PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in and relating to Calculating Machines

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The subject matter of the invention is an automatic calculating machine in which, before beginning the operation of the machine, the whole multiplicand and multiplier are set up on separate setting mechanisms, after which these mechanisms act automatically in succession on two systems of numeral wheels or register mechanisms on a carriage which moves in front of the setting mechanisms. In the first place, one setting mechanism enters the multiplier in one of the systems of numeral wheels, and after this the other mechanism repeatedly enters the multiplicand according to the requirements of the first register in the other system of numeral wheels, or the so-called product register. The entry of the multiplier in the carriage is effected by a single rotation of the machine shaft and this entry as well as the following multiplication is effected in a single operating step or automatic jump which is produced by depressing a key or by a similar manipulation.

For setting the two factors in the setting mechanisms, there are preferably employed two full keyboards each of which possesses in known manner ten keys for each denomination to be entered. The complete pre-setting of the two factors has the advantage that, even while the machine is operating, the multiplier can already be altered for the next calculation. For obtaining multiple products (within the capacity of the machine) no setting of the partial results is necessary as is the case with known machines.

In the case when the digits of the multiplier are higher than 5 automatic multiplication takes place by the well-known contracted or short-cut method. By setting a lever, the operation of the machine can also be altered in such a manner that the product is entered not additively but subtractively in the result mechanism of the slide, that is to say is subtracted from the number entered in the slide. In this case also the multiplication takes place by the contracted or short-cut method referred to.

Owing to the entry of both factors in their full value before any operation of the machine and owing to the contracted multiplication and to the entire calculating process being carried out automatically, the result can be obtained very rapidly and a minimum amount of manipulation on the part of the calculator is necessary, since this manipulation is limited to the setting of the two factors and the depression of the operating key, if the drive of the machine is effected not by a handle but by means of a motor, for example an electric motor. This method of operation is effected by means of an extremely simple form of driving gear whereby the cost of manufacturing the machine is reduced to a minimum.

A constructional embodiment of the calculating machine in accordance with the invention is illustrated by way of example in the accompanying drawings, in which:—

Figure 1 is a side elevation of the multiplier setting mechanism;

Figure 1*a* is a partial side view of the multiplicand setting mechanism;

Figure 2 is a plan of the driving mechanism for moving the carriage;

Figure 3 is a front elevation of the multiplier and multiplicand register mechanism;

Figure 4 is a side elevation of the apparatus for setting the reversing fingers for the multiplier register;

Figures 5, 5*a*, 6 and 6*a* show the apparatus for carrying out contracted multiplication in different positions; and

Figures 7 to 9 show details of the mechanism for contracted multiplication; while

Figure 10 is a general view of the complete machine.

In the first place the method of opera-

[*Price* 1/-]

ting the machine in the case of the four different kinds of calculation will be described in broad outlines with reference to Figure 10.

In the case of multiplication, the complete multiplier is set up on the keyboard T1 and the complete multiplicand on the keyboard T2. The lever B is set to the left on the mark M and with the carriage G in the left hand position illustrated the starting key A1 is depressed. This causes the internal main shaft of the machine which is not visible in this figure to rotate. This effects in the first place, by rotating the main shaft of the machine, the entry of the multiplier in the register Z1 of the carriage, the digits of the multiplier appearing in the sight-holes of this register. After this the carriage makes a jump to the right so that the product register Z2 is located properly in front of the keyboard T2, and after this the multiplication takes place while the carriage G moves forward in steps to the right. The multiplication is effected in that the multiplicand which is set up in the keyboard T2 is entered in the product register Z2 as often as is required by each one of the successive digits of the multiplier. The digits of the product appear in the sight-holes of the product register Z2.

The entry of a new multiplier in the keyboard T1 is effected either by entirely cancelling the existing multiplier by depressing a key L1 (Figure 10) and setting-up the new multiplier in the keyboard T1 or by immediately undertaking this last operation, the freshly selected key in a row then releasing the key in this row which had previously been locked. A key L2 for effecting a complete clearance of the keyboard T2 is arranged on the right hand side of the machine (Figure 10).

In the case of subtraction and addition the carriage has not to be driven since only a single transfer of the subtrahend or addendum to the product register Z2 takes place by a single rotation of the main shaft.

For adding, the first term is set on the numeral wheels of the product register Z2 of the carriage, these wheels being provided for this purpose with milled discs which project outwardly from the casing, and the second term is then set up on the keyboard T2. The lever B is then set to the mark A, the carriage is set in the correct position in front of the keyboard T2 by drawing the handle H to the right and the key A2 is depressed.

Subtraction is effected by setting-up the minuend in the register Z2, entering the subtrahend in the keyboard T2, adjusting the lever B to the mark S, setting the carriage in the correct position in front of the keyboard T2 by drawing the handle H to the right and depressing the key A2.

In the case of division the carriage, as has already been mentioned, moves from right to left. The divisor is entered by means of the keyboard T2. The dividend is set by hand on the numeral wheels of the product register Z2 of the carriage. After setting the lever B on the mark D the carriage is drawn completely to the right by hand by gripping the handle H (Figure 10) after which it is released. It then at once begins to make its step-by-step movement to the left. The quotient from the division is visible in the register Z1 of the carriage, whereas the remainder from the division remains in the product register Z2.

The invention only relates to the arrangements for carrying out multiplication. This is effected, as previously mentioned, by abbreviated or contracted methods. In the case of so-called negative multiplication the lever U (Figure 10) has in addition to be shifted.

THE MULTIPLIER SETTING MECHANISM.

Figure 1 is a side sectional elevation taken on the line *m*—*m* of Figure 10 of one element of the multiplier setting mechanism T_1, S_1. This element comprises a row of keys on the keyboard T_1, a stationary gapped disc 3 and a wheel 6 which is freely movable on the machine shaft 7 and surrounds the disc 3. A pawl 5 which rotates with the machine shaft engages with the internal teeth of the wheel 6 and an intermediate wheel 8 on the carriage G is driven by the external teeth of said wheel 6. The wheel 8 engages a wheel 9, which is of the same diameter, and thereby correspondingly adjusts the pertaining numeral wheel 9*a* of the register Z_1 of the carriage which is a well-known revolution counter. When the multiplier is being entered in the numeral wheels, the wheels 8 of the carriage are opposite the wheels 6 of the setting mechanism S_1, since the carriage is then located in a standard initial position opposite the mechanism S_1.

The setting mechanism S_2 for the multiplicands is arranged in axial continuation of the setting mechanism S_1. The shaft 42 (Figure 1*a*) of the mechanism S_2 forms a continuation of the line of the shaft 7 of the mechanism S_1 but is revoluble independently of the shaft 7. The setting mechanism S_2 for the multiplicand is, as shown in Figure 1*a*, similar to that of the multiplier setting mechanism. The keyboard is indicated by the reference T^2.

The keys 1 to 9 (Figure 1), the bearings of which are omitted, act by means of their stems 2 on the more or less steeply inclined teeth 2*a* of a longitudinally mov-

able rail 2*b* so that the rail is longitudinally displaced to a greater or less extent against the action of the spring 2*c* according to which of the keys 1 to 9 is depressed. By means of the pin 2*d* and the double armed levers 2*e*, 2*f*, which are pivoted at 2*g* and 2*h* respectively, and are connected together by means of a slot and pin at 2*i*, as well as by means of the coupling rod 2*k* which is pivotable at 2*m* and 2*n*, the arm 1*a* of a sector 1 is rotated to a greater or less extent about the shaft 7 and a gap 4 in the stationary disc 3 is more or less enlarged. When the pawl 5, which is acted on by a spring and is connected with the shaft 7 and pivoted at 5*a*, is moved in a counter-clockwise direction and its roller 5*b* thereby enters into the gap 4, the other end of the pawl engages the internal teeth of the wheel 6 and rotates this by a distance corresponding to the length of the gap. The wheel 6 drives the corresponding numeral wheel of the register Z_1 of the carriage G through the agency of the wheels 8 and 9 and thus sets the wheel correspondingly to the multiplier digit. All the pawls 5 rotate simultaneously so that all the digits of the multiplier are simultaneously entered in the register Z_1.

The movement of the pawl 5 in a counter-clockwise direction takes place on the return oscillating movement of the shaft 7. This oscillating movement of the shaft 7 is effected by the driving mechanism of the machine which is hereinafter described. When the shaft 7 moves in a clockwise direction, the pawl 5 remains ineffective since it snaps over the teeth of the wheel 6. In Figure 1*a* the pawl 5 is imagined to be rotating with the rotating shaft 4*e*.

For the transfer of the multiplier from the setting mechanism to the register Z_1 of the carriage, which has just been described, the carriage is held in its extreme left-hand position by means of a lever 10 which is pivoted at 10*b*. The lever 10 is acted on by a spring 10*a* and engages in a notch 19*a* in the base plate 19 of the carriage. This position of the lever 10 is illustrated in Figure 1 which shows the setting mechanism S_1 in its position of rest in which the gaps 4 in all of the discs 3 are closed.

An electric motor 12 is employed for driving both the setting mechanisms S_1 and S_2. The rotor of the motor is axially displaceable by the distance *p* (Figure 2). On the shaft 12*a* of the rotor is mounted a belt pulley 29*a* which is freely revoluble on the shaft and is secured against axial displacement by a fixed fork 28. One part 29 of a clutch is fast on the rotor shaft and the other part 29*c* of the clutch is connected with the pulley 29*a*. On the shaft 12*b* which is connected by a coupling member 12*c* with the shaft 12*a* which always rotates in the same direction is mounted a worm 16*a* which engages a worm wheel 16 (see Figures 1 and 2). The worm wheel 16 rotates the shaft 14*a* with it through the agency of a coupling 14 when, after setting the factors on the keyboards, the key A_1 (see Figure 2) is pressed. On pressing the key A_1, a double-armed lever 13 which is pivoted at A_3 and is linked to the shaft of the key A_1 at A_2, releases the hook 13*a* which is thus freed from the stop 27 on the coupling 14 and thereby sets the coupling free to come into engagement. To the coupling 14 is fixed a crank disc 17 which drives the rails 15 and 20 through the agency of the crank pin 18. The disc 17 rotates in the direction indicated by the arrow in Figure 2.

