Jan. 7, 1941. A. KOTTMANN 2,227,785

CALCULATING MACHINE HAVING MEANS FOR PERFORMING DIVISION

Filed May 20, 1936 5 Sheets-Sheet 1

Fig. 1

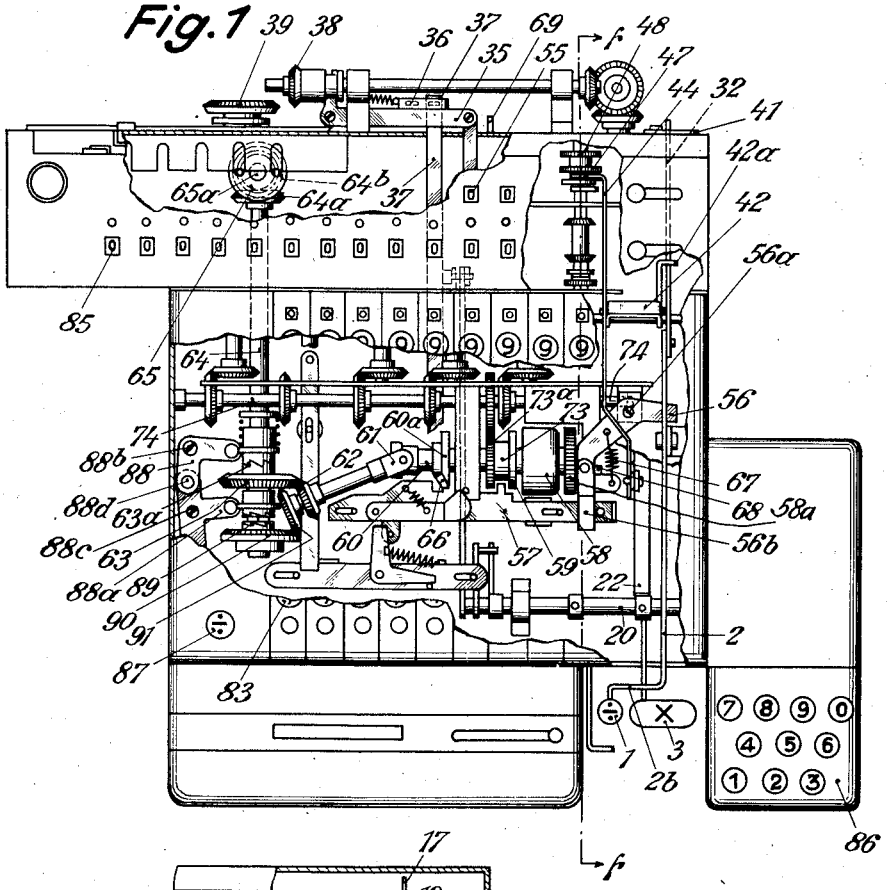
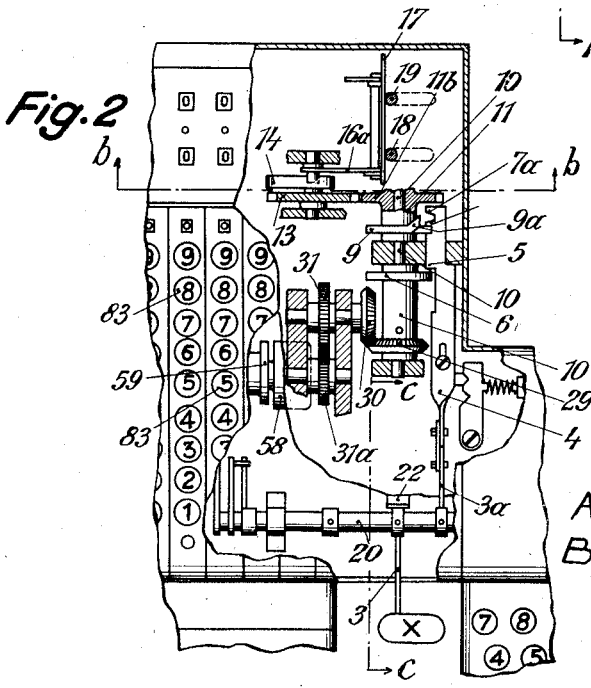


