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BY A. P. C.

K. B. W. KIEL
ADDING MACHINE
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12 Sheets-Sheet 1

Fig. 19.

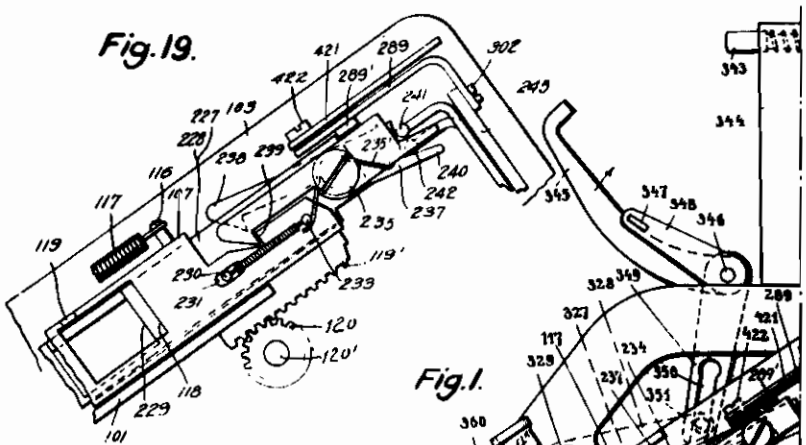
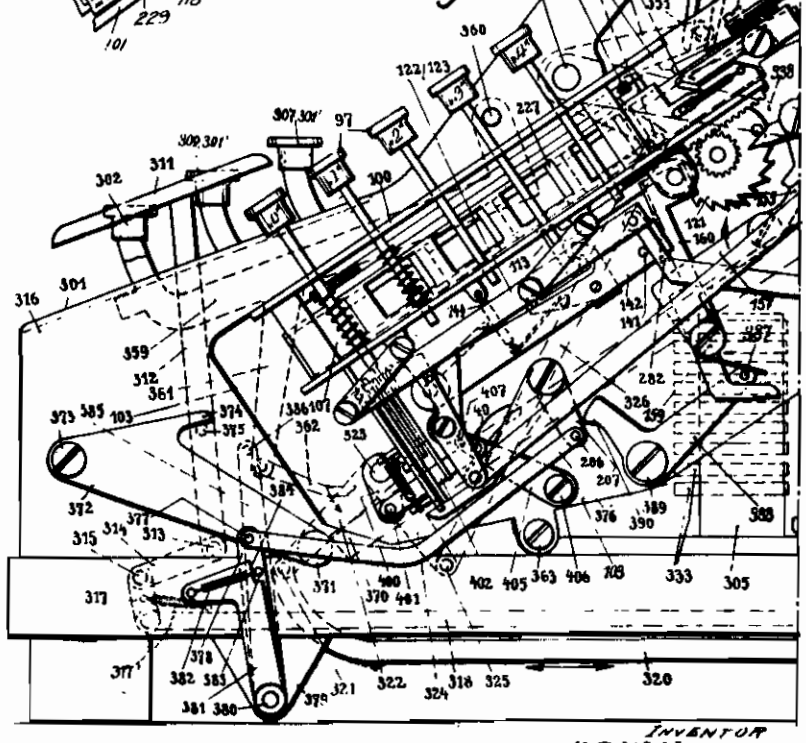


Fig. 1.



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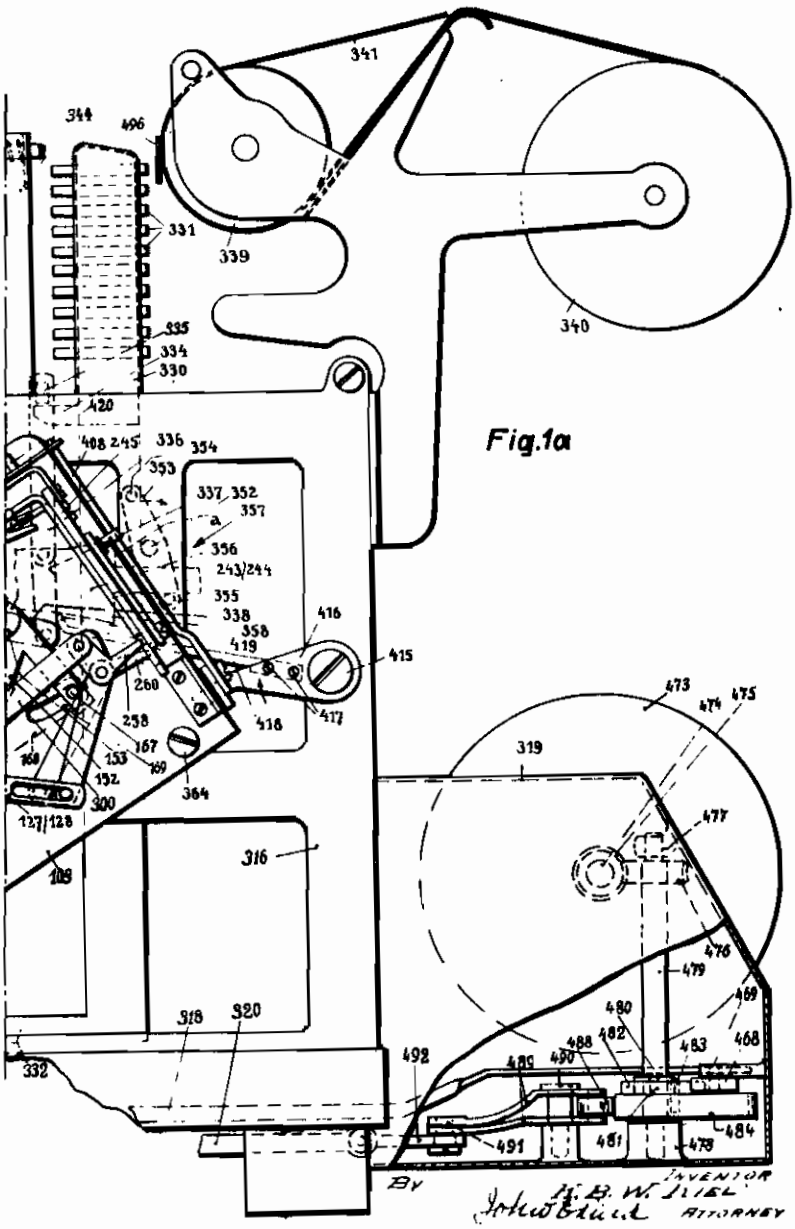

Fig.1a

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Fig. 2

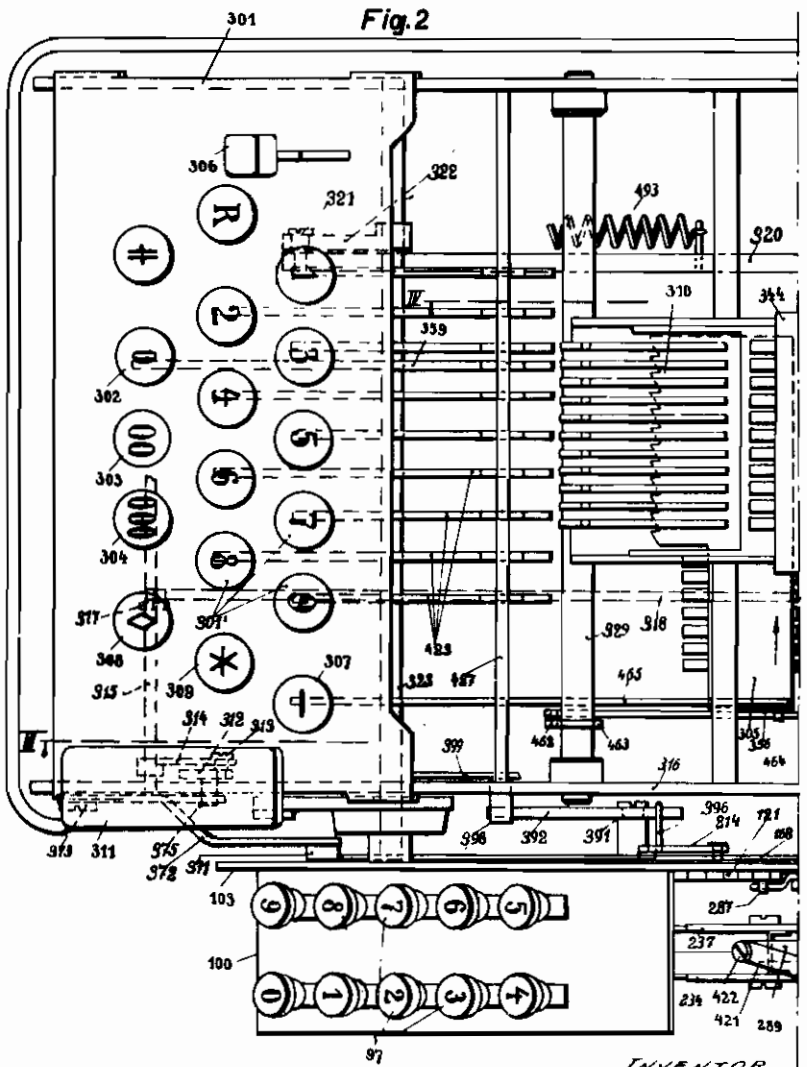

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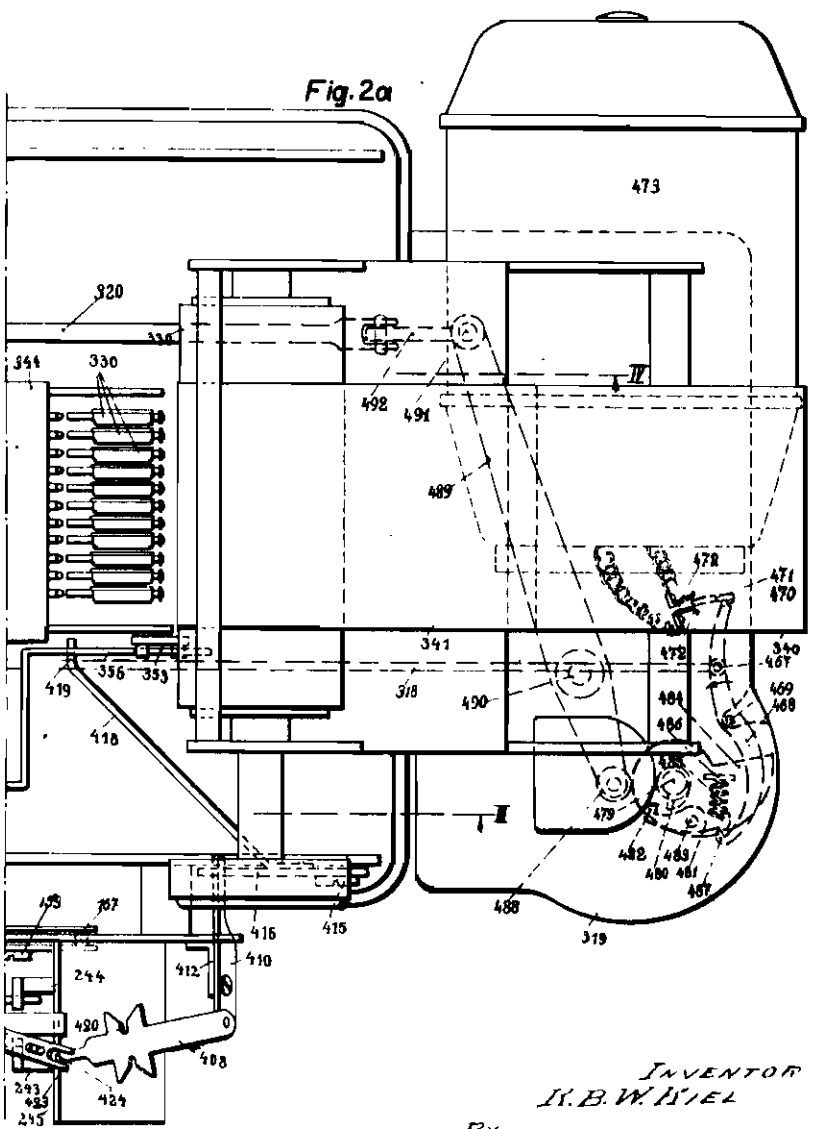
Fig. 2a



