PATENT SPECIFICATION 804,771

Date of Application and filing Complete Specification:
Feb. 14, 1955. *No. 4344/55.*

Application made in Italy on Feb. 20, 1954.
Application made in Italy on Aug. 13, 1954.

Complete Specification Published: Nov. 19, 1958.

Index at Acceptance:—**Class 106(1)**, B2(E2B1 : E2B2B : E4 : F).

International Classification:—G06c.

COMPLETE SPECIFICATION.

Multiplying Machines.

We, S.p.A. F.A.I.—FABBRICA ADDIZIONATRICE ITALIANA, an Italian Company, of Viale Umbria 36, Milan, Italy, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to calculating machines and is particularly concerned with ten key adding machines adapted for automatic multiplication.

A specific object of the invention is to provide a ten key adding machine adapted to perform fully automatic multiplication by an abbreviated method.

Another object of the invention is to provide means for eliminating the last two figures of the multiplier from any calculation. This is very useful when the value of the last total or sub-total is reutilized as a multiplier for subsequent operations, and when only an approximate instead of an accurate result will suffice.

In conventional ten key multiplying machines, the step-by step movement of the pin carriages transversely during the carrying out of a multiplication by successive additions, is often carried out by hand at each step. That is to say, when the series of additive cycles corresponding to one digit of the multiplier is exhausted, the operator has to stop the operation of the machine and move the pin carriage one step by hand before continuing to carry out the series of additive cycles corresponding to the digit of next highest order.

On the contrary, in a machine in accordance with the present invention, the transverse step-by-step movement of the pin carriage is caused automatically at the end of each series of additive cycles corresponding to the digits of the multiplier, which digits are entered before starting multiplication, without having to perform any action during the operation of the machine, which automatically disengages and stops as soon as all the additive cycles corresponding to the figures of the multiplier are exhausted.

The invention consists in a multiplying machine of the motor-driven ten-key type having a pin-carriage controlling a set of differential actuating sectors which includes a rockable frame supporting a plurality of toothed bars which are slidable longitudinally in the frame between two end positions corresponding respectively to zero and "10", means for clearing all the toothed bars to the end position corresponding to zero, means for setting a multi-digit multiplier in said toothed bars comprising a plurality of oscillatable sectors each of which is connected to a corresponding one of said differential actuating sectors and each of which is adapted to co-operate with a corresponding toothed bar during the setting of a multiplier, means for localising the toothed bars, a finger carried by an additional slidable carriage, said finger being adapted to move each toothed bar successively one step at a time to one end position or the other, and means for automatically stopping the operation of the machine when all the toothed bars are each in one or other of the end positions.

The invention will be best understood from the following description of a specific example, reference being made to the accompanying drawings, in which:—

Figure 1 shows the machine in plan view;

Figure 1*a* is a longitudinal section of the machine;

Figure 2 shows the carriage carrying the setting pins, and also the device for eliminating at will from computation the last two figures of the multiplier;

[*Price 3s. 6d.*]

Figure 3 shows part of the machine as seen from the right;

Figure 3*a* is a view on the line A—A in Figure 3;

Figure 4 is another view from the right showing the system for lifting the toothed bars or rack cursors and recovering the same;

Figure 4*a* is another view from the right showing the toothed bars or rack cursors at rest but in engagement with the toothed sectors and disengaged from the rack cursor locating means;

Figure 4*b* is another view from the right showing the rack cursor clearing system at rest;

Figure 4*c* is a view from the right showing the toothed sectors which have entered the digit "1" on the rack cursors in end-of-stage engagement, with the locating means in action and the rack cursor recovering system at rest;

Figure 4*d* shows the toothed sectors disengaged from the rack cursors and at the end of their forward stroke;

Figure 5 is another view from the right on the line A—A in Figure 1 and shows the counting finger and the oscillating system of the rack cursors forming the counter;

Figure 6 shows the connection with the total key and sub-total key;

Figure 6*a* is another view in the direction of the arrow A in Figure 6;

Figure 7 is a view from the right along the line B—B in Figure 1;

Figure 7*a* shows the reversing system of control for addition and subtraction for abbreviated computation;

Figure 7*b* shows the locating device for the control illustrated in Figure 7*a*;

Figure 8 is a view from the right on the line A—A of Figure 1 showing the lift motion of the rack cursors articulated to the zero selecting member;

Figure 9 is a view from the right on the line A—A in Figure 1, showing the rack cursors in computing position at digit 5, with the counting finger in engagement, the localizer acting on the rack cursors and the computation reversing device in positive and direct phase (summing);

Figure 9*a* shows the digit 6 entered on the rack cursors and the reversing device in subtracting position;

Figure 9*b* shows the parts shown in Figure 9*a* but also shows the rack cursors in position 10;

Figure 10 shows the articulated portion of a rack cursor with the tooth for automatic forwarding control of the column in its position corresponding to zero;

Figure 10*a* shows the articulated portion of the rack cursor with the tooth for the automatic forwarding control of the column in its intermediate inactive position;

Figure 11 is a longitudinal section showing the connections of the mechanism with a key designated "X";

Figure 12 is a longitudinal section showing the connections of the mechanism with a key designated "Equal" ("="); and

Figure 13 is another longitudinal section of the machine.

In order to make a multiplication by means of a machine in accordance with the invention, it is necessary to perform the following operations:—

1. Set the multiplier in the keyboard.
2. Operate the control key 256 designated "X".
3. Set the multiplicand in the keyboard.
4. Operate a second control key 236 designated "=".

Upon performing the fourth operation mentioned above the machine makes the required calculation, prints the product, clears itself (returns to zero), and switches itself off. Instead of being cleared, the calculated product may alternatively remain in the totalizer of the device and may be used, if required, during subsequent calculations.

The four operations mentioned above will now be separately described in detail.

1. *Setting the multiplier*:—

The multiplier is entered upon the keyboard of the 10-key adding machine exactly in accordance with normal practice, that is to say, as if it were the first of a number of different figures which were to be added together.

2. *Operation of the key 256*:—

When the key 256 (Figure 11) is depressed, it turns about its pivot 235 and unlatches a dog 260. When the dog 260 is released it rotates about its pivot 259 and starts the motor of the adding machine (not shown). The key 256 has a nose 256^1 which, when the key is pressed, engages a pin 257^{11} carried by a lever 257, which lever 257 is movable with the key 256 due to the fact that it carries a further pin 235^1 which engages in a short slot in the body of the key 256. The end of the lever 257 remote from the key 256 is pivoted at 258^1 to a link 258 which it lifts when the key 256 is depressed. A pin 264 carried by a dog 262 engages in a slot formed in the lower end of the link 258 and the lifting movement causes the dog 262 to pivot about its connection with a lever 261, its far end 263 being in continuous engagement with a roller 250 carried by a lever 240. The lever 240 is made to oscillate about a fixed pivot 241 by the rotation of a shaft 234 driven by the motor of the adding machine. An eccentric 229 attached to the shaft 234 is pivoted at 249

to a link 230 which, in turn, is pivoted to a further link 246, the other end of which is pivoted to the said lever 240. A member 231 which can turn about a fixed pivot in the form of a shaft 233 is articulated to the connection between the said links 230 and 246. It will be seen from Figure 11 that, upon depressing the key 256, the lever 261 will be made to oscillate about its fixed pivot 267 by virtue of the engagement of the dog 262 with the small roller 250.

The movements which are brought about during the first oscillation of the lever 261 will now be described. During the first half of the said oscillation the device is making a forward stroke with the lever 261 (Figure 11) turning in an anti-clockwise direction about its pivot 267. A connecting rod 269 is pivoted to the lever 261 at 266 and to a crank 26 at 27. The crank 26 rotates a half-round shaft 25 as a result of which each toothed bar or rack cursor 7 is disengaged from the tooth 23 of a corresponding lever 22, (see particularly Figures 1, 4, 4*a* and 11). The levers 22 are mounted on a shaft 21 (Figures 1—4*a*) and are held in the working position by means of springs 24 (Figures 1 and 5). A second longer link 270 (see Figure 11) is also pivoted to the lever 261 at the point 266 and this link 270 which is resiliently connected to a pin 100 by means of a spring 271, turns a shaft 98 by means of a crank 99 and the pin 100, the shaft 98 passing through a bush 97 attached to the frame of the device 1 (see Figure 1). The end of the shaft 98 remote from the crank 99 carries a further crank 101 having a pin 102, from which pin 102 a connecting rod 103 extends to a further pin 104 (see Figures 1 and 4 to 4*d* and 11). The pin 104 forms part of a crank 9 attached to shaft 8 which turns about fixed pivots. The crank 9 is pivoted to another crank 10 which carries a transverse bar 11 (Figures 1, 4, 4*a* and 11). It will be seen that during the forward stroke the transverse bar 11 will be moved towards the right in Figures 1, 4 and 4*a* and that during this movement it will engage a projection 189 (Figures 5 and 8) which is formed on each of the rack cursors 7 and will thus return each one to its zero position unless it happens to be already in that position.

A still further link 265 is pivoted to the lever 261 at the point 266 and this link 265 turns a shaft 91 by means of a crank 93 and a pin 94. A lost motion arrangement is provided between the link 265 and the pin 94, this arrangement being in the form of an elongated slot in the link 265 in which the pin 94 engages. Thus, it is only towards the end of the forward stroke that the shaft 91 commences to turn, the said pin 94 being normally maintained at one end of the slot by a spring 268 which extends between it and a further pin carried by the link 265. (Figure 11). A pair of cams 92 are fast with the shaft 91 and when the cams turn they lift a pair of pins 30 which are fast with the side panels 4 of the frame supporting all the racks cursors 7. (Figures 1, 4 and 11). The frame supporting the rack cursors 7 is constituted by two side panels 4 connected to each other by a shaft 5 and by two transverse members 6 which also serve to guide the rack cursors 7. On the side panels 4 there are also mounted two transverse shafts 28 upon which are mounted turnable rollers 29, which serve to facilitate the sliding of the rack cursors 7 (Figures 1 and 5). Two bushes 12, in which the pins 3 rotatably engage, enable the frame to pivot about their axes. Consequently, each rack cursor 7 is lifted into engagement with a corresponding toothed sector 152 by means of a toothed rack 170 rigidly coupled to it. Each sector 152 is pivotally mounted on a transverse shaft 151 fixed to the adding machine, and is connected to the toothed sectors 218 of the adding machine (see particularly Figure 1*a*) by means of pins 153 and links 154. Each toothed sector 152 corresponds to one digit of the multiplier which has been entered in the keyboard of the machine and will accordingly have been set in an angular position corresponding to the value of that digit.

Towards the end of the lifting movement which has just been described a slotted link 210 connected to one of the cams 92 by means of a pin 190 (see Figures 1*a* and 8) commences to move a lever 211 about its fixed pivot 212, this movement dragging a link 213 downwardly (see Figure 1*a*). A dog 214 then moves a control member 216 so that the pinions of an accumulator 217 are disengaged from the sectors 218. The adding machine is then in a non-adding position and the multiplier is printed by the machine and next to it the symbol "X" is also marked.

Immediately after the rack cursors 7 have become engaged with their corresponding toothed sectors 152 in the manner described, the crank 99 is released and the transverse bar 11 returns to its original position (see particularly Figures 1 and 4*b*).

At this stage (after the movement of the sectors 152 and the rack cursors 7), the second part of the oscillation of the lever 261 commences, the said lever moving in a clockwise direction about its pivot 267 and the device as a whole making a return stroke.

As has been said, each sector 152 is connected to a corresponding sector 218 by way of a link 154 (see Figure 1*a*). Each sector 218 has previously been set in a position corresponding to the value of one digit which has been entered on the key board of the adding machine by means of a link 219 pivoted at 218^1 to the sector 218. During

the return stroke, a rake-like member 281 which is driven by the drive shaft 234, returns all the sectors 218 to zero by means of a link 280 and further links 279 each of which is pivoted to a sector 218 at 279^1 and to the link 280 at 279^{11}. The lever 280 is normally maintained in a raised position by means of a spring 280^1. Each toothed sector 152 will, of course, also be returned to its zero position and at the same time it will carry with it its corresponding rack cursor 7. After the rack cursors 7 have been moved, the crank 26 and the shaft 25 return to their original position due to the clockwise movement of the lever 261, so that the levers 22 can turn about their pivots 21 to localise each rack cursor 7 in the position in which it has been set, by means of its tooth 23 (see particularly Figs. 1, 4*b*, 4*c* and 11).

At the end of the return stroke, the lower end of a lever 277 (Figure 13) engages a pin 96 projecting from an arm 95 (Figure 1) and thus turns the shaft 91 so that the cams 92 return to their original position. The lever 277 is acted upon by the eccentric 229. As a result of this movement the frame 4 supporting the rack cursors 7 is lowered and thus each rack cursor is disengaged from its corresponding toothed-sector 152 (see Figure 4*d*). At the end of this first oscillation of the lever 261 the adding machine clears its setting pin carriage in known manner. At the end of every operation of the adding machine, all the control means are cleared by a fork 263 (Figure 11).