On pressing the key A_1 a roller A_4 of insulating material which is fixed on the extended shaft of the key closes the contact 51 which makes the circuit to the motor. This contact remains closed during the first half-rotation of the disc 17. For this purpose the disc 17 is provided with two notches 17*a* in which, when the machine is in its position of rest, a pin 13*b* fitted on the lever 13 engages. As soon as the disc 17 begins to rotate after the key A_1 has been pressed, the pin 13*b* rests on the edge of the disc 17. Consequently, the key A_1 holds the contact 51 closed against the counter pressure of the contact-spring for the duration of a semi-rotation of the disc 17.

During this first semi-rotation of the disc 17, the multiplier which has been set by the keys T_1 in the setting mechanism S_1 is entered in the numeral wheels of the register Z_1 of the carriage. This is effected by means of a connecting rod 20 which is linked to the disc 17 which moves a rail 20*b* which is coupled to it by means of the pin 20*a* backwards and forwards in a straight line in the bearings 20*d*. To the rail 20*b* is linked, by means of the rod 20*c* an arm 26 of a sector 26*b* which can turn about the pivot 10*b* and engages a toothed wheel of the setting mechanism S_1 and, when the rail 20*b* is moved backwards and forwards, imparts to the shaft 7 of this mechanism and to the pawl 5 connected to it an oscillating movement which effects the transfer of the multiplier to the register Z_1 of the carriage, as above described.

After a semi-rotation of the crank disc 17 the hook 13*a* on the lever 13 engages the second stop 27 on the coupling 14. The coupling connection between the worm wheel 16 and the disc 17 is thereby broken. At the same time, the pin 13*b*

on the lever 13 falls into the second notch 17*a*, so that the key A_1 is returned into the position of rest and the contact 51 is opened. The motor, therefore, is switched off and stopped.

The shaft 12*a* of the rotor which, as above mentioned, is displaceable longitudinally to the right together with the shaft 12*b*, is displaced by the distance *p* to the right when the motor is started, owing to the fact that the worm wheel 16 is at first held fast owing to the resistance of the parts to be moved by it. Consequently, at the beginning of the rotation of the worm 16*a* a longitudinal displacement of the shafts 12*a*, 12*b* takes place to the right against the action of the spring which surrounds the bolt 31, and the shafts 12*a* and 12*b* remain in this displaced position. Therefore, the part 29 of the clutch is released from the part 29*c* which is fixed to the pulley 29*a*. Consequently, during the first semi-rotation of the disc 17, that is during the subsequent transfer of the multiplier to the carriage the pulley 29*a* does not rotate and the multiplicand setting mechanism S_2 is not driven. In this way the two setting mechanisms S_1 and S_2 are prevented from being driven simultaneously. When the transfer of the multiplier is completed and the coupling 14 has been disconnected in the manner previously described, the spring-actuated bolt 31 presses the shafts 12*a* and 12*b* towards the left back into their normal position whereby the connection at 29, 29*c* between the rotor shaft 12*a* and the pulley 29*a* is again restored.

During the semi-rotation of the crank disc 17 which has been described, the carriage stands in its left-hand position and a linkage 22, 22*a*, 22*b* (Figure 2) which is pivoted to it at 25, assumes the position illustrated in the drawing. During this semi-rotation, the rail 15, the rail 15*a* which is connected to it, and the double armed lever 21, which is connected to the latter and is pivoted at 21*a*, are drawn upwards by the upwardly moving crank pin 18 so that the right-hand arm of the lever 21 assumes the lowest position illustrated by dotted lines in Figure 2.

At the end of this first semi-rotation of the crank disc 17 and after the completion of the entry of the multiplier in the register Z_1 of the carriage, the lever 10 is lifted out of the notch 19*a* in the base plate 19 of the carriage by a stop 11 on an arm 26 of the sector 26*b*. The carriage is thereby released so that it can yield to the pull of a spring which is not illustrated in the drawing. The carriage, therefore, makes a jump to the right into the position for starting the multiplication.

After that first semi-rotation of the disc 17 the carriage is now located in the position ready for beginning the multiplication, as mentioned above. In this position the lever 22 which is connected with the carriage stands in its uppermost position, in which it is separated by a considerable distance from the lever 21. At this time a lever A_5 is pressed to the left by means of the carriage through the agency of a rod which is not illustrated in the drawing, so that the insulating roller A_6 which is fixed to the lever closes the contact 51 which makes the connection to the motor. The motor thus starts to rotate and rotates the setting mechanism S_2 by means of the pulleys 29*a*, 29*b*.

During the multiplication which takes place by the rotation of the setting mechanism S_2 the worm wheel 16 runs idly and the crank disc 17 as well as the rods 15, 20 and 21 remain at rest. The lever 21 remains in the lowered position indicated by the dotted lines in Figure 2, since the crank pin 18 on the disc 17 is in its uppermost position. During the multiplication the lever 22 gradually approaches the lever 21 since, as previously mentioned, the slide gradually advances towards the right.

THE CARRIAGE DRIVING MECHANISM.

The drive of the carriage G to the right during the multiplication is effected by means of the double rack 22*c* (Figure 2) which is linked to the lever 22*a* at 22*d* and by means of the slot 22*e* slides on the stationary pin 22*f*. Between the two rows of teeth on the rack 22*c* is located the pinion 22*g* which is mounted on the shaft 22*h* of a spring drum 22*i*. The shaft 22*h* of this drum is mounted in the angle lever 22*k* which can pivot about the pin 22*f*. By means of the pin 22*m* which is fixed to the lever 22*k* and runs in the slot 22*n* in the selecting lever B the lever 22*k* can be set in two different positions in such a manner that, when the lever B is set for multiplication on the mark M as indicated in the drawing, the pinion 22*g* engages in the lower row of teeth of the rack and the spiral spring arranged in the drum displaces the rack 22*c* and therefore the carriage to the right as is indicated by the arrow in Figure 2. On the other hand, in the remaining positions of the lever B the toothed wheel 22*g* engages in the upper row of teeth in the rack and then the spiral spring in the drum 22*i* displaces the rack 22*c* and therefore the carriage G to the left. The latter occurs in the case of automatic division which is carried out in the manner known, for example in the German specification No. 531,178, in calculating machines of a similar kind.

When the carriage has arrived in the

extreme right hand position at the end of the multiplication, the lever 22 abuts against the lever 21. In this position of the carriage its base plate 19 presses a lever A_7, a small distance to the right. Since a pin A_8 on this lever engages in the fork A_9 of the shaft of the key A_1, the key A_1 is drawn towards the right and the stop 27 of the coupling 14 is released from the lever 13. The coupling 14 is, therefore, connected and the motor now rotates the crank disc 17, after the motor shaft has first again been displaced to the right and the clutch 29, 29*c* has been disconnected. The crank disc 17 now carries out the second half of its revolution. During this, since the joint 15*b* of the rods 15, 15*a*, now forms a rigid connection, the right-hand arm of the double lever 21 is raised and, taking the rod 22 with it, returns the carriage to the extreme left-hand position. This takes place with great speed in a single jump. After the semi-rotation of the crank disc 17 has been completed, the pin 13*b* of the lever 13 engages in the notch 17*a* and the hook 13*a* abuts against the stop 27. At the same time the lever 10 engages in the notch 19*a* in the base plate of the carriage. The key A_1 is moved to the left and the contact 51 is now opened and the supply of current to the motor is cut off. The coupling 14 is disconnected and the carriage G is in its normal extreme left-hand position. The crank pin 18 remains in the lower position indicated in the drawing (Fig. 2). The multiplication is then complete and the machine is ready for a further operation.

The joint 15*b* is of no importance when the machine carries out the operation which has been described. The only object of the joint is to enable the carriage G to be displaced by hand from the normal position into desired decades for other kinds of calculation. During this the lever 22 makes oscillating movements which would be prevented by the lever 21 in its upper position if the rod could not give way. Instead of the jointed lever 15, 15*a* another form of construction could be used for the same purpose, for example in combination with the lever B which determines the kind of calculation.

In order to carry out multiplication the digits of the multiplicand are set up with the aid of the keys of the keyboard T_2 in the same manner as the multiplier to transmit the setting to the wheel 6*a* actuating the register Z_2. The method whereby this transfer is effected is of no importance for the present invention and, therefore, need not be considered here. It is sufficient to say that each digit of the multiplicand is expressed in a corresponding angular position of its pertaining disc or wheel and the corresponding wheel 6*a* and all these angular positions are transferred by a rotation of the shaft 42 from the wheels 6*a* to the wheels 8*a*, 9*a* of the products register Z_2 of the carriage, whereby corresponding digits are set up in the numeral wheels 58*a*. In this way the multiplicand is set up in the product register Z_2. This corresponds to multiplication of the multiplicand by 1. If the multiplicand is to be multiplied by 2 then the shaft 42 is rotated twice. If the multiplicand is to be multiplied by 3 the shaft 42 is rotated three times and so on. When the unit digit of the multiplier is 5 for example and the tens digit is 4 for example, i.e. the multiplicand has to be multiplied by 45, then the shaft 42 is first rotated five times and after this the carriage is moved one step to the right and the shaft 42 is rotated four times. This method is the same in all calculating machines having toothed wheel mechanism and is generally well known.

The multiplication is effected in abbreviated or contracted form, that is to say when one digit of the multiplier is higher than 5, not, as is usual, by adding with this digit, but by subtracting with the complementary value of this digit and then adding a unit in the next higher denomination, for example instead of multiplying by 7 the multiplier employed is (10—3).