Fig. 2



Inventor:
August Kottmann
By Emil Bömelyche
Attorney

Jan. 7, 1941. A. KOTTMANN 2,227,785

CALCULATING MACHINE HAVING MEANS FOR PERFORMING DIVISION

Filed May 20, 1936 5 Sheets-Sheet 2

Fig. 5

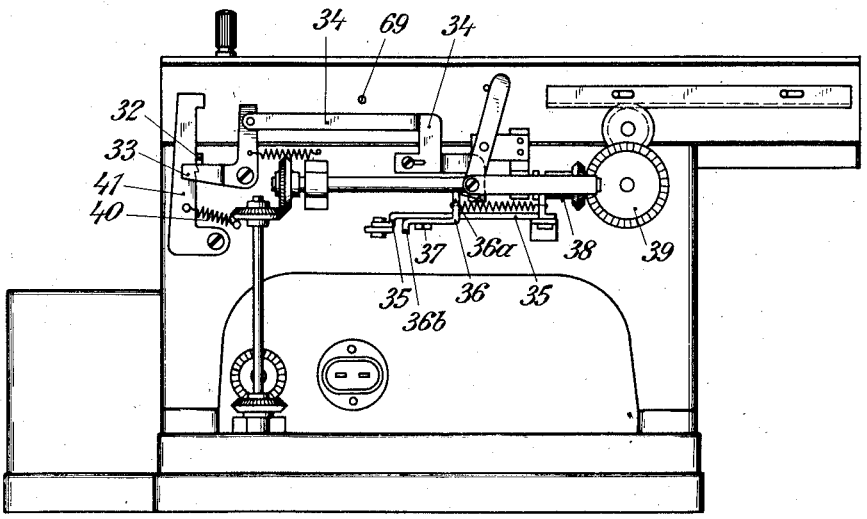
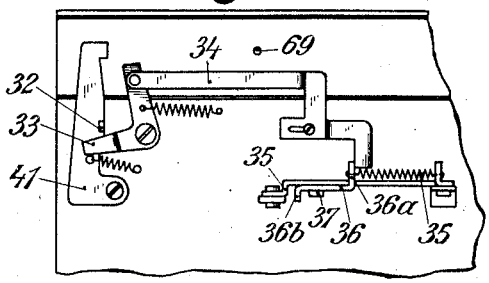


