PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in Calculating and Printing Machines.

We, ROCKFORD MILLING MACHINE COMPANY, a corporation organized and existing under the laws of the State of Illinois, United States of America, whose post office address is Harrison and Eleventh Streets, City of Rockford, County of Winnebago, State of Illinois, United States of America (Assignees of OSCAR JOSEPH SUNDSTRAND, a citizen of the United States of America, of Route 4, East State Road, City of Rockford, County of Winnebago, State of Illinois, United States of America), do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to machines for adding a plurality of items and for printing the items and the total upon a sheet or strip of paper, and particularly to such machines provided with means for performing calculations in which subtraction is involved, and having for that purpose a set of pinions which, according to the operation to be performed, are moved to mesh with one or the other of two sets of racks, and consists in that each of said sets of racks is provided with a set of transfer devices arranged to be operated by the pinions when in mesh with the corresponding set of racks.

Further features of the invention will be hereinafter described and delimited in the appended claims.

In the accompanying drawings:

Figure 1 is a fragmentary longitudinal vertical sectional view of a machine embodying the features of this invention, the view being taken from the handle side of the machine. The machine is shown at rest.

Fig. 2 is a plan view of the keyboard.

Fig. 3 is a view similar to Fig. 1, but showing the parts in the positions occupied just after the handle has commenced its return stroke.

Fig. 4 is a fragmental detail view of the adding and subtracting mechanism.

Fig. 4^a is a fragmental transverse view showing the totalizer wheels.

Fig. 4^b is a detail view.

Fig. 5 is a view showing the parts in position for addition.

Fig. 6 illustrates the parts in position for subtraction.

Fig. 6^a is a fragmental view of the carrier cross-bar 136.

Fig. 7 is a fragmental side elevation of the machine, the view being taken from the handle side.

Fig. 8 is a fragmental view looking from the right-hand side of Fig. 7.

Figs. 8^a and 8^b are detail views.

Fig. 9 is a fragmental side elevation.

Fig. 9^a is a detail sectional view.

Fig. 9^b is a fragmentary longitudinal vertical sectional view illustrating the operation of printing a subtraction and credit sign.

Figs. 10 to 16 illustrate specimens of work done upon the machine.

The sheet or tape on which the items and totals are to be printed and the calculations recorded may be supported in any ordinary or suitable way. In the present instance, a cylindrical platen 2 is employed. The printing is effected by means of vertically reciprocatory type bars 3, one such bar being provided for each numerical order. The machine herein illustrated is adapted to register and print up to 9,999,999.99, hence nine bars 3 are employed. Said bars are arranged compactly side by side, and they are guided near their upper ends by means of a transverse rod 5 fixed in the framework of the machine, said rod extending through vertically elongated openings 6 in the type bars. The lower ends of the type bars are located between

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and guided by two transverse fixed bars 7 and 8, the latter being slotted to receive the rear edges of the type bars.

Each type bar 3 is provided at its upper end with ten type 9 adapted to print from nought to 9, respectively. The uppermost type is adapted to print " 0 ", the next to the top " 1 ", and so on.

The means for vertically moving each bar 3 into and out of printing position comprises an arm 10 carrying a headed stud that lies in an elongated opening 11 in the type bar. The arm 10 is loosely mounted on a shaft 12 which is supported in the framework of the machine. Rigid with the arm 10 is an arm 13 which is yieldingly connected through two helically coiled contractile springs 14 to a rod 15. The latter is carried by two side members 16 (Fig. 1) which are guided for approximately vertical movement by a transverse rod 17 (Fig. 1) fixed in the framework of the machine, said rod extending through elongated openings 18 in the side members 16. Pivoted to the upper ends of the side members 16 are two levers 19 (Figs. 7 and 8) which are mounted in the framework of the machine to swing on the axis 19ª. To the lower ends of the levers 19 are pivoted links 23 (Figs. 7 and 8) the forward ends of which are pivoted to two crank arms 24 and 25 (Figs. 7 and 1) fixed to opposite ends of the main rock shaft 26. The shaft 26 is arranged to be rocked by means of a handle or crank 27 mounted to swing upon the axis 28. It will of course be understood that an electric motor may be used to rock the shaft 26, if desired.

When the operator pulls the handle 27 forward, the crank arms 24 and 25 swing upwardly, thereby drawing the lower ends of the levers 19 forwardly and moving the side members 16 and the rod 15 downwardly. The movement of the rod 15 is yieldingly transmitted through the springs 14 and the arms 13 and 10 to such of the bars 3 as are at liberty to rise. When the operator releases the handle upon the completion of the forward stroke, means hereinafter mentioned returns the handle to its normal position (shown in dotted lines in Fig. 1). The means for positively moving down those bars 3 which were raised in the forward stroke of the handle comprises a transverse rod 29 (Fig. 1) overlying the forward portions of the arms 10. The rod 29 is supported at its opposite ends by two arms 30 (Figs. 1, 3 and 8). The arms 30 are loosely mounted upon the shaft 12. A helically coiled contractile spring 31 (Fig. 8) connected at its upper end to the rod 29 and at its lower end to the framework of the machine tends to draw the rod down. To the ends of the rod 29 are pivoted two cam plates 32 (Fig. 8) each having a cam slot (not shown) in which are mounted anti-friction rollers (not shown) that are pivoted in the machine frame. In the rear portion of each cam plate 32 is a notch (not shown) in which lies an anti-friction roller 36 (Fig. 8) on a stud 37 that projects inwardly from the lower end of the lever 19. These studs are prolongations of the pivots by means of which the links 23 are connected to the levers 19. During the rearward stroke of the handle 27 the cam plates are drawn downwardly and rearwardly over the anti-friction rollers by the studs 37, whereby the restoring rod 29 is drawn downwardly in proper time relation to the operation of the printing mechanism, thus drawing down those type bars 3 that were raised in the forward stroke of the handle.

The means for returning the handle 27 to its normal or initial position may be of any suitable character, as, for example, a contractile spring 38 (Fig. 8).

The means herein shown for limiting the extent to which the type bars 3 may rise, and thus to determine which numerals shall be brought to the printing position, is of a known type and comprises a stationary group of stops 42 (Fig. 1). It will here be sufficient to say that each stop is horizontally slidable in a forward and back direction, there being one vertical row or column of nine stops for each numerical order. When moved rearwardly from the position shown in Fig. 1, the stops are in the path of movement of devices carried by the type bars 3 and thereby limit the upward movement of said bars. These devices consist of arms 45 pivoted to the lower portions of the type bars 3, and pins 46 having openings through which the arms 45 extend. The pins 46 are guided for vertical movement in a slide 47 which is mounted on a stationary guide rod 48 extending transversely of the machine. The guide rod 48 is so positioned with reference to the group of stops 42 that the slide 47 is movable to carry the pins 46 from their normal or initial position at the left-hand side of the group of stops 42 into vertical alinement with the columns of stops.

The type bars 3 are normally about one step below the cipher-printing position, a slight movement being necessary to raise the pins 46 against the nought stops 42 or the detent plate 48ª (Fig. 9) hereinafter mentioned. When a bar 3 is raised until its pin 46 stops against a projected stop 42 in the second horizontal row from

the bottom, said bar is in position to print the numeral " 1 ". The stops 42 in the third row from the bottom serve to position the type bars for the printing of the numeral " 2 ", and so on. Those type bars 3 which are not needed in printing a given item are prevented from rising when the handle is pulled forward, by the detent plate 48[a] (Fig. 9) guided to move in a horizontal plane, said plate being connected through a bar 48[b] to a rigid frame 48[c]. The frame 48[c] is mounted to swing on the rod 5 and is normally impelled forward by contractile springs 48[d], only one of which is shown in the present drawings. When the slide 47 is in the initial position (that is to say, at the left-hand side of the machine) the detent plate 48[a] is out of the vertical plane of the pins 46. As soon as the slide moves one step to the right the detent plate 48[a] is moved back far enough to overlie all the pins 46 except the one farthest to the right.

This construction is similar to that shown in British Patent No. 107,403 (see particularly the plan view given in Figure 8 thereof). The present machine, however, is provided with mechanism (not shown) which, when a total is to be printed, enforces the taking of a blank spacing stroke of the handle 27, that is —after all the numbers to be added have been set up, a stroke is made necessary or enforced during which the type bars 3 do not rise and so no total is printed. During that stroke, however, the platen 2 is moved so that when the total is printed upon the succeeding handle stroke a space appears between the said total and the last number set up in the machine. This mechanism acts to hold the plate 48[a] in its rearward position until this enforced blank or spacing stroke is taken. The mechanism which compels the taking of this extra stroke is as indicated not shown herein nor will it be described as it forms no part of the present invention. This reference thereto is made, however, to explain the meaning of the term " enforced blank or spacing stroke " as used hereinafter.

The means for projecting the stops 42 into the path of the pins 46 comprises 10 keys 49 which are numbered from " 0 " representing nothing to " 9 " as shown in Figure 2. The means whereby movement of the numeral keys 49 is transmitted to the stops 42 may be of any suitable character.

The repeat or multiplying key 84 (Fig. 2) may be constructed and arranged in a known manner.

In case the operator, when setting up an item, should strike a wrong numeral key, he may correct the error by operating the back spacer key 86 (Fig. 2) to restore the slide 47 to the position occupied just before the error occurred. The back spacer key 86 may be connected to the slide 47 in any convenient manner. The back spacer key may also be employed when it is desired to set the slide 47 for the printing of a number one-tenth that of the number previously set up, as will appear more fully hereinafter.

The calculating mechanism comprises a series of pinions 125 (Figs. 3, 4 and 4[a]) rotatably mounted upon a transverse shaft 126. The shaft 126 is supported for sliding movement fore and aft of the machine. For this purpose the ends of the shaft are extended through elongated openings 127 (Fig. 4[a]) in guide plates 128 which form part of the stationary framework of the machine. The set of pinions 125 (of which there is one for each type bar 3) is located between two sets of racks 129 and 130 (Fig. 1). Both of these sets of racks are connected to the bars 3 in the manner to be presently described, and the set of pinions 125 is arranged to be moved into mesh with either set of racks.

Addition is accomplished by means of the set of racks 130. When an item is to be added, the set of pinions is moved forward into neutral position between the two sets of racks before the type bars 3 are raised; and the set of pinions is moved rearwardly into mesh with the racks 130 just before the bars 3 are moved downwardly. Addition therefore occurs in the down stroke of the racks 130, the extent of rotation of the pinions depending, of course, upon the extent of movement of the type bars 3 and racks 130.

The upper end of each rack is attached to a rearwardly extending portion 131 (Fig. 5) of one of the type bars 3 by means of a headed pin or stud 132 extending through a vertically elongated opening 133 in the rack. A contractile spring 134 attached at its upper end to the rack at 134[a] and at its lower end to a downwardly-extending portion 135 of the type bar tends to move the rack downwardly with relation to the type bar one tooth space for transfer purposes. The backs of the racks slide in grooves 136[a] (Fig. 6[a]) in stationary guide bars 136. The part 134[a] of the rack being virtually a short lever arm, the spring 134 tends to turn the rack on the stud 132 as a pivot, and thus serves to hold the rack in place in its guide groove 136[a]. However, in order to prevent the rack from being pulled out of place in case the pinion teeth should stick thereto when the

pinion is being moved to central position between the sets of racks, there is provided a rod 136[b] fixed in the framework and extending adjacent to and transversely of the racks. Normally, there is clearance between the racks and said rods 136[b].

The guide bars 136 are located directly opposite the point of tangency of the racks to the pinions, and hence serve effectively to guide the racks. Even if the racks were slightly bent or bowed, or if there were a tendency to move in a non-rectilinear path, they would be compelled to reciprocate in proper relation to the pinions.

The pinions 125 are moved into and out of mesh with the racks 129 and 130 by means of two links 137 (Figs. 3 and 4[a]), one at each side of the machine, the forward ends of which have bearings to receive the ends of the shaft 126. The rear ends of the links 137 are pivoted at 138 to the lower arms of two levers 139 which are rigidly secured to a shaft 140 journaled in the framework of the machine.

The means for swinging the levers 139 and the shaft 140 to move the pinions into and out of mesh with the racks comprises a link 141 (Fig. 9[b]), the forward end of which is supported by a lever 141[a] pivoted on a rod 141[b]. The rear end of the link 141 is provided with notches 142 and 143 to receive pins 144 and 145, respectively, on opposite ends of the right-hand lever 139. Rearwardly of the notches 142 and 143 are lugs 146 and 147, respectively, which serve to prevent disengagement of the lever 139 from the link 141. Forwardly of the notches 142 and 143 are curved surfaces adapted to slide in contact with the pins 144 and 145. The link 141 is moved forward and back by means of an oscillatory cam plate 148 having a cam slot 149 therein, the upper portion of said slot being concentric with the axis 150 of said plate. On the forward end of the link 141 is a roller 151 that lies in the slot 149. A contractile spring 151[x] (Fig. 3) connected to the lever 141[a] and anchored to the machine frame holds the roller 151 against the front wall of the cam slot 149 and thus takes up play. The tension of the spring overcomes the weight of the cam 148 and the link 141, and thus prevents the weight of these parts from causing the pinions to move out of central position.

The means for oscillating the cam 148 comprises a pawl 152 (Fig. 9[b]) which is pivoted at 153 upon a plate 154 which is rigidly secured to the arm 24. A contractile spring 155 (Fig. 7) is connected at one end to an extension of the pawl 152 and at its other end to the plate 154. The pawl 152 has a shoulder 152[a] (Fig. 9[b]) adapted to engage a pin 156 (Fig. 9[b]) set in the cam 148 at one side of its axis 150, and another shoulder 152[b] adapted to engage a pin 157 fixed in the cam 148 at the opposite side of its axis. There is a guide finger 158 on the pawl between the shoulders referred to, said guide finger extending into the space between the pins 156 and 157 so as to strike said pins as the arm 24 swings, whereby the pawl is swung to one side or the other of its pivot. The spring 155 tends to swing the pawl into central position. Under certain conditions the pawl 152 engages the pin 156 when the handle 27 is pulled forward, thereby swinging the cam 148 upwardly and drawing the link 141 forward, thus operating the levers 139 and consequently shifting the set of pinions; and when the handle swings rearwardly, the pawl 152 engages the pin 157 and swings the cam 148 downwardly, thus pushing the link 141 rearwardly with a resultant shifting of the pinions.

