

Jan. 23, 1934.

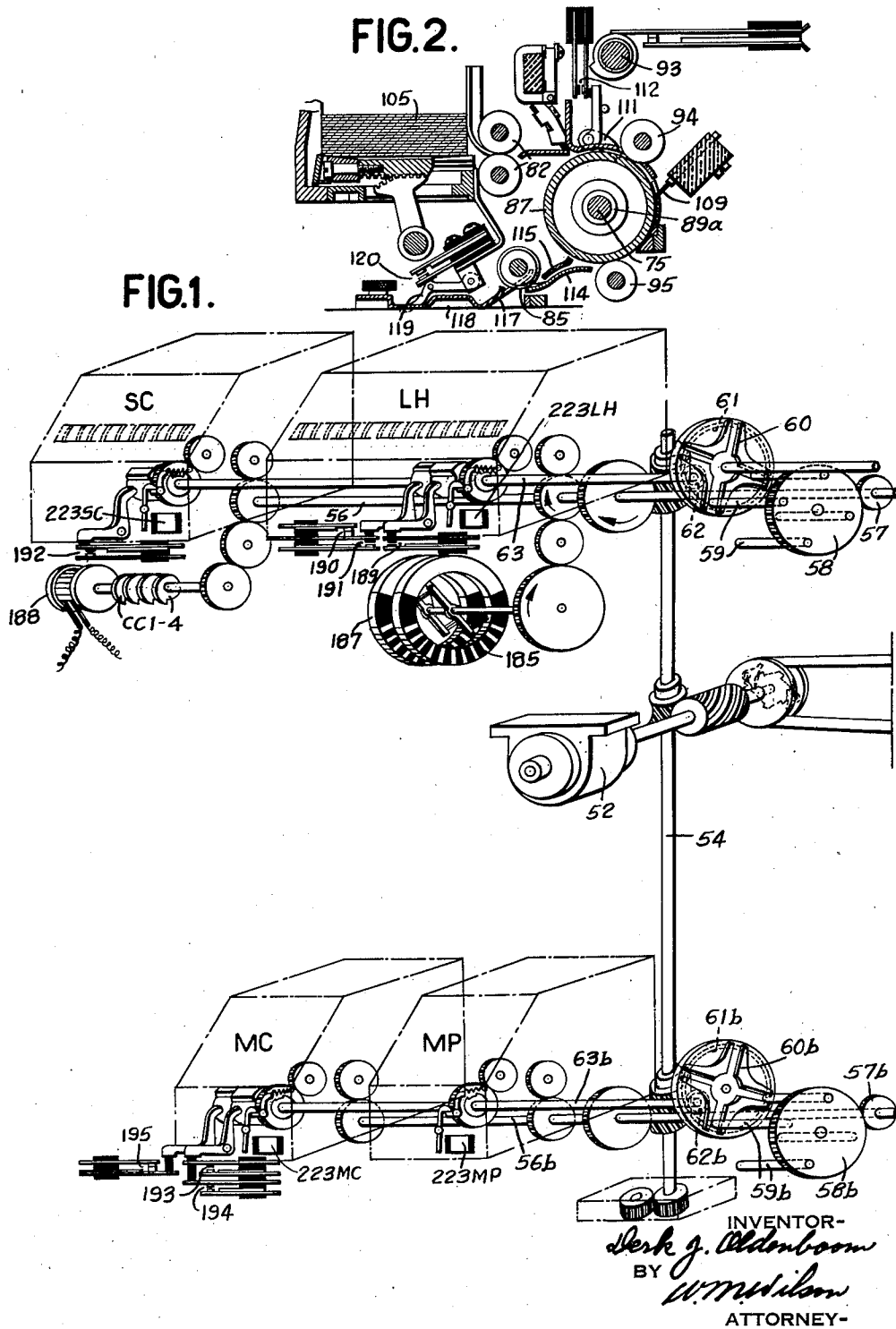
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1,944,665

MULTIPLYING MACHINE WITH IMPROVED CHECKING FEATURES

Filed March 16, 1933

13 Sheets-Sheet 1



Jan. 23, 1934.

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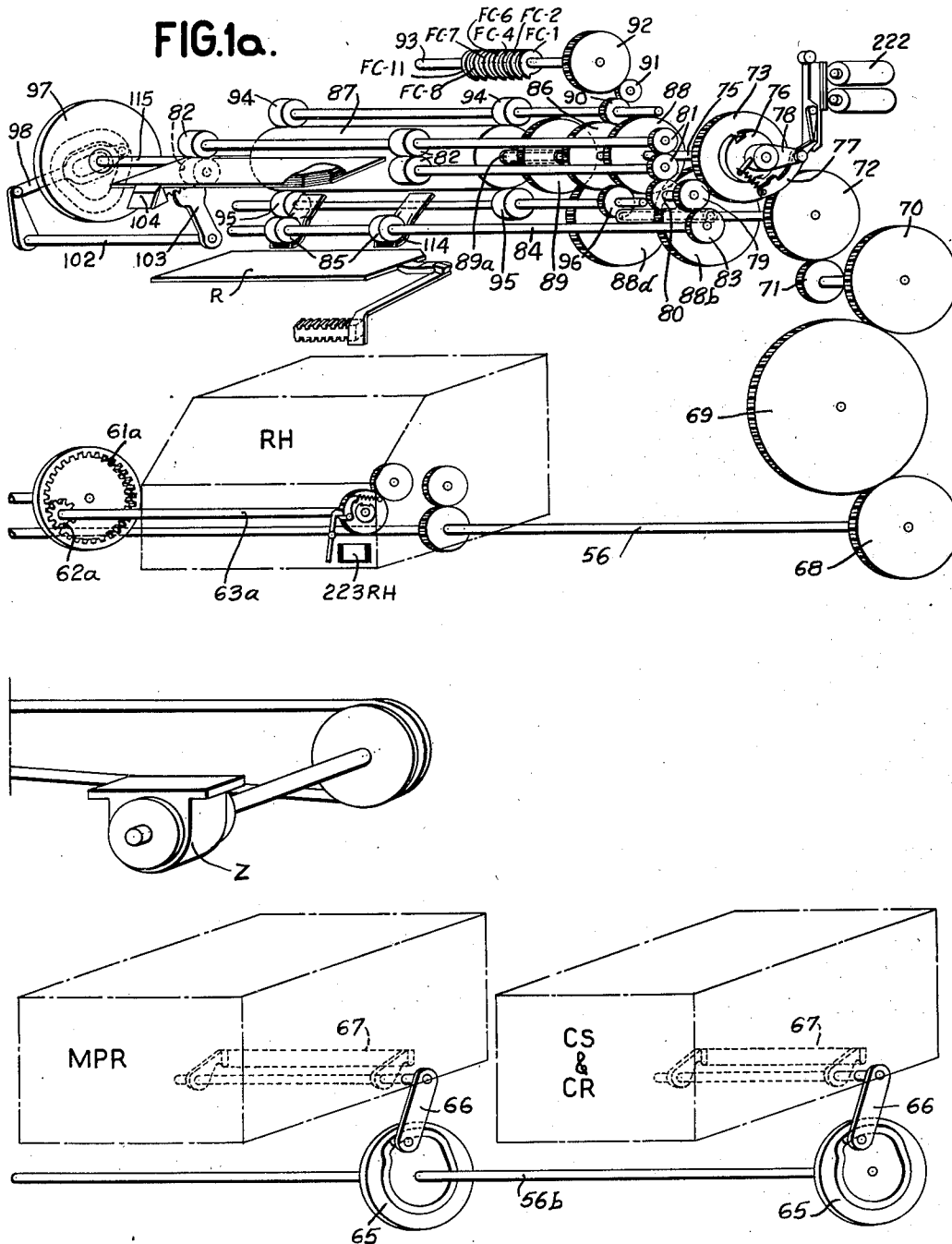
1,944,665

MULTIPLYING MACHINE WITH IMPROVED CHECKING FEATURES

Filed March 16, 1933

13 Sheets-Sheet 2

FIG. 1a.



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Filed March 16, 1933

13 Sheets-Sheet 3

FIG. 3.

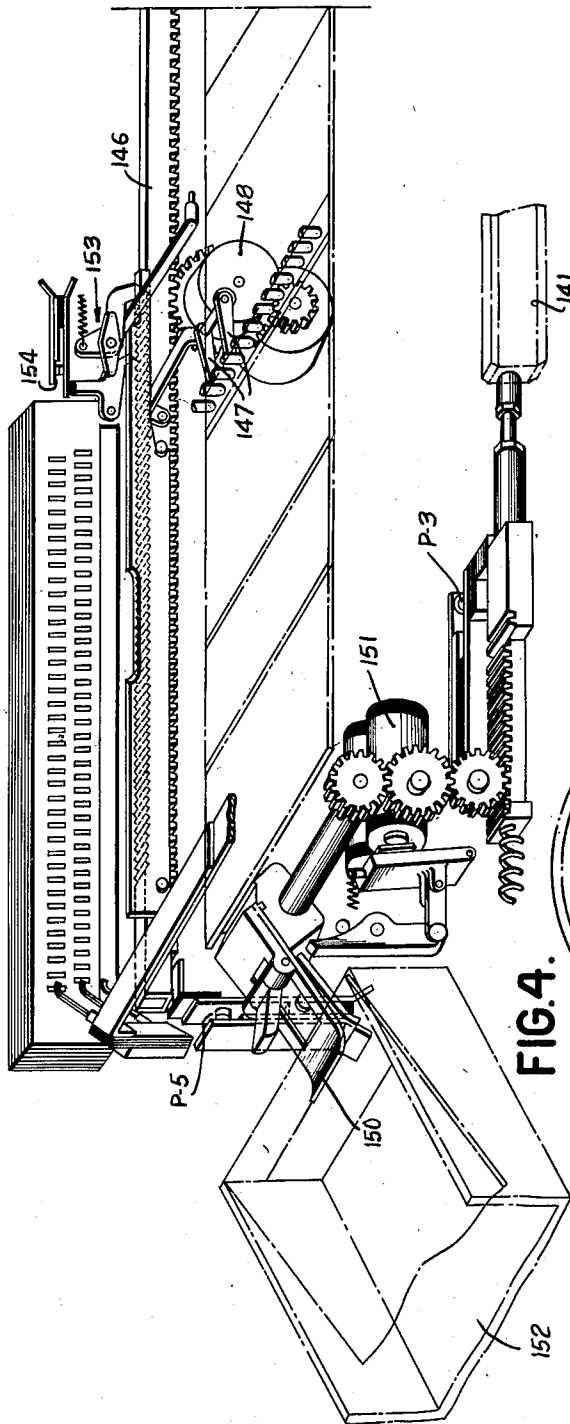
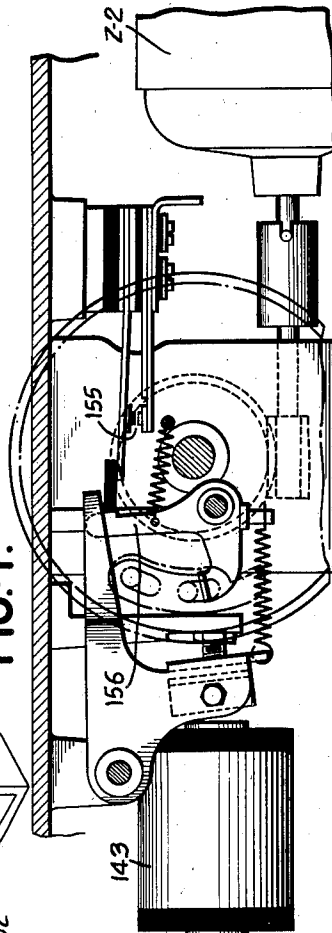


FIG. 4.