Fig. 6



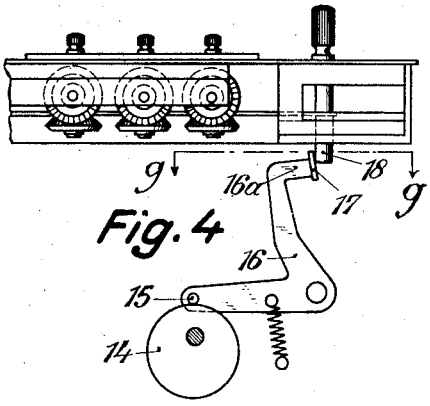


Fig. 4

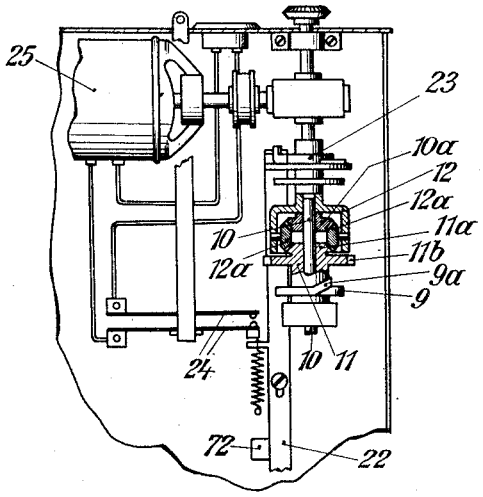


Fig. 3

Inventor:
August Kottmann
By Emil Bönnelycke
Attorney

Jan. 7, 1941. A. KOTTMANN 2,227,785

CALCULATING MACHINE HAVING MEANS FOR PERFORMING DIVISION

Filed May 20, 1936 5 Sheets-Sheet 3

Fig. 7

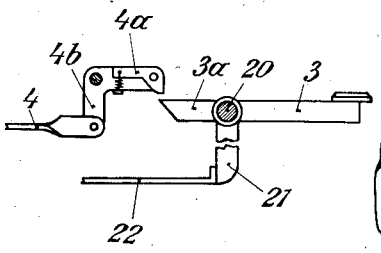


Fig. 8

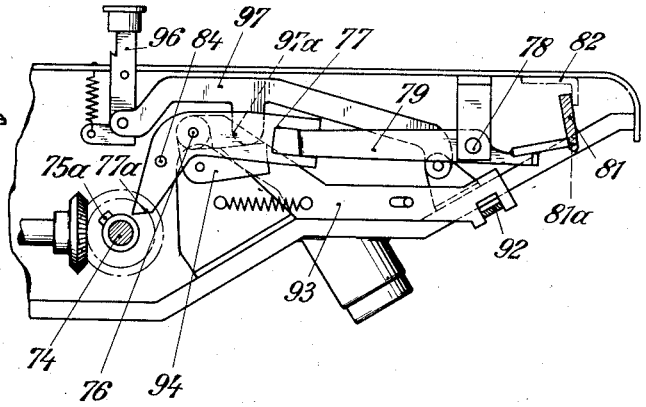


Fig. 9

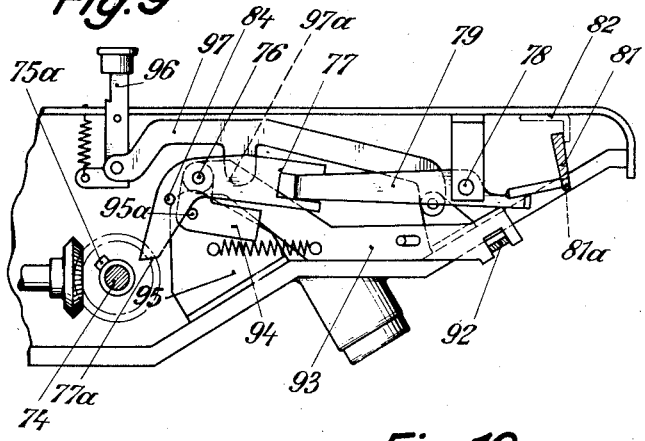
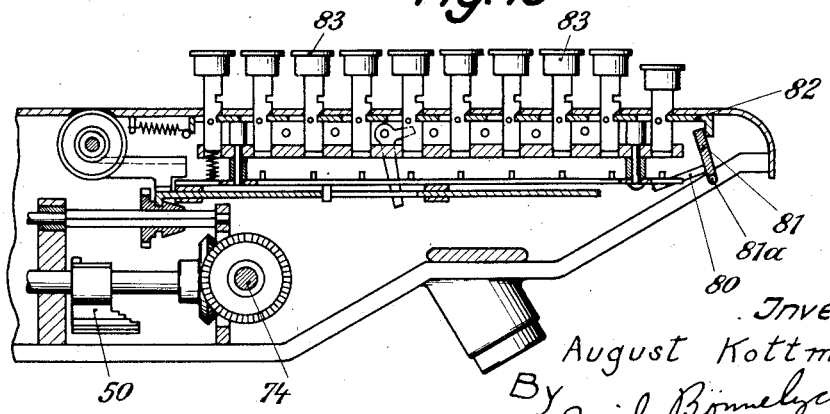


Fig. 10



Inventor:
August Kottmann
By Emil Bönnelycke
Attorney

Jan. 7, 1941. A. KOTTMANN 2,227,785

CALCULATING MACHINE HAVING MEANS FOR PERFORMING DIVISION

Filed May 20, 1936 5 Sheets-Sheet 4

Fig. 11

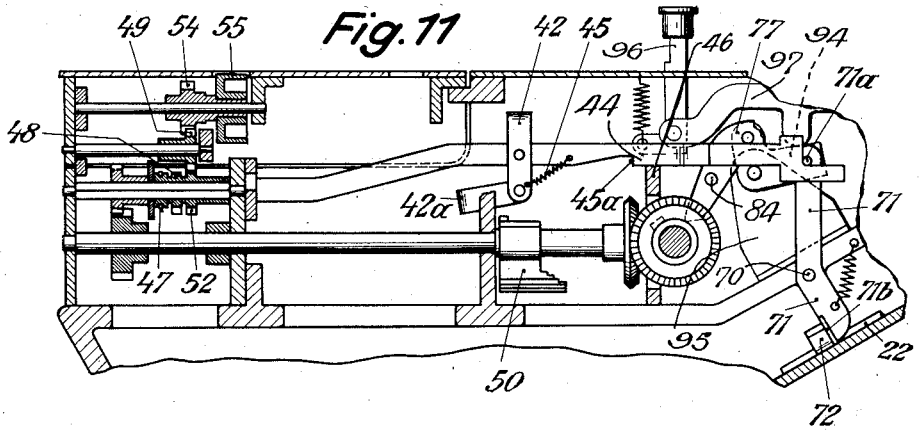
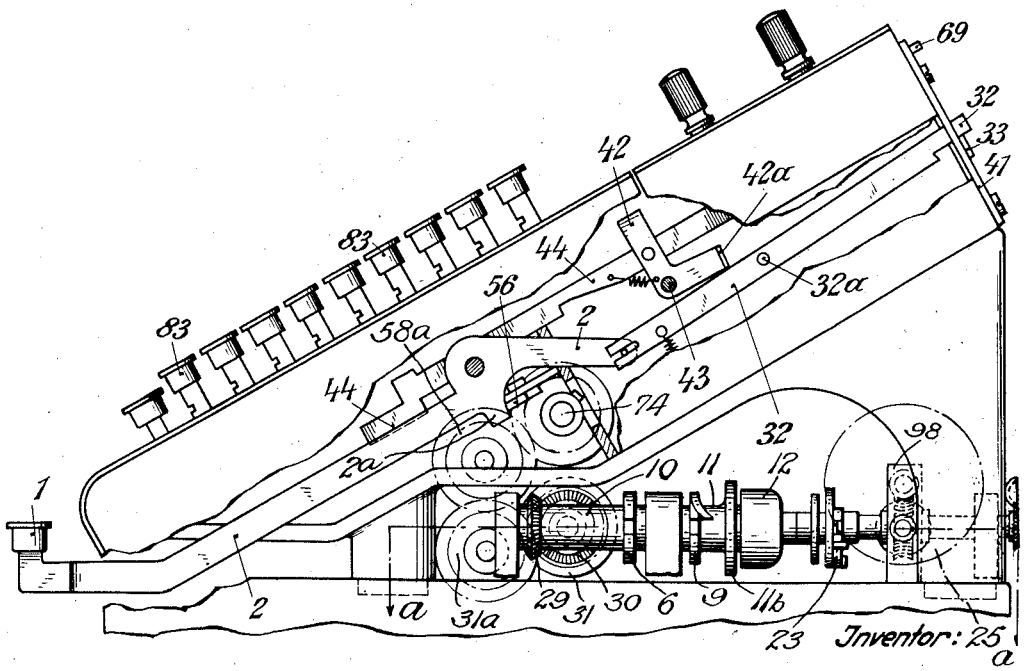


Fig. 12



Inventor:

August Kottmann

By Emil Bönnelycke

Attorney

Jan. 7, 1941. A. KOTTMANN 2,227,785

CALCULATING MACHINE HAVING MEANS FOR PERFORMING DIVISION

Filed May 20, 1936 5 Sheets-Sheet 5

Fig. 14.