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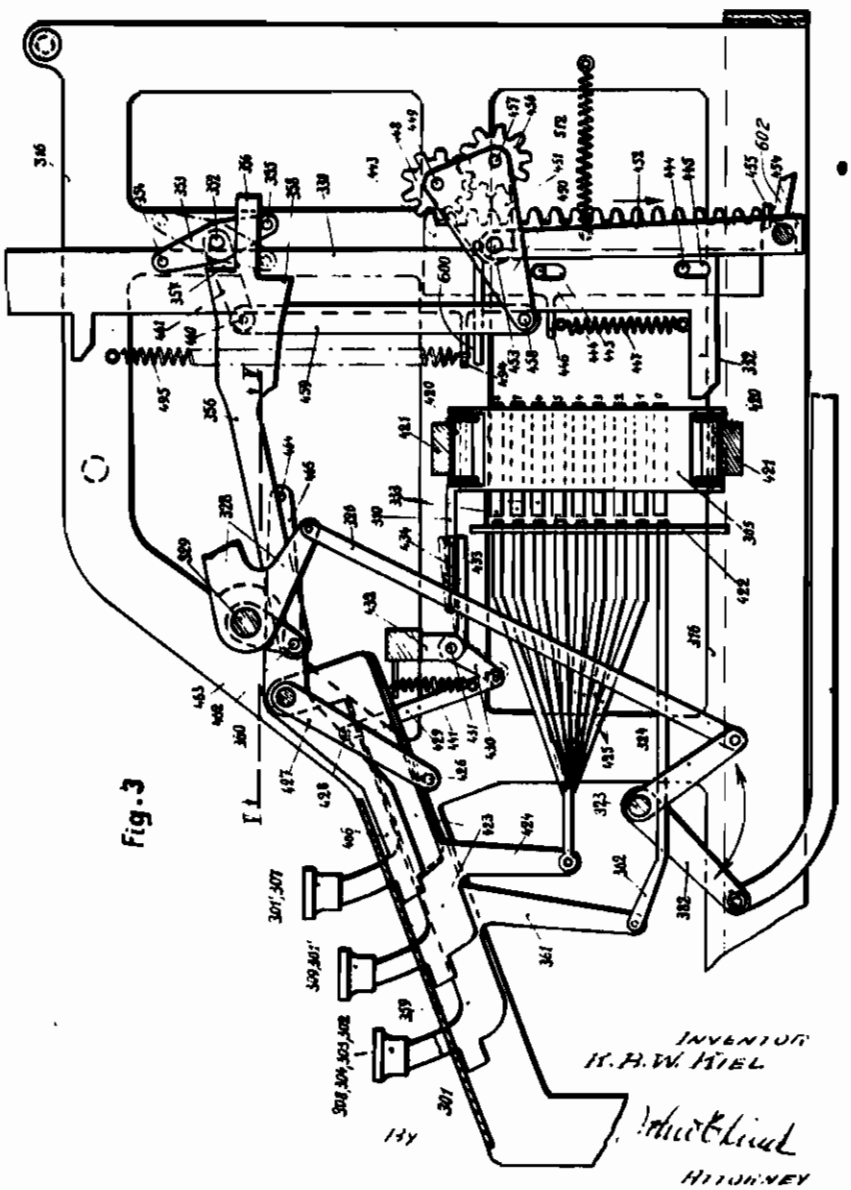

Fig. 3

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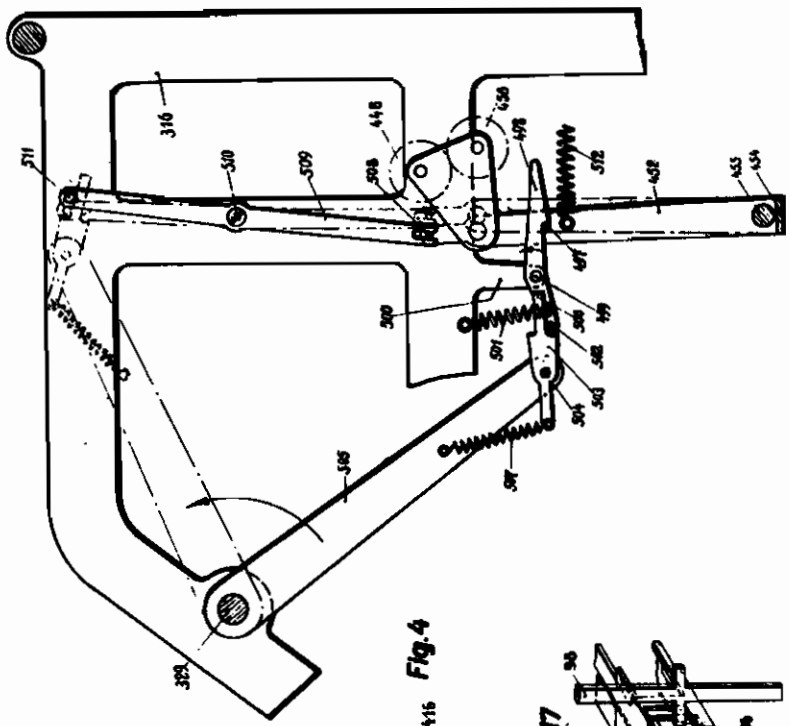

Fig. 4

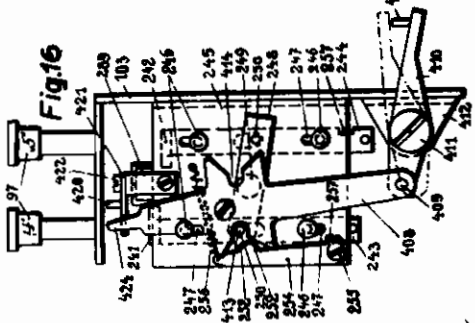

Fig. 16

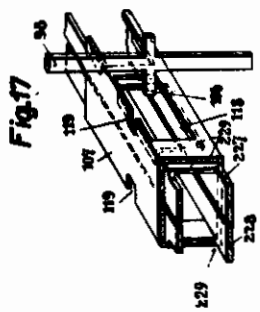

Fig. 17

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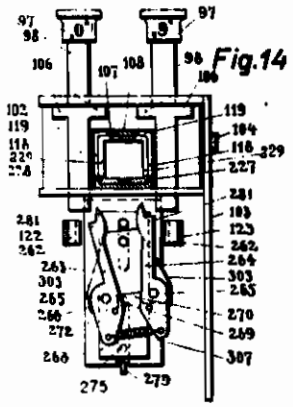