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Filed March 16, 1933

13 Sheets-Sheet 4

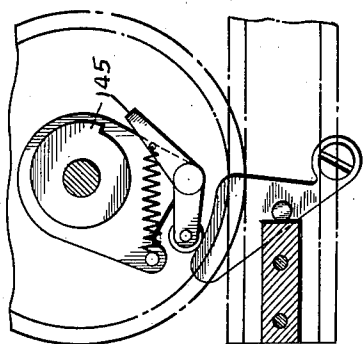
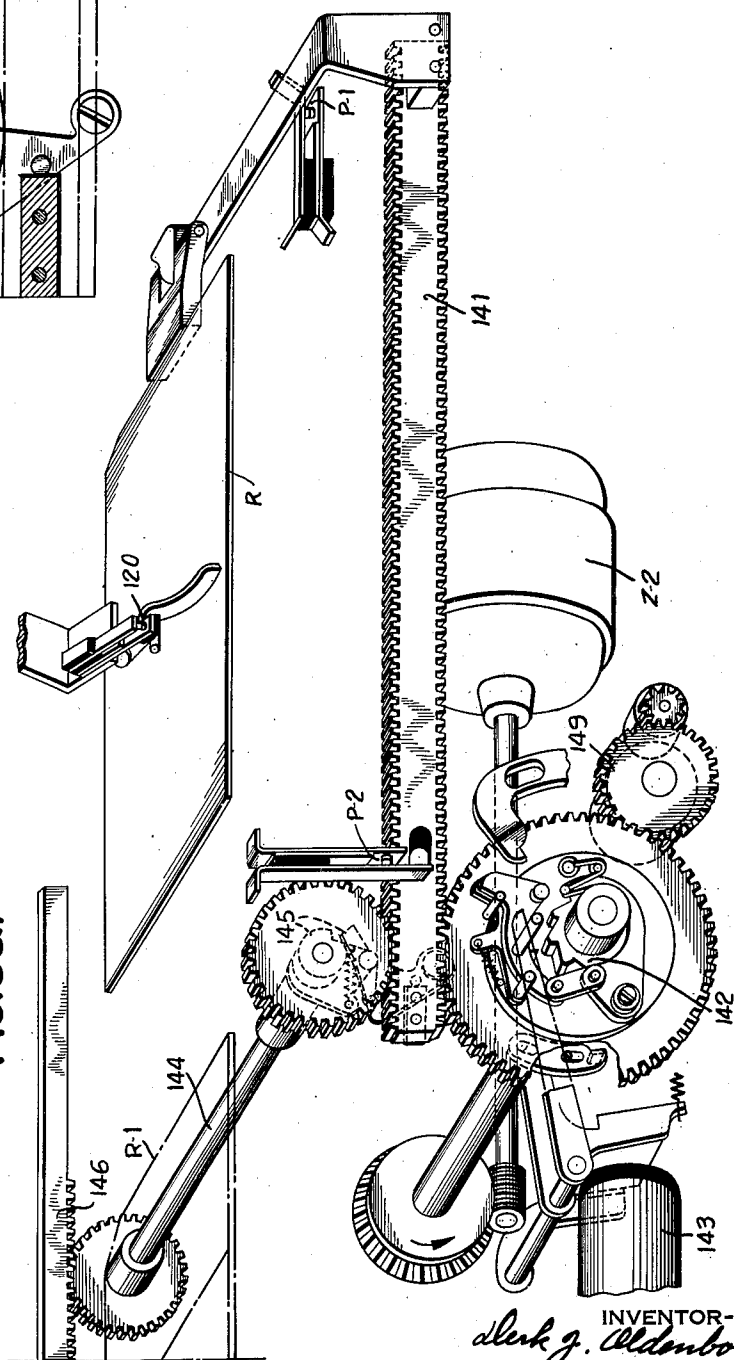


FIG. 5.

FIG. 3a.



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1,944,665

MULTIPLYING MACHINE WITH IMPROVED CHECKING FEATURES

Filed March 16, 1933

13 Sheets-Sheet 5

FIG.6.

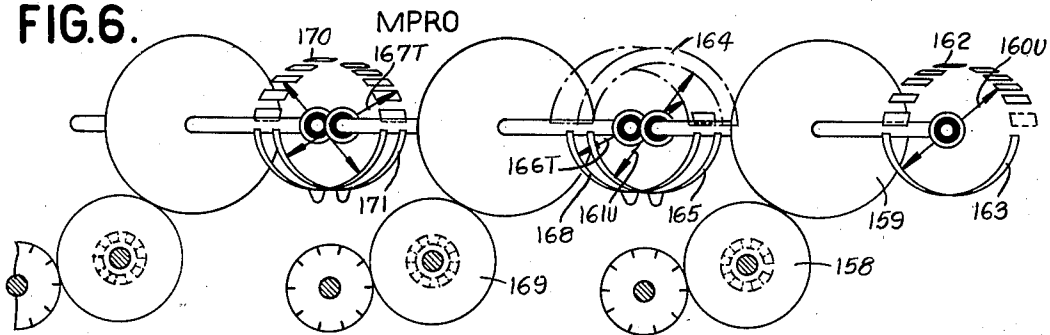


FIG.8.

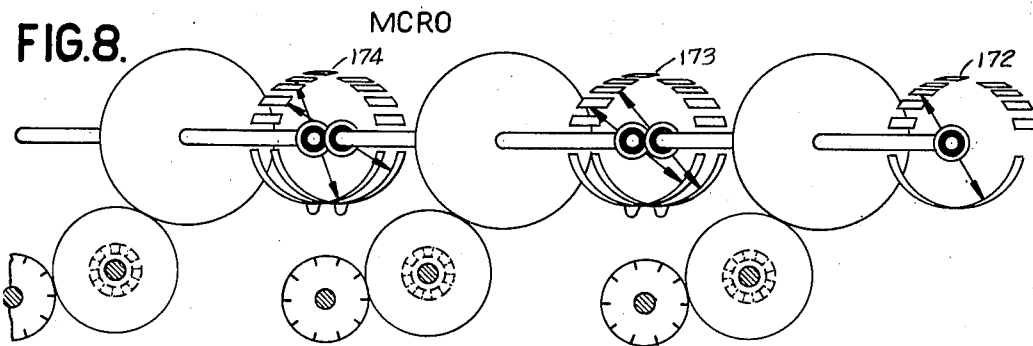


FIG.10.

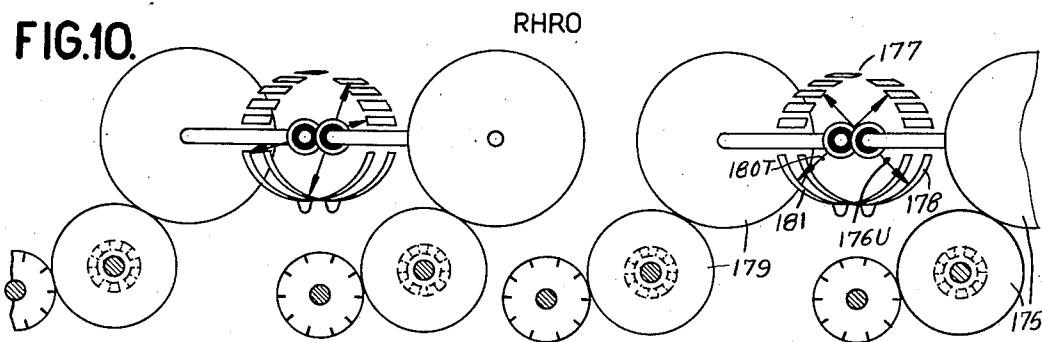


FIG.7.

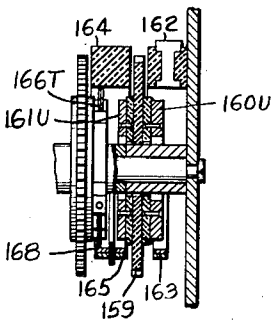


FIG.9.

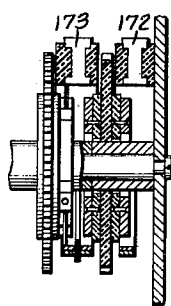
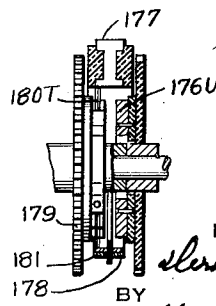


FIG.11.



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MULTIPLYING MACHINE WITH IMPROVED CHECKING FEATURES

Filed March 16, 1933

13 Sheets-Sheet 6

FIG.12.

LHRO

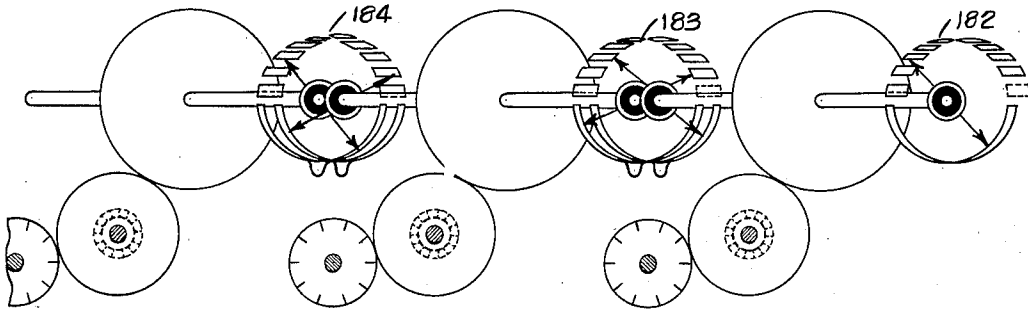


FIG.13.

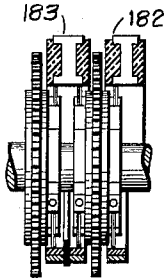


FIG.14.

