Jan. 9, 1962 J. LYDFORS 3,016,188

MULTIPLIER PRINTING MECHANISM

Filed May 27, 1959 6 Sheets-Sheet 1

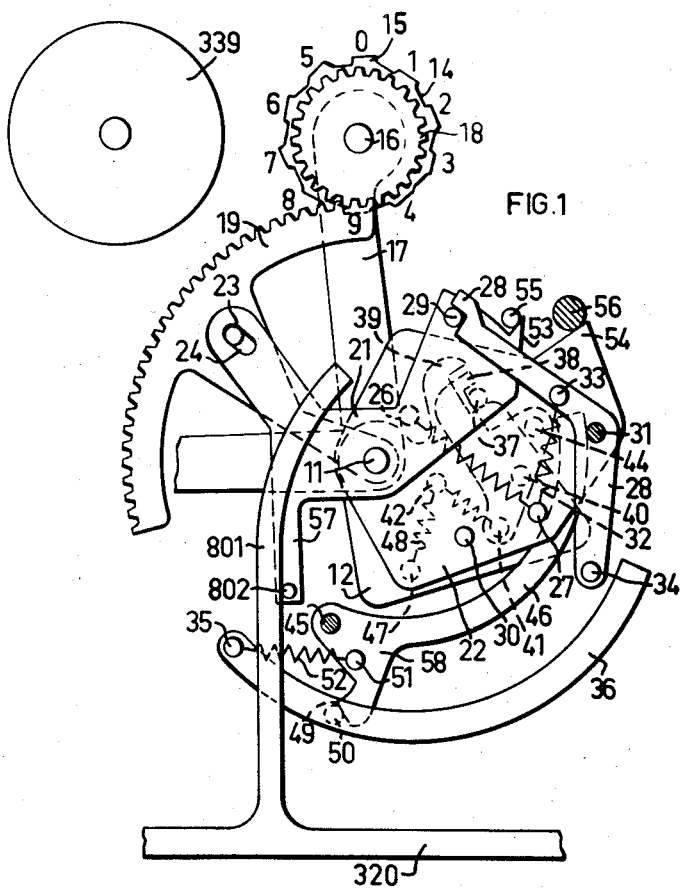

FIG.1

Jan. 9, 1962 J. LYDFORS 3,016,188

MULTIPLIER PRINTING MECHANISM

Filed May 27, 1959 6 Sheets-Sheet 2

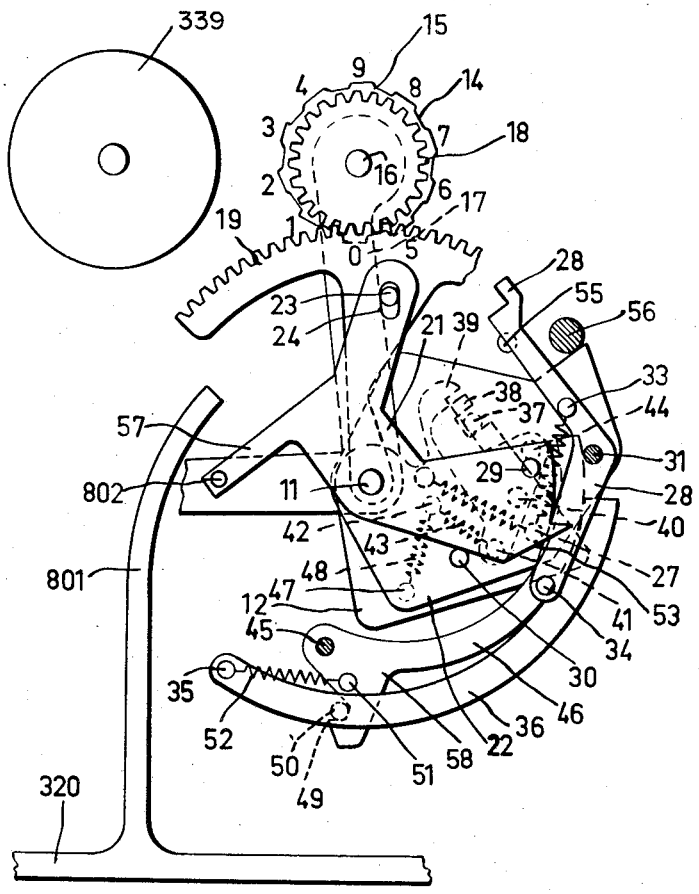

FIG.2

Jan. 9, 1962 J. LYDFORS 3,016,188

MULTIPLIER PRINTING MECHANISM

Filed May 27, 1959 6 Sheets-Sheet 3

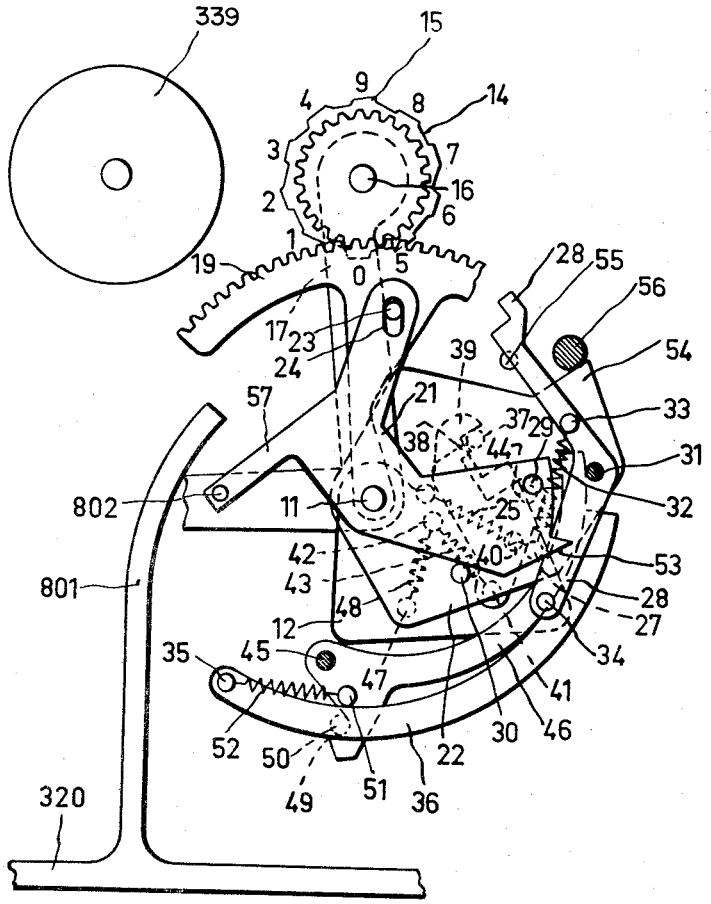

FIG.3

Jan. 9, 1962 J. LYDFORS 3,016,188

MULTIPLIER PRINTING MECHANISM

Filed May 27, 1959 6 Sheets-Sheet 4

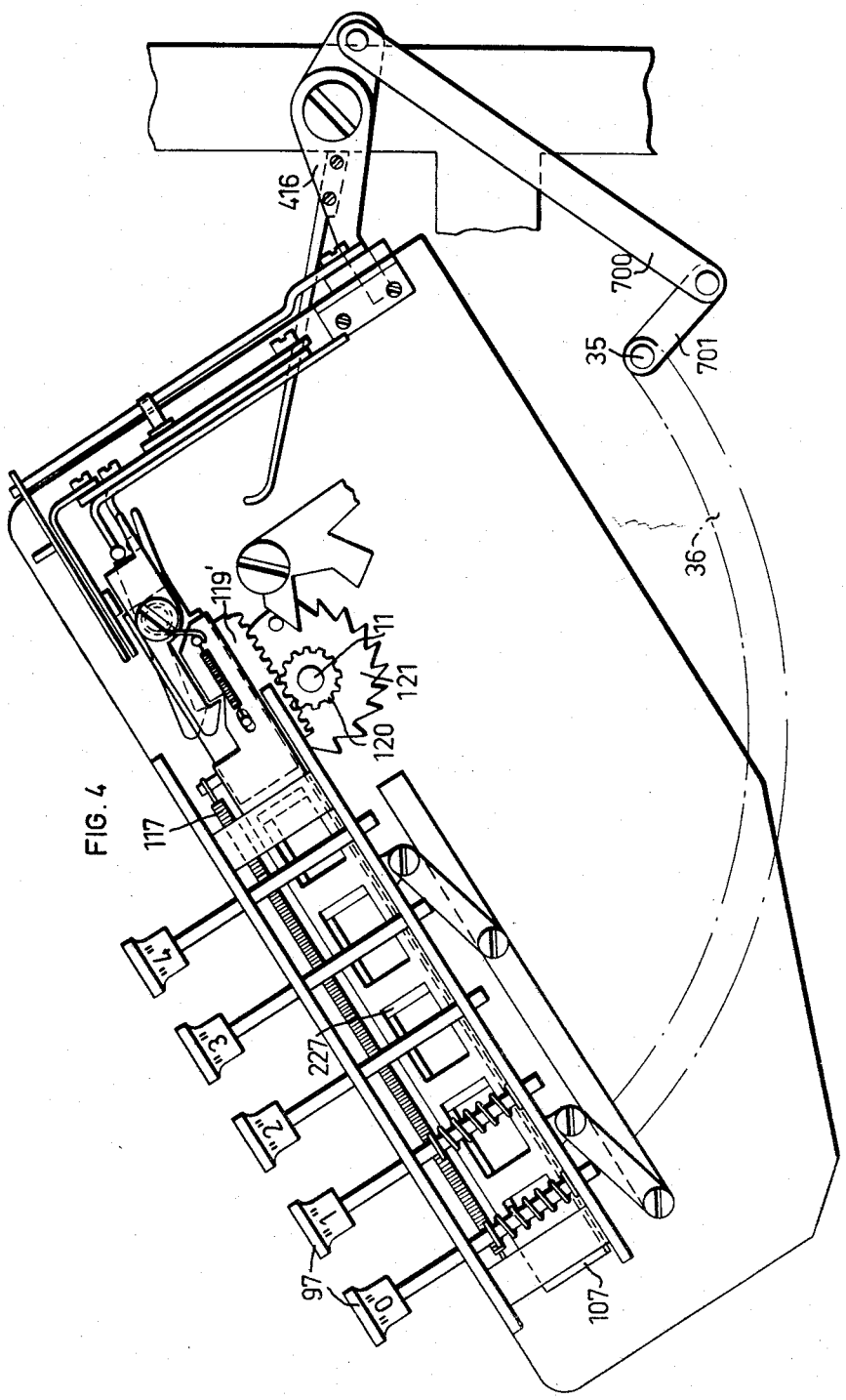

FIG. 4

Jan. 9, 1962 J. LYDFORS 3,016,188

MULTIPLIER PRINTING MECHANISM