For the purpose of carrying out contracted multiplication the setting mechanism S_2 is provided with a spindle 56*a* (Figure 3) on which pairs of toothed wheels 56, which are of equal size and rigidly connected together are mounted. Each pair of wheels is loose on the spindle 56*a* which is mounted in the frame of the machine and the pairs of wheels 56 are mounted side by side on this spindle in such a manner that their left hand part is continuously in engagement with a wheel 6*a* which coacts therewith. By the displacement of the carriage along the setting mechanism S_2 the carriage comes either into positions in which the wheels 8*a*, which are mounted on a spindle journalled in the carriage and are each continuously in engagement with a pertaining toothed wheel 9*a* of a numeral wheel 58*a*, come into engagement directly with the wheels 6*a*, or into positions in which the said wheels 8*a* come into engagement with the right hand parts of the wheels 56. The step of the carriage to bring it from the one adjustment into the other is smaller than the step between two adjustments of the same kind. When the carriage is set in the first mentioned adjustment and the shaft 42 is rotated, the numeral wheel 58*a* is rotated in the

positive or addition sense by the wheels 6*a*, 8*a*, 9*a*. In the other positions of adjustment of the carriage, on the other hand, the numeral wheel 58*a* is rotated in the negative or subtracting sense by the wheels 6*a*, 56, 8*a*, 9*a*. In both cases the shaft 42 rotates in the same direction. The rotation of the numeral wheels 58*a* in the adding sense takes place both in the case of addition and ordinary multiplication. The rotation in the subtracting sense takes place in the case of subtraction, division and contracted multiplication.

The determination of the various multiplication positions of the carriage is effected by the arrangement which is hereinafter described and is illustrated in Figures 4 to 9 and 5*a* and 6*a*.

Beside each numeral wheel 58 of the register mechanism Z_1 is suspended so as to be freely revoluble about the shaft of the numeral wheel an angle lever 81, 86, the arm 81 of which coacts with a stepped disc 82 which is connected fast with the wheel 8 belonging to the numeral wheel 58 in question. The wheels 8 come successively within the range of the opposite oscillating fingers 90, 91 (Figures 4 and 6), of which the one or other engages in the corresponding wheel 8 at each revolution of the machine shaft 42 and advance it one step in one direction or the other.

The periphery of the disc 82 has three steps so arranged that the arm 81 of the pertaining angle lever 81, 86 either abuts against the tooth 85 of the disc 82 or on the part of the periphery having the greater diameter (see Figure 5) or on the part of the periphery having the smaller diameter (see Figure 6) and thus takes up one of three different positions according to whether the numeral wheel connected with the disc 82 is set to a value from 1 to 5 or from 6 to 9 or 0. These figures are visible in a window which in Figure 4 is located by the Figure 0.

Below the guide plate 19 of the carriage is located in the frame of the machine a bent rail 47 which is illustrated in cross section in Figures 4 to 6 and in plan Figures 7 and 8 and in side elevation in Figure 9. This rail 47 is linked to a two-armed lever 38 (Figure 9) which can pivot about the point 46. When the rail 47 is displaced to the right in the direction of the arrow shown in Figure 9 it effects by means of the lever 38 a displacement of a lever A_5 (Figure 2) which closes by means of a roller A_6 the contact 51 arranged in the circuit of the electric motor 12. At the same time the lever A_5 unlocks the setting mechanism S_2 in any appropriate manner not illustrated in the drawing, so that this mechanism can rotate.

The left-hand end of the rail 47 (see Figures 7 to 9) is provided with a tongue 47*a* which can be separated from the rail by the member 47*b* and is somewhat longer than the rail 47. The end 63*a* of the rail 47 is bent round and extends laterally round the end 63 of the tongue 47*a* and forms a wider abutment surface than the end 63. In the two end positions of the part 47*a* the head 63, 63*a* forms a stop member having two steps which in the drawing are indicated by + and −. These steps form stops for the arm 86 of the angle lever 81, 86 which is mounted on the carriage so that the carriage which moves from left to right is arrested in the denominational position (decade) in which it arrives at any time either by the stop indicated by + in the addition position or by the stop indicated by − in the subtraction position. In the first case, with the parts set in the position shown in the Figure 7, the finger 90 (Figure 3) engages the wheel 8 of the register mechanism Z_1 which is opposite to it at the time, and in the latter case the finger 91 engages this wheel and consequently the register mechanism Z_1 is driven in one direction or the other. In the position illustrated in Figure 8 the method of operation is reversed in a manner which is hereinafter explained. For accomplishing the said action of the fingers 90, 91 these are moved from the machine shaft 42, which always rotates in the same direction, by means of an eccentric 23 (Figures 4 to 6) which is fixed on the shaft 42. The fingers are provided with longitudinal slots in which pins 95 and 96 can be laterally engaged (see also Figure 3) in such a manner that when, in the case of one of the fingers, a pin engages in the slot between the eccentric and the point of the finger the corresponding pin of the other finger engages in the other slot of this other finger situated at the other side of the eccentric. The result of this is that when the eccentric rotates the points of both fingers carry out oscillating movements in opposite directions and the one finger advances the numeral wheel of the register mechanism Z_1 opposite to it at the time, if it happens to be in engagement with it, and the other finger, if in engagement, moves the numeral wheel backwards.

Assume the parts being positioned, as is shown in Figure 7, which is the case in the ordinary method of multiplication. If then for example the multiplier " 10928 " is set on the numeral wheels of the register mechanism Z_1, the arms 86 of the levers 81, 86 are set in the corresponding positions. When the carriage then moves to the right in the manner which has been described, the first arm 86 (reckoning

from right) which corresponding to the digit 8, is thrown by the greater diameter of the disc 82 in the right-hand position shown in Figure 5, strikes against the broad part 63*a* of the rail 47 (Figure 7). The carriage consequently stops in the subtraction position and the right-hand finger 91 (Figure 3) engages the wheel 8 of the register mechanism Z_1. Thus, this is advanced by one tooth at each revolution of the machine shaft 42 in such a manner that the pertaining numeral wheel 58 is rotated by its wheel 9 forwardly in the direction, in which the numerals run, towards "0." In the present case two steps of the wheels 8, 9, 58 are necessary for this purpose, that is to say the machine subtracts the multiplicand twice. For on the second and last step of the wheel 8, the tooth 85 of the disc 82 moves the lever 86 into the extreme right-hand position illustrated in Figure 4 and consequently, the carriage looses its hold on the rail 47 and moves further towards the right. The numeral wheel 58 went therefore from 8 to 9 and from 9 to 0. By this means an actuation of the adjacent left-hand numeral wheel 58 of the tens place in the register Z_1 takes place in known manner, so that this moves from 2 to 3 (tens carrying in contracted multiplication).

The carriage released by the lever arm 86 only moves to the right until the lever arm 86 which belongs to the next numeral wheel 58 (tens place of the multiplier) abuts against the rail 47. This lever arm 86 of the tens place is located, corresponding to the numeral 3 (=2+1), in the left-hand position according to Figure 6 and, therefore, strikes against the + stop of the rail 47, namely against the head 63 of the part 47*a* which is in the position shown in Figure 7. The slide, therefore, is arrested in the addition position so that the product-register Z_2 adds the multiplicand. The addition takes place three times since the numeral wheel 58 of the tens place of the register Z_1 has been moved owing to the preceding tens carrying from the numeral 2 to which it was originally set to the numeral 3. During this addition the left-hand finger 90 engages in the opposite wheel 8 so that the pertaining numeral wheel 58 is rotated back to 0 in the direction opposite to the direction in which the numerals run on the wheel. This is effected in this case by three steps of the wheels 8, 9, 58, that is to say by three rotations of the machine shaft 42. The numeral wheel 58 does not then go from 9 to 0 and no tens carrying takes place, that is to say in this case the numeral wheel 58 of the next denomination (hundreds place) in the register mechanism Z_1 is not affected.

On the last or third step of the numeral wheel 58 of the tens denomination the pertaining lever arm 86 arrives in the right-hand position illustrated in Figure 4, since it is pushed to the side by the tooth 85 of the disc 82. The carriage is now released from the rail 47 and moves further to the right.

In the hundreds place of the multiplier the numeral 9 is set on the numeral wheel 58 of this denomination and the pertaining lever arm 86 is again in the right-hand position illustrated in Figure 5. The arm 86, therefore, strikes against the stop 63*a* of the rail 47 and arrests the carriage in the subtracting position in which, as has already been described in connection with the units place, the right hand finger 91 engages the wheel 8 and the machine subtracts. In this case the subtraction only takes place once. During this, the numeral wheel 58 of the fourth decade (thousands denomination) in the register Z_1 is simultaneously advanced by one step, that is to say from 0 to 1.

In the fourth decade the setting mechanism S_2 adds once. After a further movement of the carriage addition is performed once in the fifth place. In the last two places the arms 86 of the corresponding levers 81 take up the left-hand position illustrated in Figure 6.

In this manner by two subtractions in the units place, three additions in the tens place, one subtraction in the hundreds place and one addition in both the thousands and also in the ten-thousands place, that is to say by eight revolutions of the machine in all, multiplication by the number 10928 is carried out by the contracted method, instead of twenty revolutions corresponding to the sum of the digits in the number 10928 being necessary.

At each release of the rail 47 from an arm 86 it makes a small movement to the left under the counter-action of the right-hand spring of the contact 51. The latter is therefore opened, the motor is disconnected and the setting mechanism S_2 is locked, every time the carriage is moved into its next position.

When the part 47*a* of the rail is in the position illustrated in Figure 8, the operations which have been described are reversed, that is to say the longer stop 63 is effective in the range of the numerals 6 to 9 and the shorter stop 63*a* in the range of the numerals 1 to 5. Figures 5*a* and 6*a* show the relative position of the parts 63, 63*a*, 86 corresponding thereto. The product register Z_2 of the carriage then no longer adds in the case of digits 1 to 5 but subtracts, and adds in the case of digits 6 to 9.

This would give incorrect results if the drive of the register mechanism Z_1 were not reversed at the same time as the position of the part 47*a* was changed. This is effected by means of a lever U (Figure 4) which reversed the fingers 90, 91. The lever U can turn about the pivot 93 (Figure 4) and displaces at the same time by means of its lower arm 87 and the sliding member 94 the claw 47*b* which engages the part 47*a* (Figures 7 and 8).

For effecting this the pins 95 and 96 are fixed on an arcuate member 97 (Figures 3 and 4) which can turn in the space between the two fingers about a fixed pivot 98. Two loops on the member 97 (see Figure 3) hold the lever U in such a manner that when it is reversed (see the dotted position U in Figure 4) the pins 95 and 96 in the case of each finger are withdrawn from the one slot and inserted into the other. By this reversal of the lever U and the reversal of the fingers a product (b. c) is in originating simultaneously subtracted from a number (a), which was entered into the register Z_2 as described above. In this manner the so-called negative multiplication is effected.

