No. 633,374. Patented Sept. 19, 1899.

A. R. BALL & A. T. RIGGS.

ADDING AND SUBTRACTING MACHINE.

(Application filed Feb. 16, 1899.)

(No Model.) 2 Sheets—Sheet 1.

Fig. 1.

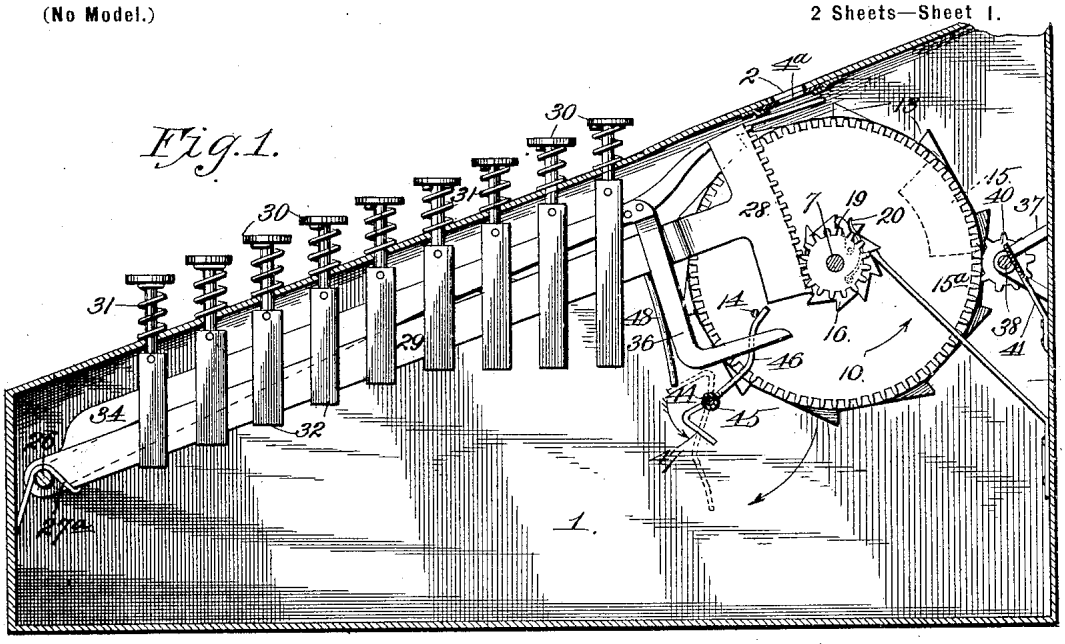
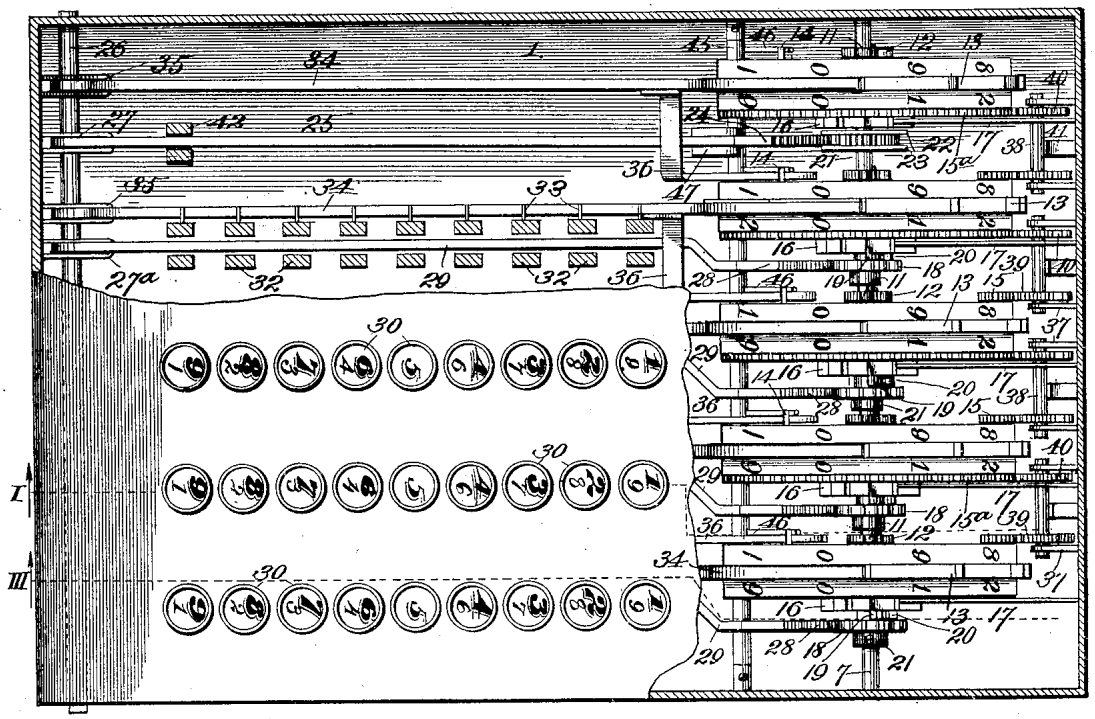


Fig. 2.