Filed May 27, 1959 6 Sheets-Sheet 5

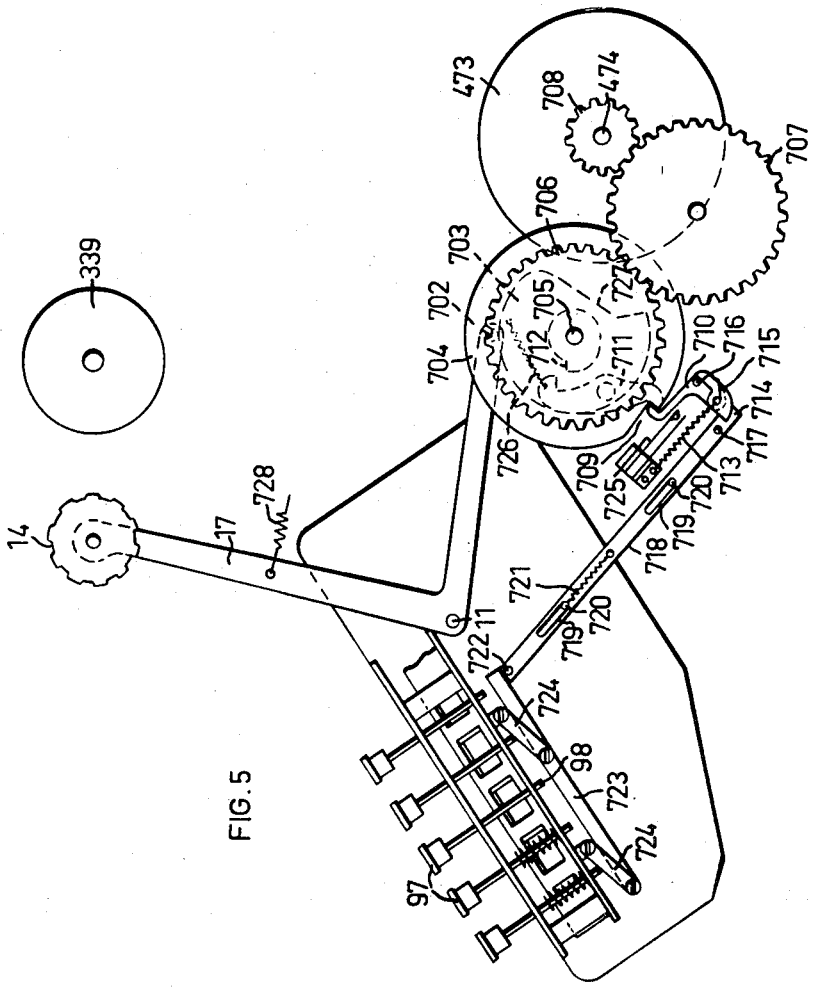

FIG. 5

Jan. 9, 1962 J. LYDFORS 3,016,188

MULTIPLIER PRINTING MECHANISM

Filed May 27, 1959 6 Sheets-Sheet 6

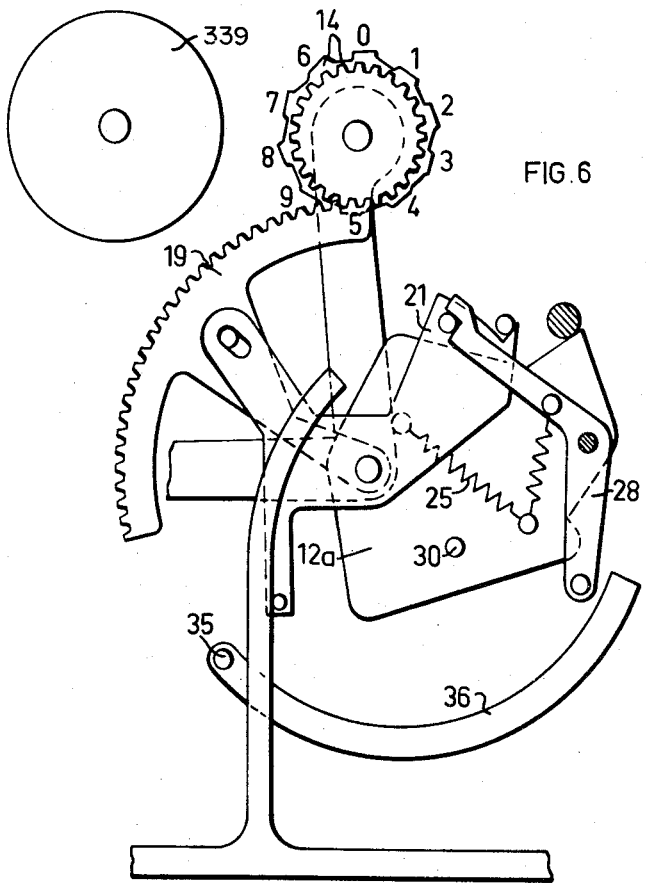

FIG. 6

United States Patent Office

3,016,188
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3,016,188

MULTIPLIER PRINTING MECHANISM

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Filed May 27, 1959, Ser. No. 816,295
Claims priority, application Sweden Sept. 8, 1955
6 Claims. (Cl. 235—60)

This is a continuation in part of the application Serial No. 605,316, filed the 21st day of August, 1956, now abandoned.

