 24 is provided in the bar 22 and a pin 23 provided on the machine frame extends therethrough. The other end of the bar 22 engages by means of a pin 25 with a lever described hereinafter.

An upwardly extending member 22' of the bar 22 is connected by a pin 26 with a lever 27 which is journalled in the machine frame at 28. Attached to the lever 27 is another lever 29 which carries a pin 30 which engages in the slot 31 of a lever 32. Lever 32 is pivoted at 33 to a plate 34 which is journalled by means of a pin 35 on the frame 14. Plate 34 is provided with a cam roller 36 which cooperates with a cam 38 mounted on the main calculating shaft 37. The cam 38 is circular and is provided with a recess 38' (see also Fig. 9), in which the cam roller 36 seats when shaft 37 is inoperative.

When the shaft 37 operates the plate 34, through the cam 38, is rocked against the traction of the spring 34' engaged therewith into the position shown in Fig. 17 by dot and dash lines.

The lever 32 thereby moves in the direction of the arrow in Fig. 2.

The lever 32 is provided with two shoulders 32' and 32''. According to the direction in which the lever 32 is rocked about the pivot 33 by the rod mechanism 22—30, one or the other of these shoulders will contact with one of the pins 39' or 39''. These pins are on a plate 39 mounted on a shaft 40. The latter is journalled in the two frame walls and provided with two upwardly extending pins 41 which engage at their free ends in two corresponding openings provided in a bar 42. The bar 42 is slidable transversely to its longitudinal axis in the machine frame.

The bar 42 engages in the annular recesses 46 of the mountings 47 which carry the bevel gears 48 and 49 at both sides and the mountings are longitudinally slidably but non-rotatably mounted on the square shafts 50.

Attached to each shaft 50 is a check disc 51 (see Fig. 29) the periphery of which is provided with ten circular recesses 51'. Connected with each disc 51 is a spur gear 52, each provided with ten teeth. With each shaft 50 there is coordinated a similar square shaft 53, on which a mounting 54 is non-rotatably but axially slidably mounted. This mounting 54 is provided with a check segment which, when the mounting is in the inoperative or starting position, checks the coordinated disc 51.

Also mounted on the mounting 54 is a tooth 56 which, when the corresponding housing is moved backwardly, that is, to the left according to Fig. 25, is carried into the plane of the gear 52. The movement of the individual mountings is effected by special fingers, which are actuated by the shift teeth 66 of the totaliser dials 63 provided in the carriage 2. These fingers are omitted so as not to confuse the drawing.

Mounted on each shaft 53 is a stepped roller 57, usual with Thomas machines, and bevel gear 58 (see also Fig. 19). The bevel gears 58 are driven by means of the bevel gears 59 on the main calculating shaft 37. Cooperating with the stepped rollers are the gears 60, mounted axially slidable but non-rotatably on the shafts 50, and the adjustment or setting of the gears 60 depends on the key depressed in the coordinated key bank 45.

The gears 60, one of which is coordinated with each key bank 45, according to the exemplary construction shown, are set in the following manner. Each key bank 45 contains nine key stems 100, which carry the keys "1"–"9." Journalled on the stems 100 (which are held in the initial position by springs not shown on the drawing) are the rollers 101 which extend into the plane of a bar 102. The later is pivoted at 103 and 104 to two levers 105 and 106 respectively. Lever 105 is journalled at 107 and lever 106 at 108 on the wall of the key bank.

Engaged with a lever arm 109 provided on lever 105 is a traction spring 110 which tends to apply the lever 105 and lever arm 109 against a stop pin 111. Lever arm 109 cooperates with a roller 112 carried by a downward extension 113 of a bar 114. Bar 114 is slidably guided along the key bank frame, and is engaged by a traction spring 115 which tends to hold the bar 114 in the initial position according to Fig. 19. The bar 114 is provided with a rack 116 which engages a gear 118 carrying a number dial 117. A downwardly extending extension 119 provided at one end of bar 114 is bifurcated and engages the gear 60.

Operation of calculating machine

The operation of this arrangement is as follows.

When, in the coordinated key bank, the key "4" is depressed, for example, the coordinated gear 60 is moved to the left as shown in Figs. 19 and 19A, by the rod mechanism 102—118, so that the gear 60 is moved opposite that portion of the stepped roller 57 on which there are four teeth. In a complete revolution of the main calculating shaft 37, during which the shafts 53 each describe a complete revolution, through the coordinated stepped roller the corresponding gear 60 as well as the shaft 50 carrying it, is rotated, for 4/10 revolution, corresponding to the four teeth entering into the operation on the stepped roller.

According to the position of the coordinated gear mounting 47, either the bevel gear 48 or the bevel gear 49 engages with the corresponding totaliser bevel gear 61. Each of the totaliser sight openings 62 provided in the carriage 2 has coordinated with it a number dial 63 attached to the shaft 64. The latter is journalled in the carriage 2 and, in addition to the bevel gear 61, carries the shift tooth 66 which, when the number dial is turned from "9" to "0," actuates a pawl which, in its turn, acts on the drive of the mountings 47.

Accordingly as the gear 49 or the gear 48 is engaged with the gear 61, the number dial 63 is rotated in the positive or negative direction, that is, when the shaft 50 is turned for a 4/10 revolution the number dial, for example, showing a "*a*," is either set forward to "6" or back to "8." The meshing of the bevel gear 49 or 48 with the gear 61 depends on the position of the lever 32, for in the rocking movement of the plate 34, if the lever 32 is in the upper end position as shown in Fig. 2, the plate 39 and the shaft 40 are rocked clockwise, while if the lever 32 is in the lower end position (as shown in Fig. 17), the plate 39 and the shaft 40 are rocked counterclockwise.

Shifting mechanism for revolutions counter

A very similar mechanism is provided for the revolutions counter mechanism 3. Coordinated with each sight opening 120 of this latter mechanism is a number dial 121 which is attached on a shaft 122 journalled in the carriage 2. Shaft 122 also carries a shift tooth 123 for the tens transfer and a bevel gear 124, with which latter the gear mountings 125 are coordinated, which are mounted non-rotatably but longitudinally slidably on the square shafts 126 extending coaxially with the shafts 50. Each mounting 125 is provided with a pair of bevel gears 127 and 128.

Engaged in the annular grooves 129 of the gear mountings 125, is the common bar 130 which is mounted on the machine frame and is slidable transversely to the longitudinal axis thereof. The bar 130 is shifted by means of two pins 132 on the shaft 131 which engage in corresponding bores in the bar 130.

Affixed to one end of the shaft 131 is a plate 133 provided with the pins 134 and 135, with which the shoulders 136 and 137 of a lever 138 cooperate. Lever 138 is journalled together with the lever 32, at 33, on the plate 34. The lever 138 is pivoted by the lever 139 which engages therewith by means of a pin 140 disposed in a slot 141 provided in the lever 138. Lever 138 is journalled at 142 in the machine frame and connected with another lever 143. The latter is connected by a link 144 with a double armed lever 145,

which is journalled at 146 in the machine frame. At the ends of the lever 145, pins 147 are provided which engage the slots 149 of a rocking plate 150. The rocking plate 150 is pivoted at 151 to the bar 22.

Through the elements 139—150 above described, the rocking movement of the lever 138 is simultaneously combined with the rocking movement of the lever 32. The movements of the levers 32 and 138 relative to each other can be reversed by means of the reversing members 145—150.

Means controlling carriage shift mechanism

The two carriage shift keys 5 are mounted on two adjacent levers 152 and 153 which are oscillatably mounted on the pins 154 attached to the machine frame. A traction spring 155, which tends to hold the lever 152 in the position shown in Fig. 2, engages the lever 152 of the key 5, which initiates the movement of the carriage to the right.