3. *Setting the Multiplicand*:—

The multiplicand is entered on the key board of the adding machine in the normal manner as if it were one of a number of figures which were to be added together. The carriage 220 of the adding machine carrying the setting pins 221 shifts transversely along the shaft 222 by as many places as there are digits forming the multiplicand and as it does so, a lever 203 mounted on the carriage (Figures 1*a*, 2), moves a similar number of places. The said lever 203 carries a pin 184 and this pin 184 thus becomes aligned with a corresponding notch of a toothed bar 180. For example, if the multiplicand consists of 3 digits the pin 184 becomes aligned with the third notch of the toothed bar 180.

4. *Operation of the key 236.*

When the key 236 (Figure 12) is depressed, it turns about its fixed pivot 235 and releases a lever 237 allowing it to turn about its pivot 255 under the action of a spring 238. In its new position, the lever 237 maintains the key 236 depressed and starts the motor of the adding machine (not shown). The end of the key is pivoted to a link 239 at 239^1 and, when the key is depressed, this link is lifted carrying with it a dog 244 to which its lower end is pivoted at 244^1. The dog 244 turns about its pivot on a further lever 247 and moves a further dog 242, against the action of a spring 243, into engagement with the roller 250 carried by the oscillating lever 240. The oscillating lever 240 is connected to the link 246 which, in turn is connected at 246^1 to the link 230. As previously stated, the link 230 is connected to the cam 229 by means of a pivot 249, the member 231 being pivoted on the shaft 233 carried by a side panel 232.

When the key 236 is depressed it also turns a generally angle-shaped member 251 (Figures 2 and 12) about its pivot 253 by means of a pin 252, the member 251 being normally maintained in a raised position by means of a spring. During this lowering movement, the slotted arm of the member 251 which engages a pin carried by a further member 188 (Figure 2), lowers said further member 188 which, in turn, lowers the toothed bar 180 into engagement with the pin 184 connected to the carriage 220 by means of the lever 203 mentioned above.

The multiplication operation now commences and it takes place in respect of each digit of the multiplier in one of the ways depending on whether the value of the digit lies between 1 and 5 inclusive, 6 and 9 inclusive or is a 0.

A. Multiplication when the digit of the multiplier lies between 1 and 5.

Due to the engagement of the dog 252 with the roller 250, the lever 247 (Figure 12) commences to oscillate about its fixed pivot in a similar manner to the lever 261 shown in Figure 11. During the forward stroke of the device, that is to say when the lever 247 is moving in an anti-clockwise direction, a link 276 rotates an eccentric shaft 89 by means of a crank 90, and this movement serves to engage a counting finger 167 with the first rack cursor 7 (see Figure 9). At the same time a further link 248 pivoted to the lever 247 turns a crank 112 to which it is pivoted by a pin 118. The crank 112 rotates on a pin 119 mounted on the frame 1 and carries a pin 115 (Figure 7*b*) which serves to entrain a restraining member 116, which, at its left hand end has two projections bearing against pins 107 and 108 carried by the member 106, to maintain it in a predetermined position. The restraining member 116 is held in the position shown in Figure 7*b* by means of a return spring 117. The crank 112 moves the member 116 towards the right in Figure 7*b* leaving the member 106 free to oscillate. As the crank 112 moves it also entrains, by means of a pin 111, an anchor member 110, which is attached to a return spring 114 and which in turn, engages the pin 107 carried by the member 106 which is pivoted on a pin 105 mounted on the left

side panel of the frame 1. The member 106 also carries a spur 109, that engages a plate 57 (Figures 1, 3, 7*a*, 9, 9*a* and 12), which plate 57 is guided for lateral movement in its own plane by means of a slot 56 formed in a member 53 fixed rigidly on the frame of the machine. The spur 109 moves the plate 57 laterally which, in turn, moves a member 55. The member 55 (see Figure 3) has a pin 58 which will be, after its movement, in either the right or the left tooth of an arm 59 which is loaded by means of a spring 60. The member 55 is guided and fulcrumed by forks 54 formed on the member 53. The movement of the plate 57 causes similar movement of a member 165 which has a projection that engages around the plate 57 (see Figures 1 and 9*a*). The member 165 is rigidly connected to the counting finger 167 and the range of movement is such that the said counting finger 167 moves the rack cursor 7 by one tooth towards its zero position (see Figure 9).

Towards the end of the forward stroke the eccentric shaft 89 is returned to its original position by the crank 90 and the counting finger 167 is accordingly disengaged from the rack cursor 7 and it remains in this position throughout the return stroke of the device.

A complete oscillation, that is to say both a forward stroke and a return stroke, is carried out in respect of each unit of the digit entered upon the rack cursor 7 in question. Thus, the device makes either one, two, three, four, or five complete oscillation depending upon the value of the said digit. During each return stroke, a small tooth 162 (Figures 1, 5, 10 and 10*a*) carried by a lever 158 pivoted in a pin 157 mounted on a member 156 and loaded by a spring 163, is urged into engagement with the lower side of a rod 174 by means of a small transversely projecting member 64 carried by a pivoted lever 63, said member 64 engaging a projection 161 forming part of the lever 158. The lever 63 is connected to a link 197 (Figure 1*a*) whose other end is connected to the eccentric 229 by way of a spring 197^1. Thus the spring 197^1 urges the tooth 152 upwardly in a non-positive manner. The rod 174 is connected to the rack cursor 7 by means of a pin 173 mounted on the rack cursor 7 and, if the tooth 152 does not engage in a recess 176 in the rod 174, the lever 158 is prevented from movement (see Figure 10*a*) so that its left-hand side blocks the movement of a member 66 and shaft 67 described below. If, however, the counting finger 167 has just moved the last tooth of the rack cursor 7, the recess 176 will be in such a position that the small tooth 162 can engage in it (see Figure 10). Consequently, the shaft 67 that is urged into engagement with a cam surface 160 formed on the lever 158, can move relative to the said cam surface 160 when the tooth 162 has entered the said recess 176. The shaft 67 is mounted upon the member 66 which is pivotable about a further shaft 65 and upon the foregoing movement taking place the shaft 67 moves towards the left in Figures 10 and 10*a* and at the same time it turns a member 85 about its pivot 87 by means of a link 84.

The member 85 carries a pin 86 which, (see Figure 2) by means of a link 275 connected to the carriage 220, moves the said carriage 220 one place transversely towards the left. At the same time the counting finger 167 and the members 156, 158, 164, 165, 166 and 169 (see Figure 5) are all moved transversely one place to the left by means of a slide 155 (see Figures 1 and 2) on which they are mounted so that the counting finger is in position beneath the second rack cursor 7. The slide 155 (Figures 2 and 8) is moved transversely to the left because it is connected to the carriage 220 by means of a support member 277 (Figure 2) which it carries, this member being guided by shafts 276 and 276^1 which it engages by means of slots, and being pivoted at 278 to an extension 179 of the toothed bar 180. The key 236 remains depressed during this operation so that the machine then commences to carry out all the preceding operations, or those which are to be described hereafter depending upon the value of the digit entered upon the second rack cursor, in respect of the second rack cursor and of the succeeding cursors until the figure of the entered multiplier is exhausted.

B. Multiplication when the digit of the multiplier lies between 6 and 9.

At the beginning of the forward stroke the counting finger 167 is raised into engagement with the rack cursor 7 in the manner previously described in connection with Figure 9 (see Figure 9*a*). In this case, however, a member 169 is turned about it pivot 168 with the counting finger 167 by virtue of the engagement of its enlarged end with the lower side of the rack cursor 7 which, in this case, has been moved further to the left in Figure 9*a* because of the larger value of the digit which is entered upon it. The other end of the member 169 lifts a plate 52 which projects from a shaft 50 and thus the shaft 50 is turned about its longitudinal axis carrying with it a small lever 191 (see Figure 1 and 7*a*). As the small lever 191 is moved upwardly it engages a pin 194 carried by a member 193 pivoted on a pin 195 rigid with the frame and the member 193, in turn, lifts the anchor member 110 by means of a pin 113 which projects from it. The anchor member 110 is thus brought into engagement with a pin 108 projecting from the member 106.

An arm 51 (Figures 1—3) rigid with the shaft 50 engages a projection 48 carried by a lever 45 pivoted on a pin 46 provided on the side panel 1 and loaded by a spring 49, and upon the said lever 45 being moved it disengages a tooth 47 from a projection 44 of a fork 42, whereupon the fork 42 is moved towards the right in Figure 3 (sliding by means of its forked arms on a pin 43 mounted on the frame 1) by a link 39 pivoted to it by means of a pin 38, the link 39 being loaded by a spring 41 (see Figure 1 and 3). A lever 36 pivoted at 35 has its lower end connected to the pin 38 and is therefore turned in an anti-clockwise direction when the fork 42 is moved. At the same time a lever 33 rigid with a shaft 32 supported by a bush 31 and mounted on the frame, is turned in a clockwise direction due to the fact that it is pivoted to the link 39 at a point 40. The end of the shaft 32 remote from the lever 33 carries a member 34 which pushes a pin 17 projecting from an arm 14 which is rigid with a shaft 13 (see Figure 1 and 3*a*) which shaft 13 carries a further similar arm 14 at its other end.

A pair of pins 16 projecting from the two arms 14 raise a shaft 18 by way of two small connecting rods 15 and the shaft 18, in turn, lifts a plurality of levers 19, which are subsequently returned to their rest positions by springs 20, (see Figures 3, 3*a* and 9*b*). Each lever 19 has a projection at its lower end extending at right angles to the plane of the remainder of the lever and, when the shaft 18 is raised, each of these projections is brought into engagement with a tooth of the rack cursor 7 immediately to its left (see Figure 7*a*). When any rack cursor 7 is being moved from its ninth to its tenth tooth, a spur 171 (see Figures 1 and 9*b*) carried by the said rack cursor engages one of the levers 19 and moves it forward such a distance that the rack cursor 7 immediately to the left is moved one tooth forward by virtue of the engagement of the afore-mentioned projection carried by the lever 19 with the rack cursor 7 immediately to the left.

During the upward movement of the afore-mentioned small lever 191, a plate 192 carried thereby (see Figures 1 and 7*a*) lifts a link 196 which is connected directly to the totaliser of the adding machine and acts upon the said totaliser to effect the reversal thereof. This reversal is necessary since the adding machine has to compute negatively at this stage as will be hereinafter explained.

As a consequence of the lifting of the anchor member 110 engaging the upper pin on the member 106, the anchor member 110, when moved towards the right in Figure 7, by means of the crank 112, link 248 and lever 247 (Figure 12) will move in such a way that the action of the anchor member 110 upon the member 106 will be reversed and as a result the movement of the member 106, the plate 57, and the associated parts 165, 166 and 167 will all be reversed. The rack cursor 7 is therefore moved one tooth in a forward direction instead of rearwardly as previously described (see Figure 9*a*). This movement continues by one tooth at a time until the tooth 162 (Fig. 10*a*) engages in a notch 177 similar to the notch 176 in the lower side of the rod 174. Upon engagement of the tooth 162 with the notch 177, the sequence of movement previously described is reversed and the movements are then the same as during the multiplication of a digit from one to five, the particular rack cursor concerned engaging, by means of its tooth 171, the lever 19 immediately to its left and consequently moving the next cursor 7 by one step. At the end of the forward stroke a pin 37 (see Figure 3) carried by the eccentric 229 engages the lever 36 and returns it to its original position.

The return stroke takes place in exactly the same way as has been described in connection with a multiplication step when the digit of the multiplier lies between one and five. The movements just described take place a number of times corresponding to the complement to 10 of the particular digit of the multiplier concerned.

Assuming, for example, that multiplication by eight is to be carried out, the first rack cursor is moved forward by eight teeth during the setting of the multiplier in the key board of the machine. Subsequently the same rack cursor is moved two teeth forwards by the counting finger 167 and, therefore, it is shifted into its tenth position. However, these latter movements take place when the totaliser of the adding machine is adjusted for subtraction. The second rack cursor is then moved one tooth forwardly and the carriage 220 carrying the setting pins of the adding machine is moved by one place towards the left together with the counting finger 167 whilst the totaliser of the adding machine is adjusted for addition, since the shaft 169 is in its inoperative position (see Figure 9).

It will be seen from the foregoing description that multiplication by eight is accomplished by the first rack cursor performing a multiplication by minus 2 whilst the second rack cursor performs a multiplication by plus 10.