The present invention relates to an improved multiplier digit type selecting mechanism in a multiplier digit printing mechanism of calculating machines adapted for multiplication of the multiplicand by consecutive digits of the multiplier in accordance with the principle of short cut multiplication.

In calculating machines adapted for multiplication of the multiplicand by consecutive digits of the multiplier in accordance with the principle of short cut multiplication according to which the multiplier digits 0 to 9 are divided into two groups, viz. a lower group comprising the lowest digits, and a higher group comprising the highest digits, it is known to control the multiplication by means of a control member which is displaced from a starting position at the beginning of the multiplication operation with one multiplier digit a number of steps corresponding to the value of a digit from the lower digit group and to the value of the formula 10–*n* for a digit from the higher digit group, said digit being represented by *n* in the formula. In such a calculating machine it is also known to provide a multiplier digit printing mechanism which is controlled by a multiplier digit type selecting mechanism and prints the multiplier digits consecutively by means of a multiplier digit type carrier.

For several reasons it is desirable that the multiplier digit type carrier be set by means of the control member controlling the consecutive multiplication operations of the machine but this invloves a severe problem as at least some of the control positions of the control member have a dual meaning, i.e. the control member is displaced the same distance from the starting position for a digit from the lower group and a digit from the higher group.

Accordingly, one object of the invention is to solve said problem by providing a multiplier digit type selecting mechanism by means of which the multiplier digit type carrier is set by the control member for printing of the appropriate multiplier digit despite the duality of at least some of the control positions of the control member.

In order to arrive at the result of a multiplication with as few operating cycles of the machine as possible it is also known in machines of the above-mentioned type to provide a control member which is displaced from a starting position in one direction at the beginning of a multiplication operation with one multiplier digit a number of steps which corresponds (*a*) to the value of a digit from the lower group and to the value of the formula 9–*n* for a digit from the higher group, said digit being represented by *n* in the formula, when the last preceding multiplication operation was by a multiplier digit belonging to the same group, and (*b*) to the value of a digit from the lower group plus one step and to the value of the formula 9–*n* plus one step for a digit from the higher group, said digit being represented by *n* in the formula, when the last preceding multiplication operation was by a multiplier digit belonging to the other group. This involves a further severe problem when it is desired to set the multiplier digit type carrier by means of the control member as at least some of the control positions of the control member may represent four different multiplier digits.

Accordingly, it is a second and important object of the invention to provide a multiplier digit type selecting mechanism in a calculating machine of the type mentioned by means of which selecting mechanism the multiplier digit type carrier is set by the control member for printing of the appropriate multiplier digit despite the fact that at least some of the control positions of the control member are common to four multiplier digits.

Further objects and advantages of the invention will be clear from the following description of two embodiments of the invention shown by way of example on the accompanying drawings.

In the drawings:

FIG. 1 schematically shows a mechanism according to the invention in the starting position as viewed from the left side of the machine,

FIGS. 2 and 3 correspond to FIG. 1 but show the parts in different positions of adjustment,

FIG. 4 schematically shows a partial side view of a multiplier keyboard and related parts for entering multiplier digits one at a time into a calculating machine provided with the mechanism according to FIGS. 1 to 3, FIG. 4 being shown from the right side of the machine,

FIG. 5 schematically shows the keyboard and its control of a printing mechanism as seen from the right side of the machine, and

FIG. 6 shows a modification of the mechanism according to FIG. 1.

The preferred embodiment of the multiplier digit type selecting mechanism according to the invention is shown in FIGS. 1–5 and is embodied in a calculating machine of the well-known type having a ten key keyboard for entering a multiplicand into a setting pin carriage, a printing mechanism for printing the multiplicand on a paper sheet extending around a platen **339**, a totalizer, and a multiplier mechanism having a ten key keyboard by means of which the multiplier digits are entered digit after digit. Such a calculating machine is for instance shown and described in detail in U.S. Patent No. 2,397,745, issued April 2, 1946, in the name of Karl Berthold Wilhelm Kiel. Therefore, reference is made to this patent concerning the details of the machine and its mode of operation. In the present specification and FIGS. 1 to 5 only some details of the known machine are shown and described in order to elucidate how the multiplier digit type selecting mechanism according to the invention may be incorporated in the machine according to said patent. In order to make the relationship easier to understand the known details shown in FIGS. 1 to 5 have been given the same reference numerals as in said patent.

Although the above-mentioned division of the multiplier digits 0 to 9 into a lower group and a higher group may be made in an arbitrary manner, it is assumed in the following for the sake of simplicity that said division in the

mechanism shown in FIGS. 1 to 5 is made according to said patent so that the lower digit group comprises the multiplier digits 0 to 4 and the higher group comprises the multiplier digits 5 to 9. Consequently, the machine according to said patent has a multiplier keyboard (see FIGS. 4 and 5) which has ten keys **97** for the multiplicator digits 0–9 arranged in two rows, one of which contains in due order the keys for the digits 0–4, as is shown in FIGS. 4 and 5, while the other row in due order contains the keys for digits 5–9, said latter keys being hidden from view in FIGS. 4 and 5 behind the keys shown therein in such a way that the key for digit 9 is behind the key for digit 0, the key for digit 8 behind the key for digit 1 . . . and the key for digit 5 behind the key for digit 4. As described in said patent, upon depression of some of the multiplier keys **97** a differential bar **107** will be moved to the left, as seen in FIG. 4, through a suitable number of steps by the action of a pull string **117**. Attached to the differential bar **107** is a rack **119'** engaging with a gear **120** which is secured to a shaft **11**. Also secured to the shaft **11** is a multiplication control member in the form of a toothed wheel **121**. When the differential bar **107** is moved to the left, as seen in FIG. 4, through a given number of steps, the control member **121** will consequently also be rotated through a corresponding number of tooth pitches from its initial position. As described in said patent, the depression of a multiplier key **97** also results in the starting of the drive motor **473** of the machine which drives the machine through a suitable number of machine cycles, during each one of which the multiplicand entered into the machine is entered once in the totalizer of the machine and the control member **121** is fed back through one tooth pitch in the direction toward its starting position. When the control member again reaches the starting position the motor is cut out until the next multiplier key is depressed or the totalizer key of the machine is depressed for printing the result of the multiplication, which has been stored in the totalizer of the machine. How these operations are effected in detail is apparent from said patent.