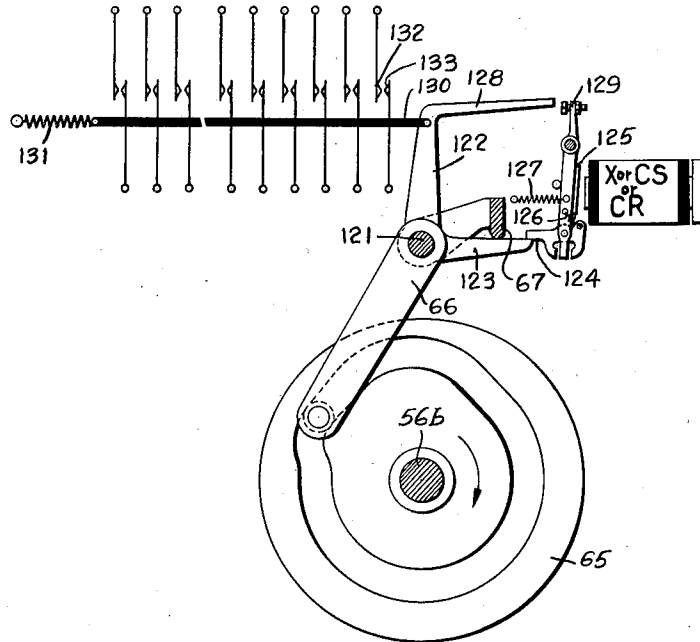
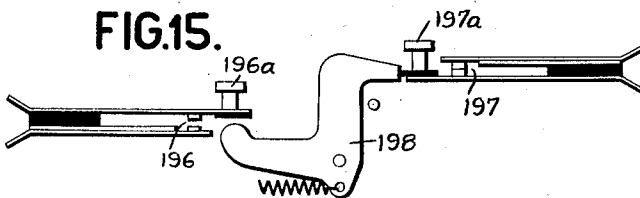


FIG.15.



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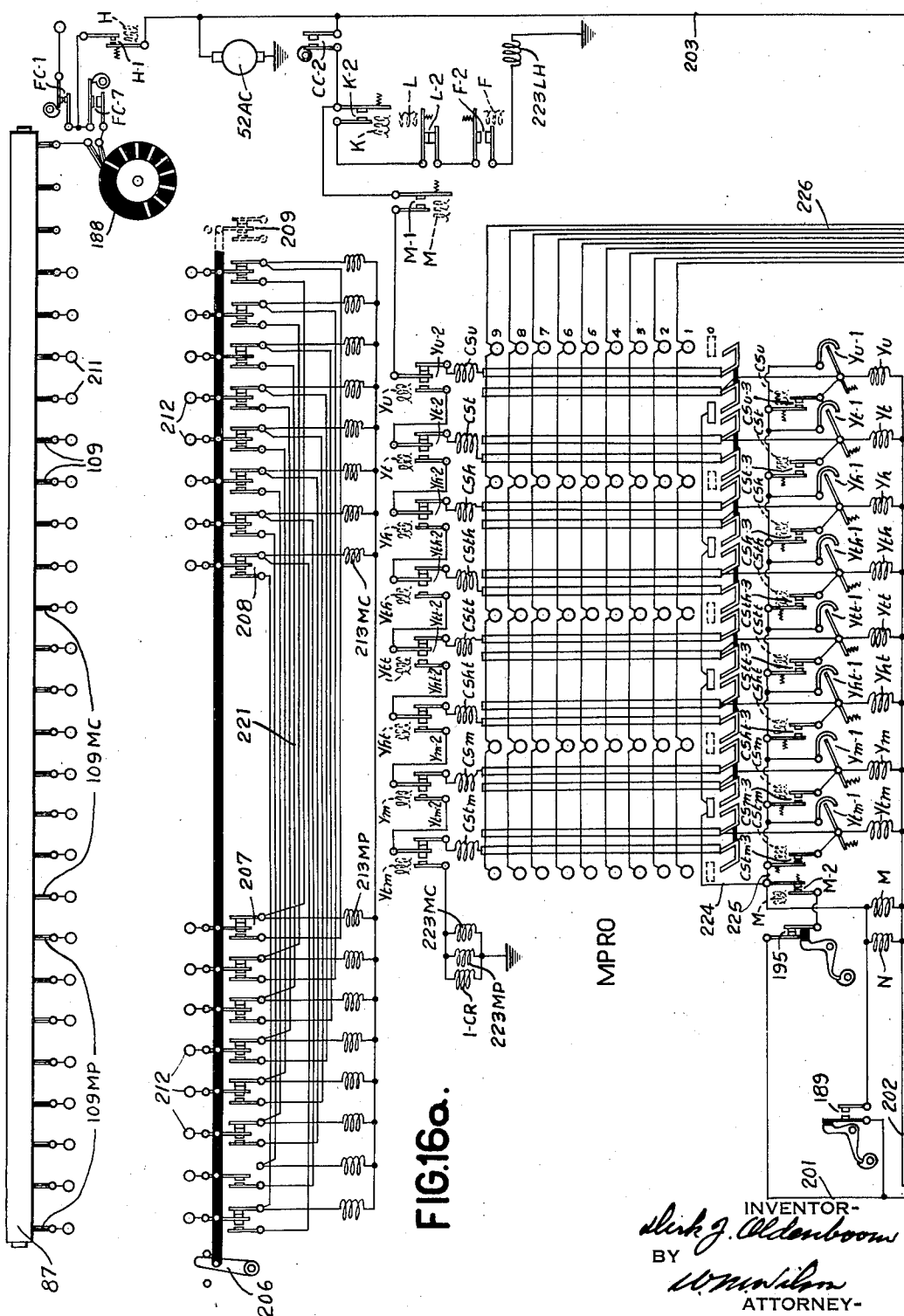
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1,944,665

MULTIPLYING MACHINE WITH IMPROVED CHECKING FEATURES

Filed March 16, 1933

13 Sheets-Sheet 7



1,944,665

13 Sheets-Sheet 8

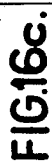


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1,944,665

13 Sheets-Sheet 9



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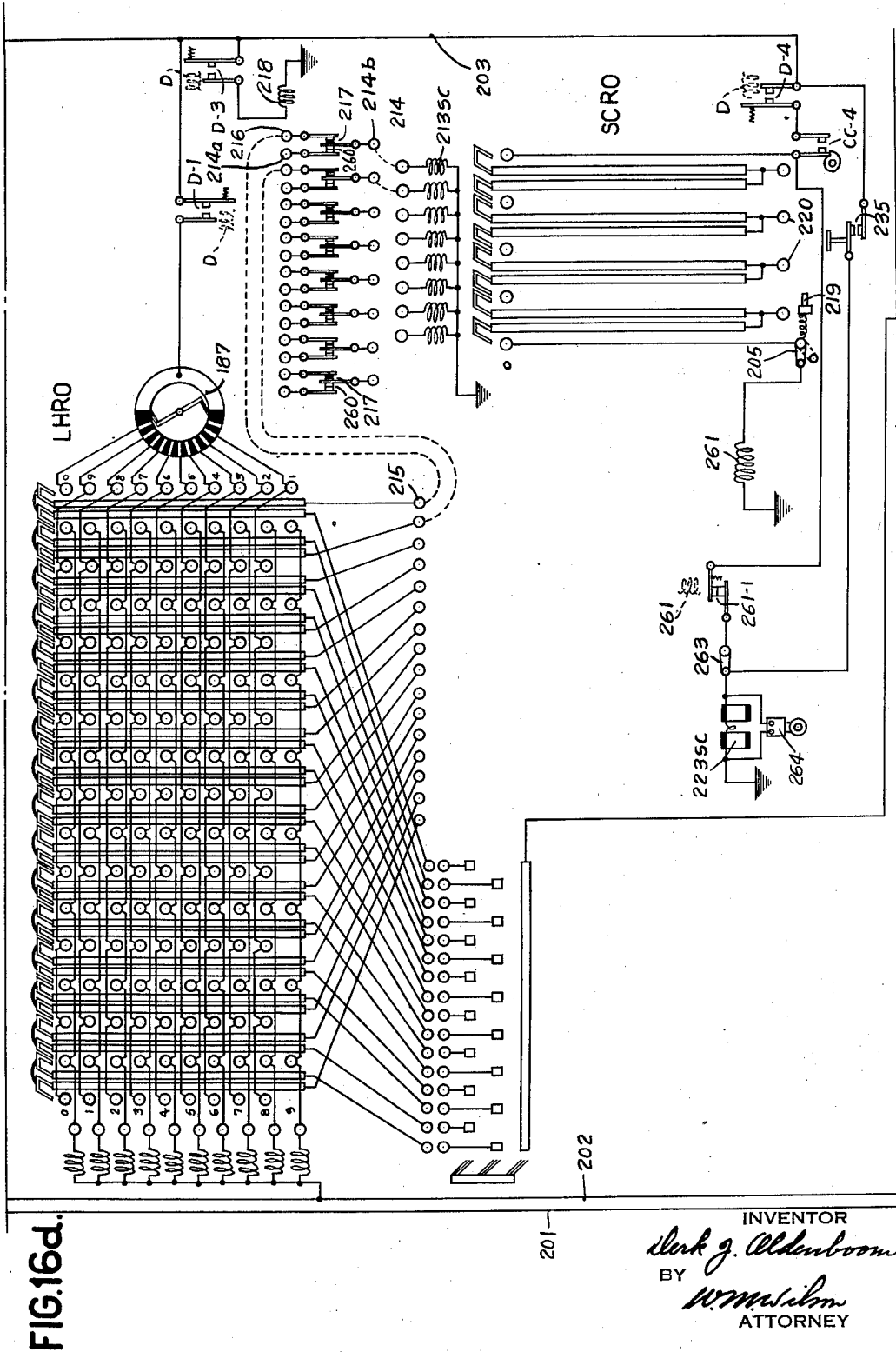
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MULTIPLYING MACHINE WITH IMPROVED CHECKING FEATURES

Filed March 16, 1933

13 Sheets-Sheet 10



Jan. 23, 1934.

