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A. F. POTT

Serial No. 301,289

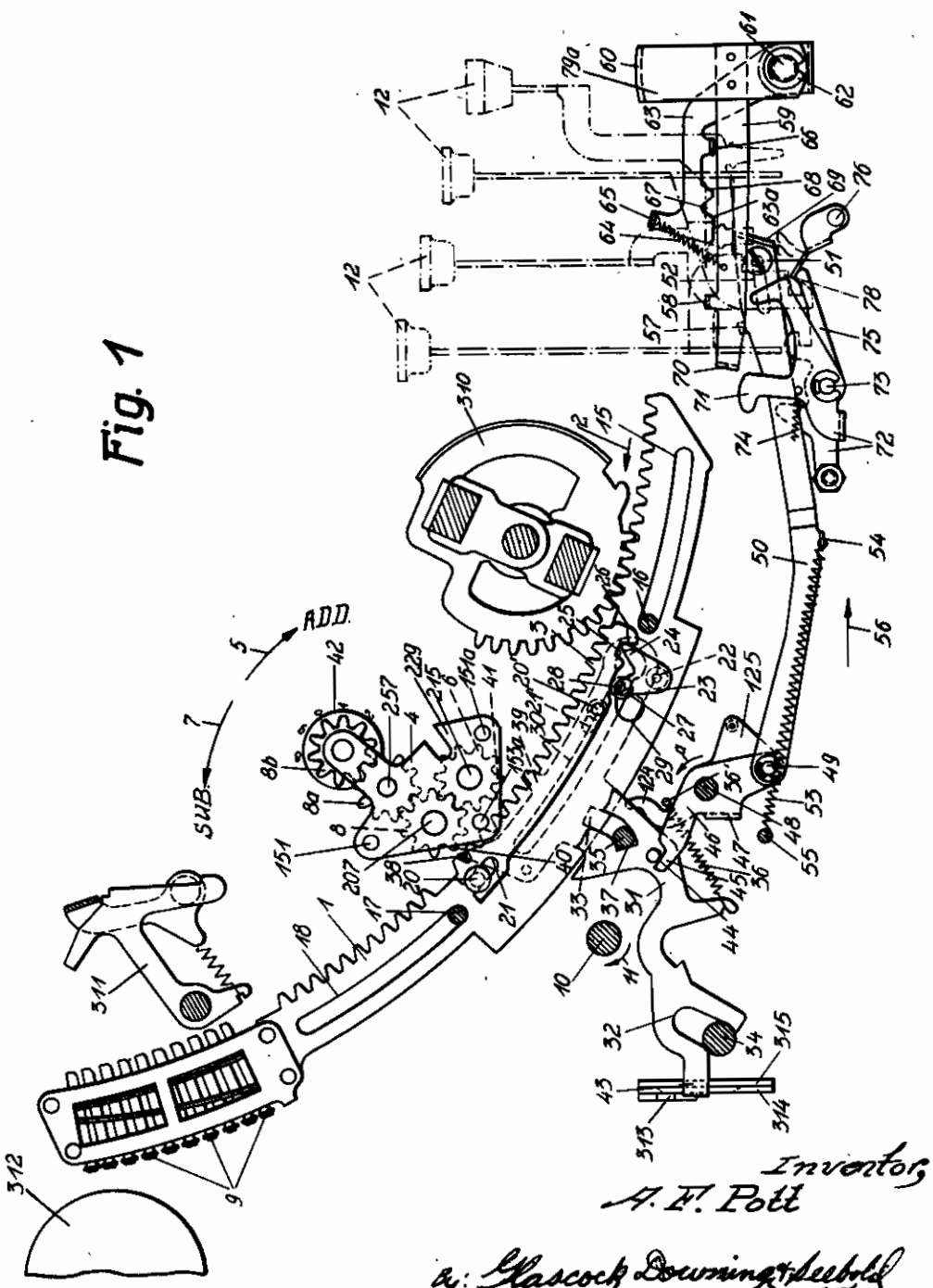
CONTROLLING MECHANISM FOR ACCOUNTING MACHINES

BY A. P. C.

Filed Oct. 25, 1939

15 Sheets-Sheet 1

Fig. 1



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15 Sheets-Sheet 2

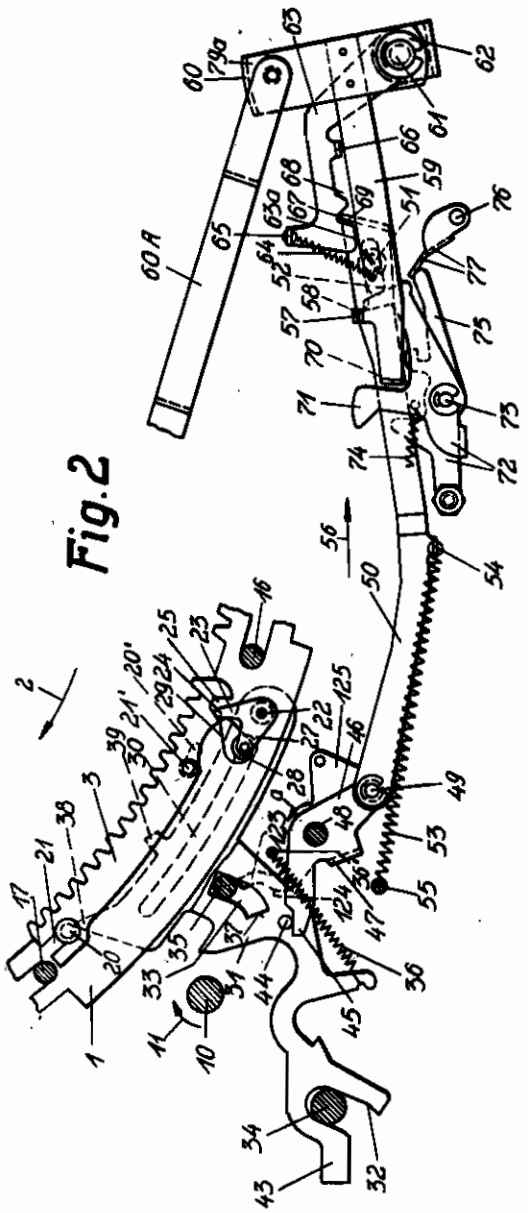

Fig. 2

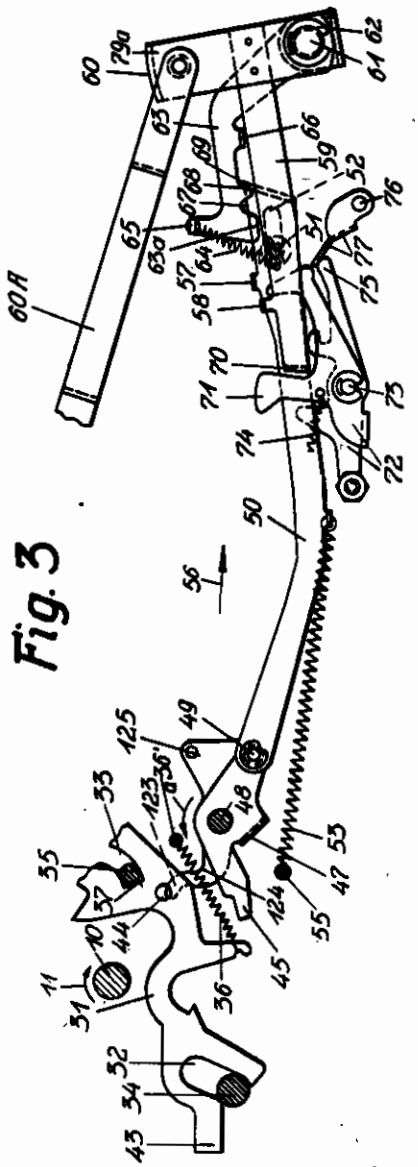

Fig. 3

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BY A. P. C. Filed Oct. 25, 1939 15 Sheets-Sheet 3

Fig. 4

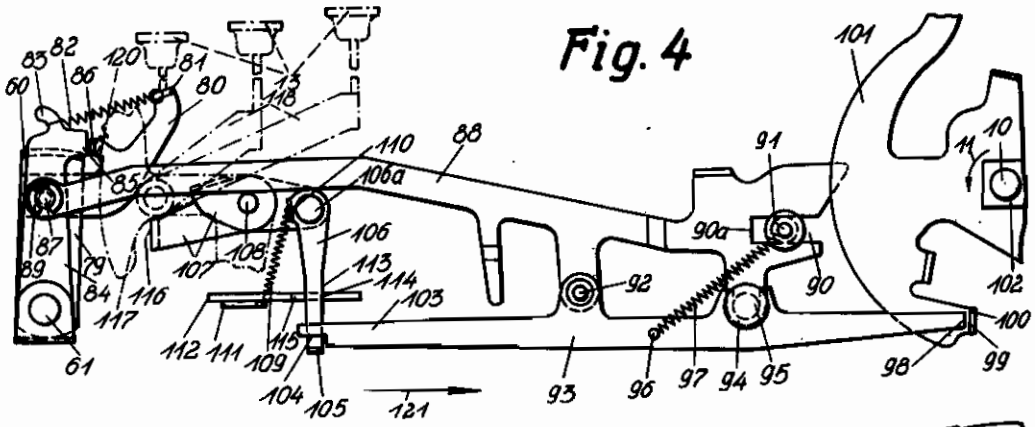

Fig. 5

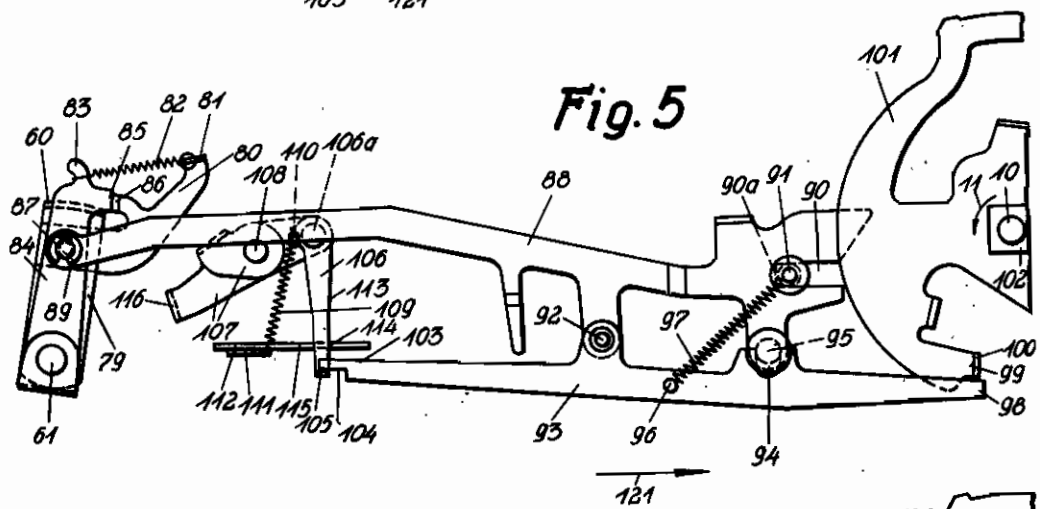

Fig. 6

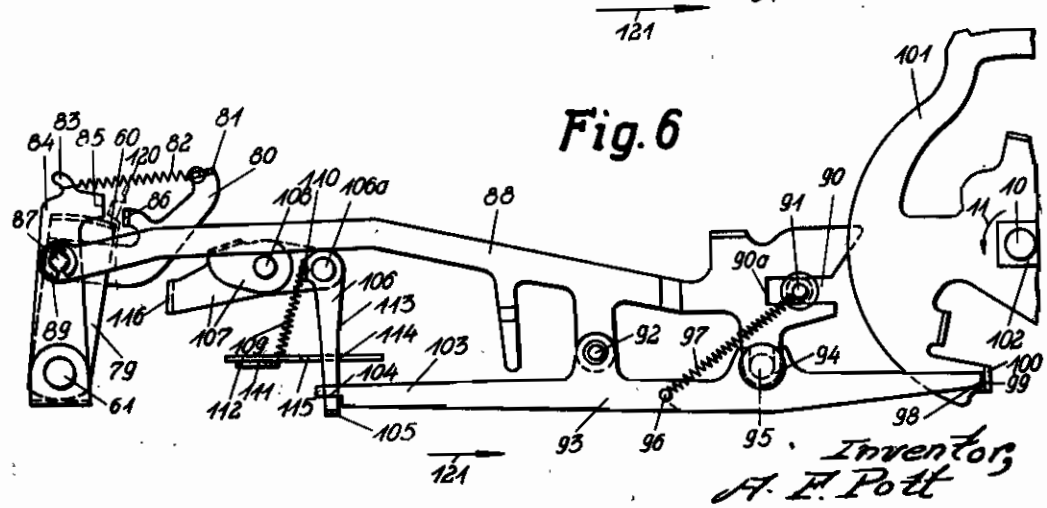

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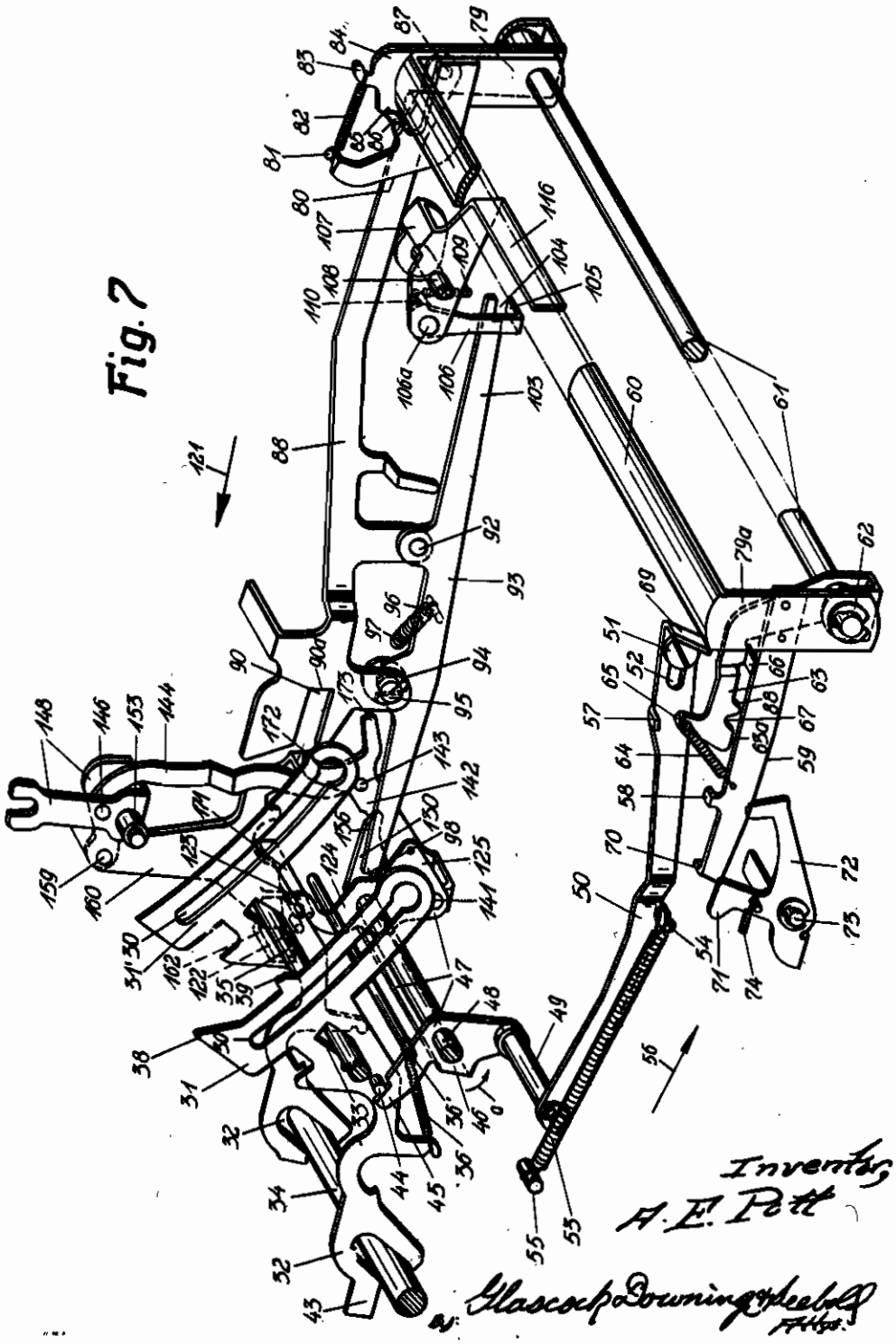
Fig. 7



