G. M. BACON.

MULTIPLYING MACHINE.

APPLICATION FILED NOV. 2, 1916.

1,338,274.

Patented Apr. 27, 1920.

4 SHEETS—SHEET 1.

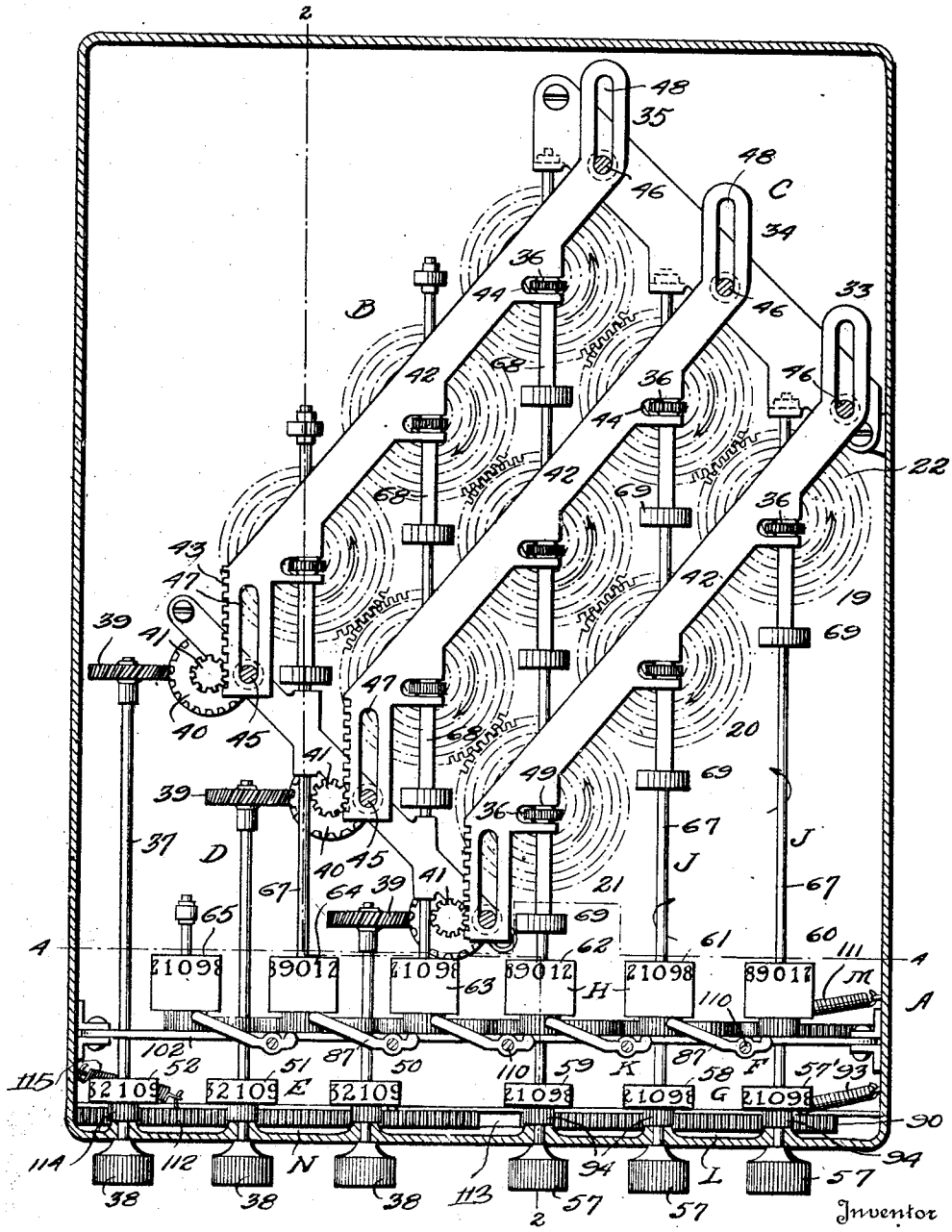


Fig. 1.

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4 SHEETS—SHEET 2.

Fig. 2.