It is further assumed that according to said patent the multiplier mechanism operates according to the principle of short cut multiplication by complementary numbers in the following preferred manner. At the depression of a multiplier digit key **97** belonging to the lower group 0 to 4 the control member **121** is turned counter-clockwise from the starting position shown in FIG. 4 through a number of tooth pitches which corresponds to the digit value of the depressed key, i.e. zero tooth pitches for the digit 0 and four tooth pitches for the digit 4. At the depression of one of the multiplier keys of the lower group a multiplying operation is started by the machine, during which operation, after the control member has first been turned the requisite number of tooth pitches and the multiplier digit has been typed in the manner described in the following, the control member for each operating cycle of the machine is fed back one tooth counter-clockwise towards the starting position under additive entry of a multiplicand, set in the setting pin carriage or multiplicand mechanism, once into the totalizer and finally, after the control member has returned to the starting position, the setting pin carriage is advanced one denominational order step towards a higher decade or denominational order position with respect to the totalizer. At depression of one of the multiplier keys of the higher digit group 5–9 the control member **121** is turned counter-clockwise (in FIG. 4) from the starting position shown a number of tooth pitches which constitutes nine tooth pitches reduced by the digit value of the depressed multiplier key, i.e. zero tooth pitches for the key for the digit 9 and four tooth pitches for the key for the digit 5. In other words, the control member **121** is turned through the same angle from the starting position at depression of the keys for the digits 0 and 9; 1 and 8; 2 and 7; 3 and 6; and 4 and 5. At the depression of one of the multiplier keys of the higher group a multiplying operation is started by the machine, during which operation, after the control member **121** has been turned a requisite number of tooth pitches and the multiplier digit has been typed, the control member for each operating cycle of the machine is fed back towards the starting position one tooth pitch under subtractive entry of the multiplicand, set in the multiplicand mechanism, once into the totalizer and finally, after the control member has returned to the starting position, the multiplicand mechanism is fed stepwise one decade step towards the higher decade position with respect to the totalizer. At the depression of the multiplier keys **97** for the digits 0 and 9 a stepwise feeding only of the multiplicand mechanism takes place, as will appear from what is mentioned above, without any entry of the multiplicand into the totalizer. Finally, it is also assumed that according to said patent the multiplier mechanism of the machine, in order that the multiplication method described above may give the correct result, is arranged in such a way that when a multiplier key of one group is depressed after the immediately preceding multiplying operation has been carried out through depression of a key of the other group, i.e., on going over from additive to subtractive entry, or from subtractive to additive entry, of the multiplicand into the totalizer, which action is called reversal of signs hereinafter, it carries out one operating cycle more than what corresponds to the depressed key according to what is stated above. As disclosed in detail in said patent this extra operating cycle at reversal of signs is brought about by a mechanism including two compensating bars (one shown at **227** in FIG. 4), which are slidable in the tubular differential bar **107** between two positions, in one of which the control member **121** is advanced by the rack **119'** one tooth pitch more than in the other position of said compensating bars, when the depression of a key **97** entails a reversal of signs, so that the control member **121** at its subsequent clockwise movement back to its starting position during the multiplying operation of the machine consequently also entails the desired extra operating cycle. Although this is of no importance in connection with the present invention it may also be pointed out for the sake of completeness that in order to indicate the correct result of a multiplication in the totalizer, when the last multiplying operation has been carried out by means of a key of the higher group, i.e., a key for any of the digits 6 to 9, the machine may be constructed to bring about, in another manner than by means of the control member **121**, a single additive entry of the multiplicand into the totalizer in the higher denominational order position to which the multiplicand mechanism has been fed in relation to the totalizer at the end of the multiplying operation which has been brought about through the multiplier key last depressed. Another possibility is indicated in the above mentioned patent, viz. that the operator, always at the termination of the calculation, depresses the zero multiplier key.

After the preceding discussion of the construction and mode of operation of the calculating machine according to the U.S. Patent 2,397,745 I will now describe how my multiplier digit type selecting mechanism may be built into the machine according to said patent, so that the correct multiplier digits are printed under control of the control member **121**, when said member is set in the manner described above by means of the multiplier keys **97**.

A wheel-shaped type carrier **14** carries around its periphery ten raised portions **15** for the digits 0 to 9 arranged with equal pitch. As shown in FIGS. 1–3, the digit types are disposed in a row around the type wheel **14** in such a manner that, beginning at the type for the digit 0 in clockwise sequence around the type wheel, there follow first the types for the digits 1 to 4 of the lower multiplier digit group in a rising digit value sequence and then the types for the digits 5 to 9 of the higher multiplier digit group in a declining digit value sequence, i.e. the digit sequence is 0–1–2–3–4–9–8–7–6–5. The type wheel **14** is rotative-

ly mounted on a shaft 16 which is supported by a bell crank lever 17 swingably mounted at the left side of the machine on the shaft 11 which at the right side of the machine is fixedly connected with the control member 121 (FIG. 4). The type wheel 14 is fixedly connected with a gear wheel 18 which is also rotatively mounted on the shaft 16 and engages with a gear segment 19 which is rotatably mounted on the shaft 11. The lever 17 is swingable counter-clockwise by means of a printing mechanism to be described from the shown starting position for pressing a selected type on the wheel 14 against the platen 339 of the machine in order to leave an imprint of the type in question on a paper (not shown) disposed around the platen 339, by means of an ink ribbon (not shown). During the swinging of the lever 17 the gear wheel 18 of the type wheel 14 rolls against the stationary gear segment 19 and, in so doing, turns counter-clockwise approximately 90°, so that when the parts are in the starting position shown in FIG. 1 the type for the digit 0 will consequently be pressed against the platen at the swinging of the lever 17. In order that other types may print in response to the respective depressed multiplier key, the type wheel 14 is rotatable to other angular positions before the swinging of the lever 17 by resetting of the gear segment 19 from the starting position shown in FIG. 1 by means of the control member 121 and the coupling mechanism described in the following. The control member 121 is fixed on the right hand end of the shaft 11 (FIG. 4) which extends through the machine to the left hand side where a plate 12 is fixed on the shaft so that the plate 12 is rotated through the same angle as the control member 121 during the multiplication operations.

The coupling mechanism has two plate-shaped coupling members 21 and 22 which are rotatively mounted on the shaft 11. The coupling member 21 is fixedly connected with the gear segment 19 in the rotational sense by means of a pin and slot connection 23, 24. A pull spring 25, one of whose ends is fixed in a hole 26 in the coupling member 21 while its other end is anchored on a pin 27 on the coupling member 22, tends to swing the coupling member 21 clockwise relatively to the coupling member 22. Such swinging is limited either through the engagement of a pawl 28 mounted on the coupling member 22 with a pin 29 on the coupling member 21 or, when the pawl is brought out of engagement in the manner indicated in the following, by the abutting of the edge of the coupling member 21 against a pin 30 on the coupling member 22. The pawl 28 is mounted on the coupling member 22 by means of a pin 31, and a pull spring 32, which is extended between a pin 33 on the pawl and the pin 27 on the coupling member 22, tends to swing the pawl counter-clockwise. The pawl 28 besides carries a pin 34 which can be operated, in order to swing the pawl out of engagement with the pin 29 on the coupling member 21, by means of a reversing member in the form of an arm 36 fixedly mounted on a shaft 35 rotatably mounted in the machine frame. The shaft 35 and consequently the arm 36 are adjustable to two different rotational positions, on one hand the "positive" position shown in FIG. 1, in which the arm 36 is out of engagement with the pin 34 of the pawl 28 while the pawl engages with the pin 29 of the coupling member 21, and on the other hand a "negative" position shown in FIGS. 2 and 3, in which the arm 36 is swung counter-clockwise from the position shown in FIG. 1 and rests against the pin 34 of the pawl 28 and has swung the pawl against the action of the spring 32 out of engagement with the pin 29 of the coupling member 21. The shaft 35 and the arm 36 are swung between their two described positions of adjustment every time the above-mentioned reversal of signs takes place during the multiplication work. The turning of the shaft 35 which is necessary for this purpose is controlled by means of the lever 416 shown in FIG. 4. As described in the above mentioned patent the lever 416 is located in the "positive" position shown in FIG. 4, when one of the multiplier keys 97 for the digits 0–4 is depressed, and is maintained in this position as long as only keys 97 for the digits 0–4 are depressed in succession. When one of the keys 97 for the digits 5–9 is depressed the lever 416 is swung clockwise from the position in FIG. 4 to a "negative" position and is held in the "negative" position as long as only keys for the digits 5–9 are depressed in succession. As apparent from FIG. 4, the lever 416 is connected by a link 700 with a crank arm 701 which is fixed on the shaft 35. Thus, the lever 36 fixed to shaft 35 occupies the "positive" position shown in FIGS. 1 and 4, when one of the keys 97 for the digits 0–4 is depressed, and occupies the "negative" position shown in FIGS. 2 and 3, when one of the keys 97 for the digits 5–9 is depressed.