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

1. Automatic calculating machine in which, for automatically carrying out multiplication, there are provided two independent setting mechanisms in each of which one complete factor of the multiplication can be set up, and these setting mechanisms are actuated by a rotary shaft of the machine in such a manner that the one mechanism first transfers the complete multiplier which has been set up in it in a single operation to a register mechanism on a carriage and the other mechanism then transfers, the factor, e.g. the multiplicand, which has been set up in it a number of times depending on the multiplier to a second register mechanism of the carriage.

2. Calculating machine in accordance with claim 1, in which the setting mechanisms for the multiplier and the multiplicand each comprise a keyboard each of which is preferably provided with ten keys in each denomination.

3. Automatic calculating machine according to claim 1 or claim 2, in which the members on the register mechanism of the carriage which receive the multiplier from the multiplier setting mechanism are provided with adjusting members which can be set in two positions differing from the position of rest and depending on the setting of the former members and thereby set the carriage in different positions relatively to the second setting mechanism, so that the carriage is driven either in the additive direction or in the subtractive direction.

4. Automatic calculating machine in accordance with any of the preceding claims, wherein the machine shaft which always rotates in the same direction first effects by one revolution a simultaneous movement of all members of the multiplier register mechanism of the carriage by means of the multiplier setting mechanism and then moves the carriage until it is in front of the multiplicand setting mechanism.

5. Automatic calculating machine in accordance with any of the preceding claims, in which the members of the multiplier setting mechanism which drive the multiplier register mechanism of the carriage are oscillating levers, which, according to the adjustment, abut against one of two steps on a stop mounted in the machine frame and thereby determine the movement of the carriage.

6. Automatic calculating machine in accordance with any of the preceding claims, in which the adjusting members of the multiplier setting mechanism are constructed in the form of segments which can turn freely on the machine shaft and in their different positions relatively to fixed discs form gaps of different sizes in the paths of pawls which rotate with the machine shaft and drive wheels of the carriage register mechanism according to the size of the gap.

7. Automatic calculating machine in accordance with any of the preceding claims, in which the stepped stop mounted on the frame of the machine for the carriage as well as fingers controlled by the multiplicand setting mechanism can be reversed by hand, for example by means of a lever, for the purpose of carrying out subtraction operations.

8. Automatic calculating machine according to any of the preceding claims, in which a driving mechanism released by pressing a key or by a similar manipulation automatically effects firstly a sudden movement or jump of the carriage from the multiplier entry position (left hand position) to the right into the position for beginning multiplication and then a step-by-step movement to the right through the various denominations into the final multiplication position and finally a sudden movement or jump to the left back into the first-mentioned position.

9. Automatic calculating machine in accordance with any of the preceding claims, in which a single driving means, for example an electric motor, effects by

means of an automatic mechanism both the jumps of the carriage referred to in claim 8 and also the step-by-step movements of the carriage which are necessary for the calculating operation.

10. Automatic calculating machine in accordance with any of the preceding claims, in which the main shaft of the machine drives on the one hand the carriage by means of a worm gear and on the other hand the multiplicand setting mechanism by means of a disconnectable coupling in such a manner that the latter coupling is automatically disconnected at the beginning of the entry of the multiplier and during its duration by the reaction of the setting mechanism and of the worm gear, and the same action takes place during the return jump of the carriage owing to the reaction of the carriage.

11. Automatic calculating machine in accordance with any of the preceding claims, wherein the drive of all members of the machine is effected by means of an electric motor provided with an axially displaceable rotor.

12. Automatic calculating machine in accordance with any of the preceding claims, wherein a crank disc driven from the main shaft of the machine through the agency of a coupling or clutch effects during its first half revolution by means of a reciprocating rod which drives the shaft of the multiplier setting mechanism the entry of the multiplier in the carriage, and during the second half of its revolution it effects the return of the carriage by suitable transmission means.

13. Automatic calculating machine according to claim 12, in which the transmission means driven by the crank disc for returning the carriage is capable of yielding, being provided, for example, with an automatically locking joint, for allowing the free movement of the carriage by hand in the case of division, addition, subtraction.

14. An automatic calculating machine substantially as described with reference to the accompanying drawing.

Dated the 2nd day of May, 1934.

For the Applicants,
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Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1935.