Fig.14

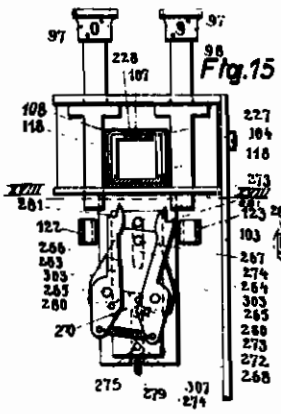

Fig.15

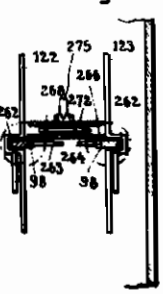

Fig.18

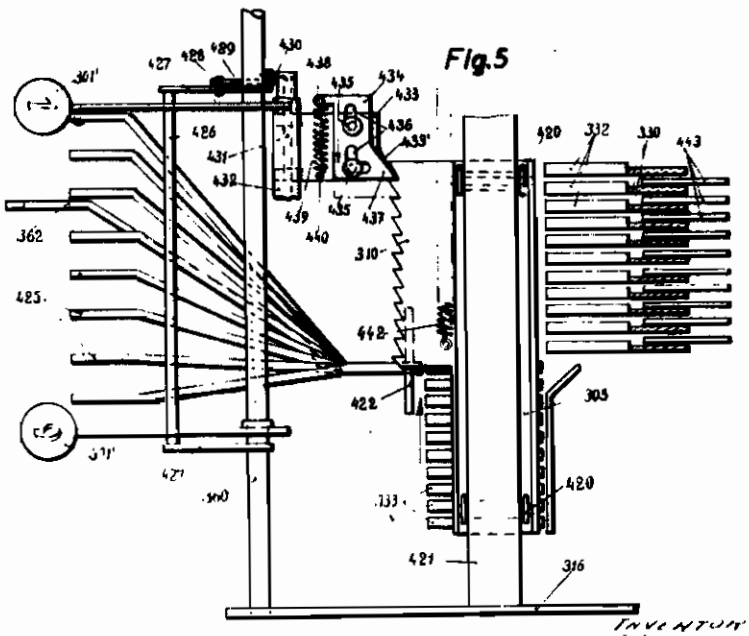

Fig.5

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Fig.13

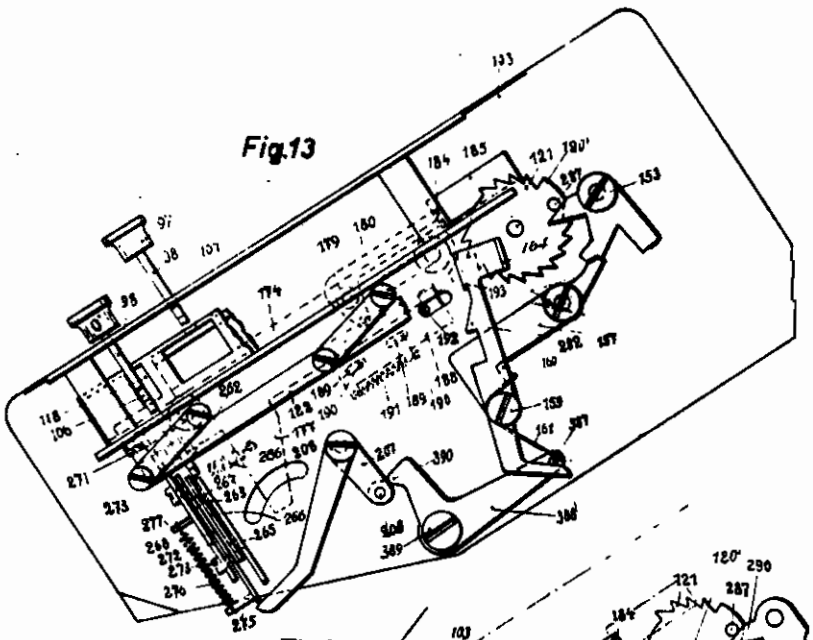

Fig.6

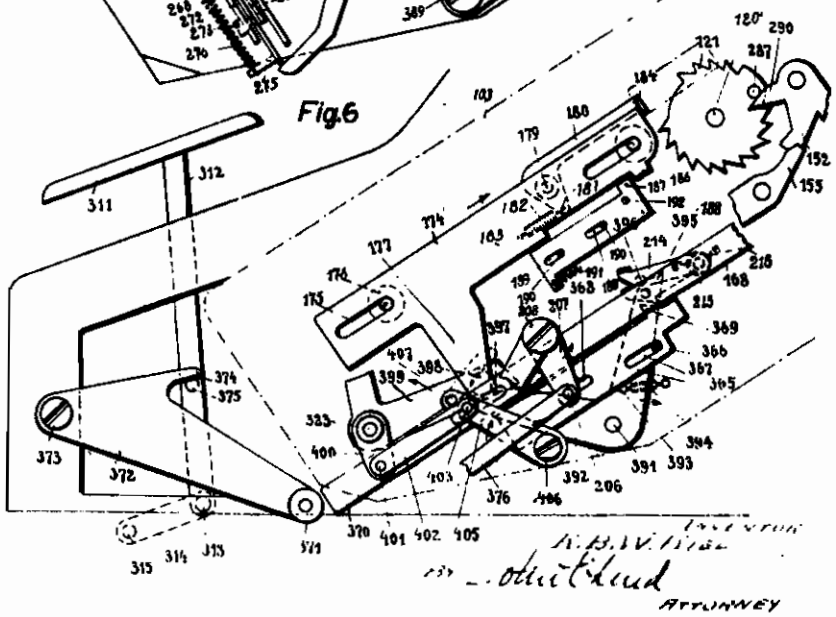

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Fig.7

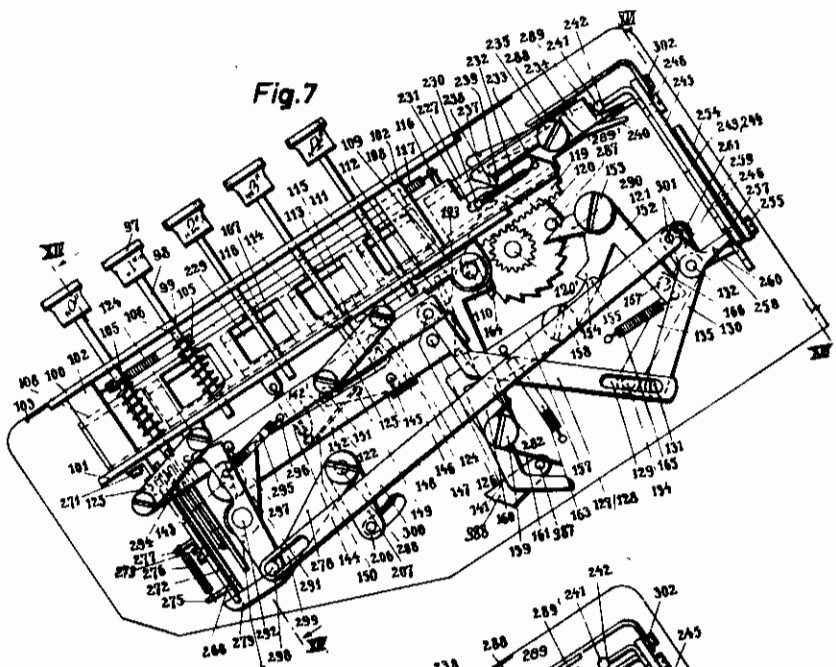
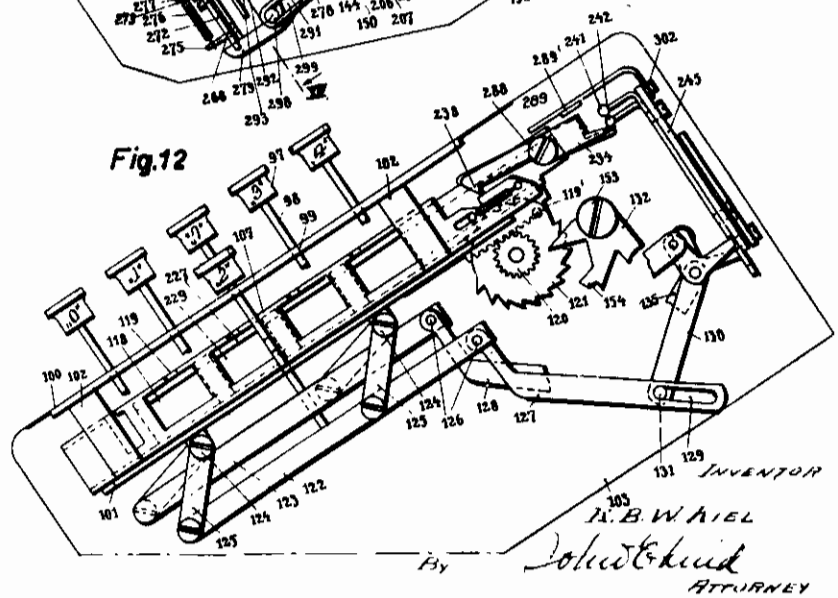


Fig.12



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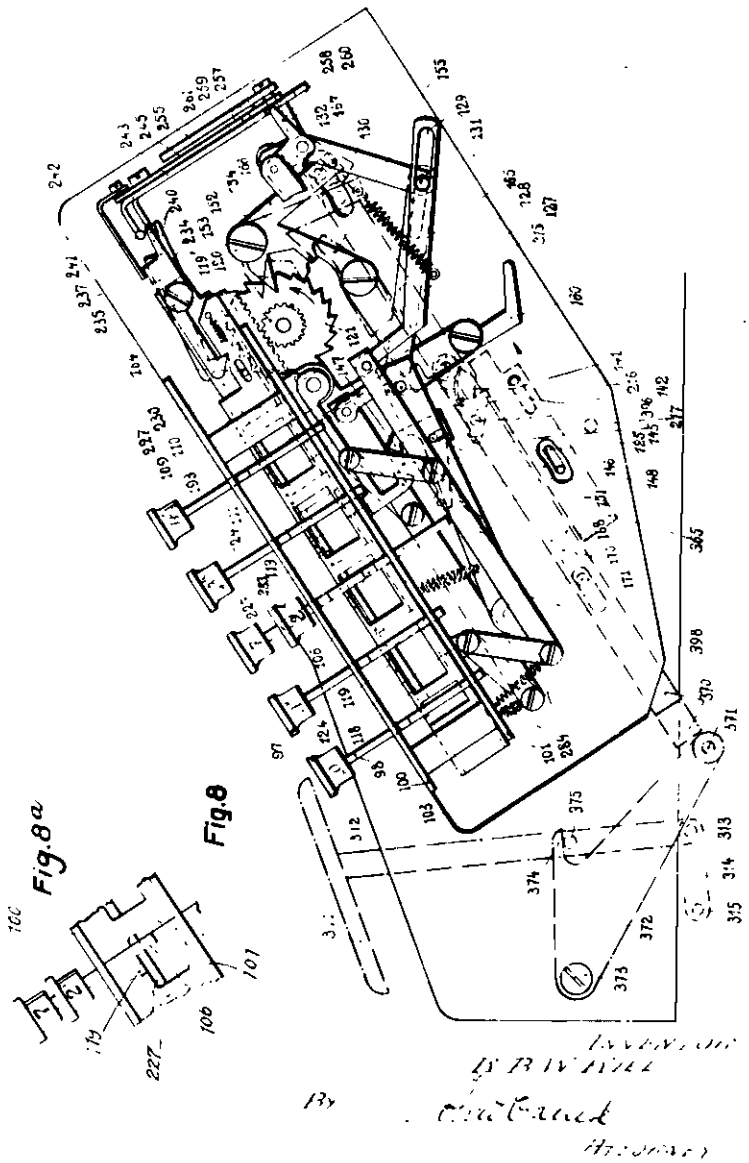

Fig.8

Fig.8a

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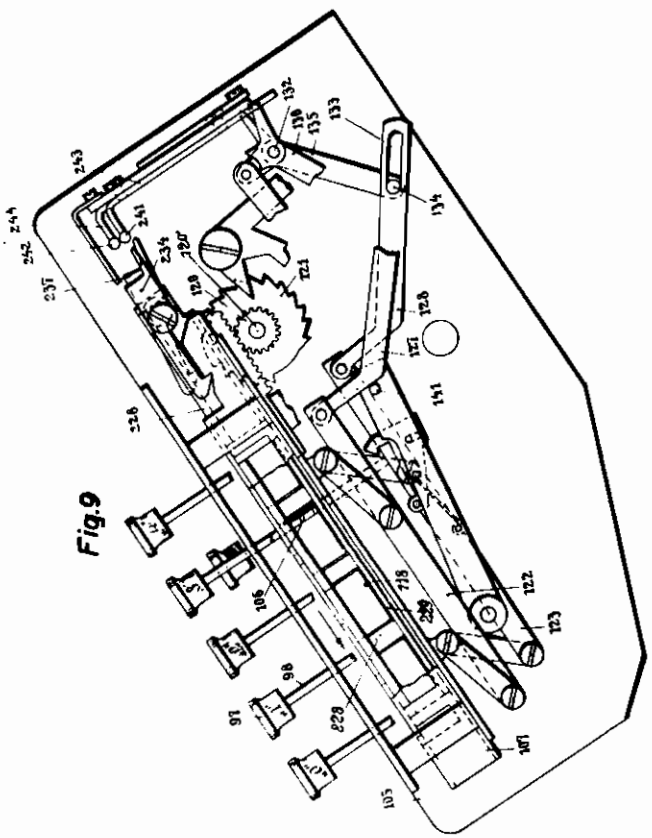

Fig. 9

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Fig.10

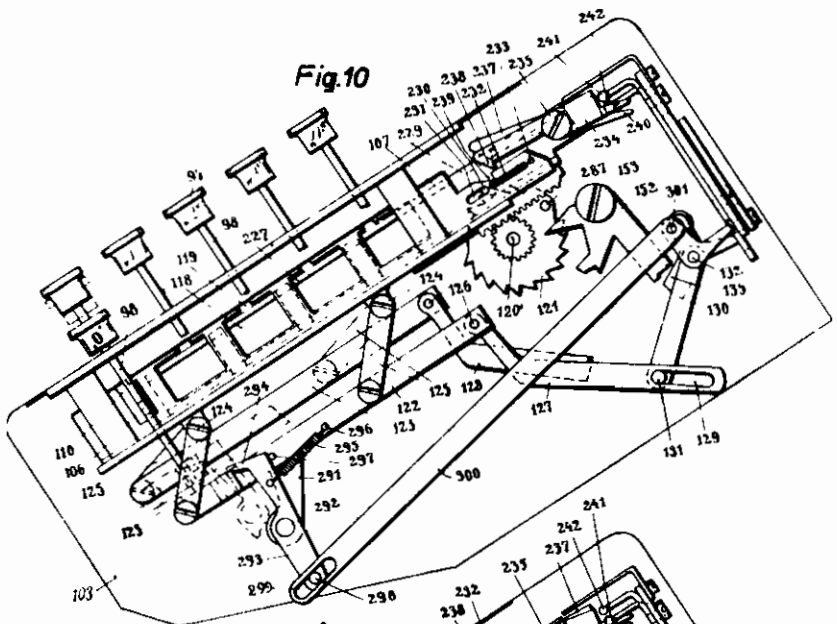
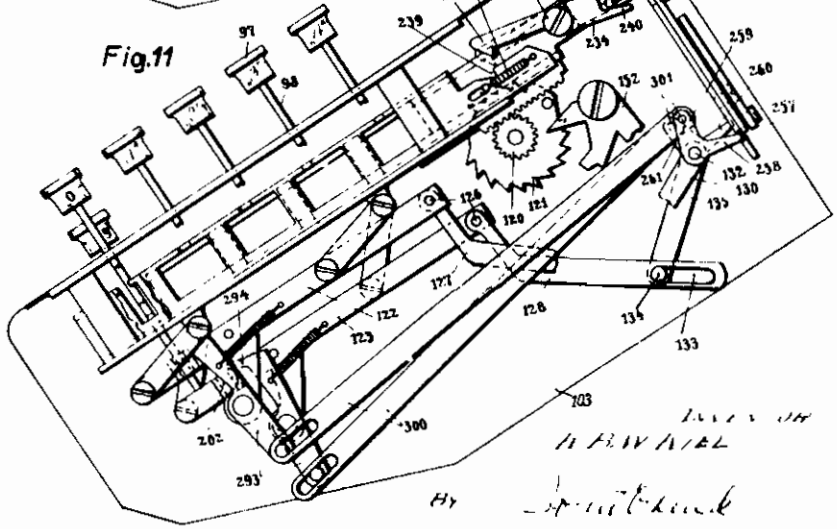


Fig.11



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ALIEN PROPERTY CUSTODIAN

ADDING MACHINE

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

Application filed March 17, 1941

This application is a continuation of application Serial Number 224,630 filed August 12, 1938.