The means for controlling engagement of the pawl 152 with the pin 156 comprises an arm 159 (Figs. 7 and 9) pivoted at 160 in the machine frame, the upper end of said arm having an angular lug 161 adapted to hold the pawl 152 out of position to engage said pin. In the arm 159 is an elongated opening 162 in which lies a pin 163 fixed to the swinging frame 48[c]. When there is no number set up in the group of stops 42, the frame 48[c] is in its forward position. As soon as a digit is set up in the machine, the frame 48[c] swings back, thereby swinging the arm 159 rearwardly away from the pawl 152 and leaving said pawl in position to engage the pin 156 when the handle 27 is pulled. When a sub-total is to be printed, the frame 48[c] is in its forward position, and the pawl 152 is held out of engagement with the pin 156. The printing of the sub-total is thus automatic, that is to say, without any manipulation other than the operation of the handle 27.

The means for shifting the pinions 125 out of mesh with the racks 130 before the latter rise for the printing of an item, and the means for returning the pinions into mesh with the racks 130 before the latter start down have been described. When a debit or positive total (whether subtotal or final total) is to be printed, the pinions are retained in mesh with the racks 130 during the upward movement thereof, the pawl 152 being automatically held out of position to engage the pin 156, as described. When it is not

desired to clear the machine after printing a debit total, the pinions are allowed to remain in mesh with the racks 130 during the downward movement thereof, and therefore during the downward movement of the racks the several pinions are rotated to the positions they occupied just before the taking of the sub-total. When, however, the operator wishes to clear the machine of a debit total, the pinions are withdrawn from the racks 130 before the latter descend. The means for swinging the cam 148 to effect such movement of the pinions comprises a lever 164 (Fig. 3) pivoted on the shaft 26 and having a cam slot 165 in which lies a roller 166 on the cam 148. The lever 164 has an arm 167 which is arranged to be engaged by a pin 168 (Figs. 3 and 9[a]) on the arm 24. The means for swinging the lever 164 forward to disengage the pinions from the racks 130 is controlled by a clear or total key 169 (Fig. 7) having a stem 170. On the stem 170 is a stud 171 that underlies the forward end of a lever 172. The lever 172 has an elongated opening 173 through which a pivot rod 174 extends, the lever 172 thus being movable longitudinally to a slight extent. A contractile spring 175 tends to slide the lever 172 rearwardly. 176 is a contractile spring stretched between a pin on the stem 170 and the front end of the lever 172 and tending to hold the pin 171 and the lever 172 in contact with each other. During the printing of an item and during the enforced blank or spacing stroke prior to the taking of a total, the lever 172 is held against movement by the spring 176 by means comprising a cam plate 177 (Figs. 3 and 7) which is pivoted at 178 and is acted upon by a contractile spring 179. On the rear end of the lever 172 is a pin 180 underlying the cam plate 177. The spring 179 normally holds the cam plate 177 in contact with the stud 37 (Fig. 8) carried by the adjacent lever 19. The movement of the cam plate 177 under the influence of the spring 179 is restrained at times by a detent arm 181 (Figs. 7, 8 and 8[a]) pivoted at 182 in the framework of the machine and normally held by a contractile spring 183 in contact with the stud 37. On the detent arm 181 is a pin 184 (Fig. 8) adapted to engage a hook 185 (Figs. 3 and 7) on the cam plate 177. At times the detent arm 181 is prevented from moving under the influence of the spring 183 into position where the pin 184 is in front of the hook 185, by means of a pin 186 (Fig. 7) on an arm 187 which is rigid with the arm 159. The upper end of the arm 181 is cut away so as to clear the pin 186 when the arm 159 is in its rearward position (as it is when an item has been set up or an enforced blank stroke is to be taken).

A detent plate 188 (Fig. 4[b]) pivoted on the center 178 has a cam slot 189 having a dwell portion 190 in which the stud 37 (Fig. 8) is arranged to run. That portion of the pin 180 which projects from the inner side of the lever 172 underlies the plate 188 (see Fig. 8). In the lower edge of the plate 188 is a notch 191 (Fig. 4[b]).

It will be remembered that the stud 37 is connected to swing back and forth with the handle 27. Even if the total key were held depressed while the handle was being drawn forward to print an item, or take an enforced blank stroke, the lever 172 would be held against movement by the spring 176, by the cam plate 177 overlying the pin 180; the spring 179, in turn, being prevented from moving the cam plate 177 by means of the pin 184. But after the blank stroke has been taken, the swinging frame 48[c] (and consequently the arm 187) are in their forward position, and therefore if the total key 169 be depressed, the cam plate 177 is free to follow the stud 37 as the handle is drawn forward to clear the machine, until the pin 180 on the rear end of the lever 172 has risen under the influence of the spring 176 until said pin 180 is in a locking notch 192 (Fig. 3) in the cam plate 177. The pin 180 does not enter said notch 192 until the movement of the plate 188 (Fig. 4[b]) under the action of the stud 37 has brought the notch 191 into register with said pin 180, whereupon the pin 180 enters the notches 191 and 192. Very shortly after the handle 27 has commenced its return stroke, the stud 37, acting on the walls of the cam slot 189, swings the plate 188 downwardly, thus pushing the pin 180 and the lever 172 forwardly. On the lever 172 is a shoulder 193 (Figs. 3 and 7) adapted to engage a pin 194 on the lever 164 when the lever 172 is tilted by the spring 176. When the lever 172 is pushed forward by the plate 188, the shoulder 193 pushes the lever 164 forward, thereby swinging the cam 148 upwardly, and thus pulling the link 141 forward. Said link being in engagement with the pin 145 on the lever 139, the pinions are moved out of mesh with the racks 130. As before indicated, this occurs during the early part of the return movement of the handle 27 and before the racks descend, the pinions being therefore left standing at zero, as will appear more fully hereinafter. As the stud 37 continues on its return stroke, it swings the plate 177 against the tension of the spring 179, the lower edge

of said plate positively camming the pin 180 down, and thus, in conjunction with the spring 175, restoring the lever 172 to its initial or inoperative position. As the arm 24 (Fig. 3) returns to its initial position, the pin 168 thereon engages the arm 167 and restores the lever 164 to its initial position.

When the pinions were withdrawn from the racks 130, the type bars used in printing the total rose to the top limit of their movement, under the influence of the springs 14. In the continuation of the back stroke of the handle 27, the racks are drawn down to normal position by the rod 29, as before explained.

To prevent casual rotation of the pinions while they are out of mesh with the racks, there is provided a bar 195 (Fig. 4[a]) extending longitudinally of the series of pinions and adapted to enter between the teeth thereof. Said bar is rigid with two arms 196 which are pivoted on the links 137 at 197 (Fig. 3). At the free ends of the arms 196 are pins 198 which lie in cam slots 199 (Fig. 3) in two cams 200 pivoted to the fixed guide plates 128 at 201. The cam slot 199 in each cam 200 is below the pivot 201. Above the pivot is a notch 202 to receive the projecting end of the pinion shaft 126. Upon reference to Fig. 3, it will be observed that when the pinions are out of mesh with both sets of racks, the pins 198 are in the central dwell portions of the slots 199, and that upon movement of the pinions into mesh with either set of racks, the cams 200 will swing and will cam the pins 198 down, thus withdrawing the locking bar 195 from the pinions. See Fig. 9[b].

Reference will now be made to the transfer mechanism (best shown in Figs. 4, 5 and 6): There is a set of transfer devices for the racks 130 to carry amounts from one numerical order to the next higher order in operations involving addition, and a set of transfer devices for the racks 129 to transfer amounts from one numerical order to the next lower order in operations involving subtraction. It has been explained that the type bars 3 are moved to their normal lower position by the rod 29. The extent of downward movement of the type bars 3 is limited by the rod 5. The extent of downward movement of the racks is limited (except in the transfer operation) by contact of the lugs 203 on the racks with stop lugs 204. When an amount is to be transferred from one order to the next higher order, the stop lug 204 for the rack belonging to such higher order is withdrawn, thereby allowing that rack to descend under the action of its spring 134 until its lug 203 stops against the bar 136 as indicated in the right-hand portion of Fig. 5 and the left-hand portion of Fig. 6. The extent of such further descent of the rack is just sufficient to turn the pinion for that rack through the distance of one tooth. Each stop lug 204 is formed on an arm or pawl 205 which is suspended from a pivot 206 in the framework of the machine, said pivot being above the pinions 125. To the lower end of each pawl 205 is pivoted a dog 207 (Fig. 4) having a tooth 208 adapted to engage the edge of the adjacent bar 136. The dog 207 lies within a groove 207[a] (Fig. 6[a]) in the bar 136. A contractile spring 209 (Fig. 5) normally holds the tooth 208 in engagement with the bar 136, the tooth 204 being then in position to support the corresponding rack.

The means for disengaging the tooth 208 from the bar 136 consists of two diametrically opposite lugs 210 (Fig. 4) fixed to each pinion. (Two lugs 210 are provided because each pinion has twenty teeth.) When the amount registered by a pinion reaches 9, continued rotation of the pinion as the rack descends brings one of the lugs 210 against the end of the dog 207, thereby depressing the dog until the tooth 208 is clear of the bar 136, whereupon the spring 209 (assisted by the downward pressure of the rack) pulls the dog and the pawl 205 away from the rack until a lug 211 on the dog stops against a restoring rod 212. The lug 204 is then out of the path of the rack of the next higher order, and the latter therefore moves down under the influence of its spring 134 until stopped by the bar 136.

After each transfer operation the pawl 205 and the dog 207 are restored to their normal position by the rod 212, there being one such restoring rod for each of the sets of transfer mechanism. Each rod 212 is carried by two bell crank levers 213 which are pivoted in the framework of the machine at 206. The bell crank levers at each side of the machine are connected for simultaneous swinging movement by a pin and slot connection, as shown at 214 in Fig. 1. The restoring rods 212 are simultaneously moved toward and away from each other by means of two arms 215 each formed integral with one of the bell crank levers 213, said arms 215 extending into the space between the side members 16. A rod 216 (Fig. 1), the ends of which lie in elongated openings 217 in the side members 16 is normally held against the lower end walls of said openings by means of two springs 218 (Fig. 1). When the side members 16 move downwardly in

the forward stroke of the handle 27, (and hence as the type bars 3 are moving upwardly), the rod 216 is carried into engagement with the arms 215, thereby causing the rods 212 to move toward each other to restore any transfer devices that may have been concerned in a previous transfer operation. When the side members 16 rise, a contractible spring 218[a] (Fig. 5) returns the rods 212 to the normal position shown in said view. Such normal position is determined by contact of the bell crank levers 213 with the stop rods 136[b].

When the type bars are raised for a printing operation, the racks do not begin to rise until the studs 132 (Fig. 5) engage the upper ends of the elongated openings 133. Those racks, however, which have descended below the normal position, in order to effect a transfer, rise practically simultaneously with the type bars, and thus are lifted before the stop lugs 204 are restored to normal position by the rod 212. So, also, the movement imparted to the type bars during the enforced spacing stroke of the handle 27 is sufficient to raise the lugs 203 to permit the placing of the stop lugs 204 thereunder.

It may be here stated that when any pinion stands at zero, one of the lugs 210 on said pinion lies directly beneath one of the dogs 207 associated with the set of racks 130 if the amount accumulated is a debit or positive amount, or directly beneath one of the dogs 207 associated with the group of racks 129 if the amount accumulated be a credit or negative amount. Therefore, when a total is to be printed, those racks which mesh with the pinions standing at zero cannot rise, the remaining racks rising until the rotation of their pinions brings the lugs 210 thereon into contact with the respective dogs 207. The type bars 3 are then in position to print the total amount accumulated on the pinions.

Referring now more particularly to the means for controlling the machine during operations involving subtraction: When the machine is clear, the link 141 is in engagement with the pin 145, as in Fig. 7, the pinions being then in mesh with the racks 130. Reciprocation of the link 141 will therefore shift the pinions into and out of mesh with those racks. When an amount is to be subtracted, the link 141 is shifted into engagement with the pin 144 as in Fig. 9[b]. It will be seen that the link 141 is reciprocable in one plane for adddition and in a higher plane for subtraction. The means for shifting the link 141 from one plane to another comprises a lever 219 (Fig. 9[b]) pivoted at 220 in the machine frame and having a forked rear end which engages a pin 221 on the link 141. The lever 219 has a downwardly extending arm 222 to which is attached a contractile spring 223 that serves to raise the lever 219 and hence the link 141. The lever 219 is controlled by means including a subtraction key 224 having a stem 225 which is guided for vertical movement. A contractile spring 226 normally holds the subtraction key elevated. Carried by the stem 225 is a pin 227 that overlies a forwardly extending arm 228 pivoted at 229. Rigid with the arm 228 is a downwardly extending arm 230. A contractile spring 231 connected to the arm 230 tends to draw said arm forward. When the subtraction key is depressed, the arm 230 is locked against actuation by the spring 231 by means of a finger 232 fixed to one end of a rock shaft 233 and adapted to overlie the arm 228. On the other end of the shaft 233 is another finger (not shown) which is acted on by a contractile spring (not shown). The lower end of this latter finger normally bears against a roller (not shown) which is carried by a slide bar (not shown) that returns the slide 47 to initial position. The finger 232 also serves to lock the subtraction key down, there being a hook 238 (Fig. 9[b]) rigid with the arms 228 and 230 which is adapted to engage a pin 239 on the stem 225.

To the lower end of the arm 230 is pivoted a link 240 which has a lost-motion connection with the arm 222 consisting of a headed stud 241 on the arm 222 extending through an elongated hole 242 in the link. The contractile spring 223 is anchored to the link 240, as shown in Fig. 7.

When the machine is clear, and also when there is a debit or positive balance in the machine, the link 141 is in engagement with the pin 145, as shown in Fig. 7. If an item is to be subtracted, the subtraction key 224 is depressed after the item has been set up, thereby pushing the link 240 rearwardly and thus moving the rear end wall of the opening 242 away from the stud 241. When the handle 27 is pulled, the link 141 is drawn forward, as before explained, to withdraw the pinions from the racks 130 before the racks rise. The forward movement of the link 141 causes the lever 139 to rock, as a result of which the pin 144 is brought into register with the notch 142. Thereupon the spring 223 draws the arm 222 rearwardly, thus placing the notch 142 in engagement with the pin 144. In the return stroke of the handle (see Fig. 9[b]), the link 141 is pushed rearwardly, there-

by rocking the lever 139 in the direction to place the pinions in mesh with the racks 129 before the latter start down. If the next item is subtracted, the notch 142 remains in engagement with the pin 144. If, however, the next item is to be added, the notch 143 is placed in engagement with the pin 145 in the following manner: In the forward stroke of the handle, the link 141 is drawn forward to place the pinions in central position before the racks ascend. As soon as the pin 145 comes into register with the notch 143, the spring 231 pulls the link 240 forward, the rear end wall of the opening 242 causing the arm 222 also to move forward, and thereby lowering the link 141 so as to place the notch 143 in engagement with the pin 145. In the return stroke of the handle, the link 141 is pushed rearwardly by the cam 148, whereby the lever 139 is swung in the direction to place the pinions in mesh with the adding racks 130 before the racks descend.