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CONTROLLING MECHANISM FOR ACCOUNTING MACHINES

Fig. 8

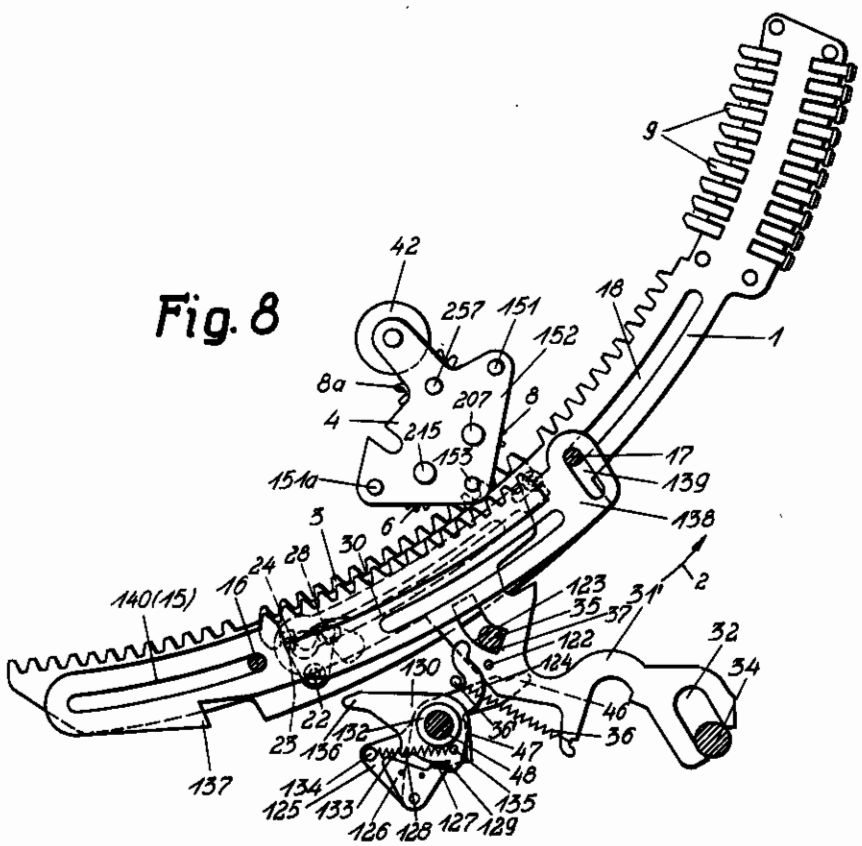

Fig. 9

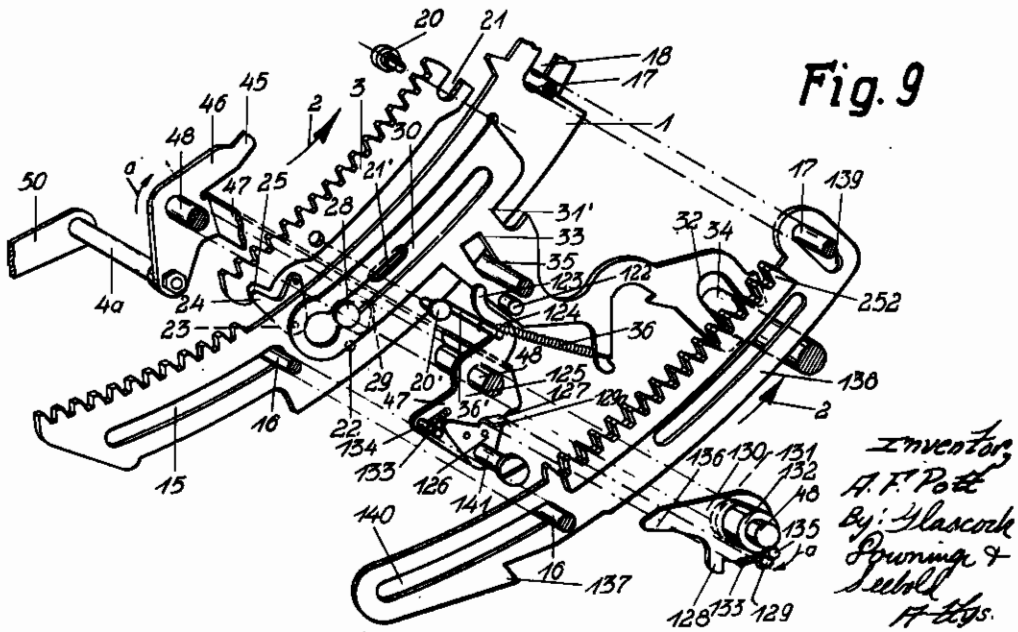

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Fig. 10

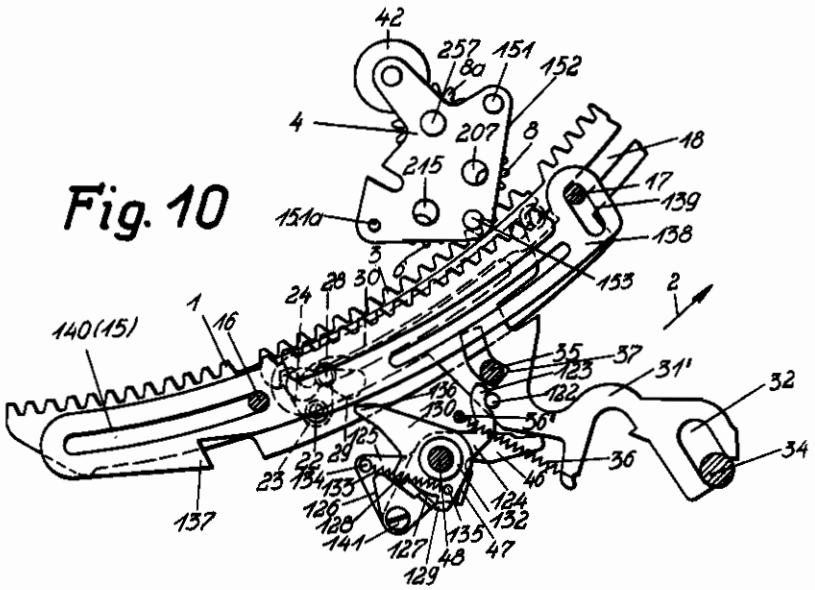

Fig. 11

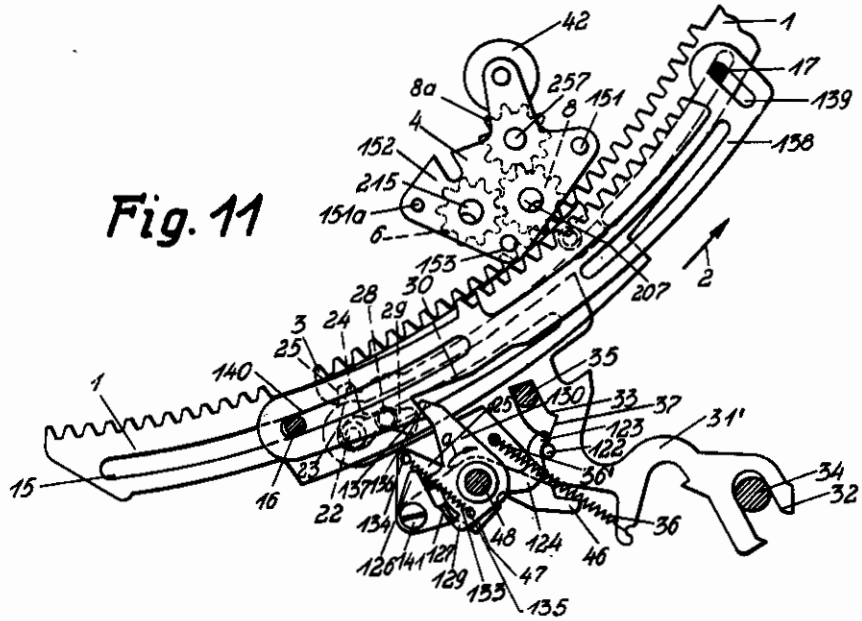

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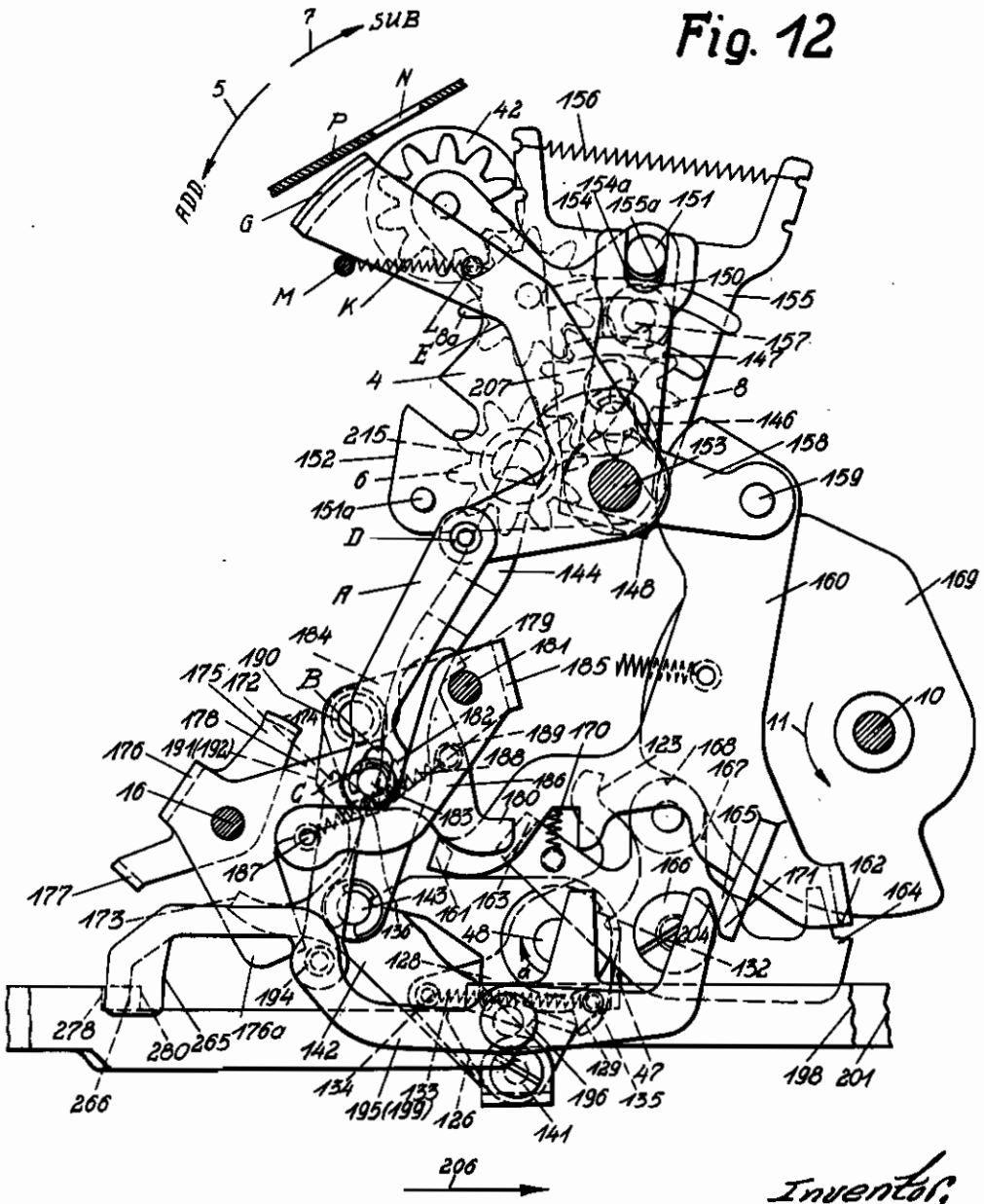
Fig. 12



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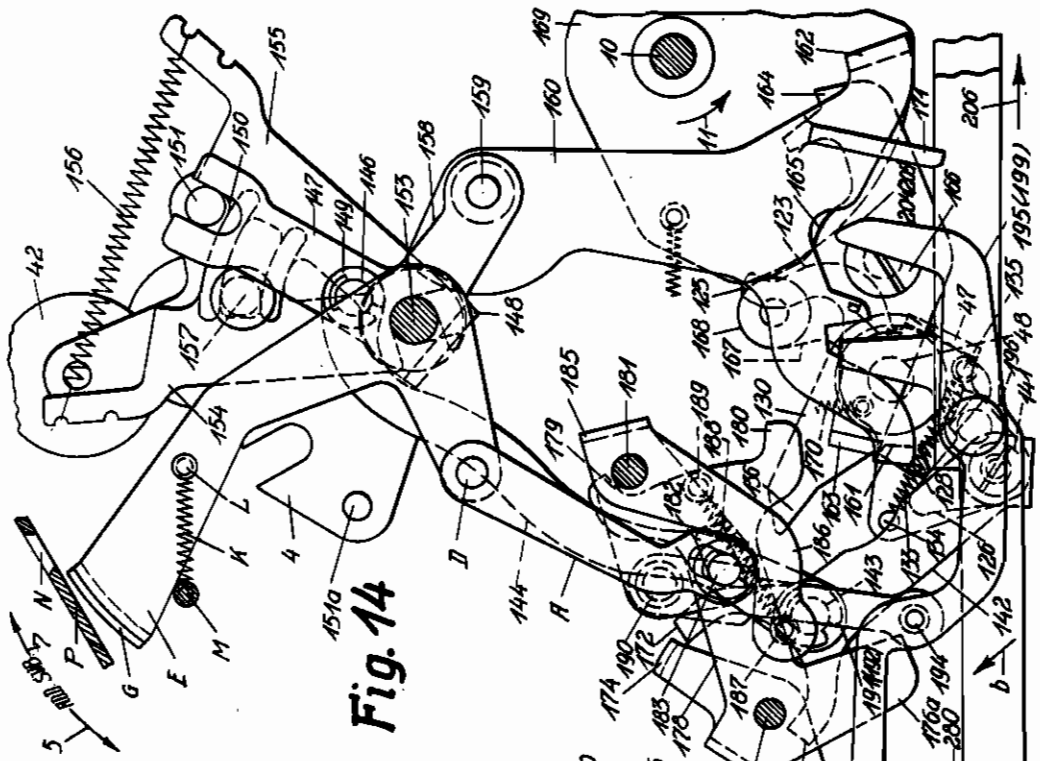