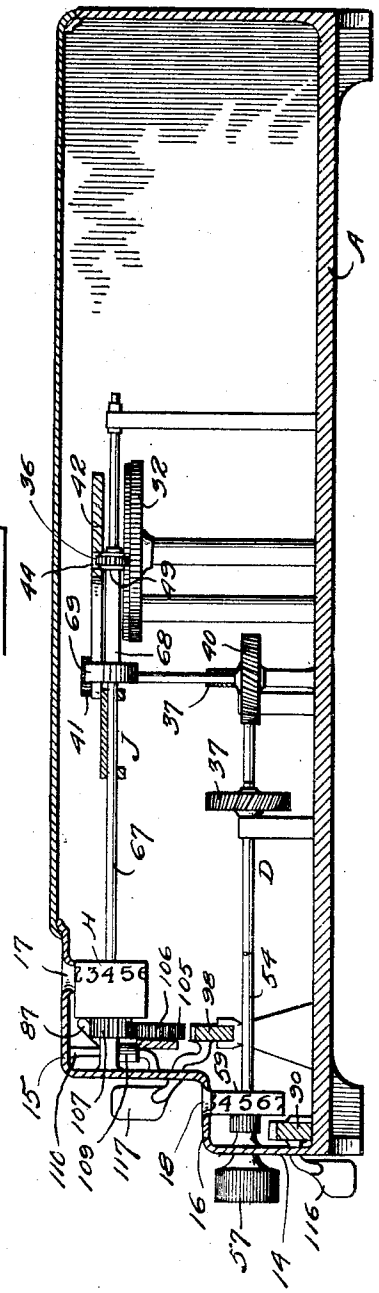
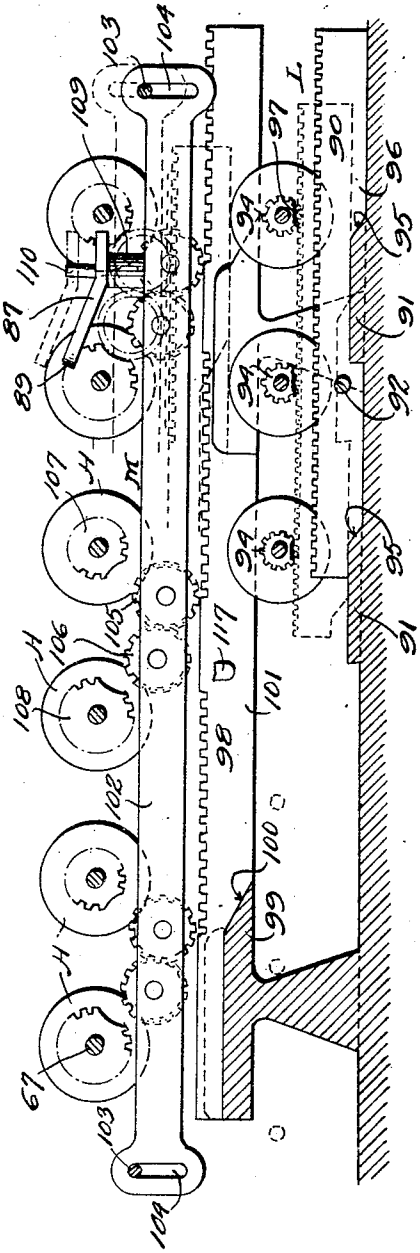


Fig. 3.



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4 SHEETS—SHEET 3.

Fig. 5.

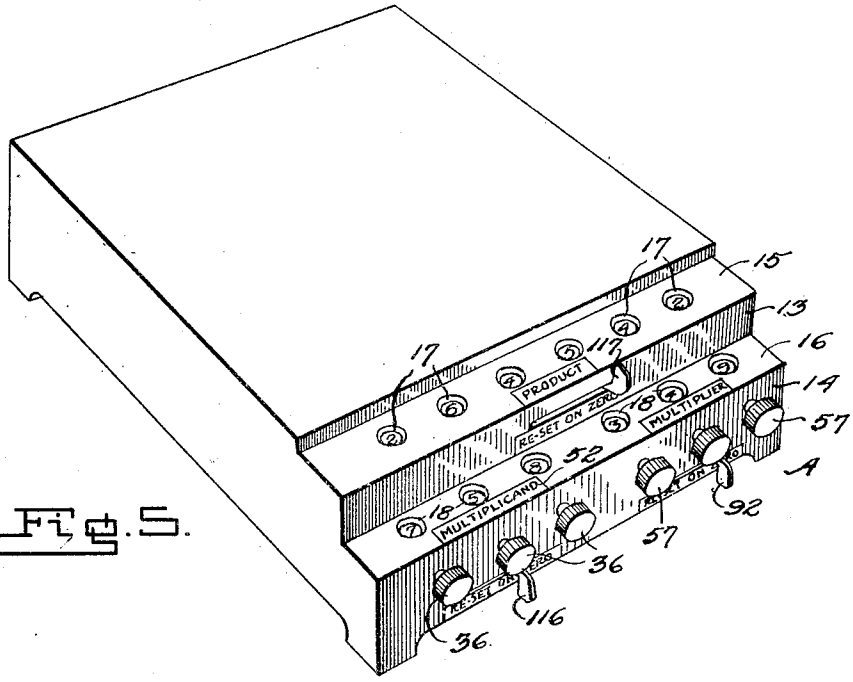
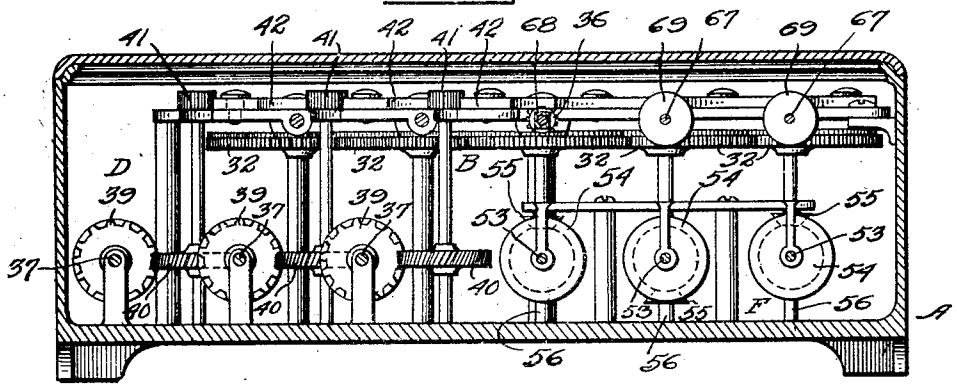


Fig. 4.



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4 SHEETS—SHEET 4.

Fig. 6.

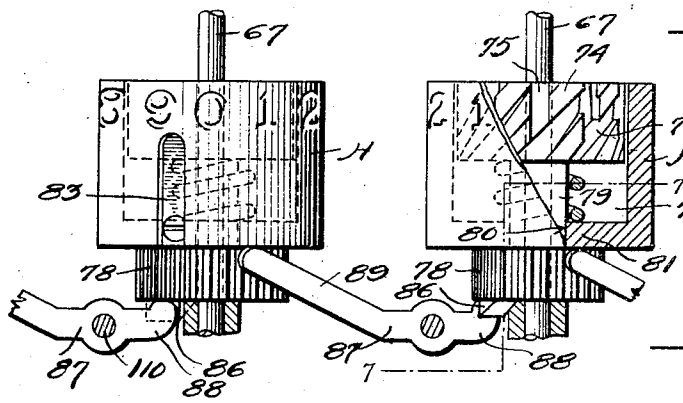


Fig. 10.