C. Multiplication when the digit of the multiplier is an 0.

In this case the rod 174 connected to the rack cursor 7 will be in either its rearmost or foremost position with either the notch 176 or the notch 177 in alignment with the tooth 162. At the beginning of the forward stroke of the device, the adding machine moves a link 197 (see Figure 1*a*) which has

one end connected by way of a spring 197^1 to the eccentric 229 and the other end pivoted to a lever projecting from an arm 63. The arm 63 carries a small transverse member 64 which engages a projection 161 forming part of the lever 158 (see Figures 1*a* and 5) and turns the lever about its pivot 157 so that the tooth 162 enters one or other of the afore-mentioned notches. The small transverse member 64 also moves a link 225 (see Figure 1*a*) which is connected to a member 226. The member 226 moves towards the right and its lower part engages a pin 213^1 carried by a lever 211 pivoted at 212 and pivotally supporting the link 213. The member 226 is pivoted at 226^{11} to a part 227, which latter can oscillate on a pin 227^1. The main shaft 234 carries a roller 228 which during its oscillation, at the end of the forward stroke of the machine, engages the right arm of the part 227, and lowers it. The part 227 then lowers the pin 226^{11} and the member 226, the lower part of which latter engages the pin 213^1 and lowers the link 213 to disengage the dog 214 of the accumulator control 216 so that the pinions of the accumulator 217 are disengaged from the sector 218. That is to say, as in the previous instances, the totaliser is prevented from adding. During the return stroke of the device a shaft 67, to the right end of which is hooked a spring 76 (Figure 1) is lowered by the adding machine through the intermediary of a lever 79, a member 73, a further lever 71 and a connecting rod 69 (see particularly Figures 1 and 7). The shaft 67 is lowered by means of the cam 229, a lever 277, a pin 277^1 and a small connecting rod 278 (Figure 13) connecting the pin 81 with the lever 79 (Figures 1 and 7). The lever 79 can oscillate on a pin 80 rigid with the side panel 1 and, by means of a small roller 76^1 mounted on a pin 78 rigid with the lever 79, it acts upon a member 73 loaded by a spring 75. The member 73 has projection 82 engaging the roller 76^1 and a further projection 77 which serves to limit its stroke. The member 73 controls the lever 71 (not shown in Figure 13) which is mounted on a pin 72 mounted within the left hand side panel, and controls the left arm of the small transverse member 66 by means of a connecting arm 69 connected to the member 66 by a pin 68 and to the lever 71 (Figure 7) by a pin 70. The shaft 67 is mounted on the transverse member and when it moves down as previously described it moves (Figure 10) the pin 86 by way of the link 84 and the plate 85 which is carried by a lever pivoted about a shaft 87, the said lever being connected to the link 84 at the point 83. The pin 86 moves the link 275 (Figure 2) which in turn, moves the carriage 220 one place towards the left.

At the end of the multiplication operation when all the rack cursors 7 have been returned to their zero positions, the key 236 is disengaged.

When the key 236 is in its normal raised position a knife 62 is maintained above the rods 174 (see Figure 5) but when the key 236 is depressed the knife 62 is lowered and rests against any one or more of the rods 174 that are connected to corresponding rack cursors 7 upon which a figure has been entered. When a rack cursor 7 has no figure entered upon it, it is in either its foremost or rearmost positions, that is to say, it is in a position corresponding to the figure 0 or to the figure 10. It will be understood that at the end of a multiplication all the rack cursors will be in one or other of the aforementioned positions corresponding to the figure 0 since all the figures which have been entered will have been exhausted. When each rod 174 is in one of the aforementioned positions the knife 62 is in register with either a notch 175 or with empty space and therefore, at the end of a multiplication, the knife 62 can move downwardly.

The knife 62 is carried by two half shafts 61 (see Figure 1) one of which has a lever 150 rigid therewith, the said lever 150 being provided with a pin 198. The pin 198 is connected to a link 198^1 (see Figure 12) which lowers the dog 237 thus disengaging it from the body of the key 236 which accordingly returns to its original position, the motor of the adding machine being switched off. When the key is released it frees the member 251, which can then rise thus disengaging the bar 180 from the pin 184 and freeing the carriage 220 carrying the setting pins so that the carriage can return to its starting point together with the slide 155 (see Figure 2). The lever 150 is connected by a pin 149 (see Figure 6) to a link 148 which moves a pin 147 carried by a crank 146 rigid with a shaft 145. The shaft 145 also carries a lever 144 that, when it moves, releases a projection 202 carried by a lever 140 so that the said lever 140 can turn about its pivot 139 under the action of a spring 141, hooked at one end on the member 140 and at the other end to a pin 142 which also acts as a stop for the member 135. This movement causes the engagement of a tooth 143 carried by the lever 140 with a pin 138 carried by a member 229^1 rigid with the driving shaft 234 of the adding machine.

As a result the lever 140 is dragged towards the left in Figure 6 carrying with it the member 135 pivoted at the point 138^1. The lever 135 turns about its pivot 138^1 and releases a projection 199 forming part of a further lever 132 which immediately turns about its pivot 134 under the action of a spring 133. A fork 129 which is pivoted on a pin 131 mounted on the double-armed

lever 132 is thus pushed into engagement with either the pin 127 of a member 121 (Figure 6*a*) or the pin 128 of a member 122 depending upon the angular position of a cam member pivoted at 130^{11} with which a pin 130 carried by the fork 129 engages. The members 121 and 122 are mounted on a pin 120 projecting from the right hand panel of the frame 1. The cam member can be adjusted by means of a projection 130^{1} (see Figures 6 and 6*a*).

Both the members 121 and 122 are pivoted about a shaft 120 and both of them are normally maintained in engagement with a fixed pin 124 by means of springs 123. The member 121 is pivoted at 125 to a link 200 which, when moved, depresses the total key of the adding machine, whereas the member 122 is pivoted at 126 to a link 201 which, when operated, depresses the sub-total key of the adding machine. The total or sub-total is then printed in known manner.

After actuation of either the total or sub-total key, the motor of the adding machine commences a new rotation during which a forked lever 137 (see Figure 6) pivoted to the lever 132 at a point 136, which had previously been thrust into engagement with the pin 138 carried by the member 229^{11}, is forced downwardly against the action of the spring 133 thus permitting re-engagement of the projection 199 with the lever 135, the lever 140 also being re-engaged with the pin 138 and with the projection 202 carried by the lever 144.

As has been previously stated, the last two figures of the multiplier may be eliminated from the operation and this is achieved by movement of the lever 223 (see Figure 2) which turns about a pivot 223^{1} and is connected at its lower end to a dog 254. The dog 254 is connected to the slide 155 and, upon movement of the lever 223 in the direction A shown in Figure 2 into the position $223a$ shown in chain-dotted line, the slide 155 is moved towards the left by an amount corresponding to twice the lateral distance between two of the rack cursors 7. Thus, the counting finger 167 is located beneath the third rack cursor so that any figures entered upon the first two rack cursors are eliminated. The slide 155 is maintained in engagement with the dog 254 by means of a lever 272 pivoted at 272^{1} and loaded by a spring 272^{11}. The slide 155 is prevented from returning towards the right in Figure 2 by means of a catch 273 pivoted at 273^{1} and loaded by a spring 274.

WHAT WE CLAIM IS:—

1. A multiplying machine of the motor-driven ten-key type having a pin-carriage controlling a set of differential actuating sectors which includes a rockable frame supporting a plurality of toothed bars which are slidable longitudinally in the frame between two end positions corresponding respectively to zero and "10", means for clearing all the toothed bars to the end position corresponding to zero, means for setting a multi-digit multiplier in said toothed bars comprising a plurality of oscillatable sectors each of which is connected to a corresponding one of said differential actuating sectors and each of which is adapted to co-operate with a corresponding toothed bar during the setting of a multiplier, means for localising the toothed bars, a finger carried by an additional slidable carrigae, said finger being adapted to move each toothed bar successively one step at a time to one end position or the other and means for automatically stopping the operation of the machine when all the toothed bars are each in one or other of the end positions.

2.. A machine as claimed in Claim 1, in which two cams are provided for oscillating the frame, the said cams being controlled by a shaft deriving its forward and return movements from two cranks actuated directly by the drive members of the machine.

3. A machine according to Claim 1 or Claim 2, in which the ends of all the toothed bars engage a small traverse which carries them along with it during its forward-stroke towards their zero-position and which is disengaged from the bars during its return stroke, the said small traverse being controlled by a crank system deriving both its forward and return motion from the drive members of the machine.

4. A machine as claimed in any of the preceding claims, in which members are provided for locating the individual toothed bars in position, the said members being in the form of small toothed levers oscillating on a supporting shaft, and the engagement and disengagement of the small levers with the teeth of the bars being obtained by means of the rotation of an eccentric shaft controlled by the driving members of the machine.

5. A machine as claimed in any of the preceding claims, in which each toothed bar automatically controls, during each advancement corresponding to the passage from a 9th to a 10th tooth, the advancement by one tooth of the bar immediately to its left, there being provided oscillating members engaging with the individual bars which are equal in number to the bars, the oscillation of each oscillating member being determined by the engagement of that member with a projection rigid with the end of the bar immediately to the right thereof, the engagement of the oscillating members with the corresponding bars being automatically controlled by means associated with the finger.

6. A machine as claimed in any of the preceding claims, in which the finger is connected to a slide provided with a toothed rod having a number of notches corresponding to the digital capacity of the machine, the said toothed rod being adapted to engage, by means of one of the said notches, a pin connected to and slidable with the carriage carrying the setting pins.

7. A machine as claimed in any of the preceding claims, in which the finger is brought alternately into engagement and disengagement with the corresponding teeth of one of the toothed bars by means of the rotation of an eccentric shaft controlled by the driving members of the machine.

8. A machine as claimed in any of the preceding claims, in which the movement of the finger for the progressive step-by-step shifting, one tooth at a time, of each bar is controlled by a transverse plate connected to a projection of an oscillating element which is coupled to a slidable anchor controlled by the driving members of the machine.

9. A machine as claimed in any of the preceding claims, in which the finger is associated with a lever which engages in a notch in each toothed bar, when the latter arrives at the end of its stroke, and causes the shifting by one place to the left of the carriage carrying the setting pins, which carries with it the finger and thus puts it in connection with the bar immediately to the left.

10. A machine as claimed in any of the preceding claims, in which a lever is provided which directly controls the counting finger to shift it transversely through a predetermined distance to bring it in connection with the third toothed bar.

11. A machine as claimed in any of the preceding claims, in which a lever is connected to the finger which, by abutting with a projecting part of a toothed bar when the latter has a digit of the multiplier lying between 6 and 9 entered upon it, causes the reversal of the totalizer of the machine putting it to subtraction and also the reversal of the control of the motion of the counting finger.

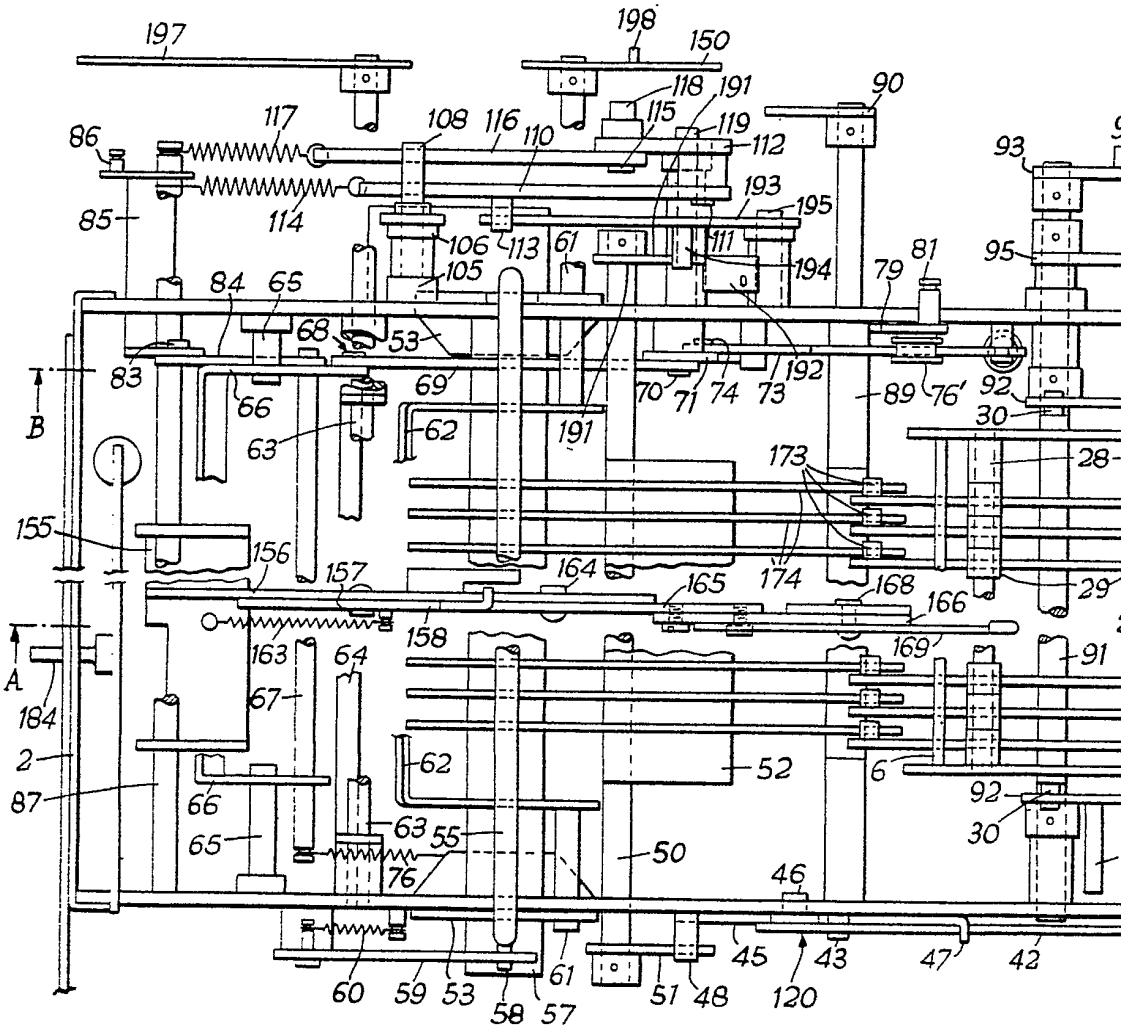
12. A multiplying machine substantially as described with reference to the accompanying drawings.