An interconnecting means is arranged between the coupling member 22 on one hand and the plate 12 and the control member 121 on the other hand. Thus, the coupling member 22 carries an abutment in the form of a pin 37 by means of which the coupling member is connected to the plate 12 in such a way that the plate 12 during its clockwise movement (by means of control member 121 and shaft 11) away from the starting position shown in FIG. 1 may bring with it the pin 37 and consequently the coupling member 22, on one hand by means of a latch 38 mounted on the control member and on the other hand, when the latch 38 is moved out of engagement with the pin 37 to inoperative position (FIG. 3) in the manner described in the following, by means of a dog hook 39 which is made integral with the plate 12. The latch 38 is mounted on the plate 12 by means of a pin 40, and a pull spring 43 stretched between a pin 41 on the latch and a pin 42 on the plate 12 tends to keep the latch 38 swung clockwise to the position shown in FIGS. 1 and 2 in engagement with the pin 37 on the coupling member 22. The latch 38 also has a pin 44 which can be operated, in order to swing the latch out of engagement with the pin 37, by means of a compensation member in the form of an arm 46 swingably mounted on a shaft 45 on the machine frame at the swinging of said arm 46 counterclockwise from the position shown in FIG. 1 in the manner described in the following. A pull spring 48 stretched between the pin 42 on the plate 12 and a pin 47 on the coupling member 22 tends to bring about such a relative swinging of the coupling member 22 and the plate 12 that the pin 37 abuts against the dog hook 39 (FIG. 3) when the latch 38 is moved away from the pin 47 by means of the compensation arm 46. Swinging of the compensation arm counter-clockwise about the shaft 45 for actuation of the latch 38 takes place every time the above-mentioned reversal of signs is effected, i.e. every time the reversing arm 36 is swung between its two positions of adjustment. For that purpose the compensation arm 46 has a laterally directed leg 58 which has a nose 49 and rests against a pin 50 on the reversing arm 36 under the action of a pull spring 52 stretched between the shaft 35 and a pin 51 on the compensation arm. In the two positions of adjustment of the reversing arm 36 the pin 50 rests against the leg 58 on one and the other side, respectively, of the nose 49 (FIG. 1 and FIGS. 2 and 3, respectively), and it is evident that the pin 50 at each swinging of the arm 36 from one of its positions of adjustment to the other will slide over the nose 49 and thus swing the compensation arm 46 temporarily counterclockwise in order to swing the latch 38 out of engagement with the pin 37 on the coupling member 22.

In the starting position shown in FIG. 1 the coupling members 21 and 22 each rest with a nose 53, 54 against a stop abutment pin 55, 56 respectively, on the frame of the machine, the pawl 28 engages with the pin 29 on the coupling member 21, the latch 38 engages with the pin 37 on the coupling member 22, the plate 12 occupies its starting position, the reversing arm 36 occupies the "posi-

tive" control position which implies that the multiplying operation last effected took place with additive entry of the multiplicand into the totalizer and which is always occupied by the reversing arm after a finished multiplying calculation, and the type wheel **14** is in position for printing with the type for the digit 0 on the platen. If a multiplying calculation is now to be effected, in which the digit of the multiplier in the lowest denominational order position is one of the digits 0 to 4, the machine operator, after entering the multiplicand into the multiplicand mechanism, depresses the multiplier key **97** corresponding to the said digit of the multiplier. If that multiplier key is the key for the digit 0, only one stepwise feeding of the multiplicand mechanism to the immediately higher decade position in relation to the totalizer will take place (as described in the above mentioned patent), and the arrangement shown in the drawings is not influenced thereby except for the printing mechanism described in the following, which prints the digit "0." However, if it is the key for the digit 1, 2, 3 or 4, the plate **12** is swung clockwise one, two, three or four tooth pitches from the starting position (by means of control member **121** and shaft **11**), the latch **38** of the plate **12** bringing with it the pin **37** on the coupling member **22** in that movement, so that the coupling member **22** is swung through a corresponding angle and thus brings with it the coupling member **21** through an equally large angle by the engagement of the pawl **28** of the coupling member **22** with the pin **29** of the coupling member **21**, whereby the coupling member **21** swings the gear segment **19** through the same angle via the pin and slot connection **23, 24**, the gear segment turning the type wheel **14** counter-clockwise respectively one, two, three and four type pitches. Consequently, the type wheel **14** becomes adjusted in such a way that at the subsequent swinging of the lever **17** in a manner to be described it will print on the platen the digit 1, 2, 3 or 4 corresponding to the depressed multiplier key. Thereafter the control member **121** during its stepwise feeding backwards to the starting position causes the machine to enter the multiplicand additively into the totalizer the requisite number of times, as described in said patent, whereupon the machine stops with the parts in the position shown in FIGURE 1. If the next digit in the multiplier again belongs to the lower group 0 to 4, the multiplication with this new digit takes place in the same manner as the one described above. However, if the next digit in the multiplier belongs to the higher group 5 to 9, reversal of signs takes place. On depression of the multiplier key **97** in question for one of the digits 5 to 9 the reversing arm **36** according to what has been said above will be swung counter-clockwise from its "positive" position of adjustment shown in FIG. 1 to its "negative" position of adjustment shown in FIGS. 2 and 3. In that case the arm **36** actuates the pin **34** of the pawl **28**, so that the pawl is swung clockwise out of engagement with the pin **29** on the coupling member **21** and is held out of such engagement as long as the arm **36** occupies its "negative" position, whereby the spring **25** has an opportunity to swing the coupling member **21** clockwise relatively to the coupling member **22**, until the coupling member **21** abuts against the pin **30** on the coupling member **22**, as shown in FIGS. 2 and 3. This relative rotation entails that the coupling member **21** swings the gear segment **19** about the shaft **11** such a distance clockwise that the gear segment will turn the type wheel **14** counter-clockwise five type pitches, so that the type wheel, if the plate **12** is assumed to have remained in the starting position, would cause the type for the digit 9 to effect a printing operation at the subsequent swinging of the lever **17**. This condition is shown in FIG. 2. However, as reversal of signs takes place at the multiplying operation now started, the control member **121** and the plate **12** will be swung clockwise in relation to FIGS. 1–3 and counter-clockwise as seen in FIG. 4 through an extra tooth pitch from the starting position in addition to what corresponds fundamentally to the depressed key, i.e. the plate **12** will be swung clockwise in relation to FIGS. 1–3 one tooth pitch for the key **9**, two tooth pitches for the key 8, three tooth pitches for the key 7, four tooth pitches for the key 6 and five tooth pitches for the key 5. As the type wheel **14** has been turned through the inactivation of the pawl **28** to a position for printing the type for the digit 9 already without swinging of the plate **12** in the manner described above, the type wheel, if no other measures were taken, would consequently be turned one type pitch too much by the indicated swinging of the control member **121** and the plate **12** an extra tooth pitch in connection with the reversal of signs. This error is compensated for by the reversing arm **36** at its counter-clockwise readjustment from the position shown in FIG. 1 sliding over the nose **49** on the compensation arm **46** and thus swinging said arm temporarily counter-clockwise, so that the compensation arm actuates the pin **44** of the latch **38** and swings the latch counter-clockwise to an inoperative position, whereby the pin **37** on the clutch member **22** is released and the spring **48** is able to turn the coupling member **22** and consequently the coupling member **21** which, in accordance with what has been mentioned above, rests against the pin **30** of the coupling member **22**, as well as the gear segment **19** in relation to the plate **12** through an angle which corresponds to the rotation of the control member **121** and the plate **12** through one tooth pitch, until the pin **37** of the coupling member **22** engages the dog hook **39** of the control member **12** as shown in FIG. 3. This compensation turning of the gear segment **19** and the coupling members **21** and **22** relatively to the control member **121** and the plate **12** takes place in a sense opposite to the rotation of said parts by means of the plate **12** during the clockwise swinging motion of said member from the starting position, and will consequently compensate for the effect of the extra turning step, taking place at reversal of signs, of the plate **12** on the type wheel **14**, so that said wheel, as will be understood from the explanation given, will print the correct type against the platen **339** despite the extra turning step of the control member **121** and plate **12**. Thus, in FIG. 3 the plate **12** has been swung one step clockwise in response to actuation of the multiplier key for the digit 9 and this extra step of control member movement has been compensated in the manner set forth by the interconnecting means **37, 38** and **39**, so that despite one step of setting movement of the control member **121** the type wheel **14** is in position for printing with the digit type 9.