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(No Model.) 2 Sheets—Sheet 2.

Fig. 3.

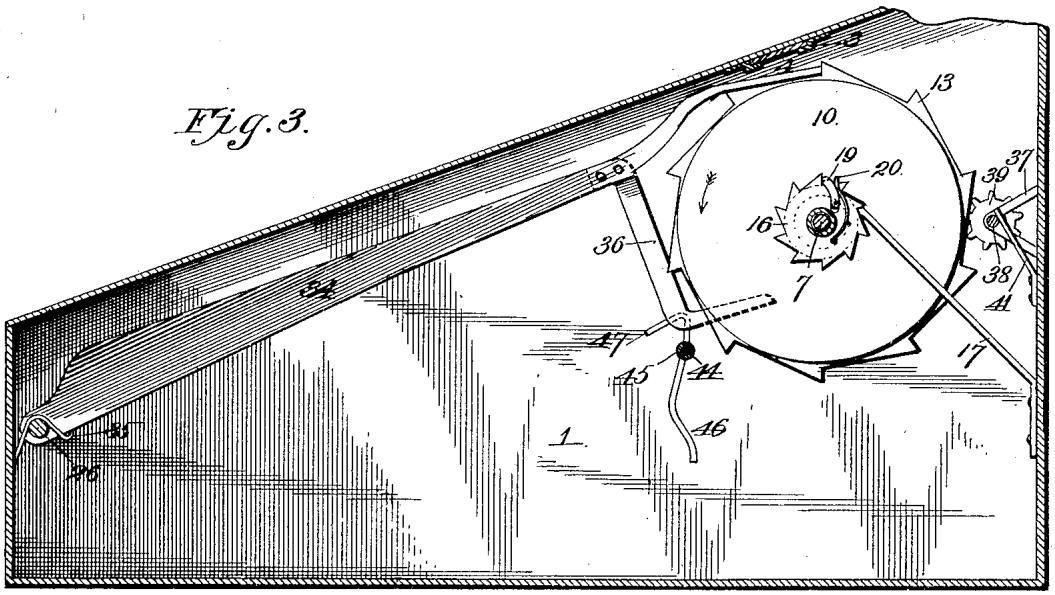
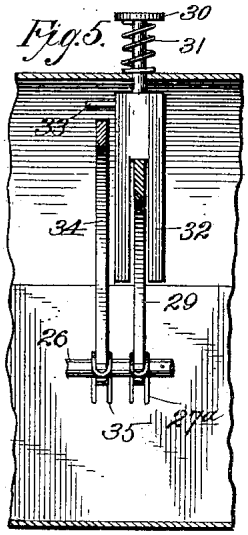


Fig. 5.



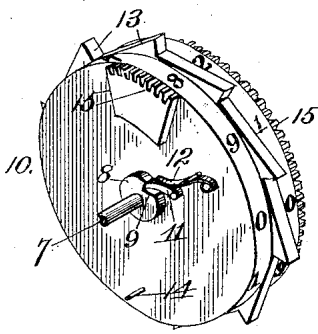
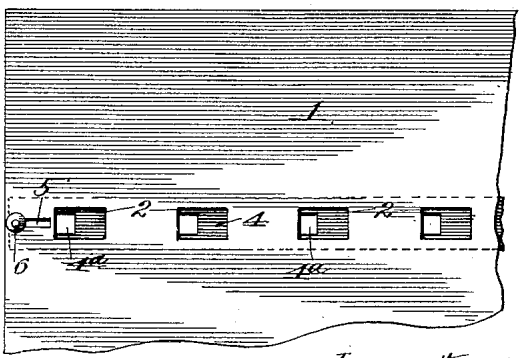


Fig. 6.

Fig. 4.



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UNITED STATES PATENT OFFICE.

ARTHUR R. BALL AND ALBERT T. RIGGS, OF MELVERN, KANSAS.

ADDING AND SUBTRACTING MACHINE.

SPECIFICATION forming part of Letters Patent No. 633,374, dated September 19, 1899.

Application filed February 16, 1899. Serial No. 705,719. (No model.)