Agents for the Applicants:—

STANLEY, POPPLEWELL, FRANCIS & ROSS,
Chartered Patent Agents,
Cursitor House,
9, 10, 11 Cursitor Street,
London, E.C.4.

Abingdon: Printed for Her Majesty's Stationery Office, by Burgess & Son (Abingdon), Ltd.—1958.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2,
from which copies may be obtained.

Fig .1.


197
198
150
118
191
90
117
108
116
110
115
119
112
86
93
114
193
195
85
106
113
61
111
194
79
81
95
105
84
65
68
53
192
83
69
70
71
74
73
89
76'
92
B
66
63
62
191
30
173
28
155
156
157
164
165
174
168
166
29
158
169
91
163
64
A
67
184
2
62
52
6
87
66
92
63
55
30
65
76
50
46
60
59
53
61
58
57
51
48
120
45
43
47
42

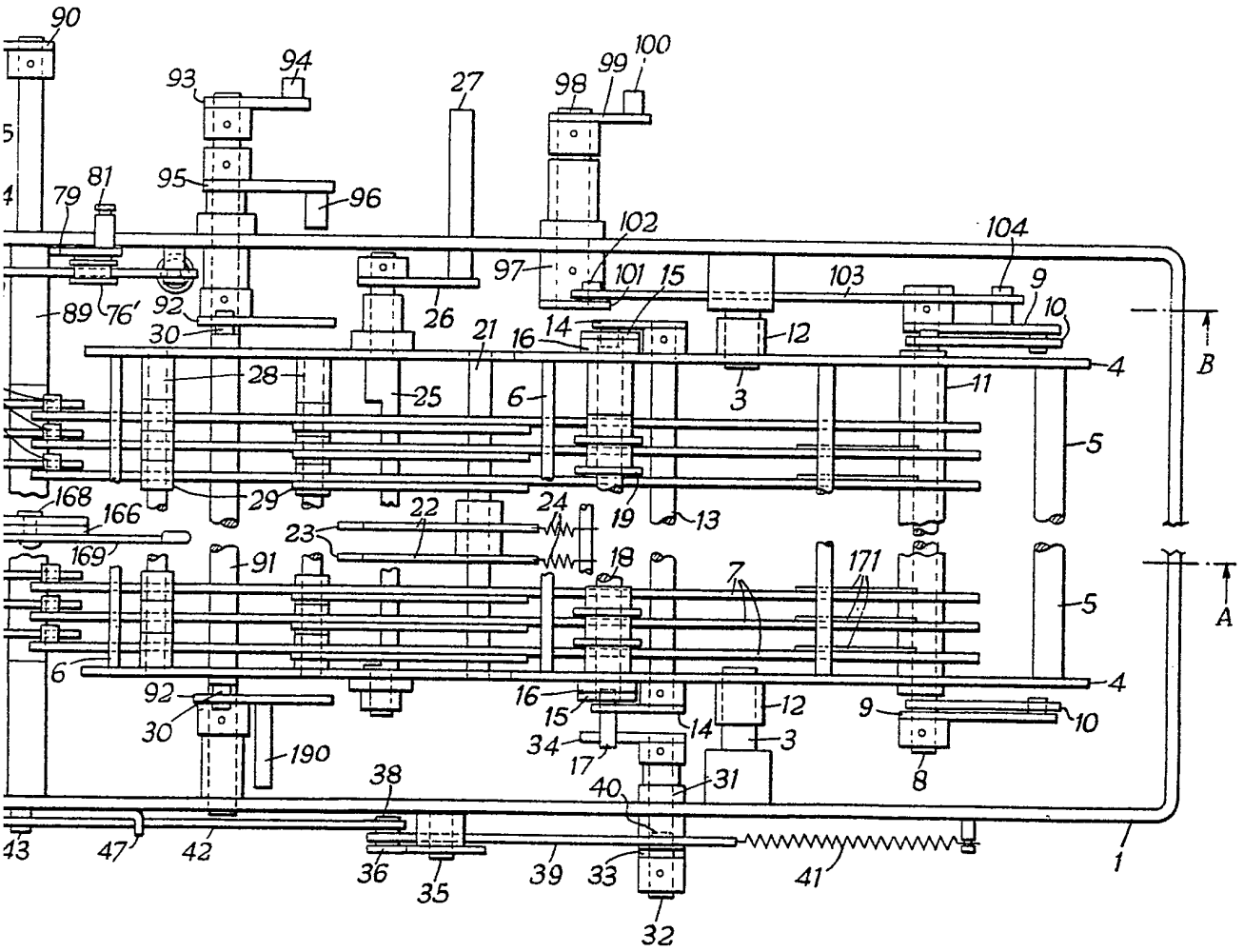
804,771 COMPLETE SPECIFICATION

8 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEET 1

Fig. 1.



804,771 COMPLETE SPECIFICATION

8 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEET 1

Fig. 1.

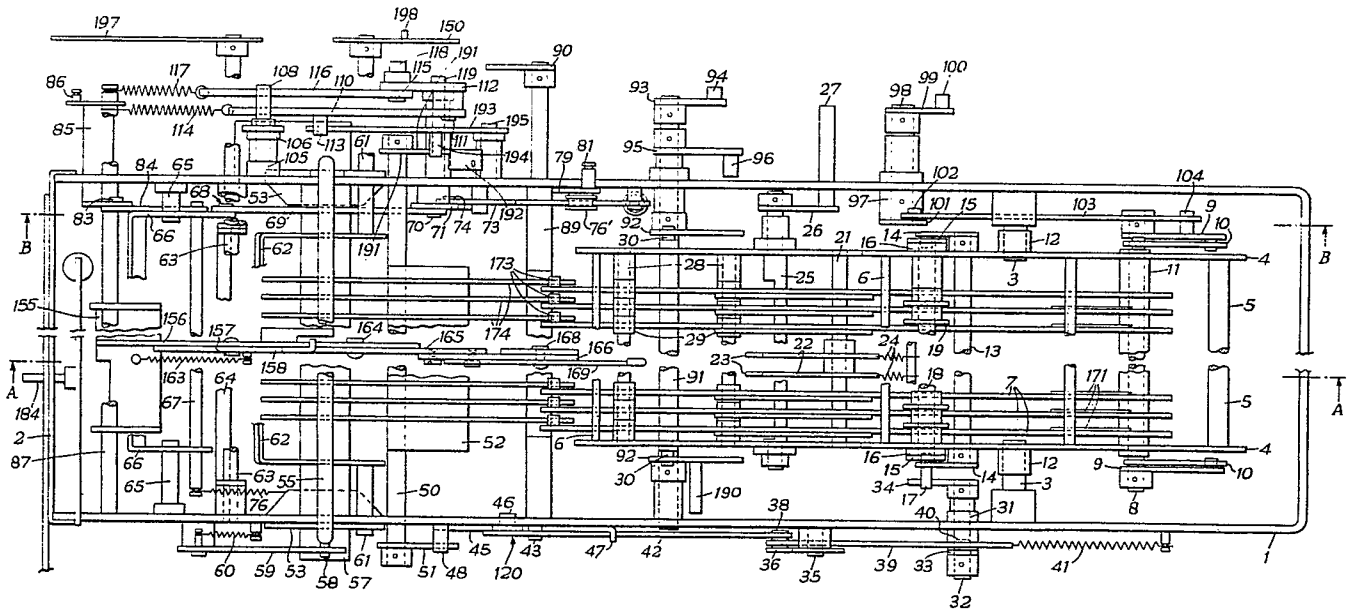
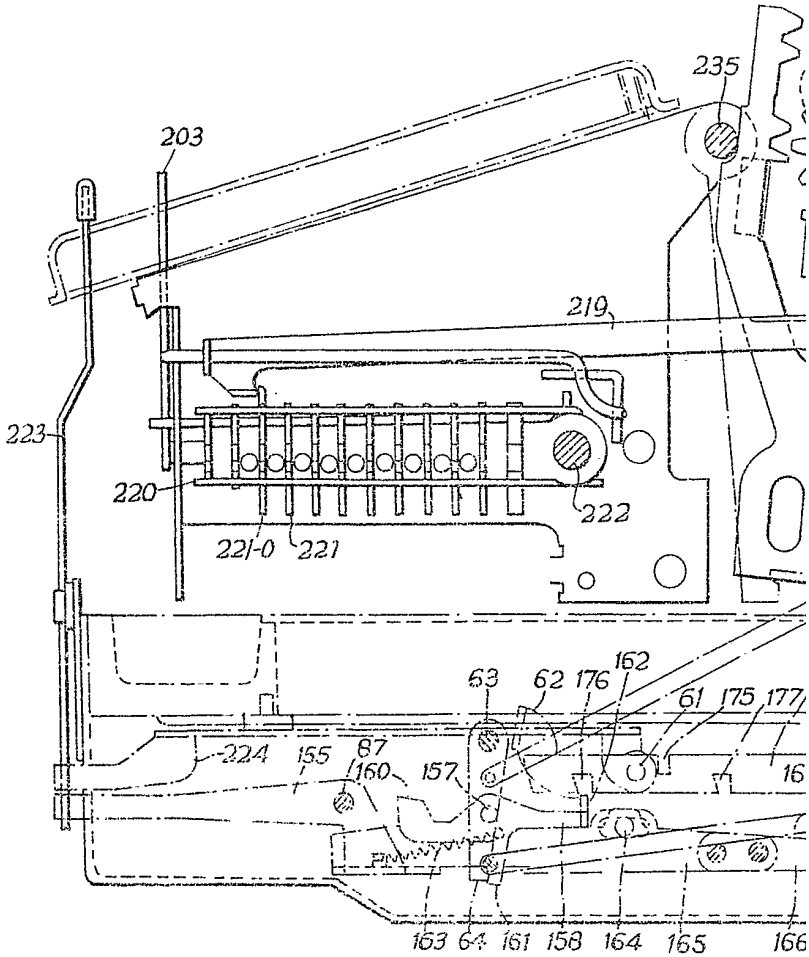
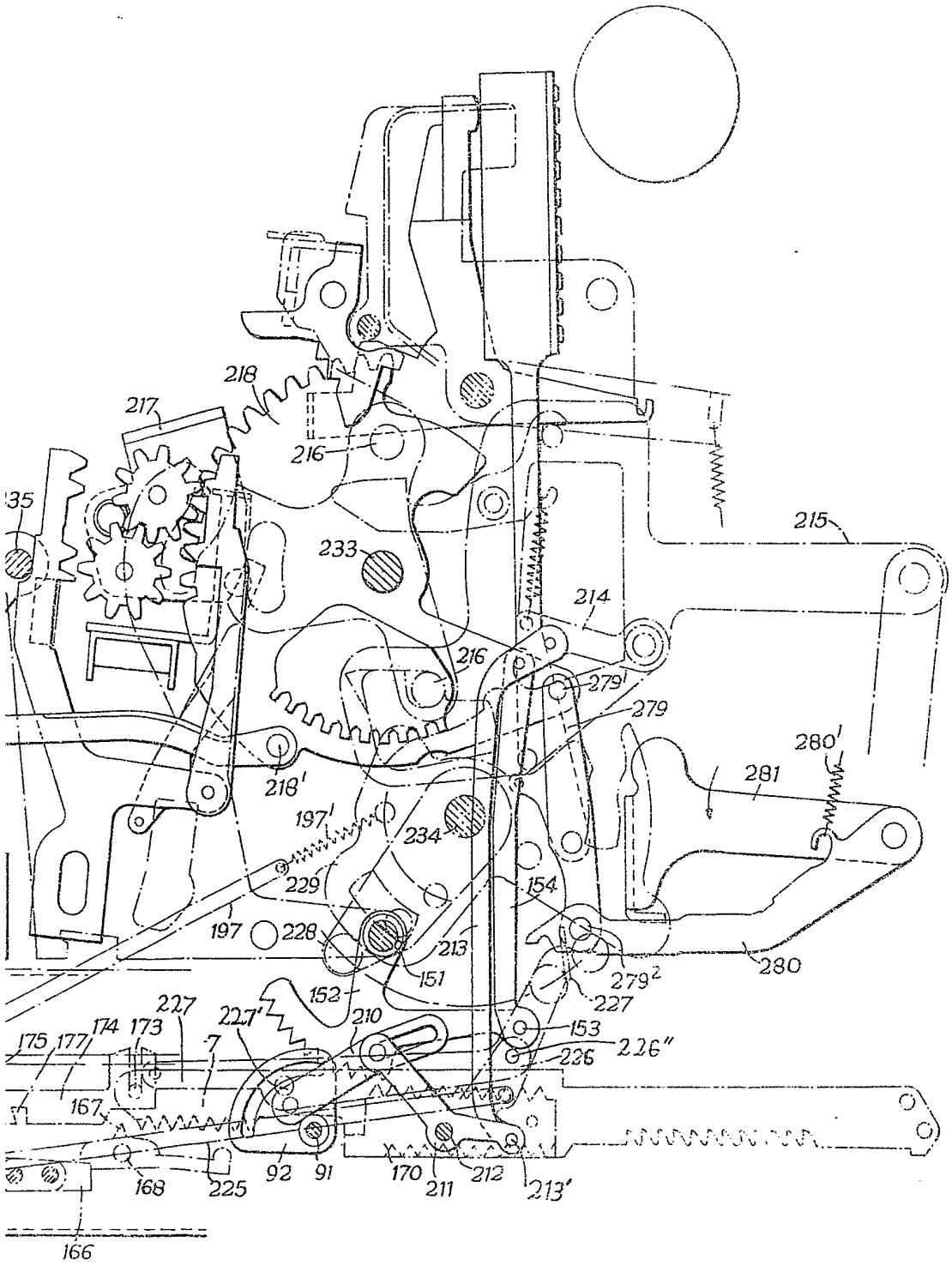


Fig. 1A.