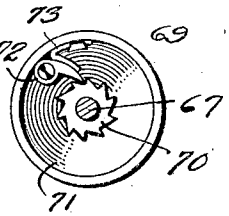


Fig. 11.

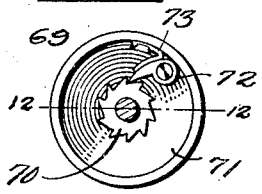


Fig. 7.

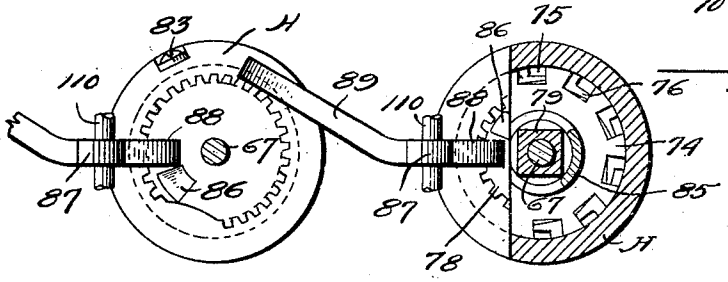


Fig. 12.

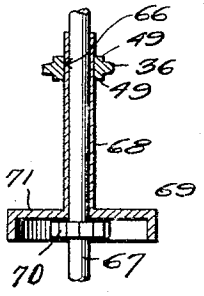


Fig. 8.

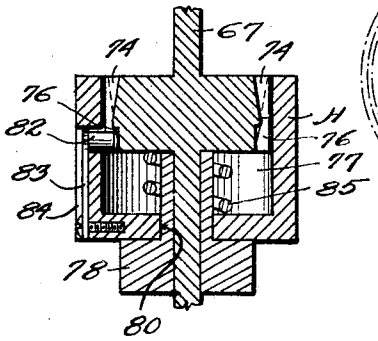
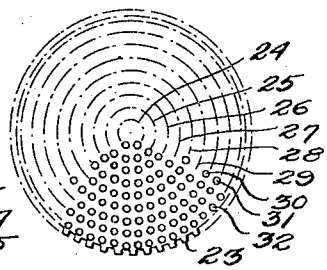


Fig. 9.



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UNITED STATES PATENT OFFICE.

GEORGE M. BACON, OF SALT LAKE CITY, UTAH.

MULTIPLYING-MACHINE.

1,338,274. Specification of Letters Patent. Patented Apr. 27, 1920.

Application filed November 2, 1916. Serial No. 129,176.

To all whom it may concern:

Be it known that I, GEORGE M. BACON, a citizen of the United States, and a resident of Salt Lake City, in the county of Salt Lake and State of Utah, have invented certain new and useful Improvements in Multiplying-Machines, of which the following is a specification.

My present invention relates broadly, to the class of registers, and more specifically to multiplying machines, manually operable, and whereby the product of multiplying numbers may be determined.

The principal objects of my invention are, first, to provide machines of the character described with which it is merely necessary to manually set off, as at sight openings, numerals, on dials to represent the multiplicand, and others to set off numerals, as at other sight openings, to represent the multiplier, directly after which the product appears, as at other suitable sight openings, without the necessity of operating a crank, lever, or other element, after the multiplicand and multiplier have been set off, in order to determine the product; second, to provide multiplying machines by which the multiplier and product may be quickly reset at zero, leaving the multiplicand set, as when it is involved in one or more subsequent calculations under which conditions, it is necessary to re-set merely the new multiplier, and the product is made visible; and, third, to provide multiplying machines which are compact, neat in appearance, and embodying a minimum number of movable elements according to the capacity of the machine.

Others objects of my invention will appear in the following detailed description, taken in connection with the accompanying drawings, forming a part of this specification, and in which drawings:—

Figure 1 is a horizontal sectional view through a machine constructed according to my invention, and showing the parts, most of which are normally concealed by the upper portion of the casing.

Fig. 2 is a sectional view on the line 2—2 of Fig. 1.

Fig. 3 is an enlarged detail view of mechanism for re-setting the dials.

Fig. 4 is a sectional view on the line 4—4 of Fig. 1.

Fig. 5 is a perspective view of the machine complete.

Fig. 6 is a detail view, on an enlarged scale, partly in plan and partly in horizontal section of product dials, and devices coöperating with said dials whereby one is moved one digit upon a complete turn of the adjacent dial at the right.

Fig. 7 is a view partly in elevation and partly in vertical section of the mechanism shown in Fig. 6, and partly on the line 7—7 of Fig. 6.

Fig. 8 is a horizontal sectional view through one of the product dials and associated mechanism.

Fig. 9 is a partial plan view of a differential wheel forming a part of the machine.

Fig. 10 is an enlarged view partly in elevation and partly in section of motion transmitting means.

Fig. 11 is a view similar to Fig. 10, adapted to transmit motion in the direction counter to that imparted by the device shown in Fig. 10.

Fig. 12 is a sectional view on the line 12—12 of Fig. 11.