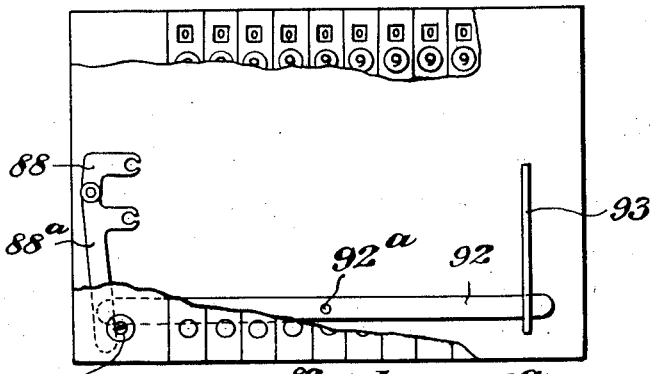


Fig. 15.

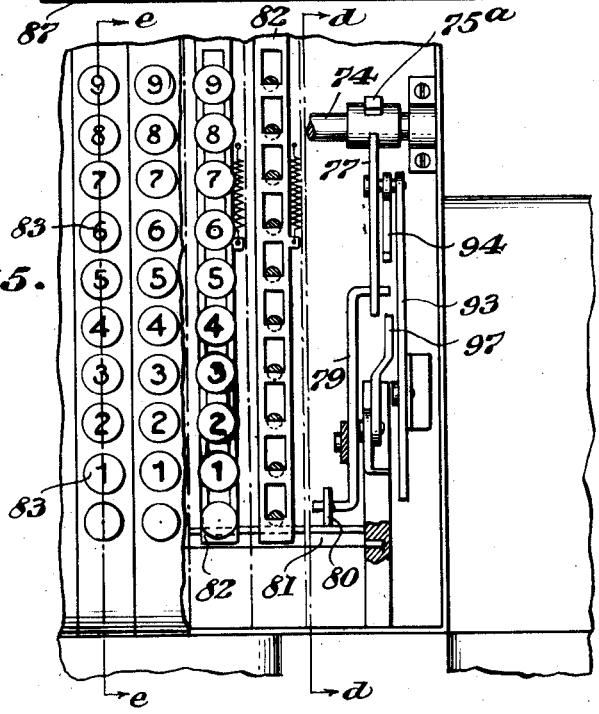


Fig. 14a

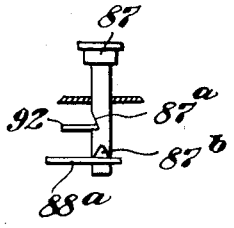
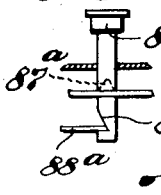


Fig. 14b



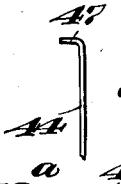


Fig. 13.

Fig. 13a

47

Inventor,
August Kottmann

By Bonnelycke, Young, Emery & Thompson
attys.

Patented Jan. 7, 1941 2,227,785

UNITED STATES PATENT OFFICE

2,227,785

CALCULATING MACHINE HAVING MEANS FOR PERFORMING DIVISION

August Kottmann, Sommerda, Germany, assignor to Rheinmetall-Borsig Aktiengesellschaft, Dusseldorf, Germany, a corporation of Germany

Application May 20, 1936, Serial No. 80,891
In Germany May 23, 1935

1 Claim. (Cl. 235—73)

The invention relates to calculating machines having automatically operating means for performing division.

Before proceeding to perform a division in known calculating machines of this kind, the amounts remaining in the machine from a previous calculation are cancelled by hand, and the accumulator carriage is moved, by hand, into the position suitable for division. The dividend is then set in the keyboard and the mechanism conditioned for addition is actuated so as to transfer the dividend into the accumulator; the transfer movement of the mechanism being registered in the revolution counter (quotient indicator). After the transfer of the dividend, the revolution counter is set manually to zero and the dividend is cancelled from the key-board, also manually. The divisor can then be set in the keyboard and the automatic performance of the division be effected by depressing the division key.

In preparing for division, the dividend can also be set directly in the accumulator mechanism; but this is troublesome and time-wasting because the accumulator mechanism must first be zeroised and the accumulator carriage then pushed into its right-hand end position and only inexperienced calculators proceed in this manner. Experience has shown that one or the other manipulation is often forgotten, so that errors occur.