A plate 156 is also mounted rotatably on the pin 154 and this plate carries a pin 157 which extends into the path of movement of the lever 152. By means of a pressure spring 159 acting on an extension 158 of the plate 158, the plate 156 is urged to the position shown in Fig. 2. On depressing the corresponding carriage shift key 5, the plate 156 is rocked in the direction of the arrow shown in Fig. 2, so that the detent shoulder 160 of the plate 158 releases the square pin 161 on the lever 162.

Lever 152, journalled at 163 in the frame wall 14, can thereby rock downwardly under the action of the strong traction spring 164. A pin 165, attached to a lever 166, engages under the lever 162. Lever 168 is carried by the shaft 167 journalled in the wall 14, to which shaft 167 the lever 168 is affixed. This pair of levers 166 and 168 is rocked by the action of the spring 164 into the position shown in Fig. 9, and a pin 169 attached to the end of the lever 168 moves in the oblong slot 170 of a thrust rod 171. In this rocking movement of the pair of levers 168 and 168, the end of the lever 168 contacts with the lever 16 and rocks it to the dot and dash position shown in Fig. 19A, and the machine is set in operation by means of shaft 17.

A pair of levers 174 (see also Fig. 9) are journalled at 172 and at 173 on the lever 162. Through the action of the spring 175 engaged therewith, these levers are applied against a pin 178 affixed to lever 162. The ends of levers 174 receive the projecting extension 177 of a bar 178 between them. The bar 178 has a slot 179 through which a pin 180 attached to the lever 162 extends. The other end of the bar is pivoted to a slidable bar 162 by means of a pivot pin 181. The shift of the carriage is controlled by the movement of the bar 162.

Carriage shift mechanism

The following means serve for the shifting of the carriage. A spur gear 183 (see Fig. 18) meshing with a spur gear 164 of equal dimensions is affixed at the end of the shaft 53 at the extreme right as shown in Fig. 1, and this shaft is extended almost to the rear wall of the calculating machine. The spur gear 164 is fixed to a shaft 165 journalled in the machine frame and the shaft 165 has fixed thereto a clutch element 166. Slidably mounted on the shaft 185 is a spur gear 187 which is connected with the cooperating clutch element 168. The spur gear 187 is provided with an annular groove in which the bifurcated end 189 of a plate 190 engages. The plate 190 is mounted on the slidable bar 162. The spur gear 187 meshes with a spur gear 191 which in turn meshes with another spur gear 192 which is journalled on a pivot pin 193 attached to the machine frame. The spur gear 192 is provided with two diametrically opposed pins 194 which cooperate with the shift slots 195 of a bar 196 connected to carriage 2.

If, through the traction of the spring 164, the lever 162 is rocked into the position of Fig. 9 then, through the action of one of the levers 174, the bar 178 is drawn to the left, from the position shown in Fig. 2, so that the plate 190 is carried to the dotted line position shown in Fig. 2, and the two clutch elements 186 and 189 interengage. The drive motor being set in operation simultaneously, the gear 183 is rotated in the direction of the arrow in Fig. 18, and, through the intermeshing gears 184, 187 and 191, the gear 192 is rotated in the direction of the arrow in Fig. 18. The rotation of the gear 192 shifts the carriage 2 in the direction of the arrow in Fig. 18, which constitutes an advance to the right for one decimal position with respect to Fig. 1.

The drive control mechanism

The driving means are controlled as follows. Affixed to the shaft 17, at the left side of the machine as shown in Fig. 1 is a lever 483 (see Figs. 19 and 19A) to which is engaged a traction spring 494 which tends to retain the lever 483 in the full line position shown in Fig. 19A. Pivoted to the free end of the lever 493, at 495, is one end of a bar 496, which is connected at the other end, by means of the pivot pin 197, with a bell crank lever 198, which is oscillatably journalled on the pin 199 fixed to the wall 43.

Attached to the free end of the lever 196 is a pin 200 contacting one end of a double armed lever 201, which latter is pivoted at 202 on another lever 203 which in turn is journalled by means of the pivot pin 204 to the wall 43. A traction spring 205 engages the free end of the lever 201 and tends to apply the other end of the lever 201 against the pin 200. A pin 206, on a lever 207, engages under the lever 201. Lever 207 is oscillatably journalled by means of a pin 208 in the wall 43 and is subject to the action of a traction spring 209 which tends to rock the lever 207 upwardly.

Lever 207 is also provided with an abutment 210 which serves as a lock for a shoulder-like extension 211 provided on a lever 212 mounted on the shaft 213 journalled in the wall 43. The other levers 214 and 215 are also attached to the shaft 213. Engaged with the lever 215 is a traction spring 216 which tends to rotate these three layers clockwise as shown in Fig. 19. Attached to the end of the lever 214 and insulated therefrom is the contact member 217 which, when the lever is swung, bridges the contacts formed by the contact springs 218 and 219 in the circuit of an electric motor 44.

A projection 220 of the lever 115 extends into the path of movement of the coupling member 221, which is pivoted by means of the pivot pin 222 on a disc 223 attached to the main drive shaft 65. A pressure spring 224 engaged with the member 221 tends to press the friction surface 225 of such member into the wedge-shaped groove 226 of a collar 227 provided on a spur gear 228. Through the coupling 221 the shaft 65 is always stopped in a certain predetermined position.

Affixed to the shaft 65 is a cam 229 with which a roller 230 journalled on the lever 203 cooperates. A traction spring 231 connected to the lever 203 holds the roller 230 engaged with the cam 229. It is to be noted that the extension 211 also extends into the plane of the lever 201 which is provided with a locking shoulder 232 cooperating therewith.

The spur gear 228 is freely rotatable on the shaft 65 and carries the collar 227. A spur gear 233 which is fixed on the shaft 234 journalled in the machine frame meshes with the spur gear 228. Shaft 234 carries a belt pulley 235 which is connected by a drive belt with the pulley 237 on the motor shaft.

Multiplier key mechanism

Coordinated with the calculating machine above set forth are the multiplier setting keys 238 which, as shown particularly in Fig. 1, are arranged in two parallel adjacent rows. Each key 238 with the exception of the "0" key is mounted on a key stem 239. The stem 239' of the "0" key has a somewhat different form than the other stems (see particularly Figs. 3, 12 and 13).

The upper ends of the stems 239 and 239' are guided in the guide slots provided in a plate 240. The lower ends of the stems are guided in correspondingly shaped slots in a plate 241 which is disposed parallel to the plate 240. The plates 240 and 241 are connected together by the blocks 242 which are attached to a vertical plate 243 which in turn, as shown in Fig. 1, is supported by the two arms 244 on the machine frame. The stems 239 and 239' are provided with lateral extensions 245, against the lower edges of which bear the upper ends of the pressure springs 248. The springs 248 are carried by the stems, and at their lower ends bear against the guide plate 241.

Disposed below the key stems 239 of the keys "1"–"5" is a bar 247 which is carried by the two links 248. The lower ends of the stems 239 of the keys "6"–"9" have coordinated therewith a corresponding bar 249 carried by the links 250. The stem 239' of the "0" key is provided with a recess 251 of such shape that when this key is depressed, the stem 238' freely passes the bar 249. The link members 250 and 248 are mounted oscillatably, at 252, on the lower guide plate 241.

The setting member and cooperating parts

Between the two rows of key stems a square cross-sectional tube 253 is longitudinally slidably disposed, and is guided between the blocks 242. The tube is provided with recesses 254 which align with the key stems when the tube 253 is in the position shown in Fig. 3, so that the extensions 245 of the stems 239 and 239' may pass freely into the interior of the tube.