This invention relates to an adding machine with which is combined a multiplying arrangement capable of operating by shortened multiplication.

It is well known that multiplying can be done on adding machines by adding repeatedly the value set up as by actuating the repeat key and pressing down the motor key repeatedly. This method of operating, however, requires keen attention on the part of the operator, and experience has demonstrated that it is not carried out without calculating errors. In order to overcome these difficulties a so-called multiplier setting mechanism has been provided on the adding machine and by means of this the "repeat" additions were carried out automatically by pressing a suitable key.

However, this did not provide means for utilizing the adding machine for large scale multiplication operations, because the adding machine, as a result of the oscillatory movements of its principal parts, was too slow in operation for the purpose intended.

It is an object of the present invention to adapt an adding machine notwithstanding its relatively slower operation for use as a multiplying machine. The multiplier setting mechanism according to the present invention is arranged so that the values above 5 are calculated by shortened multiplication.

A further object of the invention is to provide a particularly simple construction wherein a shifting member actuated by the multiplier setting mechanism acts on the stem of the motor key by means of an intermediate member such as a lever or the like.

A further object of the invention is to provide an arrangement wherein the shifting means of the multiplier setting mechanism, which determines whether addition or subtraction is to be used, is connected with the means of the adding machine for reversing the calculating mechanism gears so as to set them for the desired addition or subtraction.

The accompanying drawings show an example of the invention. Referring to the drawings:

Figure 1 is a partial side view of the invention with the cover plate removed.

Figure 1*a* is a continuation of the view shown in Figure 1 and to the right thereof.

Figure 2 is a partial plan view with a portion of the cover plate removed.

Figure 2*a* is a continuation of the view in Figure 2 and to the right thereof.

Figure 3 is a cross sectional view taken on the section line III—III of Figures 2 and 2*a* with parts broken away and omitted for greater clarity.

Figure 4 is a cross sectional view taken on the section line IV—IV of Figures 2 and 2*a* looking in the direction of the arrows and with portions omitted for greater clarity.

Figure 5 is a horizontal cross sectional view taken on the section line V—V of Figure 3 with portions omitted for greater clarity.

Figure 6 is a cross sectional view illustrating particularly the connections with the motor key and the means for securing the step-by-step return motion of the ratchet wheel.

Figure 7 is a cross sectional view of the multiplier setting mechanism in initial position.

Figure 8 is a cross sectional view similar to Figure 7 but with some of the parts omitted for greater clarity illustrating the position of the parts when the multiplier setting key "2" is depressed with a further showing in dot-dash lines showing the position of some of the parts after the key "2" has been released and has moved upwardly to the position shown in Figure 8*a*.

Figure 8*a* is a view of a portion of Figure 8 showing the position of key "2" after being depressed and released so as to return part way to its original position.

Figure 9 is a view similar to Figure 7 with parts omitted for greater clarity illustrating the position assumed by certain elements when the multiplier setting key "6" is depressed.

Figure 10 is also a view similar to Figure 7 with parts omitted for greater clarity illustrating the position taken by some of the parts when the multiplier key "0" is depressed.

Figure 11 is a view similar to Figure 7 with some of the parts omitted for greater clarity illustrating the position assumed by various elements when the multiplier setting key "9" is depressed.

Figure 12 is also a view similar to Figure 7 with parts omitted for greater clarity illustrating the position taken by some of the elements when the multiplier setting key "2" is depressed with the controls however in a different position from that shown in Figure 8.

Figure 13 is a partial cross sectional view similar to that shown in Figure 10 with parts omitted for greater clarity and other cooperating parts inserted in order to more clearly show the operation between such cooperating parts.

Figure 14 is a cross sectional view taken on

the section line XIV—XIV of Figure 7 looking in the direction of the arrows and illustrating the particular controls for the multiplier setting keys "0" and "9."

Figure 15 is a similar view to Figure 14 showing the parts in a different position.

Figure 16 is a cross sectional view taken on the section line XVI—XVI of Figure 7 and looking in the direction of the arrows illustrating particularly the control means for the reversing of the calculating or counting gears and the control for the means governing the step by step movement of the ratchet shifting means.

Figure 17 is a partial perspective view illustrating the construction of a control tube and cooperating U-shaped bars determining the step-by-step movements to be given to the ratchet shifting wheel in accordance with the particular multiplier setting key depressed, and

Figure 18 is a cross sectional view taken on section line XVIII—XVIII of Figure 15.

Figure 19 shows a portion of Figure 7 on an enlarged scale.

The invention is illustrated and described as based upon the well known "Astra" type of adding and subtracting machine, such as shown in Patent No. 1,987,932 issued February 14, 1933.

The adding and subtracting machine

Arranged on the keyboard **301** of the adding machine in well known manner are the nine keys **301'**, which are designated "1"–"9." The zero keys **302**, **303** and **304** cooperate in well known manner with the setting piece carriage **305**. "R" designates the repeat key through the setting of which the well known clearing mechanism acting on the carriage is disconnected. **306** designates the clearing lever for the setting mechanism. The key **307** having the minus sign (—) sets the machine for subtraction, that is, by pressing such key, the means for reversing the calculating or counting gears is actuated and the calculating mechanism operates subtractively. **308** designates the key by which the intermediate total is determined and **309** designates the total key. The operation controlled by keys **308** and **309** need not be described since it is fully shown in Patent No. 1,897,932 granted February 14, 1933 to J. E. W. Greve and in Patent No. 1,953,557 granted April 3, 1934 to J. E. W. Greve.

The setting piece carriage **305** is provided below and above with two rollers **420** by means of which it runs on two guide rails **421** attached to the machine frame. The carriage is provided with a plurality, in the present example ten, vertical rows of setting pins **333**, each row comprising nine pins, so that the carriage of the present exemplary embodiment carries ninety such pins. The setting pins are set by means of the keys **301'** or **302**, **303** and **304**.

Key **302** is attached to a key lever **359** which is journaled on a shaft **360** attached to the machine frame. The lever **359** is provided with a downwardly extending arm **381** with which a rod **362** is engaged. The right end of rod **362** is slidably guided longitudinally in a perpendicular bracket plate **422** attached to the machine frame. The end of rod **362** extends within range of the lowermost sliding setting pin **333**, which corresponds to the "0" value. The keys **303** and **304** act in a similar manner on a similar rod. The operation of these keys is shown in Patent No. 1,707,303 granted to J. E. W. Greve, April 2, 1929.

The keys **301'** are attached to the suitably formed nine key levers **423**, which are also journaled on the shaft **360**. Each key lever **423**, except that which carries the "9" key, has a downwardly extending arm **424**, each connected with a rod **425**. The rods **425** are held so as to be longitudinally slidable at their free ends in the guide plate bracket **422**.

The rod **425** which is connected with the key **301'** designated "1," acts on the second row of sliding setting pins **333** which correspond to the value "1." The key **301'** designated by "2" cooperates with the rod which is coordinated with the third row (from the bottom) of sliding setting pins **333**, and so on. Keys **302** and **301'** also cooperate with an escapement mechanism for the lateral movement of the carriage **305**, which comprises the following construction.

The key levers which carry the corresponding keys **301'** and **302** engage by their lower surfaces a rod **426**, whose ends, as shown in Fig. 5 are attached to two levers **427**. The levers **427** are attached to the shaft **360**, which is rotatably journaled in the machine frame. One lever **427** is connected by a pin **428** to one end of a link **429** which at the other end, engages a lever **430**. Lever **430** is attached to a shaft **431** rotatably journaled in a bearing **432** attached to the machine frame.

A plate **433** is also attached to shaft **431** and carries a shift tooth **433'**. (See Fig. 5.) Another plate **434** is slidably mounted on plate **433**. For this purpose, the two attaching screws **435** engage through corresponding slots **438** of plate **434**. Plate **434** is provided with a shift tooth **437** corresponding to the shift tooth **433'**. Also engaged with plate **434**, at **438**, is a traction spring **439** which is attached at **440** to plate **433**. This spring tends to move plate **434** in the direction of the arrow in Fig. 5. According to Fig. 5, this plate is prevented from movement by its tooth **437** engaging in a rack **310** attached to the carriage.

If one of the keys **301'** or **302** are depressed not only is the corresponding setting pin **333** of the vertical pin row in front of the rods **425** moved to the right from the position shown in Fig. 3, but also, at the same time, by means of the elements **426** to **430**, the plate **433** is swung, against the traction of a spring **441**, into the dotted line position of Fig. 3. In this swinging movement of the plate **433**, the tooth **433'** passes into the denture of rack **310**, while tooth **437** is released therefrom and moves to the dotted line position of Fig. 5 through the traction of spring **438**.

If the depressed key is released, then, through the traction of the spring **441**, plate **433** again swings downwardly and the tooth **433'** passes out of the range of the denture of rack **310** and the spring urged tooth **437** simultaneously passes into the denture of rack **310**. Under the pull of the stronger traction spring **442** engaged with the carriage, the carriage is moved in the direction of the arrow in Fig. 5 for the distance of one rack tooth and the plate **434** again assumes the position shown in full lines in Fig. 5. The carriage has thereby been moved the distance between adjacent rows of pins **333** since each rack tooth corresponds thereto.

Associated with carriage **305** are a number of type carrying bars **330**, of which, as shown in Figs. 2*a* and 5, eleven are provided arranged in adjacent relationship. It is to be noted that ten of these bars carry the types "0"–"9," while the eleventh contains the symbols or signs. The in-

dividual types 331 are arranged slidably on the bars 330. Provided at the lower end of each type bar 330 is a projecting shoulder 332 which extends within range of the setting pins 333 slidably mounted in carriage 305.

The type bars 330 are also each provided with an arm 334 over which a common cross bar 335 engages. The bar 335 is carried by a slide 336 which is moved upwardly by means of a link 337 connected thereto and by a control lever 338, connected to link 337 when the machine is operated. In this manner all the type bars 330 are released, so that they can pass upwardly under the pull of the traction springs 495 engaged with projections 494 thereon until the corresponding shoulders 332 contact the extruded setting pins 333 of the pin row coordinated therewith.

A rack 443 is associated with each type bar 330. Each rack 443 is provided with two pins 444 engaging in slots 445 of the bars 330. Each rack is provided with an arm 446 to which a traction spring 447 is engaged. The other end of spring 447 is attached to the bar 330 with which the rack 443 is associated. The spring 447 tends to move the rack 443 relative to the bar 330 in the direction of the arrow in Fig. 3.

The control of the bars 330 and consequently the actuator racks 443 is described in the above mentioned Patent No. 1,707,303. This control acts on the bars 330 so as to retain the bars 330 into whose range no vertical pin row in the carriage 305 has entered.

The calculating mechanism gears and reversing means therefor

Coordinated with the racks is a calculating mechanism consisting of a suitable number of counting gear wheels 448. The gears 448 are journaled on a shaft 449, which is attached in the two parallel plates 458 and 451. The two plates are pivoted to two levers 452 by pins 453, and the levers 452 are disposed at both sides of the set of bars 330. The levers 452 are interconnected at the bottom by a crossbar 454 and are mounted oscillatably on a trunnion 455 attached to the machine frame.