Fig. 14

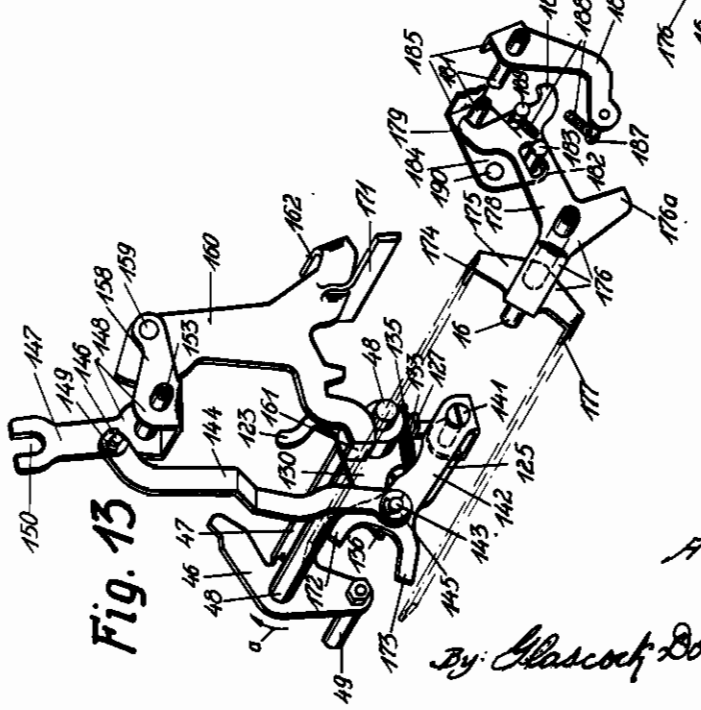

Fig. 13

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Fig. 15

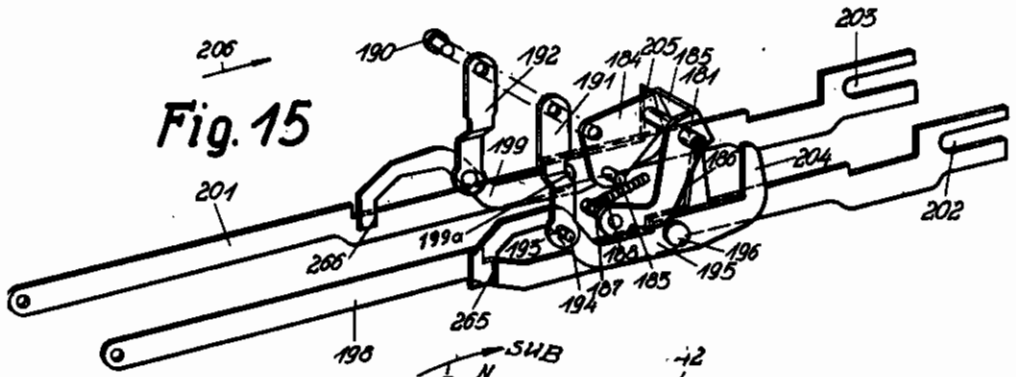

Fig. 16

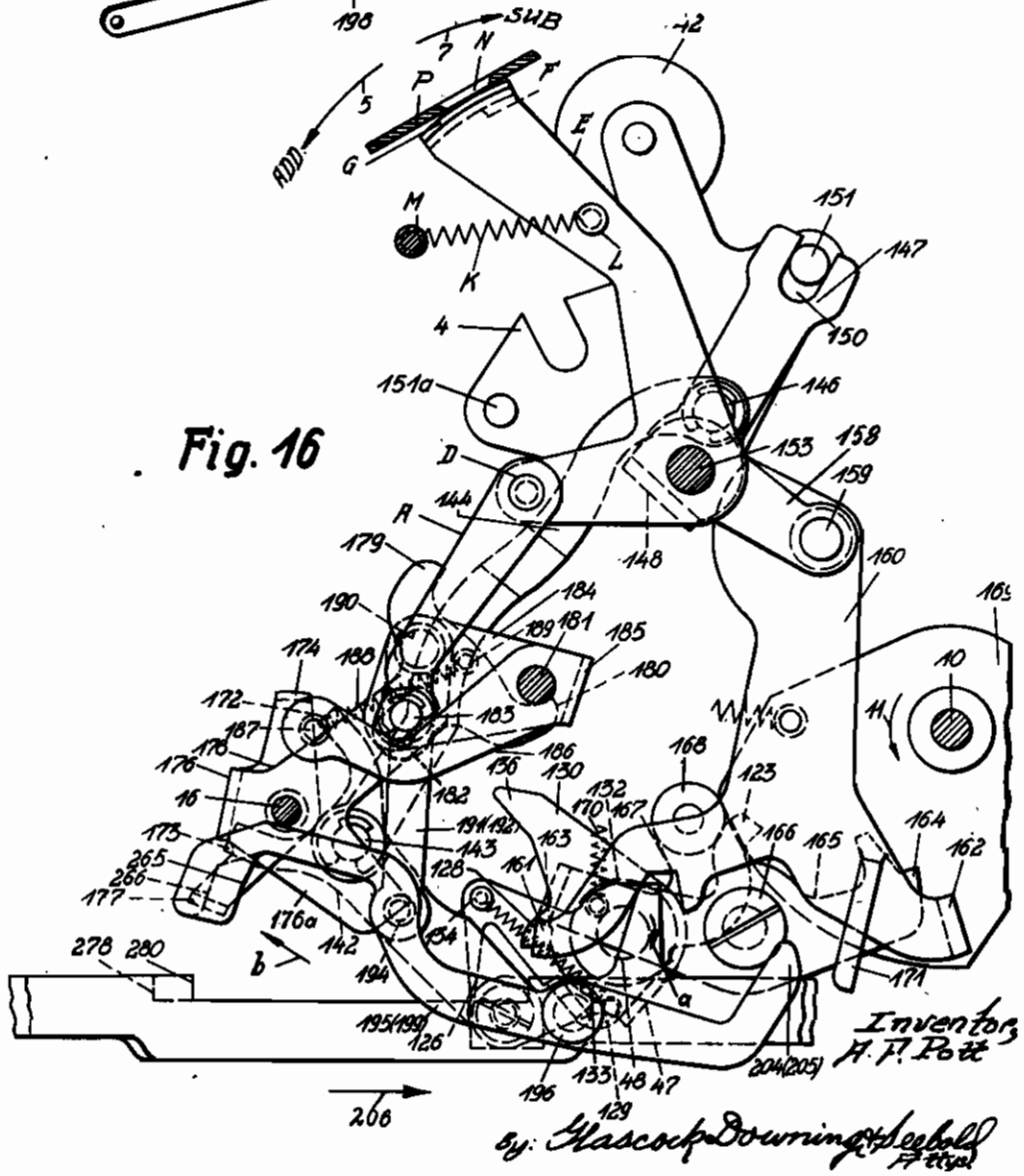

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Fig. 17

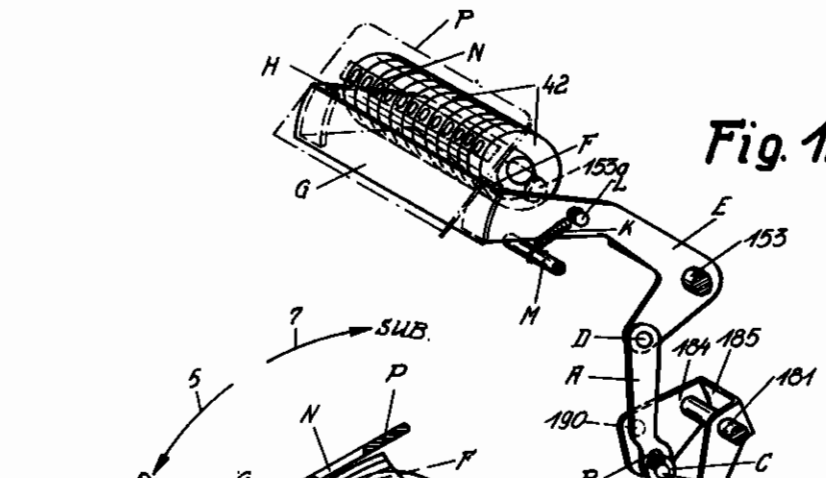

Fig. 18

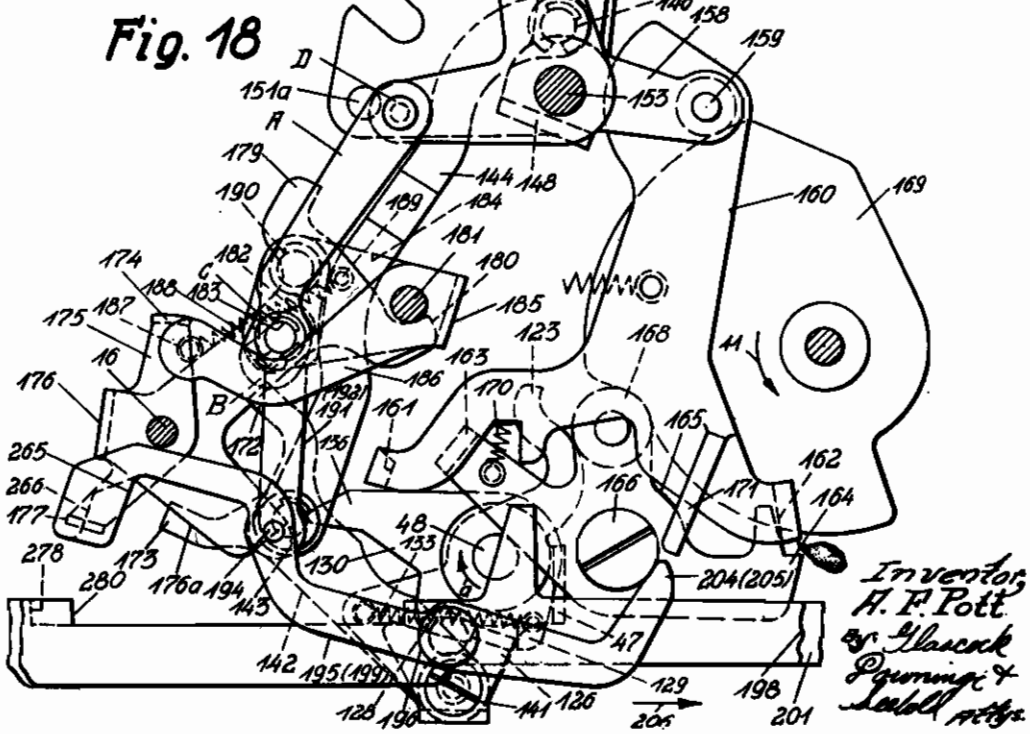

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Fig. 19

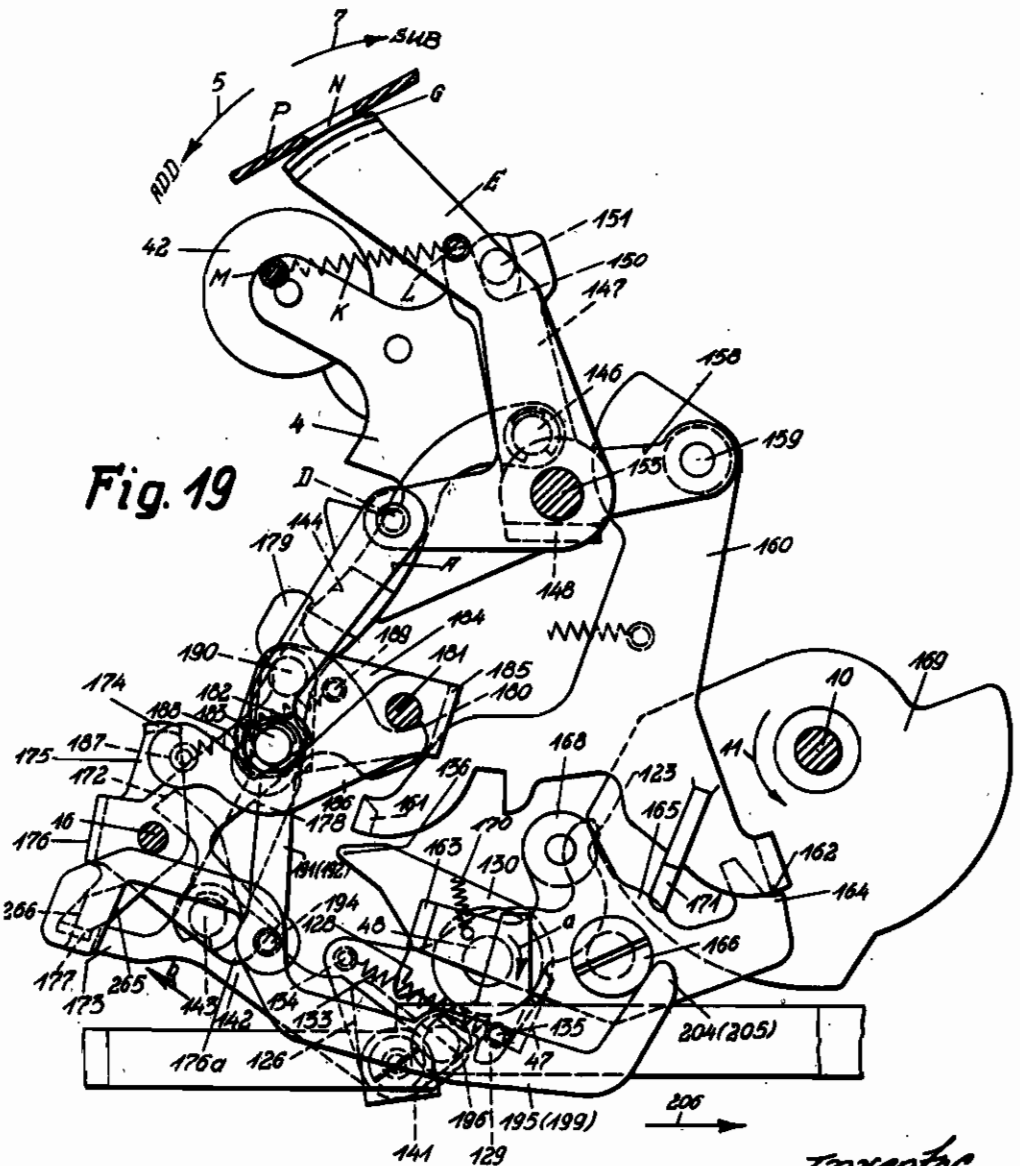

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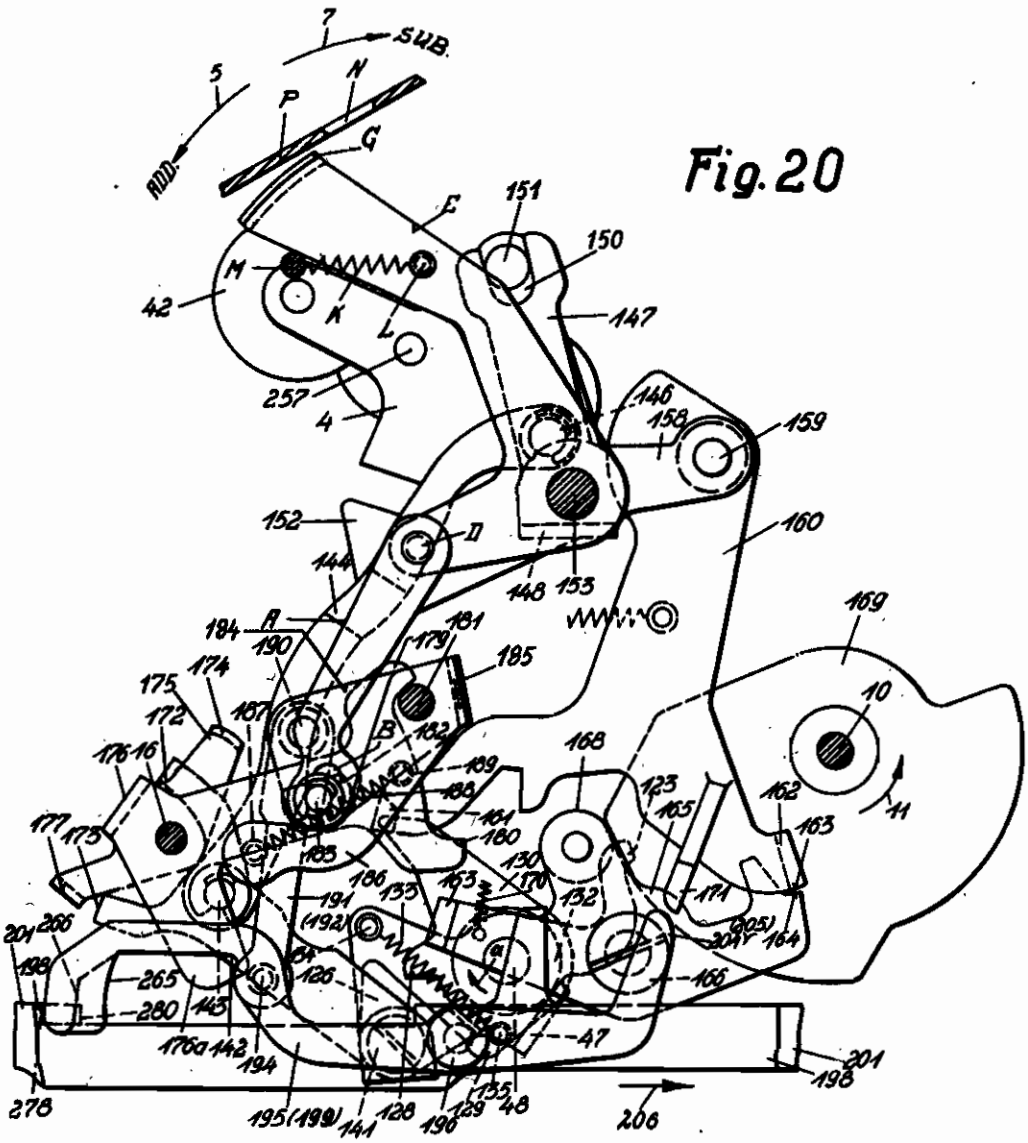
Fig. 20



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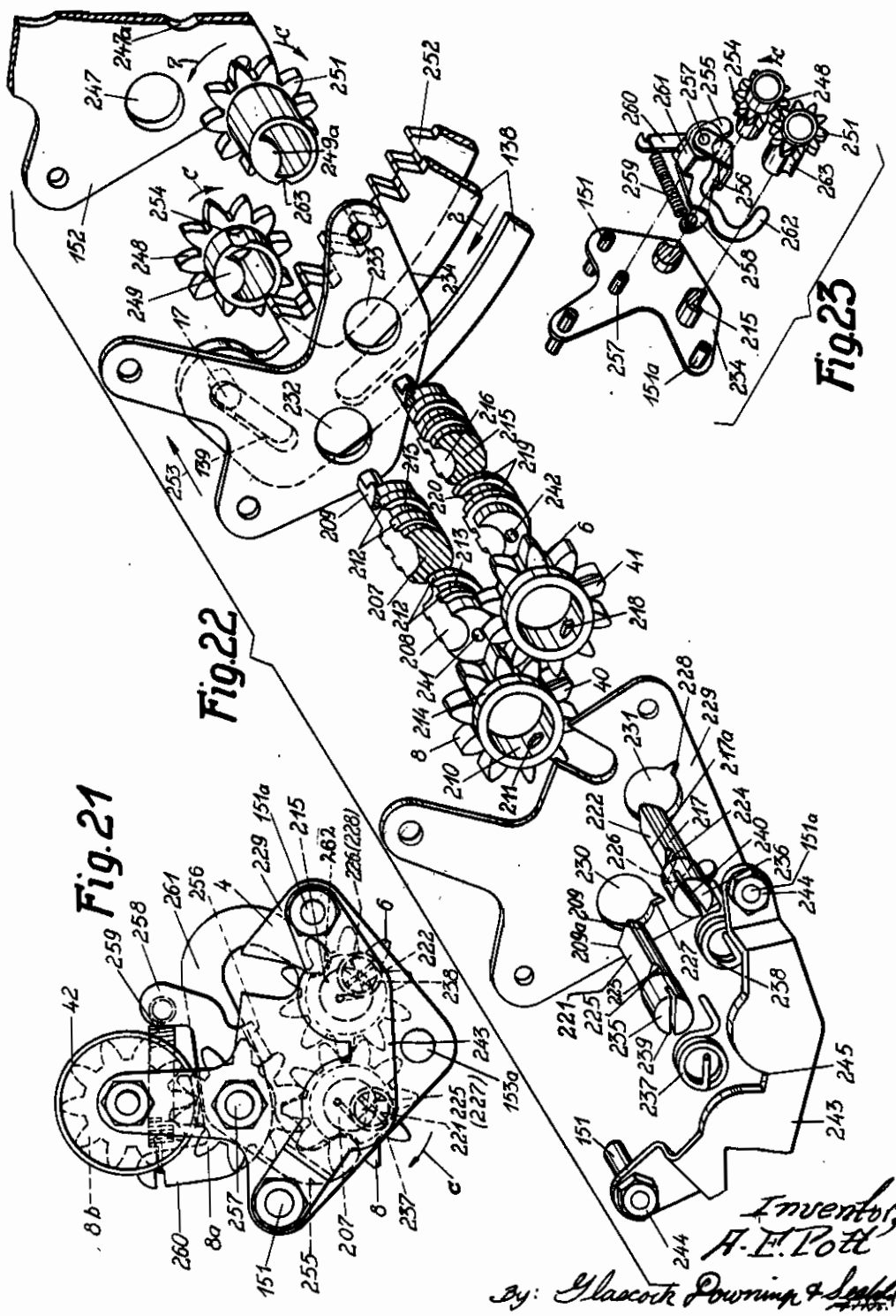

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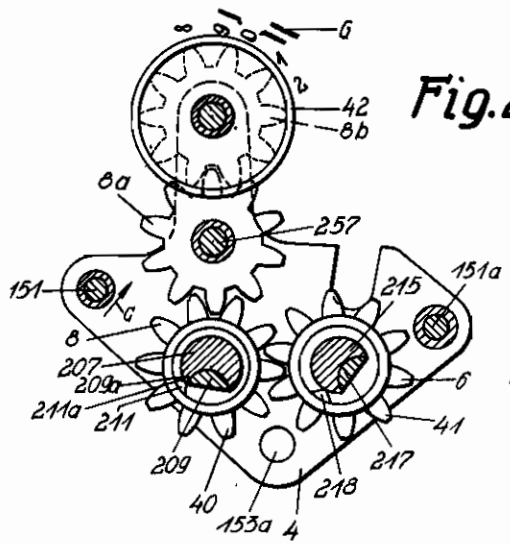