It will be noted that the link 141 is shifted into and out of engagement with the pins 144 and 145 when the pinions are in central position, that is to say, out of mesh with both sets of racks.

The printing of a credit or negative total is effected as hereinbefore explained, except that the number " 1 " must be first introduced into the totalizer, the subtraction key 224 being held depressed during the introduction of said number and during the taking of the blank or spacing stroke and the total-printing stroke.

The use of twenty teeth on each pinion lends itself well to a simple organization for obtaining a true negative total.

A credit or negative balance having been printed, and it being desired to clear the machine and prepare it for addition, the following described operations are performed: The pinions stand in mesh with the racks 129. The total key is depressed and the handle pulled. The pinions remain in mesh with the racks 129 during the upward movement of the latter, one of the lugs 210 on each pinion stopping against the forward set of dogs 207, whereby the pinions are alined at the zero position. In the return stroke of the handle, the pinions leave the racks 129 before the latter descend, the pinions being thus left with the lugs 210 at each side of the pinions in alinement. As the handle approaches its initial position and after the racks have descended, the pinions are shifted into mesh with the adding racks 130. Now it will be apparent from Fig. 4 that when the lugs 210 at the forward side of the set of pinions stand at zero, the lugs at the rear side of the set of pinions are at the " 9 " position. Consequently, when the pinions are shifted into engagement with the racks 130, as just stated, the debit or positive number " 9999999.99 " is in the totalizer. To clear the totalizer for adding purposes, or, in other words, to bring the lugs 210 at the rear side of the pinions to zero position, the total key is again depressed and the handle pulled, whereby the number " 9999999.99 " is printed, together with the clear sign, and the totalizer left with the lugs 210 at the rear side thereof disposed in alinement directly beneath the points of the dogs 207 associated with the adding racks 130.

It is sometimes desirable to print an item without introducing it into the totalizer wheels 125. This may be accomplished by means acting to prevent the pawl 152 (Fig. 9[b]) from engaging the pin 157, so that the pinions 125 shall not be thrown into mesh with the racks at the beginning of the down stroke. A slide 255 (Fig. 3) is mounted on two guide studs 256 for movement fore and aft of the machine, the slide being slotted at 255[a] to receive said studs. On the slide 255 is a cam surface 257. A contractile spring 258 tends oo draw the slide 255 rearwardly to bring the cam surface 257 into such position that when the pawl 152 is carried forward a pin 259 on said pawl shall engage the surface 257, thus holding the pawl down so that on its return stroke the shoulder 152[b] (Fig. 9[b]) shall be unable to engage the pin 157. The slide 255 is normally locked in its forward position by a stud 260 (Figs. 3 and 7) on a bell crank 261 pivoted on the axis 174. A contractile spring 262 normally holds the bell crank in such position that the stud 260 lies behind a lug 263 on the slide 255. The means for withdrawing the stud 260 from said lug comprises a non-add key 264 having a stem 265 which is guided for vertical movement. On the stem 265 is a pin 266 that overlies a lug 267 on the bell crank 261. The spring 176 that normally holds the total key up serves also to hold the non-add key elevated, there being a lug 268 on the total key stem which underlies the pin 266. The non-add key is locked in depressed position by means of a lever 269 (Fig. 8[b]) pivoted at 270 and having a notch 271 to receive a pin 272 on the non-add key stem. The free end 273 of the lever 269 is arranged to be engaged by the locking finger 232 (Fig. 7).

The slide 255 is restored to its forward position by means of the lever 274 (Fig. 7) that actuates the ribbon feed mech-

anism, the lower end of said lever lying behind the rear end of the slide. The lever 274 is connected to the adjacent lever 19 through a link 275.

When a number is to be printed, but not added, the operator depresses the non-add key 264 and pulls the handle 27 forward. Depression of the non-add key withdraws the stud 260 from the lug 263. As the handle 27 swings forward, the ribbon-feed lever 274 swings rearward, thus allowing the spring 258 to draw the slide 255 to its rearward position, that is to say, until the end walls of the slots 255^a stop against the studs 256. As the handle 27 makes its forward swing, the pin 259 on the pawl 152 engages the cam surface 257, whereby the pawl is depressed to such an extent that on the return stroke of the pawls it fails to engage the pin 157. The pinions therefore are not thrown into mesh with the racks at the beginning of the downward stroke of the latter, and consequently the number set up and printed is not added. As the handle makes its rearward swing, the pin 168 (Fig. 9^a) on the arm 24 engages the arm 167 and restores the lever 164 to initial position, thereby returning the pinions into mesh with the racks. In the return stroke of the handle, the lever ribbon-feed 274 pushes the slide 255 forward to its normal position, as in Fig. 7. As the handle is approaching its initial position, the locking finger 232 (Fig. 7) is disengaged from the lever 269, whereupon the non-add key springs up to its normal position, thus allowing the spring 262 to place the stud 260 behind the lug 263 on the slide 255.

The machine is preferably arranged to print items and totals in contrasting colors, as, for example, items in blue and totals in red. The means for shifting the ribbon to print in the desired color may be of any suitable character, and therefore has not been disclosed herein in detail.

If desired, means may be provided for printing a distinguishing character in connection with certain imprints, as, for example, in connection with a final debit total, or a credit total, or an item which is printed but not added to the previous items, or an item which is subtracted. Herein is shown a special sign-printing bar 3^1 (Figs. 3 and 9^b) which is constructed and mounted substantially like the type bars 3. The bar 3^1, however, carries only two type, the imprint of the upper type being the total sign when in red and the non-add sign when in blue, and the imprint of the lower type denoting a subtracted item when in blue and a credit or negative balance when in red. A contractile spring 295 attached to the bar 7 and to a pin 296 on the type bar 3^1 tends to raise the latter. The extent to which the type bar 3^1 may rise is determined by the arm 222, said arm having a shoulder 297 that is engaged by the pin 296 to define the position of the type bar when the clear and non-add signs are to be printed, and a shoulder 298 to determine the position wherein the negative sign is printed. When the link 141 is in position to shift the pinions into and out of mesh with the adding racks 130, the shoulder 297 is in the path of the pin 296, as in Fig. 3. When said link is in position to shift the pinions into and out of engagement with the subtracting racks 129, the shoulder 298 is in the path of the pin 296, as in Fig. 9^b.

After each printing operation the sign-printing bar 3^1 is pushed down to its normal position by engagement of the adjacent arm 30 with a pin 299 on said type bar.

The capabilities of the machine are indicated by the specimens of work reproduced in Figs. 10 to 16. In these views dotted lines are employed to indicate red imprints. Referring first to Fig. 10, the red imprint *a* is a sign denoting that the machine is clear. Fig. 10 shows that the operator first set up, printed and added an item of 50¢. There being an item of 20¢ to be subtracted, the operator set up the item by means of the keyboard, then depressed the subtraction key 224, and then pulled the handle 27, whereupon the item of 20¢ and the subtraction sign *b* were printed. Another item of 50¢ was then set up, printed and added. The handle was then pulled twice, whereupon the debit or positive balance of 80¢ was printed. It will be seen that the item of 20¢ was automatically subtracted, and that the debit balance was printed automatically, that is to say, without any manipulation other than the operation of the handle 27.

To produce the work shown in Fig. 11 the item of $1.00 is set up, printed and added in the usual manner, after which the item of $1.10 is set up, printed and subtracted automatically. Since the balance contained in the totalizer is a credit or negative balance, it is necessary in order to print the true credit balance to introduce the fugitive 1, the subtraction key being depressed in connection with such operation. After taking a spacing stroke the true credit balance of 10¢ may be printed.

Fig. 12 illustrates an instance where the operator has a number of items to add and subtract and may not know at the time when she desires to take the total

whether the total be a debit total or a credit total. Upon taking the subtotal in the regular way the operator obtains a total representing all the numerical orders the machine is adapted to handle. Realizing, therefore, that the machine must contain a credit balance, she introduces the fugitive 1, holds the subtraction key down while taking the spacing stroke, and then obtains the correct credit balance on the next operation of the handle.

Fig. 13 illustrates a method of deducting a discount. Assuming that it be desired to deduct 2% from $7596.00, the operator first sets up the item of $7596.00, depresses the multiplying key 84, and operates the handle 27 to print said item. The back spacer key 86 is then depressed two times so as to reduce the number set up on the keyboard to one one-hundredth of the amount originally set up. The operator then depresses the subtraction key 224 and pulls the handle, thereby subtracting 1% from the amount first set up. By pulling the handle a second time (the multiplying key being first released), another 1% is subtracted from the item first set up. The debit or balance remaining in the total may then be printed by operation of the handle 27.

Fig. 14 illustrates another method of deducting a discount. If it be desired to deduct 2% from $7596.00, the operator first calculates what the 2% will amount to. This she does by setting up 1% of the principal, depressing the multiplying key 84, pulling the handle 27 once, releasing the multiplying key and pulling the handle 27 a second time. By operation of the handle 27 and the total key 169, the operator ascertains that the 2% amounts to 151.92, and clears the machine. The operator then sets up, prints and adds the minuend 7596.00, then sets up the subtrahend 151.92, depresses the subtraction key 224 and pulls the handle 27 to print the subtrahend and subtract it from the minuend. By operating the handle 27 twice the operator obtains the remainder of 7444.08.

Fig. 15 illustrates the operation of deducting 15% from $7596.00. The operator first sets up the minuend 7596.00, depresses the multiplying key 84 and pulls the handle 27. By depressing the back spacer key 86 once the operator reduces the number set up on the keyboard to one-tenth of the minuend. After depressing the subtraction key 224 the operator subtracts from the minuend 10% thereof. By again depressing the back spacer key 86 the operator reduces the number set up on the keyboard to 1% of the minuend. This 1% the operator then proceeds to subtract five times by pulling the handle that number of times, releasing the multiplying key before pulling the handle the fifth time. Having thus subtracted 15% from the minuend the remainder is obtained by pulling the handle twice.

Fig. 16 illustrates the manner in which multiplication may be performed by repeated addition followed by subtraction. If it be desired to multiply $45.69 by 19, the operator sets up the number 45.69, then depresses the nought key and the multiplying key, and then pulls the handle 27 twice, thereby introducing into the machine a number equal to twenty times 45.69. By depressing the back spacer key once, the operator reduces the number set up in the keyboard to 45.69, releases the multiplying key, depresses the subtraction key and pulls the handle 27, thereby subtracting 45.69 from the amount in the machine. Operation of the handle will then result in the printing of the product 868.11, which is equivalent to twenty times 45.69, minus 45.69.

While the present embodiment of the invention has been described in considerable detail, it should be understood that the invention is not limited to the particular construction and arrangement of the parts and mechanisms shown, and that various modifications coming within the scope of the appended claims will suggest themselves to those skilled in the art.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A calculating machine of the type adapted for addition and subtraction and having for that purpose a set of pinions, which according to the operation to be performed, are moved to mesh with one or the other of two sets of racks, wherein, each of said sets of racks is provided with a set of transfer devices arranged to be operated by the pinions when in mesh with the corresponding set of racks.

2. A machine according to Claim 1, in which in order to control the moving of the set of pinions into or out of mesh with one or the other of the two sets of racks, a member is provided that is shiftable into either of two planes and reciprocable in one plane for addition and in the other for subtraction, the shifting of the reciprocable member to either of the two planes being effected by a spring controlled lever connected thereto and to a

link operable by a subtraction key and controlling the movement of said lever by the spring acting thereon.

3. A calculating machine according to Claim 2 in which the connection between the spring controlled lever and the link provides for lost motion between said lever and link while the subtraction key is arranged to shift the link against the influence of a spring acting thereon to restrain the spring acting on said lever.

4. A calculating machine according to Claim 2 in which the placing of the set of pinions in the desired position is effected by the reciprocable member through the engagement, according to the plane of movement of said member, of one or the other of a pair of notches on said member with one or the other of a pair of studs carried by an intermediately pivoted lever to which the set of pinions is connected.

5. A calculating machine according to any of Claims 2 to 4 inclusive, in which the reciprocatory member is connected to an oscillatory cam plate to be reciprocated thereby while the cam plate is swung in opposite directions alternately by an oscillatory member, the engagement of said plate and member for such swinging movement being controlled by a non-add key.

6. A calculating machine according to Claim 5 in which the engagement of the oscillatory cam plate and member is effected by the contact of a pawl pivoted on the latter with one or the other of two pins carried by the former, said pawl normally engaging both pins successively and causing simultaneous movement of the plate and member, but being controlled by the non-add key to miss one pin when that key is operated so that the plate and member do not move simultaneously during the return movement of the member.

7. A calculating machine according to any of the preceding claims, having a sign printing type bar arranged to occupy one position in adding operations and another position in subtracting operations, the movement of the type bar from one position to the other being related to and effected simultaneously with the change over of the set of pinions from one to the other of the two sets of racks.

8. A calculating machine according to Claim 7, in which the movement of the sign printing type bar is controlled by the engagement of a stop thereon with one or the other of a pair of shoulders provided on the spring controlled lever which effects shifting of the reciprocable member between the two planes.

9. A calculating machine according to Claim 1, in which each pair of racks in the two sets of racks are connected to a common type bar for independent movement relative thereto, which movement is under the control of the corresponding element of the transfer devices and permitted thereby when a transfer is necessary.

10. A calculating machine according to Claim 9, in which the pair of racks are connected to a rearward extension of the common type bar by a lost motion connection which permits the independent movement of the racks relative to said type bar, said racks being also under the influence of springs connecting the same to the lower end of a downward extension of the type bar lying between the racks.

11. A calculating machine according to Claim 9 or 10, in which all the racks in one set are normally similarly positioned by a series of stop lugs forming part of the transfer devices, each of which lugs is automatically withdrawn from its respective rack to permit that rack to move relative to the type bar for transfer purposes, when necessary.