In automatic-division calculating machines of the known kind, therefore, a large number of manual operations are necessary to prepare for the division operation. By contrast the machine according to the invention is provided with a division preparation device which prepares for the division quite automatically and requires no manual operations other than the keyboard manipulations specifically associated with division, namely setting the machine for division and setting up the dividend and the division. The device starts the motor in operation, zeroises the accumulator, then shifts the accumulator carriage into the end position on the right, and drives the accumulator that is set for addition so that the dividend set in the keyboard is transferred to the main accumulator, puts out of action the gear of the revolution counter (so that the machine movement to perform the aforesaid operation is not registered therein) clears the keyboard, and disconnects the motor again.

A typical embodiment of the invention is illustrated in the drawings, in which Fig. 1 is a plan, with certain cover plates partly broken away, of a calculating machine arranged according to the invention.

Fig. 2 is a plan view of the machine shown in Fig. 1 with certain parts in section and of which the middle part is taken on line *a*—*a* of Fig. 12 and the upper part taken on line *g*—*g* of Fig. 4. Fig. 3 is a partial plan view of the electric motor driving the machine, together with the associated gearing taken on line *a*—*a* of Fig. 12. Fig. 4 is a front elevation of the accumulator and parts of the clearing mechanism taken on line *b*—*b* of Fig. 2. Fig. 5 is a rear elevation of the calculating machine. Fig. 6 is an elevation showing details of the arrangements shown in Fig. 5. Fig. 7 is a sectional view showing a detail and taken on line *c*—*c* of Fig. 2. Fig. 8 is a sectional view taken on line *d*—*d* of Fig. 16 and showing the arrangement of automatically cancelling the dividend set in the keyboard.

Fig. 9 is a view similar to Fig. 8 showing the parts in another position. Fig. 10 is a sectional view of the keyboard taken on line *e*—*e* of Fig. 16. Fig. 11 is a sectional view taken on line *f*—*f* of Fig. 1 and showing the members required for disconnecting the revolution counter. Fig. 12 is a view of the right side of the machine with certain cover plates broken away and showing the manually operated means for initiating operation of the division preparation device. Figs. 13 and 13*a* are side and end views respectively of the locking bar, Fig. 14 is a top view of the main keyboard partly broken away to show the levers operated by the division key, Figs. 14*a*, 14*b*, are side views of the details shown in Fig. 14, and Fig. 15 is a top view partly broken away of a part of the keyboard.

In the embodiment shown, the invention is shown in combination with a calculating machine, sold in America, under the trade-mark "Mathemation" by the Ralph C. Coxhead Corporation, New York, and manufactured by the Rheinmetall-Borsig Aktiengesellschaft, Sommerda, Germany. Such of the arrangements as are important in relation to the invention are described in the U. S. Patents 1,599,093; 1,668,531 and 2,034,724, and in the German Patent 580,027. Nevertheless the invention may also be employed in other known automatic-division calculating machines.

In the embodiment shown, the division preparation device is made operative by depressing the division preparing key 1, with the key lever 2 (Figs. 1 and 12). In depressing the key 1 the bent portion 2_b of the lever 1 depresses the key 3. Through the shaft 20 and intermediate lever 21 (Fig. 7), movement is thus imparted to the control bar 22, which throws-in the clutch 23 (Fig. 3) and at the same time—by closing the contacts

24, admits current to the motor, so that the latter actuates the casing of the differential 12, through the clutch 23. The planet wheels 12_a of this differential gear, which revolve with the casing mesh with the sun wheels 10_a and 11_a the first of which is fixed on the solid shaft 10 and the second on the hollow shaft 11. The solid shaft turns freely in the hollow shaft. The solid shaft 10 Fig. 2, which is an extension of the shaft 10 of Fig. 3, carries the locking wheel 6 and, by means of the bevel pinions 29, 30 and spur pinions 31, 31_a drives the casing of the differential 58. The hollow shaft 11 carries the locking wheel 9 and by means of the pinions 11_b, 13, drives a cam 14 (Figs. 2 and 4).

In addition, on the division preparation key being depressed, the key 3, acting through the shaft 20 and intermediate member 3_a, by-pass pawl 4_a and 4_b, pushes the latching bar 4 (Figs. 2 and 7)—which is adapted to be fixed in two positions—so that its projecting corner 5 engages in a radial slot in the locking wheel 6 on the shaft 10, and its other projection 7 moves out of a radial slot in the locking wheel 9 on the hollow shaft 11. In this way, the shaft 10 is locked and the shaft 11 released so that the cam 14 is actuated by the motor. The parts 4, 6 and 9 are clearly illustrated and described in Patents Nos. 1,846,207 and 2,034,724 in which the parts 32, 20 and 22 of Figs. 6, 7 and 8 in the first patent correspond to these parts and in the second patent these parts are numbered 10, 11 and 14 of Fig. 1 thereof.

A roller 15 of the spring-controlled bell-crank lever 16, runs on the rim of the cam 14 which during the first half turn swings the lever 16 in such a way its end 16_a (Fig. 4) moves towards the right, and the plate 17 attached to said lever is pressed against the clearing devices 18 and 19 of the main accumulator 85 and revolution counter 55, the clearing devices being displaced and thus setting the accumulator to zero. U. S. Patents Nos. 1,797,699 and 2,034,724 show the zeroizing mechanism.