Each gear 448 of the calculating mechanism is engaged with a reversing gear 456. The gears 458, which have the same number of teeth as the gears 448, are journaled on a shaft spindle 457 which is attached to the two frame plates 450 and 451. Engaged with the lower end of the plate 450, at 458, is a link 459 which is connected by a pivot pin 460 to a lever arm 461. The lever arm 461 is fixed to the shaft 352 journaled in the machine frame 316. A plate 353, which is provided at both diametrically opposite ends with pins 354 and 355 is fixed to shaft 352. By setting or pivoting plate 353 into the dotted line position of Fig. 3, the plates 450 and 451 are swung about the pins 453 so that the calculating mechanism gears 448 unmesh from and the reversing gears 456 mesh with the racks 443. In this manner a certain predetermined movement of the racks in one direction with respect to the calculating mechanism gears 448 is reversed to the opposite direction and brings about the opposite method of calculation, that is, the value based on the magnitude of the rack movement is not added, but subtracted.

The tens transfer for the calculating mechanism 448, 456 is effected through the lever arm 602. The details of the tens transfer are described in Patent No. 1,897,932 granted to J. E. W. Greve, February 14, 1933.

The plate 353 is set in one or the other terminal position by means of a plate 356 which is provided with the two shoulders 357 and 358. Plate 356 is journaled at one end on a pin 462 provided on the end of a lever arm 463. The lever arm 463 is attached to a shaft 329 which is journaled in the machine frame 316. Also mounted on shaft 329 is a bellcrank lever 328 which is connected by a link 326 to a lever arm 324 attached to the main drive shaft 323. Through a means hereinafter described, the main shaft describes an oscillatory movement which is transmitted through the link 326 into a similar movement of the lever 463 connected to shaft 329.

A pin 464, attached to an arm 465, engages under the plate 356. Arm 465 is an extension of the key lever 466, which is journaled on shaft 350 and which carries the key 307 bearing the minus (—) sign. It is apparent that by pressing on the key 307, through the pin 464 the plate 356 is swung upwardly so that the shoulder 357 comes in front of the pin 354.

If the plate 353 was previously in the position shown by the full lines in Fig. 3, then, in the outward swinging of the lever 463, the plate 353 will be swung by the plate 358 into the dotted line position in Fig. 3 and the calculating mechanism gears 448 and 456 thus moved to the subtracting position.

The motor drive and coupling means

The keyboard 301 is also provided with the motor key 311 carried by the rod 312. The lower end of rod 312 is pivoted at 313 to a lever 314 which is fixed to shaft 315 journaled in the machine frame 316. Connected to shaft 315 is another lever arm 317 to which a rod 318 is connected. The arm 317 is under the action of a spring 317' to return the motor key 311 after such key has been released. Rod 318 is connected by a pivot pin 467 to the lever 468 which actuates the clutch and contact devices. Lever 468 is journaled at 469 in the housing 319.

Attached to one end of the lever 468, with an interposed insulating member 470, is an electrical switch member 471 which cooperates with the two spring pressed contacts 472. The springs of the contacts are in the circuit of an electric motor 473, on the shaft 474 of which is attached a worm gear 475 which meshes with a worm gear 476. Worm gear 476 is attached to a vertical shaft 479 journaled in bearings 477 and 478 in the housing 319.

Attached to the shaft 479 is a ratchet tooth 480 with which the nose 482 of pawl 482 cooperates. Pawl 481 is mounted by means of the pivot pin 483 on a cam disc 484 which is freely rotatable on the shaft 479. A pressure spring 485, supported on a projection 486 on the cam disc 484 acts on the pawl 481. Cooperating with the free end of the pawl 481 is the hook end 487 of the lever 468, so that when the lever 468 assumes the position of Fig. 2a the hook end 487 holds the nose 482 of the pawl 481 out of engagement with the ratchet tooth 480.

Cooperating with the cam disc 484 is a cam roller 488 mounted on one arm of a double armed forked lever 489 pivoted on pin 490 provided in the housing 319. The other arm of lever 489 is pivotally connected by pin 491 to a link 492 which in turn is pivotally connected to rod 320 at one end thereof. The other end of rod 320 is pivotally connected by pin 321 to lever arm 322 fixed to main shaft 323.

Thus, if the motor key 311 is depressed, then,

by means of the levers 314 and 317, the rod 318 is moved to the left as shown in Figs. 1, 1a, 2 and 2a and the lever 468 is swung in the direction of the arrow in Fig. 2a whereby, through the switch member 471, the circuit for the electric motor 473 is closed and at the same time the hook end 487 releases the pawl 481, so that its nose 482 engages ratchet tooth 480.

In the ensuing rotation of shaft 479 by motor 473, the cam disc 484 is carried along and through the action of the double armed lever 489, the rod 320 is at first drawn to the right from the position shown in Figs. 1, 1a, 2 and 2a, thereby rotating the main shaft 323 counter-clockwise. The spring 493 connected at one end to the frame and at the other end to rod 320 maintains roller 488 in contact with cam disc 484 and returns the rod 320 to its initial position thereby rotating shaft 323 clockwise and returning the members connected therewith.

It is to be noted that during the swinging movement of the lever arm 322 in the direction of the arrow in Fig. 1, the slide 336 is moved upwardly, so that the bars 330 are released and can pass upwardly due to the traction of the springs 495 engaging projections 494, until the projecting shoulders 332 strike against an extended sliding pin 333. The stop for the key 301', designated "9," is the plate 600 (Fig. 3). If such key is depressed the carriage 305 makes an advance without one of the pins 333 being moved out. The corresponding bar 330 can then ascend until its shoulder 332 strikes against plate 600. This operation is also described in Patent No. 1,707,303 above mentioned. In this upward movement of bars 330 the types 331 are carried into the range of the printing device, which consists substantially of the platen 338 over which the paper strip 341 coming from the roll 340 runs. The ribbon 496 is disposed in front of the platen 339.

The calculating gears control

It is to be noted primarily that during the upward movement of the bars 330 the calculating mechanism gears 448 and 456 must not operate. On the contrary, the calculating gears are to be swung into operative position on the return of the rods 330 to the initial position. For this purpose the control means shown particularly in Fig. 4 are provided.

Fixed on a lever arm 452 is a pin 497 which cooperates with a latch 498. The latch is journaled at 499 to a frame extension arm 500 and is subjected to the action of a traction spring 501 which always tends to hold latch 498 engaged with the pin 497. The free end of latch 496 is provided with a pin 582, with which a toggle impact lever 503 cooperates. The toggle lever is pivoted at 504 to the free end of swinging lever arm 505 attached to shaft 329. In the initial position of the machine, the lever arm 505 assumes the position indicated in Fig. 4 by the full lines, and the finger-like extension 506 of the lever 503 is applied, through the pull of the engaging traction spring 507, against the pin 502. However the spring 507 is so weak that it cannot overcome the action of spring 501.

Mounted on the lever 452, on which pin 497 is provided, and by means of a suitable extension, is another pin 598 over which the forked end provided on one arm of a double armed lever 509 engages. The lever 509 is journaled by means of the pin 510 on the machine frame 316. The free end of lever 509 is provided with a pin 511 which extends into the movement range of the toggle impact lever 503 carried by lever arm 505.

If, by actuating the motor key, the main shaft 323 is rotated counter-clockwise, then, at the same time, by means of the link 326, the shaft 329 is rotated counter-clockwise and the lever arm 505 is swung out in the direction of the arrow in Fig. 4. In this swinging movement, the lower shoulder of the toggle lever 503 strikes against the pin 502 and the latch 498 describes a swinging movement in the direction of the arrow in Fig. 4. Through this swinging movement, the pin 497 is released from the latch catch so that the levers 452 together with the calculating mechanism gears 448 and 458 can swing through the traction of spring 512 to the right as shown in Fig. 4, so that the gears of the calculating mechanism can move outside the range of the racks 443. After the lever 503 has passed over the pin 502, the latch 498 is again drawn into the operative position, wherein the end of latch 498 is applied on the pin 497. Thus, immediately after the beginning of the upward movement of the bars 330, the calculating mechanism gears are swung into the inoperative position.

When the lever arm 322 reaches its extreme right end position, the lever arm 505 assumes the dotted line position of Fig. 4, in which position the finger-like extension 506 is applied against the pin 511 of the double armed lever 509 which is in the dotted line position of Fig. 4 corresponding to the swung out position of the levers 452. At the beginning of the reverse or return rotation of the shaft 329, and therefore before the downward movement of the bars 330, the upper shoulder of the toggle impact lever 503 strikes against the pin 511 and the double armed lever 509 is swung back into the position shown in full lines in Fig. 4.

In this swinging movement of the lever 509, pin 508 moves the levers 452 back to the initial position shown in full lines in Fig. 4. As soon as this initial position is reached, the latch 498 can again, due to the action of spring 501, lock the pin 497. This means, however, that while the bars 330 have been carried downwardly towards the initial position, the calculating mechanism gears 440 and 458 are in the position shown in Fig. 4 and in Fig. 3. While the bars 330 are moved downwardly, the calculating mechanism gears are shifted positively or negatively, according to whether the plate 353 has thrown gears 456 into mesh with racks 443 or not.

The printing mechanism

The printing mechanism which enters into operation when lever arm 505 assumes the dotted line position of Fig. 4 operates in the following manner.

It is first to be noted that the pin-like intermediate members 343, shown in Fig. 1, are opposite the ribbon 496. The hammer levers 345, mounted oscillatably on the common shaft 346, cooperate with the pin-like intermediate members, which are guided axially slidable in the support 344 and are held by the springs 343' in the position shown in Fig. 1. The hammer levers 345 are subjected to the action of springs (not shown) which tend to swing them in the direction of the arrow shown in Fig. 1. The tensioning of the levers 345 is provided by the crossbar 347 which is attached to a lever 340. The latter is connected with a lever arm 349 in the slotted end 350 of which a pin 351 on one arm of the bell crank lever 328 engages. The hammer levers

are provided with the well known checks, stop or the like which, when the machine is actuated, and assuming that it is set for printing, are released, so that, under the pull of the springs engaged therewith the hammer levers contact the reinforced ends of the intermediate members **343** and move these so that they strike the type in front of them against the paper **341** with the ribbon **496** interposed.

The above well known arrangements, which serve for addition and subtraction, are coordinated with a multiplier setting mechanism, described hereinafter and by means of which shortened multiplication is possible.

The multiplier setting mechanism

The parts belonging directly to the multiplier setting mechanism are mounted on the base plate **103**, which is attached by screws **363** and **364** to the machine frame **316** of the adding machine. The multiplier setting mechanism has ten multiplier setting keys **97** bearing the indicia "0"–"9" which are disposed at the right of the keyboard **301** of the adding machine.

Each of the keys **97** is mounted on a slide **98** (Figs. 7 and 11). The upper ends of the slides **98** are guided in slots **99** provided in a plate **100**, while the lower ends are guided in corresponding slots of a plate **101**. The latter is attached by cross members **102** to the upper plate **100**.

The cross members **102** are fixed to the frame wall **103** by means of the screws **104**. Encircling the lower end of the slides **98** are the springs **105** which urge the cross extensions **106** on the slides **98** against the lower side of the plate **100** and thus tend to hold the slides in the initial position.