12. A calculating machine according to Claim 11, in which the stop lug is withdrawn from any particular rack by means of a projection on the pinion of next lower order than the rack, said projection acting to free a dog holding said lug in position and permitting movement thereof under action of a spring.

13. A calculating machine according to Claim 11 or 12, in which two rods, each carried by a pair of levers and movable thereby towards and away from each other are provided to restore the stop lugs to normal position, the effective movement of each pair of levers being caused, in the upward movement of the racks, by the engagement of an arm on one lever of each pair with a rod yieldably carried by two reciprocatory side members forming part of the means for reciprocating the racks.

14. A calculating machine according to Claim 12, in which each pinion has twenty teeth and two projections which are diametrically opposed and operable to cause the withdrawal of the stop lugs in both sets of transfer devices.

15. A calculating machine of the type set forth, constructed and operable substantially as hereinbefore described with reference to the accompanying drawings.

Dated this 24th day of June, 1924.

MARKS & CLERK.

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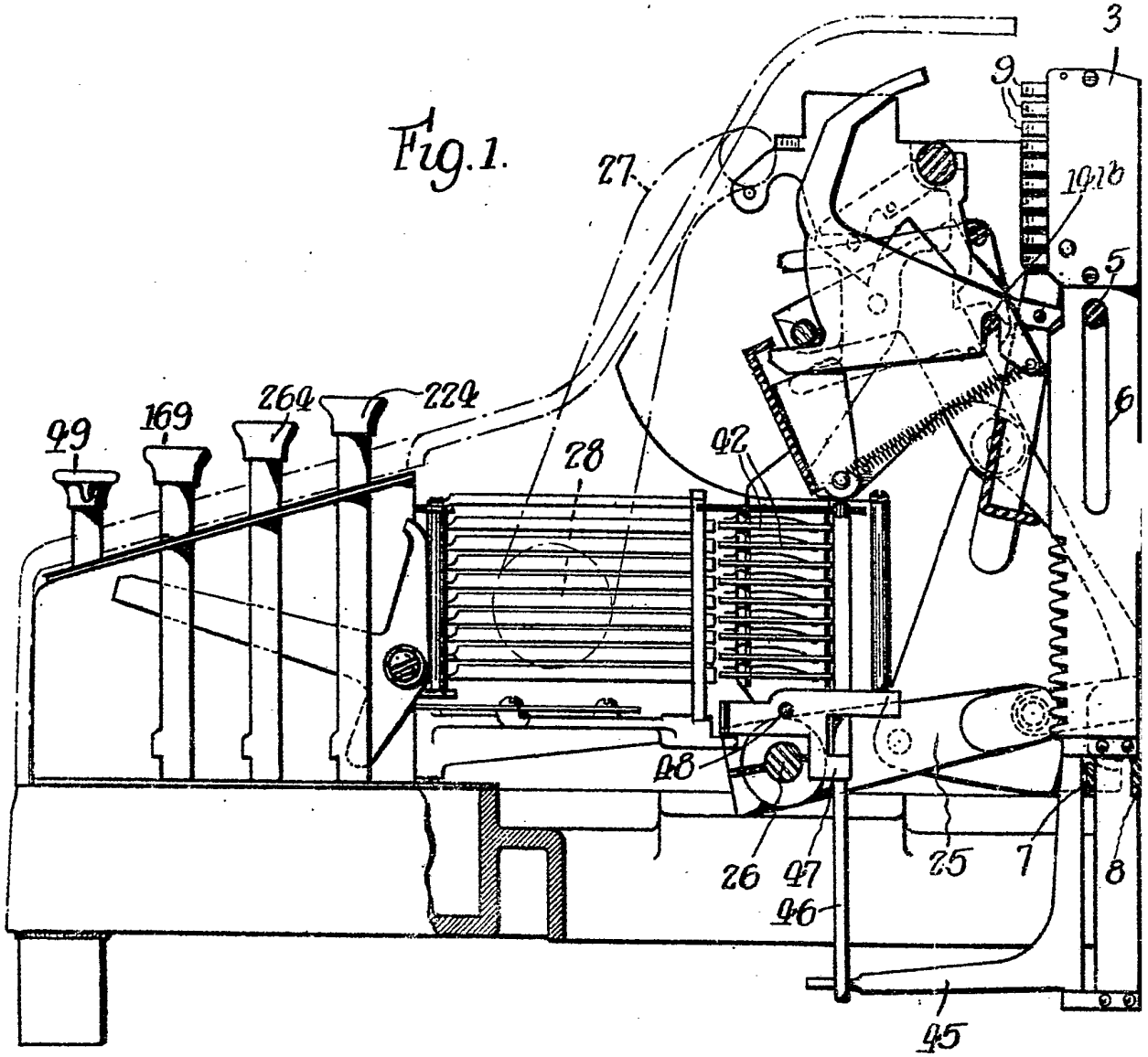
Fig. 1.



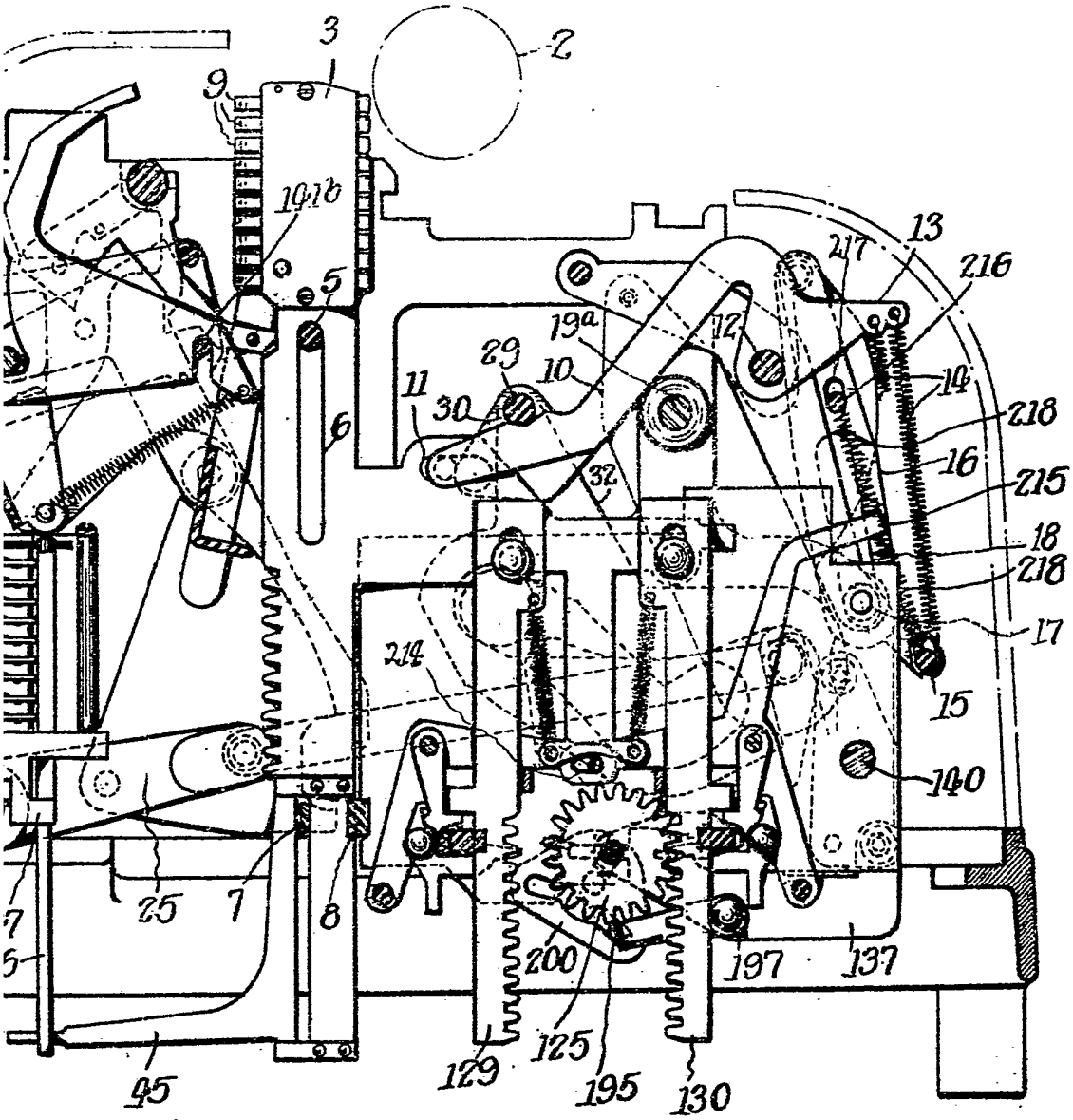


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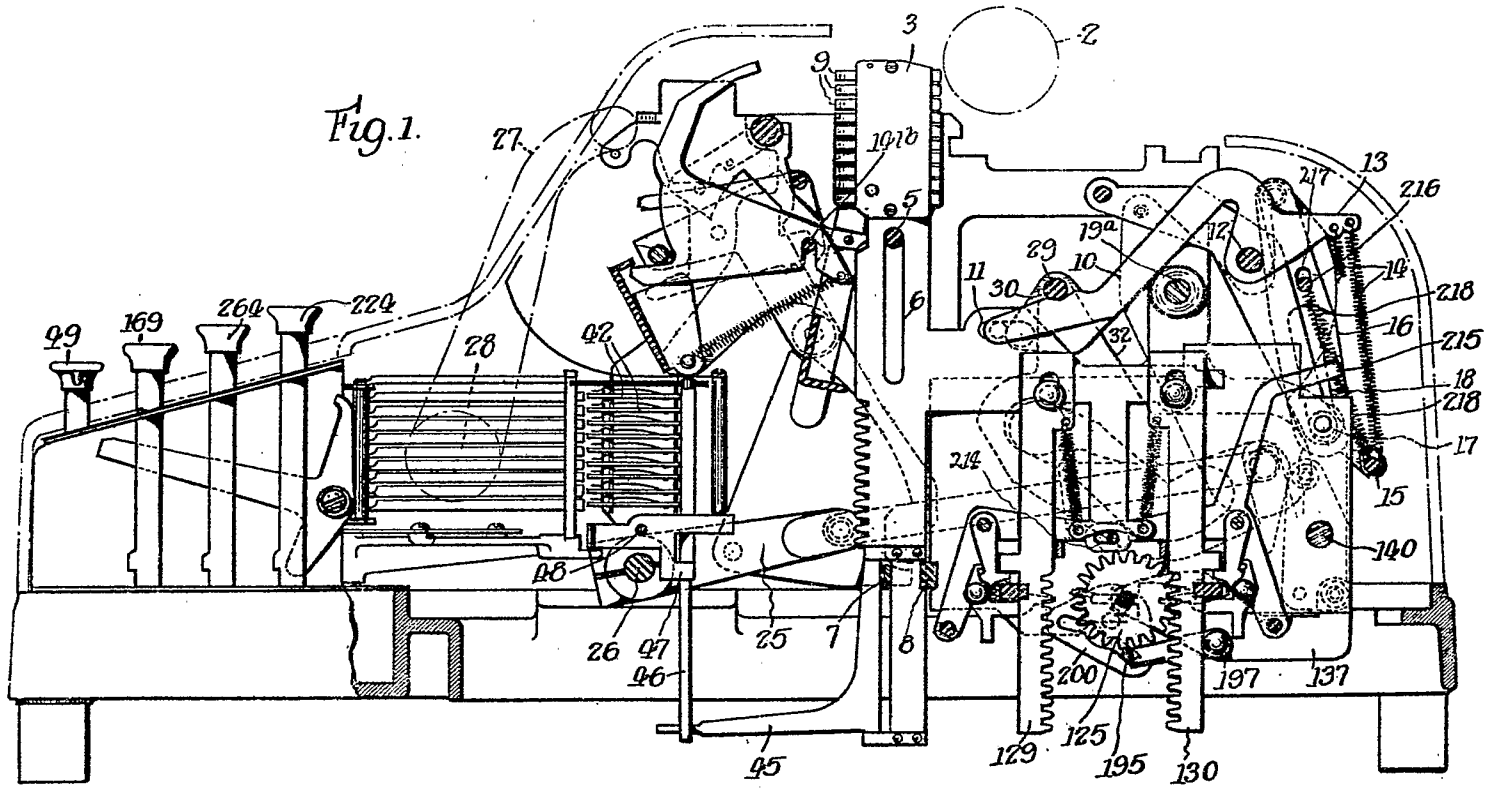
Fig. 1.