Fig. 1

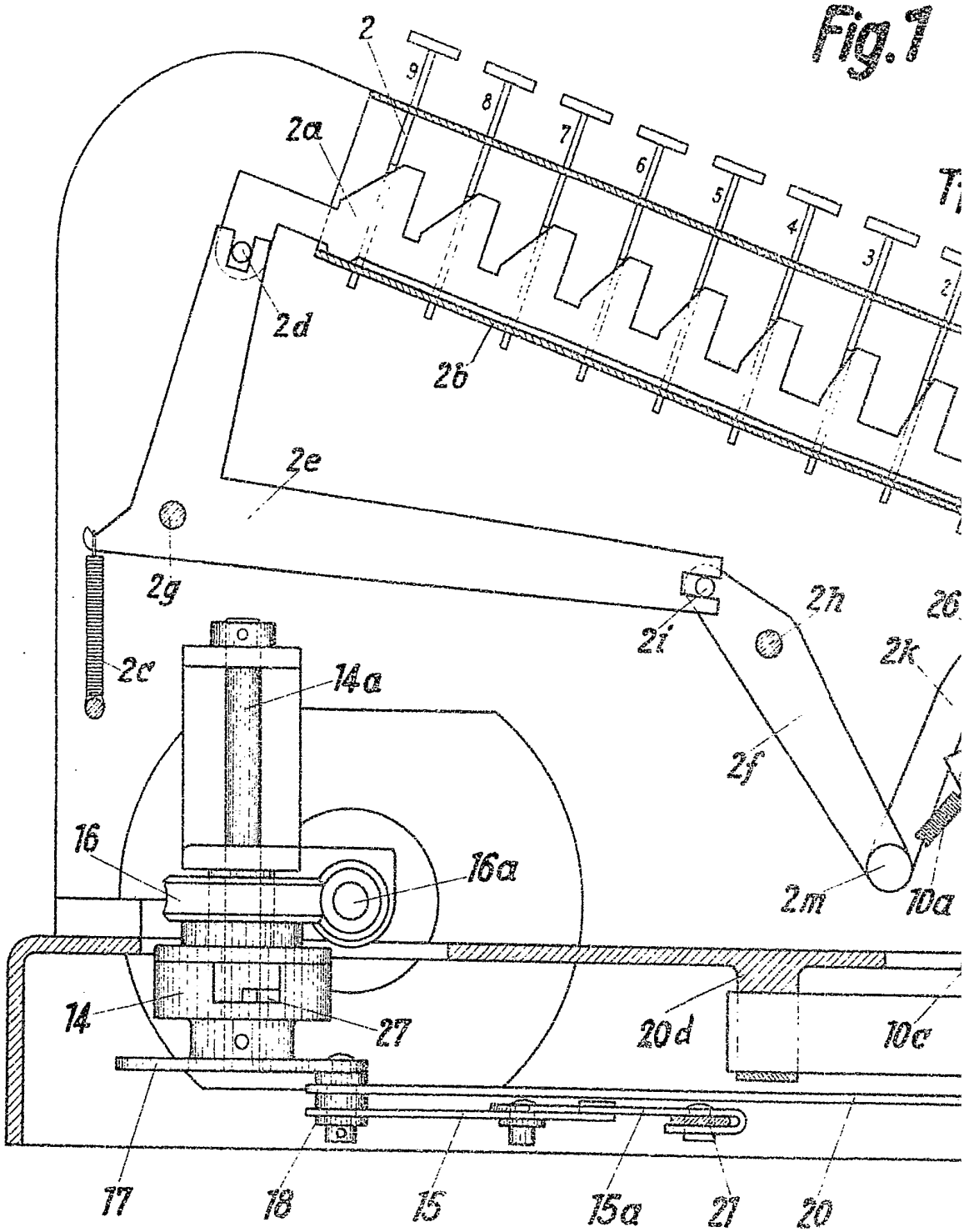

Fig. 1

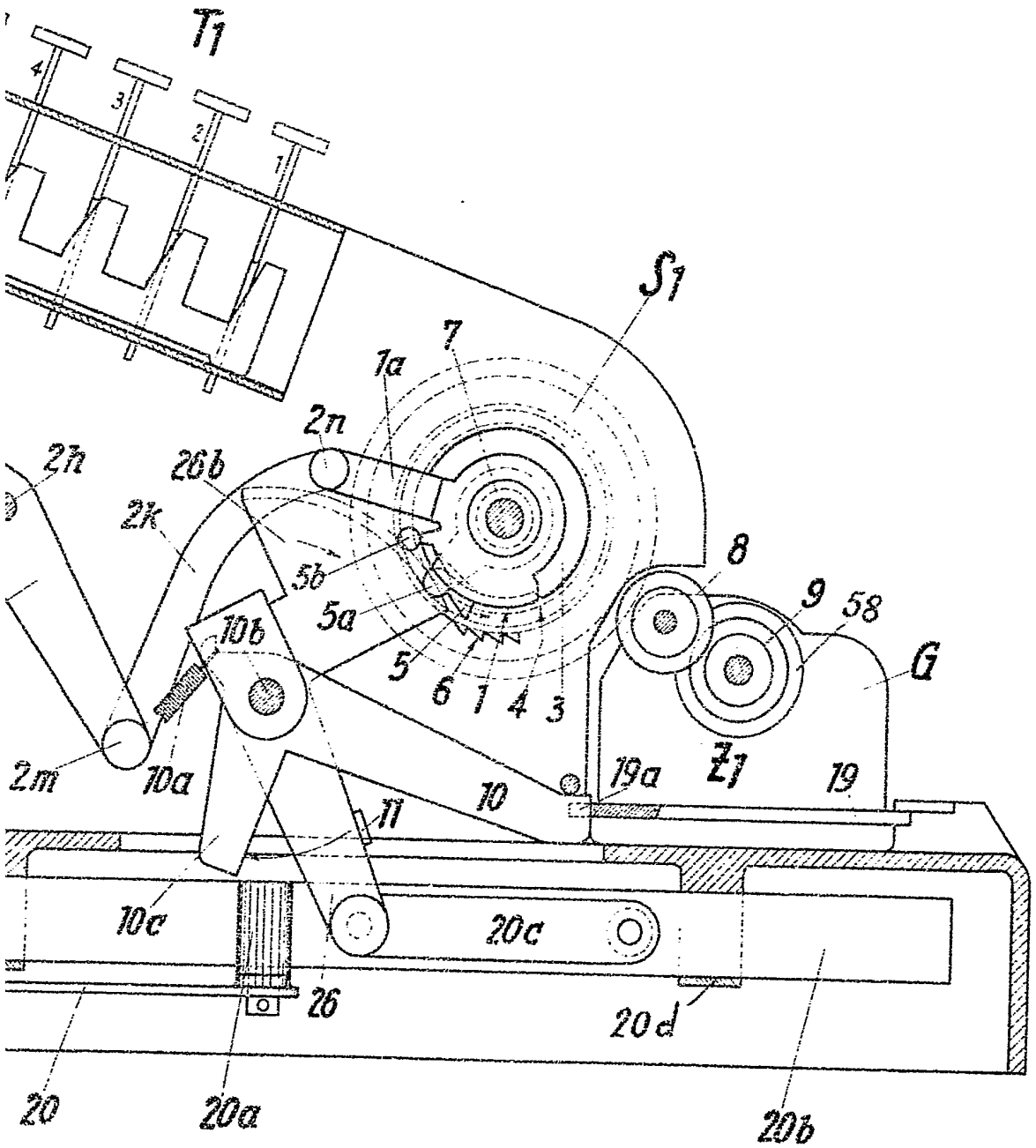

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Fig. 1

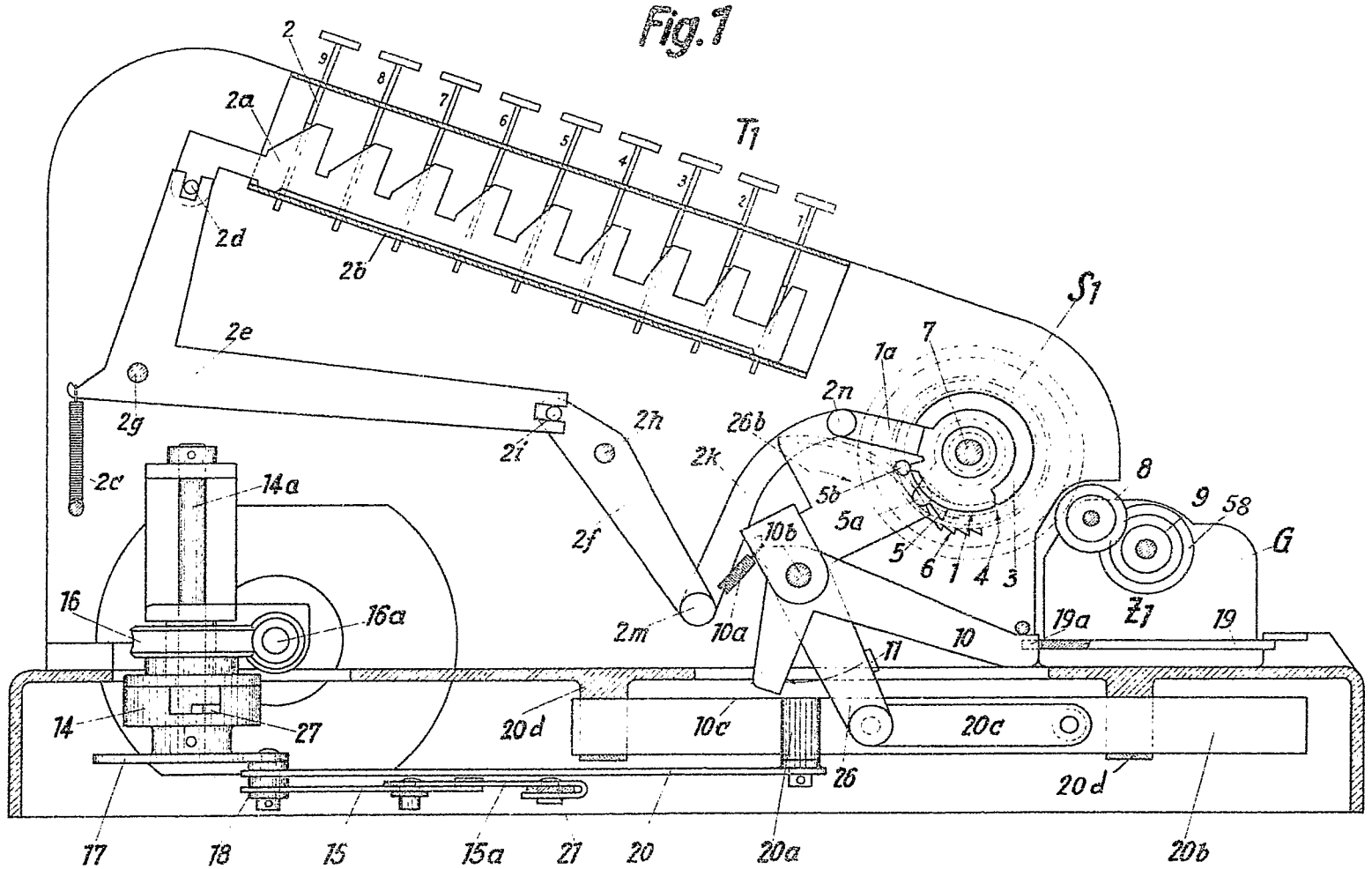

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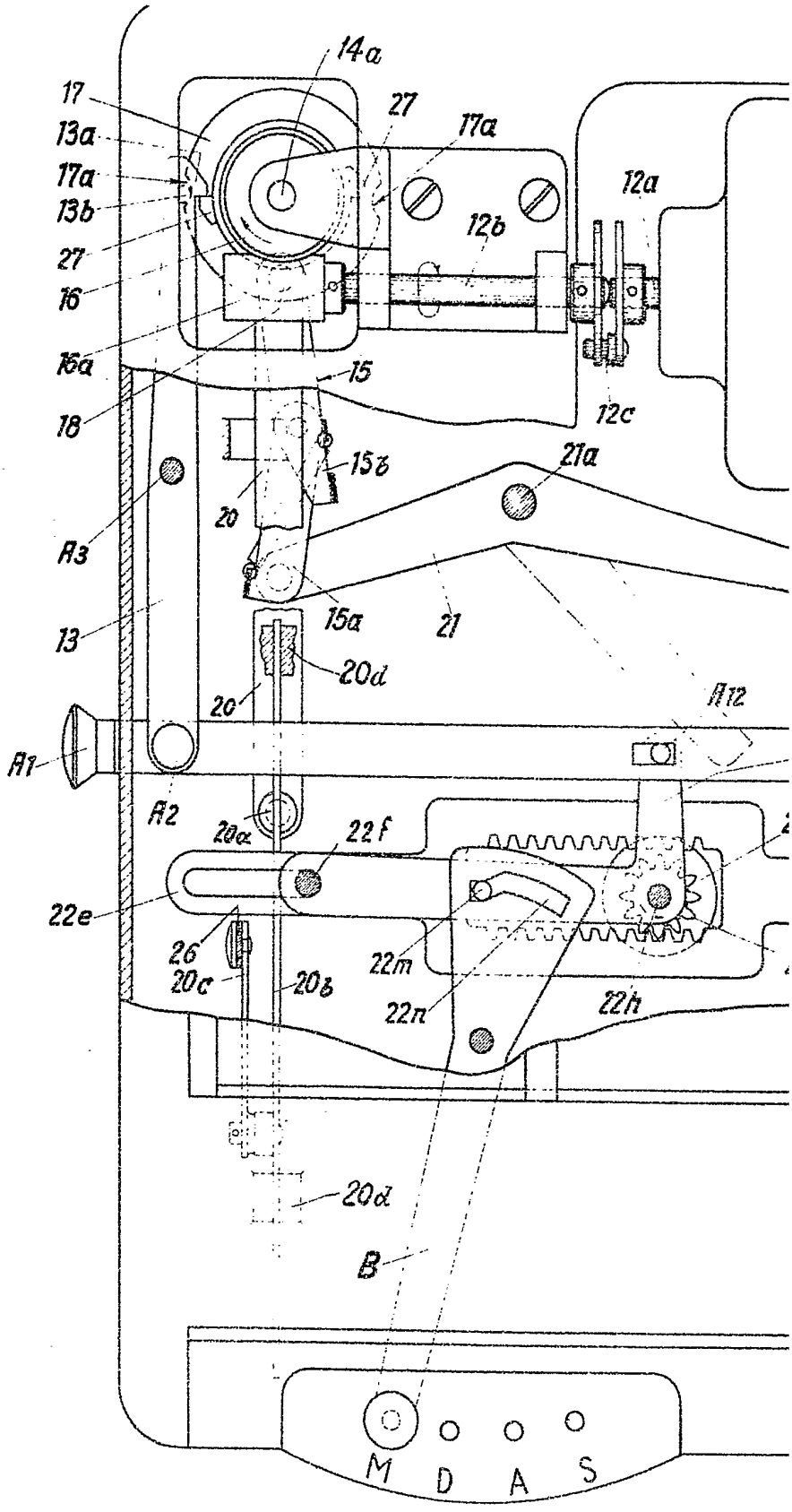
Fig. 2