The tube is, also, provided on both sides with window-like recesses, of which the recesses 255 coordinated with the "5" and "6" keys have a width in the direction in which the tube moves, to accommodate six separate shift movements of the tube. The recesses 258 coordinated with the keys "4" and "7" have a width which accommodates five seperate shift movements of the tube 253. The widths of the window-like recesses 257 coordinated with the keys "3" and "8" correspond to four shift movements, and those of the recesses 259 coordinated with the keys "2" and "9" correspond to three shift movements. The recess 259 coordinate with the stem 239' extends to the window-like recess 258 on the corresponding side, while the recess 260 coordinated with the key "1" has a width extending longitudinally of the tube 253 which corresponds to two shift movements of the tube 253.

Attached at the right end of tube 253 is a pin 261, as shown in Figs. 3 and 4, with which a traction spring 262 is connected. The traction spring is connected at the other end, at 263, to the machine frame, and urges the tube 253 in the direction of the arrow in Fig. 3.

In the initial position shown in Fig. 3, the tube is held by a pivoted locking lever 264 which is journalled in the bearing block 265 extending downwardly from the tube 253 and, through a torsion spring 268, the lever 264 is given a tendency to swing upwardly. The front and free end of the locking lever is applied against an abutment 267 provided on the plate 241 forming the terminal of a groove 268 (see Fig. 15) provided in the plate 241. Attached to the tube 253 is a rack 269 which extends downwardly through the slot 268 of the plate 241 and meshes with a spur gear 270. The latter is journalled on a spindle 271 fixed to the frame plate 243 and connected by a tubular housing 272 with a ratchet wheel 273.

Provided on one side of the ratchet wheel 273 is a pin 274 with which an extension 278 provided on a lever 275 cooperates. Lever 275 is oscillatably journalled at 277 on the plate 243 and is provided with another extension 278 in which a V-shaped recess is provided with which the correspondingly formed end 270 of a double armed lever 280 engages. The lever 280 is journalled on a pin 281 fixed to the frame plate 243. Connected to the lower end of the lever 275 is a traction spring 283 which has its other end connected at 282 to the frame plate, and which tends to rock the lever 275 clockwise as seen in Fig. 3. The lever is, however, held in the checked position shown in Fig. 3 by the cooperation of the lever end 279 and the extension 278. Also attached to the lever 275 is a pin 284 which passes through a recess 285 of the frame plate 243 and to which one end of a bar 286 is pivoted. Bar 286 has a slot-like recess 287 through which a pin 288 attached to frame plate 243 passes. An extension 289 is provided on the bar 286 and projects upwardly so as to come within the path of movement of a pin 290 provided on the lever 16.

A traction spring 292, connected at 291 to the frame plate, and connected to the lever 280 tends to swing it in the direction of the arrow in Fig. 3. A double armed lever 293 is journalled at 294 on a downward extension of the lever 280 and has a hook-like form on its upwardly extending arm 295. A traction spring 296 is connected to the arm 295 and is connected at 297 to the lever 280 and urges the lever 293 against a stop 298 provided on the lever 280.

Fixed on the guide plate 241 is a bearing block 299 which carries the pivot pin 300 for a lever 301, the free end of the latter being provided with a pin 302 which extends below both of the bars 247 and 249 (see Fig. 14). A spring 303 is connected at one end to the lever 301 and at the other end is connected to the plate 241, and tends to hold the lever 301 in the initial position shown in Fig. 3. Journalled on the lever 301 by means of the pivot 304 is a pawl plate 305 to which is connected one end of a traction spring 306 while the other end is attached to the lever 301, and which tends to apply the right-angularly bent end 307 of the pawl plate against the upper edge of the lever 301, so that the upwardly extending, hook-shaped end 308 of the pawl plate 305 extends within range of

the hook-like extension 309 provided on the lever 284.

An angular bar 312 has a slot 313, through which a pin 314 attached to the frame plate 243 passes and is connected to the bar 249 which, like the bar 247, is held in its initial position by the springs 310. A corresponding bar 315 is pivoted to the bar 247 and also has a slotted end engaging the pin 314. Fixed to the bar 312 is a pin 316 with which the obliquely extending surface 317 of a lever 318 cooperates.

Lever 318 is connected by a tubular housing 319 with a lever 320 whose obliquely extending surface 321 cooperates with a pin 322 corresponding to the pin 316, and attached to the bar 315. The housing 319 is fixed on a shaft 319' journalled in the frame plate 243, and this shaft also carries the lever 323, to the end of which, by means of the pin 324, is pivoted a plate 325 which is provided at its free end with two oppositely extending recesses 326 and 327 which have V-shaped guiding margins (see Fig. 2A).

The plate 325 is provided with a slot 328 in which a pin 329 engages. The latter is disposed slidably in a slot 330 with the cooperation of a drag spring (not shown), and the slot 330 is provided in a frame plate 331. If the plate 325 is in the position shown in Fig. 2A the recess 326 engages over a pin 332 which, together with another pin 333, is attached to the plate 334. Plate 334 is mounted on a shaft 335 journalled in the wall 14 and the shaft 335 also carries a lever 336. The bifurcated end 337 of the lever 336 engages the pin 25 on the end of the bar 22.

Journalled oscillatably on the pin 281, in addition to the lever 280, are two other three-armed levers 338 and 339, of substantially the same form. Attached to the arm 340 of the lever 338 is a pin 341 which extends into the plane of movement of the bar 249, while the arm 340 of the lever 339 carries a pin 342 which extends into the plane of movement of the bar 247. A bell crank pawl lever 344 is pivoted at 345 to each arm 343 of the levers 338 and 339 and the hook-shaped upper ends 346 cooperate with a pin 347. The free end of each pawl level 344 is provided with a pin 348 against which the torsion springs 349 are applied and which tend to rock the pawl levers in the direction of the arrow in Fig. 3.

In the inoperative position, the arms 343 of the levers 338 and 339 are applied against a pin 350 attached to the frame plate 243.

Lever 338 carries an upwardly directed arm 351, while the lever 339 has a corresponding upwardly directed arm 352. The levers 338 and 339, which are substantially of the same form, differ, as shown particularly in Fig. 3, only in that the arm 251, as compared with the arm 352, projects further to the left, for the distance of a shift movement, and both arms project into the movement plane of the rack 269 attached to the shift tube 253.

The pin 347 cooperating with the pawl levers 344 is attached, right angularly projecting, to the end of a lever 353 and passes through a rectangular recess 354 of the plate 243. Lever 353, whose projecting shoulder 355 cooperates with an abutment pin 356 attached to the plate 243, is pivoted at 357 to the upwardly directed arm 358 of a three-armed lever 350, 359, 360, which is journalled by means of the pin 361 oscillatably on the plate 243. See Figs. 2, 8 and 9. The second arm 359 of this lever extends into the movement plane of a pin 362 which is provided on the lever 363. The lever 363 is fixed on a shaft 364 journalled in the machine frame and which carries another lever 365, at the end of which latter lever 365 there is a pin 366 which passes through a slot 367 at the end of a bar 368. The bar 368 engages the plate 156 by means of the pivot pin 389. Pivoted to the third arm 360 of the three-armed lever 356—360, at 371, is another lever 370, with which there is engaged a torsion spring 372 which tends to force the inclined end of the lever 370 against a pin 373 provided on the frame plate 243.

Lever 370 is provided with a finger-like extension 374 which cooperates with a finger-like extension 375 which is connected with the downwardly extending lever 323.