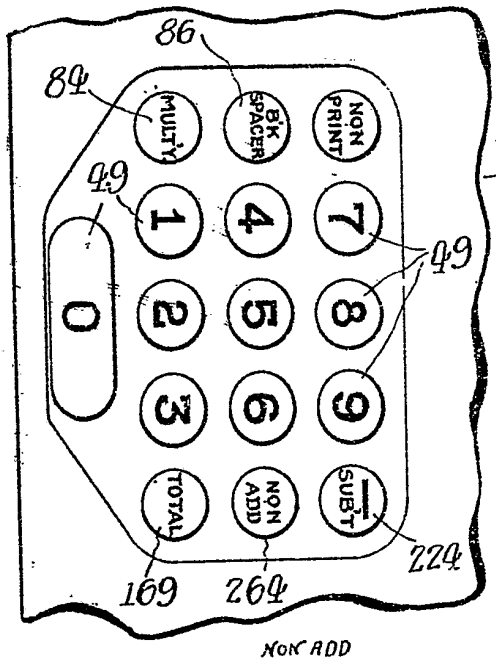
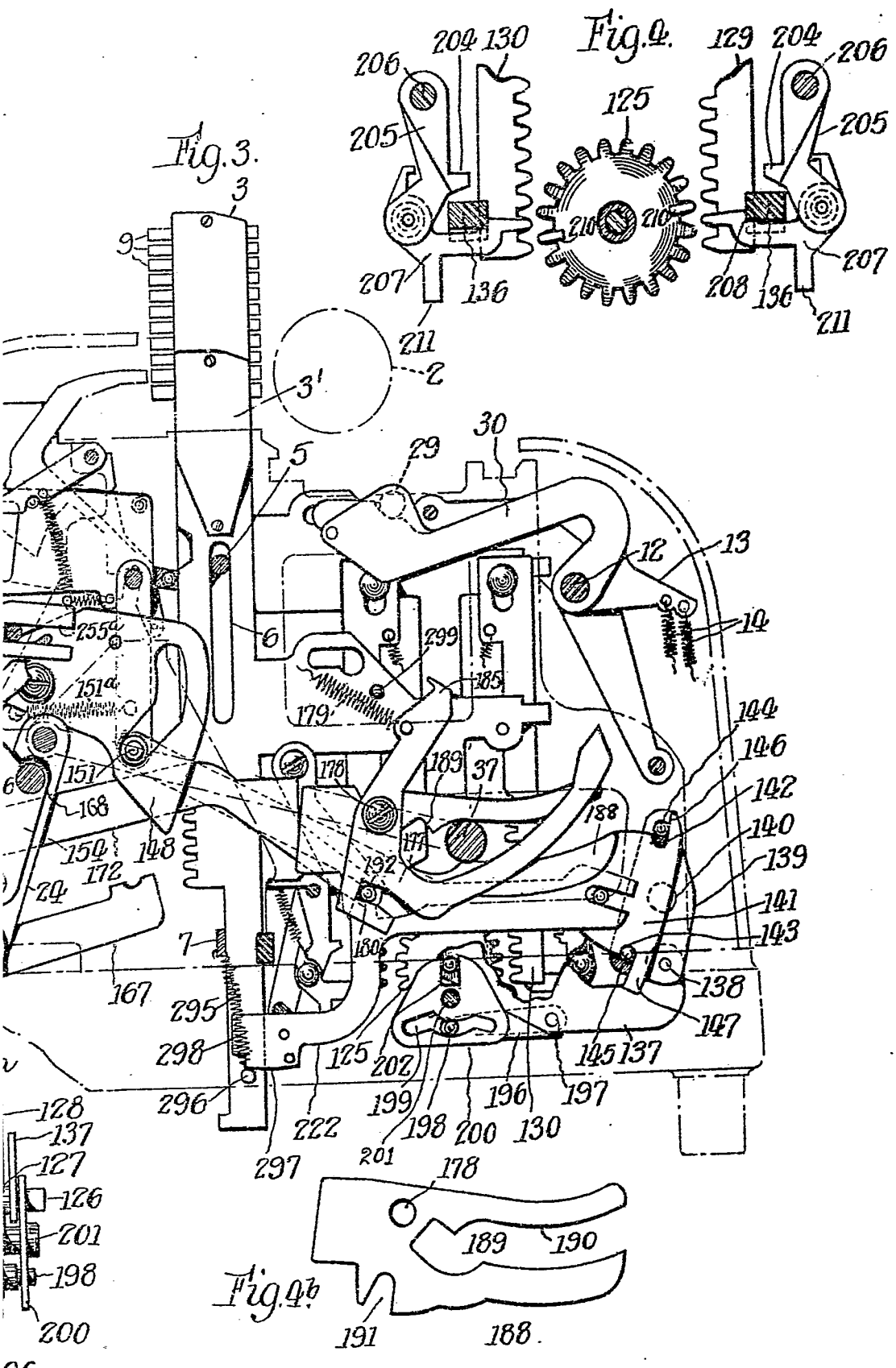


Fig. 2.

Fig. 3.

Fig. 4a.

Fig.



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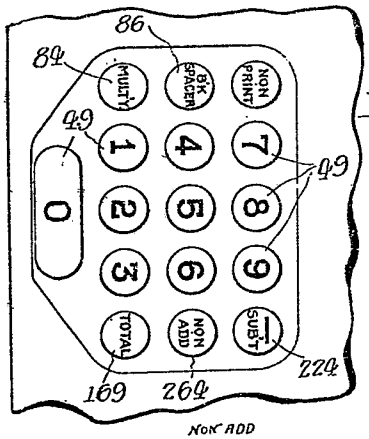

Fig. 2.

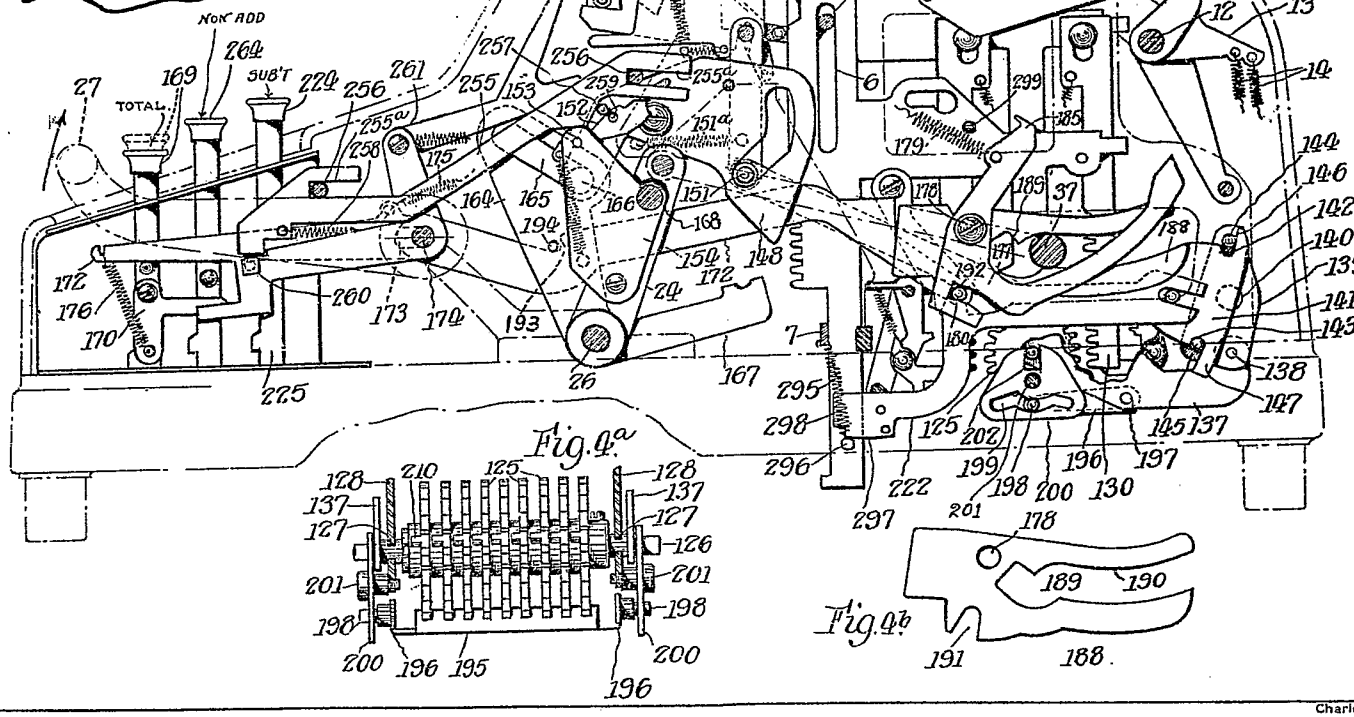

Fig. 3.

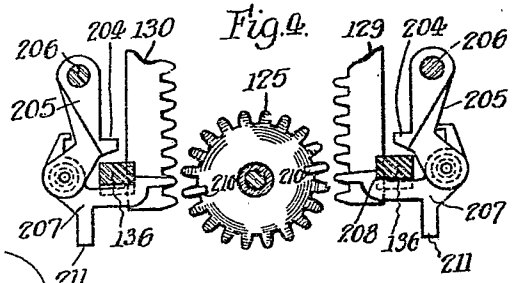

Fig. 4.

Fig. 4a.

Fig. 4b.

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Fig. 5.

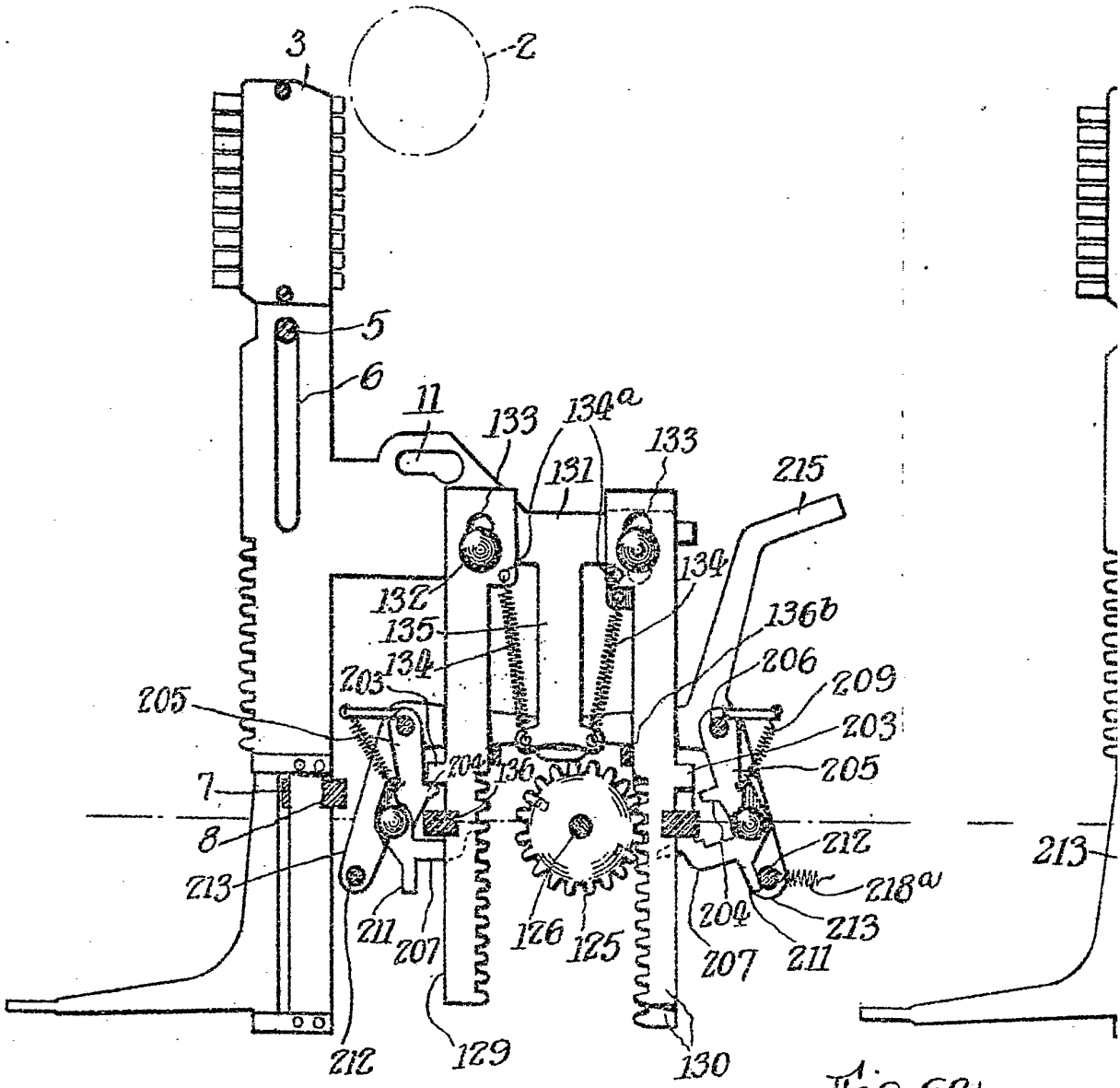

Fig. 6a.

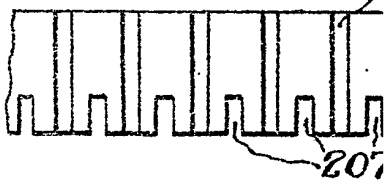

Fig.6.

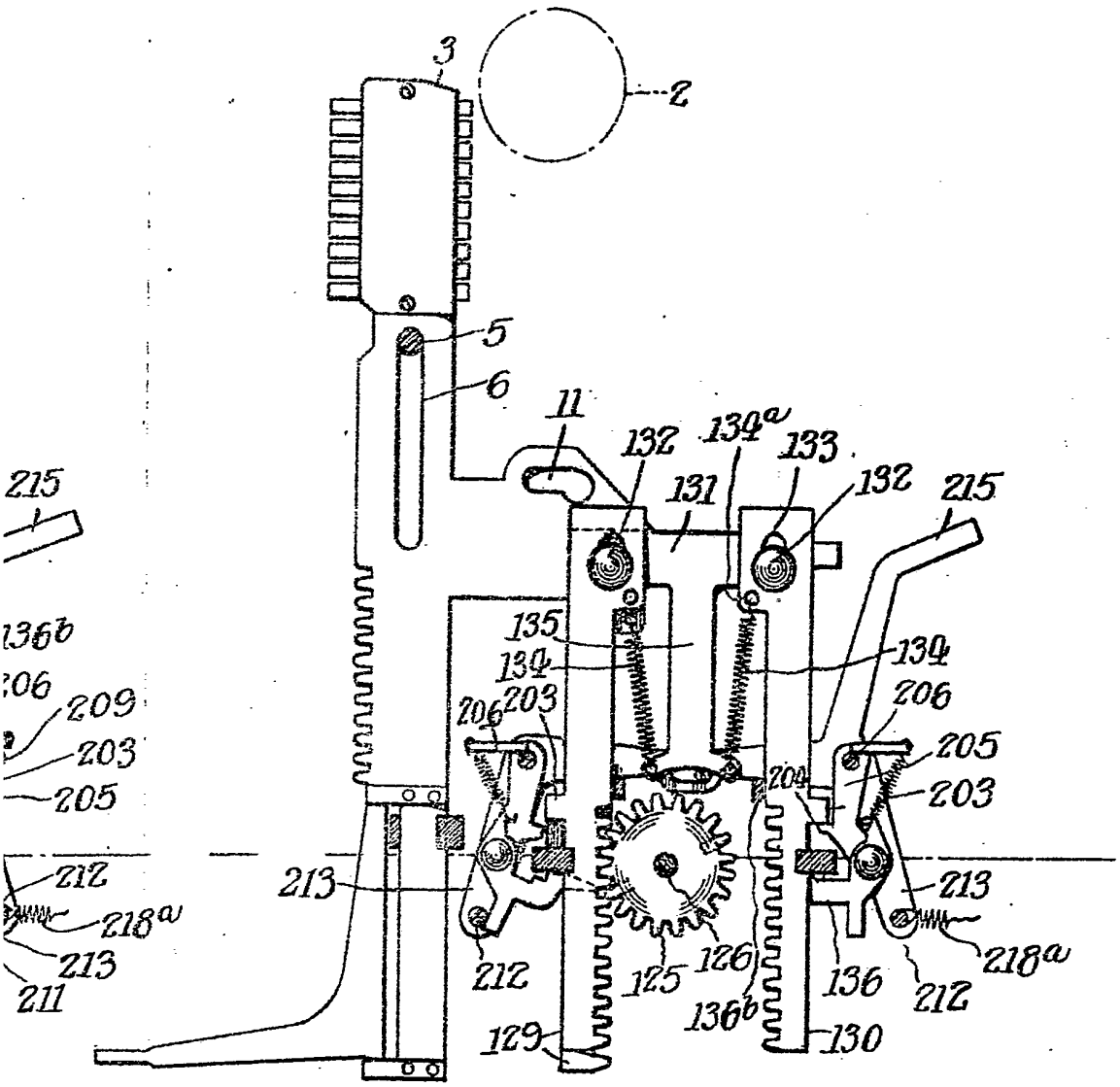

Fig.6a

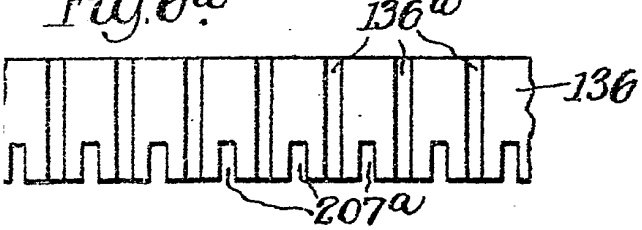

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Fig. 5.