In the drawings, where similar characters refer to similar parts throughout the several views, A designates a housing; B a plurality of sets of differential cog-wheels; C a plurality of sets of selective pinions for coaction with the differential cog-wheels; D mechanism for adjusting the position of said sets of selective pinions independent one of another with respect to said differential cog-wheels; E multiplicand dails movable with mechanism D; F mechanisms for rotating said sets of differential cog-wheels independently one of another; G multiplier dials movable with mechanisms F; H product dials; J means for imparting movement of the selective pinions of sets C to said dials H; K devices coöperating with dials H whereby one is moved one digit upon a complete turn of its adjacent dial at the right; L mechanism for re-setting dials G; M mechanism for re-setting dials H; and, N mechanism for re-setting dials E.

Referring first to the housing A, as clearly shown in Fig. 5 of the drawings, it is preferred to form said housing with a stepped front portion, through the upright walls 13 and 14 of which extend manually operable members as hereinafter set forth,

while faces 15 and 16 are provided with sight openings 17 and 18, respectively. The remaining portion of the top of the housing is preferably plane, and constituting the major portion of the top is well adapted to support data pertinent to calculation.

Referring now to the sets of differential cog-wheels B, in the example shown, three sets are provided, as shown,—primary set 19, second set 20, and third set 21. Each set comprises three differential wheels 22 movable in unison, as by being provided with teeth 23 extending from their peripheries, the teeth of the wheels of any set being in meshing relation, as clearly shown in Fig. 1 of the drawing. Each differential wheel is provided with a plurality of concentric circumferentially disposed series of cogs 24 to 32 on its face. In the present example, nine series are shown, and they are arranged so that the number of cogs in any particular series is an increase over the number of cogs in the next adjacent inner series equal to the number of cogs making up the innermost series. That is, the number of cogs in series 25 is twice that making up series 24, and likewise the number of teeth in series 26 is three times the number of teeth in series 24, this for a purpose to be subsequently set forth. The sets of differential wheels are arranged, in the example shown, with the initial wheel of the primary set 19 nearest the right of the machine, the initial wheel of the second set and the second wheel of the primary set next adjacent to the left; the initial wheel of the third set, second wheel of the second set, and third wheel of the primary set, next adjacent the left; and, the third wheel of the third set next adjacent to the left, as is clearly shown in Fig. 6. In other words, in the example shown, the axes of the wheels of each set are in a common plane, and the planes of the sets are in parallel relation, and the initial and succeeding wheels of the sets have their axes in common planes, the outermost of said planes comprehending a diamond.

As to the sets of selective pinions C, in the example shown, three sets are provided,—a first set 33 for the initial wheels of the said sets of differential wheels; a second set 34 for the second wheels of the said sets of differential wheels; and a third set 35 for the third wheels of the said sets of differential wheels. Each set comprises three pinions 36, one for each differential wheel, and in the example shown, these pinions contain the same number of cogs, as the second series of their respective differential wheels.

In order that the position of any set of selective pinions may be adjusted independently of the other sets with respect to its set of differential cog-wheels, the mechanisms D are provided. Each may comprise a shaft 37 projecting through the upright 14 of housing A, and provided with a button 38 exteriorly of said housing; a pair of spiral gears 39 and 40 with axes at a right angle, the gear 39 rigid with shaft 37; a pinion 41 rotatable with spiral gear 40; and, a guide bar 42 provided with a rack 43, parallel to the axis of shaft 37, and co-meshing with pinion 41. The guide bar 42 extends above and over the sets of differential wheels and is provided with three recesses 44, one for each pinion 36 of its respective set of selective pinions. Each guide bar 42 may be guided in a line of movement parallel to rack 43 as by pins 45 and 46 extending through elongated slots 47 and 48 respectively, the axes of these slots being parallel to the rack 43. Each pinion 36 may be provided with an enlargement 49 which engages the confronting wall of its respective slot 44, so that the cogs of a pinion cannot engage the guide bar. Thus, by rotating any button 38, the guide bar 42 coöperating therewith may be moved through the motion transmitting means comprising the shaft 37, spiral gears 39 and 40, pinions 41 and the rack 43 of the guide bar, which enables an operator to dispose all of the pinions of any particular set uniformly in co-meshing relation with a selected series of teeth on the differential wheels with which the pinions coöperate.

In order that an operator may quickly arrange the sets of selective pinions as desired, the multiplicand dials E are provided, movable with mechanisms D. Referring more specifically to Figs. 1 and 5, of the dials E, that designated 50 represents "units," each dial provided with digits 1 through 9, and including "0". Dial 51 represents "tens", and dial 52 "hundreds". One digit of each dial is visible at a sight opening 18, it being preferred to provide delineations 52 designating the sight openings through which digits are visible and representing the multiplicand. The dials E are normally at 1, at which time the pinions of their respective sets are in co-meshing relation with the first series, that designated 24, of their respective differential wheels. The motion transmitting means between any button 38 and guide bar 42 is such that when the button is turned to advance its dial from one digit to another, all of the selective pinions of its particular set are moved from one series of cogs on the differential to the next adjacent series.

Referring now to the mechanisms F for rotating the sets of differential wheels independently one of another, each mechanism may comprise a shaft 53; bevel gear 54 rigid with said shaft; a co-meshing bevel gear 55; and a spindle 56 for the initial differential wheel of the series, the shaft 53 extending through the upright wall 14 of

housing A, and provided with a button 57 whereby the shaft may be manually rotated. In the example shown, the gear 54 is of a diameter with respect to gear 55, that upon one complete turn of the shaft 53 and its gear 54, two complete turns are imparted to gear 55 and hence the spindle 56 of the initial differential wheel.