The end of the lever arm 358 extends within the operative plane of a chisel-like extension 377 provided on a bar 376, which latter is guided slidably on the two pins 378 attached to the frame plate 243 and which pass through two elongated slots 379 in the bar 376. The bar 376 is provided with a downwardly directed extension 376' (Fig. 7) which extends into the movement plane of a pin 380 attached to the thrust rod 171 which latter, by means of a bearing eyelet 381, encompasses an eccentric 382 which is attached to the main drive shaft 65 journalled in the machine frame. As shown in Fig. 2 a spur gear 383 is attached on the shaft 65 and meshes with the spur gear 384 attached on the main calculating shaft 37.

Totaliser and revolutions counter disconnecting means

The cam 36 is mounted freely rotatable on the shaft 37 and is provided with a coupling pawl 385 which is pivoted at 386 on the disc 36. Engaged with one end of the jawl 385 is a leaf spring 387, attached to disc 38, which tends to force the shoulder-like projecting end 388 into a recess 389 of a drive disc 390, which is rigidly connected with the main calculating shaft 37.

Coordinated with the pawl 385 is a roller 391 which is journalled on the upwardly extending end of a double armed lever 392, which is oscillatably attached to the machine frame by means of the pivot 393. The lower end 394 of the lever 392 extends into the movement plane of a shoulder-like extension 395 provided on the end of a bar 396, which has an oblong opening 397 through which a pin 398 attached to the frame wall extends. The other end of the bar 396 is pivoted to the pin 169.

Ratchet shifting means

A traction spring 401, fastened at one end to the plate 243 and at the other end to the bar 376 at 400, tends to apply the extension 376' constantly against the pin 380 (Fig. 7). A shift pawl lever 403 is journalled on the bar 378 by means of the pivot 402 and is provided with a shift tooth 404 extending through a corresponding opening provided in the frame plate 243 engaging in the corresponding denture of the ratchet wheel 273. A spring 403' engaged with pawl 403 tends to apply it against a pin 403'' attached to the bar 376 (Fig. 7).

Multiplier keys stop means

As shown in Figs. 12, 13, 14 and 21, there is coordinated with the key row "6"–"0" a stop bar 405 having oblong openings 406 in which the pins 407, serving as guides, engage. Connected to the bar 405, at 408, is a traction spring 409 which is connected at its other end to the pin 410 on the guide plate 241. This spring urges the stop bar 405 in the direction of the arrow in

Fig. 21. In the position of the bar 405 shown in full lines in Fig. 21, the recesses 411 provided in the stop bar are opposite the key stems 239 and 239' so that on pressing the keys the corresponding lateral extensions 245 can enter into the recesses.

The bar 405 is provided with a pin 412 which engages in an oblong opening 413 provided at one end of an actuating bar 414. The latter is connected at its angularly bent-down end 415, by means of a pivot 416, with one end of an angle lever 417 which is pivotally mounted on the machine frame at 418. The free, upwardly bent end 419 of the lever 417 extends into the movement plane of a stop bar 420 attached to the carriage 2.

The rectangularly bent end 421 of an extension 422 directed at right angles to the plane of the frame plate 243, is coordinated with the key stem 239'. The extension 422 is carried by a lever 423 which is journalled on the pivot 424 provided on the frame plate 243. Connected with the lever 423 is another lever 425 at the end of which a pin 426 is attached. The pin 426 extends through a recess 427 (Fig. 3) provided in the frame plate within range of the upper end of an angle lever 428 which is journalled at 429 on the plate 243. The free end of the angle lever 428 engages over the pin 362 on lever 363.

In order that both bars 247 and 249 cannot be depressed simultaneously by the keys the lock plate 430 is provided which is journalled by means of the pivot 431 on a downwardly extending flap 432 attached to the guide plate 241.

It is also to be noted that a pin 433 (Fig. 9) is attached to the arm 359 of the triple-armed lever 358, 359, 360 and such pin extends through a recess 434 (Fig. 4) of the plate 243 to cooperate with the downwardly extending bent end of the lever 283.

Operation

The operation of the machine is explained with reference to the following calculation: 45×703. The "5" of the key bank farthest at the right is first set up in the keyboard, and the "4" in the next adjacent key bank. The result thereof is, in known manner, that the gear 60 coordinated with the extreme right key key bank is moved on its shaft so that it comes into position opposite that part of the cooperating stepped roller 57 which has five teeth. The gear 60 coordinated with the second key bank is, on the other hand, moved on its shaft 50 so that it comes opposite that part of its cooperating roller 57 which has four teeth. It is also to be noted that the parts are at first in the basic position shown in Figs. 2, 2A, 19 and 19A.

After the multiplicand has been set up on the keyboard in the manner described, the multiplier can be set up by means of the keys 238, beginning with the lowest decimal position. Thus the "3", thereafter the "0" and finally the "7" of the highest decimal position is depressed.

Operation upon pressing multiplier key "3"

On pressing the multiplier key "3" into the position shown in Fig. 4, the lower end of its key stem 238 strikes against the bar 247 and carries it, against the action of the spring 310, into the position shown in Fig. 4. In the descent of the bar 247, the angular bar 315 connected therewith is moved into the position shown in Fig. 4, and its pin 322, contacting with the inclined surface 317 of the lever 320, holds the latter in the position shown in Fig. 4.

At the same time, the lever 301 is rocked into the position shown in Fig. 4 by the descending bar 247 striking against the pin 302. Thereby, through the cooperation of the hook-shaped end 308 and the extension 309, the locking lever 264 is swung downwardly until the front end of the lever 264 is released from the abutment 267 and the square tube 253 can then pass into the position shown on Fig. 4.

In accordance with the width of the recess 257 coordinated with the key "3", the tube 253 can move a distance equal to the left as shown in Fig. 4. As soon as the lever 301 assumes the position shown in Fig. 4, the lever 293 can rock into the position shown in Fig. 4, wherein its hook-shaped arm 295 engages over the pin 302. Shortly before the bar 247 attains the end position shown in Fig. 4 its right end contacts with the pin 342 of the lever 339, whereby the latter is rocked into the position shown in Fig. 4, in which the pawl 344 pivoted thereto, engages by its hook-shaped end 346 over the pin 347.

As soon as pressure is removed from the "3" key it can return to the intermediate position shown in Fig. 5, wherein the lateral extension 245 of its key stem 239 is applied against the upper edge of the tube recess 257. By the return of the key stem to the intermediate position of Fig. 5, the bar 247 and the lever 301 also rock back into the position of Fig. 5. In doing so, however, the lever 301, by means of the pin 302, carries the lever 293 along upwardly, which in turn moves the lever 280 into the position of Fig. 5. This releases the extension 278 of the lever 275, which then, under the traction of the spring 283, rocks into the position shown in Fig. 5, and moves the bar 286 connected with the lever 275 into the position of Fig. 5.

In this movement of the bar 286 the upwardly directed extension 289 strikes against the pin 290 on he lever 16 and swings the lever 16 into the position of Fig. 5. Referring to Figs. 19 and 19A, this means that the lever 16 moves from the base position shown in dotted lines into that shown by dot and dash lines. As the lever 16 is connected by the shaft 17 with the lever 483, the latter is swung into the position shown in dot and dash lines. This moves the rod 496 and pivots the lever 198 to the dot and dash line positions. When the lever 198 is pivoted, the lever 201 is moved by means of the pin 200 into the position of Fig. 20. This, through the pin 206, results in the simultaneous rocking of the lever 207 into the position of Fig. 20.