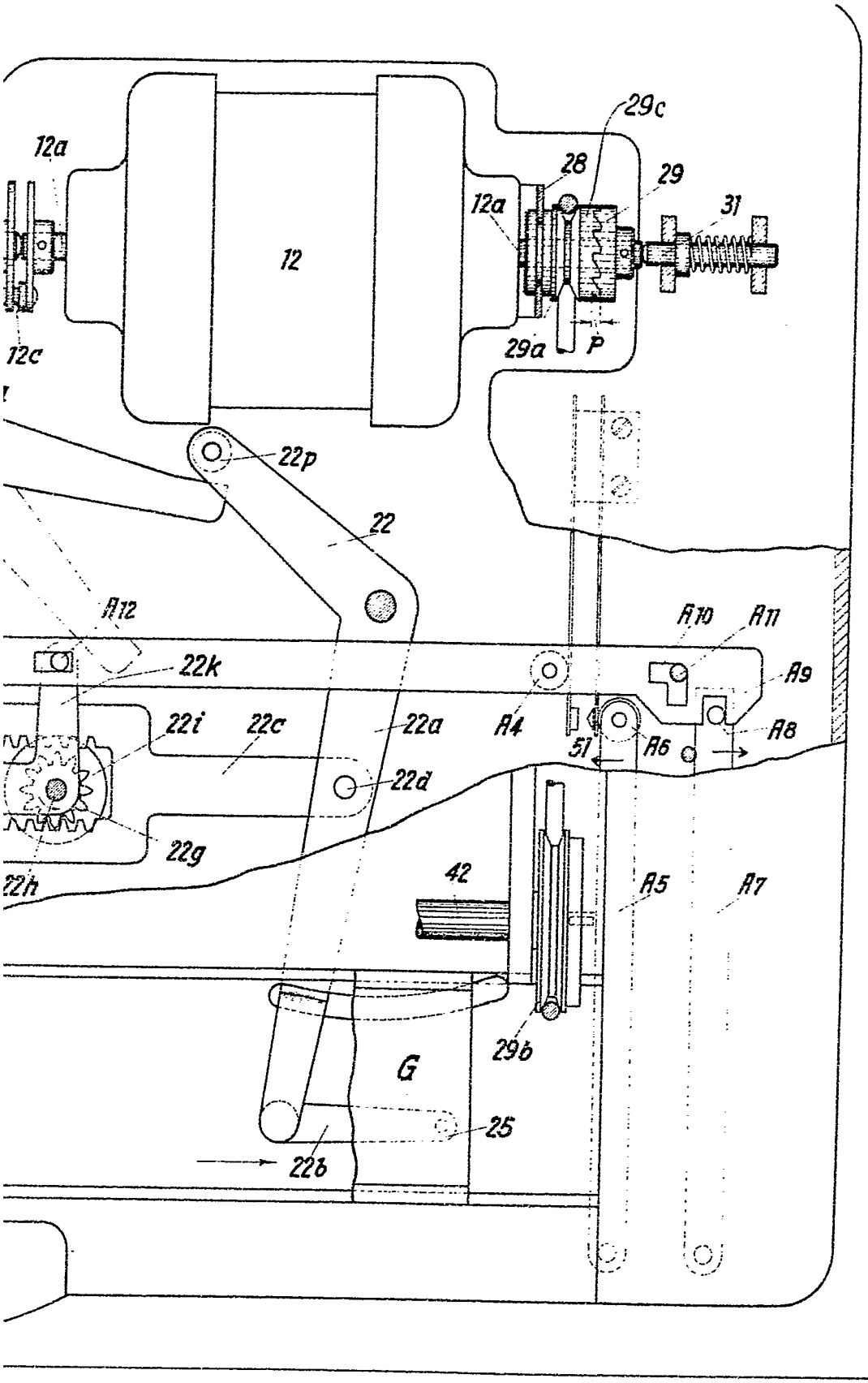


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Fig. 2

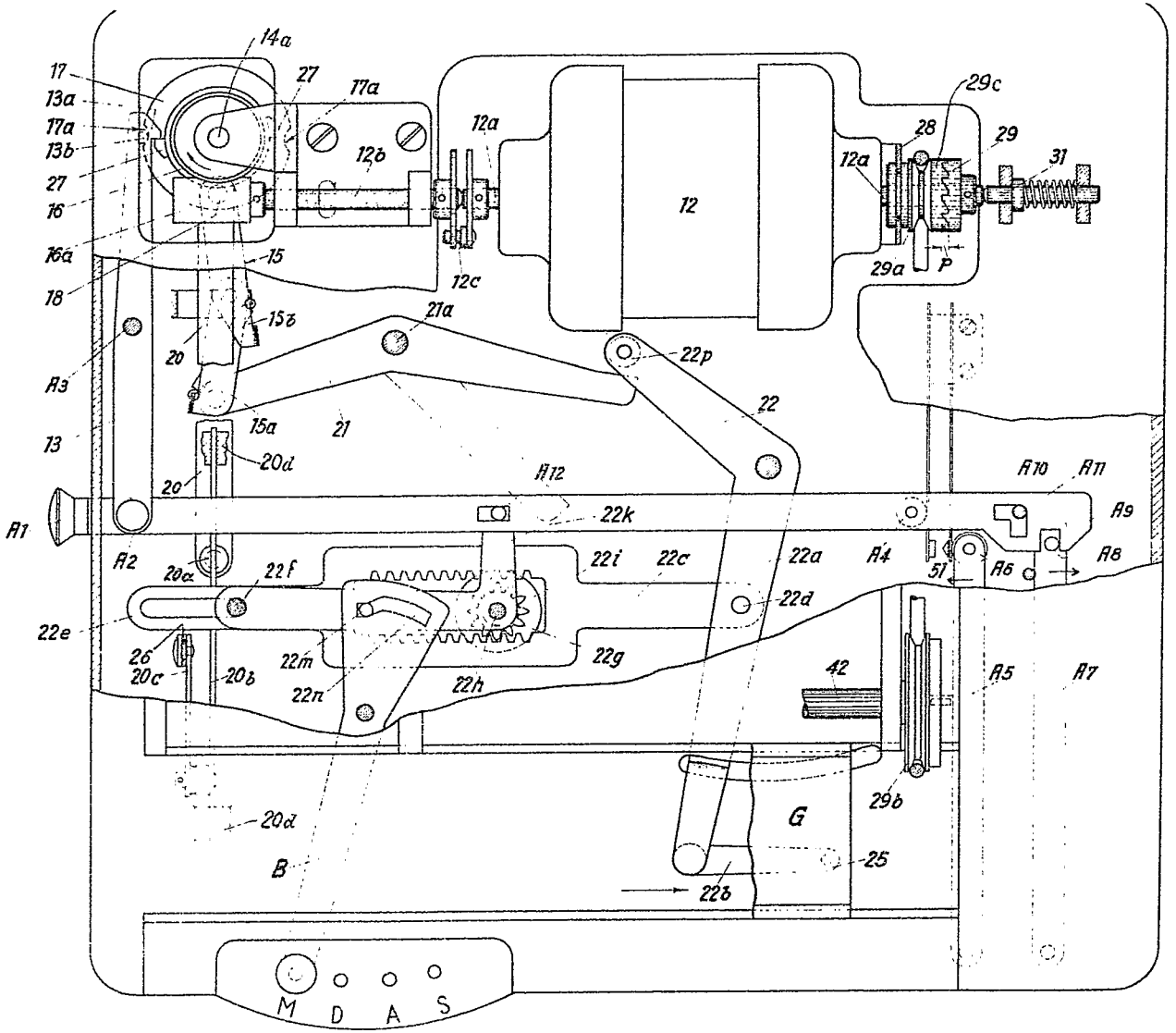

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Fig. 1a

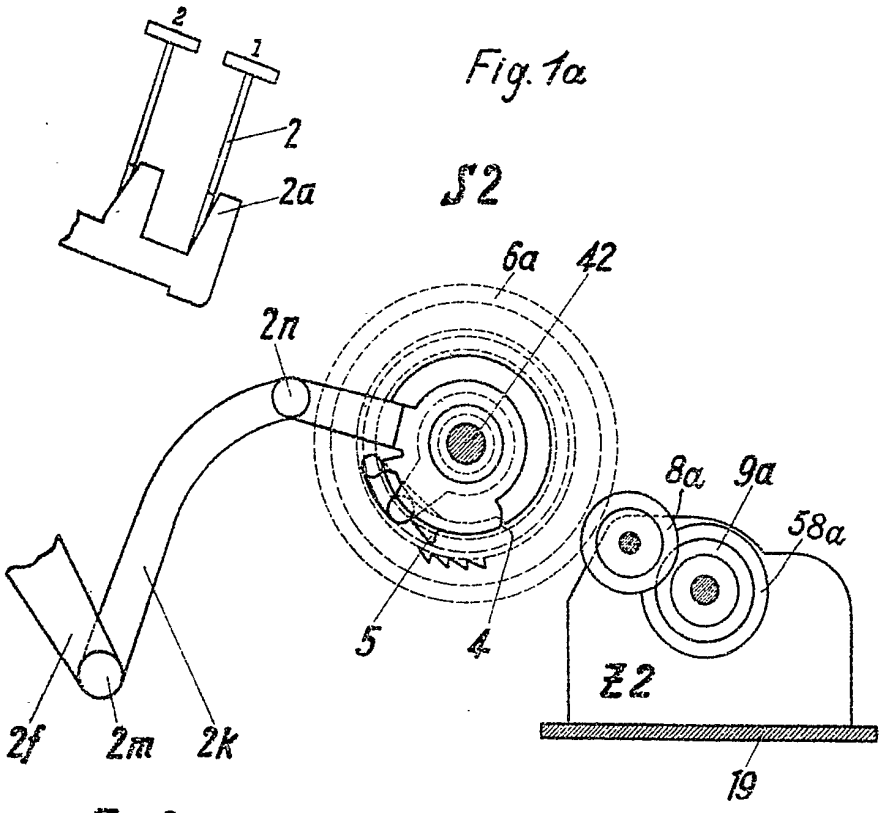
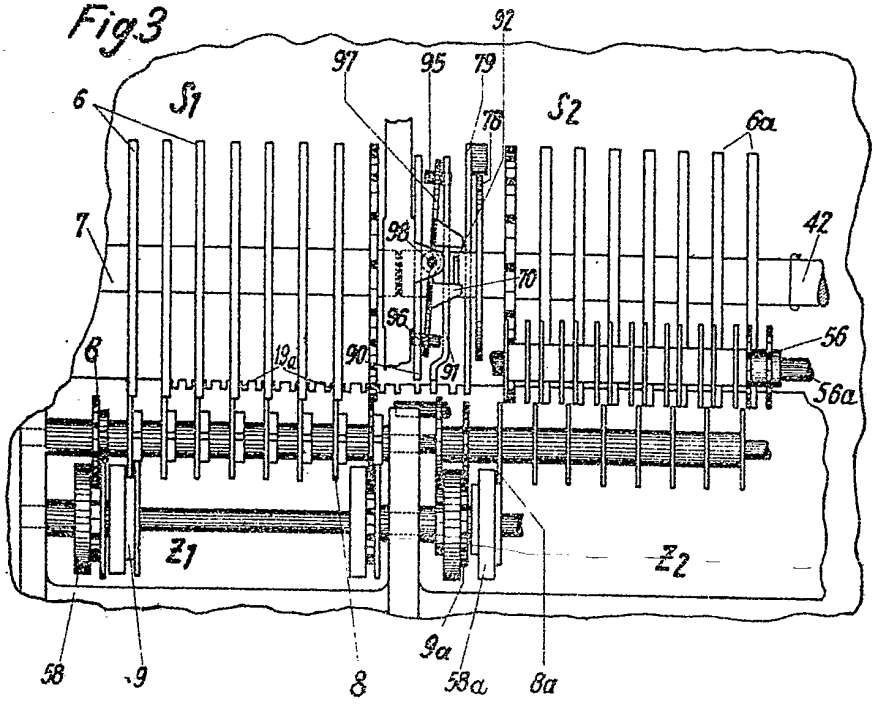