To all whom it may concern:

Be it known that we, ARTHUR R. BALL and ALBERT T. RIGGS, of Melvern, Osage county, Kansas, have invented certain new and useful Improvements in Adding and Subtracting Machines, of which the following is a specification.

Our invention relates to adding and subtracting machines; and it consists in certain novel and peculiar features of construction and combinations of parts, as hereinafter described and claimed.

The object of the invention is to produce a machine of this character whereby a column of numbers of any size may be added accurately and swiftly and by which a given number may be subtracted from another with practically no mental exertion on the part of the operator.

A further object of the invention is to provide an adding and subtracting machine which is of simple, compact, durable, and inexpensive construction.

In order that the invention may be fully understood, reference is to be had to the accompanying drawings, in which—

Figure 1 is a vertical section taken on the line I of Fig. 2. Fig. 2 is a top plan view with the top plate partly broken away to expose the internal construction. Fig. 3 is a vertical section taken on the line III of Fig. 2, the keys and key-levers being omitted. Fig. 4 is a top plan view of part of the machine to illustrate the arrangement and function of the exposure-slide. Fig. 5 is a cross-section showing the bifurcated stem of a key and its relation to a key-lever and the contiguous stop-bar. Fig. 6 is a detailed perspective view of one of the indicator-wheels.

In the said drawings, 1 designates the casing of the machine, with its top plate extending for convenience in an inclined plane about like the keyboard of a typewriter. Said top plate is provided near its rear and upper end with a transverse series of openings 2, and supported slidingly at the under side of said openings by means of the cleats 3 is what we term the "disclosure-slide" 4, said slide being provided with a series of openings 4^a, which always register with one end or the other of the longer openings 2 of the top plate. At one end of the slide the top plate is provided with a transverse slot 5, and projecting from the slide through said slot is a pin or handle 6, whereby the slide may be adjusted so as to dispose its openings 4^a at one end or the other of the openings 2, said pin or handle at the same time preventing the slide from moving too far by striking against one end or the other of said slot.

Extending horizontally across and journaled in the side walls of the casing a suitable distance below the openings 2 is a shaft 7, provided with a plurality of rigid collars 8, each having a notch 9 in its periphery.

10 designates a corresponding number of indicator-disks journaled upon shaft 7. In this case there are represented units, tens, hundreds, thousands, and tens-of-thousands disks, one of these disks being located centrally under each opening 2 of a top plate and against the collar 8, said disks each carrying a pivoted dog 11 and a spring 12, which presses the dog against the periphery of the proximate collar, except at such times as said dog engages the notch of the collar. At the center of its periphery the disk is provided with a circular series of ten ratchet-teeth 13, which divides it practically into two sections—viz., a right-hand section, which is numbered progressively from zero to nine, inclusive, and a left-hand section, which is numbered retrogressively from zero to nine, inclusive, the zero numbers of each series being arranged side by side or in the same radial plane. (See Fig. 6.) Each disk at the side occupied by the collar 8 is formed or provided at about diametrically opposite points with a laterally-projecting pin 14 and a cog-segment 15, the latter extending on a line struck from the center of the disk. Formed at or secured to the opposite side of the disk and struck from the same center as the cog-segment 15 is a cog-wheel 15^a, and secured to or formed at the same side of the wheel is a ratchet-wheel 16, the latter being provided with the same number of teeth as in the series 13, but disposed in the opposite direction, to the end that the spring-pawl 17, projecting from the back wall of the casing, shall engage the successively-presented teeth of said ratchet 16, and thereby prevent the back rotation of the indicating-disk, of which said ratchet is a part.

18 designates a series of small cog-wheels journaled upon the shaft 7, there being one of said cog-wheels for each indicator-disk except the last disk or two of the series, and provided with a series of pivoted pawls 19, held yieldingly in engagement with the ratchet-wheels 16 by the springs 20, also carried by said cog-wheels. Said wheels are held adjacent to the ratchet-wheels 16 by means of collars 21, secured upon the shaft, or by other suitable means. Adjacent to the last indicator-disk of the series a small cog-wheel 22 is secured rigidly on the shaft and is by preference provided with guide-flanges 23, and engaging said wheel and guided between said flanges is a segmental rack-bar 24, formed with or secured to the free or rear end of a key-lever 25, pivoted at its rear end upon a cross-rod 26, and held normally elevated by means of a spring 27, approximately V-shaped, which is fitted down upon the shaft 26 and has its opposite ends bearing against the front wall of the casing and the under side of the said lever. This key-lever is adapted to be depressed when it is desired to return all of the indicator-disks to their initial positions—viz, with their ciphers visible through the openings of the exposure-slide—by means of a cipher-key constructed as hereinafter described.