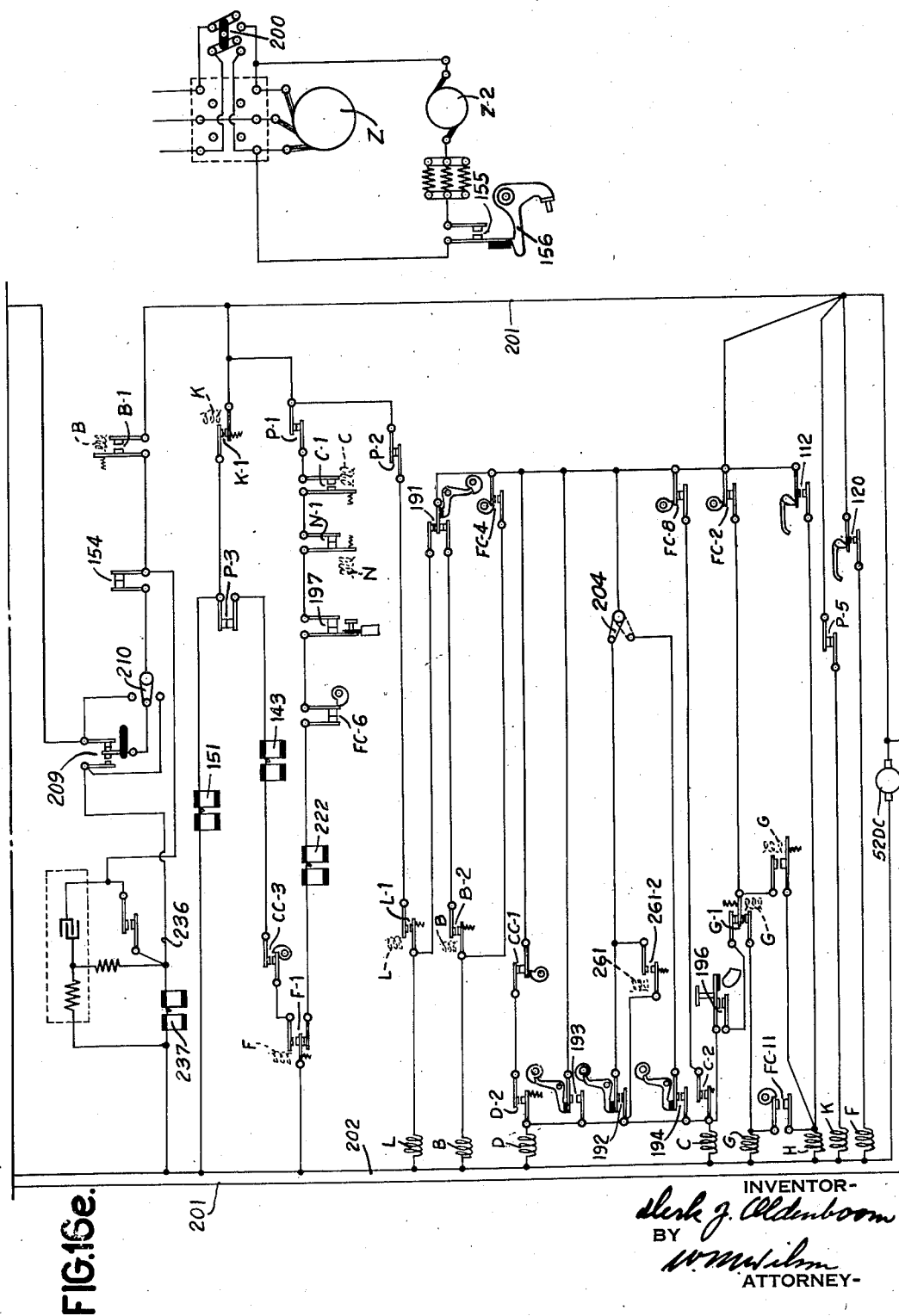
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1,944,665

MULTIPLYING MACHINE WITH IMPROVED CHECKING FEATURES

Filed March 16, 1933

13 Sheets-Sheet 11



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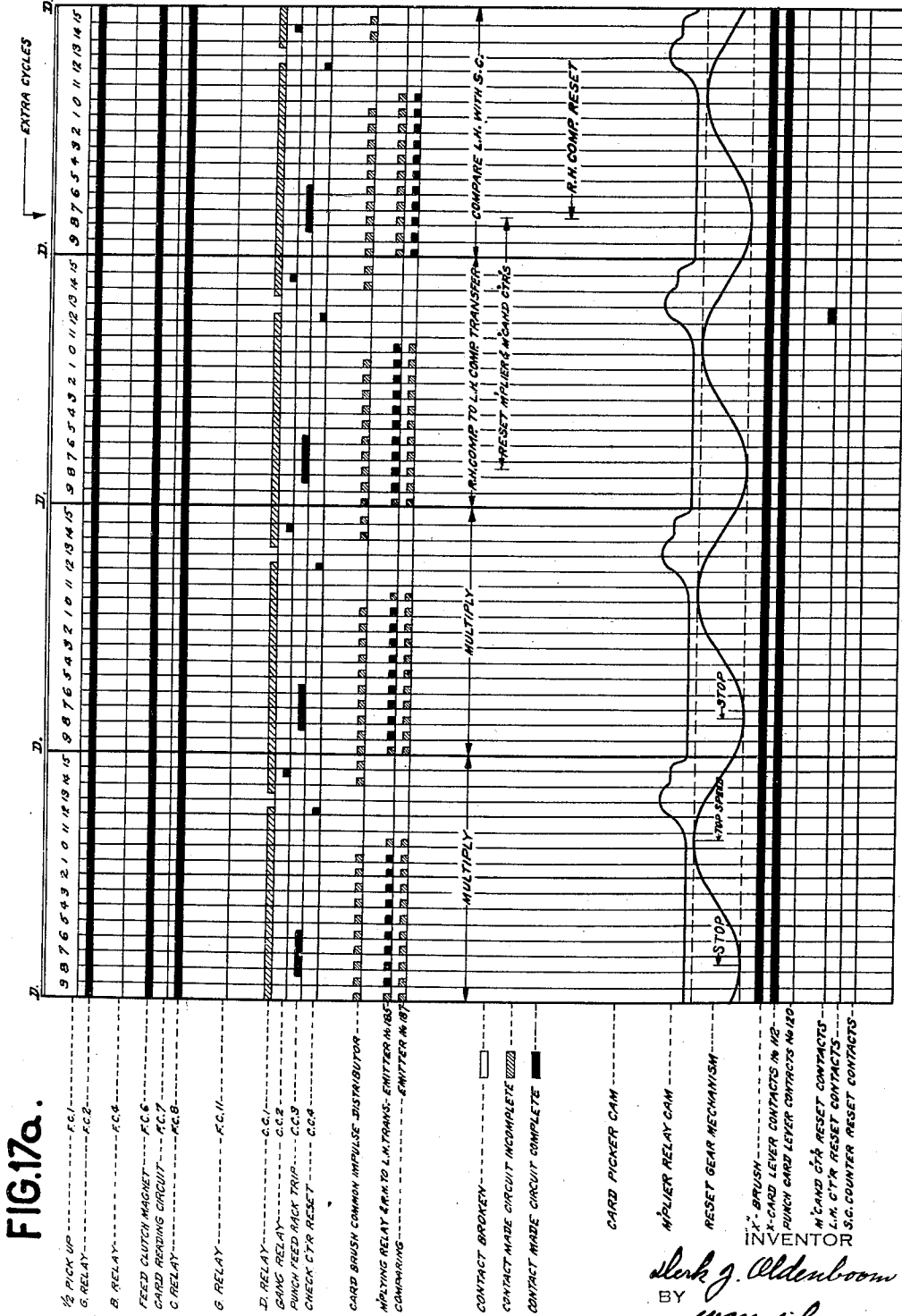
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13 Sheets-Sheet 12



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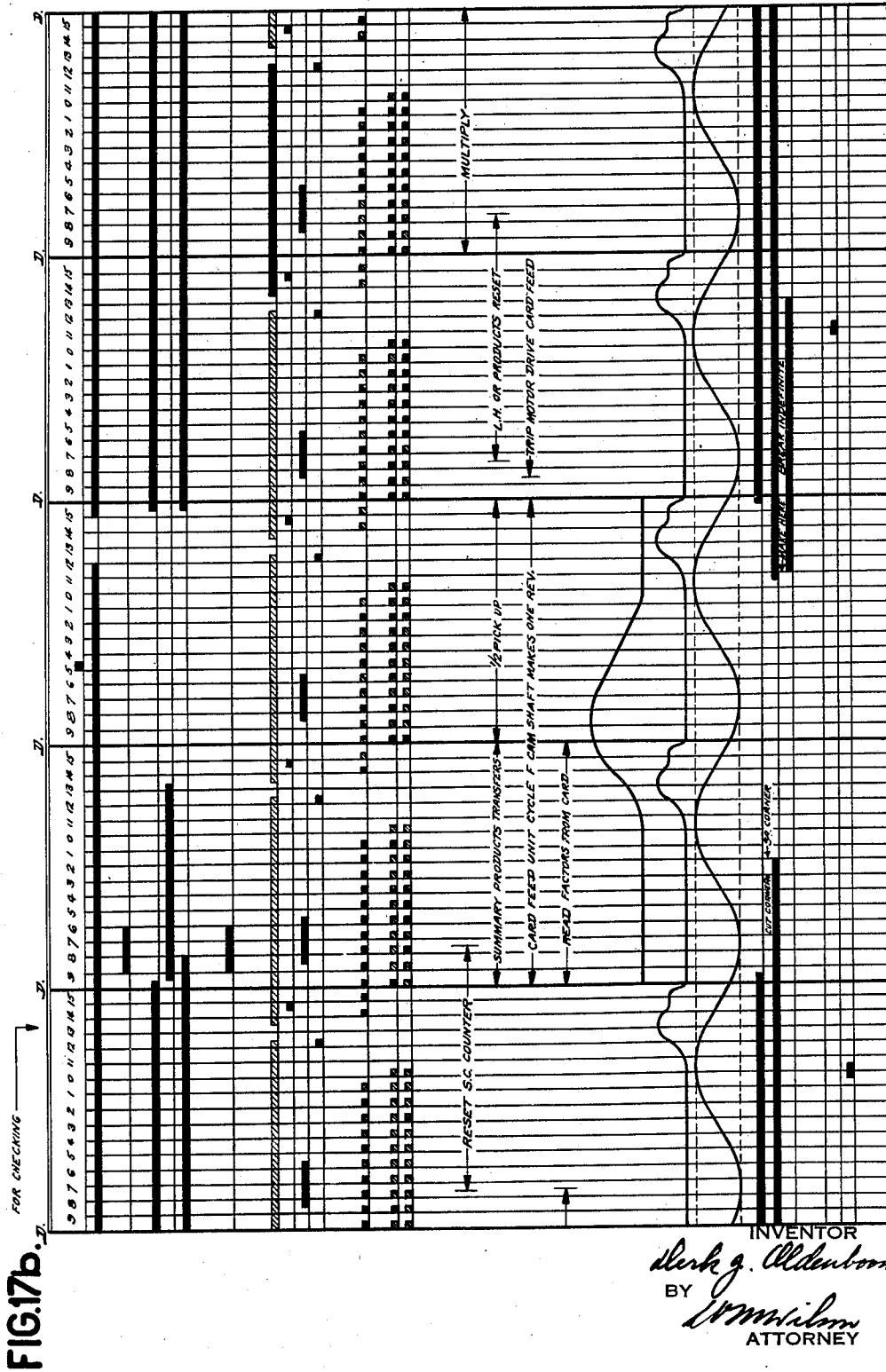
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MULTIPLYING MACHINE WITH IMPROVED CHECKING FEATURES

Filed March 16, 1933

13 Sheets-Sheet 13



UNITED STATES PATENT OFFICE

1,944,665

MULTIPLYING MACHINE WITH IMPROVED
CHECKING FEATURES

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Application March 16, 1933. Serial No. 660,984

10 Claims. (Cl. 235—92)

This invention relates to improvements in record controlled multiplying machines.