Fig. 3



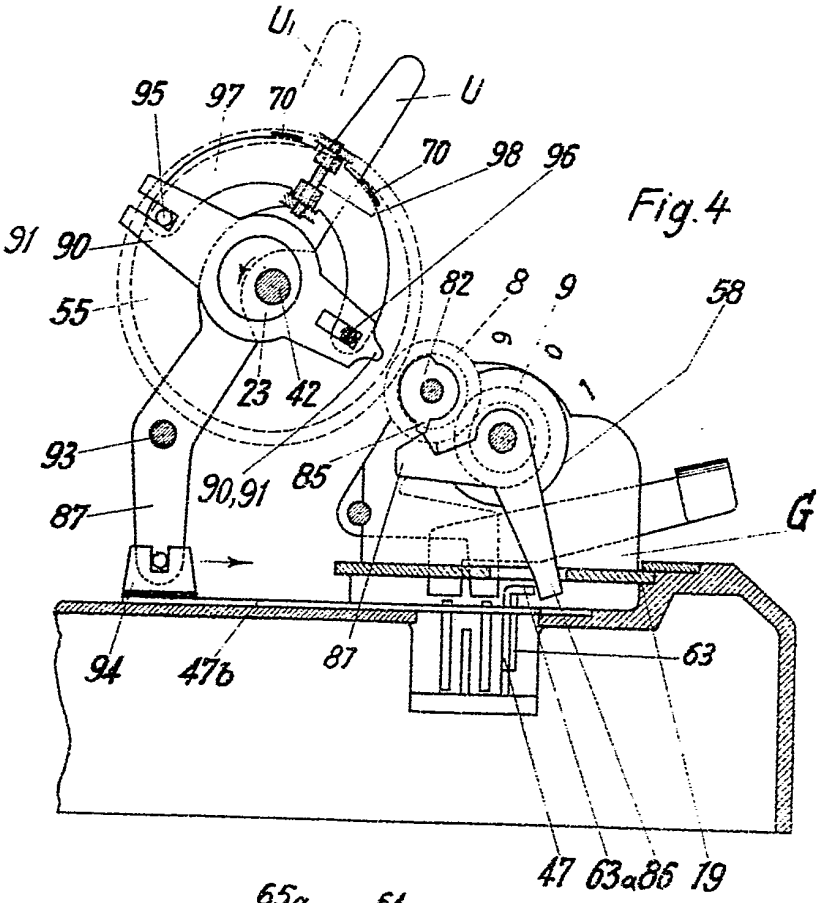


Fig. 4

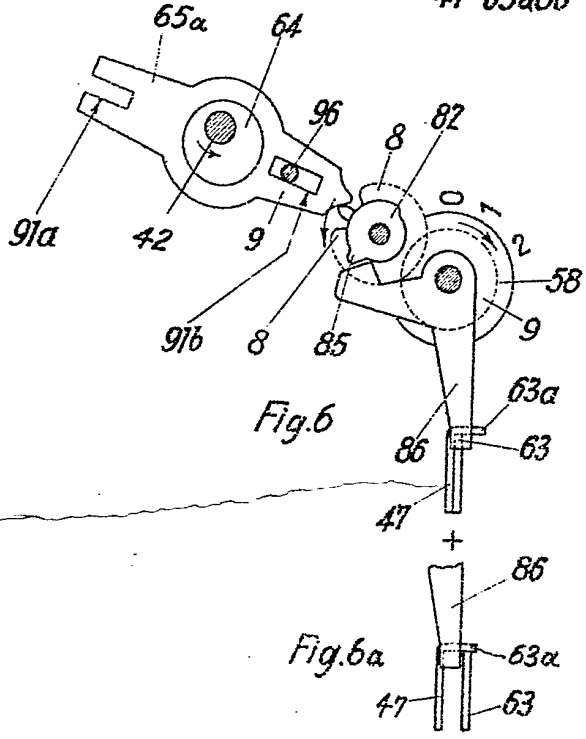


Fig. 6

Fig. 6a

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Fig. 1a

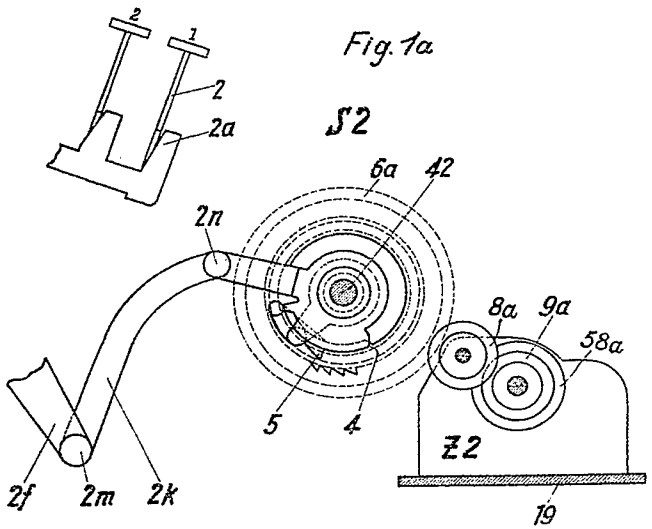
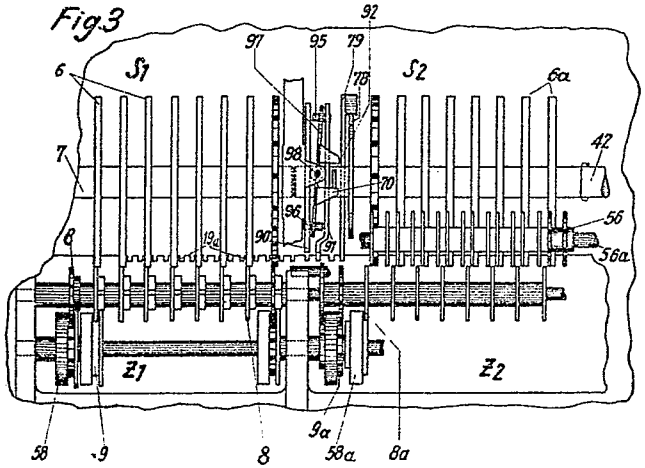


Fig. 3



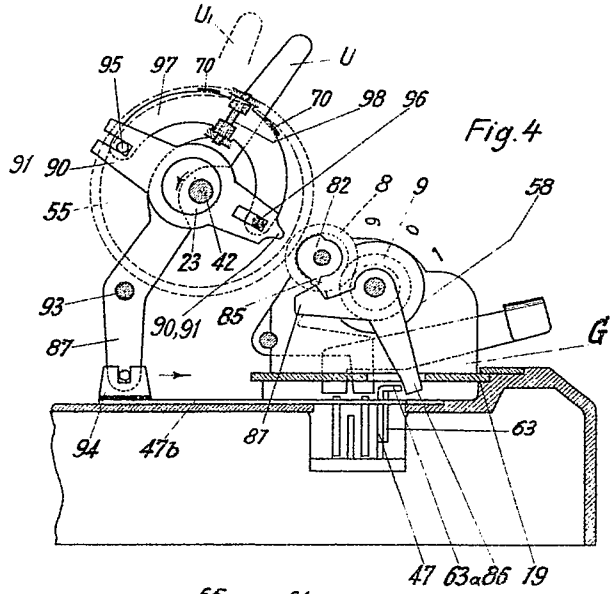


Fig. 4

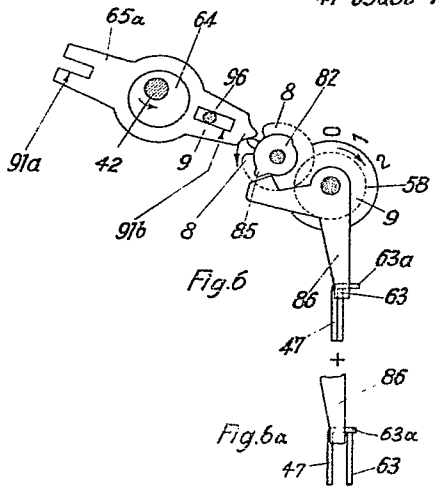


Fig. 6

Fig. 6a

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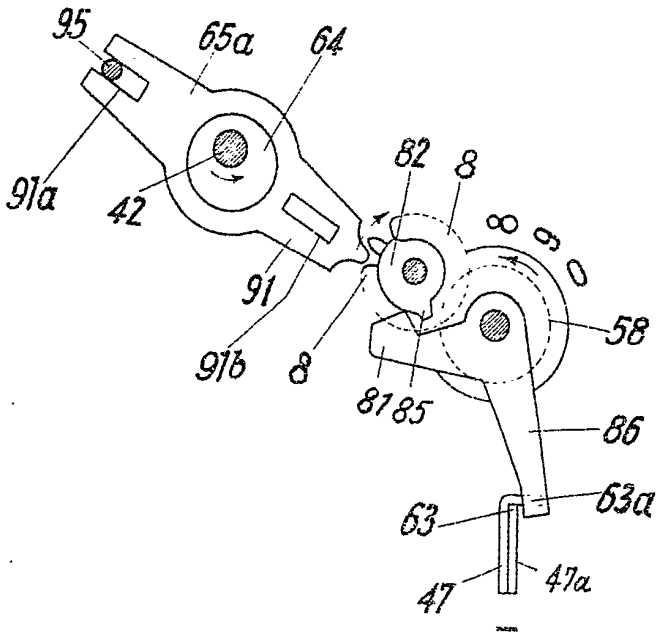
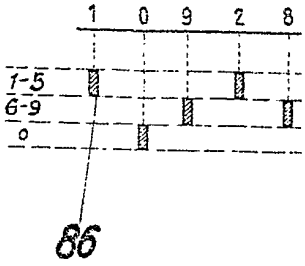
Fig. 5