As soon as the lever 207 reaches the position of Fig. 20, its shoulder 210 releases the extension 211, so that the three interconnected levers 212, 214 and 215, under the action of the traction spring 216, rock into the position of Fig. 20. The contact springs 218 and 219 are thereby bridged by the contact member 217, so that the circuit of the electric motor 44 is closed. The electric motor then revolves the shaft 234 in the direction of the arrow in Fig. 19. The projection 220 on the lever 215 has released the coupling member 221 at the same time and the disc 223 and the collar 227 are coupled together with the result that the shaft 85 is rotated in the direction of the arrow in Fig. 19.

During the course of the first revolution of the main shaft 65 (see Fig. 7) the pin 280 on the thrust rod 171 contacts with the downwardly directed extension 376' of the slidable bar 376, and such bar is moved against the traction of the spring 401, in the direction of the arrow in

Fig. 7. The shift tooth **404** on the bar **376** contacts an opposing tooth of the ratchet wheel **273** and turns it back for one shift movement toward the initial position. The tube **253** is, therefore, moved back to the right from the position shown in Fig. 4 for one shift movement by means of the rack **269** and the gear **270**.

During the second half of the first revolution of the main shaft **65**, the thrust rod **171** is carried to the left with respect to Fig. 2, and the bar **376** also moves back to its initial position. Inasmuch as the bar **288** is still in the position of Fig. 5 at the end of the first revolution of the main shaft **65** the motor circuit remains closed, so that the main shaft passes at once from the first to the second revolution. During the second revolution of the main shaft, the ratchet wheel is moved back for another shift step. This is repeated twice more before the machine comes to a standstill.

It is to be noted that after the second shift, thus during the second revolution of the main shaft, the tube **253** has been moved back into the position of Fig. 8, in which position the right edge of the rack **269** almost contacts with the upwardly directed extension **352** of the lever **339**. During the first half of the third revolution, the bar **378** is moved to the right and through the shift tooth **404**, the ratchet wheel **273** is shifted back for the third shift movement. During the accompanying shift movement of the tube **253** the right end of the rack **269** strikes against the end **352** of the lever **339** and rocks it into the position shown in Fig. 9, and the pawl lever **344** on the lever **339** carries the lever **353** therewith downwardly so that its shoulder **355** is released from the abutment pin **356**. The three-armed lever **358**, **359**, **380** then swings under the traction of its spring **435** and applies its upper end **436** against the extension **377** of the bar **376**.

During the second half of the third revolution of the main shaft the bar **376** is moved back to the initial position of Fig. 2 on the movement to the left of the thrust rod **171**. Lever **358**, **359**, **360** rocks into the position shown by dotted lines in Fig. 9. The pin **433** on the triple-armed lever strikes against the angularly bent down lower end of the lever **293** and the lever **293** is swung into the position shown in Fig. 9. In this position, the hook on the arm **295** releases the pin **302**, so that it may move against the bar **247** which is still in the intermediate position shown in Fig. 5. In this rocking of the triple-armed lever **358**, **359**, **360** into the dotted position of Fig. 9, the lever **370** pivoted to the lever arm **360** moves to the dotted position shown in Fig. 9, and the extension **374** on the lever **370** passes freely by the extension **375**.

In addition, the levers **363** and **365** are rocked into the position of Fig. 9 in the rocking of the three-armed lever **358**, **359**, **380**, since the lever arm **359** strikes against the pin **362**. In this rocking movement, by means of the bar **368** the plate **156** is rocked into the position of Fig. 9, in which its detent shoulder **160** releases the square pin **161**.

Through the release of the pin **161**, the lever **162** may rock into the position of Fig. 9, under the traction of the spring **164** engaged therewith. In this movement of the lever **162**, the bar **178**, by means of one of the levers **174**, is moved to the left from the position shown in Fig. 2, and the bar **182** with the parts connected thereto move into the dotted position of Fig. 2. The spur gear **187** is thus moved on the shaft **185** so that the clutch elements **186** and **188** interengage.

At the same time, however, in the rocking of the lever **162**, it strikes against the pin **185**, so that the pair of levers **166** and **168** are rocked into the position of Fig. 9. In this rocking movement of the levers **166** and **168**, the pin **169** on the lever **168** moves the bar **386** into the position of Fig. 9, and the shoulder **395** on the bar **396** carries the lever **392** into the position shown in Fig. 9. The roller **391** on the lever **392** thereby passes into the range of the coupling pawl **385**.

If, at the end of the third revolution of the main shaft, the end of the coupling pawl **385** comes within the range of the roller **391**, the coupling pawl is swung into the position of Fig. 9, against the pressure of the spring **387**, and the projecting end **388** on the lever **385** is swung out of the recess **389** of the drive disc **390**.

During the fourth revolution of the main shaft the cam **38** therefore remains stationary and the rocking plate **34** and the levers **32** and **138** connected therewith remain in the initial position shown in Fig. 2. This means, however, that during the fourth rotation of the main shaft **65** the bars **42** and **130** are not moved from their median position and the gear mountings **47** and **125** are not moved and remain in neutral position. Nevertheless although the gear mountings **47** and **125** are rotated by the main calculating shaft **37**, there is thus no transfer into the dials during the fourth revolution of the main shaft. On the other hand, by the engagement of the clutch elements **186** and **188**, the spur gear **187** is set in rotation which, through the interposed gear **191**, causes a half revolution of the carriage shift gear **192**. During the fourth revolution of the main shaft, the carriage is moved to the right, from the position shown in Fig. 1, for one decimal position.

During the first half of the fourth revolution of the main shaft **65** the ratchet wheel **273** has been moved by the shift tooth **404** back to the initial position shown in Fig. 3. In such movement the pin **274** on the ratchet wheel **273** strikes against the extension **276** of the lever **275** and swings it back into the initial position shown in Fig. 3, and the end **279** of the lever **280** moves, as a support, into the V-shaped recess in the extension **278** of lever **275**. As the lever **275** again moves into the initial position of Fig. 3, the bar **286** is also drawn back into the initial position, so that its extension **289** releases the pin **290** on the lever **16**.

As the lever **16** is returned through the traction of the spring **494** to its initial position, then at the same time, the pin **200** is returned to the initial position shown in Fig. 19 by the bar **498** and the lever **198**. The pin **200** releases the lever **201** which is rocked upwardly counter-clockwise by the traction of the spring **205**, and the locking shoulder **232** moves to a position in front of the extension **211**.

Shortly before the termination of the fourth revolution of the main shaft, the lever **203** is swung to the left by means of the cam **229**, from the position shown in Fig. 19 and the shoulder **232** carries along the lever **212** and the levers **214** and **215** connected therewith to the initial position shown in Fig. 19. After the passage of the high point of the cam **229**, the lever **203** swings back to the initial position under the traction of the spring **231** and the abutment **210** of the lever **207**, which has been released by the

lever 201, locks the extension 211, so that the three levers 212, 214 and 215 are held in the initial position shown in Fig. 19.

This, however, means that the circuit for the electric motor 244 is broken at the contact springs 218 and 219, and the connection between the disc 223 and the spur gear 228 is interrupted. As shown in Fig. 19, the shoulder 220 of the lever 215 has moved into the path of the coupling member 221, and the latter has been moved into the uncoupling position against the pressure of the spring 224. The machine is thus brought to a stop after the fourth revolution of the main shaft. The totaliser shows a value of "135", while a "3" appears in the revolutions counter.

In the last shift movement of the ratchet wheel 273 into the initial position the tube 253 was also moved back to its initial position as shown in Fig. 3. In this position, the slot passage 254 of the corresponding recess 257 is in the plane of the stem 239 of the key "3" so that the stem snaps back to the initial position under the action of the spring 246 associated therewith. The machine is thus ready for receiving the next multiplier digit.