235
203
219
223
220
222
221-0
221
63
62
176
162
61
175
177
224
155
87
160
157
163
64
161
158
164
165
166

804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 2



804,771 COMPLETE SPECIFICATION
8 SHEETS This drawing is a reproduction of the Original on a reduced scale
SHEET 2

Fig. 1A.

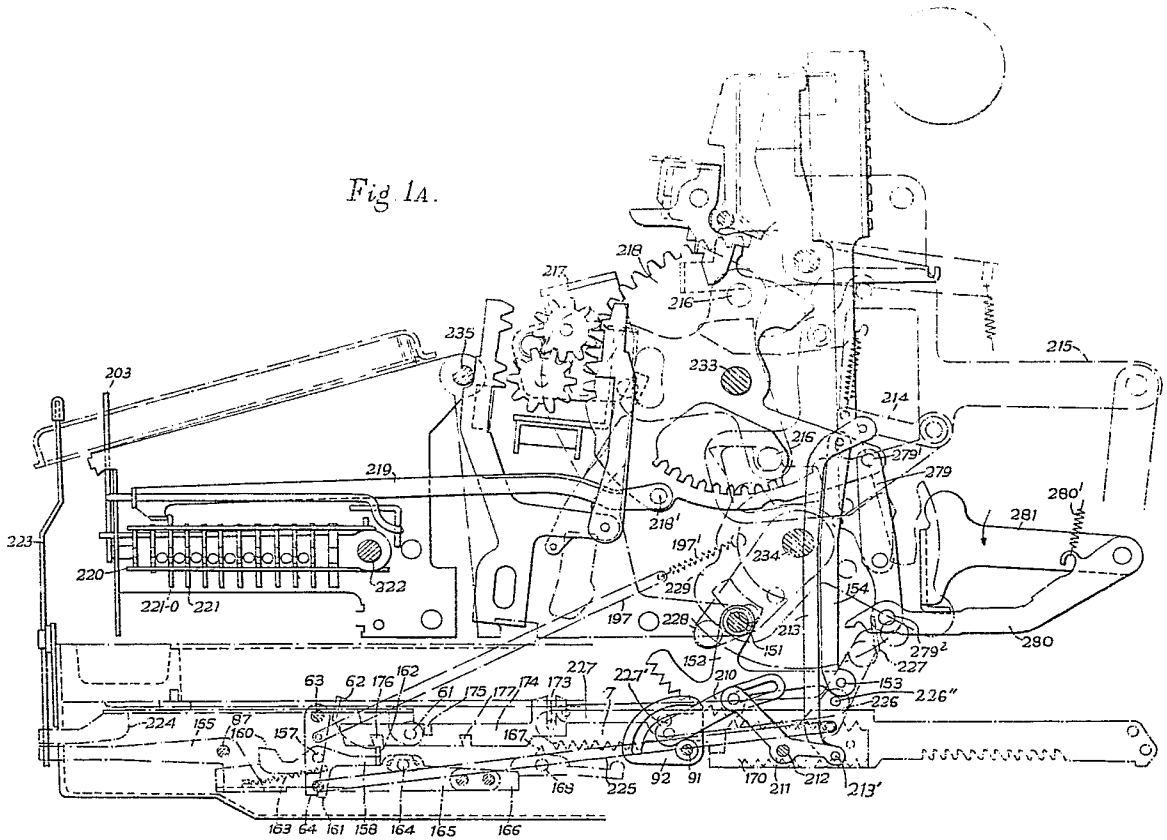


Fig. 2.

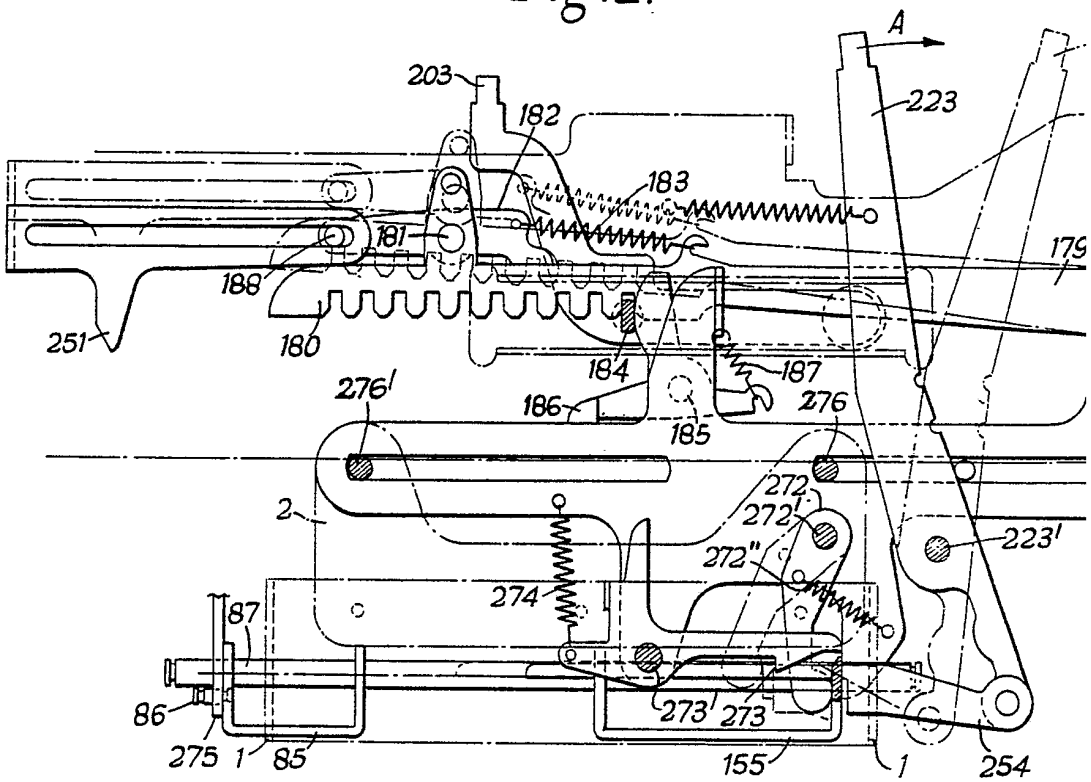
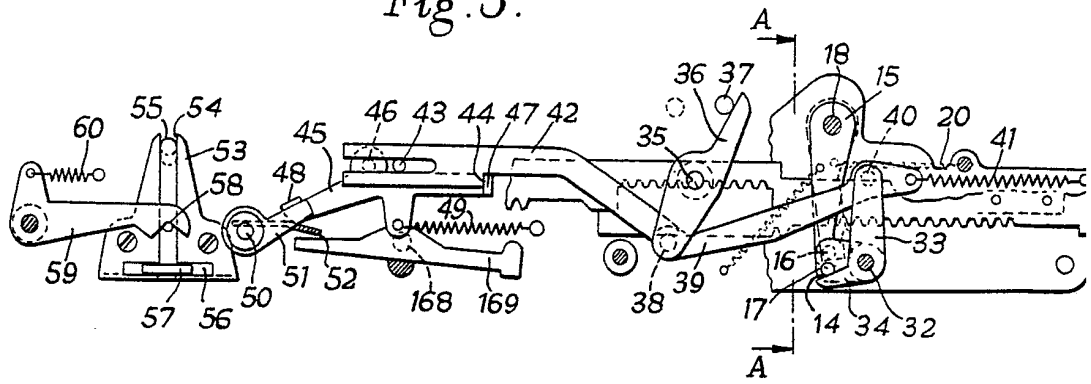
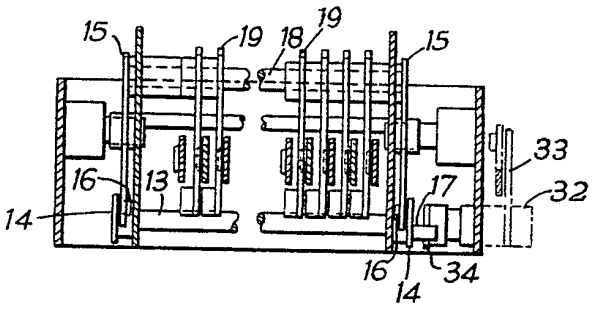

A
203
182
223
183
181
179
188
251
180
184
187
276'
186
185
276
272
272'
272"
223'
2
274
87
86
275
1
85
273'
273
155
1
254

Fig. 3.


A
18
36
37
15
55
54
46
43
44
47
42
40
20
41
60
45
35
53
48
58
49
33
59
51
52
50
168
169
38
39
16
17
14
34
32
57
56
A

804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 3

Fig.3a.



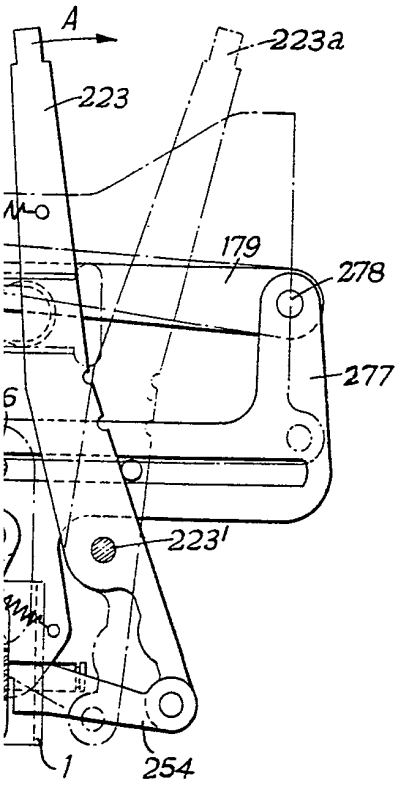
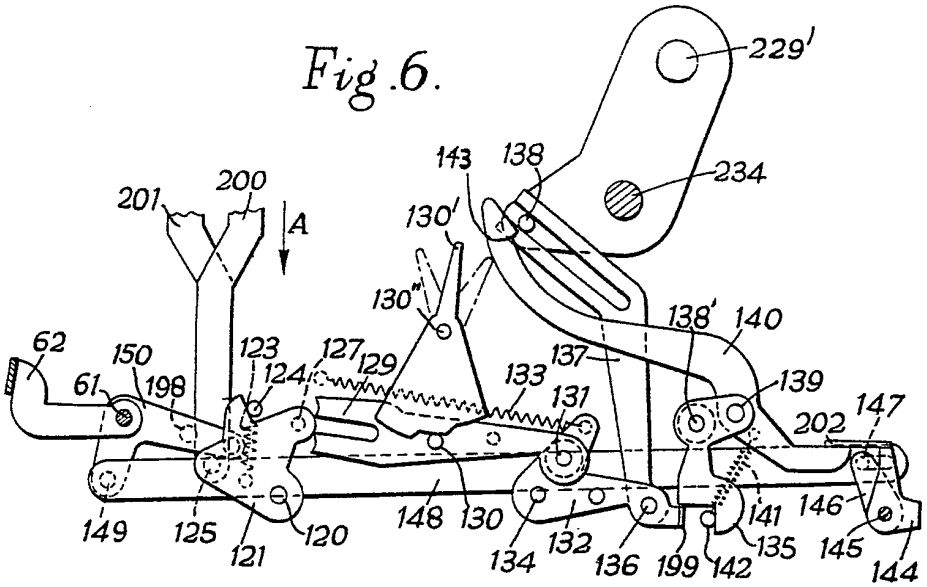


Fig.6.



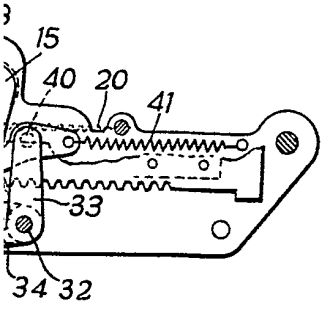
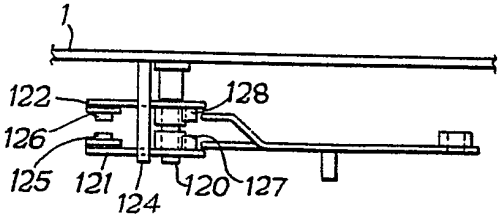


Fig.6a.



804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 3

Fig.2.