To restore the coupling members **21** and **22** from the adjusted positions according to FIG. 3 (and as far as the coupling member **21** is concerned also from the position according to FIG. 2) so that the latches **28** and **38** are again able to engage with the pins **29** and **37**, respectively, if this is necessary for a subsequent multiplication, the following measures have been taken. As is described in said patent, the machine has a bar **320** which is driven by the machine motor and actuates the machine main shaft in the manner described in said patent. During each operating cycle of the machine the bar **320** first moves to the left as seen in FIGS. 1–3 to the position shown in FIGS. 2 and 3 and then back to the starting position shown in FIG. 1. Attached to the bar **320** is an upwardly directed cam bar **801** which has its upper end curved and which is adapted to cooperate with a roller **802** mounted on an arm **57** of the coupling member **21**. When a multiplier key **97** is depressed and the machine starts its first operating cycle, the bar **320** and the cam bar **801** move to the left, as seen in FIGS. 1–3, thus permitting the coupling member **21** to adjust itself in the manner earlier described corresponding to the adjusted position of the plate **12** and the control of the latches **28** and **38** before printing of the multiplier digit takes place in the manner described in the following, and after the printing the bar **320** and the cam bar **801** return to the

position shown in FIG. 1, the cam bar 801 restoring the coupling member 21 to the position shown in FIG. 1 in that it actuates the roller 802 and biases the spring 25 without carrying the coupling member 22 along, so that the nose 53 of the coupling member 21 will be applied against the stop pin 55. Should the machine effect several operating cycles, the coupling member 21 will again swing clockwise by the action of the spring 25 when the cam bar 801 is again moved to the left as seen in FIGS. 1–3. After the last operating cycle of a multiplication the coupling member 21 however stops with its nose 53 in engagement with the stop pin 55 by the action of the cam bar 801 bearing against the roller 802 so that the latch 28 can engage with the pin 29 of the coupling member 21 at the beginning of the next multiplication if this multiplication is initiated by means of any of the keys 97 for the digits 0–4. The coupling member 22 accompanies the control member 12 back toward the starting position shown in FIGS. 1 and 2 during the stepwise feeding backwards of the control member during the calculating operation under the action of the spring 48, until the coupling member 22 has come into engagement with the nose 54 against the pin 56, whereupon the spring 48 is tensioned during the last small portion of the return of the control member 12 to the starting position, when the control member is turned relatively to the coupling member 22 stopped against the pin 56, so that the pin 37 leaves the dog hook 39 on the control member and the latch 38 snaps into engagement with the pin 37.

If the subsequent mutiplier digit again belongs to the higher group 5 to 9, no reversal of signs is to take place, i.e. the reversing arm 36 remains in its position keeping the pawl 28 out of engagement, as seen in FIG. 2, and the compensation arm 46 occupies its inoperative position shown in FIG. 2. When the cam bar 801 returning the coupling member 21 in the manner described above through engagement with the roll 802 on the arm 57 leaves said roll, the coupling member 21, since the pawl 28 is kept out of engagement with the pin 29 by the reversing arm 36, will consequently swing into engagement with the pin 30 of the coupling member 22, under the action of the spring 25, so that the gear segment in the manner described above turns the type wheel 14 into position for printing with the type 9 instead of with the type 0, when the plate 12 is not swung away from its starting position. This condition is shown in FIG. 2. If the depressed key is the key for the digit 9, no turning of the plate 12 away from the starting position takes place but only stepwise feeding of the multiplicand mechanism in relation to the totalizer, and consequently the type wheel at the swinging of the lever 17 will print the digit 9 on the paper sheet of the platen 339. If the depressed key is the key for the digit 8 or 7 or 6 or 5, the plate 12 is swung clockwise from the starting position shown in FIG. 2 one or two or three or four tooth pitches, which entails counter-clockwise turning of the type wheel 14 one or two or three or four type pitches via the coupling mechanism 21, 22 in the manner described above, away from the position for printing with the type for the digit 9, so that the correct digit will consequently be printed on the paper sheet of the platen in each case. If a multiplier digit of the lower group 0 to 4 then follows, reversal of signs shall take place. At depression of one of the keys for the digits 0 to 4, the reversing arm 36 will be swung clockwise to the position shown in FIG. 1, the pawl 28 being released and, under the action of its spring 32, swinging into engagement with the pin 29 on the coupling member 21 before the arm 57 of said coupling member is released by the cam bar 801 returning the coupling member to the starting position, so that the pawl 28 will retain the coupling member 21 in the starting position according to FIG. 1 relatively to the coupling member 22. At the clockwise swinging of the reversing arm 36 its pin 50 will slide over the nose 49 and swing the compensation arm temporarily counter-clockwise, so that the compensation arm, in the manner described before, swings the latch 38 out of engagement with the pin 37 on the coupling member 22 in order to bring the pin 37 to engage with the dog hook 39 of the plate 12 under relative rotation of the coupling member 22 in relation to the plate in the manner described before, in order to compensate for the extra tooth pitch through which the control member 121 is fed from the starting position in connection with the reversal of signs. Consequently, the type wheel 14 will be set, in the manner described above for the digit group 0 to 4, to the correct printing position despite the extra turning step of the control member 121 taking place in connection with the reversal of signs.

The pivoting of the bell crank lever 17 for pressing a set type on the type wheel 14 against the platen 339 is effected by the following mechanism which is shown in FIG. 5. The arm of the bell crank lever 17, which is directed rearwardly in the machine, carries a roller 702 which is applied against a cam 703. The cam is fixedly connected to the driven part 704 of a known one-revolution clutch. The part 704 is mounted for rotation on a shaft 705 which is mounted in the machine frame and to which is secured the driving part 706 of the one-revolution clutch, which is in the form of a gear. Said gear is in mesh with an intermediate gear 707 which meshes with a gear 708 secured to the shaft 474 of the machine drive motor 473. The driven part 704 of the one-revolution clutch is formed as a circular cam with a recess 709 in which engages a latch 710 mounted in the machine frame. In the position of engagement shown in FIG. 5 the latch 710 also bears against a clutch dog 711 mounted on the driven part 704 of the clutch, and holds the clutch dog out of engagement with a clutch tooth 712, secured to the driving part 706 of the clutch, so that the said driving part can be rotated by the motor without carrying the driven part 704 of the clutch along.