Of the multiplier dials G, that designated 57' has digits thereon representing "units," and is rigid with the shaft 53 forming a part of the motion transmitting means between the first button 57 at the right, and the initial differential wheel of the first set 19, these digits being visible at sight openings 18 in the housing A. The next adjacent dial 58 is rigid with the shaft 53 forming a part of motion transmitting means between the second button 57 and the initial wheel of set 20 of the differential wheels, the dial 58 representing "tens." That dial designated 59, representing "hundreds" is rigid with the shaft forming a part of motion transmitting means between the third button and the initial wheel of set 21 of the differential wheels. It is preferred to arrange the bevel gears 54 and 55 of the motion transmitting means associated with dial 58 so that its respective initial wheel of set 20 will be rotated in a direction counter to that imparted by movement of outermost button 57 to the initial wheels of sets 19 and 21, as is obvious from an inspection of Fig. 4 of the drawings. In order to set any particular set of differential wheels into motion, the operator has merely to rotate its respective button 57 clockwise.

The product dials H are arranged to be visible at the sight openings 17 of housing A, and in the example shown are designated by characters 60 and 65 inclusive. The dials at the right designated 60 represent "units," dial 61 "tens," dial 62 "hundreds," dial 63 "thousands," dial 64 "tens of thousands," and dial 65 "hundreds of thousands."

Means J is adapted to transmit movement of the selective pinions to the product dials, and in the example shown, contemplates the provision of a polygonal transverse way 66, in each selective pinion. The means may comprise a shaft 67 for each dial H, one or more hollow polygonal bars about the shaft and fitting into the way of the pinion; and a device 69 for each bar 68 adapted to impart movement of the bar in one direction to the shaft. In the example shown, each device 69 comprises a ratchet wheel 70 rigid with the shaft 67, a carrier 71 rigid with and at one end portion of the bar 68; a pawl 72 coöperating with ratchet wheel 70 and supported by carrier 71; and, a spring 73 acting upon the pawl 72, maintaining it in engagement with the ratchet wheel.

With reference to Fig. 1, since, in the example shown, the shaft of dial 60 rotates contra-clockwise, its device 69 is constructed as shown in Fig. 11 of the drawing, so that movement of said shaft in a contra-clockwise direction, will advance dial 60 with its digit from the zero to 9 successively. However, each alternate shaft rotates clockwise, and hence the devices associated with such shafts as rotate clockwise are constructed as shown in Fig. 10 of the drawing. It is to be observed that any of these shafts may rotate in a direction counter to that necessary for advancing the digits successively, without imparting movement to the dials since the pawls 72 will ride over the teeth of the ratchet wheels 70. It is also to be observed that any particular shaft 53 provided with a plurality of devices 69 may be rotated through the instrumentality of any one of the selective pinions upon said shafts, without affecting the other selective pinions. For instance, assuming that motion is being imparted to the wheels of set 19, the selective pinion co-meshing with a series of cogs on the second wheel of series 19 will be moved clockwise. This movement will be imparted to the shaft 53 of dial 61 through the polygonal bar 68 and device 69 directly associated with the said selective pinion, however, the selective pinion co-meshing with a series of cogs on the initial wheel of set 20 will be unaffected, since the ratchet wheel 70 of device 69 associated with said second mentioned selective pinion will merely oscillate its pawl 72, and there is then lost motion between shaft 53, and the second mentioned selective pinion.

In order that the product will be accurately made visible at the sight openings 17 of housing A, the devices K are provided whereby any dial H is moved one digit upon a complete turn of its adjacent dial at the right, or in other words, after one dial has passed through a phase of movement from zero back to zero, the next adjacent dial to the left is moved one digit. Each device may comprise a drum 74 rigid with the shaft of the dial to be moved upon a complete turn of the next adjacent dial to the right, said drum provided at its periphery with ten transverse slots 75 the bottoms of said slots converging toward one end of the shaft, and in the example shown, toward the selective pinions, so as to be shallow at one end portion of the drum and deep at the other end portion thereof, and ten spiral grooves 76 leading from but deeper than the shallow end of said first mentioned grooves, but more shallow than the deep end of the next adjacent of said grooves, as is clearly shown in Fig. 6 of the drawings, said drum fitting in a hollow 77 of its respective dial; a disk-like member 78 freely mounted on the shaft 67, but movable with the dial H, and provided with a polygonal projection 79 which ex-

tends through a similarly shaped perforation 80 in the hub 81 of the dial; a pin 82 yieldably carried by the dial, as through springs 83 fitting in a longitudinal slot 84 in the face of the dial, this pin normally fitting into the deep part of one of the spiral grooves 76; a spring 85 yieldably disposing said dial with said pin in a normal position, but permitting the dial to move longitudinally of shaft 67; a wedge-shaped projection 86 on the face of the disk 78 of the next adjacent device K to the right; and, a pivoted lever 87 one arm 88 for engagement with the disk 78 of the preceding device K, and the other arm to engage the one end portion of the disk to be advanced.

The operation of each device K is as follows:—

The wedges 86 are so arranged that they actuate the lever 87 only after they have passed through a complete phase of movement, that is, successively presenting the digits from 0 to 9 at the sight openings of the housing. As any particular wedge engages the arm 88 of the lever 87, it actuates said lever in a manner that the arm 89 moves the next adjacent dial to the left longitudinally of its shaft 67. The pin 82 of the dial H then rides in the spiral groove 76, which causes relative movement between the product dial and its shaft one digit until said pin drops into the deep part of grooves 75 adjacent the shallow part of the groove 76 in which the pin has moved. At this point, the wedge 86 has moved out of operative relation to the lever 87, the dial H responsive to spring 85, is returned to a normal position. It is to be observed that any dial H may not only be receiving motion through the shaft 67 to advance it from one digit to another, but may also be actuated at the same time through a device K.