It is to be noted that during the first half of the fourth revolution of the main shaft, while the bar 376 is carried to the right by the thrust rod 171, the extension 377 of the bar strikes against the upper end 438 of the three-armed lever 358, 359, 360 and moves it back to the initial position, and the shoulder 385 of the lever 353 hooks in behind the abutment pin 356. At the same time the pin 347 is positioned in front of the pawl lever 344 again, as shown in Fig. 3.

Operation upon pressing multiplier key "0"

The second, or the tens digit of the multiplier is then carried into the machine, by depressing the multiplier key "0". When this key is depressed there is no simultaneous downward movement of the coordinated bar 249 because the key stem 239' is provided with a recess 251 to avoid this. On pressing this key, the lever 301 which releases the locking lever 264 is not carried along downwardly therewith. The tube 253 remains in the initial position.

On the other hand, the key stem 239' strikes the end 421 of the extension 422 of the lever 423, the levers 423 and 425 are moved to the positions shown in full lines in Fig. 16. Through this movement of the lever 425 the lever 363 is rocked clockwise by the pin 426 and the cooperating bell crank lever 428 as shown in Fig. 16. In this rocking movement, the plate 156 is carried by the connecting bar 368 into the position of Fig. 9, in which position the detent shoulder 180 thereon releases the pin 161. Through the release of the pin 161, the lever 162 can likewise rock to the position of Fig. 9 which, through the bar 178, couples the clutch elements 188 and 198.

Simultaneously with the rocking movement of the lever 162, the levers 166 and 168 are swung into the position of Fig. 9 and the bar 396 is carried into the position shown in Fig. 9. The lever 392 is pivoted moving the roller 391 to depress the end of the pawl 365 to uncouple the end 388 from the recess 389.

Furthermore, as a result of the rocking of the lever 168, the lever 16 has been moved to the position shown in dot and dash lines in Fig. 19 and through the bar 496 and the lever 198 the electric motor's circuit is closed and the disc 223 and collar 227 coupled together.

Through the pivoting of the levers 423, 425 and 428 following the pressure on the multiplier key "0" the machine is set in operation, but with the cam 38 disconnected, so that the dials of the totaliser and the revolutions counter are not actuated. On the contrary, however, on the rotation of the main calculating shaft 37 and the corresponding shaft 53, the carriage is shifted one decimal place to the right with reference to Fig. 1 by the coupling of the clutch elements 186 and 186.

If, as in the present case, only a "0" is to be transferred then, after a short pressure on such key, the latter is at once released. After the release of the "0" key, the traction spring 437 acting on the angle lever 428 returns the levers 423 and 425 again to the initial position, as shown by the dotted lines in Fig. 16. The pin 362 is also released, and the stop plate 156 rocks through the action of the pressure spring 159 into the intermediate position shown in Fig. 9, in which the plate 156 has its curved part 438 applied against the pin 161.

Slightly after the main shaft 65 has described a half revolution the levers 166 and 168 are swung by the thrust rod 171 to the right, and the pin 165 engaging under the lever 162 swings the latter upwardly so that the square pin 161 comes in front of the shoulder 160 of the lever 156. As soon as this occurs, the plate 156, through the action of the spring 159, snaps into the initial position as shown in Fig. 2, in which the lever 162 is held, against the traction of spring 164.

When the levers 166 and 166 are rocked into the initial position of Fig. 2, the lever 16 is also released and the lever 493 returns to the initial position shown by the full lines in Fig. 19A. This position requires, however, that the pin 200 on the lever 198 be in the position shown in full lines in Fig. 19 with the result that on the termination of the revolution, the motor current is broken and the extension 220 which disconnects the clutch comes into operative position. Thus, after the carriage has made a further shift movement to the right, the machine is brought to a stop. The "1" of the value "135" in the totaliser is thus moved to a position opposite the extreme right hand bank of the keyboard.

Operation upon pressing multiplier key "7"

To complete the calculation, it is now only necessary to carry the digit in the hundreds position of the multiplier into the machine, which is done by pressing the multiplier key "7." On pressing the "7" key to the lower position shown in full lines in Fig. 6, the lower end of its key stem 239 moves the bar 248 into the position shown in Fig. 6.

As the pin 302 on the lever 301 also engages under the bar 249, the lever 381 is simultaneously rocked against the traction of the spring 303 into the position of Fig. 6. The hook shaped end 308 therefore swings the lever 264 downwardly and the front end thereof is released from the abutment 267. The tube 253, then moves into the position of Fig. 6 under the action of the spring 262.

In this position of the tube, the right edge of the window-like recess 256 is applied against the key stem extension 245 which has been moved through the slot passage 254 into the interior of the tube. In accordance with the width of the window-like recess 258, the tube moves from its initial position five shift movements to the left and the rack 269 cooperating with the gear 270

rotates the ratchet wheel 273 into the position shown in Fig. 6.

Through the descent of the bar 249, the bar 312 pivoted thereto has been moved into the position of Fig. 6, and the pin 318 on the bar 312, in cooperation with the surface 317 on the lever 318, has swung the three interconnected levers 318, 320 and 323 into the position of Fig. 6. In the rocking movement of the lever 323 from the dotted line position into the full line position, (see also Fig. 17) the bar 22 moves into the position shown in full lines in Fig. 17 through the action of the elements 325, 332, 334 and 336. The result of this is that the lever 32 is rocked downwardly by the levers 27 and 29, and the lever 136 is rocked downwardly by the levers 143 and 139, whereby the lower shoulders 32'' and 138 of the levers 32 and 138 are positioned in front of the pins 38'' and 134. Thus, when the cam 38 is set in operation, the bevel gear mountings 47 and 125 are negatively connected with the dial bevel gears 61 and 124 of the totaliser and revolutions counter, that is, the control bars 42 and 130 are moved in such manner that the bevel gears 46 and 126 become operative.

Shortly before the bar 248 reaches its lowermost end position, its right end strikes against the pin 341 of the lever 338 and rocks it into the position shown in Fig. 6, in which position the shoulder 348 of the pawl lever 344, pivoted to the lever 338, engages over the pin 347.

It is to be noted that in the downwardly swung position of the lever 301, the pawl shoulder 295 lies over the pin 302. If now the depressed key is released so that it can return to the dotted position of Fig. 6 then, in the consequent swinging of the lever 301 to the dotted intermediate position of Fig. 6, the lever 280 is in the position shown in Fig. 6 by the lever 283. In this position the end 279 on the lever 280 releases the extension 278 of the lever 275 so that the latter can swing into the position of Fig. 6 under the traction of the spring 283 engaged therewith. In this position, the extension 278 of the lever 275 which is formed as a stop pawl engages in the teeth of the ratchet wheel 273.

In the rocking movement of the lever 275 into the position shown in Fig. 6, the bar 286 is moved to the left so that the machine is set in operation through the lever 16, shaft 17 and lever 493 in the manner above described.

Inasmuch as in the preceding rotation of the main shaft 65 the levers 188 and 186 were swung back by the thrust rod 171 into the initial position shown in Fig. 2, the bar 398 was also carried back to the initial position shown in Fig. 2. This, however, caused the lever 392 to be released by the shoulder 395, so that it could rock under the traction of its spring 439 into the initial position shown in Fig. 2. Thus, for the next operation of the machine, the coupling pawl 395 is in the operative position as shown in Fig. 2.

During the first revolution of the main shaft the multiplicand "45" (4500) is subtracted from the value "135" in the totaliser, so that at the end of the first revolution of the main shaft the value 9 999 995 635 appears in the totaliser. At the same time the ratchet wheel is turned back for one shift by means of the bar 378 and the shift tooth 484 during the movement to the right of the thrust rod 171, which takes place on each revolution of the main shaft 65, so that the ratchet wheel moves into the position shown in Fig. 5.