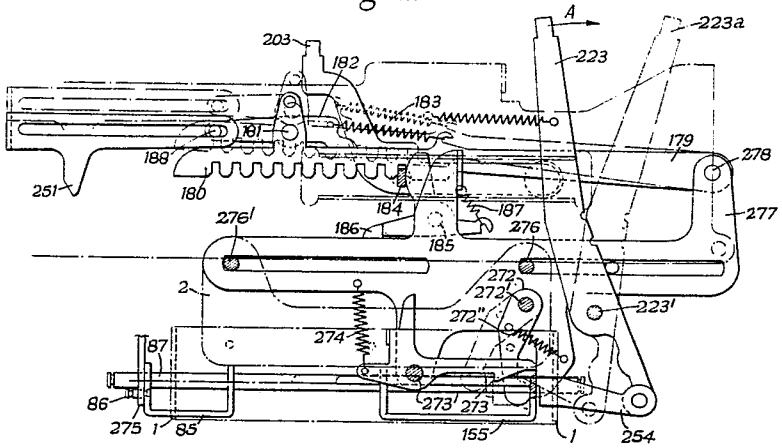


Fig.3.

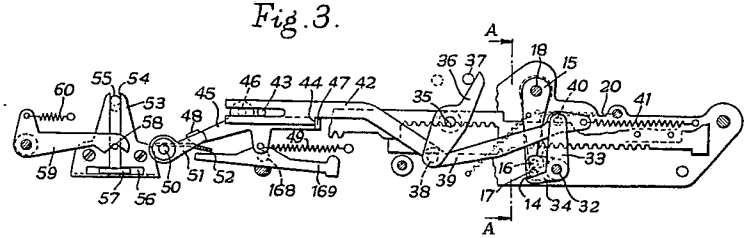


Fig.3a.

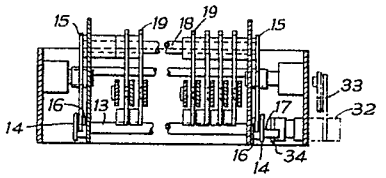


Fig.6.

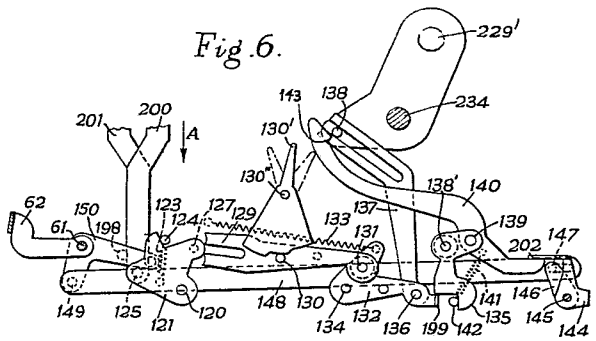
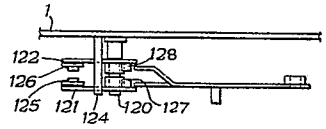


Fig.6a.



804,771 COMPLETE SPECIFICATION
8 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEET 4

Fig. 4.

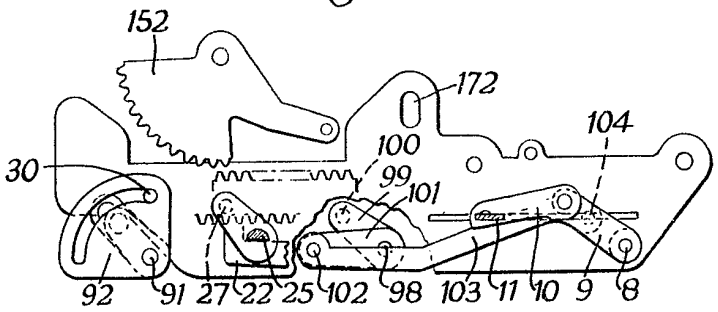


Fig. 4a.

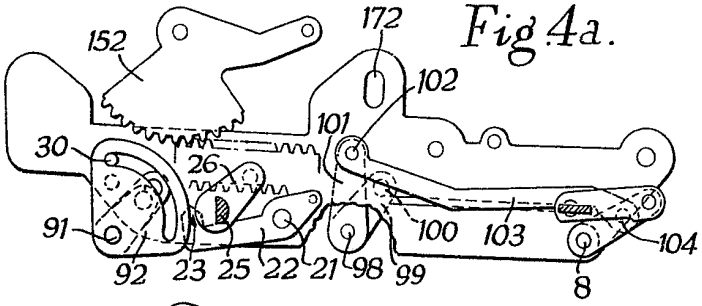


Fig. 4b.

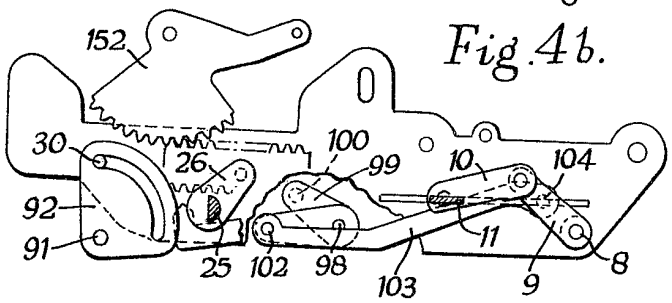


Fig. 4c.

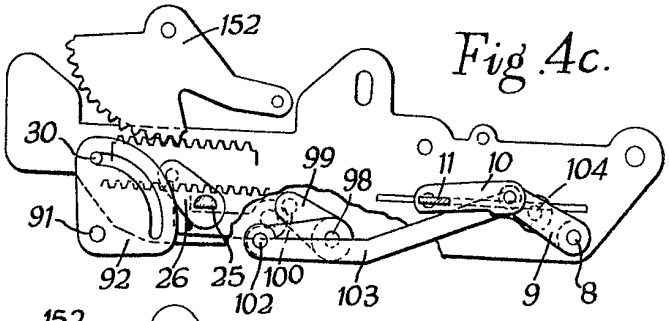


Fig. 4d.

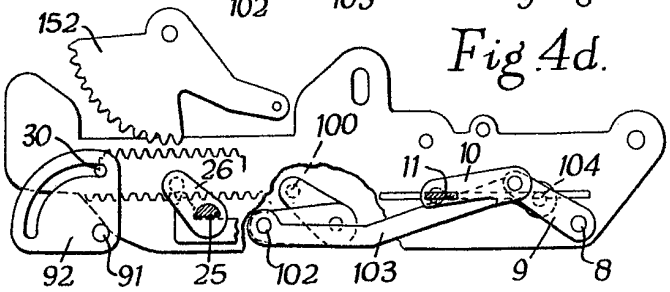


Fig. 5.

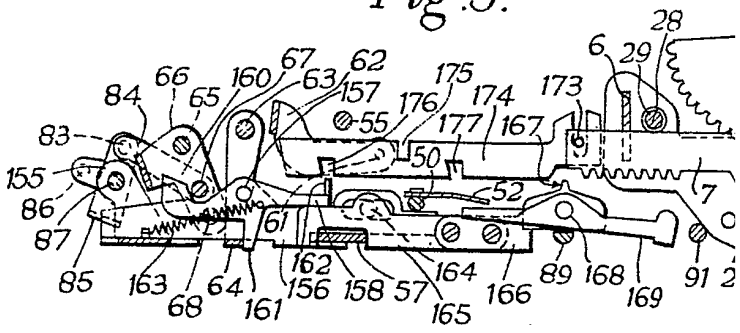
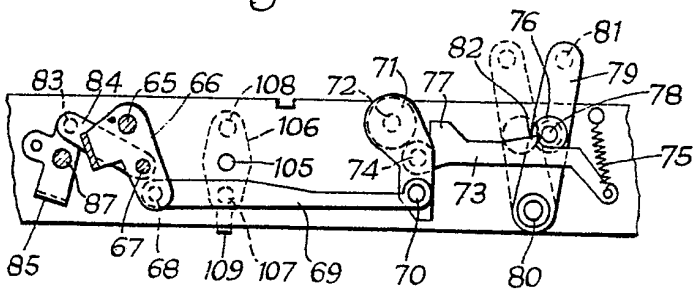


Fig. 7.



Fig

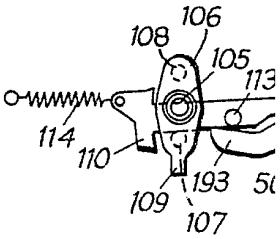
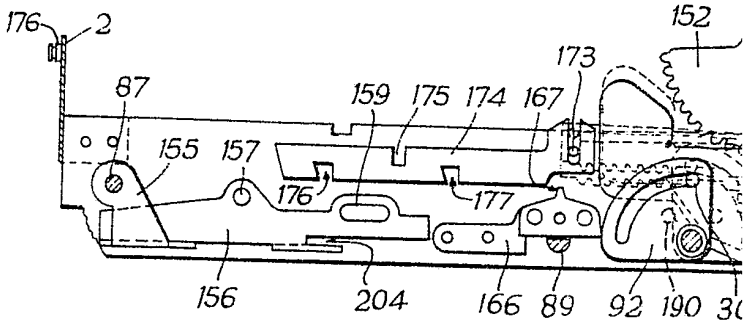


Fig. 8.



804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 5

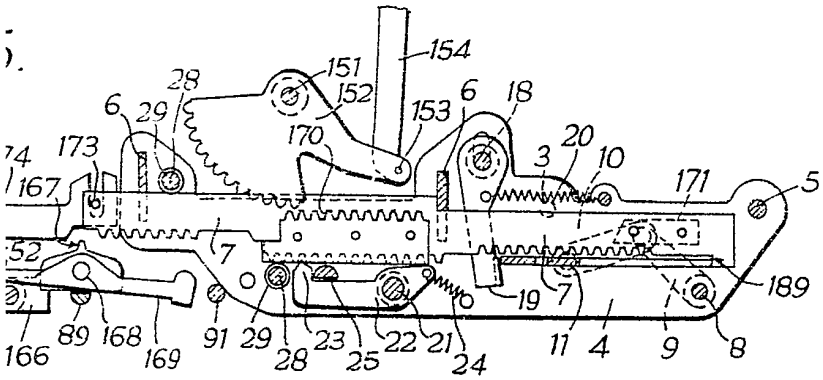


Fig. 7a.

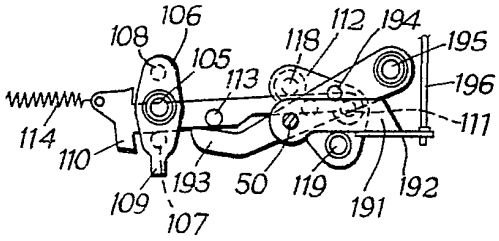
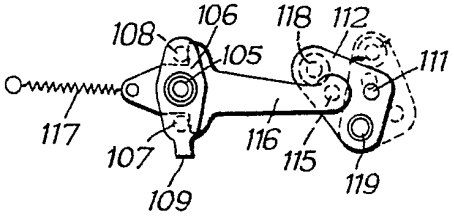
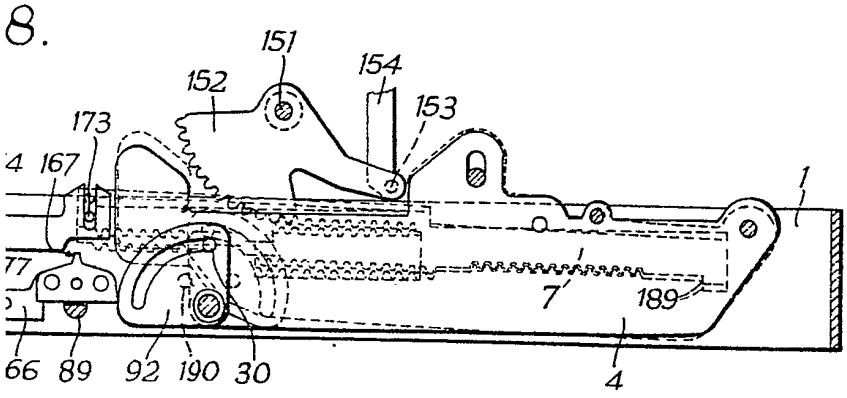


Fig. 7b.



8.



804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 5

Fig. 5.

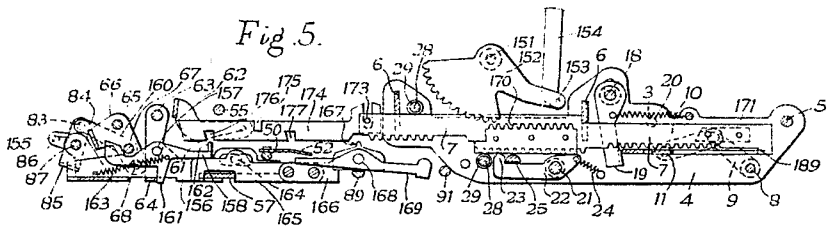


Fig. 7.

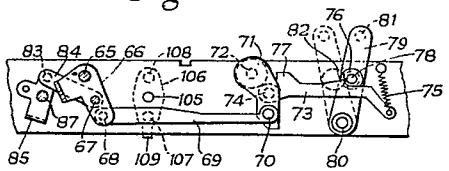


Fig. 7a.

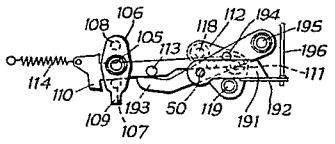


Fig. 7b.

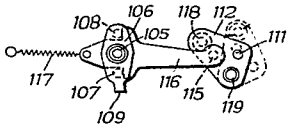


Fig. 8.