Fig.24

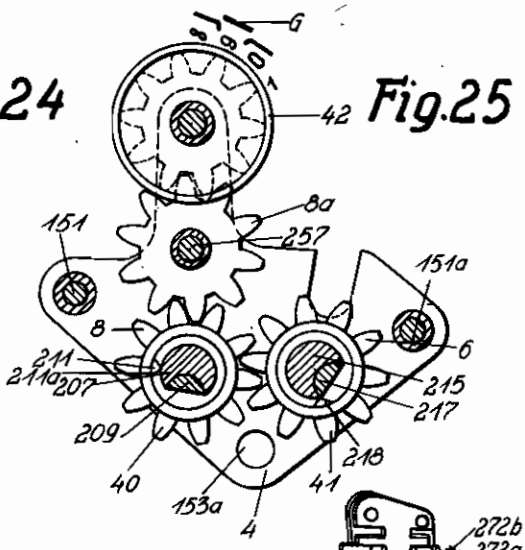


Fig.25

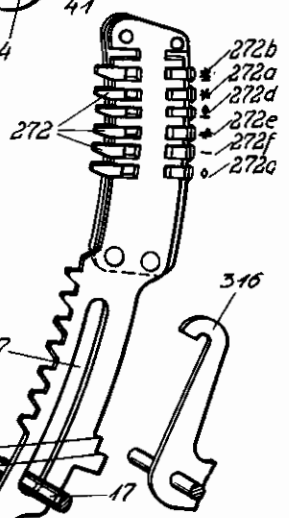
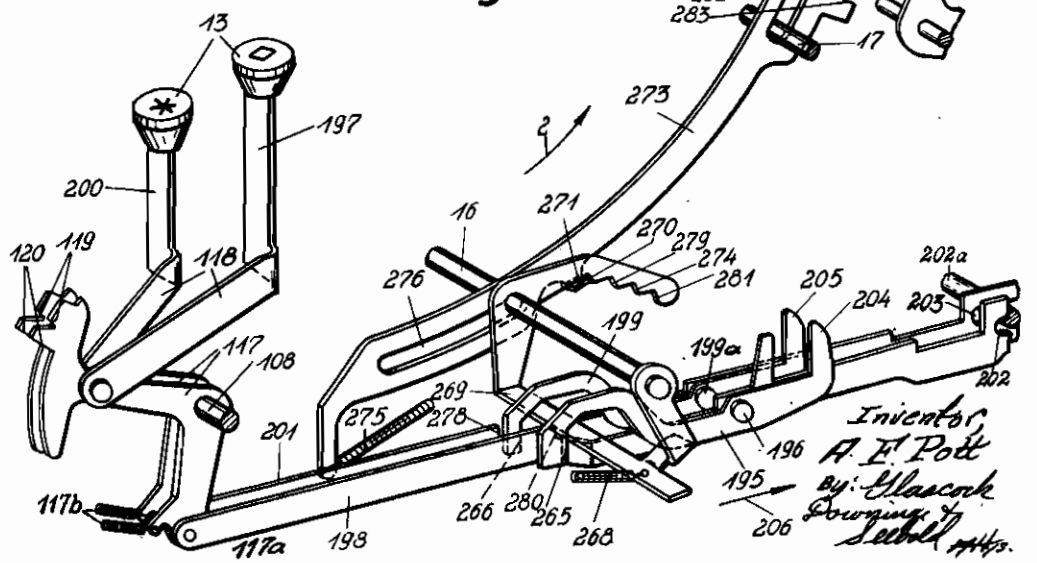


Fig.26



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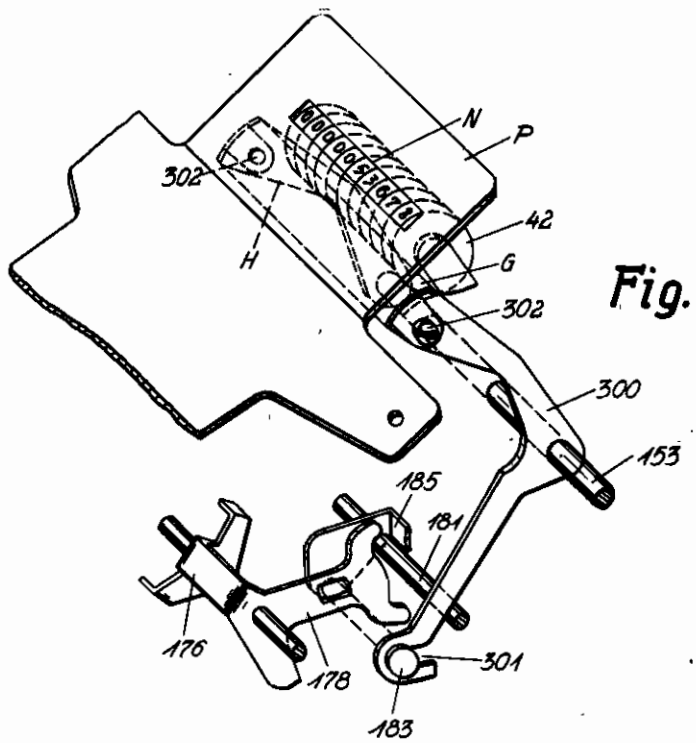

Fig. 27

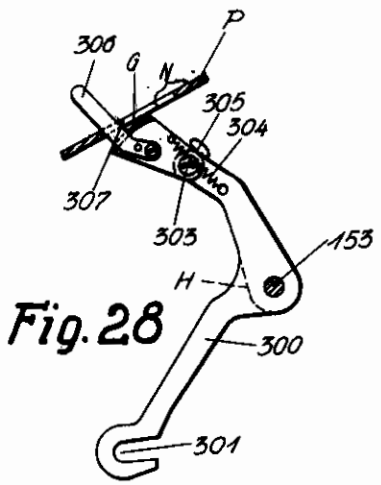

Fig. 28

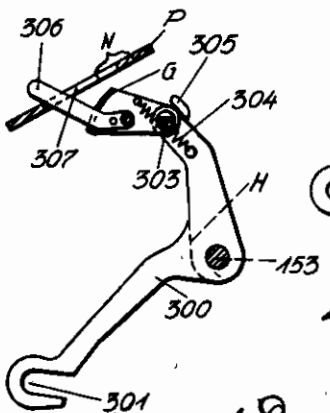

Fig. 30

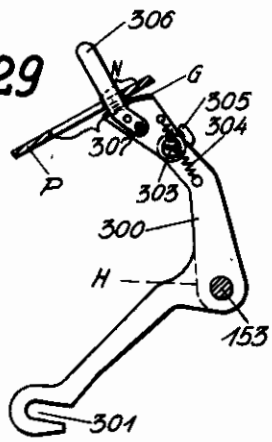

Fig. 29

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ALIEN PROPERTY CUSTODIAN

CONTROLLING MECHANISM FOR ACCOUNTING MACHINES

August Friedrich Pott, Zella-Mehlis, Germany; vested in the Alien Property Custodian

Application filed October 25, 1939

This invention relates to a controlling mechanism for accounting machines which is especially suitable for, but not limited to, adding machines equipped with a printing mechanism for settling accounts.

Controlling mechanisms for such machines have already become known but were all more or less complicated.

This drawback is eliminated according to the invention by arranging the controlling mechanism to be operated automatically in dependence of the species of calculation and of a tens-shift member allotted to the highest place, when the capacity of the totalizer is overstepped. This operation is performed in such manner that the controlling mechanism locks the keys and releases the drive of the machine for another cycle for introducing the fugitive 1 and for preparing the control for total or subtotal taking, with corresponding printing of symbols, for a negative value which is in positive form, or for a positive value.

In the drawings a control embodying the invention is illustrated by way of example.

In the drawings

Fig. 1 is an elevation of the control in its initial position, viewed from the left of the machine it is adapted to.

Fig. 2 is a detail view, showing certain parts of the control as illustrated in Fig. 1 in the position, they occupy during the tens transfer of the highest place of the totalizer.

Fig. 3 is a detail view showing the parts of the control as illustrated in Fig. 2 in the position they occupy after the introduction of the fugitive 1.

Fig. 4 is an elevation, viewed from the right and showing the means for locking the operation keys of the machine in their initial position.

Fig. 5 shows the position the parts occupy upon depression of an operation key.

Fig. 6 shows the position the parts occupy when the driving shaft of the machine has returned into its initial position after a partial rotation through 90 degs.

Fig. 7 is a perspective illustration viewed from the left and the front of the machine and showing the means for locking the number and operation keys of the machine, some parts being shown at a distance from each other for the sake of clearness.

Fig. 8 is an elevation, viewed from the right, of the mechanism for introducing the fugitive 1. in its initial position.

Fig. 9 is a perspective illustration, viewed from the right and the front of the machine, of the parts shown in Fig. 8, some parts being shown at a distance from each other for the sake of clearness.

Figs. 10 and 11 are elevations which are similar to Fig. 8 and show, respectively, the position the parts occupy when the driving shaft of the machine has returned into its initial position after a partial rotation through 90 degs., and at the close of the introduction of the fugitive 1.

Fig. 12 is an elevation, drawn to a larger scale and viewed from the right, showing the totalizer and the mechanism which is operatively connected thereto, the initial position.

Fig. 13 is a perspective detail illustration of certain parts as illustrated in Fig. 12, viewed from the right and the front of the machine, some parts being shown at a distance from each other for the sake of clearness.

Fig. 14 is an elevation which is similar to Fig. 12 but shows the parts in the positions they occupy upon completion of the tens transfer in the highest place of the totalizer when its capacity has been overstepped in the negative direction.

Fig. 15 is another perspective detail illustration, viewed as in Fig. 13 and showing other parts from Fig. 12, some parts being shown at a distance from each other for the sake of clearness.

Fig. 16 is an elevation which is similar to Fig. 12 but shows the parts in the positions they occupy after the fugitive 1 has been introduced negatively.

Fig. 17 is a perspective illustration, viewed from the right and the front of the machine and showing a shutter for closing an inspection opening in the top plate of the machine.

Figs. 18, 19, and 20 are other elevations which are similar to Fig. 12 but show, respectively, the positions of the parts when the driving shaft—which has performed a second partial rotation through 90 degs. upon negative overstepping of the totalizer capacity—has returned into its initial position, when the tens transfer has been completed in the highest place of the totalizer if a minus value is exceeded by a plus value, and after the positive introduction of the fugitive 1.

Fig. 21 is an elevation of the totalizer, viewed from the left.

Fig. 22 is a perspective illustration of the cancelling device in the totalizer, for total and subtotal taking, some parts being shown at a distance from each other, and some being broken away for the sake of clearness.

Fig. 23 is a perspective illustration of certain parts of the totalizer, viewed from the right and the front of the machine.

Figs. 24 and 25 are central sections through the totalizer, viewed from the left and, respectively, in the positions of its gears in which the number rollers of the totalizer display "0" and in which they display "9."

Fig. 26 is a perspective illustration of the mechanism for printing symbols, viewed from the right and the front of the machine.

Fig. 27 is a perspective illustration which is similar to the one in Fig. 17 but shows a modified shutter, and

Figs. 28 to 30, inclusive, show three distinct positions of another modified shutter.

1. General description of the controlling mechanism

The machine is preferably driven by a motor but it may also be driven by a crank for manual operation. Through suitable gearing, the motor first turns the driving shaft **10** of the machine through 90 degs. in the direction of the arrow **11**, and then back into its initial position for the same angle against the arrow **11**. These two partial rotations of the driving shaft through 90 degs. make up what will be referred to as the cycle of the machine. If a crank is provided instead of a motor, the driving shaft **10** is returned into its initial position by a spring.

The machine to which the controlling mechanism has been adapted, is a usual adding machine with a set of ten number keys **12** and a set of six operation keys **13** two of which, viz. the total taking key, with its key bar **200**, and the subtotal taking key, with its key bar **197**, have been illustrated in Fig. 26.

When an operation key **13** has been depressed, the motor is cut in by means of a switching member **60A** (Fig. 2). At the same time, the depressed key is locked by means that will be fully described below, until a cycle has been completed and the driving shaft **10** has returned into its initial position whereupon the key, is released and the motor is cut out by the switching member **60A**.

The motor, its switching means and its gearing, have not been illustrated.

The ten-key adding machine is equipped with a setting wheel carriage having spring-controlled setting wheels **310** to be operated from the number keys **12** by the usual mechanism, not shown. Teeth on each setting wheel **310** mesh with teeth of sectors **1**, one sector being allotted to each setting wheel **310**. A front slot **15** and a rear slot **18** are made in each sector by which the sectors are guided on a fixed rod **16** at the front of the machine and a rod **17** at its rear which is reciprocated for a purpose to be described below. The sectors **1** have teeth at both ends and a plain central portion where a movable rack **3** is arranged. This rack **3**, as best seen in Fig. 9, has a slot **21** in its rear and with which this end is guided on a headed rivet **20** in the corresponding sector **1**. Near its front end the rack **3** is equipped with another headed rivet **20'** which slides in a slot **21'** in the sector.

The setting wheels **310** which have been rotated in conformity with the values of their number keys **12**, are returned into their initial positions by the drive of the machine and, in thus returning, shift the sectors **1** on their rods **16** and **17** in the direction of the arrow **2** in conformity with the values which have been introduced. This movement is transmitted to a totalizer **4** through the racks **3**. The totalizer **4** has an end plate **229** at the left, an intermediate plate **234**, Fig. 22, and an end plate **152** at the right. The end plates **152** and **229** are connected by stays **151** and **151***a* which extend through holes in the intermediate plate **234**. The end plate **229** at the left is mounted to swing about a trunnion **153***a* in the left-hand side plate—not shown—of the machine. Similarly, the end plate **152** is mounted on a trunnion **153** which is supported by the right-hand side plate of the machine and intermediate frame plate, both not shown. Addition gear wheels **6**, with tens shift cams **41** (Fig. 22), are mounted on a shaft **215** in the totalizer **4**, and subtraction gear wheels **8**, with tens-shift cams **40**, are mounted on another shaft **207**. The gear wheels **6** and **8** are in mesh, and an intermediate gear wheel **8***a* on a shaft **257** is inserted between each subtraction wheel and the corresponding number roller **42**. A portion of the top plate P of the machine, with an inspection hole N for exposing the number rollers **42**, has been shown in Fig. 12.

When values are introduced additively into the totalizer **4**, it is turned about its trunnions **153** and **153***a* in the direction of the arrow **5** ADD and the addition wheels **6** move into mesh with the racks **3** on the sectors **1**. When values are introduced subtractively, the totalizer **4** is turned in the opposite direction, arrow SUB **7**, and the subtraction wheels **8** of the totalizer move into mesh with the rack **3**.

The values which have been introduced are printed by types **9** in the upper ends of the sectors **1** which are thrown against a sheet on the paper cylinder **312** of the machine by the usual hammer mechanism **311**. The symbols on the operation keys **13** are printed by an arcuate member **273**, Fig. 26, as will be described in due course.

The object of the invention is as follows:

Suppose that there is a plus value in the totalizer **4** which, for instance, has 11 places. Suppose that this plus value is 000 000 005 75 and that it is understepped by the minus value **752**. When the first cycle has been completed, there appears in the totalizer **4** an intermediate value which is the complement of the negative balance without deduction of the fugitive 1, and, in the present instance, is 999 999 998 23. In order that this complementary may be printed in positive form on the paper of the cylinder **312**, the keys are locked during the first cycle and the drive of the machine is thrown in for another cycle, for the introduction of the fugitive **1**.

The introduction of the fugitive **1** is necessary because the machine has two total taking mechanisms which are operated by a single key, the number rollers **42** of the totalizer **4** being returned to "0" if it is desired to print a positive value by total taking, and advanced to "9" if it is desired to print a negative value in positive form by total taking.

During the second cycle of the machine, the fugitive **1** is subtracted from the complementary value 999 999 998 23, and the number rollers **42** of the totalizer **4** now indicate 999 999 998 22. The negative balance is now printed in positive form by total or subtotal taking, the number rollers **42** being advanced to "9." In the present instance, the positive form of the negative balance is 177. When the capacity of the totalizer **4** is overstepped, in the negative sense, the inspection opening N is closed by a shutter, as will be described.

If, on the other hand, a minus value, for in-

stance, 999 999 999 951 is overstepped, for instance, by a plus value 75, the complementary value 000 000 000 025 appears in the totalizer 4 after the first cycle has been completed, this being the positive balance without the fugitive 1. As the value 999 999 999 951 represents an understepping of the zero position for 50, the fugitive 1 must be added in order that the positive value be correctly indicated in the totalizer 4 and printed. This is the reason why during the first cycle the keys are locked and the drive of the machine is released for one more cycle for introducing the fugitive 1. During this second cycle the fugitive 1 is inserted and the totalizer 4 now displays the real positive balance 000 000 000 26.

In order to keep the circuit of the motor which has been closed during the introduction of positive or negative values positively by the key locking means, in made condition also during the second cycle and to prevent the depression of number and operation keys during this cycle, the means have been provided which will now be described.

2. The means for locking the number and operation keys

As mentioned, there are as many sectors 1 as there are places in the totalizer 4, that is, eleven. It has been described that the sectors 1, by their slots 15, are mounted to slide on the rod 16 which is secured in the left and right-hand side plates of the machine, and, by their slots 16, are mounted to slide on the other rod 17 which is positively reciprocated in the slots 16 of the sectors 1 by the drive of the machine. As also described, the rack 3 is guided at the left-hand side of each sector 1 in the region of its plain central portion by the slot-and-rivet means 20, 21 and 20', 21'.

A pawl 23 as best seen in Figs. 1 and 9, is fulcrumed at the left-hand side of each sector 1 about a rivet pin 22. The free end of the pawl 23 is forked. Its arm 24 engages in a notch 25 in the lower edge of the rack 3 whose front edge 26 it engages in the initial position, so that the rack 3 can move in the direction of the arrow 2 only while positively engaged by the pawl 23. A rivet 28 is inserted in the other arm 27 of the pawl 23 and extends through a drop-shaped hole 29 in the sector 1 and into a longitudinal slot 30 in the corresponding tens-shift member 31.