Many users of multiplying machines insist that on certain classes of work all computations be checked and verified for accuracy. Such checks are and have been required heretofore where multiplying operations are effected by computing machines in which the entries are made by hand and accordingly the practice of requiring checking has been carried over into the record controlled multiplying machine art where entries are made automatically by machine operations under record card control.

Furthermore, in the use of automatic record controlled machines, occasionally the operator of the machine makes faulty settings of certain machine controls or fails to properly or fully insert the plug connections. At other times damaged cards are introduced into the supply magazine of the machine and such cards some times fail to properly feed through the punch, causing faulty or missing recording of product results in certain columns of the records. Some times while a result may be properly computed by the machine the punching section of the machine may not properly record the product, due to maladjustment of the punch which may be caused by the operator improperly setting up the machine for desired product punching.

All of the foregoing have brought about some demand for checking adjuncts upon a record controlled multiplying machine to enable a series of previously made and recorded computations to be re-checked for accuracy of the computations and the accuracy of the recorded results.

Heretofore, checking operations on these record controlled multiplying machines have been carried out by group checking in contradistinction to individual record checking and the checks have been made as to the accuracy of the machine made computations in contradistinction to checking the accuracy of the previously recorded product result and the checking of such previously recorded result with a re-computed calculated amount.

Checking has been performed heretofore by summarizing the computed products obtained upon the first run of the records through the machine and then comparing such product summary with a new re-calculated summary of products. If the two product summaries matched the set of records were considered correct. Such methods previously employed did not (1) localize an incorrectly computed record; (2) localize a correctly computed record carrying an incorrectly

recorded product. Furthermore, if the products were correctly computed on the first run but certain of the products were incorrectly recorded, the observation of the summary counter readings did not in any way point out the presence in a group of records of correctly computed records with incorrectly recorded products thereupon.

Accordingly, the present invention has for its objects the provision of improved checking adjuncts, attachments and devices for record controlled multiplying machines which will enable not only a check to be made upon previously computed computations, but which will also provide for the checking of the previously recorded product result and to the provision of means whereby an incorrect record, which carries an incorrect product due to either a previous erroneous computation or to a previous erroneous recording of a correctly computed result, may be definitely and quickly localized and separated from a large group of correctly computed and recorded records.

A further object of the present invention resides in the provision of an improved checking means for a record controlled computing machine which will enable quick checking and comparing operations to be made of the previously computed products as previously recorded with a re-computed and checked product and for accurately, quickly and definitely localizing the records with the incorrect product results thereon.

A further object of the present invention resides in the provision of a checking attachment and supplementary checking controls for a multiplying machine which will enable the machine to be run at the usual normal high speed for first run multiplying and recording operations and which will enable checking operations to be performed on the same machine with a minimum loss of speed and with the minimum of extra machine cycles for checking purposes.

Further and other objects of the present invention will be hereinafter set forth in the accompanying specification and claims and shown in the drawings, which by way of illustration show what is now considered to be a preferred embodiment of the invention.

Before describing the construction and operation of the machine in detail, the general mode of operation of the machine may be briefly alluded to. The first run operations in which the products are computed and results recorded on the cards are first performed in the usual way. After a group of cards have been computed and the results recorded, certain checking switches on

the machine are adjusted and the machine is re-plugged so that upon the following check run, on the same set of cards, the machine receives not only an entry of the multiplicand and of the multiplier, but also an entry of the recorded and previously computed product from each card. This product derived from the record is then compared with a re-computed product of the multiplicand and multiplier and upon the re-computing operation the multiplier and multiplicand are preferably reversed. If the re-computed product compares with the product previously computed and derived from the product perforations of the record upon the check run, the machine proceeds automatically to check the next record. If there is a failure of a comparison or any non-matching of the re-computed result with the read in previously computed and recorded product, the machine stops and the incorrect record may be removed.

In the drawings:

Figs. 1 and 1a taken together show a somewhat diagrammatic view of the various units of the machine and the driving mechanism therefor;

Fig. 2 is a vertical sectional view taken through the card handling and reading section of the machine;

Figs. 3 and 3a, taken together show a somewhat diagrammatic view of the punching section of the machine;

Fig. 4 is a sectional detail view of certain parts in the punching section of the machine;

Fig. 5 is another detail view of certain parts of the punch;

Fig. 6 is a diagrammatic view of the readout device for the MP counter;

Fig. 7 is a fragmentary sectional view showing the construction of the parts of this MPRO readout device;

Figs. 8 and 9 are respectively, diagrammatic and sectional views of the multiplicand readout device;

Figs. 10 and 11 are respectively, diagrammatic and sectional views of the readout device for the RH accumulator. A readout of the same general form is used for the checking accumulator, except that ten segment spots are provided in lieu of nine as in the RH accumulator;

Figs. 12 and 13 are respectively, diagrammatic and sectional views of the readout device for the LH accumulator;

Fig. 14 is a view showing one of the electromagnetically controlled mechanically positioned multi-contact relays which are used in the machine for multiplier selection and column shift purposes;

Fig. 15 shows certain latching mechanism which is used on the stop and start keys of the machines;

Figs. 16a, 16b, 16c, 16d, and 16e, taken together and arranged vertically in the order named, show the complete circuit diagram of the machine; and

Figs. 17a and 17b taken together, show the timing diagram of the machine.

A general description will first be given of the units and their location in the machine. The machine embodies a card feed and card handling section (see Figs. 1a and 2) and there is also the usual successively actuated punch which receives each card as the card emerges from the card handling section. The punch is shown in Figs. 3 and 3a and a portion of the punching mechanism, viz. a portion of the receiving tray, is shown in Fig. 2.

The counters and receiving devices used are as

follows: In the upper part of the machine there is provided the usual RH and LH accumulators designated RH and LH respectively. In lieu of the summary products accumulator heretofore used in machines of this class, an inverting counter is provided designated SC on Fig. 1. This accumulator is similar in construction to the usual summary products accumulator, but is provided with a readout section. In the lower part of the machine there are two counters which are used as multiplier and multiplicand entry receiving devices which are designated MP and MC on Fig. 1. The lower part of the machine also includes a multiplying relay unit MPR and column shift and control unit generally designated CS and CR.

The usual emitters, cam contact devices and impulse distributor, etc., are likewise provided.

The main upper counter drive shaft 56 is driven in the customary manner from the driving motor Z which also drives the AC—DC generator 52. The usual Geneva reset drive is provided for the upper reset shaft 63 for the LH and SC accumulators. Such drive comprises parts 57, 58, 59, 60, 61, and 62.

The reset shaft 63a for the RH accumulator is driven from the cross element 60 of the geneva, through an internal gear 61a and pinion 62a. The lower main drive shaft 56b is also driven from the vertical connecting drive shaft 54 and reset drive for the lower reset shaft 63b is provided by parts 57b, 58b, 59b, 60b, 61b, and 62b.

Card feed and card handling unit drive

Referring to Figs. 1a and 2, the customary card feed drive is provided which may be briefly described as follows: Shaft 56 through gearing 68, 69, 70, 71, and 72 drives a gear 73, revolutely mounted on shaft 75. Fixed to gear 73 is the element 76 of the one revolution clutch, the complementary part of which comprises a pawl 77, carried by an arm 78 fixed to shaft 75. Gear 73 through a gear 79 fixed to gear 80, drives a train of gears 81, which in turn drive the card feed rolls 82. Also in train with gear 79 is a gear 83 for driving drag roll shaft 84 carrying drag rolls 85. The usual card transfer and contact cylinder 87 is provided driven in the following manner. Fixed on shaft 75 is a gear 88 which, through gearing 88b, 88d, drives a gear 89 which is fixed to the sleeve 89a revolutely mounted on shaft 75 but fixed to the card transfer and contact roll 87. The intermittently actuated FC group of cam contact devices are driven in the following manner: A driving train is provided from gear 86 which gear is fixed to shaft 75 and which train includes gearing 90, 91 and 92, the latter gear being fixed to the cam contact shaft 93. Fixed to the shaft of gear 90 are spring pressed card feed rolls 94. Other spring pressed card feed rolls 95 are driven by the gear 96. The card picker is driven in the customary manner by a box cam 97 fixed on shaft 75 cooperating with the follower 98 which rocks a rock shaft 102 carrying a gear sector 103 which is in engagement with the picker block 104.

Upon engagement of the one revolution card feed clutch, the picker is called into action to withdraw a single card from the magazine (Fig. 2) and advance the card into the bite of rolls 82, which rolls in turn forward the card to the card transfer and contact roll 87. A curved card guide is provided around the transfer and contact cylinder and the advancing card is carried around by the forward rotation of the cylinder and by the rotation of rolls 94 to traverse the

card past the main sensing brushes designated 109 in Fig. 2. Also in cooperation with the card is a pivoted card lever 111 operating card lever contacts 112.

5 After sensing, the card is advanced by the rolls 95 and cylinder 87 between guiding members 114 and 115, and while between these members it is advanced by drag rolls 85. The drag rolls 85 deliver the card under the guiding member 117 and ultimately the card is flipped down into the tray of the punching section of the machine. The location of the tray is indicated at 118 in Fig. 2 and the position of a card in this tray is indicated at R in Fig. 1a.

15 A card lever 119 (Fig. 2) is provided adjacent the tray for closing card lever contacts 120 when a card is in the tray.

When the machine is to be used for checking purposes with the traverse of the card past the main sensing brushes 109, the amount of the multiplier and the amount of the multiplicand will be read from the card and will be entered into the MP and MC receiving devices of the machine. The amount of the previously punched product will also be read from the card and such a previously computed and punched product amount will be entered into the SC accumulator of the machine.

Multi-contact relays

30 The machine includes a number of electromagnetically controlled and tripped multi-contact relays. These are used in the MPR, CS and CR sections of the machine. The mechanical drive for these relays is provided for in the following manner:

The lower drive shaft 56b drives operating cams 65 (see Figs. 1a and 14). Cooperating with each cam 65 is a follower arm 66 which is adapted to rock a bail 67. Loosely mounted on shaft 121 are a number of U-shaped members 122 each provided with an arm portion 123 extending under the bail 67 and cooperating with a latch member 124 which is pivotally mounted on the armature member 125 and spring urged in an anti-clockwise direction by a spring 126. The armature is normally rocked clockwise by a spring 127. Each member 122 has an armature knockoff arm 128 adapted to cooperate with a knockoff extension 129 of the armature. Also fixed to each member 122 is an insulated contact operating part 130 which is normally drawn to the left by a spring 131. The contacts 132 and 133 are provided, the latter 133 being fixed to the member 130. Upon the full movement of 130 to the left the contacts 132 and 133 will close.