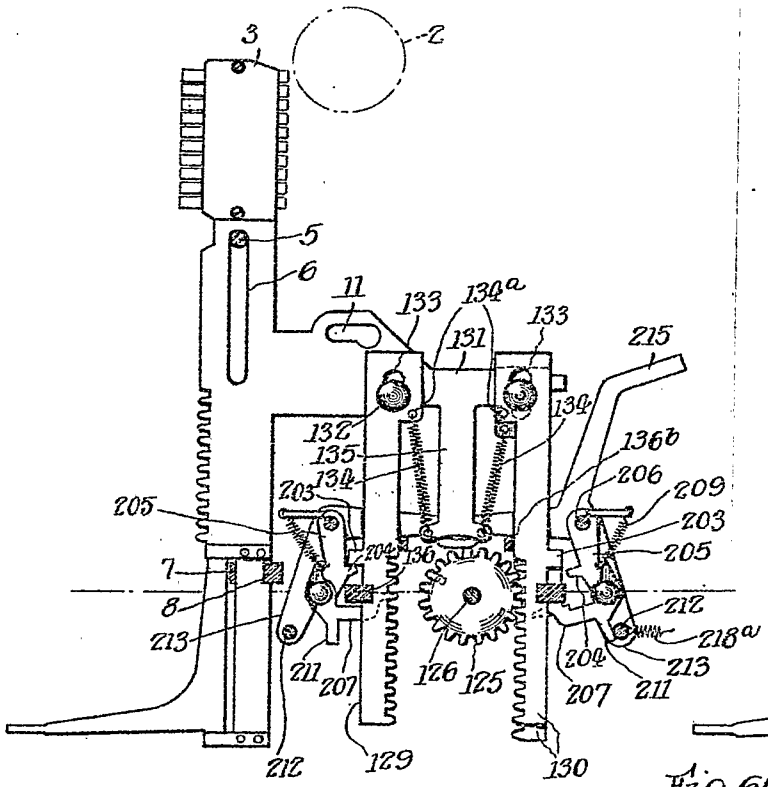

Fig. 6.

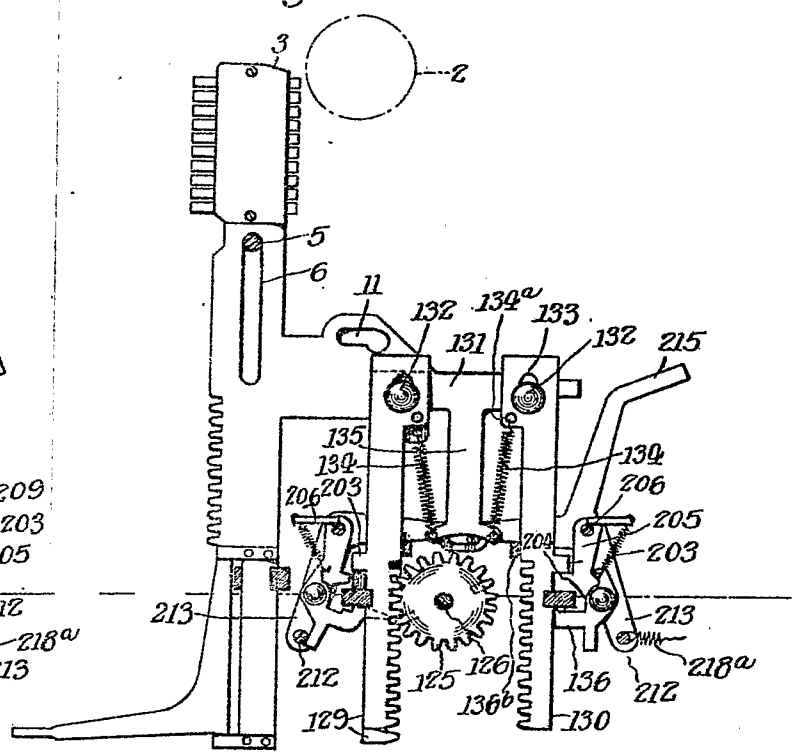

Fig. 6a.

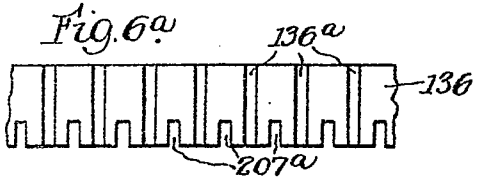

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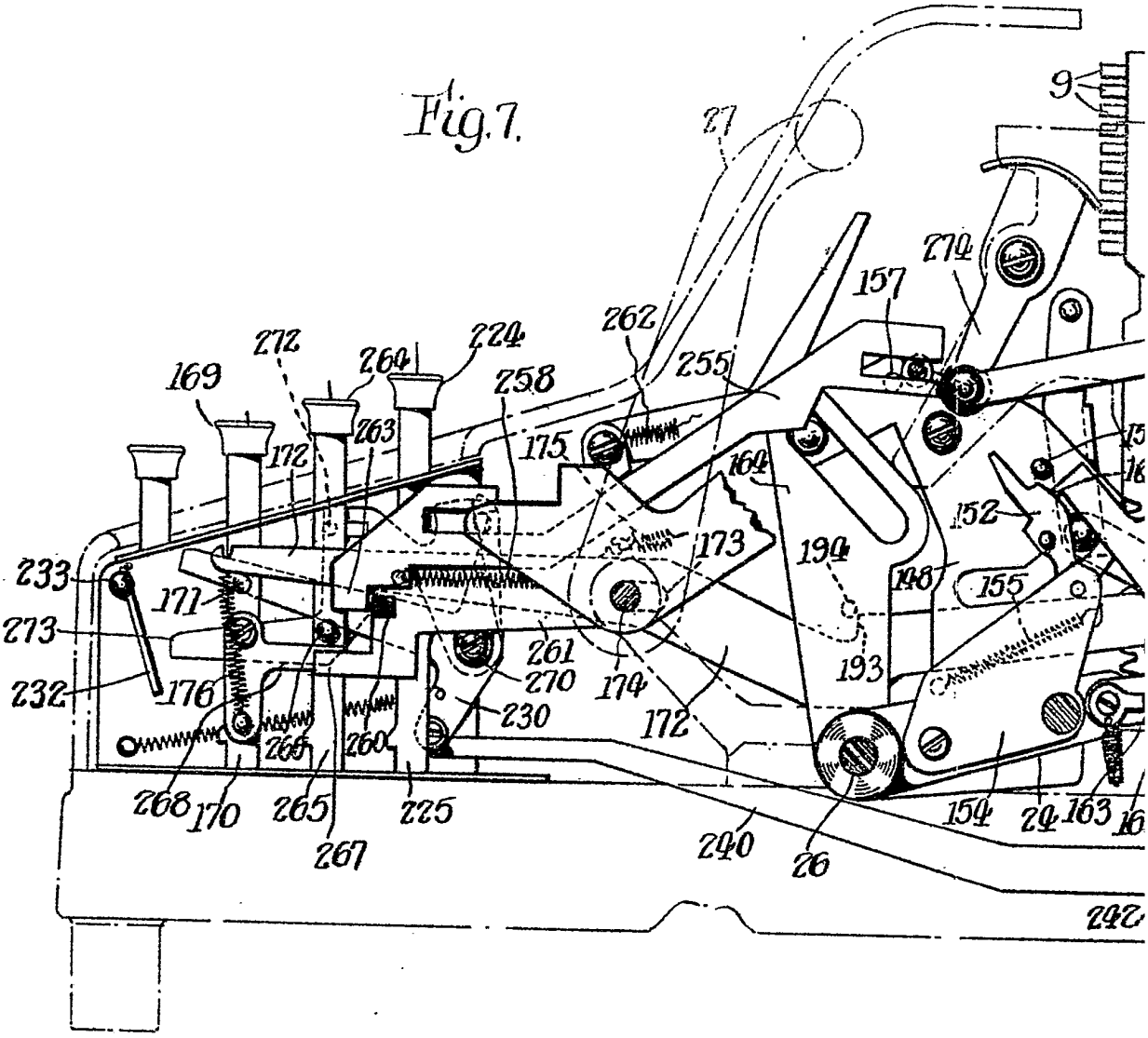
Fig. 7.



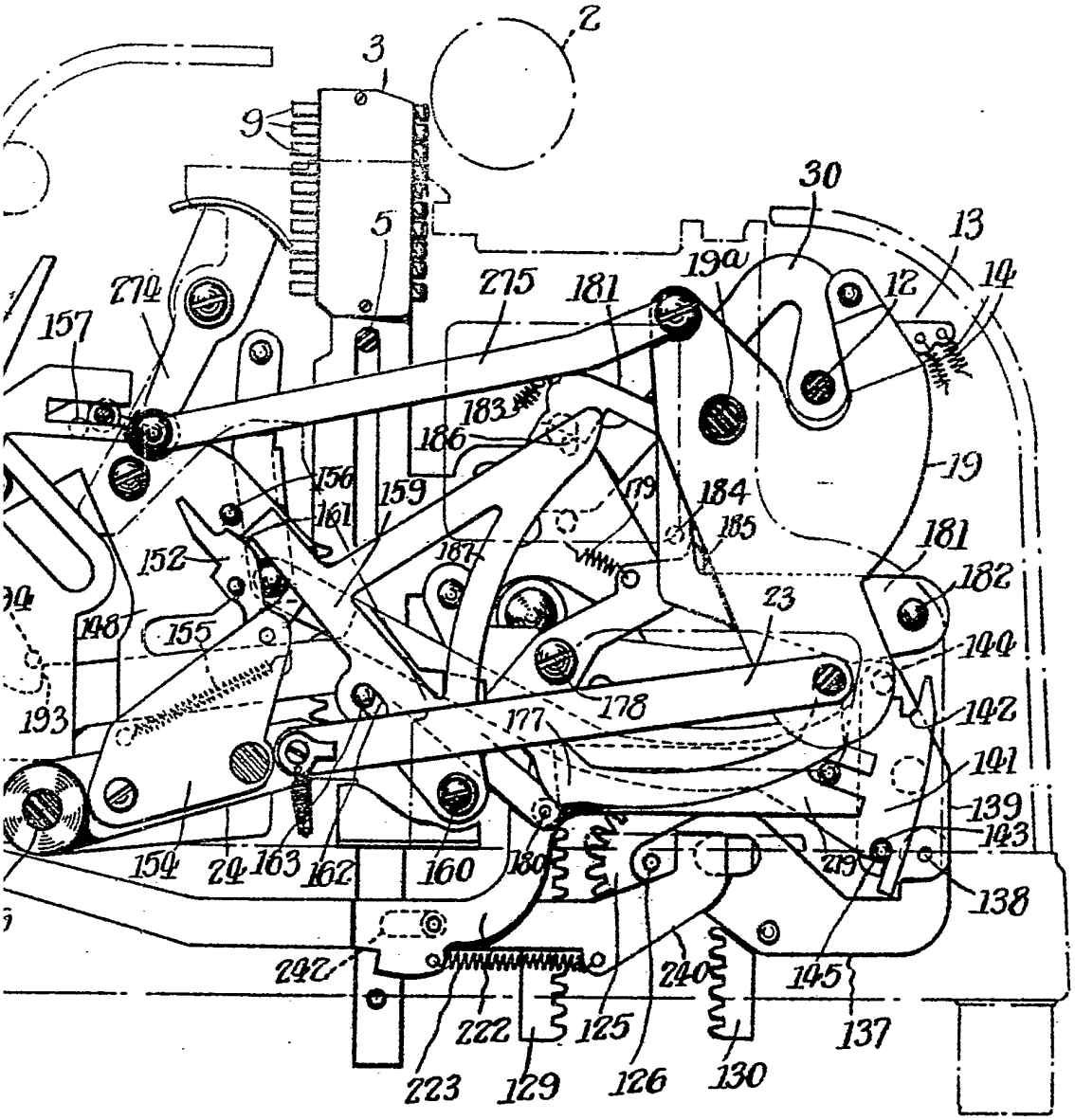


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Fig.7.