At the end of the first revolution of the main shaft, since the lever 276 and the bar 286 are still in the position of Fig. 6, the main shaft 65 at once moves from the first into the second revolution. During the second revolution, the multiplicand "45" (4500) is again subtracted, so that at the end of the second revolution of the main shaft, the value 9 999 991 135 appears.

During the third revolution of the main shaft, during which the ratchet wheel 273 is turned back for a third shift movement, the multiplicand is again subtracted, so that at the end of the third revolution of the main shaft, the value 9 999 986 635 appears in the totaliser.

During the third revolution of the main shaft, the tube 253 is carried from the full line into the dotted line position of Fig. 10. The right end of the rack 289 therefore strikes against the arm 351 of the lever 338 and rocks it into the dotted line position of Fig. 10, in which movement of the lever 338, the pawl lever 344 thereon carries the pin 347 along therewith, so that the lever 353 is swung into the dotted line position of Fig. 10. In this position, the hook-shoulder 355 of the lever 353 is drawn away from the abutment pin 356. The lever 358, 359, 360 is therefore held in the initial position only by the extension 377 on the bar 376, as indicated by the full line position in Fig. 9.

In the second half of the third revolution of the main shaft, the bar 376 returns to the initial position and the extension 377 releases the three-armed lever 358, 359, 360 so that the latter can rock into the dotted line position of Fig. 9.

By this movement of the lever 358, 359, 360, the machine is set for a carriage shift movement in the manner above described and this takes place in the fourth revolution of the main shaft. The thousandths position of the totaliser then appears over the right hand key bank of the keyboard.

It must be also noted that in the rocking movement of the three-armed lever 358, 359, 360, which takes place during the second half of the third main shaft revolution, the lever 370 is carried into the position shown in full lines in Fig. 11, in which the finger-like extension 374 is positioned in front of the finger-like extension 375 of the lever 323.

During the fourth main shaft revolution, in which the carriage is shifted, the bar 378 is carried into the dotted line position of Fig. 11. The extension 377 on the bar 376 moves the lever 358, 359, 360 into the dotted line position of Fig. 11 (initial position). In this movement the lever 353, which was in the meantime released by the lever pawl 344, again positions its shoulder 355 in front of the abutment pin 356. Also when the three-armed lever 358, 359, 360 was swung into the dotted line position of Fig. 11, the lever 370 connected therewith, by means of its extension 374 swings the extension 375 and the lever 323 connected therewith, into the dotted line position of Fig. 11.

Through this rocking movement of the lever 323 into the dotted line position of Fig. 11, which corresponds to the position shown in Fig. 2, the levers 32 and 138 are pivoted upwardly by means of the elements 325, 332, 336, etc. into the position shown in Fig. 2 in which the totaliser and the revolutions counter are in position for positive operation.

At the same time, the three-armed lever 358, 359, 360 which has moved to the initial position, has released the pin 347, so that the lever 353 may move into the locked position. At the end

of the fourth revolution of the main shaft the parts are thus again in the position shown in Fig. 2.

During the fourth revolution of the main shaft, however, the ratchet wheel 213 has been turned back for a fourth shift and it is now still one shift from its initial position.

The main shaft thus passes at once from the fourth rotation into the fifth, and the multiplicand is carried once, positively, into the totaliser in accordance with the position above set forth of the levers 32 and 138. At the end of the fifth rotation, the result in the totaliser is 31 635.

During the fifth revolution of the main shaft the bar 276 is again carried to the right from the position shown in Fig. 2 and the ratchet wheel is shifted back to the initial position shown in Fig. 3. The pin 274 on the ratchet wheel 213 strikes against the extension 276 of the lever 275 and swings it to the initial position shown in Fig. 3. This takes place with a tensioning of the spring 283 and a simultaneous movement of the bar 286 to the initial position, in which the upwardly directed extension 289 of this bar releases the pin 290 so that the lever 16 may rock back to its initial position. The return of the lever 16 to the initial position causes the elements shown in Figs. 19 and 19A to be returned to their initial positions which brings the machine to a stop at the end of the fifth revolution of the main shaft. As soon as the tube 253 is returned to its initial position during the last revolution of the main shaft, the extension 245 on the depressed key stem can pass through the recess 254 and thus the key "7" returns to its initial position.

Multiplier key lock operation

For the case in which the multiplier has seven positions, that is, as many decimal positions as there are in the revolutions counter 3, the stop device shown in Fig. 21 is employed. The purpose thereof is to prevent a key being depressed in the seventh decimal position of the multiplier whose value is greater than "5." In such case, as soon as the carriage 2 describes its last shift movement and moves from the sixth to the seventh decimal position, the stop bar 420 affixed on the upper side of the carriage comes in contact with the end 419 of the lever 417 and swings it into the dotted position of Fig. 1, thereby moving the bar 414 into the dotted line position of Fig. 21. The stop bar 405 is thereby left to the traction of spring 409 engaged therewith. If the value of the sixth multiplier position should correspond to a key value of the key row "6"–"0" then, when bar 414 passes to the dotted line position of Fig. 21, the extension 245 of the corresponding key stem is in the coordinated slot 441.

Only after the operation in the sixth multiplier position has progressed to such an extent that the depressed key stem can ascend, does the corresponding extension 245 release the stop bar which then, through the traction of spring 409, moves to the dotted position of Fig. 21 and checks any further depressions of the keys in the coordinated key row. The keys of the key row "1"–"5," on the other hand, can be depressed even after the check bar 405 is in the operative locking position.

Lock for preventing accidental pressure on multiplier keys

After a key has been depressed in the seventh position of the revolutions counter, in order to prevent calculating errors by a further unintentional pressure on the multiplier keys, inasmuch as the carriage cannot be shifted any more, use is made of the arrangement shown in Fig. 22. This arrangement consists substantially of a check or stop bar 440 which corresponds to the bar 405. The bar 440 is coordinated with the multiplier key row "1"–"5" and is provided with slots 441 for the extensions 245 on the key stems. Provided at the left end of the bar 440 as shown in Fig. 22 is an oblong or elongated eyelet 442 which serves for the reception of a special pin 443 attached to the check bar 405. Attached to the bar 440 is a pin 444 with which one end of a traction spring 445 engages while the other end is attached at 446 to the frame plate 243. At the other end of the bar 440 a pawl lever 448 is pivoted by means of the pivot pin 447 and the lever 448 has a projecting shoulder 449 which extends over the front edge of the plate 241. A torsion spring 450 engaging with the lever 448 tends to hold the pawl lever 448 in the extended position shown in full lines in Fig. 22. The front end 451 of the lever 448 cooperates with a cam member 452 affixed on the main calculating shaft 37.

Operation of locks

The operation of the arrangement is as follows: If the check bar 405 is in its initial position, according to Fig. 21 or Fig. 22, the bar 440 is held in the position according to Fig. 22 against the traction of the spring 445.

If, after the carriage has assumed its right end position, the check bar 405 moves to the stop position, the pin 443 releases the bar 440, which is then held for the time in the released position by the pawl lever 448. If, at such time the machine is set in operation by depressing one of the multiplier keys 238, at the first rotation of the main shaft 37 the cam 452 strikes against the end 451 of the pawl lever 448 and raises it into the released position (see dotted line intermediate position in Fig. 22). The pawl shoulder 449 is thereby released and the stop bar 440 moves to the dotted line stop position of Fig. 22 and the multiplier key row "1"–"5" is also checked, so that unintentional further depression of keys is then precluded. Thus, failures which could result through carelessness are avoided by means of the stop bar 440.