Re-setting of the dials G may be accomplished after the machine has been brought into use and it is desired to set the dials at zero, as by a rack 90 slidable on supports 91, and provided with an operating projection 92 extending exteriorly of the housing A, and below the buttons 57, as clearly shown in Fig. 5 of the drawings; a spring 93 for normally holding said rack in one position; and, a plurality of pinions 94, one for each shaft 63. The supports 91 are provided with inclined faces 95, normally engaged by end portions of projections 96, at the lower portion of rack 90. The pinions 94 are devoid of teeth, or mutilated as at 97. By moving the rack 90 longitudinally of the supports 91, said rack is first raised into co-meshing relation with any teeth on pinions 94 which may be lowermost, and movement is imparted to the shafts 53 through said rack until that portion of its respective pinion devoid of teeth is lowermost, it being understood that, when the portion devoid of teeth is lowermost, the digit "0" is visible at the sight opening of the housing.

The mechanism M comprises a toothed rack 98, slidable on supports 99, said supports provided with inclined faces 100 for engagement with the end portions of projections 101 of the rack, in a manner similar to that described in connection with mechanism L; a vertically reciprocable carrier 102, guided in its movement, as by pins 103 extending through elongated slots 104 at its end portion; co-meshing sets of pinions 105 and 106, the pinions 105 being lowermost so that their teeth will engage with the teeth of rack 98, but that the teeth of gears 106 will be free of said rack; mutilated gears 107 and 108 on shafts 67, as hereinafter more fully set forth; a collar 109 about the support 110 of each lever 87, and beneath the same, said collar resting upon the carrier 102.

When it is desired to re-set the product dials, the operator merely moves the rack 101, so as to slide upwardly, its teeth coming into meshing relation with the teeth of pinions 105, which in turn rotate the pinions 106, these pinions engaging with any of the teeth of mutilated gears 107 and 108, as may be adjacent the set of pinions 105 and 106 as the carrier 102 is also moved upwardly responsive to actuation of the bar 101. Those portions of gears 107 and 108 as are devoid of teeth, are so arranged that when the pinions and gears are no longer in motion transmitting relation, the digits "0" appear at the sight openings 17 in the housing. The function of the collars 109 is to raise the levers 87 out of motion transmitting relation to the product dials during operation of the re-setting mechanism, since the devices K might have a tendency to cause the digit "1" to appear at some of the sight openings during the return of rack 101 to a normal position, responsive to action of a spring 111, for the purpose of disposing the rack 98 with its projection 101 fitting between the supports 99, at which time the pinions 105 and 106 are out of the sphere of movement of gears 107 and 108. The disposition of these gears, as shown in the drawings, and their coöperating pinions, is such as to return the product dials to indicate zero at the sight openings, and to reset them in such position, some of the dials being movable clockwise, and some contra-clockwise, as hereinbefore set forth.

The mechanism N is substantially the same as that described in connection with mechanism L, except that the dials E are turned back or contra-clockwise, and comprises a like rack 112 mounted to slide in an opposite direction to the rack 90, sup-

ports 113, mutilated gears 114, rigid with shafts 37; and, a spring 115 to return the rack 112 to a normal position, an extension 116 being disposed exteriorly of the housing A, beneath the buttons 36. The rack 98 may be actuated by an extension 117 projecting through the upright walls 13 of the housing A.

The operation of the machine is as follows:—

Normally the dials E and H are at zero, and the dial G at "1". Assuming that it is desired to multiply the numeral "758" by "349", the operator proceeds by turning the "unit" button 38 to the right until the dial 50 shows "8". This is followed by turning the button 38 of dial 51 until said dial shows "5", and turning the button 38 of dial 52 until it shows "7", after which the multiplicand numeral "758" is visible at the sight openings 18 of housing A. Turning the dial 50 caused its shaft 37 through gears 39 and 40 to turn pinion 41 eight-tenths of a revolution, thus drawing guide bar 42 of set 33 of the selective pinions 49 eight-tenths of its travel and moving said pinions each into the series of cogs 31 or, in other words, the eighth series from the center of each differential wheel, first, in each set B. Precisely the same action causes the turning of dial 51 to move the selective pinions of set 34 into meshing relation with the fifth series of cogs on the second differential wheels of the sets 19, 20, and 21; while the turning of dials 52 moves the selective pinions of set 35 into meshing relation with the seventh series of cogs on the third differential wheels of the sets 19, 20, and 21.

The multiplier "349" is then set off by using the buttons 57. While it makes no difference whether it is produced with the right or left hand button in setting off the multiplier, assuming that button 57 coöperates with dial 57', it is rotated to show digit "9" at the sight openings 18 at the right hand side, its shaft 53 will be turned nine-tenths of a revolution, and by means of the bevel gears 54, 55, and the spindle 56, the differential wheels of set 19 will be turned 1.8 revolutions. The turning of the first differential wheel of this set causes the selective pinions coöperating with its eighth series of cogs to turn four times 1.8 or 7.2 revolutions. The dial 60 will therefore show digit "2" and having made seven complete revolutions, through means K, the dial 61 will show digit "7". At the same time, the second differential wheel of set 19 has turned selective pinion coöperating with its fifth series of cogs, two and one-half times 1.8, or 4.5 revolutions. The dial 61 will therefore be turned 4.5 revolutions from the position showing figure "7", or, in other words, will show digit "2", while the dial 62 through means K will have turned one-tenth for each full turn of dial 61, and show digit "5". Also at the same time, the third differential wheel will have moved its selective pinion coöperating with the seventh series of cogs, three and one-half times 1.8, or 6.3 revolutions. The dial 62 will therefore be turned 6.3 revolutions from position showing figure "5", or, in other words, will show digit "8" while the dial 63, through means K will have turned one-tenth for each full turn of dial 62 and will show character "6". It is to be observed that the means K operates independently of any action of the selective pinion and the sole function of such means is to register a full turn of any dial by moving the next dial to the left one-tenth turn. This is followed by operating the next button 57 so as to dispose numeral 4 at the sight opening, by means of dial 58. Since the selective pinion of the initial differential wheel of set 20 is in meshing relation with the eighth series of cogs, and all of the differential wheels of set 20 make eight-tenths of a revolution responsive to actuation of its button 57, the said selective pinion will be turned four times 0.8, or 3.2 revolutions. This actuates dial 61 3.2 revolutions from digit "2", and consequently shows digit "4", while three-tenths of a revolution has been carried to dial 62, making it show "1" and one-tenths revolution has been carried to disk 63, through means K which will then show "7". At the same time the second wheel of set 20 has turned selective pinion coöperating with its fifth series of cogs, two and one-half times 0.8 or 2.0 revolutions. Dial 62 will then be turned two complete revolutions from "1" and still show "1", while the dial 63 will be advanced two digits through means K, showing "9." Simultaneously, the third differential wheel of set 20, will turn its selective pinion co-meshing with its seventh series of cogs, three and one-half times 0.8 or 2.8 revolutions. Dial 63 will therefore be advanced from "9" 2.8 revolutions, and will show "7," and through means K will transmit motion to the dial 64 which will then show "3" at the sight opening.