The main shaft oscillation control

Disposed longitudinally slidable between the two rows of slides **98** is a rectangular tube **107** which is guided in suitable recesses **108** provided in the cross members **102**. Attached to tube **107** is a bearing eye **109** which extends downwardly through a longitudinal slot provided in the plate **101**. Journaled in the eye **109** by means of the pivot pin **110** is a pawl **111** with which a spring **112** engages and which tends to force the pawl upwardly. In the initial position shown in Fig. 7 the nose **113** of the pawl **111** is applied against the end **114** of the slot **115** provided in the plate **101**. A traction spring **117** engages at one end the pin **118** provided on tube **107** and at the other end is attached to the front cross member **102**. This spring urges tube **107** to the left as shown in Fig. 7. In the initial position shown in Fig. 7 the tube is locked by the pawl nose **113**.

Tube **107** is provided on both sides with window-like recesses **118** (see Fig. 17) which connect with recesses **119** provided on the upper side of the tube. When the tube **107** is in the initial position, these recesses **119** are positioned exactly under the cross extensions **108** of the slides **98**. It is to be noted that the recesses **119** are substantially only as wide as the thickness of the slides **98**. Also, the window-like recesses **118** are so arranged with relation to the recesses **119** that, when the cross extensions **106** of the slides have entered the recesses **118** due to pressure on the keys, and the pawl **111** is released, the tube **107** may move for graduated lengths corresponding to the particular number value. Thus, the recess **118** coordinated with the "0" key permits movement of the tube for the distance x, the recess coordinated with the "1" key for the distance $2x$, and the recess coordinated with the "4" key permits a movement of the distance $5x$, etc. It is the same with the keys "5"–"9", but therein the movement corresponds to the complementary value. The recess coordinated with the "5" key thus permits a movement of the distance $5x$ and the recess coordinated with the "9" key permits a movement of the distance x.

A rack **119'** is attached to the square tube **107** and engages gear **120**. Gear **120** is mounted on pivot **120'** on the base plate **103** and is connected to a ratchet shifting wheel **121**. A one tooth shift or rotation of the wheel **121** will cause a movement of the rack **119'** and consequently of the tube **107** for a distance x.

Associated with the lower ends of slides **98** are the two bars **122** and **123** which are carried link-parallelogram-like by the four members **125** journaled by pivots **124** to the bottom of the plate **101**. Angular bars **127** and **128** (see Figs. 7 and 9) are pivoted at **126** to the ends of the bars **122** and **123**. The bar **127** is provided with a slot **129** in which a pin **131** provided on a lever **130** engages. Lever **130** is oscillatably journaled on a pin **132** attached to the frame wall **103**. The other bar **128** (see Fig. 11) is provided with a slot **133** into which a pin **134** extends. Pin **134** is attached to the lever **135** which is likewise journaled on pin **132**.

Extending into the path of movement of bars **122** and **123** (see Fig. 9) is a pin **141** which is attached to a lever **142** pivoted at its front end to the frame **103** at **143**. A traction spring **144** (see Figs. 7 and 8) is engaged at **142'** with the lever **142**, and the spring **144** tends to hold the lever **142** in the position shown in Fig. 7. Journaled on the lever **142**, at **145**, is a pawl **146** having a projecting shoulder **147** which engages a shoulder **148** provided on the pawl **111**. A spring **150** engages the pin **149** on the pawl **146** and tends to apply the pin **151** on the pawl **146** against the upper edge of the lever **142**.

Cooperating with ratchet shifting wheel **121** is a plate **152** which is journaled oscillatably by pin **153** on the base plate **103**.

Plate **152** has an arm acting as a pawl **154** which is retained in the initial position shown in Figs. 1 and 7 by the locking extension **155**, which extends into a recess provided in the pawl **154** of the plate **152**. The locking extension is provided on the end of one arm of a double armed lever **157** which is oscillatably journaled by the pin **158** in the wall **103**.

Journaled at the free end of the other arm of lever **157** by the pin **159**, is a second lever **160** with which is engaged one end of a torsion spring **161** which, at the other end, is supported by a pin **307**. Engaged with the lever **157**, as shown, is the traction spring **163**, which tends to hold the locking extension **155** in engagement with pawl **154**. By means of the torsion spring **161**, lever **160** is given a tendency to swing counter-clockwise about pin **159**. A lateral projection **164** provided at one end of the lever **160** is applied, in this manner, against the corresponding projecting pivot pin **110**.

Plate **152** is subjected to the action of a traction spring **165** which tends to turn the plate clockwise. The spring **165** is connected to an arm **166** of the plate **152**, and the arm **166** has a pin **167** connected to a bar **168** (Figs. 1 and 8). For this purpose the pin **167** engages through a slot **169** of the plate **103**. Bar **168** is provided with a longitudinal slot **170** into which extends a pin **171** attached to the wall **103** (Fig. 8). The left end **370** of the bar **168** extends within range of a

pin 311 (Fig. 1) which is on a lever plate 372. The latter is journalled by a pin 373 to the frame of the adding machine and provided with an extended finger 374 which engages over a pin 375 provided on the rod 312 of the motor key 311.

The pin 387 serving as a support for the spring 161 extends into the plane of movement of the angularly bent end of the lever 160. The pin 387 is attached to the end of a double armed lever 388 (Fig. 1) which is journaled by pin 389 on the frame plate 103. Lever 388 has a cam-like end 390 extending into the range of movement of a lever 207.

Pivoted to the frame plate 103, at pivot 391, (Fig. 6) is a V-shaped plate 392 to which, at 393, there is secured a traction spring 394 which tends to swing the plate in the direction of the arrow in Fig. 6. One end 395 of the plate 392 extends within range of a pin 396 provided on a pawl 214. The other free end 897 of the plate 392 extends into the range of movement of a pin 398 which is attached to one end of the bellcrank lever 399, which is carried by the main shaft 323 of the adding machine and in every oscillation swings from the initial position shown in Fig. 6 in the direction of the arrow and back.

The step by step actuation of ratchet wheel

Attached to shaft 323 is also a lever 400 at the free end of which, at pivot 401, there is secured a connecting rod 402 which is pivoted at the other end on the pin 403. Pin 403 is attached to a lever 405 which is oscillatably journaled by pin 406 on the plate 103. Provided also at the end of lever 405 is a pin 407 which engages through a corresponding slot of the supporting plate and extends within range of an arm 177 provided on a slide 174. The latter is longitudinally slidable on plate 103 and for this purpose is provided with longitudinal slots 175 through which the screws 176 attached to the wall 103 project. Journaled on the bar 174 by pin 179 is a lever-like plate 180, at one end of which, at 181, there engages a traction spring 182 and the other end of the spring is attached, at 183, to the bar 174. The lever-like plate 180 is provided with a rectangular bent extension 184 which extends through a recess 185 provided in plate 103 within range of ratchet shifting wheel 121 (see Figs. 6 and 13).

Plate 174 is provided with a downwardly extending projection 188 (see Figs. 6 and 13) cooperating with the projection 187 of a sliding plate 188. The sliding plate is longitudinally guided by means of two slots 189 provided therein through which extend two pins 190 attached to the plate 103. The traction spring 191 engaged with plate 188 tends to move the plate to the right as shown in Fig. 6. Provided on the plate 188 is a pin 192 which extends into the plane of an abutting surface 193 provided on lever 180.

Pivoted to bar 160 by pin 215 is the pawl 214, with which the torsion spring 216 engages and which tends to apply the angular projection 217 of pawl 214 against the upper edge of the bar 168. (Figs. 6 and 8).

The carriage shift control

Coordinated with bar 168 is a sliding plate 365 which is provided with longitudinal slots 367 and 388. Engaging through the slot 367 is the screw pin 366 attached to the plate 103. Engaging through the other slot 366 is the pin 206, which is attached to a lever 207 and the lever 207 is journaled on a pin 206 attached to plate 103. The sliding plate 365 is provided with a shoulder-like projection 369 which cooperates with the correspondingly formed projection 395 of the pawl 214.

Means for aligning and disaligning recesses

Considering the case in which, through shortened multiplication in the immediately preceding decimal position, the next decimal position is greater by the value "1" than the value of the number, two U-shaped bars 227 and 228 are longitudinally slidably positioned (see Fig. 17) in the tube 107. These bars have recesses 229 corresponding to the recesses 118 in tube 107. Attached to each bar is a pin 230 (Fig. 7) which extends through a slot 231 provided in each side wall of the tube 107. Engaged with each pin is a traction spring 232, fastened at the other end, at 233, to the tube 107. The springs 232 thus tend to move the U-shaped bars 227 and 228 relative to the tube 107, in such direction that the pins 230 are applied against the right ends of the slots 231. In this position of the bars 227 and 228 relative to the tube 107, the operative edges of the recesses 118 are in operative relation to the window-like recesses 229 of the bars 227 and 228. These latter, however, as explained hereinafter, can, also, alternatively assume another position in which the corresponding edges of the window-like recesses 229 project forwardly of the edges of the window-like recesses 118, for a certain distance. This distance corresponds to the precedingly mentioned distance x, which at the same time represents a one step movement of the ratchet shifting wheel 121.

This alternative position is produced by a double armed lever 234 journaled on bar 227 by means of the screw pin 235 while the lever 237 is likewise rotatably attached by a screw pin 235 to the bar 228. The levers 234 and 237 are provided with hook-shaped projections 238 which alternately engage with corresponding recesses 239 provided on the tube 107. In the initial position according to Figs. 1 and 7 the hook-shaped projection 238 of the lever 234 lies in the coordinated recess 239, while the lever 237 is swung out so that its hook-shaped projection 239 is raised out of the range of its cooperating recess 239.

The bars 227 and 228 are returned from the position shown in Fig. 12 to that shown in Fig. 7 by striking an abutment 288' carried by the bracket 289 secured to a plate 245 by the screw 302. See Fig. 19. Therefore, when the tube 107 assumes its initial position shown in Figs. 1 or 7, the abutment 209' moves the bars 227 and 228 to their initial position.

Torsion springs 235' (see Fig. 19) urge the projections 238 of the levers 234 and 237 into the corresponding recesses 239 of the tube 107 provided their own weight is not sufficient to do so.

Setting control

The levers 234 and 237 are provided with extensions 240 which extend obliquely downwardly and into the range of the pin-like abutments 241 and 242. The abutment 241 is attached to the angular extension of a bar 243, while the abutment 242 is attached to the angular extension of a bar 244 (see Fig. 9). Bars 243 and 244 are vertically slidable on a plate 245 attached at right angles to the plate 103. For this purpose, screws 248 attached to bars 243 and 244 engage through slots 247 provided in plate 245. See Fig. 16. Journaled between the two bars 243 and 244, at pivot 249, is a double armed lever 248 having the pins 250 which engage the bars 243 and 244.

The pins **250** project through the elongated recesses **251** provided in the plate **245**. By means of this lever **248** the two bars **243** and **244** are positively interconnected so that when the one is moved downwardly the other is moved upwardly correspondingly. Lever **248** is held at both end positions. For this purpose, the pointed end **252** of the lever **248** cooperates with the gable-shaped extension **253** provided on a lever **254**. The lever **254** is journaled by pin **255** on the plate **245** and is subjected to the traction of a spring **256**.

Each bar **243** and **244** is provided with a recess **257**. Extending into the recess **257** of the bar **243** is one arm **256** of a bellcrank lever having another arm **259**. The bellcrank lever **256**, **259** is connected with the lever **130** (Fig. 11). Engaging in the recess **257** of the bar **244** is an arm **260** of a similar bellcrank lever having another arm **261** and the bellcrank lever is connected to the lever **135**.

As the lower ends of the key slides **98** extend into the range of the bars **122** and **123**, on pressing a key **97** the lower end of the corresponding key slide contacts with the bar **122** or **123** and carries it into the position shown in Fig. 10 or Fig. 11. This causes the lever **142** to be swung downwardly and through the action of the pawls **146** and **111** releases the lock of the tube **107** and such tube can snap into a position determined by the particular cross extension **106**.