The tens-shift members 31, as best seen in Fig. 7, have each a slotted tail 32 by which they are guided on a rod 34, and an arcuate slot 33 in the body which engages about an abutment rod 35. A spring 36 whose rear end is connected to a hook projecting from the member 31, and whose front end is secured to a transversely extending rod 36', pulls the member in upward direction until the lower end 37 of its arcuate slot 33 bears against the rod 35 from below, this defining the initial position of the member 31. With the exception of the tens-shift member 31' at the right-hand side of the sector 1 at the units place, Fig. 7, each tens-shift member 31 has a pair of cams 38 and 39 projecting from its upper edge for cooperation, respectively, with the tens-shift cams 40 and 41 of the gear wheels 8 and 6 in the totalizer 4, the cams 40 and 41 being best seen in Fig. 22. When the totalizer 4 is turned about its trunnions 153 and 153a in the direction of the arrow 5 ADD in Fig. 1, for addition, the tens-shift cams 41 on the shaft 215 of the addition wheels 6 cooperate with the cams 38 of the corresponding tens-shift members 31 when the number wheels 42 move from "9" to "0." When the totalizer 4 is turned in the direction of the arrow SUB 7, for subtraction, the cams 40 on the shaft 207 of the addition wheels 8 perform a similar function with respect to the cams 38 when the number wheels 42 move from "0" to "9." By these means, the tens transfer to the next higher place is prepared. For completing the tens transfer, each tens-shift member 31, with the exception of 31', has a rearward extension 43 for cooperation with actuating members 313, 314 and 315, Fig. 1.

Arranged at the left of the section 1 which corresponds to the highest place is an extra tens-shift member 31, Figs. 1 and 7. The cams 38 and 39 of this extra member cooperate with the tens-shift cams 41 and 40 for the gear wheels 6 and 8 at the highest place. A pin 44 is riveted into the extra member 31 and cooperates with the upper end 45 of the left-hand arm 46 of a coupling frame 47 whose right-hand arm 125, Fig. 7, has an extension 124 whose free end 123 engages a pin 122 in the tens-shift member 31' at the units place. The arms 46 and 125 are fulcrumed on a rod 48 which is secured in the left-hand side plate and an intermediate frame plate—both not shown—of the machine.

A bolt 49 is screwed into the lower end of the left-hand arm 46 of the coupling frame 47 and on this bolt is pivoted the rear end of a locking slide 50 whose front end presents a hook 69 and is slotted at 52 for sliding on a headed screw 51 in the left-hand side plate of the machine. A spring 53 whose front end is connected to a lug 54 extending from the lower edge of the locking slide 50, and whose rear end is anchored on a rod 55, pulls the slide 50 to the rear against the arrow 56 and turns the coupling frame 47 against the arrow *a*, the initial position of the slide 50 and frame 47 is defined by the end 45 of the arm 46 engaging the pin 44 on the extra tens-shift member 31.

A frame for locking the operation keys 13 as best seen in Figs. 1 to 7 comprises a bar 60, an arm 79*a* at the left, and an arm 79 at the right by which the frame is pivoted about a bar 61 secured in the side plates of the machine. The arm 79*a* is held on the bar 61 by a spring washer 62. Secured to the inner side of the arm 79*a* is a pusher 59 which extends to the rear and is equipped with a horizontal lug 58 extending to the right from its upper edge, and a hook 70 at its rear end. A lug 57 extends to the left from the upper edge of the locking slide 50 for cooperation with the lug 58 of the pusher 59. A catch 63 is mounted to swing on the bar 61 at the inner side of the arm 79*a* with its boss which is bent to the shape of the letter "U." The catch 63 has a lug 66 which extends to the left and is held against the upper edge of the pusher 59 by a spring 64 whose lower end is anchored in the pusher 59 and whose upper end is connected to a lug 65 at the upper end of the catch 63. This defines the initial position of the catch 63. Notches 67 and 68 are formed in the lower edge of the catch 63 for engaging alternately the hook 69 of the slide 50 which extends to the right from the slide.

The means for locking the number keys 12 will now be described. The hook 70 (Figs. 1, 2, 3 and 7) which extends to the right from the rear end of the pusher 59, is for cooperation with an arm 71. The arm 71 forms part of a

locking-control frame 72 which is fulcrumed about a shaft 73 in the left-hand side plate of the machine and an intermediate frame plate—not shown. An arm 75 extends in forward direction from the frame 72 and a spring 74 turns the locking control frame 72 anti-clockwise and the front end of the arm 75, Fig. 1, engages a locking strip 77 which is fulcrumed about a shaft 76. The locking strip 77 is turned clockwise and engages lugs 78 on the key bars of the number keys 12. When a key 12 is depressed, its lug 78 swings the locking strip 77 anti-clockwise which, through arm 75, turns the locking control frame 72 clockwise against its spring 74, and the arm 71 of the frame 72 engages below the hook 70 at the rear end of the pusher 59.

Secured to the inner side of the right-hand arm 79 of the operation key locking frame 60, Figs. 4, 5, 6 and 7, is a bracket 80 which at its rear end presents a spring hook 81. A spring 82 extends from this to a spring hook 83 of an unlocking arm 84 whose boss is bent to the shape of the letter "U" and is placed on the right-hand end of the bar 61 at the outer side of the arm 79. The spring 82 pulls a lug 85 of the unlocking arm 84 against an abutment 86 on the bracket 80, as best seen in Fig. 5. A rivet pin 87 is inserted in the arm 84 and on this is pivotally mounted and held by a spring washer 89, the front end of an unlocking slide 88 whose rear end is slotted at 90 and is mounted to slide on a headed rivet 91 in the right-hand side plate of the machine. A double-armed lever 93 is pivotally connected to the unlocking slide 88 by a rivet pin 92, and a rivet 95 which engages in a recess 94 in the double-armed lever 93 limits the swinging movement of 93 with respect to 88. A spring 97 which connects a pin 96 in the double-armed lever 93 to the rivet 91 by which the slotted rear end of the unlocking slide 88 is guided, turns the double-armed lever 93 anti-clockwise and holds the base of the recess 94 in the double armed lever 93 against the rivet 85 in the unlocking slide 88. This position is shown in Fig. 4. The rear end 98 of the double-armed lever 93 is engaged by a lug 100 (Figs. 4 to 6) on a cam plate 101 which is mounted to rotate on the driving shaft 10 by a square bearing boss 102. The lug 100 extends to the right from the cam plate 101 and its front side 99 engages the end 98 of the double-armed lever 93. The cam-plate 101 performs the same cycle as the machine, that is, 90 degs. in the direction of the arrow 11, and the same angle in the opposite direction, as described for the driving shaft 10. The means for actuating the cam plate 101 from the drive of the machine have not been illustrated.

The front end 103 as best seen in Figs. 4, 5, 6 and 7 of the double-armed lever 93 is recessed at 104 for engaging a lug 105 extending to the right from the lower end of a connecting rod 106. The upper end of the connecting rod 106 is pivoted on a rivet pin 106*a*, Fig. 7, at the rear end of an operating frame 107 which which is fulcrumed about, a shaft 108 secured in the right-hand side plate and an intermediate frame plate, and is held by spring washers (not shown). A spring 109, Figs. 4, 5 and 6, whose uper end is connected to a spring hook 110 of the connecting rod 106, and whose lower end is anchored in a holder 111 below the bottom plate 112 of the machine, tends to turn the connecting rod 106 anti-clockwise as viewed in Figs. 4 to 6. The connecting rod 106 extends through a hole 115 in the bottom plate 112 and the spring 109 holds the rear edge 113 of the connecting rod 106 against the rear end 114 of the hole 115. At the same time, the spring 109 turns the frame 107 clockwise. A tongue 116 extends to the left from the front end of the frame 107 for cooperation with the operation keys 13, as will presently be described.

The key bars of the operation keys 13, Figs. 4 and 26, with the exception of the repetition key, are riveted to bellcranks 117 at their lower ends, Fig. 26. The bellcranks 117 are mounted to swing about the shaft 108 on which the operating frame 107 is fulcrumed. At the lower end of the bellcrank 117, which is associated to the total taking key 13 is pivoted to a total slide 201, and at the lower end of the bellcrank 117, which is associated tot he subtotal key 13, is pivoted a s-bu total slide 198, at 117*a*, and a spring 117*b* tends to turn the bellcranks 117 clockwise. At its upper end, each bellcrank 117 has a sector-shaped cam, with a notch 118 and a tooth 120 at the lower side of the notch 119. Under the action of spring 109 the tongue 116 of the operating frame 107 bears against the front sides of the bellcranks 117. When one of the operating keys 13 is depressed the locking bar 60 of the frame 79, 79*a*, 60 engages in the notch 119 of the bellcrank 117 which is connected to the depressed key, and at the same time the bar 80 engages below the teeth 120 of the bellcranks 117 allotted to the other keys 13.

3. The operation of the locking means for the keys 12 and 13

The operation of the locking means when the capacity of the totalizer is overstepped in the negative sense will now be described. Assume by way of example that it is intended to introduce the numeral "2" subtractively into the totalizer 4 which is in zero position.

When the number key 12 with the numeral "2" is depressed, the corresponding setting wheel 310 (Fig. 1) which, as described, is mounted on a setting-wheel carriage and controlled by a spring, is rotated for two units by mechanism, not shown. At the same time, an abutment 78 on the said key 12 acts on the locking strip 77 and swings this anti-clockwise about its shaft 76. The strip 77 now acts on the arm 75 of the locking-control frame 72 and swings this frame clockwise about the shaft 73 against the action of the spring 74. When the number key 12 is released the setting wheel carriage is moved to the left for one place and the setting wheel 310 which, as mentioned, has been rotated for two units, is moved into operative connection with the sector 1 of the lowest calculating place. For calculating the value "2" subtractively, the subtraction key 13 is depressed and its bellcrank 117 is turned anti-clockwise. The bellcrank 117 now exerts pressure on the tongue 116 of the operating frame 107 and the frame is turned anti-clockwise against the action of the spring 109. The coupling rod 106 is now raised and its lug 105 engages in the recess 104 of the double-armed lever 93, Fig. 5, turning this clockwise against the action of the spring 97 and moving its rear end 98 away from the lug 100 of the cam plate 101. The unlocking slide 88 and the double-armed lever 93 are now shifted to the rear, as indicated by the arrow 121, until the end 90*a* of the slot 90 in the unlocking slide 88 bears against the headed rivet 91. The front end of the unlocking slide 88 is pivotally connected to the arm 84 at 87, Fig. 7, as described, and when the unlocking slide 88 is shifted in the

direction of the arrow 121, the arm 84 is turned about the bar 61 anti-clockwise, as viewed in Fig. 7. The lug 85 of the arm 64 now strikes the abutment 86 of the bracket 80 which, as described, is secured to the right-hand arm 79 of the locking bar 60. The bracket 80, the arm 84, and the locking bar 60 are now turned anti-clockwise about the bar 61. This causes the locking bar 60 to enter the notch 119, Fig. 4, of the bellcrank 117 which is allotted to the subtraction key 13, holding the subtraction key depressed. At the same time, the locking bar 60 engages below the teeth 120 of the bellcranks 117 allotted to the other operation keys, preventing depression of another operation key.

When the locking bar 60 is moved anti-clockwise and into its locking position, as shown in Fig. 2, the hook 70 at the rear end of the pusher 59—which, it will be remembered is secured to the left-hand arm 79*a* of the locking bar 60—moves toward the front edge of the arm 71 on the locking control frame 72 and, through the means operatively connected to this frame 72, as described, also prevents depression of the number keys 12 for introducing a value, as the locking-control frame 72 which upon depression of a number key 12 tends to turn clockwise, is arrested immediately it begins to turn, by the arm 71 engaging the hook 70 of the pusher 59. In the vertical or initial position of the locking frame 60, 79, 79*a*, as shown in Fig. 1, the rear end 63*a* of the catch 63 which, through spring 64, is moved anti-clockwise with the pusher 59, is intercepted by the hook 69 of the locking slide 50 after the locking control frame 72 has been turned through a certain angle so that the catch 63 is now arrested and tension is put on the spring 64 upon further movement of the pusher 59.

When the locking frame 72 has been moved into its locking position the contact in the circuit of the motor is closed by the switching member 60A and mechanism, not shown. The motor now is started and, through the drive of the machine, throws the totalizer 4 into subtraction position, that is, in the direction of the arrow SUB 7 in Fig. 1. In this position of the totalizer 4, its driving gear wheels 8 mesh with the racks 3 of the sectors 1. Hereupon, that setting wheel 310 of the setting-wheel carriage which has been rotated for two units by depression of the said number key "2," is returned into its initial position and shifts the sector 1 of the lowest place for two units in the direction of the arrow 2. The rack 3 of this sector, through gear wheels 8, 8*a*, and 8*b*, turns the number wheel 42 of the lowest place in the totalizer 4 through two units in clockwise direction. When this number roller 42 changes from "0" to "9," the widened tens-shift cam 40, Fig. 22, of the driving gear wheel 9 of the lowest or units place engages the cam 36, which is presented to it, of the tens-shift member 31 of the next higher or tens place. The tens shift member 31 of this place is now shifted downwards at an inclined angle by its tail 32 and slot 33. This tens-shift member 31 whose rearward extension 43, due to the shifting of the member, extends into the path of the actuating members 313, 314, and 315, is now shifted into its active position, Fig. 2, in downward direction by the said actuating members. As has been described, a rivet 28 in the arm 27 of the pawl 23 engages in a longitudinal slot 30 in each tens-shift member 31 through the hole 29 in the corresponding sector 1. The shifting of the tens-shift member 31 of the tens place causes the pawl 23 on the corresponding sector 1 to swing anti-clockwise and its arm 24 to shift the rack 3 of the sector 1 at the tens place for one unit in the direction of the arrow 2. By this shifting of the rack 3, the set of gear wheels 8, 8*a*, 8*b*, and the number roller 42 at the tens place of the totalizer 4 are turned through one unit subtractively, and similar operations as with the units number roller 42 are now performed when the tens number roller 42 moves from "0" to "9." These operations are repeated step by step until the highest calculating place. At the moment the number roller 42 at the highest place of the totalizer 4 is turned from "0" to "9" in consequence of the said tens-shifting operations, the tens-shift cam 40 of the driving gear wheel 8 of this place prepares in the usual manner the tens-shift slide 31 at the left of the sector 1 of the highest place, and this tens-shift member 31 is also shifted into its lower final position, Fig. 2, by its rearward extension 43 and the actuating members 313, 314, and 315. The pin 44 of this tens-shift member 31 acts on the upper end 45 of the arm 46 at the left of the coupling frame 47 and swings this frame 47 in the direction *a*, Fig. 1, about its rod 48. This, through bolt 49, shifts the locking slide 50 forward in the direction of the arrow 56 against its spring 53. The lug 57 of the locking slide 50 is now on the lug 58 of the pusher 59. At the same time, the rear end 63*a* of the catch 63 is cleared by the hook 69 at the front end of the locking slide 50 which hook now enters the notch 67 in the catch 63 and, as the catch 63 is no longer retained by its rear end 63*a* engaging the hook 69 from above, the tensioned spring 64 turns the catch 63 anti-clockwise until it is arrested by its lug 66 bearing against the upper edge of the pusher 59. The hook 69 at the front end of the locking slide 50 is now caught in the notch 67. The locking slide 50 and the coupling frame 47 are now arrested in the positions shown in Fig. 2.

The drive of the machine now completes the partial rotation through 90 degs. of its driving shaft 10 in the direction of the arrow 11 and the driving shaft 10 then returns into its initial position. At the same time the tens-shift members 31 which have been released by the actuating members 313, 314, and 315, return into their initial positions under the action of their springs 36.

Shortly before the cam plate 101, Figs. 4 to 6, which, as described, rotates with the driving shaft 10, as occupied its normal position, Fig. 6, its lug 100 engages the rear end 98 of the double-armed lever 93 and shifts this end the unlocking slide 88 into their normal positions, as also shown in Fig. 6, against the arrow 121. The unlocking slide 88, through the rivet pin 87, turns the arm 84 back in anti-clockwise direction. The spring 82 which connects the arm 84 to the bracket 80 on the right-hand arms 70 of the locking frame 79, 60, 79*a* is tensioned and tends to turn the locking frame 79, 60, 79*a* and, through the pusher 59, the catch 63 in the same direction. This, however, is prevented by the lug 57 which, as shown in Fig. 2, is on the lug 58 of the pusher 59. By these means, the locking frame 79, 60, 79*a* and the catch 63 are held in locking position, and the return movement of the arm 64 merely tensions the spring 62. As the locking bar 60 of the locking frame 79, 60,

79a remains in its locking positions the contact of the motor remains closed, the motor remains active and performs a second cycle.

During this second cycle, the coupling frame 47, in the manner which will be described in section 5, "The operation of the mechanism for introducing the fugitive 1", is turned further in the direction of the arrow *a* and into the position shown in fig. 3. The coupling frame 47, through bolt 48, shifts the locking slide 50 further in the direction of the arrow 56 and its lug 57 clears the lug 58 of the pusher 59 while its hook 69 moves from the notch 67 in the catch 63 and enters the notch 68. When, in this relative position of the lugs 57 and 58 at the end of the cycle the lug 100, figs. 4 to 6, of the cam plate 101 returns into their normal positions the double-armed lever 93, the unlocking slide 88, and the arm 84, the spring 82 of the arm 84 is able to move the locking frame 79, 60, 79a, the pusher 59, and the catch 63 out of the position in which the number keys 12 and the operation keys 13 are locked, and this positively opens the contact in the motor circuit. The notch 68 in the catch 63 releases the hook 69 of the locking slide 50, and the slide and the coupling frame 47 return into their initial positions under the action of the spring 53, in which initial positions the end 45 of the arm 46 on the coupling frame 47 engages the pin 44 of the tens-shift member 31 which is at the left of the highest place. The number roller 42 of the lowest or units place has been rotated for two units negatively at the beginning of the cycle, and this number roller 42 displays "8" while the number rollers 42 of the other places are rotated from "0" to "9" by tens shifting. In order to calculate the usual complementary value of the value "2", that is "7", in the units place of the totalizer 4, and in order to print the complementary value in positive form when total or subtotal taking, it is necessary to introduce the fugitive 1 into the lowest calculating place during the second cycle, in the present instance, subtractively. This is effected by the mechanism which will now be described.