This is followed by actuating the third button 57 so that dial 59 shows "3." Through the motion transmitting means each differential wheel of set 21 will be turned 0.6 of a revolution. As the initial differential wheel of this set has its selective pinion set on the eighth series of cogs, the dial 62 will be advanced four times 0.6 or 2.4 revolutions. This will turn said dial 62 from showing digit "1" until it shows "5," in addition to two complete revolutions which are transmitted through device K to dial 63, making it show numeral "9." At the same time the second differential wheel of set 21 will actuate its selective pinion which is co-meshing with the fifth series of

cogs, two and one-half times 0.6 or 1.5 revolutions. This will turn the dial 63 1.5 revolutions from figure 9 and hence will show "4," while two-tenths revolutions will be imparted to the dial 64, making it show "5." Simultaneously with this, the third differential wheel of set 21 will turn its selective pinion, co-meshing with the seventh series of cogs, three and one-half times 0.6, or 2.1 revolutions. This will actuate the dial 64, 2.1 revolutions from figure 5, making it show "6," while two-tenths revolutions will be transmitted to dial 65 through means K, causing it to show digit "2."

The operation is now complete and the multiplicand dials E show the number "758", the multiplier dials G show the number "349," while the product dials H show the product of these numbers,—"264,542."

The mechanism for re-setting the machine has been hereinbefore fully set forth, however, it is to be noted that if the multiplicand is involved in subsequent calculations, it is not necessary to re-set the multiplicand dials. When the multiplier dials G show zero, the cogs of selective pinions 36 are free to slide radially over the face of the differential wheel. From an inspection of Fig. 9 of the drawings it will be seen that on the vertical or central radial line of the teeth shown the teeth are parallel and it is along this line that the corresponding pinion is adapted to slide.

While in the present example, the machine is adapted for multiplying two figures of three digits each, it is obvious that a machine of greater capacity can be constructed by simply increasing the number of sets of differential cog wheels, sets of selective pinions and their operating mechanisms, and that changes in details may be made without departing from the spirit or scope of my invention; but

I claim:—

1. In a multiplying machine, the combination of a plurality of differential wheels, each wheel comprising a plurality of gears concentric with the axis thereof, means for simultaneously rotating all of said wheels in accordance with a digit of the multiplier, a corresponding plurality of pinions adapted for radial movement with respect to said wheels to coöperate with the gears thereon, shafts upon which said pinions are slidably mounted, said shafts being adapted to actuate product dials, and means for moving said pinions, relative to the respective differential wheels in accordance with the digits of the multiplicand.

2. In a multiplying machine, the combination of a plurality of sets of differential wheels, each wheel comprising a plurality of gears, concentric with the axis thereof, means adapting each set to be rotated independently in unison, the gears of all the differential wheels being arranged in the same plane, and the several sets of wheels indented denominationally, a pinion for each differential wheel, adapted by sliding radially of the respective wheels to coöperate with the gears thereon, a plurality of shafts upon which said pinions are slidably mounted, said shafts being arranged in parallel relation on and extending in denominational relation across said sets of wheels, means for moving the initial and succeeding pinions of each set to engage corresponding gears of the differential wheels, and product dials operated by said shafts.

3. In a multiplying machine, the combination of a plurality of sets of differential wheels, each wheel comprising a plurality of gears, concentric with the axis thereof, the axes of all of said wheels being parallel and the gears thereof in the same plane, a corresponding plurality of sets of pinions adapted to coöperate with the gears of the respective differential wheels, a plurality of denominationally arranged shafts upon which said pinions are mounted to slide radially of the respective differential wheels, said shafts carrying the pinions of the respective sets in denominational relation, means connecting the initial and succeeding pinions of each set for simultaneous sliding movement on the respective shafts, dials connected with said last named means for indicating the extent of sliding movement of the connected pinions, means for rotating each set of differential wheels independently, dials for indicating the extent of such rotation and product dials operated by said shafts and pinions.