Means for securing one decimal advance

Since, in certain cases, on pressing the key "0" and the key "9" (such as when on pressing the "0" key, when shortened multiplication was not used in computing the preceding decimal position, and on pressing the "9" key when shortened multiplication was used relative to the preceding decimal position) an advance is to be made for one decimal position, the following arrangement is provided.

The bars **122** and **123** (see also Figs. 15 and 18) are provided, in the range of the slides carrying the "0" and "9" keys, with bent portions **262**, so that the key slides can pass by the bars **122** and **123** freely. Disposed in the range of these two key slides for the keys "0" and "9" are the double armed levers **263** and **264** (see also Fig. 14).

These two levers are journaled by means of pins **265** on a plate **266** which is journaled by means of a pin **267** on a sliding plate **268**. The two end positions of the plate **266** are determined by a pin **269** mounted on the sliding plate **268** and this pin **269** extends into a rectangular recess **270** of the plate **266**.

The sliding plate **268** is vertically slidable on a plate **272** attached by screws **271** to the plate **101** (see also Figs. 7, 13). For this purpose, the screws **273** attached to sliding plate **268** extend through corresponding slot-like recesses **274** provided in plate **272**. Extending also through the lower guide slot **274** is the pin **275** attached to the slide **268**, with which pin **275** there is engaged a traction spring **276** which is attached at the other end to the pin **277** provided on the plate **272**. As shown in Figs. 7 and 14, the extension **279** on the lever **278** engages under the sliding plate **260**. The lever **278** is connected with the above-mentioned lever arm **207** journaled on pivot **208**.

Connecting the free lower ends of the levers **263** and **264** is the common traction spring **307** which tends to apply the pins **280** attached to said levers against the lower edge of plate **266** (see Fig. 15). The upper ends of levers **263** and **264** are provided with shoulders **281** which extend alternately within the range of the key slides coordinated therewith. In the position shown in Fig. 14, which corresponds to the initial position according to Figs. 1 and 7, the shoulder **261** of the lever **263** is in the range of the key slide 98 carrying the "0" key.

Plate **266** is provided on both sides, in the manner shown in Figs. 14 and 15, with projecting inclined surfaces **303**. When the plate **266** is in the position shown in Fig. 14 and the bar **122** is moved downwardly then such bar moves freely over the corresponding edge **303**. On the other hand, if bar **123** is moved downwardly, it comes into engagement with the oppositely projecting surface **303** and oscillates the plate **266** into the position shown in Fig. 15. It is to be noted, in this regard, that the plate **266** is frictionally mounted on the sliding plate **268** in such manner that the plate **268** remains in the position to which it is brought by the bar **123**.

When the plate **266** is in the position shown in Fig. 15 and upon a further operation, the bar **123** is moved downwardly, such bar moves freely over the juxtaposed surface **303**. On the other hand if, in this position of the plate **266**, the bar **122** is moved downwardly, the plate **266** is swung back into the position shown in Fig. 14. It is clear from this, that the position, at any time, of plate **266** depends upon which of the two bars **122** or **123** was last moved downwardly. However, it depends upon the particular position of plate **268** whether the shoulder **281** of lever **263** is moved within range of the stem carrying the "0" key or whether the shoulder **281** of lever **264** lies within range of the "9" key stem.

Therefore, if the bar **122** was last depressed, the members **266**, **263**, **264** will assume the position shown in Fig. 14, and if the bar **123** was last depressed, they will assume the position shown in Fig. 15. When the said parts are in the position shown in Fig. 14, then, if the "9" key is depressed, the sliding plate **268** is not moved. On the other hand, if the said parts (**266**, **263**, **264**) were in the position shown in Fig. 15, the plate **268** would be moved and when the "0" key is pressed, the plate **268** is not moved downwardly.

Provided on each of the bars **122** and **123** is a downwardly extending arm **291** (see Figs. 7 and 10) to which a double armed lever **293** is pivoted by means of the pin **292**. These levers **293** are provided at their upper ends with tongue-like extensions **284** and the bent portions **282** of bars **122** and **123** are slotted in the range of such extensions (see Figs. 10 and 11). Engaged with each lever **293** is a traction spring **295** attached at the other end, at **296**, to the bar **122** or **123** and which tends to draw the tongue-like extension out of the range of the coordinated key slide and apply the upper end of the lever **293** against an abutting pin **297** provided on each bar.

The lower free end of each lever **293** is provided with a pin **296**. These pins **296** extend into slots **298** provided at the ends of the two bars **300**. These two bars are connected at their other ends by pins **301** with the arms **259** or **261** of the bellcrank levers cooperating with recesses **257**. By means of these bars **300** and the members **257** to **261**, **243**, **244** and **248**, the levers **293** are so interconnected that only the tongue-like extension **294** of one lever **293** will always extend into the range of its cooperating key slide. In the initial position of Fig. 1 the tongue-like extension **294** coordinated with the key "0" would thus be carried out of range of the corresponding key slide, while the other tongue-like extension **294** extends in

the range of the corresponding key slide of the key "9".

Pivoted on the pin 206 of lever arm 207 is a control bar 378 (Fig. 1) which, at the other end, is connected by a pin 377 with a lever arm 378. The latter is mounted freely rotatable on a shaft 380 journaled in a frame extension 379. Attached to the shaft 380 is a plate 381 which is engaged by a traction spring 382 attached at the other end, to pin 383, on the lever 378. This traction spring tends to apply the shoulder 384 of the plate 381 against the pin 383. A lever arm 385 is also attached on the shaft 380 and has a pin 386 extending into the plane of the extension 361 provided on the key lever 359.

Control of reversing mechanism

The reversing or shifting of the calculating mechanism, that is, its positive or negative, or additive or subtractive, connection with the rods 330, is initiated by the two slides 243 and 244 arranged on the wall 245 connected to the plate 103. These slides are controlled by the bellcrank arms 258 and 260. For this purpose, there is coordinated with the slides 243 and 244, a setting plate 408 (Fig. 16) which is pivoted by means of the pin 409 to the double armed lever 410. Lever 410 is journaled on the pivot pin 411 secured to plate 412 which is connected to plate 103.

The setting plate 408 is provided with two slot-like recesses 413 and 414 which open into two V-shaped openings. The pins 250 on the slides 243 and 244 are so constructed that they project with their ends into the range of movement of plate 408. If the plate 408 is in the position shown in Fig. 16, the coordinated pin 250 has passed into the recess 413. Inasmuch as the rods 243 and 244 are still in the initial position, lever 418 is in the position shown in Fig. 16. The end of a lever 418 (see also Fig. 1*a*) journaled at 415 on the machine frame contacts the free end of lever 410. Attached to lever 416, by rivets or the like 417, is an arm 418 having a bent end 419 which engages under the setting plate 356.

If, now, the slides 243 and 244 are shifted from the initial position according to Fig. 16, which takes place for example when one of the keys "5"–"9" is depressed, the slide 243 is moved downwardly and the slide 244 upwardly, and at the same time lever 410 is swung by the plate 408 so that the lever 410 causes the lever 416 to swing out in the direction of the arrow in Fig. 1, that is, raises. The setting plate 356 is thereby raised to such extent that its shoulder 357 passes into the range of the pin 354.

If minus multiplications are desired it is only necessary, by means of the handle 420, to swing the plate 408 into the other end position, in which the pin 250 coordinated with the recess 414 is engaged. The handle 420 (Figs. 2 and 16) is mounted on a lever 421 journaled on pivot 422 on the frame bracket 289 and the forked end 423 of lever 421 engages the correspondingly reduced end 424 of the plate 408.

The operation

The operation is explained with reference to a calculating example:

$$12738 \times 26092$$

The multiplicand 12738 is first set up on the keyboard 301, beginning with the highest decade, thus the "1," then the "2," the "7," then the "3" and finally the "8," by depressing the corresponding keys 301'. Then, after the repeat key "R" has been actuated, beginning with the lowest digit, the multiplier is set up in the multiplier setting mechanism keys 97. The key designated "2" in the two key banks carried in plate 100 is next depressed.

By depressing key "2," the parts are carried into the position of Fig. 8 by contact of the slide 98 on the bar 122. Bar 122 contacts pin 141 and lever 142 is swung downwardly which, through the pawl 147, carries pawl 111 into the release position. The tube 107 is now moved by its spring 117 as far to the left as the cross extension 106 of the key slide associated with key "2" will permit. Since, in the initial position, the lever 234 is engaged with the notch 239 on tube 107, the U-shaped bar 227 is adjusted in tube 107 so that the edges of its window-like recesses 229 project beyond the corresponding edges of the window-like recesses 118.

Thus, as shown in Fig. 8, the corresponding cross extension 106 contacts with the edge of a window-like recess 229 of bar 227. The stroke or shifting space of tube 107 coordinated with key "2" is thus shortened one shift from three shift movements, so that the ratchet shifting wheel 121, as shown in Fig. 8, has been turned from the initial position in the direction of the arrow for two spaces or shift movements, corresponding to this adjustment.

Simultaneous with the downward movement of the bar 122 into the position shown in Fig. 8, bar 127 is carried downwardly due to its pivotal connection with bar 122. As the lever arm 130 is already positioned downwardly in the initial position, no movement takes place.

It is to be noted that in the initial position, the members 408, 409 and 410 are in the position shown by full lines in Fig. 16 and thus the setting plate 356 is in the position shown in Fig. 1*a*. At the same time however pin 110 has released the lateral extension 164 of lever 160 so that it engages by a shoulder 282 over the pin 141 of the downwardly swung lever 142. If the key "2" is thereupon released, so that its cross extension 106 may be applied against the upper limiting edge 283 of the window-like recess 118 on tube 107, then at the same time the bar 122, through the pull of a spring 284, will follow the slide 98 since the bar 122 remains engaged with the lower end of the slide. On the return of the bar 122 it releases the pin 141, so that lever 142 can likewise follow under the pull of the spring 144. The pin 141 then carries the lever 160 somewhat upwardly, so that the lever 157 on which the lever 160 is mounted, is swung into the dotted position shown in Fig. 8. The lever 157 then releases the plate 152, so that it swings the pawl 154 against the ratchet wheel 121, in the position shown in Fig. 8 in dotted lines.

During the swinging movement of the plate 152, the bar 168 is at the same time carried by means of pin 187 to the left in Fig. 8, into the dotted position. In this movement of the bar 188, its end 370 contacts the pin 371 of the plate 372 and swings it into the position shown in Fig. 8. In this movement, finger 374 of the plate 372 has moved the rod 312 of the motor key 311 downwardly. Through the downward movement of rod 312, the circuit of motor 473 is closed by means of the members 314, 317, 318, 468 and 471. The coupling 480 and 482 is also connected so that the shaft 323 is oscillated by means of the elements 484, 489, 492, 320 and 322.

In the counter-clockwise oscillation, in the direction of the arrow in Fig. 1, the pin 325 is

swung upwardly, so that the type carrying bars **330** are released. These are then set up according to the values of the multiplicand 12738 contained in the carriage **305**.

The oscillation of shaft **323** causes a corresponding oscillation of shaft **329** and this causes a reciprocation of setting plate **355**. As this plate, as above stated, is in the lower position, as shown in Fig. 1, the plate **353** is not reversed or shifted in this movement. On the downward return movement of bars **330**, the calculating mechanism gears **448** and **456** are swung in as described above, so that the value contained in the carriage is transferred once to the calculating mechanism by such gears.