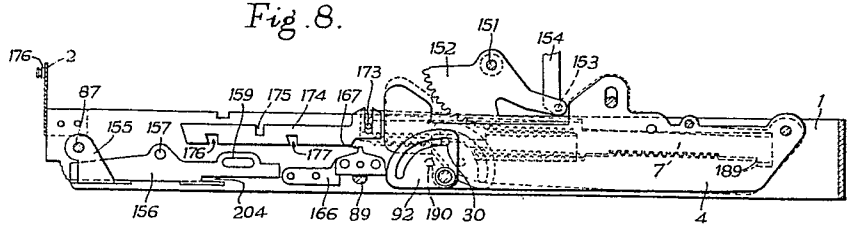


Fig. 9b

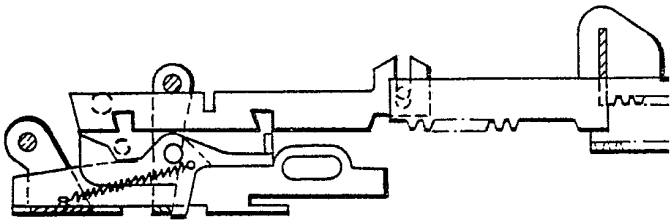


Fig. 9a

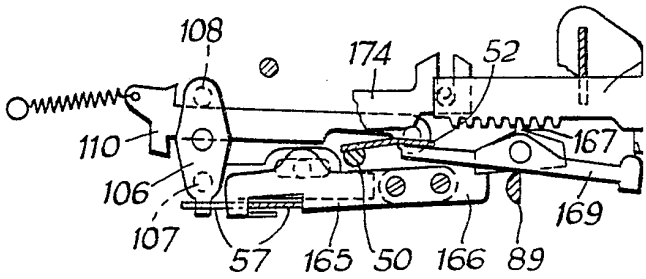


Fig. 9.

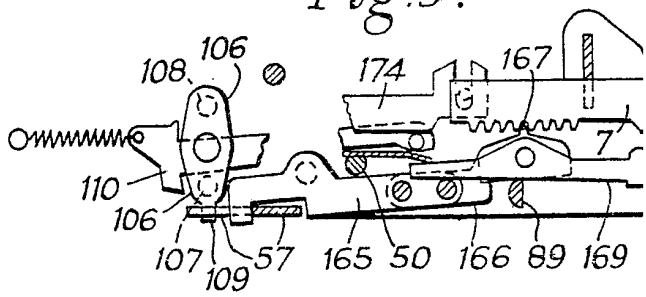
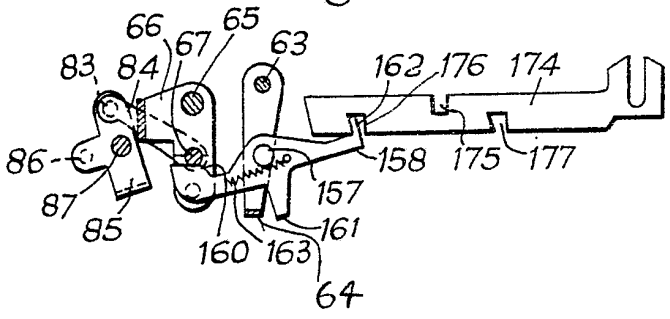


Fig. 10.



804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 6

Fig. 9b.

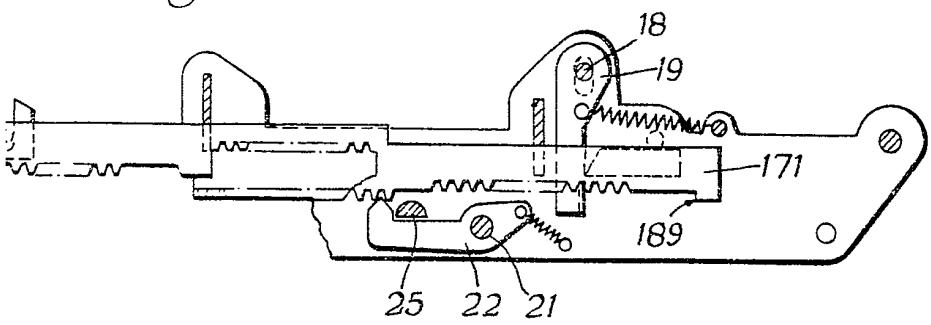
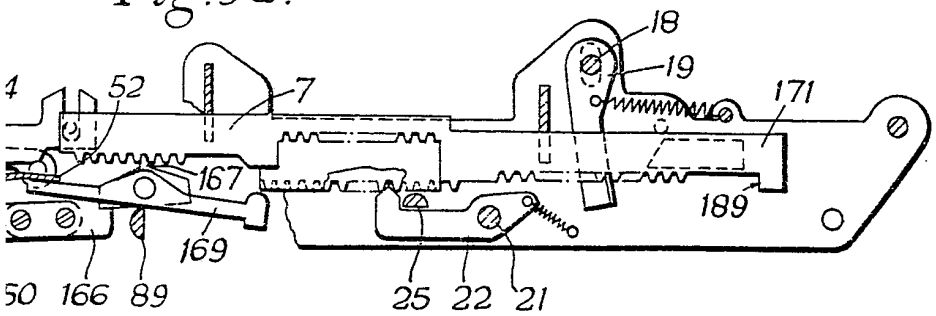


Fig. 9a.



3. 9.

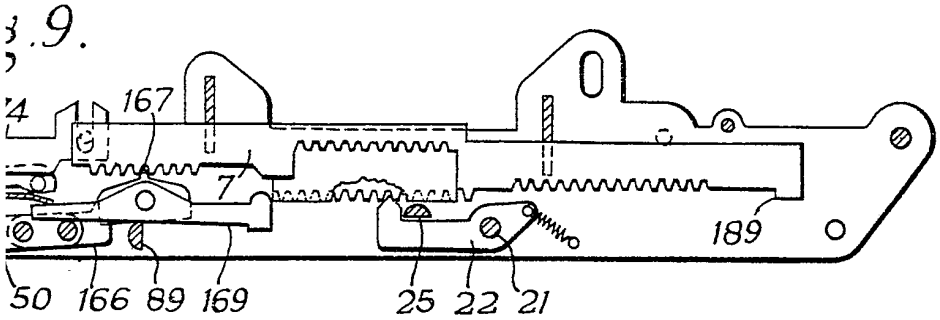
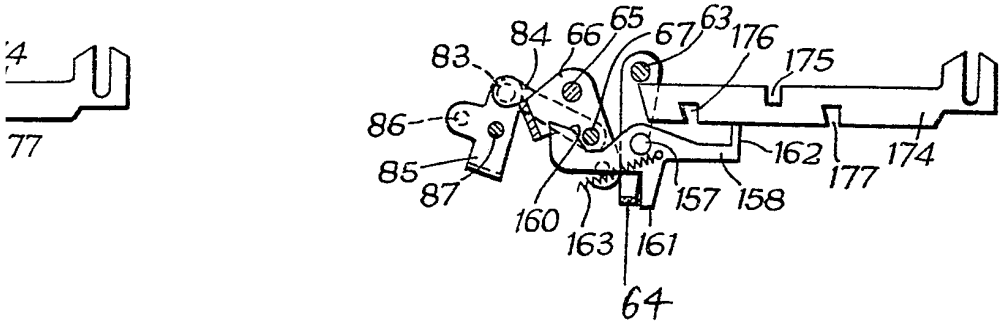


Fig. 10a.



804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 6

Fig. 9b.

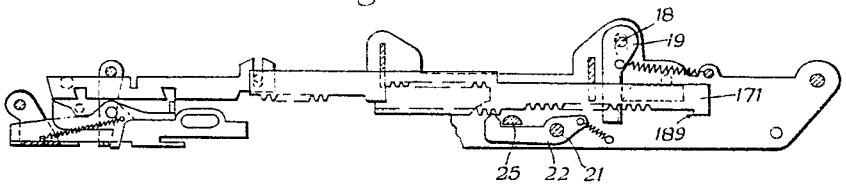


Fig. 9a.

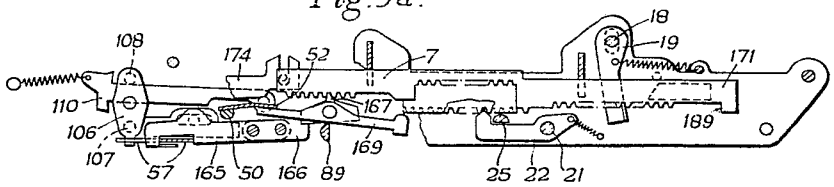


Fig. 9.

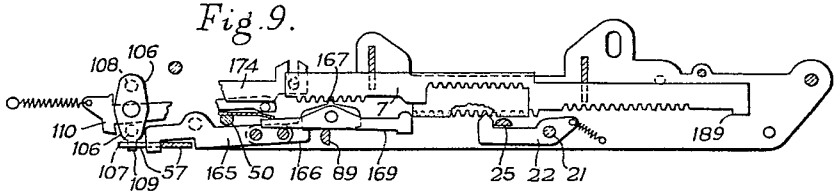


Fig. 10.

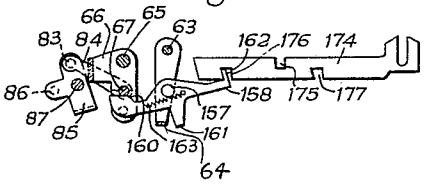
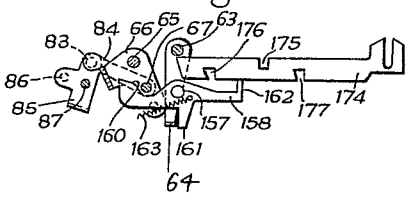
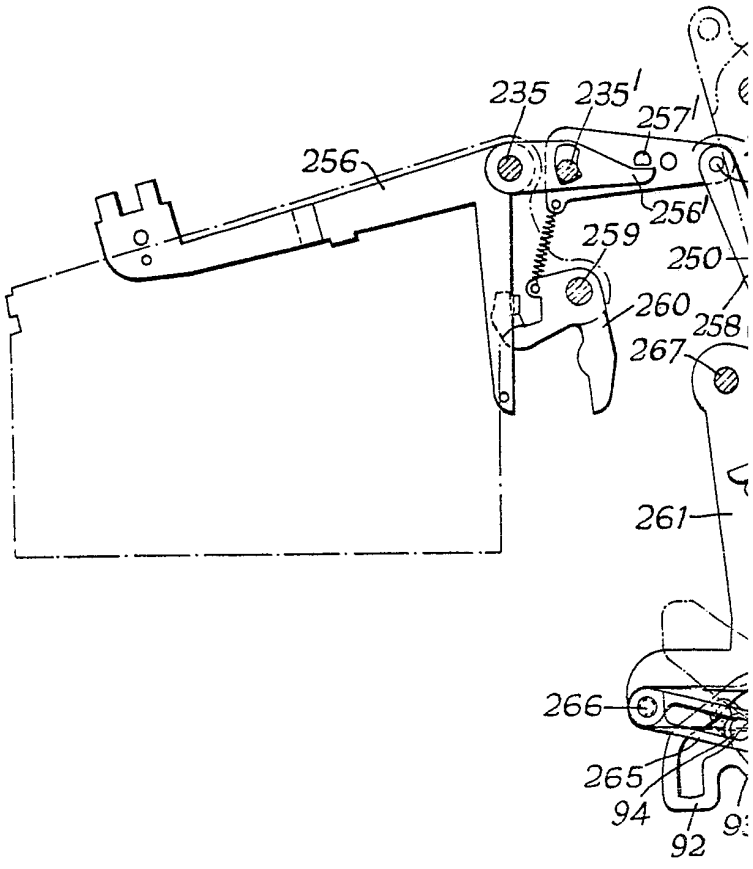


Fig. 10a.