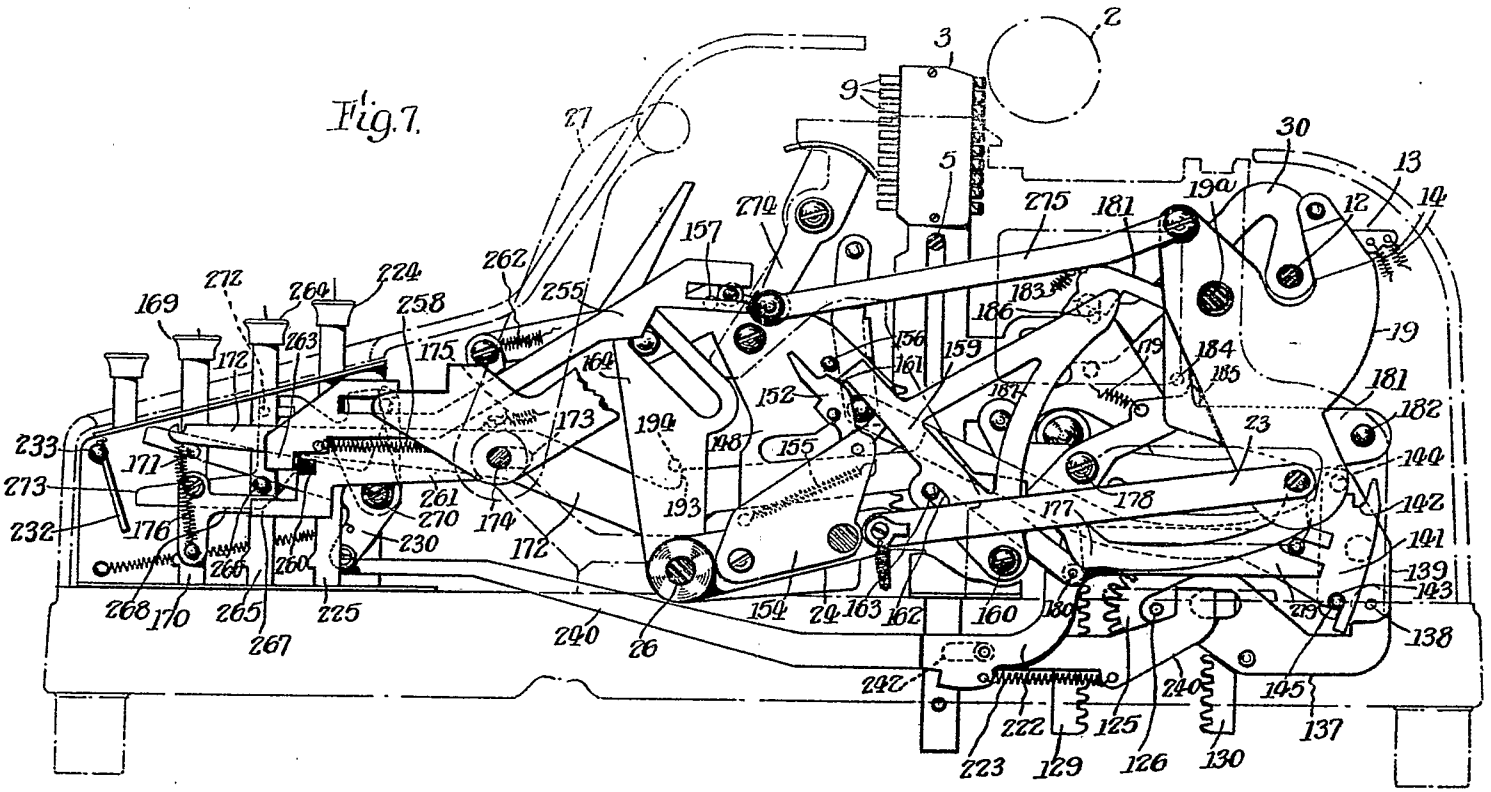

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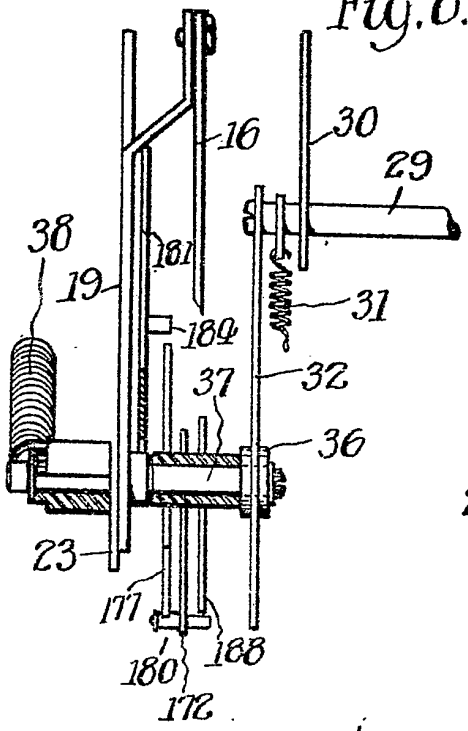
Fig. 8.



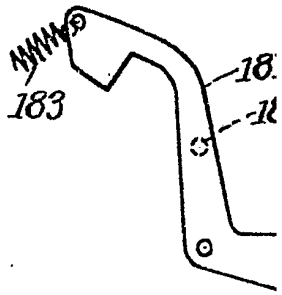


Fig. 8a.

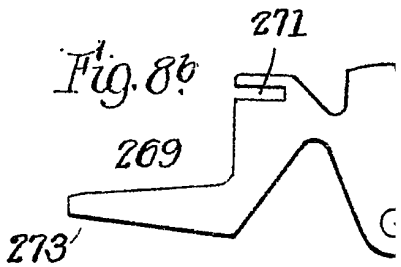
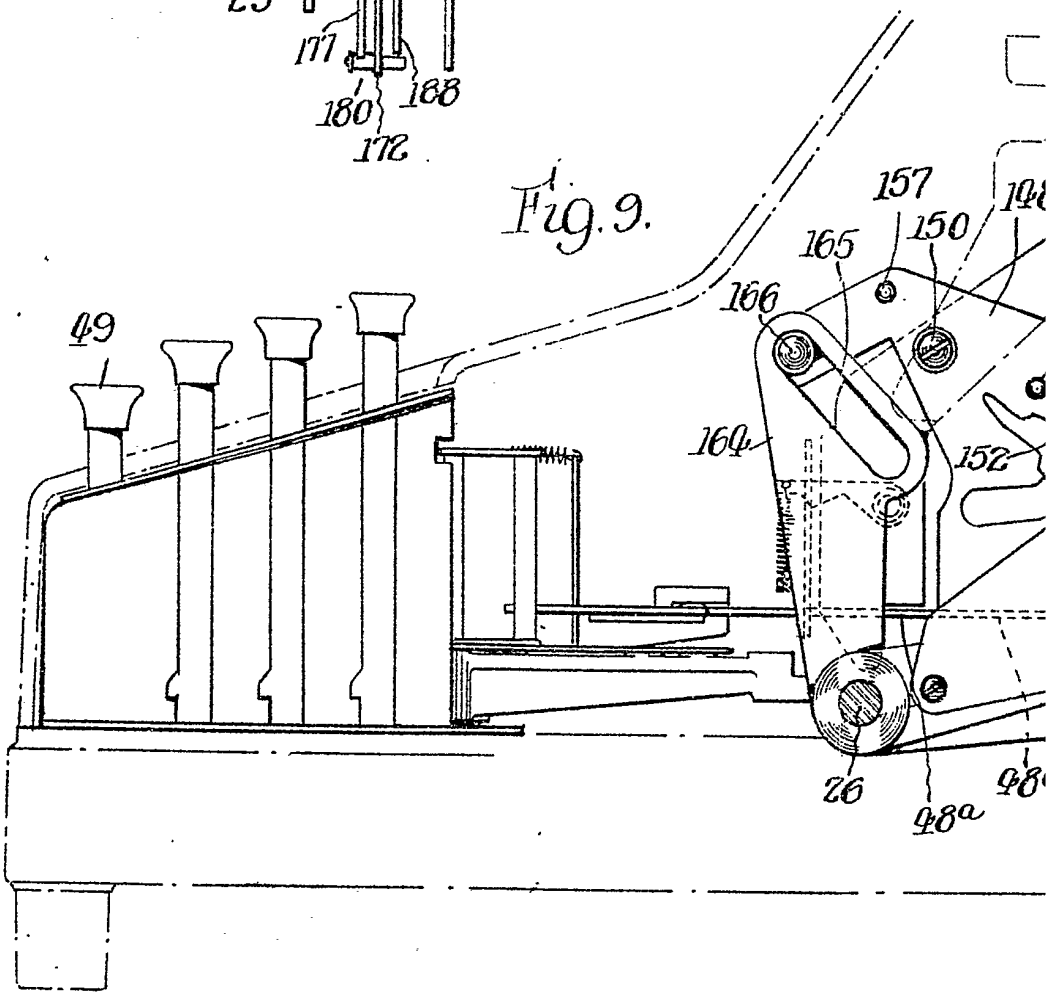


Fig. 9.



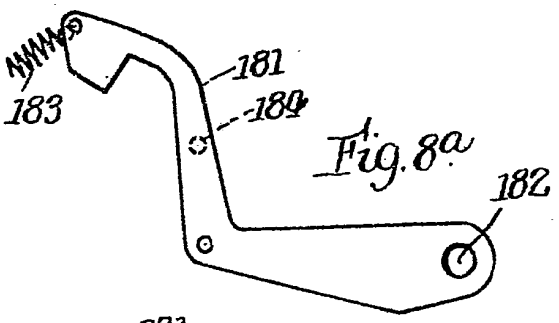


Fig. 8a

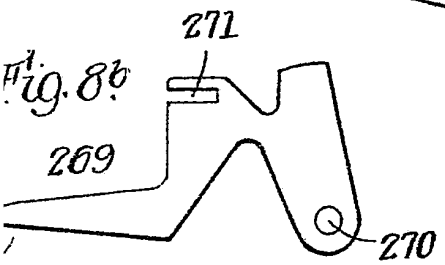


Fig. 8b

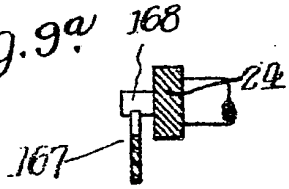


Fig. 9a

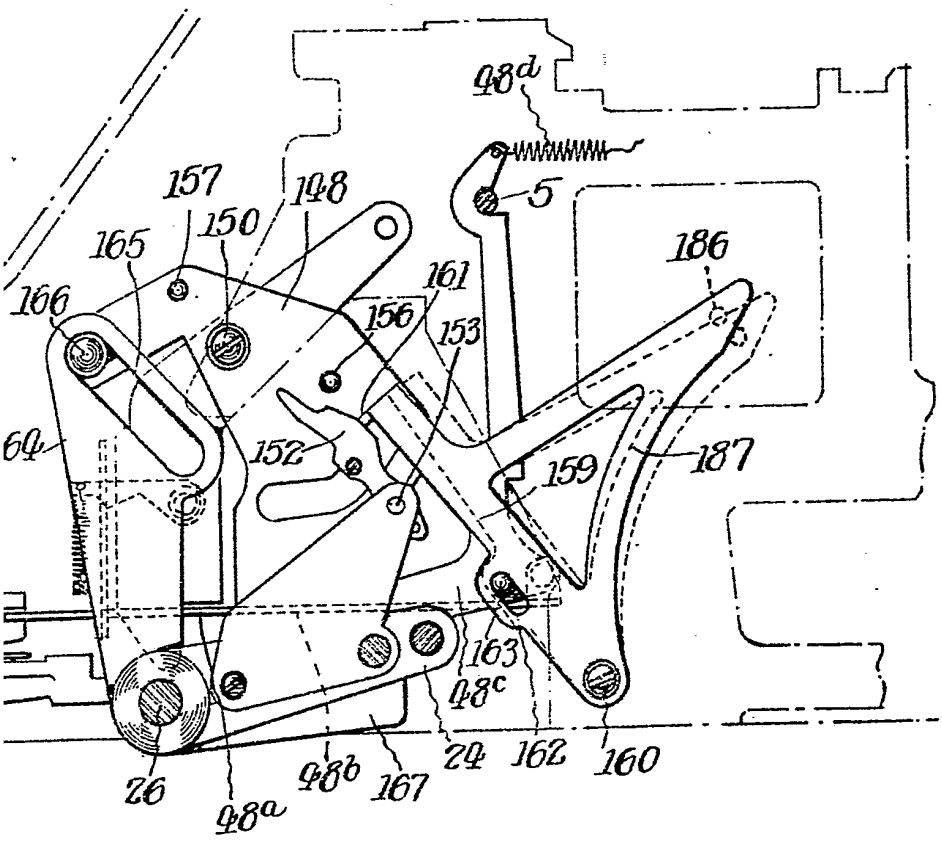


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Fig. 8.

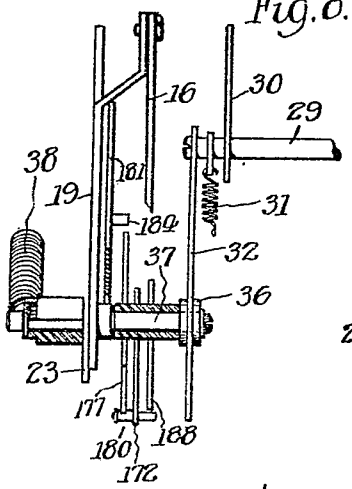


Fig. 8a

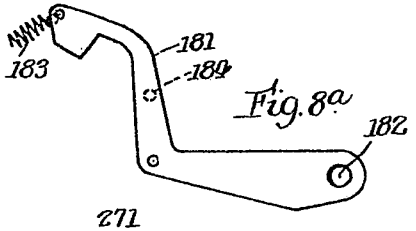


Fig. 8b

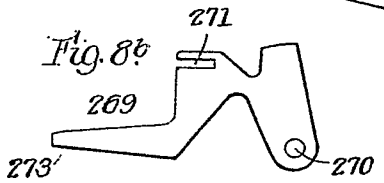


Fig. 9a

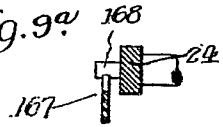
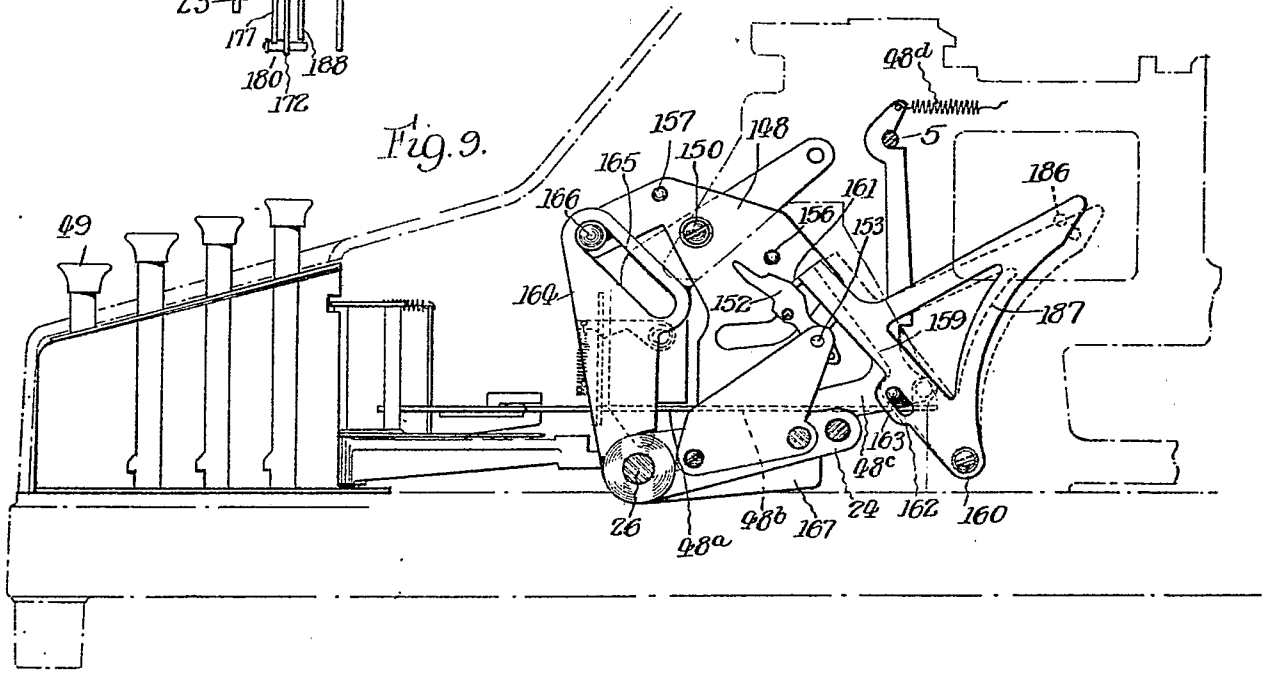


Fig. 9.