4. The mechanism for introducing the fugitive 1

The tens shift member 21, figs. 7 to 11, which is arranged at the right hand side of the sector 1 of the units place is without the cams 38 and 39 of the other tens shift members 31, and without their tail 43, so that the actuating members 313, 314, and 315 do not act on this tens-shift slide 31' for the purpose of tens shifting. This tens-shift member 31' which is furthest to the right, is equipped with the pin 122, as described, which projects to the right for cooperation with the end 123 of the extension 124 on the right-hand arm 125 of the coupling frame 47. In the initial position of the coupling frame 47, fig. 8, the end 123 is at a distance from the pin 122 which corresponds to the angle the coupling frame 47 turns through during the first cycle. Secured to the right-hand arm 125 of the coupling frame 47, preferably by spot welding, is a plate 126 from which a lug 127 extends to the right at right angles. This lug 127 cooperates with a pair of lugs 128 and 128 which project in spaced relation from the lower side of a cancelling pawl 130, as best seen in fig. 9. The cancelling pawl 130 is mounted to swing about the rod 48 at the right of the coupling frame 47 and a spring 133 tends to turn the cancelling pawl 130 clockwise. In the normal position of the cancelling pawl 130, fig. 8, its lug 128 bears against the rear edge 128a of the lug 127 of the plate 126. The spring 133 is anchored, at one end, on a pin 134 which is riveted into the arm 125 of the coupling frame 47, and its other end is attached to a pin 135 which is secured in the cancelling pawl 130. In this normal position, a tooth 136 at the front end of the cancelling pawl 130 is beyond the path of a hook 137 on a cancelling sector 138 into whose path it projects in the positions illustrated in figs. 10 and 11. The cancelling sector 138 has a slot 140, fig. 9, in its front end with which it slides on the rod 16 the front slots of the sectors 1 are mounted to slide on, and in its rear end it has a slot 139 which extends transversely to the slot 140 and with this the cancelling sector 138 is placed on the rod 17 which, as described, is reciprocated by the drive of the machine. This rod 17 which slides in the longitudinal slots 18 of the sectors 1, moves the cancelling sector 138 positively upwards with the arrow 2, and downwards against the arrow, during every cycle of the machine.

5. The operation of the mechanism for introducing the fugitive 1

When the coupling frame 47 is moved from the position in fig. 1 into that in fig. 2 in the first cycle of the machine in the direction of the arrow a while the driving shaft 10 performs its first partial rotation through 90 degs. in the direction of the arrow 11, by tens shifting up to the highest place, as described in section 3, "The operation of the locking means for the keys 12 and 13", the end 123 of the extension 124 at the right of the coupling frame 47 engages the pin 122 of the tens-shift member 31' at the units place, fig. 10. The coupling frame 47 remains in the corresponding position for the present since the locking slide 50 is locked by the lugs 57 and 58, the notch 67, and the hook 69 of the slide 50, as shown in fig. 2. When the coupling frame 47 was turned in the direction of the arrow *a*, the tooth 136, fig. 7, of the cancelling pawl 130 was also influenced. At this moment, however, the cancelling sector 138 has been shifted by the movable rod 17 so far in the direction of the arrow 2, that is, upwards, that its tooth 137 has moved beyond the tooth 136 of the cancelling pawl 130, so that the pawl 130 could not partake in the movement of the coupling frame 47. In consequence, the spring 133 of the cancelling pawl 130 has been tensioned. When the driving shaft 10 is turned back into its initial position against the arrow 11, the movable rod 17 shifts the cancelling sector 138 against the arrow 2, and the inclined lower edge of the hook 137 slides along the tooth 136 of the cancelling pawl 130. After the hook 137 has moved beyond the tooth 136 of the cancelling pawl 130 the pawl is turned clockwise by its tensioned spring 133 and its tooth 136 projects into the path of the hook 137 of the cancelling sector 138, as shown in fig. 10. The spring 133 pulls the lug 129 of the cancelling pawl 130 again toward the rear edge 129a of the angular lug 127 on the plate 126.

Now, the machine performs its second cycle. The main driving shaft 10 is again turned through 90 degs. in the direction of the arrow 11. The movable rod 17, through the transverse slot 139, shifts the cancelling sector 138 in the direction of the arrow 2. When the cancelling sector 138 has moved through about four fifths of its stroke, its hook 137 engages the tooth 136 of the cancelling pawl 130 and, as the cancelling sector 138 moves on in the direction of the arrow

2, the cancelling pawl 130 is swung clockwise in the direction of the arrow *a* in fig. 11. The coupling frame 47 is turned about its rod 48 in the same direction through the lugs 127 and 128 and the plate 126. The end 123 of its right-hand arm 125 which has engaged the pin 122 of the tens shift member 31' at the units place, as described, which member 31' is allotted to the sector 1 at the same place, and is now shifted in downward direction on the rods 34 and 35 by its tail 32 and its slot 33. As has been described, the rivet pin 28 engages in a slot 30 in the member 31' and the descending member turns the pawl 23 clockwise about its pivot 22 and the arm 24 of the pawl shifts the rod 3 of the corresponding sector 1 at the units place through one unit in the direction of the arrow 2. The rack 3, through the gear wheel 8 and the train of gears 8*a* and 8*b*, turns the number roller 42 at the units place of the totalizer 4 subtractively for one unit, and this number roller 42 now indicates the complementary value "7."

When the driving shaft 10 returns into its initial position against the arrow 11, the rod 17 pushes back the cancelling sector 138 against the arrow 2 and the hook 137 of the sector clears the tooth 136 of the cancelling pawl 130, so that, when the driving shaft 10 has arrived in its initial position, all parts are free to return into their normal positions, as shown in fig. 1 under the action of the lug 100 of the cam plate 101 which, as described, engages the rear end 98 of the double-armed lever 93, the spring 36 of the tens-shift member 31', and the spring 53 of the locking slide 50.

Obviously, the fugitive 1 may also be added additively to the lowest place if, for instance, a value is calculated additively which oversteps the value which has previousluy been calculated subtractively. In this case, after the totalizer 4 has been swung into its additive position in the direction of the arrow 5 ADD, fig. 1, and in the first cycle a number roller 42 has been turned from "9" to "0," and the tens shift cam 41 of the corresponding driving gear wheel 6 has acted on the cam 38 of the allotted tens-shift member 31, for preparing a tens-shift operation to the next higher calculating place, and after this operation has been completed, the cancelling pawl 130 is moved into its preparatory position as shown in fig. 10 by the tens transfer from place to place up to the highest place. During the second cycle which is positively started after the first cycle, the fugitive 1 is calculated in the units place as with addition the totalizer 4 is turned in the direction 5 ADD, causing the driving wheels 6 to mesh with the racks 3 and reversing the number rollers 42 which had previously been rotated clockwise.

6. The totalizer control mechanism

If it is desired to take a total or a subtotal after the calculation of minus values during which the capacity of the totalizer 4 has been overstepped negatively beyond the zero position, the members by which the species of calculation of the machine is determined must be reversed. Such members normally turn the totalizer 4 subtractively when a total or subtotal is taken. Reversing is effected upon overstepping of the totalizer capacity in the negative sense in dependence of the coupling frame 47 which, as described, controls the key locking means and effects the introduction of the fugitive 1, by the mechanism which will now be described for preparing the totalizer 4 for additive turning for total or subtotal taking, if any.

A bearing screw 141, fig. 9, is inserted in the right-hand arm 125 of the coupling frame 47 through a hole in the plate 126, as best seen in fig. 9. Fulcrumed on the bearing screw 141 is a fork 142, fig. 13, whose boss is bent to the shape of the letter "U." As described, the trunnion 153 for the right-hand end plate 152 of the totalizer 4 is supported by the right-hand side plate of the machine and an intermediate plate. Mounted to swing on the trunnion 153 at the right of the intermediate plate is a totalizer controlling bellcrank 148 with an upwardly extending arm 147 and a rearwardly extending arm 158. The upper end of the arm 147 is forked at 150 and engages the stay 151 of the totalizer, as shown in figs. 12, 14, 16, 18, 19, and 20, so that, as the totalizer controlling bellcrank 148 turns about the trunnion 153, the totalizer 4 is positively swung about its trunnions 153 and 153*a*. The bellcrank 148 is connected to the fork 142 by a coupling rod 144 whose lower end is pivoted on a rivet pin 143 and held by a spring washer 145. The upper end of the coupling rod is connected to a rivet pin 146 in the arm 147 of the bellcrank.

A pair of holders 154 and 155, fig. 12, are mounted to swing on the trunnion 153 between the right-hand side plate of the machine and the totalizer controlling bellcrank 148. A spring 156 is attached to the upper ends of the holders and tends to pull them together. In the normal position, fig. 12, of the totalizer 4 the inner edges of the holders engage both sides of the stay 151 and of a rivet 157 in the intermediate plate of the machine, holding the totalizer 4 and the bellcrank 148 in their normal positions.

Pivoted on a rivet pin 158 in the free end of the rearwardly extending bellcrank arm 158 is a T member 160, with a lug 161 extending to the left from the lower front end of the member, and a lug 162 extending to the left from the lower rear end of the member 160. These lugs 161, 162 cooperate respectively with lugs 163 and 164 at the front and the rear of a rocker 165, Figs. 12, 14, 16, 18, 19 and 20, which is fulcrumed on a bearing screw 166 in the intermediate plate of the machine. An arm projects upwardly from the rocker 165 and on this is mounted to rotate a roller 168 for cooperation with a cam plate 169. The cam plate is keyed on the driving shaft 10 and a spring 170 holds the roller 168 against the edge of the cam plate 169. In the normal position of the totalizer 4 and its control, as shown in Fig. 12, the lug 162 of the T member 160 projects into the path of the lug 164 of the rocker 165 and this causes the positioning of the totalizer 4 for addition in the direction of the arrow 5 ADD.

A finger 171 projects to the right from the lower end of the T member 160, as best seen in Fig. 13, for a purpose to be described below.

The fork 142 on the bearing screw 141 has a pair of prongs 172 and 173 for cooperation with lugs 174 and 177 of a rake 176. When the fork 142 is raised its upper prong 172 is in position for cooperation with the lug 174 and when it is lowered its lower prong 178 is in a similar position with respect to the lug 177. The two lugs 174 and 177 extend angularly from the left-hand side of a U-shaped head 175 on the rake 176. The rake 178 which is mounted to swing on the rod 16 on which the lower ends of the sectors 1 are mounted to slide, the rod 16 extending beyond the right-hand side plate of the machine for the re-

ception of the rake 176, has an upwardly directed arm which supports the head 175 with its lug 174 and 177, a rearwardly directed arm 178, and a downwardly directed arm 176a. The arm 178 of the rake 176 which extends to the rear is forked at its rear end, as best seen in Fig. 13, and has two lugs 179 and 180 which, as the rake 176 swings about the rod 16, are alternately arrested by an abutment rod 181 which is screwed into the intermediate plate of the machine. The arm 178 has a longitudnal slot 182 through which projects a rivet 183 in the left-hand arm 184 of a frame 185 for controlling the shutter G, the printing of the symbols by the arcuate member 273, Fig. 26, and for determining the species of calculation. This frame 185 is mounted to swing about the abutment rod 181. The right-hand arm 186 of the frame 185 bears a rivet 187 to which is attached one end of a spring 188 whose other end is secured to a pin 189 near the rear end of the arm 178 of the rake 176. The spring 186 turns the rake 176 clockwise about the rod 16 until the upper lug 179 of its arm 178 is arrested by the abutment rod 181, this being the normal position of the rake 176. Owing to the connection 182, 183, this also determines the normal position of the frame 185.

Riveted into the left-hand arm 184 of the frame 185 is a pin 190, Fig. 15, on which are pivoted two links 191 and 192. The link 191 at the right has a hole 193 in its lower end with which it is placed on a rivet pin 194 at the front end of an arm 195 whose rear end is fulcrumed about a rivet 196 in the sub-total slide, or manual controlling member, 198, which, as described with reference to Fig. 26, is pivotally connected at 117a to the bellcrank 117 to which is riveted the key bar 197, 118 of the subtotal key 13. The link 192 at the left is similarly connected to an arm 199 which is fulcrumed about a rivet 198a, Fig. 26 in the total slide, or manual controlling member, 201 which is, in the manner described, operatively connected to the bellcrank 117 to which the bar 200, 118 of the total taking key 13 is riveted. The rear ends of the two slides or manual controlling members, 198 and 201, are slotted at their rear ends, end with such longitudinal slots 202 and 203, respectively, are mounted to slide on a rod 202a. In the initial position projections 204 and 205 at the rear ends of the respective arms 195 and 199 can cooperate with the finger 171 of the T member 160 upon shifting in the direction of the arrow 206. The arm 195 is guided by the right-hand side of the downwardly directed arm 176a when turned clockwise.

7. The operation of the totalizer control mechanism

For a better understanding of this operation the control and the swinging in of the totalizer 4 will now be briefly described for total and subtotal taking if there is a positive value in the totalizer 4. By way of example, when the total taking key 13 in Fig. 26 is depressed, the total slide 201 is shifted in the direction of the arrow 286 in Fig. 15, and the projection 205 of the arm 199, acting on the finger 171 of the T member 160, swings the member anti-clockwise about its pivot 159 so that its front lug 161 engages below the lug 163 of the rocker 165, as shown in Fig. 14. When the drive of the machine rotates the driving shaft 10 through 90 degs. in the direction of the arrow 11, the cam plate 169 on the shaft 10 immediately acts on the roller 168 and turns the rocker 165 anti-clockwise. The lug 163 of the rocker 165 engages the lug 161 of the T member 160 and pulls this down. Through the rivet pin 159 in the bellcrank arm 158, the totalizer controlling bellcrank 148 and, through the arm 147 with its fork 150 and the stay 151, the totalizer 4 is turned into subtraction position, arrow SUB 7. The holder 155 is turned clockwise or in the direction of the arrow SUB 7 by the stay 151 while the holder 154 is retained by the rivet 157, and so tension is exerted on the spring 156. The total in the totalizer 4 is now cancelled by the corresponding cancelling sector 138 and a cancelling gear wheel 248, as will be more fully described with reference to Fig. 22, and the cancelled value is printed by the sectors 1.

When the driving shaft 10 is returned in the direction against the arrow 11 and the total taking key 13 has been positively unlocked, as described, all members of the mechanism are returned into their initial positions by the holder spring 156 and the rocker spring 170. This is shown in Fig. 12 and it will appear that in this position the roller 168 is on a depressed portion of the cam plate 169 and the lug 164 of the rocker 165 is below the rear lug 162 of the T member 160.

In contradistinction to this, in the calculation of minus values under zero and subsequent total taking, the value indicated in complementary form in the totalizer 4 must be withdrawn from the totalizer 4 by additive operation through a cancelling mechanism, in order to print this complementary value as a positive one. This is effected as follows:

In the calculation of minus values the subtraction key 13 is depressed, which key, by means of a projection—not shown—corresponding to the projections 204 and 205, Fig. 15, on the corresponding slide, so controls the T member 160 that its front lug 161 is below the lug 163 of the rocker 165. When the machine is started the totalizer 4 is turned into subtraction position, arrow SUB 7, by the cam plate 169, the roller 168 on the rocker 165, the rocker itself, its lug 163, the front lug 161 of the T member 160, and the forked upper end 150 of the totalizer controlling bellcrank 148. When the totalizer controlling bellcrank 148 is turned in the direction SUB 7, the coupling rod 144 through rivet pins 143 and 146, turns the fork 142 slightly clockwise, that is, in upward direction, about its bearing screw 141. If in the calculation of minus values the capacity of the totalizer 4 is overstepped in negative sense, the coupling frame 47 is turned into the position illustrated in Fig. 14 in the direction of the arrow a during the first cycle of the machine, in positive cooperation with the tens shifts from place to place. By the bearing screw 141 which is on the right-hand arm 125 of the coupling frame, the fork 142 is moved in the same direction until finally the prong 172 of the fork is below the lug 174 of the rake 176. When the driving shaft 10 and the totaliser 4 return into their normal positions, the coupling rod 144 turns the fork 142 slightly in anti-clockwise direction about its bearing screw 141 and the prong 172 of the fork is again withdrawn out of reach of the lug 174 on the rake 176. Since at this moment on account of the hook 69 at the rear end of the locking slide 50 being engaged by the notch 67 in the catch 63, Fig. 2, and the lugs 57 and 58 engaging, the bar 60 which locks the operation keys 13 is active and locks the depressed subtraction key 13, the lugs 101 and 163 remain in cooperative position, Fig. 14.

During the subsequent second cycle, the driving shaft 10 is again partly turned in the direction of the arrow 11 for introducing the fugitive 1, and the totalizer 4 is returned into subtraction position through cam plate 160, rocker 165, T member 160, and totalizer controlling bellcrank 146. The coupling rod 144 returns the fork into the position illustrated in Fig. 14 in which its prong 172 is again in the reach of the lug 174 of the rake 176.

During the second cycle, the hook 137 of the canceling sector 136 which is moved in the direction of the arrow 2 engages the tooth 136 of the cancelling pawl 130 and turns this in the direction of the arrow *a*, Fig. 11. Through its lug 129 and the lug 127 of the plate 126, the coupling frame 47 is also turned in the direction *a* and the fork 142 is turned in the direction of the arrow *b* in Fig. 14. The prong 172 of the fork acts on the lug 174 of the rake 176 and turns the rake 176 anti-clockwise against the action of the spring 186 which connects it to the frame 185, and the lug 179 at the rear arm 178 of the rake 176 moves away from the abutment rod 181. The frame 125 partakes in the movement of the rake 176 to which it is connected by the slot 182 and the pin 183. The frame 185 is turned clockwise about the abutment rod 181. These movements of the rake 176 and the frame 185 raise the spring 188 by which they are connected. As soon as the spring 188, has moved beyond the center of the connection 182—183, this being its dead-center position, it acts on the rake 176 in the opposite direction and turns the rake anti-clockwise until the lower lug 180 on its rear arm 178 strikes the abutment rod 181, as shown in Fig. 16. The fork 142 during this operation turns the rake 176 only slightly, that is beyond the dead center position of the spring 186 whereupon the pull of the spring 188 moves the rake 176 and the frame 185 fully into the position shown in Fig. 16. The turning of the frame 185 in upward direction raises the links 191 and 192, Fig. 15, through the rivet pin 190, whereby the arms 195 and 198 to which the links 191 and 192 are pivotally connected on the total and subtotal slides 198 and 201, respectively, are swung clockwise about their fulcrum points 198 and 199*a*.