In the operation of this multi-contact relay, the bail 67 is first displaced to the position shown and arm 123 is slightly depressed to relieve the strain from the latch point where 123 cooperates with 124. A relay magnet X, CS or CR may then be energized, swinging the armature 125 to the right causing the latch 124 to clear 123 and snap down under spring action by spring 126 to a position at the end of member 123. Thereafter upon further motion of the cam 65 in the direction indicated by the arrow, the bail 67 is elevated allowing an anti-clockwise motion of member 122 and permitting the contacts to close under spring action. Subsequently further movement of the cam 65 causes the bail 67 to be again depressed to reopen the contacts and to thrust 128 to the right to a supplemental extent to knock off any previously attracted armature. At this time there is a relatching of the latch 124 with member 123.

If a given armature is not attracted by the energization of the relay coil, latch 124 will not be tripped and such latch will prevent the anti-clockwise motion of members 122 and the closing of the contacts upon the elevation of bail 67.

In the subsequent description of the wiring diagram, certain of the contacts which have been generally designated 132 and 133 in the foregoing description of the relay, will be given designating numerals related to their associated relay control magnets. Thus 1—CR—1 to 17 will designate the seventeen contacts controlled by the relay magnet 1—CR.

Punching mechanism

The punching mechanism is of the usual successively acting repetition punching type generally used in machines of this class. It is generally of the form shown in Lee and Phillips United States Patent No. 1,772,186 and in British Patent No. 362,529, corresponding to the United States application of Lee and Daly, Serial No. 391,874.

Inasmuch as punching operations are not performed when the machine is to be used for checking purposes, the punching mechanism will not be fully described. It is sufficient to here state that on checking multiplications, the cards are read one by one in the card handling and sensing section of the machine and fed into the punch and then traversed through the punch to the discharge magazine of the punch. It is sufficient to here state that after the receipt of the card in the receiving tray 118 in the punch at the R position and with the punch driving motor Z—2 in operation that a rack 141 is displaced to the left to push the card from the R position to the R—1 position. Movement of the rack 141 to the left is effected by the one revolution punch clutch generally designated 142, which clutch is engaged by the energization of punch clutch magnet 143. The traverse of 141 to the left causes shaft 144 to rotate clockwise by means of the ratchet driving device, generally designated 145 (see also Fig. 5). The clockwise rotational movement of 144 displaces rack 146 to the right to a position in which pusher fingers 147 can engage back of the trailing edge of the card at the R—1 position. Thereafter rack 146 moves to the left under spring power from a spring in barrel 148 and another spring drive at 149 restores rack 141 to its right hand position.

After the card has been passed through the punch it ultimately reaches a position in which the eject mechanism 150 receives the card. Following this there is a trip of the eject mechanism by energization of eject magnet 151 and the eject mechanism swings to the position shown in Fig. 3 to deliver the card into a discharge magazine or box as indicated by the dotted line position of the card in Fig. 3. The box is generally designated 152. The movement of rack 146 to the left is under the influence of the usual escapement 153 and each time the card escapes a column the escapement contacts 154 are opened.

The punching section of the machine is provided with contacts which may be briefly described. Contacts P—1 are contacts which are closed when rack 141 is in extreme right hand position and in proper position to receive a new card from the card handling and sensing section of the machine. Contacts P—2 (Fig. 3a) are contacts which are normally closed and which open when rack 141 is in its extreme left hand position. Contacts P—3 are eject contacts which

open up when the eject assemblage 150 is moved to card receiving position. With the eject mechanism in the position as shown such contacts are closed. Contacts P—5 are contacts which are normally open contacts and which close upon the movement of the rack 146 and of the card to beyond the last column position.

Contacts 155 are also provided, which are arranged to be closed upon energization of the punch clutch magnet 143. Such contacts are latched closed by a latch 156 and the latch is released and the contacts are allowed to open by a knockoff associated with the one revolution clutch assembly 142.

Readout devices

Referring to Figs. 6 and 7 which show the MP readout (MPRO), 158 is a clutch gear pertaining to the units order of the MP receiving device. Gear 159 is driven from this clutch gear and this gear in turn drives brush assemblies designated 160U and 161U. 160U traverses segments 162 and current supply segment 163. 161U traverses a segment block 164 provided with a single spot at the zero position and also traverses current supply segment 165. There is also a brush assemblage 166T which traverses the 164 segment and which receives current from a current supply segment 168. This brush assemblage 166T and a brush assemblage 167T is driven from the tens order clutch wheel 169. 167T traverses segment spots 170 and receives current from a supply segment 171. This arrangement of brushes and segments is repeated for the higher orders in the MPRO readout, i. e. each alternate segment is like 164 with only a single spot in the zero position and alternating with such segments are other segments similar to 162 and 170 with a multiplicity of spots on each segment.

The wiring of the MPRO readout will be shown in connection with the description of the circuit diagram.

MCRO readout

The drive for the multiplicand readout brush assemblies is the same as previously described for the MP readout. The segment arrangement, however, is different. In lieu of the segments 162, 164 and 170, segments 172, 173 and 174 are provided each with a multiplicity of spots as shown, i. e. there are nine spots on each segment.

RHRO readout

With the RHRO readout, a different arrangement is provided. The units order gear train 175 drives a brush assemblage 176U, which traverses segments 177 and which receives current from a conducting segment 178. The tens order train 179 drives a brush assemblage 180T which also traverses the segments 177 and which receives current from a conducting segment 181. This arrangement is repeated for relatively higher orders of the readout.

The wiring of this readout will appear on the circuit diagram.

LHRO readout

The LHRO readout device has a drive which is similar to the drive for the MPRO and the MCRO readout devices. The arrangement of segments is substantially similar to the MCRO readout device with the exception of the fact that there are ten conducting spots instead of nine as with the MCRO readout device. The reference characters 182, 183 and 184 designate the segments of this

LHRO readout. The wiring of the readout will be shown on the circuit diagram.

SCRO readout

The SCRO readout device has a drive which is the same as the tens order of the MPRO readout device. The arrangement is the same, there being a single conducting spot in the zero position and none in the other positions. The wiring of this readout will be shown on the circuit diagram.

Emitters and cam contacts

The main drive shaft 56 (see Fig. 1) is adapted to drive the cams of certain CC cam contact devices. These cams are correspondingly numbered on Fig. 1 as CC—1 to 4. Also driven from the shaft 56 are two emitters 185 and 187 which are of conventional construction. An impulse distributor 188 is provided which is driven in unison with the cams CC—1 to 4.

Reset controlled contacts

Referring to Fig. 1, the reset gear of the LH accumulator is provided with a cam adapted upon the reset of this accumulator to cause closure of contacts 189 and to shift a three-blade contact arrangement to open contacts 190 and to close contacts 191. Similarly arranged reset contacts are provided in association with the SC accumulator, i. e. contacts 192 are arranged to close upon the reset of this accumulator.

On the MC accumulator in lieu of two contact pairs as heretofore used in previous machines, three contact pairs are provided, viz. 193, 194 and 195. Contacts 193 and 194 are arranged to be closed upon reset of this accumulator and contacts 195 are arranged to be opened upon the reset of this accumulator.

Referring to Fig. 15, 196 are the start key contacts controlled by start key 196a and 197 are the stop key contacts controlled by the stop key 197a. Intermediate the contacts there is a spring urged latch member 198. The arrangement is such that upon the depression of the stop key 197a the latch member 198 will keep stop key contacts 197 open and the start key contacts 196 will also be kept open. Thereafter upon depression of the start key 196a to close the contacts 196, the latch member 198 will be rocked anti-clockwise to release the stop key contacts and to permit their reclosure.

Circuit diagram

It will be understood that the present machine is intended both for the original computation and production of perforated records and for the checking of the product results on records made on a previous computing run. The initial computing runs wherein the records are initially produced and perforated need not be here described in detail. The operations will be described, however, in connection with the performance of check runs and the necessary controls for the performance of check runs to modify the operation of the machine from the performing of computing operations with product punching to a checking operation per se will be here described in detail.

For the present description it will be assumed that cards have been once passed through the machine, the factors read therefrom, the products computed and punched upon the cards. Then if the operator of the machine desires to check the previous computations, the previously

computed cards with the products punched thereon are replaced in the card supply magazine 105 of the machine (see Fig. 2). The machine is then set in operation, and when in operation, the multiplier and multiplicand factors are read from each card. The entries into the multiplicand and multiplier counters are reversed, however, so that the previous multiplier becomes the multiplicand and the previous multiplicand becomes the multiplier. This is effected in the customary manner by reversing the circuit connections to the multiplier and multiplicand entry devices. The machine when in operation for checking purposes is also arranged to read from each previously computed and perforated card the amount of the product previously computed and perforated. Such product is read from the card at the time when the multiplier and multiplicand factors are read from the card and such previously computed product is entered into the SC accumulator. The machine then proceeds with the computation of the entered and reversed multiplier and multiplicand and ultimately sets up the product of the multiplier and the multiplicand in the LH accumulator. After the final product result is set up in the LH accumulator, the machine goes through a comparing cycle of operations during which the complement of the product in the LH accumulator is added to the product previously entered into the SC accumulator directly from the card. Comparison will be indicated by the resultant positioning of the SC accumulator at zero in all orders. If the two products compare, the machine will have ascertained that the previous computation and punching is correct and the machine will then automatically initiate the handling and checking of the following card record.

With each record introduced into the machine and found to be correct, the SC accumulator will be reset to zero by the simple addition of the complement of one product to the true value of the other and no further resetting of this accumulator is required. A new product can therefore be immediately received from the following record and checked with the following computation. If during a check run the product read from the record does not compare or match with the product computed by the operation of the machine, provision is made for automatically stopping the running of the machine. The operator then is apprised that there is a mistake in the calculation or in the punching of the previously computed calculation and the operator can inspect the visible counter wheels of the LH accumulator and the product on the record card in the punching position and ascertain the difference in the computation. The erroneous card can then be removed from the discharge magazine of the punch and checking on following cards proceeded with.

In setting the machine into operation, previously computed cards are placed in the card magazine of the machine. The operator then closes the main switch 200 providing current supply for the main driving motor Z. The main motor drives the AC DC generator 52 and supplies direct current to buses 201 and 202 and alternating current impulses to the bus 203 and to ground.

For running the machine upon a check run, certain switches are thrown to certain positions as will now be set forth. Switch 204 (Fig. 16e) is thrown to the full line position shown for a check run. Switch 205 (Fig. 16d) is also thrown to the full line position as shown for a check run. The manually manipulable member 206 (Fig. 16a) is thrown to reverse position from that

shown for checking to throw the set of three-blade contacts 207 and 208 to reverse position to reverse the entries of the multiplier and multiplicand and to also shift certain extra three-blade contacts 209 which are shown in dotted lines on Fig. 16a and in full lines in Fig. 16e.