When the clearing is completed and the cam 14 proceeds to complete the first revolution, a spur 9_a, provided on the wheel 9, comes into contact with the projection 7_a on the bar 4, so that the wheel 9, together with all the clearing members, is arrested, whereas the wheel 6, and therefor the shaft 10 is released and motion can now be transmitted from the motor to the casing of the differential 58, by way of the shaft 10, bevel pinions 29, 30 and spur pinions 31, 31_a. After the clearing cycle the lateral surface of the spur 9_a slides along the projection 7_a of the bar 4 to move bar 4 rearwardly as described and shown in Figs. 6, 7 and 8 of Patent No. 1,846,207. The clearing device shown is already described in the U. S. Patent 2,034,724, and consequently, use is made, in the embodiment, shown, of a known clearing device, for the purposes of the invention. Any other kind of clearing device, however, may be employed.

The differential 58 (Figs. 1 and 2) is constructed in the same manner as the differential 12 (Figs. 3 and 12) already described. Its solid shaft 60 carries the locking wheel 60_a and drives the roller plate 65 of the accumulator carriage through the universal joint 61, bevel pinions 62, 63 clutch 63_a shaft 64, bevel pinions 64_a and 64_b and shaft 65_a. The hollow shaft 73 (Fig. 1) carries the locking wheel 59 and drives the main shaft 74 of the stepped actuator gears 50 (Figs. 1 and 10).

On the division preparing key 1 being depressed its associated lever 2 rocks the intermediate lever 32 which is pivoted on the pin 32_a of the machine frame. The lever 32 is held in the rocked position by the pawl 41 (Figs. 1, 5, 6 and 12), mounted on the rear side of the machine and controlled by the spring 40, thereby locking the key 1 in bottom position. A bail 42 (Figs. 1, 11 and 12), the one bent end 42_a of which engages over the lever 32 is turned on its axis 43 (Figs. 11 and 12) when said lever is rocked. In so doing it pushes a pivoted latching bar 44 (Figs. 11 and 12) in Fig. 11 towards the right, until the shoulder 45_a engages behind the upper edge of the wall 46. A fork 47 (Figs. 14 and 14*a*) of the bar 44 disengages the tooth 52 of a pinion 48 from a pinion 49 which drives the revolution counter 55, by way of the pinion 54, said counter being thus put out of action.

The right end (Fig. 11) of the bar 44 bears against the pin 71_a of the lever 71 (which turns on the pivot 70 on the machine frame) and rocks said lever so that its projection 71_b bears against the projection 72 on the latching bar 22 which switches-on the motor and throws the clutch 23 in, thus locking the bar 22 in the operative position.

The bar 22 is pulled forwardly (Fig. 3) by a spring 22_a, and to the right in Fig. 11. As soon as the key 3 and the bar 44 are released the bar 22 is drawn to the right (Fig. 11) and brings its projection 72 against the projection 71_b on the lower end of the lever 71. The two lockings of the bar 22 in engagement position by the arm 21 of the key 3 and by the bar 44 through the pin 71_a and the lever 71, do not mutually affect each other. The double locking is necessary because the key 3, as will be hereinafter described, is released at the instant the accumulator carriage is pushed into its right hand end position. If the bar 22 were locked only by the key 3, the motor 25 and the main clutch 23 would be disengaged as soon as the carriage arrives in the right hand end position, which would be wrong, because the divisor is not yet transferred to the main accumulator, the main keys are not yet released, and the drive of the revolution counter is not yet reengaged. In spite of release of the key 3 the bar 22 must still be held in engaging position, which is effected by the additional locking by the bar 44 and lever 71. This further locking is released only when the division preparation is completed. In Fig. 11 the bar 22 is shown in position of rest, in which it is drawn by the spring 22_a to the right (Fig. 11), because as soon as the bar 44 is released and the lever 71 turned counter-clockwise by the spring 71_c (Fig. 11) the bar 22 under the action of the spring 22_a at once follows the projection 71_b of the lever 71, so that the projection 72 of the bar 22 always lies against said projection 71_b.

In operating the key 1, the lug 2_a (Fig. 12) of the key lever 2 rocks the bell-crank lever 56 (Fig. 1) pivotally mounted on the pin 56_a. The lever 56 pushes the control bar 57 of the differential 58 as described in U. S. Patents Nos. 1,846,207 and 2,034,724 whereby the locking wheel 59, and therewith the gearing of the accumulator, is locked, whilst the wheel 60_a and therewith the accumulator carriage shifting mechanism, is released. Consequently the accumulator carriage is pushed towards the right until it reaches its end position there. At each turn of the shaft 60, the nose 66 of the locking wheel 60_a pushes the control bar 57 temporarily towards the left, but it

is at once pushed back towards the right every time by the spring 67, which tends to hold the pawl-like extension 56b of the bell-crank lever 56 in the position shown in Fig. 1 so that, as a matter of fact, the accumulator carriage can be pushed, through any convenient number of actuating steps, towards the right, although, at each turn of the shaft 60, the control bar 57 is temporarily pushed into the position in which it locks the shaft 60.