47b



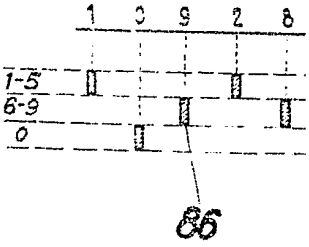
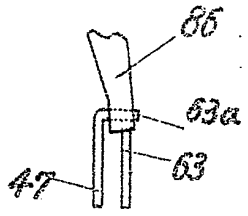


Fig. 5a



Fig

Fig. 7

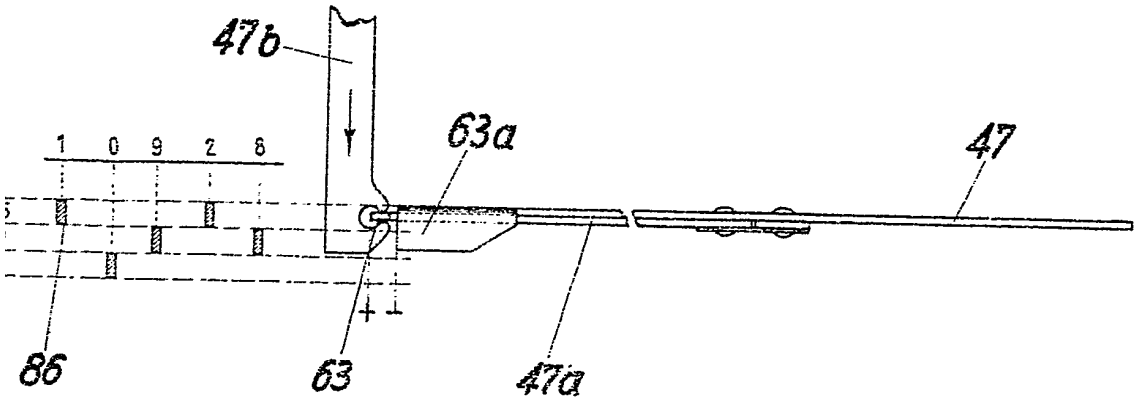
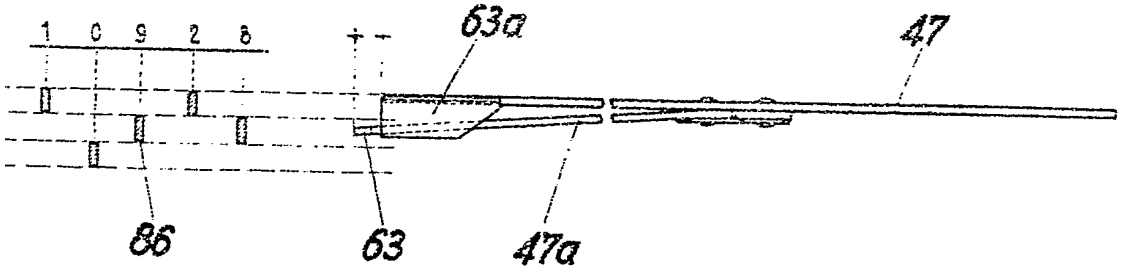


Fig. 8



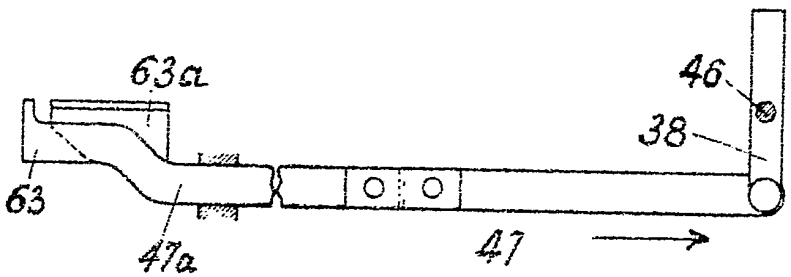


Fig. 9

Fig. 5

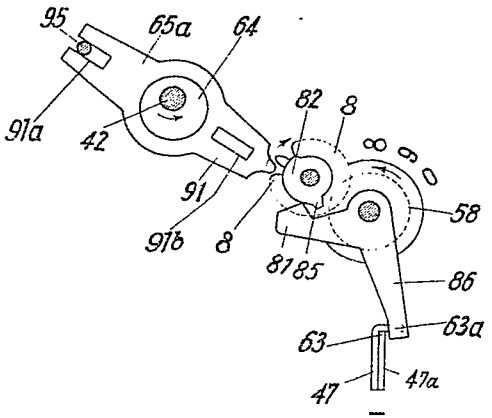


Fig. 5a

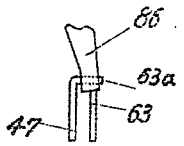


Fig. 7

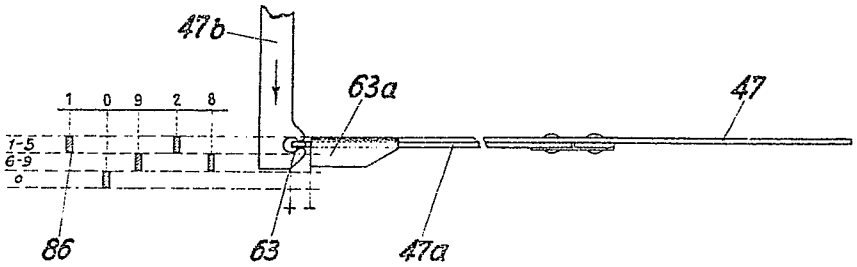
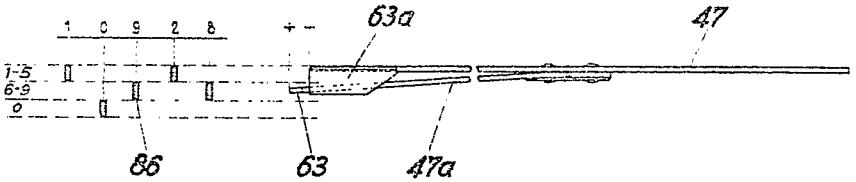


Fig. 8



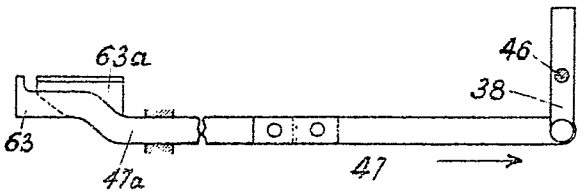


Fig. 9

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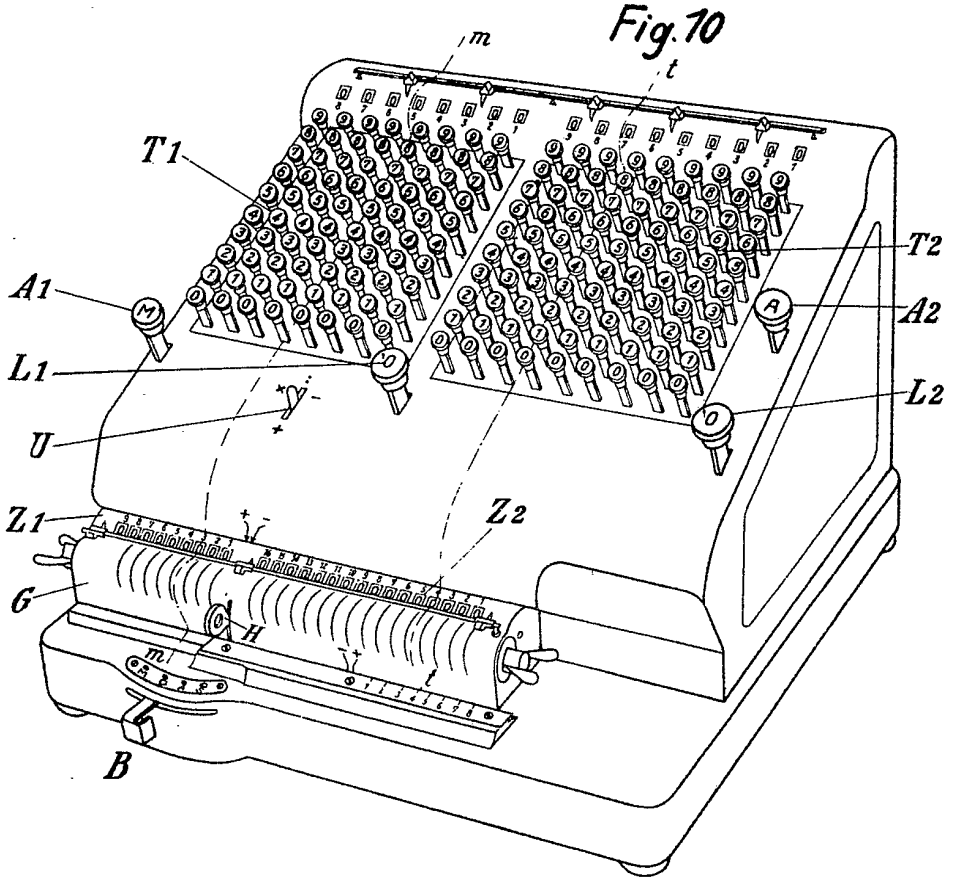
Fig. 10



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