4. In a multiplying machine, the combination of a plurality of sets of differential wheels, each wheel comprising a plurality of gears concentric with the axis thereof, means for mounting said differential wheels with their axes in parallel relation with all of said gears in a plane at right angles to the axes of the wheels, said sets of differential wheels being indented denominationally, a corresponding plurality of sets of pinions adapted to coöperate with the gears of the respective differential wheels by movement radially thereof, a plurality of shafts upon which said pinions are slidably mounted, said shafts being arranged denominationally in a plane parallel to the plane of said gears, means connecting the initial and succeeding pinions of each set for simultaneous sliding movement on said shafts, means connecting each of said last named means with a dial for indicating the extent of movement of said pinions, finger operated means for simultaneously moving the respective dials and the corresponding pinions to represent digits of the multiplicand, gear connections for rotating each set of differential wheels independently, dials

adapted to be simultaneously operated with said gear connections for indicating the extent of rotation of said differential wheels, and to represent the multiplier digits, and product dials adapted to be rotated by said shafts and pinions.

5. In a multiplying machine, the combination of a plurality of sets of differential wheels, each wheel comprising a plurality of gears concentric with the axis thereof, means for mounting said differential wheels with their axes in parallel relation with all of said gears in a plane at right angles to the axes of the wheels, said sets of differential wheels being indented denominationally, a corresponding plurality of sets of pinions adapted to coöperate with the gears of the respective differential wheels, by movement radially thereof, a plurality of shafts upon which said pinions are slidably mounted, said shafts being arranged denominationally in a plane parallel to the plane of said gears, means connecting the initial and succeeding pinions of each set for simultaneous sliding movement on said shafts, means connecting each of said last named means with an indicating dial for indicating the extent of movement of said pinions, finger operated means for simultaneously moving the respective dials and the corresponding pinions to represent digits of the multiplicand, gear connections for rotating each set of differential wheels independently, dials adapted to be simultaneously operated with said gear connections, for indicating the extent of rotation of said differential wheels, and to represent the multiplier digits, product dials adapted to be rotated by said shafts and pinions, and carrying mechanism associated with said dials for transfer of the tens.

6. In a multiplier machine, the combination of a plurality of sets of differential wheels, each wheel comprising a plurality of gears concentric with the axis thereof, all of said gears being arranged in the same plane at right angles to the axes of said wheels, means for rotating each set of differential wheels independently, said sets of wheels being indented denominationally as for partial products in multiplying, multiplier dials connected with said last named means and adapted to be operated thereby to indicate the respective multiplier digits, a plurality of pinions one for each differential wheel, adapted to coöperate with the respective gears thereof, when moved radially, a plurality of shafts extending transversely of said differential wheels in denominational relation therewith, upon which said pinions are adapted to slide, means whereby the individual pinions are adapted to rotate the respective shafts, means including a finger wheel for simultaneously sliding the initial and succeeding pinions of each set on the respective shafts, multiplicand dials adapted to be operated by said last named means for positioning said simultaneously sliding pinions in accordance with the digits of the multiplicand, product dials adapted to be operated by said shafts when rotated by the pinions and carrying mechanism associated with said product dials for transfer of the tens.

7. In a multiplying machine, the combination of a plurality of sets of differential wheels, each wheel comprising a plurality of gears concentric with the axis thereof, all of said gears being arranged in the same plane at right angles to the axes of said wheels, means for rotating each set of differential wheels independently, said wheels being indented denominationally as for partial products in multiplying, multiplier dials connected with said last named means and adapted to be operated thereby to indicate the respective multiplier digits, a plurality of pinions one for each differential wheel, adapted to coöperate with the respective gears thereof, a plurality of shafts extending transversely of said differential wheels in denominational relation therewith, upon which said pinions are adapted to slide, means whereby the individual pinions are adapted to rotate the respective shafts, means including finger wheels for simultaneously sliding the initial and succeeding pinions of each set on the respective shafts, multiplicand dials adapted to be operated by said last named means for positioning the pinions in accordance with the digits of the multiplicand, product dials adapted to be operated by said shafts when rotated by the pinions, carrying mechanism associated with said product dials for transfer of the tens, means for simultaneously restoring all of said product dials to zero independently of the differential gears, and means for restoring said multiplier dials to zero.

8. A multiplying machine comprising in combination, a plurality of product dials arranged in a row to represent units, tens, hundreds, thousands, tens of thousands, and hundreds of thousands, from the right to the left of the machine, three sets of differential wheels, each set comprising three wheels adapted to rotate in unison, each wheel provided with nine series of concentric circumferentially disposed cogs on its face, said sets of wheels arranged with the initial wheel of the primary set nearest the right of the machine, the initial wheel of the second set and the second wheel of the primary set next adjacent to the left, the initial wheel of the third set, second wheel of the second set, and third wheel of the primary set, next adjacent to the left, the second wheel of the third set, and the third wheel of the second set next adjacent to the left, and the third wheel of

the third set, next adjacent to the left; three sets of selective pinions, each comprising three pinions, and arranged with a first set for the initial wheels of the three sets of differential wheels, a second set for the second wheels of said sets of differential wheels, and a third set for the third wheels of the said sets of differential wheels, mechanisms for moving said sets of selective pinions one set independently of another to arrange the pinions of the sets in co-meshing relation with uniformly selected series of cogs of their respective sets of differential wheels, means for imparting movement of the pinion of the initial wheel of the primary set of differential wheels to said unit product dial, means for imparting movement of the pinion of the first wheel of the second set and the second wheel of the primary set of differential wheels, to said dial displaying tens, means for imparting movement of the pinions of the first wheel of the third set, second wheel of the second set, and the third wheel of primary set of differential wheels, to said dial displaying hundreds, means for imparting movement of the pinions of the second wheel of the third set and the third wheel of the second set of differential wheels to said dial displaying tens of thousands, and means for imparting movement of the pinion of the third wheel of the third set of differential wheels to said dial displaying hundreds of thousands, and devices coöperating with said product dials whereby one is moved one digit upon a complete turn of the next adjacent dial at the right.

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