Shortly before the accumulator carriage reaches its end position on the right, its pin 69 (Figs. 1, 5 and 12) encounters the pawl 41, thereby releasing the lever 32 and the division preparing key, so that these members return into neutral position under the action of springs. The key 3 is also released at the same time as the key 1, and returns into neutral position, the lever 56 passing into a position in which its resilient extension 56b no longer tends to push the control bar 57 (Fig. 1) towards the right, the bar 57 then remaining in the position into which it is pushed by the nose 66 that is in the left hand position. However, the carriage shifting mechanism is then locked and the shaft 74 driving the stepped actuator gears is actuated. The dividend previously set in the keyboard 83 is therefore transferred into the accumulator, but the machine movement is not indicated in the revolution counter, because the latter is set out of action by the displacement of the bar 44.

On the right end of the shaft 74 which rotates in Figs. 8, 9 and 10 counter-clockwise and moves the stepped actuator gears 50, is a cam 75a (Figs. 8 and 9) which when the transfer of the dividend into the accumulator is finished encounters the tip 77a of the lever 77. The cam 75a rocks the lever 77 on its pivot 76 in such a way that through the agency of the lever 79, which turns on the pivot 78 it turns the clearing member 81 on its pivot 81a. By this means the locking bars 82 (Fig. 10) of the keyboard are moved out of the locking position, so that the keys 83 return into neutral position thus clearing the dividend in the keyboard.

At the same time, the pin 84 of the lever 77 raises the bar 44 (Figs. 9 and 11) so that its shoulder 45a is moved away from the upper edge of the wall 46. Consequently, it returns into neutral position under the influence of the spring 45 (Fig. 11). In this way, the revolution counter again comes into operation, and the lever 71 releases the bar 22 so that the motor 25 is switched off and the clutch 23 disengaged.

The preparation for division is now completed, and the divisor can be set in the keyboard and the division can be performed automatically by depressing the division key 87.

Consequently, all that is needed for performing the division with the calculating machine according to the invention is to set the dividend, then depress the preparation key, set the divisor and depress the division key, whereupon the other operations for performing the division proceed in a perfectly automatic manner.

On the division key 87 being depressed, the toggle levers 88, 88a, which turn on the pivots 88b and 88c on the machine frame and are connected together by the pin and slot connection 88d disengage the clutch 63a and throw-in the clutch 89 so that the shaft 60 now drives the carriage shifting mechanism through bevel pinions 90, 91 instead of through the bevel pinions 62, 63. The direction of rotation of the roller plate 65 of said carriage shift mechanism is thereby reversed and pushes the accumulator carriage towards the left (as is required for automatic division) and no longer towards the right as before. As soon as the division is completed and the division key returns into neutral position, the clutch 63a is thrown in again and the clutch 89 disengaged, thereby preparing the carriage shifting mechanism for traverse of the carriage towards the right again.

In addition on the division key 87 being depressed the sliding bar 93 (Fig. 9) is pushed towards the right by a lever 92 (shown only in cross section in Figs. 8 and 9) disposed transversely under the machine. By this means, the pin 76 of the lever 77—which is articulated, by means of the bell-crank lever 94, to the pin 95a of the holder 95 mounted in the machine frame—is also displaced towards the right, so that the tip 77a of the lever 77 passes out of reach of the cam 75a, thereby disengaging the cancelling device of the keyboard. It is not until the division key 87 has returned into neutral position after the division is completed, that the tip 77a again comes within reach of the cam 75a, so that, now the division is completed, the divisor is cancelled. The cancelling device of the main keyboard 83 can also be put out of action by depressing the key 96, whereupon the projection 97a of the lever 97 presses on the free arm of the bell-crank lever 94, thus rocking the latter and withdrawing the tip 77a of the lever 77 from the action of the cam 75a.

The means whereby the key 87, the toggle levers 88, 88a, and the sliding bar 93 are moved by the lever 92, is shown in Figs. 15, 15a and 15b. The stem of the key 87 has two ramps 87a, 87b, which on depression of the key rock the levers 88a and 92. The lever 88a moves the lever 88, and the lever 92 which latter is pivoted at 92a moves the bar 93 to the right in Figs. 9 and 10, and downwardly in Fig. 15.

By the depression of the division key 87, the drive for the accumulator can also be conditioned for subtraction by known means, the division being performed, for example with the automatic device represented in U. S. Patent 1,846,207.

The embodiment shown represents the invention in combination with a calculating machine which is arranged for automatic multiplication (as well as division), and also for addition and subtraction.

The automatic multiplying device and the return mechanism of the machine may, for example, be designed as described in German Patent 580,027. Since the multiplying device and a carriage return mechanism which automatically returns the carriage to its initial position after every multiplication does not constitute a feature of the invention, they will not now be described again.