A spring 713 expanded between the latch 710 and the machine frame tends to hold the latch engaged in the recess 709 or with the circumference of the driven clutch part 704. Mounted on the latch 710 is a two-armed lever 714, and a torsion spring 715 tends to hold one arm of the lever 714 applied against a pin 716 on the latch 710. The other arm of the lever 714 projects from the latch 710, and obliquely above it there is located a pin 717 on a push bar 718 which is longitudinally movably mounted on the machine frame by means of slots 719 in the push bar and pins 720 on the machine frame. A pull spring 721 expanded between the push bar and one of the pins 720 tends to hold the push bar 718 in the raised position shown in FIG. 5. The push bar 718 bears with a roller 722 against the underside of two bars 724 (only one is visible in FIG. 5) which extend each beneath one row of the multiplier keys 97. The bars 723 are so mounted on the machine frame by means of links 724 as to be moved downwardly by the respective key stem 98 when one of the keys 97 is depressed.

When some key 97 is depressed, the respective bar 723 will therefore move the push bar 718 obliquely downwardly as seen in FIG. 5, the pin 717 on the push bar actuating the lever 714 which bears against the pin 716 and thereby swings the latch 710 mounted on said pin 716 counter-clockwise out of the recess 709. The latch 710 hereby actuates a normally open switch 725 and closes it, whereby the motor 473 is energized. At the same time the latch 710 releases the clutch dog 711 so that it is swung by the action of a spring 726 into engagement with the coupling tooth 712, whereby the one-revolution clutch is engaged so that the driven parts 703, 704 of the clutch begin to move clockwise. The movement of the push bar 718 is so large that the pin 717 passes beneath the lever 714. After that the spring 713 holds the latch 710 engaged with the circular circumference of the clutch part 704 which thereby holds the latch in such a swung position that the switch 725 is held

closed. When the clutch part 704 and thus the cam 703 has been rotated approximately half a revolution clockwise as seen in FIG. 5, the roller 702 falls down onto the low portion 727 of the cam 703 by the action of a spring 728 expanded between the lever 17 and the machine frame, whereby the type wheel 14 presses a set type against the platen 339. During the latter part of the revolution of the cam 703 the lever 17 is restored to the starting position shown. When the driven clutch part again reaches its starting position the latch 710 falls into the recess 709 and swings the clutch dog 711 out of engagement with the clutch tooth 712 so that the one-revolution clutch is disengaged. Simultaneously, the switch 725 is opened but the motor 473 is still held energized by means of a switch, described in said patent, which is operated by the depressed key 97 and connected in parallel with the switch 725, in the event that the depressed key 97 requires the machine to effect more than one operating cycle of the machine. During these subsequent operating cycles no printing takes place by means of the type wheel 14, as the one-revolution clutch 704, 706 remains disengaged.

When the actuated key 97 returns to raised position, the bars 723 and the push bar 718 are raised by the spring 721 to the position shown in FIG. 5. When the bar 718 moves upwards, the pin 717 cams the lever 714 aside clockwise as seen in FIG. 5 against the action of the spring 715, and the lever 714 snaps back to the position shown in FIG. 5, when the pin 717 reaches the position shown in FIG. 5.

The mechanism shown in FIGS. 1–3 can also be modified for use in prior-art calculating machines operating with short cut multiplication in the manner described in the second paragraph of this specification. Such modification is shown in FIG. 6 and substantially resides in that the plate 12 and the coupling member 22 according to FIGS. 1–3 have been combined to a plate 12*a* while the parts 37–52 and 58 occurring in FIGS. 1–3 have been left out. Although the division into a lower digit group and a higher digit group can be made optionally, in these prior-art machines the division is usually made into a lower group 0–5 and a higher group 6–9. Upon depression of the multiplier keys 0–5 the plate 12*a* is shifted in a manner, analogous to that earlier described in connection with FIGS. 1–4, through a number of steps equal to the digit value of the depressed key, and the machine effects a number of operating cycles corresponding to the digit value of the depressed key under additive entering of the multiplicand into the totalizer. Upon depression of one of the keys of the higher digit group the plate 12*a* is shifted a number of steps corresponding to the formula 10–*n*, where *n* is the digit value of the depressed key, i.e. one step for the digit 9, two steps for the digit 8, three steps for the digit 7 and four steps for the digit 6. The machine then effects a number of operating cycles corresponding to the number of shifting steps of the plate 12*a* under subtractive entering of the multiplicand into the totalizer, whereupon the multiplicand register is shifted one denominational step in relation to the totalizer and the machine effects a further operating cycle under additive entering of the multiplicand into the totalizer.

The multiplier keys for the digits 6–9 actuate, upon depression, the shaft 35 similarly to what has been earlier described for the pivotment of the arm 36, so that the latter actuates the latch 28, whereby the coupling member 21 is swung by the spring 25 into application against the pin 30 on the plate 12. As a result, the coupling member 21 shifts the toothed sector 19 through such an angle that the type wheel 14 is rotated five steps counter-clockwise so that the type of the digit 5 will be located uppermost, where the type of digit 0 is shown in FIG. 6. Moreover, as the plate 12*a* swings the toothed sector 19 by one or more steps corresponding to the formula 10–*n*, where *n* represents the digit value of the depressed key in the higher digit group, the correct digit type 6–9 will be pressed against the platen 339 during the subsequent printing cycle.

What I claim and desire to secure by Letters Patent is:

1. A multipler digit type selecting mechanism in a multiplier digit printing mechanism of calculating machines adapted for multiplication of the multiplicand by consecutive digits of the multiplier in accordance with the principle of short cut multiplication according to which the multiplier digits 0 to 9 are divided into two groups, viz. a lower group comprising the lowest digits, and a higher group comprising the highest digits, a multiplication control member displaceable from a starting position, at the beginning of a multiplication operation with one multiplier digit, a number of steps corresponding to the value of a digit from the lower digit group and to the value of the formula 10–*n* for a digit from the higher digit group, said digit being represented by *n* in the formula, said multiplier digit type selecting mechanism comprising a multiplier digit type carrier actuated by the printing mechanism for consecutive printing of the multiplier digits, digit types on said carrier arranged in a row comprising in sequence, beginning with the type for the digit 0, first all the types for the digits of the lower group arranged in a rising digit value sequence, and then all the types for the digits of the higher group arranged in a declining digit value sequence, and a coupling mechanism transmitting the movements of the control member to said type carrier and being movable between two coupling positions, said coupling mechanism, when moving from one coupling position to the other coupling position, displacing said type carrier a distance corresponding to the displacement of said type carrier from the position for printing by means of the type for the digit 0 to the position for printing by means of the type for the highest digit of the lower digit group.