A switch 210 (Fig. 16e) is also thrown to the full line position as shown. This switch is kept in this same position for normal multiplying without checking and for checking.

The multiplier and multiplicand entry circuits are plugged up in the usual way; that is, plug connections are made from certain of the plug sockets 211 which are connected to the main sensing brushes 109 to the plug sockets 212. One set of such plug connections are provided for the multiplier and similar plug connections are provided for the multiplicand to direct the entries into the 213MP counter magnets and the 213MC counter magnets. This is the customary plugging in these multiplying machines. From certain of the upper plug sockets 211 which are connected to the brushes which sense the product field on the card, plug connections are made to sockets 214a of normally closed contacts 260 (Fig. 16a) and from sockets 214b to sockets 214 which lead to the counter magnets 213SC pertaining to the SC accumulator.

By the aforesaid last mentioned plug connections, entries of the product amount as read from the card will be directly entered into the SC accumulator. For check runs other plug connections are made as follows:

Referring to Fig. 16d, plug connections are made from plug sockets 215 which lead to a section of the LHRO readout device to plug sockets 216 of normally open contacts 217. A plug 219 is provided on the SCRO readout device which can be plugged into one of the sockets 220 to shunt out unused and unplugged columns in the SCRO readout device.

Referring again to Fig. 16a, the cross wiring generally designated 221 is associated with the 207 and 208 three-blade contacts in such a way that with these three-blade contacts shifted to reverse position from that shown, the amount of the multiplier as read by the 109MP brushes will be directed into the multiplicand accumulator, the impulses controlled by the record controlling the 213MC counter magnets and the multiplicand entries which are read by the 169MC brushes will be entered into the MP accumulator, the impulses controlling the 213MP counter magnets. The transfer wires 221 and the three-blade contacts 207 and 208 control the transposition of the multiplier and multiplicand.

Having plugged up the machine in the manner above explained, the operator depresses the start key and closes start key contacts 196 (Fig. 16e). Closure of these contacts completes a circuit through relay coil C and through relay contacts G—1 now closed and through cam contacts FC—2. A stick circuit is established through the contacts C—2 of the relay and through cam contacts FC—8 now closed. Energization of coil C also closes contacts C—1 and a circuit is established to energize the card feed clutch magnet 222 (see also Fig. 1a). The circuit is completed from the 202 side of the DC line through relay contacts F—1 now in the position shown, through the card feed clutch magnet 222, through cam contacts FC—6 now closed, through stop key contacts 197 now closed, through relay contacts N—1 and C—1 now closed, 150

through contacts P—1 of the punch, now closed, to the other side of the DC line 201.

The start key is held depressed until after the second card feed cycle is initiated and until after card lever contacts 112 are closed, causing energization of relay coil H. Energization of coil H closes relay contacts H—1 (Fig. 16a). As the second card feed cycle ensues, the card is carried past the brushes 109 and the amounts of the multiplier and multiplicand and product are read from the card and entered into the multiplicand, multiplier and checking counters. The entry circuits need not be traced in detail.

While there is a manual starting up of card feed for the initial card handling cycles, on subsequent card handling cycles card feed is automatically initiated. Provision is accordingly made to cut off the hand initiating control after the initial card handling operations. Early in the second card feed cycle cam contacts FC—11 (Fig. 16e) close to energize relay coil G and shift contacts G—1 to reverse position from that shown interrupting the circuit to the start key contacts 196, but maintaining the circuit to cam contacts FC—2. The energization of coil G will also close relay contacts G—2 and establish a stick circuit for coils G and H either through the FC—2 cam contacts or the card lever contacts 112. The making time of cam contacts FC—2 overlaps the time when the card lever contacts 112 are open between cards.

The first card after being fed through the card handling and sensing section of the machine ultimately passes to the R position in the punch, closing card lever contacts 120, energizing relay coil F, causing the shift of relay contacts F—1 to reverse position from that shown. On starting up the machine, contacts P—1, P—3 and P—5 in the punch are closed. With P—5 closed, relay coil K will be energized and contacts K—1 closed. Upon the shifting of contacts F—1 and upon the closure of cam contacts CC—3, a circuit will be established to the punch clutch magnet 143. This circuit is completed to the other side of the line through the punch contacts P—3 now closed and contacts K—1 which are also closed. The energization of the punch clutch magnet 143 will cause the closure of contacts 155 which become latched closed by latch 156. In this way current is supplied to the punch driving motor Z—2. The card in the R position in the punch is now advanced endwise through the punch in the usual manner.

Initiation of multiplication

In the present machine on multiplying operations the set-up of the cycle controller is initiated by the reset of the LH accumulator. The energization of relay coils F and K in the manner previously explained cause closure of contacts F—2 and K—2 (Fig. 16a). Upon closure of cam contacts CC—2 current flows from the 203 side of the line through CC—2 now closed, through K—2 now closed, through relay contacts L—2 now closed, through F—2 now closed, through the 223LH reset magnet (see also Fig. 1) and back to ground. The energization of 223LH initiates the reset of the LH accumulator. Reset of the LH accumulator occurs with the racks in the punch in extreme outer position. During the reset of the LH accumulator, the reset control contacts 191 (Fig. 16e) close and energize relay coil L. Energization of L opens relay contacts L—2 (Fig. 16a) preventing a repetition of reset. Although L is only temporarily energized by the clo-

sure of contacts 191, a stick circuit is established for this coil, through contacts L—1 which close upon the energization of L. The stick circuit is completed through the punch contacts P—2 now closed. The cycle controller is set up in the following manner. Upon the reset of the LH accumulator a circuit is established traced as follows: (See Fig. 16a) from the 201 side of the DC line, through the reset contacts 189 of the LH accumulator, through relay coils M and N and back to the other side 202 of the DC line. The energization of relay coil M closes relay contacts M—1 and M—2 and the latter contacts establish a stick circuit for the relay coils M and N through the multiplicand reset contacts 195 which are now closed.

Column skip and cycle controller

The column skip and cycle controller are of the usual type which are fully described in the corresponding application of George F. Daly, Serial No. 643,663, filed November 21, 1932. It is sufficient to here state that if any brush of the multiplier readout stands upon a zero spot, the corresponding Y relay coil of the cycle controller will be energized. Current will flow in from the DC line 201 through the 195 reset contacts, through the relay contacts M—2 now closed, via wire 224, through the zero spots of the MP readout device, then via the corresponding brush or brushes standing on the zero spot or spots, then through the respective circuits shown and back to the 202 side of the DC line. Also connected to one side of the relay contacts M—2 is a line 225 which extends over and connects with one side of the CSu—3 to CStm—3 control contacts. The other side of each of these contacts is wired back to its respective Y relay coil and therethrough to the other side of the DC line. Accordingly when any Y coil is energized, due to a brush standing on a zero spot in its corresponding column, the energization of this particular Y relay coil will close its Y—1 stick contacts and this Y magnet will remain energized. Assuming that no zero appears in the units column of the amount upon the MP entry device, but that zeros appear in the tens and hundreds columns and that a significant figure appears in the thousands column, there will be an energization of coils Yh and Yt which will shift transfer contacts Yh—2 and Yt—2 to reverse position. Yu—2 will not have been shifted because its corresponding coil Yu had not been energized. Yth—2 will also not have been shifted. The machine is now ready to multiply by the amount in the units order of the MP entry device. Initiation of multiplication is effected in the following manner:

The energization of coil M closes relay contacts M—1. Following the setting up of the cycle controller, cam contacts CC—2 close and current flows through these contacts, through contacts M—1 now closed, through the Yu—2 transfer contacts, in the position shown, down through the CSu relay magnet and out via the brush which is standing on the "5" spot of the MP readout in the units order, down through the fifth line of the group of wires generally designated 226 to the X—5 multiplying relay control magnet (see Fig. 16b). There is a concurrent energization of the CSu magnet and the X—5 multiplier magnet. Energization of X—5 selects the proper impulses for multiplication by 5 and the energization of CSu directs the entries in the proper columnar orders of the RH and LH accumulators. Extra control contacts CSu—3

are provided controlled by the CSu relay and the closure of these extra control contacts which takes place as an incident to the flow of current to the X-5 magnet through CSu, causes the energization of the Yu relay coil, which relay coil was not previously energized because its corresponding readout brush did not stand on a zero spot. The energization of Yu then shifts stick contacts Yu-1 and transfer contacts Yu-2 so that upon the succeeding multiplication by the next significant figure, the current flowing in through M-1 and CC-2 will be diverted by Yu-2 over to the Yt-2 set of transfer contacts which are in reverse position from that shown, thence over through the Yh-2 transfer contacts, in reverse position from that shown, and over to the Yth-2 transfer contacts, in the position shown. These Yth-2 contacts will not have been shifted since their corresponding brush did not stand upon a zero spot. The next multiplying current impulse then flows through M-1, through Yth-2, through CStH, over through the brush of the MP readout to the particular wire of the 226 group, say the seventh wire and down through the X-7 magnet and out to ground upon closure of cam contacts CC-2. This current flow will effect a concurrent energization of X-7 and the CStH magnet and there will be a proper entry of the partial product amounts into the proper orders of the LH and RH accumulators at shifted over columnar positions therein.

The flow of the impulses for entering further partial products need not be traced in detail. It is sufficient to state that upon the energization of an X magnet coil of a multiplying relay that the related contacts shown on Fig. 16b are closed and at the proper time in the operation of the machine current impulses flow from the emitter 185 through the multiplying relay control contacts. Such impulses flow through the lines generally designated 227LH and 227RH to the LH and RH sections of the multiplicand readout MCRO. The multiplicand readout device allows selected impulses to flow to the LH component lines 228LH and the RH component lines 228RH. These last mentioned lines extend down through the various contacts of the CS relays, the wiring being as shown in Fig. 16c, and the other side of the contacts of these column shift relays connect to the LH and RH lines 229LH and 229RH which respectively extend to the counter magnets 213LH and 213RH pertaining to the LH and RH accumulators.

After multiplication is complete the transfer circuits in the cycle controller will all be shifted so that there will be an ultimate circuit path from the 203 side of the AC line, through CC-2, M-1, through all of the shifted Y-2 set of transfer contacts to the 1-CR relay coil and to the 223MC and 223MP reset magnets. Energization of 223MP and 223MC initiates resetting of the MP and MC counters. Energization of 1-CR brings about a closure of the related contacts 1-CR-1 to 16 (Fig. 16c) and 1-CR-17 (Fig. 16b). Closure of the 1-CR-1 to 16 contacts connects the RHRO readout with the 229LH lines. Accordingly, upon the operation of emitter 185 impulses are emitted through a group of lines 230 (Figs. 16b and 16c), through the RHRO readout device (Fig. 16c), through the 1-CR-1 to 16 contacts to the counter magnets 213LH of the LH accumulator. The amount which previously stood on the RH accumulator is entered into the LH accumulator in proper

columnar relation therein. After the transfer is complete the emitter brush of emitter 185 on encountering the extra spot supplies current through contacts 1-CR-17 now closed, to the RH reset magnet 223RH. Energization of this magnet initiates reset of the RH accumulator.