The key 3, which is depressed along with the preparing key 1 also forms, in relation to the automatic multiplying device, the multiplication key and the return key for the return mechanism. That is for automatic multiplication the depression of the key will set the multiplication in operation and upon return movement of key 3 the carriage-return mechanism is set in operation. In preparing for division, the means automatically controlling the multiplication are inoperative, nothwithstanding the depression of the multiplying key 3, because no multiplier is set in the multiplier key-board 86 and in the setting members subordinated thereto. However, directly the multiplication key 3 returns into neutral po-

sition, the accumulator carriage is automatically returned into the original position by the return device provided in the machine. This, however, must be prevented in preparing for the division, as described in German specification No. 580,027.

For automatic multiplication, the carriage-return device is connected up as soon as—during the return of the multiplier key 3 into neutral position—the bar 37 (Figs. 1, 5, and 6), is pushed rearwards out of the machine, and so strikes against the bent end 36_b of the sliding bar 36 mounted on the lever 35, to rock said lever so as to bring the bevel pinion 38 into gear with the bevel pinion 38.

In preparing for division, the connecting means for the carriage-return mechanism is rendered inoperative inasmuch as, in depressing the division key 1, the lever 32 (Figs. 12, 5 and 6) actuated by said key turns the bell-crank lever 33 (Figs. 5 and 6) mounted on the rear side of the machine which pushes the bar 36, by means of the intermediate member 34, and so withdraws the plain end 36_b of the bar 36 from the influence of the bar 37 which initiates the return stroke of the carriage.. In German Patent No. 580,027 there is individually described how the end 36_b of the bar 36 comes into operative contact with the bar 37. In said German patent other reference characters are used than in this specification as, the bar 37 by 15 (its end by 14_a), the lever 35 by 23, the bar 36 by 24, and the end 36_b by 24_b, the conical wheels 38, 39 by 29 and 30.

In the example shown, the mechanism for division preparation consists of two serially disposed differentials 12, 58. This design is preferred because the differentials to which the division preparation mechanism is to be applied are already present in the calculating machine. For automatic multiplication, the first differential 12 present in the machine serves, every time the machine is set for a new multiplication, to cancel automatically, in the first place, the product of the previous multiplication and thereafter only to switch the motor over to the multiplication gear. The second differential 58 serves for alternately actuating the accumulator mechanism and the shifting mechanism of the accumulator carriage, for automatic multiplication and automatic division, in accordance with the particular calculating operations to be performed.

The machine to which the invention is to be applied also already contains the cancelling device for the main keyboard according to Figs. 8 and 9. In this machine it serves, in cases of addition and subtraction, for the prompt automatic cancellation of the values set in the main keyboard, after the addition has been performed. In this case again, an existing device is utilized for the purposes of division preparation. A different arrangement may however be employed for cancelling the digits set up in the main keyboard.

In the embodiment shown, therefore, use is made in connection with the purposes of the invention, of existing mechanism. The only new devices in the machine shown are the division preparation key (Figs. 1 and 12); the key lever 2 (Figs. 1 and 12); the lever 32 (Figs. 1 and 12); pawl 41 (Figs. 1, 5, 6 and 12); pin 69 (Figs. 1, 5, 6 and 12); bell-crank lever 56 (Figs. 1 and 12); angular bail 42 (Figs. 1, 11 and 12); latching bar 44 (Figs. 1, 11 and 12); lever 71 (Fig. 11); pin 84 (Figs. 8, 9 and 11); bell-crank lever 33 (Figs. 5, 6 and 12), and the intermediate member 34 (Figs. 5 and 6). Thus, there are altogether 12 new members in the machine, all of which can be conveniently and cheaply made by stamping and bending, without any unusual requirements in respect of accurate workmanship.

These members combine with existing known mechanism in a novel manner and bring them into properly co-ordinated operation to prepare for division. The existing known mechanisms therefore constitute members of the assembly for preparing for division.

I claim:

In a calculating machine capable of performing division by automatic repeated subtraction having an accumulator, a revolution counter, a traversing carriage in which said accumulator and counter are mounted, drive means for the accumulator, drive means for the revolution counter, a keyboard for setting up amounts in said accumulator drive means, carriage shifting mechanism, key release means, an electric motor, drive connections between the shaft of the motor and the accumulator drive means and the counter drive means and the carriage shifting mechanism; the combination of a control mechanism operable to engage and disengage said various drive connections to complete preparation of the machine for automatic division initiated only by the keyboard operations specifically associated with division, means actuated by depression of a key to cause said control mechanism to disengage the counter drive means from the motor shaft when said division setting is effected and to start the motor, means for engaging the motor shaft with the drive connection of the carriage shifting mechanism, means actuated by the carriage at the end of its traverse to cause the control mechanism to disengage the drive connection of the carriage shifting mechanism and engage the drive connection of the accumulator drive means whereby the said drive means effects transfer of the dividend previously set up on the keyboard into the accumulator and at the end of this transfer actuates the key release means, and means actuated at the end of this transfer to cause the control mechanism to first re-engage the revolution counter drive means and to break the drive connections of the accumulator drive, and then to stop the motor, said control mechanism effecting said drive operations in the sequence stated.

AUGUST KOTTMANN.