2. A multiplier digit type selecting mechanism in a multiplier digit printing mechanism of calculating machines adapted for multiplication of the multiplicand by consecutive digits of the multiplier in accordance with the principle of short cut multiplication according to which the multiplier digits 0 to 9 are divided into two groups, viz. a lower group comprising the lowest digits, and a higher group comprising the highest digits, a multiplication control member displaceable from a starting position, at the beginning of a multiplication operation with one multiplier digit, a number of steps corresponding to the value of a digit from the lower digit group and to the value of the formula 10–*n* for a digit from the higher digit group, said digit being represented by *n* in the formula, said multiplier digit type selecting mechanism comprising a multiplier digit type carrier actuated by the printing mechanism for consecutive printing of the multiplier digits, digit types on said carrier arranged in a row comprising in sequence, beginning with the type for the digit 0, first all the types for the digits of the lower group arranged in a rising digit value sequence, and then all the types for the digits of the higher group arranged in a declining digit value sequence, and a coupling mechanism transmitting the movements of the control member to said type carrier and being movable between two coupling positions, said coupling mechanism, when moving from one coupling position to the other coupling position, displacing said type carrier a distance corresponding to the displacement of said type carrier from the position for printing by means of the type for the digit 0 through the positions for printing by means of the types for the digits of the lower digit group to the position for printing by means of the type for the highest digit of the lower digit group.

3. A multiplier digit type selecting mechanism in a multiplier digit printing mechanism of calculating machines adapted for multiplication of the multiplicand by consecutive digits of the multiplier in accordance with the principle of short cut multiplication according to which the multiplier digits 0 to 9 are divided into two groups,

viz. a lower group comprising the lowest digits, and a higher group comprising the highest digits, a multiplication control member displaceable from a starting position, at the beginning of a multiplication operation with one multiplier digit, a number of steps corresponding to the value of a digit from the lower digit group and to the value of the formula 10–*n* for a digit from the higher digit group, said digit being represented by *n* in the formula, said multiplier digit type selecting mechanism comprising a multiplier digit type carrier actuated by the printing mechanism for consecutive printing of the multiplier digits, digit types on said carrier arranged in a row comprising in sequence, beginning with the type for the digit 0, first all the types for the digits of the lower group arranged in a rising digit value sequence, and then all the types for the digits of the higher group arranged in a declining digit value sequence, a first coupling member connected with said type carrier, a second coupling member connected with the control member, a spring connected with said coupling members and tending to hold said coupling members in a first coupling position in relation to each other, and a pawl mounted on one of said coupling members and adapted to engage the other coupling member to hold said coupling members in a second coupling position against the action of said spring, said spring moving upon disengagement of said pawl said coupling members in relation to each other from said second coupling position to said first coupling position such a distance that said type carrier is displaced by means of said first coupling member a distance corresponding to the displacement of said type carrier from the position for printing by means of the type for the digit 0 to the position for printing by means of the type for the highest digit of the lower digit group.

4. A multiplier digit type selecting mechanism in a multiplier digit printing mechanism of calculating machines adapted for multiplication of the multiplicand by consecutive digits of the multiplier in accordance with the principle of short cut multiplication according to which the multiplier digits 0 to 9 are divided into two groups, viz. a lower group comprising the lowest digits, and a higher group comprising the highest digits, a multiplication control member displaceable from a starting position in one direction, at the beginning of a multiplication operation with one multiplier digit, a number of steps which correspond (*a*) to the value of a digit from the lower group and to the value of the formula 9–*n* for a digit from the higher group, said digit being represented by *n* in the formula, when the last preceding multiplication operation was by a multiplier digit belonging to the same group, and (*b*) to the value of a digit from the lower group plus one step and to the value of the formula 9–*n* plus one step for a digit from the higher group, said digit being represented by *n* in the formula, when the last preceding multiplication operation was by a multiplier digit belonging to the other group, said multiplier digit type selecting mechanism comprising a multiplier digit type carrier actuated by the printing mechanism for consecutive printing of the multiplier digits, digit types on said carrier arranged in a row comprising in sequence, beginning with the type for the digit 0, first all the types for the digits of the lower group arranged in a rising digit value sequence, and then all the types for the digits of the higher group arranged in a declining digit value sequence, a coupling mechanism transmitting the movements of the control member to said type carrier and being movable between two coupling positions, said coupling mechanism, when moving from one coupling position to the other coupling position, displacing said type carrier a distance corresponding to the displacement of said type carrier from the position for printing by means of the type for the digit 0 to the position for printing by means of the type for the digit 9, and interconnecting means selectively connecting the control member with said coupling mechanism in either one of two relative positions of displacement, the distance between said positions corresponding to one step of displacement of the control member in relation to said coupling mechanism.

5. A multiplier digit type selecting mechanism in a multiplier digit printing mechanism of calculating machines adapted for multiplication of the multiplicand by consecutive digits of the multiplier in accordance with the principle of short cut multiplication according to which the multiplier digits 0 to 9 are divided into two groups, viz. a lower group comprising the lowest digits, and a higher group comprising the highest digits, a multiplication control member displaceable from a starting position in one direction, at the beginning of a multiplication operation with one multiplier digit, a number of steps which corresponds (*a*) to the value of a digit from the lower group and to the value of the formula 9–*n* for a digit from the higher group, said digit being represented by *n* in the formula, when the last preceding multiplication operation was by a multiplier digit belonging to the same group, and (*b*) to the value of a digit from the lower group plus one step and to the value of the formula 9–*n* plus one step for a digit from the higher group, said digit being represented by *n* in the formula, when the last preceding multiplication operation was by a multiplier digit belonging to the other group, said multiplier digit type selecting mechanism comprising a multiplier digit type carrier actuated by the printing mechanism for consecutive printing of the multiplier digits, digit types on said carrier arranged in a row comprising in sequence, beginning with the type for the digit 0, first all the types for the digits of the lower group arranged in a rising digit value sequence, and then all the types for the digits of the higher group arranged in a declining digit value sequence, a first coupling member connected with said type carrier, a second coupling member, a spring connected with said coupling members and tending to hold said coupling members in a first coupling position in relation to each other, a pawl mounted on one of said coupling members and adapted to engage the other coupling member to hold said coupling members in a second coupling position against the action of said spring, said spring moving upon disengagement of said pawl said coupling members in relation to each other from said second coupling position to said first coupling position such a distance that said type carrier is displaced by means of said first coupling member a distance corresponding to the displacement of said type carrier from the position for printing by means of the type for the digit 0 to the position for printing by means of the type for the digit 9, an abutment on said second coupling member, a latch on the control member movable between engaged and disengaged position in relation to said abutment, a biasing means tending to hold said latch in engagement with said abutment so that said second coupling member is caused to accompany the control member in its movement from the starting position in said one direction by the interengagement of said latch and said abutment, and a dog hook on the control member engaging said abutment on said second coupling member when said latch is disengaged and the control member is displaced one step in said one direction in relation to said second coupling member.

6. A multiplier digit type selecting mechanism in a multiplier digit printing mechanism of calculating machines adapted for multiplication of the multiplicand by consecutive digits of the multiplier in accordance with the principle of short cut multiplication according to which the multiplier digits 0 to 9 are divided into two groups, viz. a lower group comprising the lowest digits, and a higher group comprising the highest digits, a multiplication control member displaceable from a starting position, at the beginning of a multiplication operation with one multiplier digit, a number of steps, said number being the higher, said number successively increasing in accordance with the digital value when said digit belongs to the lower

digit group, and successively decreasing when said digit belongs to the higher digit group, said multiplier digit type selecting mechanism comprising a multiplier digit type carrier actuated by the printing mechanism for consecutive printing of the multiplier digits, digit types on said carrier arranged in a row comprising in sequence, beginning with the type for the digit 0, first all the types for the digits of the lower group arranged in a rising digit value sequence, and then all the types for the digits of the higher group arranged in a declining digit value sequence, and a coupling mechanism transmitting the movements

of the control member to said type carrier and being movable between two coupling positions, said coupling mechanism, when moving from one coupling position to the other coupling position, displacing said type carrier such a distance that said type carrier when adjusted by the control member by the intermediary of said coupling mechanism, will print a digit belonging to one of said digit groups instead of printing a digit belonging to the other digit group.

No references cited.