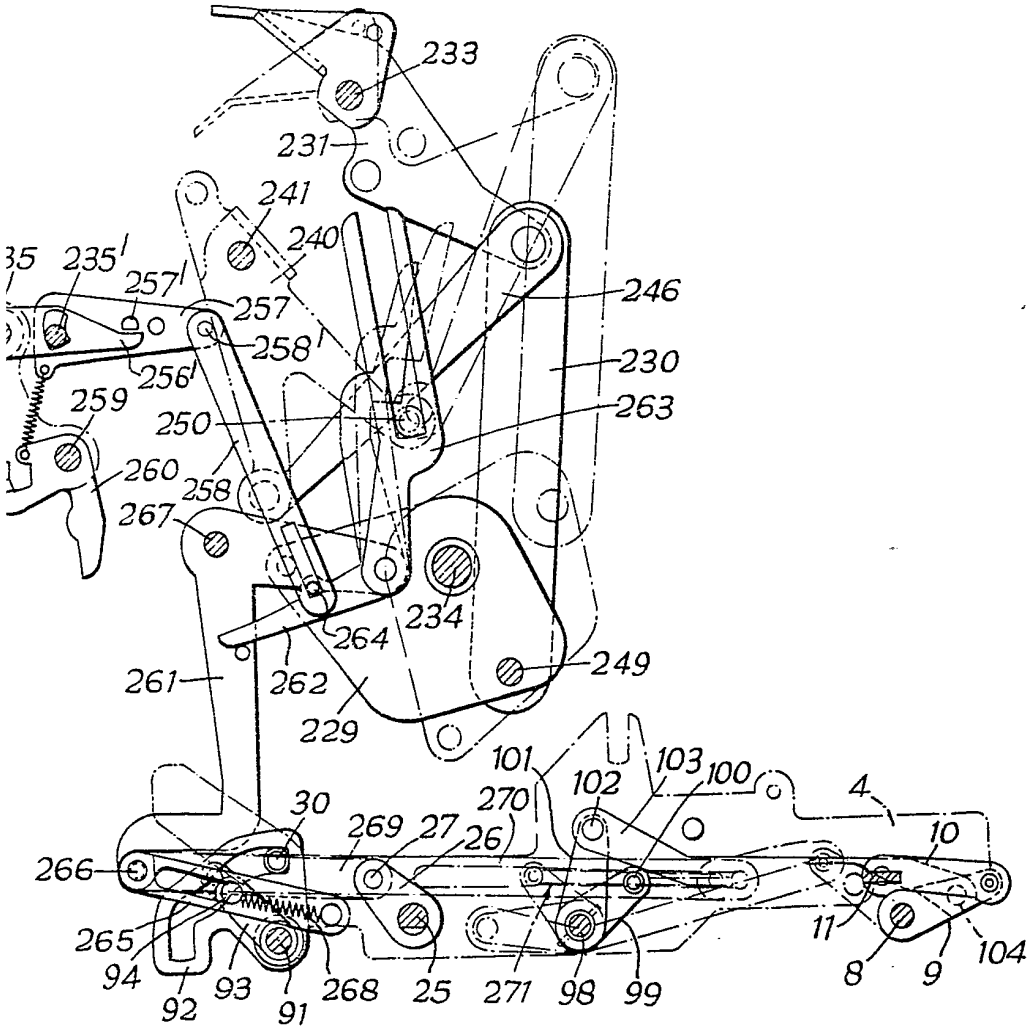


Fig



804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 7

Fig. 11.



804,771 COMPLETE SPECIFICATION
8 SHEETS
This drawing is a reproduction of the Original on a reduced scale.
SHEET 7

Fig. 11.

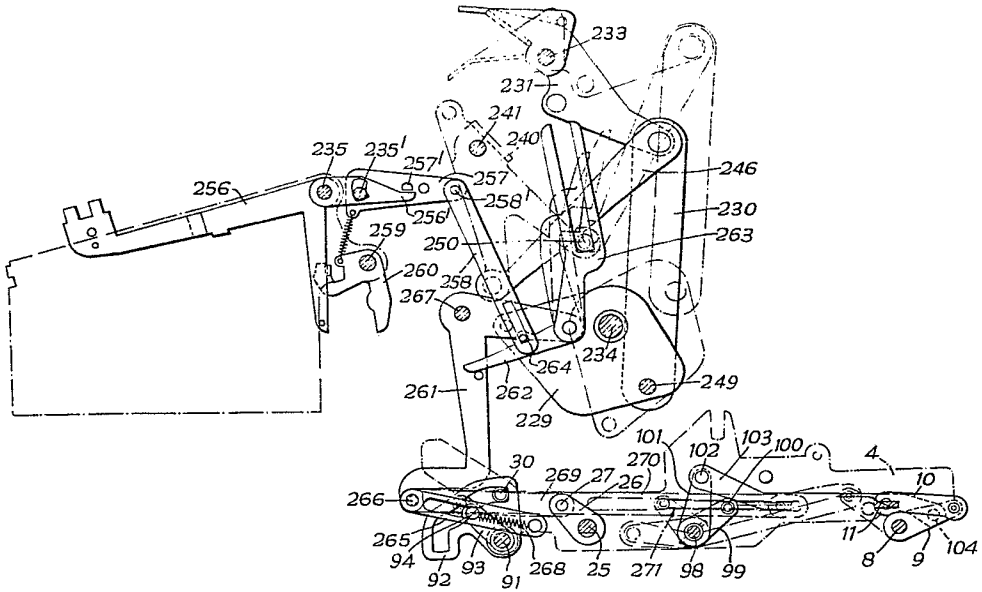


Fig .12.

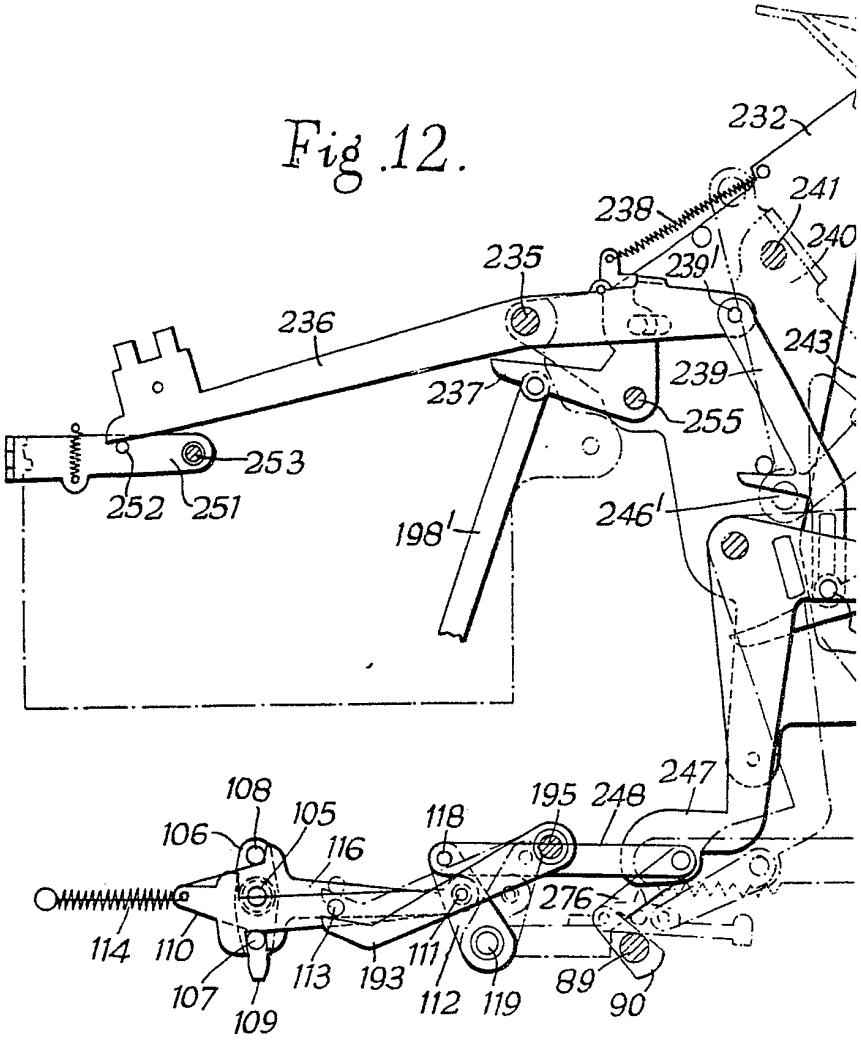
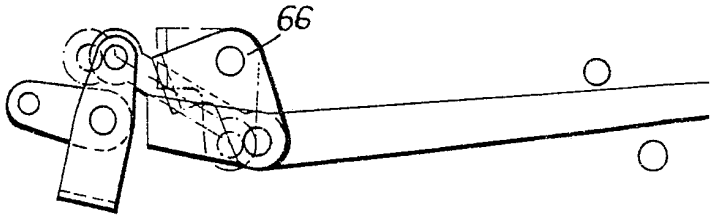

232
241
238
240
239'
235
236
243
239
237
255
253
252
251
198'
246'
247
108
105
195
248
106
116
118
276
114
110
107
109
113
193
111
112
119
89
90

Fig .13.


66

804,771 COMPLETE SPECIFICATION

8 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEET 8

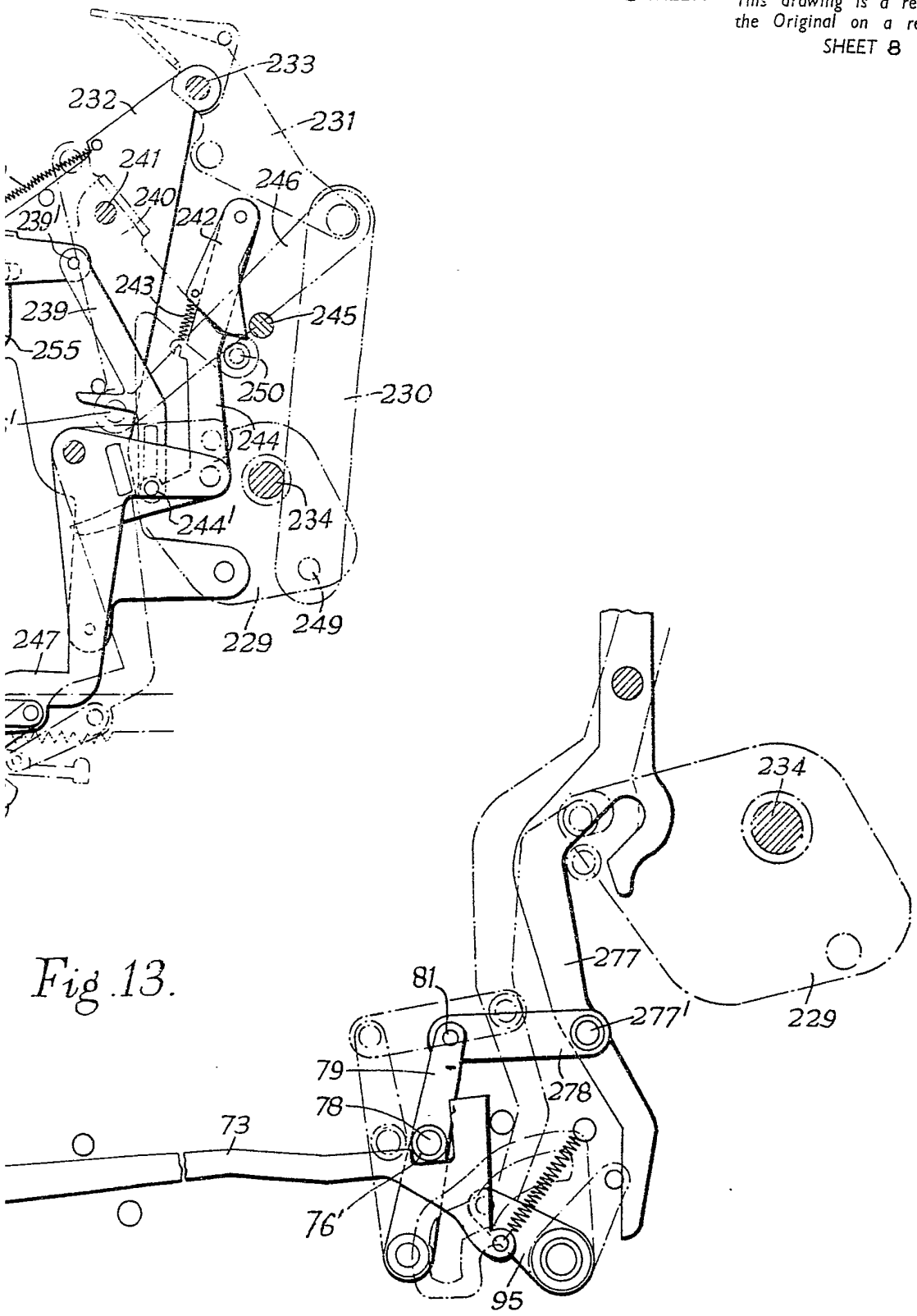


Fig. 13.

804,771 COMPLETE SPECIFICATION
8 SHEETS

Fig .12.

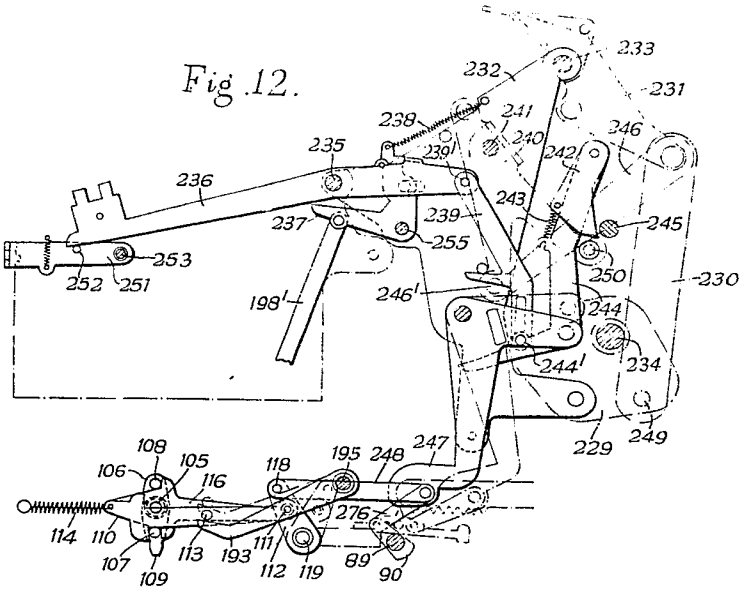


Fig .13.