When the driving shaft 10 returns, the T member 160 is first turned slightly in anti-clockwise direction by links and levers, not shown. The front lug 161 of the T member slides off the lug 163 of the rocker 165 and now the spring 158 of the holders 154 and 155 which has been tensioned as described returns the totalizer 4 and its totalizer controlling bellcrank 148 into their initial positions. The T member 160 is also raised and its front lug 161 slides along the rear face of the lug 163 on the rocker 165, but does not leave the lug 163. A short time before the driving shaft 10 and its driving means return into their initial positions, the elevated portion of the cam plate 169 releases the roller 168 of the rocker 165, whereupon the rocker 165 and the T member 160 return into their initial positions according to Fig. 18 by spring action. At the same time, as described in section 3 "The operation of the locking means for the keys 12 and 13", the notch 66 of the catch 83 releases the hook 89 at the rear end of the locking slide 50, Fig. 3, and its spring 53 turns the coupling frame 47 back into its initial position as shown in Fig. 1, and, through the bearing screw 141 in the right-hand arm 125 of the coupling frame 47, the fork 142 and the coupling rod 144 return into their initial positions, while the rake 176, the frame 185, and the links 191 and 192 with the arms 195 and 199, remain in the positions shown in Fig. 18, that is, are prepared for total or subtotal taking in the additive sense.

When, after the calculation of more minus values the total or subtotal key 13 is depressed for total or subtotal taking, the projection 204 or 205 of the arm 195 or 199, as the case may be, slides past below the finger 171 of the T member 160 and this is not influenced. In consequence, the normal operative connection of the lug 162 at the rear of the T member 160 and the lug 164 of the rocker 165 is conserved, as shown in Fig. 18. The rocker 185 is now turned anti-clockwise by the means described and raises the T member 160 which operates the totalizer controlling bellcrank 148. This, in turn, moves the totalizer 4 into addition position in the direction of the arrow 5 ADD. Total taking is now effected as will be described in section 10, "The cancelling of a value above zero in the totalizer by total or subtotal taking", whereupon the number rollers 42 of the totalizer 4 which, as mentioned, has eleven places, indicated the value "999 999 999 99".

The rake 176, the frame 185, the links 191 and 192, and the arms 195 and 199, are returned into their initial positions, upon the subsequent calculation of positive values by re-overstepping of the zero position in the totalizer 4 in the positive sense, as follows:

If, after minus values have been calculated, one or more values are calculated in the additive sense, and if the zero position is overstepped in the totalizer 4, the coupling frame 47 is moved in the direction of the arrow *a* and into the position in Fig. 19 by the pin 44 on the extra tens-shift member 31 and the end 45 of the arm 46 at the left-hand side of the coupling frame 47 by the tens shift from place to place, while the corresponding number roller 42 passes from "9" to "0". The fork 142 which is moved in the direction of the arrow *b*, and has been turned slightly in anti-clockwise direction by the coupling rod 144 about the bearing pin 141 during the preceding turning of the totalizer 4 into its addition position in the direction of the arrow ADD 5, engages the rear surface of the lug 177 on the rake 176 with its lower prong 173. When the driving shaft 10 is returned, the totalizer 4 is also positively returned into its initial position, and the coupling rod 144 moves the lower prong 173 out of engagement with the lug 177 on the rake 176. A short time after the beginning of the second cycle of the driving shaft 10, the fork 142 is moved in the direction of the arrow *b* and its prong 173 is engaged again with the lug 177 on the rake 176.

The cancelling sector 136 now moves on the coupling frame 47 further in the direction of the arrow *a* and into the position in Fig. 11, through the hook 137 on the cancelling sector 136, the cancelling pawl 130, its lug 128 and the lug 127 on the plate 126. The fork 142 is moved in the direction of the arrow *b* and its prong 173, through the lug 177, turns the rake 176 clockwise about the rod 16. Through the slot-and-rivet connection 182, 183, the frame 185 turns anti-clockwise about the abutment rod 181. The spring 188 which connects the rake 176 and the frame 185, now descends and when it has moved beyond its dead-center position it acts on the rake 176 in clockwise direction again until the lug 179 of the rear arm 179 engages the abutment rod 181, as shown in Fig. 20. Through the rivet 190 in the frame 185 and the links 191, 192, Fig.

15, which now descend the arms 195 and 199 of the total and subtotal slides (198, 201) are moved in the same direction, and the slides 198, 201 are returned into their initial positions in which the projections 204 and 205 of their respective arms are again in reach of the finger 171 on the T member 160.

When the driving shaft 10 is now turned back against the arrow 11, the T member 160 is turned slightly in anti-clockwise direction so that its rear lug 162 slides off the lug 164 of the rocker 165, whereupon the spring 156 on the holders 154 and 155 returns the totalizer 4 and the totalizer controlling bellcrank 148 into the initial positions illustrated in Fig. 12. This causes the T member 160 to descend and the front side of its rear lug 162 to slide along the rear side of the lug 164 on the rocker 165. A short time before the driving shaft 10 returns into its initial position, the roller 168 of the rocker 165 is released by the elevated portion of the cam plate 169 and the rocker 165 is now free to swing back. This is followed by the T member 160, and the notch 68 in the catch 63 releases the hook 69 at the rear end of the locking slide 50, as shown in Fig. 3, so that the coupling frame 47 and the members it actuates are free to return into their initial positions illustrated in Fig. 12.

8. The first shutter arrangement

As already explained, the calculated minus value is indicated as a complementary value by the number rollers 42 of the totalizer 4 if the capacity of the totalizer has been overstepped in the negative sense. This complementary value, however, easily causes errors, for the following reason.

If, by way of example, the totalizer 4 indicates the complementary value "999 996 583 67" and it is not notified that this is a complementary value, it may happen that the operator interrupts the operation of the machine for a longer period and, when resuming it, mistakes the said complementary value for the result of a calculation of several additions, that is, a positive value. To eliminate errors from this source, a shutter G, as best seen in Fig. 17, is operatively connected to the frame 185 for concealing the number rollers 42 of the totalizer 4 when they indicate a complementary value.

The lower end of a connecting link A is slotted longitudinally at B and placed on the rivet 183 by which the rake 176 and the frame 185 are connected, as described. The lower end of the connecting link A is secured by a spring washer C. At its upper end the connecting link A is pivoted about a rivet D on the shorter arm of a bellcrank E which is placed on the totalizer trunnion 153 at the right-hand side of the totalizer controlling bellcrank 146 so that it can swing about the trunnion 153 but is held against axial displacement thereon. A flange F projects to the right from the upper end of the longer arm of the bellcrank E and to this is secured the right-hand end of the shutter G. The left-hand end of the shutter G is secured in similar manner to the upper end of an arm H which is mounted to swing on the left-hand totalizer trunnion 153*a*. A spring K whose rear end is attached to a pin L riveted into the longer arm of the bellcrank E and whose front end is anchored on a pin M secured in the right-hand side plate of the machine pulls the inverted U frame E, G, H anti-clockwise about the trunnions 153 and 153*a* until the longer arm of the bellcrank E is arrested by the pin M, this being the initial position of the shutter G, as shown in Figs. 12, 14, 17 and 20, in which the shutter G lays open the inspection opening N in the cover plate P so that the value indicated by the number rollers 42 of the totalizer 4—this being a positive value—can be read through the inspection opening N. In this normal position of the shutter G, the upper end of the slot B in the connecting link A is on the rivet 183.

8a. The operation of the first shutter arrangement

When the capacity of the totalizer 4 is overstepped negatively, the frame 185, as described in section 7, is thrown into the position in Fig. 18 from its initial position in Fig. 12. In consequence of this movement of the frame 185 in clockwise direction the rivet 183 in the frame traverses an idle path in the slot B in the lower end of the connecting link A and then strikes the upper end of the slot B, raising the connecting link A and through rivet pin D, turning the frame E, G, K clockwise about the trunnions 153 and 153*a* against the action of the spring K. In this position of the frame E, G, H, the shutter G is below the inspection opening N in the cover plate P so that the operator cannot read the complementary value which the number rollers 42 display after the capacity of the totalizer has been overstepped negatively. At the same time, he is warned that he has negatively overstepped the capacity of the totalizer 4, that is, that there is a negative balance whose amount he can print by total or sub-total taking.

Preferably the outer surface of the shutter G is painted in a color strikingly different from that of the top plate P.

8b. The second shutter arrangement

Referring now to Fig. 27, the shutter G is a U-shaped member with lugs at both ends, and screws 302 secure the lugs to the arm H at the left and to a bellcrank 300 at the right. At its lower end, the bellcrank 300 has a hook 301 which engages over the rivet 183 already referred to. The bellcrank 300 corresponds to the bellcrank E and performs at the same time the function of the connecting link A which is pivoted to the shorter arm of this bellcrank E at D. As described, the rivet 183 operatively connects the rake 176 and the frame 185 when the capacity of the totalizer 4 is understepped. When the capacity is understepped, and the frame 185 is turned clockwise, the bellcrank 300 is positively turned clockwise about the right-hand trunnion 153 and moves the shutter G so that it conceals the number rollers 42 of the totalizer 4. Connecting the shutter G to the arm H and the bellcrank 300 by the screws 302 facilitates the assembling as compared with the flanges H of the first shutter arrangement. In addition, the rivet 183 and the bellcrank 300 are connected positively and without slack so that the spring K of the first arrangement can be dispensed with.

8c. The third shutter arrangement

If the operator desires to calculate further minus values after the capacity has been understepped and if he desires to inspect the complementary value on the number rollers 42 of the totalizer 4 which is concealed by the shutter G when the capacity is understepped, the shutter G is fulcrumed on the bellcrank 300 and the arm H and is equipped with a handle 306 for

withdrawing it to expose the number rollers 42 with the complementary value, as will now be described with reference to Figs. 28 to 30.

The shutter G is U-shaped as in fig. 27 but instead of being held by the screws 382, this shutter is fulcrumed about screws 303 on the bellcrank 308 and the arm H. A spring 304 by which the shutter G is connected to the bellcrank 380, holds the rear edge at the right of the shutter G against an abutment 305 on the bellcrank 300. This is the normal position of the shutter G, as shown in fig. 28 and when the bellcrank 300 is turned clockwise by the rivet 183 the shutter G is below the inspection opening N, fig. 29. A handle 306 is secured on the shutter G and projects through a slot 307 in the cover plate P. If the operator in case he calculates further minus values, desires to inspect the complementary value on the number rollers 42 of the totalizer 4, he lays free the inspection opening N by pulling the handle 306 to the front, as shown in fig. 30. The spring 304 moves with the shutter G and when it has overstepped its dead center position turns the shutter G anti-clockwise until the handle 306 bears against the front edge of the slot 307 and the shutter G remains in the position fig. 30 in which the number rollers 42 of the totalizer 4 can be observed through the opening N in the cover plate P. To return the shutter G into its initial position, fig. 28, from the position in fig. 30 if the negative value is overstepped by a higher positive value, the bellcrank 300 is turned anti-clockwise. As the handle 306 is retained by the front edge of the slot 307 the shutter G turns clockwise and when the spring 384 has moved beyond its dead center it again moves the shutter into contact with the abutment 305 and the parts are now again in the position fig. 28 in which the shutter G exposes the inspection opening N in the cover plate P, and the newly calculated positive value.

9. The cancelling mechanism

When a total or subtotal is taken an amount which has been indicated as a positive one in the totalizer 4, is withdrawn from the totalizer 4 by cancelling the totalizer 4 by turning back its number rollers 42, and the value is printed. In order to be able to also print in positive form a value which has been indicated by the totalizer 4 as a complementary one when total and subtotal taking, the number rollers 42 of the totalizer 4 must be cancelled by turning in the opposite direction, i. e., to "9". For this purpose, two cancelling mechanisms are provided, as will now be described.

As mentioned, and best seen in figs. 21 and 22, the driving wheels 6 of the totalizer 4 are mounted on a shaft 207. The shaft 207, as shown at the center of fig. 22, has a semi-cylindrical groove 208 in which is inserted a rotary wedge 209. The wedge 209 is shown, broken away, at the left in fig. 22. A tooth 211 projects inwardly from the boss 210 of each driving wheel 6 and engages in a space 213 defined by a pair of flanges 212 on the shaft 207. The wheels 6 are so positioned on the flanges 212 that the ends 214 of their bosses 210 extend through half the width of each flange. In this manner, all wheels 6 are mounted side by side on the flanges 212 with their teeth 211 engaging in the spaces 213 between the flanges.

Similarly, the driving wheels 6 of the totalizer 4 are arranged on their shaft 215, with a groove 216 in the shaft, and a rotary wedge 217 in the groove 216. Teeth 218 projecting from the boss of each wheel 6 project into spaces 220 between flanges 218 of the shaft 215 on which the bosses of the wheels 6 are mounted in the same manner as the bosses of the wheels 6 are on the flanges 212 of their shaft 207. The shafts 207 and 215 are so arranged with respect to each other that their grooves 208 and 216 are pitched at an angle of 30 degs. as shown in figs. 24 and 25. The teeth 211 and 218 in the bosses of the respective wheels 6 and 6, however, are in the same angular position for both shafts 207 and 215.

The rotary wedges 209 and 217 are flattened at 221 and 222, respectively, and are so positioned in their normal or initial positions that their flat surfaces 221 and 222 allow the teeth 211 and 218 of the corresponding wheels 6 and 6 to move freely. The left-hand end 235 and 236 of the respective wedges 209 and 217 are fully cylindrical heads. Grooves 223 and 224 are made in the wedges 209 and 217 between the heads 235 and 236 and the flat faces 221 and 222, preferably at 30 degs. to the adjacent face, and from each groove 223 and 224 projects a point 225 and 226, respectively, which points in the normal positions of the wedges 209 and 217 engage in slots 227 and 228 in the perimeters of holes 230 and 231 in the left-hand end plate 229 of the totalizer 4. At their right-hand ends, the wedges 209 and 217 are again set off in parallel relation to their grooves 223 and 224. In this manner, the wedges 209 and 217, together with their shafts 207 and 215, can rotate in holes 232 and 233 in the intermediate plate 234 which is positioned at the right-hand side of the number rollers 42 without jamming as the wedges 209 and 217 rotate with their shafts 207 and 215.

The heads 235 and 236 of the wedges 209 and 217 are cylinders, as mentioned, and project beyond the left-hand side plate 229 of the totalizer 4. Their free ends are notched at 239 and 240, respectively and the left-hand end of a coiled spring 237 is inserted in the notch 239, a second coiled spring 238 being arranged similarly with respect to the notch 240. The right-hand ends of the springs 237 and 238 engage, respectively, in holes 241 and 242 in the left-hand ends of the shafts 207 and 215. The reaction of the springs 237 and 238 holds the points 225 and 226 securely in their slots 227 and 228 in the left-hand side plate 29 of the totalizer 4 in the initial positions of the wedges 209 and 217.

The wedges 209 and 217 are held against axial displacement by the inner surface 245 of a spectacle plate 243 which has a pair of eyes at its ends and is U-shaped. The eyes are placed on the left-hand ends of the stays 151 and 151*a*, the inner surface 245 of the spectacle plate being held against the ends of the heads 235 and 236 of the wedges 209 and 217 with some play, thus preventing axial displacement of the wedges 209 and 217 and holding the ends of the springs 237 and 236 in their notches 239 and 240 of the heads 235 and 236.

The right-hand end of the shaft 207 extends beyond the intermediate plate 234 and is mounted to rotate in a hole 247 in the right-hand side plate 152 of the totalizer 4. A canceling pinion 240 is keyed on this end of the shaft between the intermediate plate 234 and the right-hand side plate 152 by a key 249 projecting inwardly from the left-hand end of its boss and engaging in the groove 200 in the shaft 207. In a similar manner, the other shaft 215 is extended beyond the intermediate plate 234 and its right-hand

end is mounted to rotate in a hole 247*a* in the right-hand side plate 152, and a second canceling pinion 261 is placed on this shaft and keyed thereon by a key 249*a* engaging in the groove 216 in the shaft 215. Through mechanism, not shown, the canceling sector 188 is shifted on the rods 16 and 17 in the direction of the arrow 253 when the total or subtotal key is operated. The canceling sector 138 whose upper end only is shown in Fig. 22, is made with a rack on its upper edge and a rack 252 is secured to the right-hand side of the canceling sector 138 at the side of its own rack. When the totalizer 4 is in addition position, the pinion 261, and when it is in subtraction position, the pinion 248 meshes with the racks on the canceling sector 138. It is understood that the canceling sector 138 may be a single member, that is, may be made without the rack 252.

A double-armed lever 256 and a double-armed lever 261 are mounted to swing on the shaft 257 which supports the intermediate wheels 8*a* in the totalizer 4, with their U-shaped bosses embracing each other, as best seen in Fig. 23. This fig. is viewed from the right and Fig. 21 which also shows the double-armed levers 256 and 261, partly in dotted lines, is viewed from the left. A finger 255 on the double-armed lever 256 is arranged to engage in a depression 254 in the perimeter of the boss of the subtraction pinion 248 on the shaft 207. The longer arm 258 of the lever 256 is connected to a spring 259 which is secured to the shorter arm 260 of the lever 261. The pull of the spring 259 forces the finger 255 of the double-armed lever 256 into the depression 254, and the end of the longer arm 262 of the lever 261 into a depression 263 in the boss of the addition pinion 251. This holds the two pinions and their shafts 207 and 215 against unintentional rotation while at the same time the springs 237 and 238, acting clockwise, hold the wedges 209 and 217 in their normal positions, with their points 225 and 226 engaging in the notches 227 and 229, respectively, in the left-hand side plate 229 of the totalizer 4.

10. The canceling, by total or subtotal taking, of a value above zero in the totalizer

Upon depression, for instance, of the total taking key 13, as described in section 7, the totalizer 4 is thrown into subtraction position in the direction of the arrow 7 SUB, moving the driving wheels 8 of the totalizer 4 into mesh with the racks 3 on the sectors 1. At the same time, the canceling sector 138 is shifted in the direction of the arrow 253 and into mesh with the subtraction pinion 248.