In the oscillation of the shaft **323**, the link **402** swings the lever **405** in the direction of the arrow in Fig. 6 causing the pin **403** on the lever **405** to strike the extension **177** of the sliding bar **174** and move it to the right from the position shown in Fig. 6, against the traction of the spring **286** (Fig. 13) engaged therewith. In this movement of the bar **174** the shifting extension **184** contacts the ratchet shifting wheel **121**, which in the present case is in the position shown in Fig. 8, and rotates it clockwise back for one step.

After the shaft **323** has returned to its initial position, after an oscillation, the multiplicand 12738 has been transferred once into the calculating mechanism. In the following second oscillation of the main shaft **323**, the bar **174** is once more moved to the right so that the shifting extension **184** causes a second clockwise step rotation of the shifting wheel **121**.

Inasmuch as the shifting wheel has moved previously counter-clockwise for two shift movements, thus at the end of the second oscillation of the shaft **323**, the pin **287** on the shifting wheel **121** comes into range of a projection **290** provided on plate **152** and this plate **152** is swung into the initial position shown in Fig. 7.

By the return of the plate **152** into the initial position, the bar **168** is moved to the right back to its initial position and the pin **371** on the lever **372** is released so that the lever **372** may move to the position shown in Figs. 1 and 6. This breaks the electric motor circuit and disconnects the calculating mechanism drive. During the second oscillation of the main shaft **323** the multiplicand is carried a second time into the calculating mechanism.

It is to be noted that in the return movement of the bar **168** to the right, as shown in Fig. 6, the pawl **214** which, in the movement to the left of the bar **168**, has passed in front of the shoulder **369**, carries the slide plate **365** along in the direction of the arrow in Fig. 8. In this movement of the slide plate **365**, the lever **207** connected therewith by the pin **206** is swung out in the direction of the arrow in Fig. 6. In this outward swinging of the lever **207**, the lever **378** is swung to the right by the rod **376** and the spring **362** is placed under tension. Through this movement of the lever **378**, the plate **381** is given the tendency to swing to the right (see Fig. 1). The lever **385** by means of pin **386** is applied against the extension **361** of the lever **359**, which is thereby swung downwardly. This causes, however, by means of the associated rod **362** a movement of the carriage **305** for one decimal position in the direction of the arrow in Fig. 2.

It is also to be mentioned that, while the shaft **323** is oscillated the pin **398** on the lever **399** releases the corresponding arm of bellcrank lever **392**, so that the bellcrank lever may swing under the pull of the spring **384**. When, at the end of the second oscillation of shaft **323**, the pin **388** contacts with the corresponding arm of bellcrank lever **392**, the latter is again swung into the position shown in Fig. 6. It then engages under the pin **396** of pawl **214**, which is thereby raised into the position shown in Fig. 6. This causes the shoulder **369** of the slide **365** engaged by the pawl **214** to be released and the slide **365** can now snap back to the initial position shown in Fig. 6.

Entry of second decimal position of multiplier

The second decimal position of the multiplier is now to be entered. The "9" key of the multiplier keys **97** is depressed. It is to be noted that the lever **293** coordinated with the "9" key (Fig. 11) is swung so that its tongue-like extension **294** extends into the range of the key slide **88**. If the key "9" (see Fig. 11) is depressed now it contacts with the tongue-like extension **294** of the corresponding lever **293**. The key slide can thus not pass through the bent portion **262** but contacts with the corresponding tongue **294** and the bar **123** is forced downwardly. By means of the downward movement of the bar **123**, the lever **135** is swung downwardly therewith by means of the bar **128**, which, through the setting members **257—261**, **243**, **233**, and **248**, results in the shifting as shown in Fig. 11, in which at the downward end position of key "9" the lever **293** assumes the position shown in Fig. 11, and the tongue **294** coordinated with the key "9" is drawn out of the slot in the bent portion **262**, while the tongue coordinated with the unpressed key "0" is swung into its cooperating slot.

In the downward movement of the bar **123**, the lever **142** has been swung by means of the pin **141** and the pawl **111** is released. Tube **107** can thus pass to the left (Fig. 11) until the edge of the window-like recess **118** is applied against the cross extension **106** of the key slide. When the "9" key is pressed, the pawl **237** is raised out of notch **239** and through the corresponding spring **232** the U-shaped bar **226** is adjusted so that its window-like recesses **229** are aligned with the window-like recesses **116** of tube **107**. The tube **107** may thus move to the left for one shift, as is apparent from the position of the shifting wheel **121** in Fig. 11. When the key is released, in the same manner as above described, the plate **152** will snap into the dotted line position of Fig. 8 and through the bar **168**, the circuit of the motor is established and the calculating mechanism connected. The calculating mechanism then describes an oscillating movement of the main shaft **323**, while the multiplicand 12738 is carried negatively, that is subtracted, in the second decimal position by the calculating mechanism gears **448** and **456**.

It is to be noted that in the shifting of the rods **258** and **260**, the lever **410** was moved into the dotted line position of Fig. 16, thus causing the setting plate **356** to be raised, so that its shoulder **357** is in front of the pin **354**. At the beginning of the oscillating movement of the shaft **323** the plate **353** was carried into the dotted line position of Fig. 3 so that in the next movement of the calculating mechanism the reversing gears **456** are engaged with the racks **443**.

During said oscillation of the main shaft **323**, the bar **174** is moved once in the direction indicated in Fig. 6 in the manner above described, and the shifting wheel **121** describes a backward clockwise shifting movement, and is thereby carried to the initial position shown in Fig. 7. The

plate 152 is again swung back by means of pin 287 and the bar 168 is simultaneously also drawn to the right to the pisition shown in Fig. 1, so that the motor 473 and the coupling 480 and 482 are disconnected through the member 372.

Simultaneously with the return movement of the bar 168 to the right another shift movement of the carriage 305 is brought about by means of the pawl 214 and the plate 365, as above described.

Entry of third decimal position of multiplier

The third decimal position of the multiplier is now to be entered. The "0" is carried into the multiplier mechanism by pressing the corresponding multiplier key 97. See Fig. 10. Since shortened multiplication was done in the second decimal position, the tongue 294 is in the range of the key slide 88 coordinated with the key "0." If the "0" key 97 is depressed the lower end of the key slide 88 first contacts with the tongue 294 and a descending movement of the bar 122 is initiated. On further descent to the end position in Fig. 10 the lower edge of slide 98 slides along the upper edge of the bar 122.

Since, before depressing the "0" key, the abutment 241 was in the lower position, the coordinated pawl 234 was raised from the notch 239 of the tube 107, so that on release of the tube it can pass into the position shown in Fig. 10, wherein the cross extension 108 on the key slide is applied against the corresponding edge of the recess 110. As a result of pawl 234 having been raised, the bar 227 is moved in tube 107 so that the edges of the recesses are aligned. Shifting wheel 121 ean thus rotate for one step, as shown in Fig. 10.

Through the pressure on the "0" key, the bar 122 was carried downwardly and, by means of the bar 127, the lever 130 was shifted into the position of Fig. 10. This causes a shifting of the corresponding shift members 243 and 244 into the position according to Fig. 16. The lever 410 again passes into the position shown in Fig. 16 in full lines and the arm 418 has allowed the plate 356 to drop, so that its lower shoulder 358 is within range of the pin 355. During the following oscillation of shaft 323 the multiplicand 12738 is carried once, positively, into the calculating mechanism. During this oscillation (of the shaft 323), however, the shifting wheel, which previously was moved for one step from the initial position, is again returned to the initial position as shown in Fig. 7. Therefore the bar 168 is drawn back and the lever 372 released with a consequent breaking of the motor circuit and an uncoupling of the calculating mechanism. At the same time, however, by means of the pawl 214 and the plate 365, another shift step of the carriage 305 is brought about, so that the carriage is moved to the next higher decimal position.

Entry of fourth decimal position of multiplier

The fourth decimal position of the multiplier is now carried into the calculating machine by pressing the multiplier key 97 marked "6". On depressing the "6" key the lower end of the corresponding key slide 98 (Fig. 9) strikes against bar 123 and moves it downwardly. Tube 107 is thereby released in the manner previously described, so that it can pass to the left, until the coordinated cross extension 106 contacts with the corresponding edge of the window-like recess.

Since, on pressing the "0" key, the slides were shifted so that that designated 244 assumed the lower, and that designated 243, the upper position, the coordinated pawl 234, on depressing the "6" key, assumed the swung out position, so that its U-shaped bar 228 assumed the release position. The corresponding bar 228 could thus, through the traction of spring 232, be drawn back so that its window-like edges registered with the edges of the window-like recesses in tube 107. This means, however, as shown in Fig. 9, that the tube 107 can move to such an extent that the shifting wheel 121 may describe four shift steps to bring pin 287 into action.

It is also to be noted that, by pressing on the bar 123 and actuating the bar 128, the levers 135 and 130 are carried into the position of Fig. 9. This causes the lever 410 to be shifted into the dotted line position of Fig. 16 through the action of the setting members 243 and 244. The setting plate 358 is thus swung by the arm 418 into the upper position in which its shoulder 357 comes in front of the pin 354.

In the consequent four oscillations of the main shaft 323 (corresponding to the four shifts of the wheel 121) the multiplicand 12738 is subtracted four times at the corresponding decimal position by the calculating mechanism gears 448 and 456. During the fourth oscillation of the shaft 323 the shifting wheel reaches its initial position as shown in Fig. 7 and the shift bar 168 is again moved to the right into its initial position. This, in turn, results in the disconnection of the electric motor 473 and the clutch 480, 482. In the return of bar 168, the carriage 305 is shifted a step by means of the pawl 214 and the plate 365.

Entry of fifth decimal position of multiplier

If, now, the multiplier key 97 marked "2" is pressed for the fifth decimal position of the multiplier, the position shown in Fig. 12 is assumed. As the pawl 234 coordinated with bar 227 is in the raised position, tube 107, in contrast to the position according to Fig. 8, can move to the left for three shift steps. The main shaft will, therefore, describe three oscillations before the bar 168 is moved to the right and the lever 372 is swung to disconnect the motor 473 and the coupling 480, 482. As the bar 127 is carried downwardly on depressing the multiplier key 97 marked "2", the levers 130 and 135 are shifted so that the lever 410 again assumes the position shown in Fig. 16 in full lines. Arm 418 thus releases the setting plate 356, so that its shoulder 358 can come in front of pin 355. In the first rotary movement of main shaft 323 the calculating mechanism gears 448, 456 are carried into the plus or positive position, so that during the three oscillations of shaft 323 the multiplicand is carried three times into the corresponding next highest decimal position, positively.

The calculation is then terminated and the calculating mechanism contains the result

332, 359, 898

By actuating the keys 308 or 309 this result can be transferred to the type bars and printed on the strip 341.

The adding machine has thus done the following: first, the multiplicand 12738 was carried twice, positively, into the calculating mechanism. After a shift advance of the carriage 305 into the next higher decimal position the multiplicand was introduced once into the calculating mechanism subtractively. After a further shift movement of the carriage into the next higher decimal position the multiplicand was transferred positively into the calculating mechanism. This done,

the carriage made a further shift movement into the next higher decimal position, in which the multiplicand was then introduced four times into the calculating mechanism. Finally, after another shift movement of carriage **305** into the next higher decimal position the multiplicand was added three times in the calculating mechanism. The calculation was thereby terminated and it was completed with eleven oscillations of the main shaft **323**.

In the calculating example here involved the multiplier figure last keyed is a "2". For this the machine operates normally, that is, not with short cut multiplication. In order to prevent incorrect calculation when the highest multiplier figure is above 4, it is necessary then to depress the multiplier key designated "0". In order to avoid error, it is preferable for the operator, always at the termination of the calculation, that is, after he has fully keyed the multiplier, to depress the zero multiplier key.

It is to be understood that the invention above described is not limited to "Astra" machines and may be embodied in other makes of adding machines and is capable of various modifications.

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