Modified construction of Figs. 23 to 29

The arrangement according to the invention presumes that the entire totaliser mechanism is within the range of the tens carrying-over mechanism of the machine, as is the case with the construction described above, or that the totaliser itself has a ten carrying-over mechanism passing entirely therethrough. In order to be able to use the arrangement of the invention also with machines in which the carriage projects at one side beyond the calculating machine and the calculating mechanism itself has no tens carrying-over mechanism passing entirely therethrough, it is advisable to use an arrangement such as that shown in Figs. 23 to 29.

As shown in Fig. 23 the carriage 2 extends at its left end beyond the calculating machine frame proper, so that the four decimal positions of the totalizer at the extreme left have no tens carrying-over mechanism. Notwithstanding this lack, in order to avoid calculating errors, the left end 42' of the bar 42 engages with a correspondingly shaped recess 71' in a slide 71. The recess 71', for reasons given hereinafter, is somewhat longer than the width of the bar 42. Plate 71 is pro-

vided with a slot opening 72 through which two attaching screws 73 pass so that the plate 71 can be swung from the position shown in Fig. 24 into that in Fig. 26. Spring rings are disposed under the heads of the screws to act as frictional resistances.

Affixed to the slide 71 by means of the screws 74 is a plate 75 which is provided with an upwardly extending shoulder 75', which latter acts as an abutment for the end 76' of a lever 76 oscillatably journalled at 77. The lever 76 is subject to the action of a spring 79 which is attached at 76' to the slide 71.

An abutment 79', which is provided on the lever 79 rotatably journalled at 80, cooperates with the lever 76. The arm 82 of a right angular member 82, 83 is affixed to the lever 79 by the rivets 81. The free end of the arm 83 extends into the plane of the check disc which is farthest left with respect to Fig. 1, in such manner so that when it rotates for a subdivision the arm 83 is raised into the dotted position shown in Fig. 29 against the action of a spring yoke 84. The result of this is that the abutment 76' provided on the lever 79 is raised out of the range of the lever end 76' and the lever 76 can swing under the action of spring 78.

In this connection it is to be noted that the plate 34 (Figs. 2 and 9) is swung back at the end of each main shaft revolution by the roller 36 snapping into the recess 38' and the shaft 33 returns each time to the initial position shown in Fig. 2. After the return of the plate 34 and the levers 32 and 136 connected therewith, in order that the shafts 40 and 131 will also be carried into the initial position, there are coordinated with the left ends of each of the bars 42 and 130 a pair of levers 67 (Fig. 24).

Fig. 24 shows the pair of levers only as connected with the bar 42 although it is understood a similar pair cooperate with the bar 130. A strong traction spring 69, applies the levers 67 against the stop pins 70. The levers 67 are journalled at 68 on the lateral walls of the machine. The bar 42 extends between the upper ends of the levers 67. Bar 42 can thus, by overcoming the traction of the spring 69, be carried from the central position toward the right or the left (Figs. 24 and 26). On the other hand, however, the bar 42, as soon as the plate 39 is released, is also carried into the neutral central position as shown in Figs. 2 or 24.

Operation of modified construction

The operation of the arrangement according to Figs. 23–29 is explained by using as an example, the preceding calculation 45×703. Insofar as this calculation relates to the two lower decimal places of the multiplier the arrangement shown on Figs. 23–29 is not involved. The arrangement is important in the calculation of the higher multiplier decimal place, that is the "7".

If, after depressing the multiplier key "7", the machine has completed its third main shaft revolution, the following value will appear in the totaliser as a result of the lacking, tens carrying-over mechanism extending therethrough.

0 000 999 999 986 635

(see dotted line position of Fig. 23). In the setting up of the "9" of the above value lying at the extreme left (thus the fifth dial from the left with respect to Fig. 23) the corresponding shaft 59*a* has had to describe a tenth rotation through the corresponding shift tooth 58, and the arm 83, whose outer end lies in one of the recesses 61' of the check disc 61, is raised by the passing cusp into the dotted line position in Fig. 29.

At the same time, however, the lever 79 is rocked upwardly by the arm 83, so that the abutment 79' releases the end 76' and the lever 76 can swing under the traction of the spring 78 into the position shown in Fig. 28, in which the upwardly extending projection 76'' on the lever 76 moves within range of the beveled gears 61.

As stated, the recess 71' in the slide 71 is somewhat larger than the width of the bar 42 and the result is, that when the slide 71 has been moved in the preceding movement of the bar 42 from the position of Fig. 24 into that of Fig. 26, it will remain in this position after the bar 42 has again been returned to the neutral central position shown in Figs. 2 or 25. The lever 76 will therefore remain in the position of Fig. 28.

In the following shift of the carriage to the right with the positioning of the fourth decimal position of the totaliser above the extreme right bank of the keyboard, the extension 76'', in the position shown in Fig. 28, will engage with the bevel gear 61 of the dial of the totaliser which, on the shifting of the carriage, aligns with the shaft 59*a*, which is the outermost left hand shaft 59 as shown in Fig. 23. According to the construction shown on the drawing this would be the dial coordinated with the fourth sight opening 62 from the left, in which opening there would appear a "9" after the carriage comes to a stop. The value appearing in the totaliser would then be

0 009 999 999 986 635

wherein the "86" would be above the two right banks of the keyboard.

In the following plus or positive rotation, during which the multiplicand is carried into the ten thousandths and thousandths decimal positions of the totaliser, the "9" at the extreme right of the above value is carried to "0". This forward rotation of the corresponding dial is continued by the tens carrying-over mechanism provided to all the dials toward the left, insofar as these are in the range of the calculating mechanism proper. By means of the shaft 59*a*, the corresponding dial is again rotated forward for one position which was rotated backward for one position in the previous movement of the carriage. At the end of the calculation, after the machine is brought to a stop the following actual value appears in the totaliser.

0 000 000 000 031 635

Thus, only zeros stand in front of the result proper in the totaliser and although there is no tens carrying over mechanism extending entirely through the totaliser, no incorrect "1" appears in the dials of the totaliser.

It is also to be noted that when the movement of the bar 42 is to the left from the position shown in Fig. 24, which occurs when, in the swinging of the plate 34, the shoulder 32' is positioned in front of the pin 39' as shown in Fig. 2, the slide 71 also returns to its initial position as shown in Fig. 24. The abutment 75' on the slide has also swung the lever 76 back to the position of Figs. 24 and 25 which, at the same time, results in the abutment 79' on the lever 79 again being positioned behind the pawl lever 76. The projection 76'' is therefore always carried out of the range of the bevel gears 61 if

a positive or plus multiplication has been made (the plus key 8 having been actuated).

If, on the other hand, there has been a negative or subtractive multiplication (the minus key 9 actuated) the projection 78'' is in the operative position shown in Fig. 28, so that on the shift of the carriage the new dial of the totaliser coming into the range of the calculating mechanism proper describes a rotation backward. It is, of course, obvious that the projection 78'' is operative as carriage shifts take place in the preceding negative or subtractive multiplication. For example, if a multiplier "1009" is involved, the single subtraction of the multiplicand (corresponding to the supplementary value of the "9") would be followed by three carriage shifts, each for a decimal position, so that three dials of the totaliser coming within the range of the calculating mechanism would be modified so that each dial would be turned back for a position, and the value "9" appear in the corresponding sight openings.

Inasmuch as each multiplication terminates in a plus movement of the bar 42, the lever 76 is swung into the position shown in Fig. 25 and the projection 76'' is carried out of the range of the bevel gears 61, so that on subsequent shifts of the carriage no erroneous position could be set up by the projection 76''.

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