By the operation of the machine the movable rod 17 is shifted transversely in the direction of the arrow 2 and through the slot 139, moves the cancelling sector 138 positively in the same direction and the subtraction pinion 248 is rotated in the direction of the arrow *c*. The finger 255 of the double-armed lever 256 is pushed out of the recess 254 in the boss of the pinion against the spring 259. The subtraction pinion 248 turns the shaft 207 in the same direction *c* by its wedge or key 249. The rotary wedge 209 partakes in the rotation of the shaft 207 in whose groove 208 it is placed. The point 225 is forced out of the slot 227 in the left-hand end plate 229 of the totalizer 4 and the rotary wedge 209 is turned anti-clockwise in the groove 208 of the shaft 207. The edge 209*a* where the flat surface 221 intersects the perimeter of the wedge 209, now projects into the path of the teeth 211 of the driving wheels 8 which move in the space 213 between the flanges 212. This is shown in Fig. 24. If during the preceding calculation a set of wheels 8, 8*a*, 8*b*, 42 of a calculating place in the totalizer 4 has remained in zero position the edge 209*a* of the rotary wedge 209 clears the point 211*a* of the tooth 211 in the corresponding driving wheel 8.

The subtraction pinion 248 which is driven by the cancelling sector 188, the shaft 207 and the rotary wedge 209 which are driven positively by the pinion 248, perform only one complete revolution in the direction of the arrow *c* while the cancelling sector 138 performs a complete stroke. During the complete revolution the edge 209*a* of the rotary wedge 208 engages the teeth 211 in the driving wheels 8 which are positioned at various points in the spaces 213 between the flanges 212 in conformity with the status of the several trains of gears in the totalizer 4 and returns these into their initial positions in sequence or at the same time. The driving wheels 8 which are at "9" are engaged first and the driving wheels 8 which have been rotated for few units are engaged later. Overthrowing of the driving wheels 8 beyond their zero position is prevented by their wider tens-shift cams 40 striking the cams 38 on the tens-shift members 31 after the zero position has been reached which members at this moment are locked against shifting.

As the driving wheels 8 mesh with the racks 3 on the sectors 1, driving the wheels 8 during the said cancelling operation cause a shifting of the sectors 1 in the direction of the arrow 2 in conformity with the value of the total, whereby, when the cancelling operation has been completed, those types 9 that have been moved into active position are printed on the paper carried by the cylinder 312 by the printing mechanism of the machine.

When all trains of gears in the totalizer 4 have been returned into the position corresponding to the position "0" of the number wheels 42, the single complete revolution of the subtraction pinion 248, its shaft 207 and its rotary wedge 209 has been completed, and the point 225 of the rotary wedge 209 is again opposite the slot 227 into which it is driven by the spring 237, this being the initial position of the wedge 209. The flat surface 221 of the wedge 209 is now again beyond reach of the teeth 211. The spring 258 returns the finger 255 of the double-armed lever 256 into the recess 254 in the boss of the subtraction pinion 248, Fig. 23, holding the pinion 248 its shaft 207, and its rotary wedge 209 against unintentional rotation.

The transfer of the total value to the paper on the cylinder 312 of the machine is completed by the types 9 and the printing mechanism when the driving shaft 10 has completed its partial rotation through 90 degs. in the direction of the arrow 11. At the same time, the cancelling sector 138 is moved against the arrow 253 in Fig. 22, and unmeshed from the subtraction pinion 248. At the beginning of the subsequent return movement of the driving shaft 10 against the arrow 11 the totalizer 4 is returned into its normal position. At the same time, the cancelling sector 138 and the sectors 1 are returned into their initial positions in the direction against the arrow 2 by the movable rod 17.

In contradistinction, when the subtotal key 13 is depressed, the totalizer 4 is held in its swung-

out position for the duration of a to and fro partial rotation of the driving shaft 10 so that the sectors 1 which are returned as the driving shaft 10 is turned back against the arrow 11, introduce the total value into the totalizer 4 again.

11. The cancelling, by total or subtotal taking, of a value below zero in the totalizer

If a value below zero is in the totalizer 4, the trains of gears at all calculating places in the totalizer 4 have been turned to "9" or beyond, viz. from "9" to "8," "7," etc. at the moment of capacity overstepping in the negative sense. Thereby, the teeth 218 of the driving wheels 6 of the trains of gears that have remained in "9" position also move into the position illustrated in Fig. 25.

When, for instance, the total taking key 13 is depressed, the totalizer 4 is thrown into adding position in the direction of the arrow 5 ADD. This is due to the fact that upon overstepping of the capacity in negative sense the mechanism has been reversed into the position shown in Fig. 18 and consequently the arm 199 by which the species of the totalizer 4 is determined, has been moved into inactive position with respect to the finger 171 on the T member 160. The cancelling sector 138 is now shifted so that its rack 252 meshes with the addition pinion 251 on the shaft 215. The machine now shifts the cancelling sector 130 in the direction of the arrow 2 and the cancelling sectors 138 now moves the pinion 251, its shaft 215 and its rotary wedge 217 through a complete revolution in the direction of the arrow c and the arm 292 of the double-armed lever 261 (Fig. 23) is moved out of the recess 283 in the boss of the addition pinion 251. At the beginning of this rotary movement the point 225 of the rotary wedge 217 is moved out of the notch 228 in the end plate 229 against the spring 238 and during the rotary movement the edge 217*a* of the rotary wedge 217 which is turned since the point 226 has come out of the notch 228, engages the teeth 218 in the driving wheels 6 sooner or later in conformity with their setting and turns all trains of gears in the totalizer 4 in the direction corresponding to the sequence of numerals as far as "9" whose tens-shift cams 41 at this moment engage the cams 39 of the tens-shift members 31. Those driving wheels 6 that remain in the "9" position during the calculation, are obviously not influenced. At the end of a complete revolution of the addition pinion 251, its shaft 215 and its rotary wedge 217 the point 220 on the rotary wedge 217 returns into its initial position, as defined by the notch 228, under the action of the spring 238 and the arm 262 of the lever 261 reenters the recess 263 in the boss of the addition pinion 251. During the cancelling the sectors 1 are shifted in the direction of the arrow 2 in Fig. 1 in conformity with the calculated values by the driving wheels 6 in the totalizer 4 and the racks 3 on the sectors. Finally, the total is printed by the hammer 311.

By the aforesaid means of cancelling, the negative value which has been indicated by the number rollers 42 of the totalizer 4 in complementary form, is printed on the paper on the cylinder 312 in positive form.

In order that on the paper a negative total value can be readily distinguished from a positive total value, symbols are printed when total and subtotal taking by the means that will be described in the following section.

12. The symbol printing means for total and subtotal taking

Referring now to Fig. 26, the front ends 265 and 266 of the species-determining arms 195 and 199 on the total slide 201 and on the subtotal slide 198 are arranged in stepped and staggered relation for cooperation with a crooked portion 290 of the subtotal slide 198 and an edge 278 of the total slide 201. When, for instance, the total taking key 13, with its key bar 200, 118, is depressed and there is—positive value in the totalizer 4, the total slide 201 is moved to the rear, as indicated by the arrow 206. The front portions of the arms 196 and 199 are arched in upward direction and a rail 269 is placed to extend transversely through the arched portions above the slides 198 and 201. The rail 269 is supported by a pair of arms whose upper ends are mounted to swing about the rod 16, and a spring 268 tends to move the rail toward the front, that is, clockwise about the rod 16, until a notch 270 at the inner end of a notched arm which extends to the rear from the left-hand arm supporting the rail 269, engages a lug 271 on the arcuate member 273, defining the normal position of the rail 269. The arcuate member 273 is mounted to slide on the rod 16 with a lower slot 276, and on the movable rod 17 with an upper slot 277. A spring 275 is secured to the lower end of the arcuate member 273 and the upper end of the member supports types 272 for the six symbols 272 *a–f*.

The slide 201, in moving to the rear in the direction of the arrow 206, strikes the front edge of the rail 269 with the rear edge of the front end 266 of its arm 199 and turns the rail 269 anti-clockwise about the rod 16. The notch 270 of the rearwardly extending arm clears the lug 271 and places another notch 274 in the arm in the path of the lug 271. For the present the arcuate member 273 cannot follow the pull of its spring 275 as the lower end of its slot 277 is arrested by the rod 17, but when the rod 17 is moved upwards by the drive of the machine, as indicated by the arrow 2, the spring 275 moves the member 273 in the same direction, until its lug 271 is arrested by the notch 274. In this position of the member 273, the clear sign 272*a* is printed. The member 273 is returned into its initial position by the rod 17 descending against the arrow 2.

If there is a negative value in the totalizer 4, the arms 195 and 199 have been reversed, as shown in Fig. 18, at the moment the capacity was overstepped. When in this case the total is taken the edge 278 of the total slide 201 turns the rail 298 slightly so that the notch 278 in its arm arrests the lug 271 of the symbol 272*b* is printed.

If there is a positive value in the totalizer 4 and if it is desired to take a subtotal, the end 265 of the arm 195 on the subtotal slide 198, upon depression of the subtotal key 13, with its key bar 197, 118, swings the rail 269 anti-cloekwise so far that all notches in its arm clear the lug 271 and the arcuate member 273 is free to slide upwards for the full length of its lower slot 276, and the subtotal symbol 272*c* is printed.

If there is a negative value in the totalizer 4 and it is desired to take the subtotal, the crooked portion 290 of the subtotal slide 198 swings the rail 269 so far that the notch 281 arrests the lug 271 of the member 273, and the symbol 272*d* is printed.

The symbols 272*e* and 272*f* are printed by means of steps 282 and 283 and a stop hook 316.

Obviously, the rail 269 must be released in this case.

13. A calculation example

Assume that the amount "575" has been introduced in the totalizer 4 additively in the usual manner, and that "752" is to be subtracted from this.

After the calculation of the plus amount "575" the number rollers 42 of the eleven-place totalizer 4 display "000 000 005 75". The amount "752" is introduced in the usual manner by means of the number keys 12, whereby the first three setting wheels 310 of the setting wheel carriage which have been set to "7", "5", and "2" are moved into active position with respect to the sectors 1 at the hundreds, tens and units place. The subtraction key 13 is depressed and its bellcrank 117 through the operating frame 107, Fig. 4, the connecting rod 106, the double-armed lever 93, the spring 97 and the unlocking slide 88, moves the bar 60 and the pusher 59 into position for locking the number and operation keys 12 and 13. The subtraction key 13 is held in depressed position as the bar 60 engages in the notch 119 in the sector-shaped cam of the key. At the same time, depression of the subtraction key 13 breaks the normal operative connection of the rear lug 162 at the lower end of the T member 160 and the rocker lug 164, Fig. 12, by turning the T member 160 anti-clockwise and the negative connection by lugs 161 and 163 is established. The bar 60 and the pusher 59 when moving into their active positions, positively close the contact in the motor circuit. The motor now turns the driving shaft 10 through 90 degs. in the direction of the arrow 11. At the beginning of this operation, the cam plate 169, through the T member 160, the bellcrank 148, and the stay 151 in the totalizer 4, moves this into subtraction position in the direction of the arrow 7 SUB, and the driving wheels 6 in the totalizer 4 mesh with the racks 3 on the sectors 1. The setting wheels 310 on the setting wheel carriage that embody the amount "752" are returned into their zero position, shifting the corresponding sectors 1 in the direction of the arrow 2. There is no obstruction to this shifting of the sectors 1, as at this time the movable rod 17 is also actuated in the direction of the arrow 2 by the mechanism of the machine, and the cancelling sector 138 positively partakes in this movement of the rod 17. When the sectors 1 are shifted the racks 3, through gears 8, 8a, 8b, turn back in clockwise direction the number rollers 42 which indicate the value "575" at the units, tens and hundreds place, for "7", "5", and "2". At the moment the hundreds number roller 42 is turned from "0" to "9", the tens-shift cam 40 of the driving wheel 8 at the hundreds place prepares a tens shift which is completed by the actuating members 313, 314, and 315, the numeral "1" being transferred to the next higher place by the corresponding tens-shift member 31, the rivet 28 of the pawl 23, the notch 25 in the rack 3, and the rack. As hereby this place is turned from "0" to "9" and the described operations are repeated, all number rollers 42 at the left of the hundreds place are set to "9". As the number roller 42 of the highest place is turned from "0" to "9", the tens-shift cam 40 of the corresponding driving wheel 8 moves into preparation position that tens-shift member 31 which is arranged at the left-hand side of the sector 1 at the highest place. This tens-shift member is moved into the position illustrated in Fig. 2 by the actuating members 313, 314, and 315. Through the pin 44 on the coupling frame 47, the bolt 49, and the locking slide 50, the hook 69 on the slide 50 is engaged by the notch 67 in the catch 63, and the lugs 57 and 58 on the slide 50 and the pusher 59 engage. Due to the turning of the coupling frame 47 in the direction of the arrow a, the cancelling pawl 130 is placed in cooperative position with respect to the tooth 137 of the cancelling sector 138, as shown in Fig. 10, and the prong 172 of the fork 142 is presented to the lug 174 of the rake 176.

The hammer mechanism 311 of the machine causes the printing of "752" on the paper on the cylinder 312, and the setting wheel carriage is returned into its normal position. A minus sign is placed behind the printed value to show that it is a subtraction, by the type 272 *f* on the member 273.

When the value "752" and its minus symbol 272 *f* have been printed, the driving shaft 10 has completed its partial rotation through 90 degs. in the direction of the arrow 11. The driving shaft 10 is now returned against the arrow 11 and initially the T member 160 is turned slightly in anti-clockwise direction. This breaks the connection of the lugs 161 and 163 and the spring 166 of the holders 154, 155, returns the totalizer 4 into its initial or non-calculating position, Fig. 12. The movable rod 17 returns the sectors 1, the cancelling sector 139, and the arcuate symbol printing member 273 into their initial positions. A short time before the driving shaft 10 has returned into its initial position, the lug 100 of the cam plate 101 tends to throw out the key locking means, the bar 60 and the pusher 59. This would be effected by the double-armed lever 93, the unlocking slide 88, the arm 84 and the spring 82, but, owing to the yielding connection of the arm 84 and the bar 60 by the spring 82, the locking of the keys by the bar 60 and the pusher 59 is maintained by the interengaging lugs 57 and 58, and the contact in the motor circuit remains closed so that the first cycle is positively followed by the second one, after the driving shaft 10 has completed its return movement.

At the close of the first cycle of the driving shaft 10 the number rollers 42 of the totalizer show the complementary value "999 999 999 23". The fugitive 1 which is still to be subtracted here in the units place, is introduced during the second cycle. At the beginning of the second cycle, the totalizer 4 is thrown into subtraction position, Fig. 14, because the subtraction key remains in its depressed position. When the cancelling sector 138 which is positively moved in the direction of the arrow 2, has moved through four fifths of its total stroke its tooth 137 engages the cancelling pawl 130 which, through plate 126, and 123 and pin 122, throws the coupling frame 47 into the position illustrated in Fig. 11, the rack 3 being operated by the pawl 23 through rivet 28 and slot 25 in the rack. This turns the set of gear wheels at the units place in the totalizer 4 through one unit subtractively. The units place displays "2" and the totalizer 4 displays "999 999 992 22". At the same time, the fork 142 which, being pivoted on the screw 141, partakes in the movement of the coupling frame 47 engages the lug 174 on the rake 176 and throws the reversing means, viz. the rake 176 and the frame 185, into the position illustrated in Fig. 16, and the links 191 and 192, Fig. 15, reverse the arms 185 and 189 on the slides 188 and 201 by which

arms the species of the totalizer 4 and the printing of symbols when total or subtotal taking are determined. The rivet 183 on the frame 185 through the connecting link *a*, moves the shutter G into the position of Fig. 18 in which it is below the inspection opening N in the over plate P. At the same time, through the bolt 49 on the coupling frame 47, the locking of the hook 69 at the end of the locking slide 50 is released by the notch 67 in the catch 83 and engaged by the notch 88, and the lugs 57 and 58 are moved apart, as shown in Fig. 3. The driving shaft 10 now completes its partial rotation through 90 degs. in the direction of the arrow 11 and "00—" is printed on the paper, as normally the two noughts are printed for all cycles of the machine without value calculation, and the minus sign is printed because the subtraction key has been locked in its depressed position. This indicates to the operator that the capacity of the totalizer 4 has been overstepped negatively.

The driving shaft 10 now starts for its return against the arrow 11. The lugs 161 on the T member 160 and 163 on the rocker 165 are disengaged and the totalizer 4 returns into its normal position, Fig. 18. The number rollers 42 of the totalizer 4 which now display the complementary "999 999 998 22" are concealed to the operator by the shutter G. The movable rod 17 descends and returns the arcuate symbol printing member 273 into its initial position, Fig. 26. When the driving shaft 10 has completed its return movement, the key-locking bar 60 and the pusher 59 are returned into their releasing position, as shown in Fig. 1, by the cooperation of the lug 100 on the plate 101, the end 98 of the double-armed lever 93, the unlocking slide 88, the arm 84, the spring 82 and the bracket 80. The subtraction key 13 is now free to return into its normal position and the motor contact is opened. The machine is now ready for the next operation.

If now, by way of example, a value "257" is calculated additively, the capacity of the totalizer 4 is again overstepped in positive sense. In this case, the motor has been started by depressing the addition key 13, and during the first cycle of the machine all number rollers 42 positioned at the left of the number roller 42 at the hundreds place are moved to "0" as the hundreds number roller 42 is turned from "9" to "0" as the consequence of continuous tens shifting. The hook 69 at the locking slide 50 is engaged by the notch 67 in the catch 83 and the key locking means 59 and 60 are held by the lugs 57 and 58. At the close, the totalizer 4 displays "000 000 000 79" During the second cycle, the fugitive 1 is added on the number roller 42 at the lowest calculating place and the arms 195 and 199 are returned into their normal positions through the reversing means, viz. the fork 142, its prong 173, the lug 177 on the rake 176, the frame 185, and the links 191 and 192, Fig. 20. At the same time, the rivet 183 and the connecting link A return the shutter G into its normal position, Fig. 12, in which it exposes the inspection opening N in the cover plate P. At the end of the second cycle, the totalizer 4 displayes the true value "000 000 000 80"

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