MC and MP reset occurs concurrently with the RH and LH transfer and the reset of the MC counter opens contacts 195 (see Fig. 16a). The opening of such contacts breaks the stick circuit for relay coils M and N and for all of the Y relay coils, thus preparing the cycle controller for a new entry from the following card.

Upon checking operations, the machine is now ready to compare the computed product which has been finally set up in the LH accumulator with the previously computed product read from the product field of the record card. Such product from the card, it will be remembered, was entered into the SC counter at the time the multiplier and multiplicand amounts were read from the card. Towards the end of the counter cycle in which the MC counter is being reset, contacts 193 (Fig. 16e) close, energizing relay coil D. A stick circuit for D is established through contacts D-2 and CC-1. D remains energized during the next counter cycle and causes closure of contacts D-1, D-3 and D-4 (Fig. 16d). In the counter cycle following the reset of the MC counter these contacts D-1 will be closed and current will be supplied from the 203 side of the AC line to the emitter 187.

Contacts D-3 will be closed to complete a circuit from line 203, contacts D-3, relay 218 to ground. Energization of relay 218 will shift its related contacts to open contacts 260 and close contacts 217 thereby connecting the readout devices of the LHRO accumulator to the magnets 213SC of the SCRO accumulator and disconnecting the latter from the analyzing brushes. Undesirable back circuits are thus eliminated. The emitter 187 is of the so-called inverting type in that it emits impulses to one section of the LHRO readout in complementary order.

In the units order the impulses are complements of ten and in the other order they are complements of nine so that a number 4736 standing on the LHRO readout will be emitted as 99995264. The extra nines are secured by plug connecting the four positions to the left of 4736 to fill out the capacity of the SC accumulator. These emitted impulses go through the LHRO readout to the plug sockets 215 and through plug connections to sockets 216, contacts 217 (now closed), sockets 214b, plug connection to sockets 214 to magnets 213SC and thence to ground. If the amount originally standing on the SC accumulator matches and compares with the amount standing on the LH accumulator, the SC accumulator will now register zero in all selected positions. For example, if both accumulators stood at 4736 at the beginning of the cycle, the transfer of 99995264 into the SC accumulator would result in the addition of 4736 and 99995264, the "one" to be carried from the eighth order not being entered. With all of the SCRO readout brushes set at zero a series comparison circuit is prepared therethrough so that when contacts CC-4 close current will flow from the 203 side of the AC line, through relay contacts D-4, now closed, through CC-4, through all of the zero spots and brushes of the SCRO readout in series, through switch 205 in closed position as shown, to a relay coil 261 as shown. Coil 261 thereupon opens its points 261-1 (Fig. 16d and 261-2 (Fig. 150

16e). The latter points short-circuit contacts 192 and relay coil C will be energized. The energization of coil C causes closure of contacts C—1 and there is a re-initiated energization of the card feed clutch magnet 222 through a circuit traced as follows: From the 202 side of the line, through contacts F—1 which are now in the position shown, through the card feed clutch magnet 222, through cam contacts FC—6 now closed, through the stop key contacts 197 now closed, through relay contacts N—1 and C—1 now closed, through punch contacts P—1 to the other side of the line.

The previously checked card which is still in the punch, upon re-initiation of card feed, will be discharged to the discharge magazine. This is brought about in the following manner: Shortly after a new card feed is initiated, cam contacts FC—4 (Fig. 16e) close, energizing relay coil B and causing closure of contacts B—2 to maintain B energized after FC—4 open. The stick circuit for B is completed through the LH reset contacts 190 now closed. The energization of B closes relay contacts B—1 and a circuit is established from the 201 side of the DC line, through relay contacts B—1, through the escapement contacts 154 of the punch, through switch 210, through the three-blade contacts 209 which are in shifted position for checking, out via line 236 directly to the punch magnet 237 and back to the other side of the DC line. The punch operating magnet 237 is then repeatedly energized under control of the escapement contacts 154 and the punch rack is escaped column by column over the field in which product punching would ordinarily occur until this zone is passed, after which the usual skip bar in the punch skips the punch rack to beyond the last column position. At this point the compared card is ejected in the usual manner. A card which does not compare is discharged through the punch in the same manner, but such card will be taken by hand from the discharge magazine of the punch.

If the amounts in the LH and SC accumulators do not compare the machine may do either of two things, according to a previous adjustment of switch 263 (Fig. 16d). If switch 263 is closed a circuit is completed at the comparing time in the cycle which is traceable from line 203, contacts D—4, CC—4, 261—1, switch 263, reset magnet 223SC to ground. A bell or other magnetically operated signal 264 may be wired in parallel with 223SC so as to operate therewith. It may be pointed out at this time that relay points 261—1 are controlled by relay 261 which is of the quick-acting type so that if the comparing circuit is completed, points 261—1 open before magnets 223SC and bell 264 can be operated.

Energization of 223SC will initiate reset of the SC counter after which a new card checking operation is automatically initiated upon closure of contacts 192 (Fig. 16e) in the same manner as described above, except that the initiation occurs a cycle later due to the necessity for resetting the SC counter. The bell apprises the operator that an error has been detected on the card in punching position and he can remove this card as it feeds to the magazine without delaying the further operation of the machine.

If switch 263 is open, when a non-comparison occurs, magnet 223SC cannot be energized, there will be no reset of the SC counter and the machine will stop further card feeding operations. The operator can then visually observe the read-

ing on the LH counter and the data on the card in the punching station and observe the discrepancy in the checked amount with the amount on the card. To fully remove the card and restart the machine in operation, the operator depresses a special check key 235 which supplies current to the 223SC reset magnet and a new card feeding operation is thereby initiated in the manner already described, and the erroneous card will be delivered to the discharge magazine of the punch from which it can be removed by hand.

Referring to the timing diagram (Figs. 17a and 17b) it will be noted that there are two cycles delineated as extra cycles for checking. Upon checking operations, the counter cycle to the extreme right in Fig. 17a, is the cycle which is employed for comparing the amount of the products standing in the LH accumulator with the product read from the card and standing in the SC accumulator. The following cycle, which is the first (i. e. extreme left hand) cycle upon Fig. 17b, is the extra cycle for resetting the SC accumulator.

When the machine is to be used for simple multiplying operations without checking and comparing, such extra cycles are eliminated and the cycles of the machine proceed directly from the end of the third counter cycle on Fig. 17a and continue upon the beginning of the second counter cycle shown on Fig. 17b.

Referring again to the circuit diagram, the elimination of the extra cycles which are required for checking is effected in the following manner: For normal multiplying operations without comparing and checking, switch 204 (Fig. 16e) is thrown to the dotted line position. This switch when in this position places the re-initiation of card feed under the control of the reset of the multiplicand counter instead of under control of the reset of the SC counter.

As long as the products compare only one of these extra cycles is used since the SC counter requires no resetting under conditions of comparison, it being already zeroized by the addition of the complement to the number set up therein. When a non-comparison is detected, the second of the extra cycles is brought into operation to reset the SC accumulator. This cycle will follow automatically or will be manually initiated as explained above.

While there has been shown and described and pointed out the fundamental novel features of the invention as applied to a single modification, it will be understood that various omissions and substitutions and changes in the form and details of the device illustrated and in its operation may be made by those skilled in the art without departing from the spirit of the invention. It is the intention therefore to be limited only as indicated by the scope of the following claims.

What is claimed is as follows:

1. A record controlled multiplying machine with multiplying means controlled by multiplier and multiplicand entries from a record and including a product setup means for the final product, an entry receiving device receiving from each record the product previously recorded upon the record, means for comparing the product entry setup upon said entry means with the final product derived as a result of the multiplication, resetting means for said entry receiving means and means controlled by said comparing means for controlling the operation of said resetting means.

2. In a multiplying machine having means for receiving two factors of a to be performed multiplication and means for computing the product thereof, means for receiving a predetermined product concurrently with the entry of said factors into said factor receiving means and means effective upon completion of the operation of said computing means for adding the complement of said predetermined product to said computed product whereby the result is zero if the two products are equal.
3. In a multiplying machine, means for computing the product of two factors, an entry receiving device for registering the same, a second entry receiving device for receiving a predetermined product, means for comparing said products, an indicating device, and means controlled by said comparing means operating said indicating device upon non-comparison of said products.
4. A checking device for a multiplying machine with devices for checking previously made computations and devices for also checking previously recorded products which comprise an accumulator for receiving the computed product, a second accumulator for receiving the recorded product and means for transferring the complement of one of said products from its accumulator to the other to restore the latter to zero if the two products are in agreement.
5. In a multiplying machine having means for computing the product of two factors, an entry receiving device controlled thereby to receive the product thereof, a second entry receiving device for receiving a predetermined product, means for comparing said products comprising means controlled by one of said entry receiving devices for entering an amount into the other entry receiving device, to reset the same to zero when the products are alike.
6. A checking device for a multiplying machine having means for computing the product of two factors and entering the same into an accumulator, a second accumulator and means for entering a predetermined product therein, an emitter and means controlled by said first accumulator for causing said emitter to emit impulses representative of the complement of the predetermined product to said second named accumulator whereby the same is reset to zero if the products are alike.
7. A checking device for a multiplying machine having means for computing the product of two factors and entering the same into an accumulator, a second accumulator and means for entering a predetermined product therein, an emitter, means controlled by said first accumulator for causing said emitter to emit impulses representative of the complement of the predetermined product to said second named accumulator whereby the same is reset to zero if the products are alike, a circuit and means controlled by said second named accumulator when it is reset to zero for completing said circuit for controlling further machine operation.
8. A multiplying machine with multiplying means controlled by multiplier and multiplicand entries from a record and including a product setup means for the final product, means for comparing other data derived from the record with the product in said setup means and signaling means controlled by said comparing means for indicating the result of the comparison.
9. A multiplying machine with multiplying means controlled by multiplier and multiplicand entries from a record and including a product setup means for the final product, an entry receiving device, resetting mechanism therefor, means for entering an amount in said device, means for comparing the entry in said product setup means with the entry in said entry receiving device and means controlled thereby for operating said resetting mechanism only upon a non-comparison of the entries compared.
10. In a multiplying machine, an entry receiving device, means for computing the product of two factors and entering the result in said device, a second entry receiving device, and means for entering an amount therein, means controlled by said first named device for entering the complement of the product therein, into said second device, and means controlled in accordance with the resultant of the entries into said second device for controlling the subsequent operation of the machine.

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