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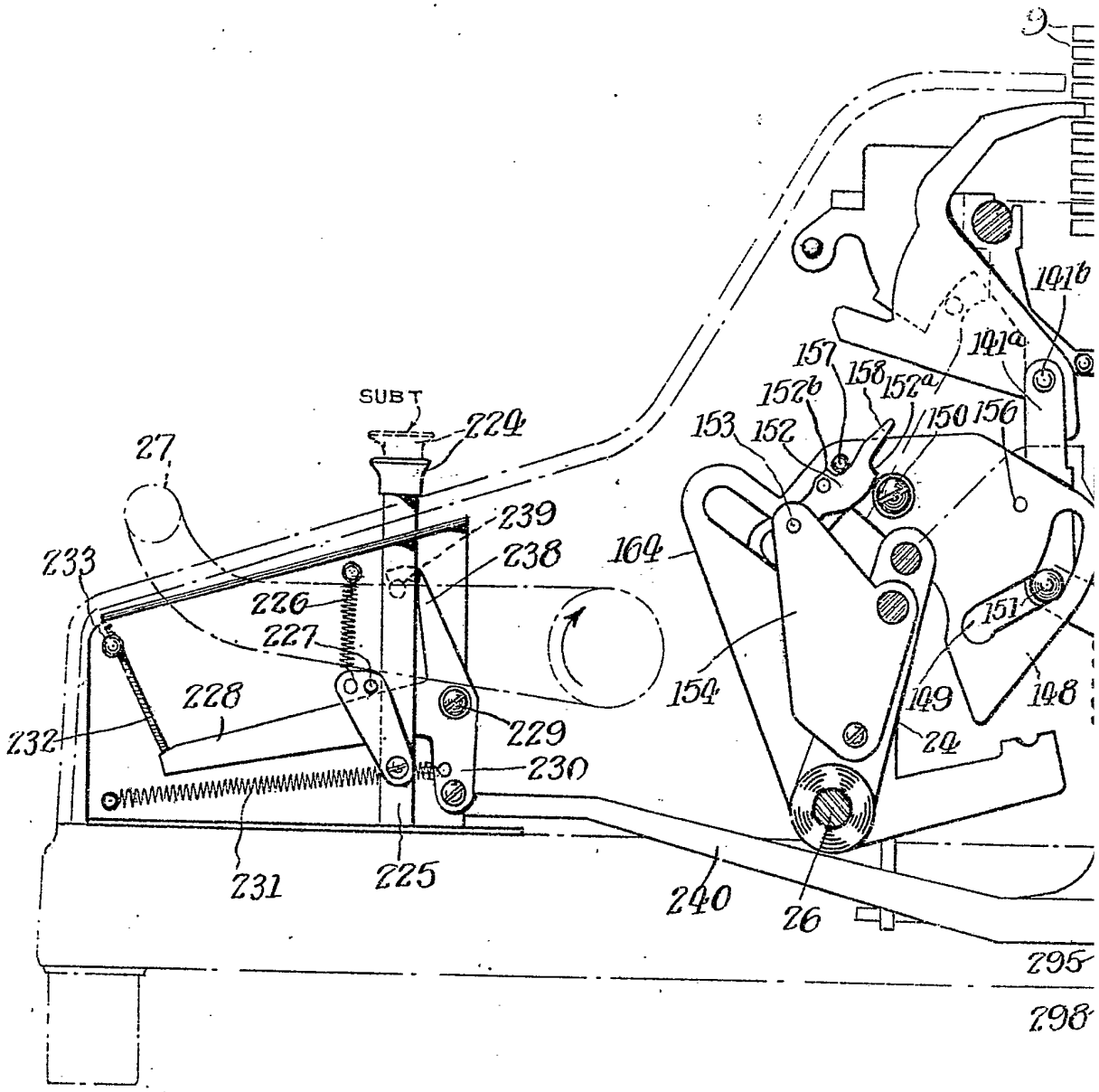

Fig. 12.

Fig. 10.

Fig. 11.

Fig. 13.

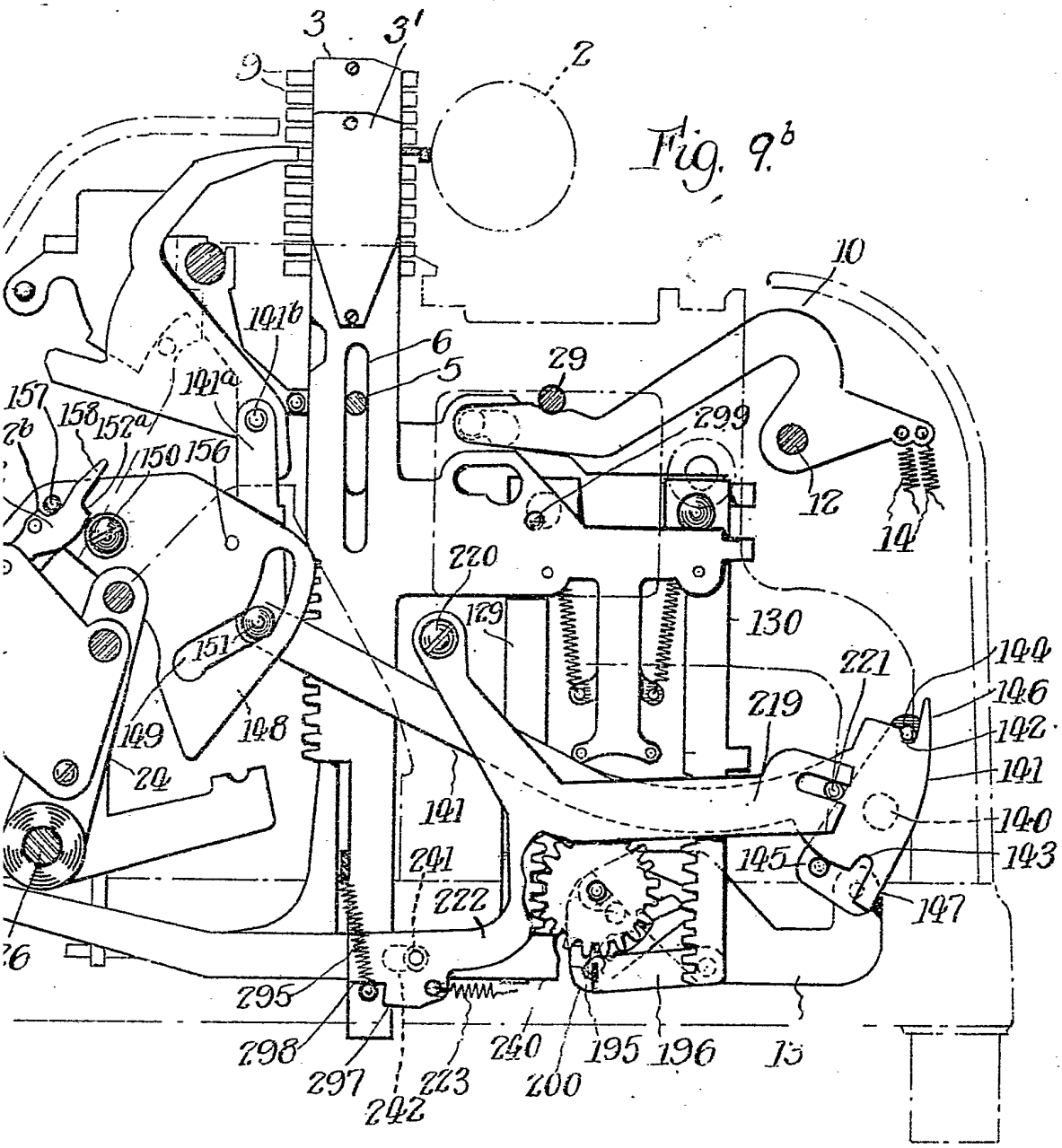

Fig. 9.

Fig. 12.

Fig. 15.

Fig. 13.

596.00	75.96	7596.00
75.96	75.96	7596.60
75.96	1519.8	75.96
	7596.00	75.96
44408	151.9	75.96
	744408	75.96
		75.96
		645660

Fig. 16.

456.90
456.90
45.69
968.11

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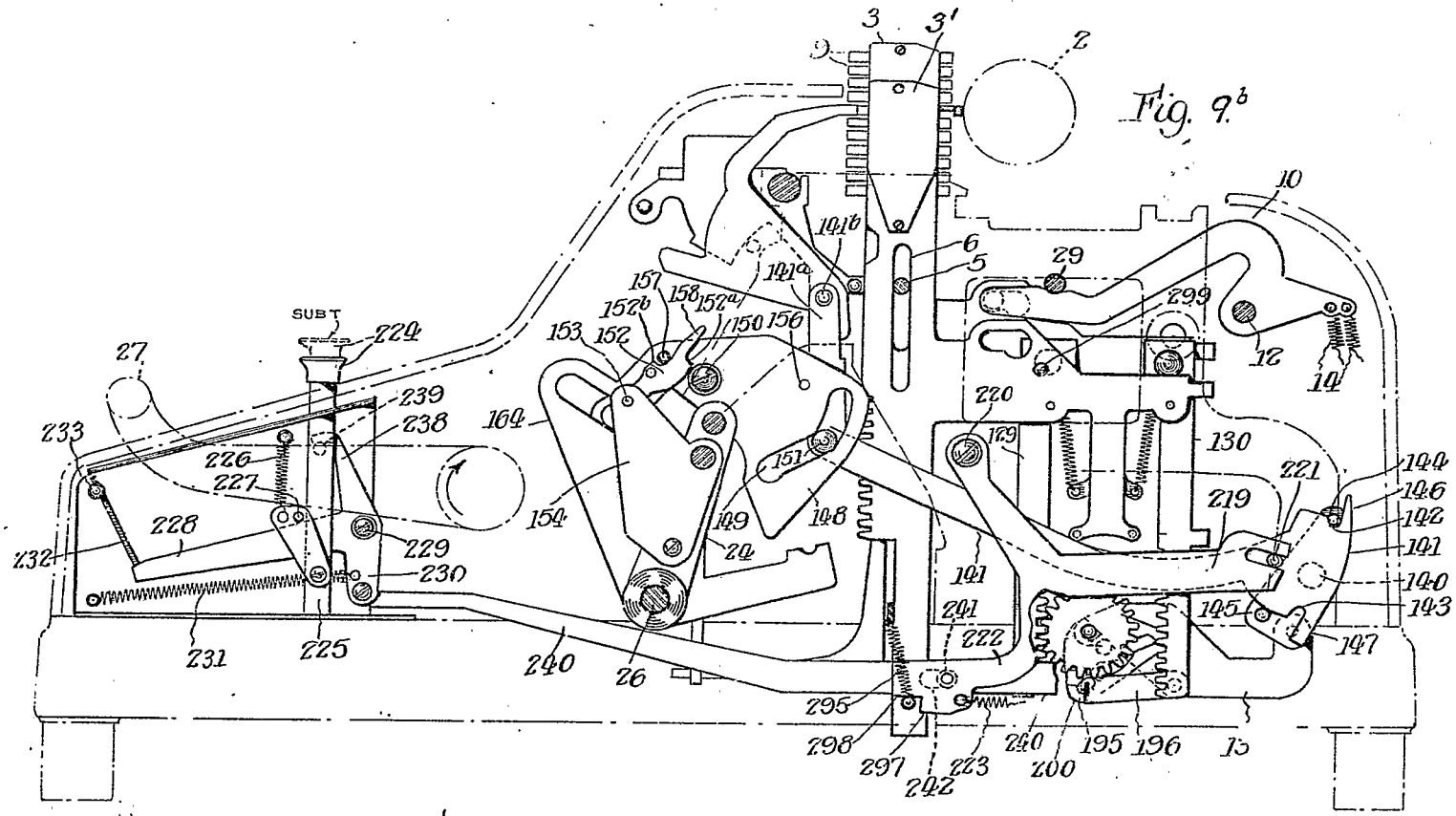

Fig. 10.

	a
.50	b
.20	
.50	
.30	

Fig. 11.

	″
1.00	
1.10	-
1	-
	-
.10	-

Fig. 12.

	″
15.69	
69.85	
98.34	
89.12	
284.60	-
999998840	
1	-
11.60	-

Fig. 13.

	″
7596.00	-
75.96	-
75.96	-
744.06	″

Fig. 14.

	″
75.96	
75.96	
151.98	″
7596.00	-
151.9	-
744.06	″

Fig. 15.

	″
7596.00	-
759.60	-
75.96	-
75.96	-
75.96	-
75.96	-
75.96	-
645.660	″

Fig. 16.

	″
456.90	
456.90	
45.69	-
968.11	″

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