28 designates a segmental rack-bar (like bar 24) engaging each cog-wheel 18 and carried at the free end of a depressible lever 29, (like lever 25,) mounted pivotally at its front end upon the cross-rod 26 and held normally in its elevated position by a spring 27^a of the same construction and arrangement as spring 27.

30 designates a series of nine keys adapted to work in conjunction with each depressible bar 29, said keys being numbered progressively forward from one to nine, inclusive, and retrogressively—that is, from front to rear—from one to nine, inclusive. Each key is supported normally in its elevated position by means of a coil-spring 31 encircling its neck and interposed between its head and the top plate of the casing, the strength or resistance of said springs being so proportioned that practically the same "touch" or pressure is required to operate them all, to the end that work may be facilitated. The neck of each key extends slidingly through the top plate and is prolonged in the shape of a bifurcated shank 32, seated astride of its respective depressible bar 29 and preferably of such length that said parts never become totally disengaged. Each key is provided with a laterally-projecting pin 33 at the upper end of its shank, said pin being adapted at the proper time to engage the companion bar 34 and depress the same into the path of the ratchet-wheel 13 of its respective indicator-disk, said bar being pivoted at its front end upon the cross-rod 26 and held normally elevated and out of the path of said ratchet-wheel by means of a spring 35 of the same construction and arrangement as the springs 28, hereinbefore described. All of the depressible bars 34 or "stop-bars," as hereinafter termed, except the one which operates in connection with the "units" series of keys are provided with an arm 36, projecting into the path of the laterally-projecting pin 14 of the indicator-disk to the right—that is to say, the arm 36 of bar 34, acting in conjunction with the "thousands" series of keys, projects into the path of the pin of the "hundreds" indicator-disk, the arm 36 of the bar operating in conjunction with the hundreds series of keys projects into the path of the pin of the "tens" indicator-disk, and so on. The object of this relation will presently appear.

37 designates a series of brackets secured to the casing, and 38 a series of short shafts journaled in said brackets, each shaft being provided at one end with a small cog-wheel 39, operated once in each complete revolution of the contiguous disk by the cog-segment 15 thereof. As said wheel has the same number of teeth as the segment, it is turned just one revolution and imparts a corresponding movement to the mutilated pinion 40. This movement of the mutilated pinion through its engagement with the cog-wheel 15^a of the contiguous indicator-disk moves the latter just one step, and in order that the mutilated pinion shall be arrested positively and reliably with its mutilated surface opposite said wheel a spring-brake 41, secured at one end to the casing, presses against the shaft of said pinion. When this mutilated pinion occupies this relation to the contiguous wheel, it is obvious that the latter is free to rotate without interference on the part of said pinion, and it is equally obvious that the operation of the pinion will cause the operation of said wheel.

By reference particularly to Fig. 1 it will be noticed that the key numbered "1" progressively can be depressed only a slight distance before its pin 33 throws the stop-bar 34 into engagement with the ratchet-wheel 13, (see Fig. 3,) and thereby arrests the movement of the corresponding indicator-disk, (imparted through the key-lever and train of gearing described,) which movement, however, was sufficient to cause the wheel to rotate one-tenth of a revolution and place its progressive number "1" opposite the registering opening 2 of the casing and 4^a of the exposure-slide. By reference to the same figure it will be seen that the depression of the progressively-numbered second key will impart a slightly-greater downward movement to the key-lever because the leverage is shorter in order that the indicator-disk may be moved two steps before the pin 33 of said key throws the stop-bar into engagement with said ratchet-wheel and that the depression of the progressively-numbered ninth key owing to its very short leverage causes the indicator-disk to make almost a complete revolution—*i. e.*, nine steps—before the stop-bar arrests its movement, and it will be understood that

the varying distances which the key-levers move is produced by a uniform or equal depression of the keys. It will also be understood by observing the relation between the numbers of the disk and the position of the cog-segment 15 that at the completion of each revolution or tenth step of the disk its cipher is disposed below its respective opening 2 of the casing and its cog-segment 15 has just passed or cleared the contiguous cog-wheel 39, and consequently as said tenth step was in progress imparted through the medium of wheels 39 and 40 one step to the next higher indicator-disk—that is to say, with each complete revolution of any indicator-disk it imparts one step to the next higher disk and said disk is reliably prevented from moving more than one step, because at the moment the cog-segment 15 of the actuating-disk passes out of engagement with the contiguous cog-wheel 39 the pin 14 of said actuating-disk in passing engages the arm 36 of and depresses the stop-bar 34 of said next higher disk into the path of the ratchet-wheel 13 of said disk, and thereby limits the movement of the same to just exactly one step.

Supposing now that it be desired to add the numbers "670," "8,467," "325," and "3,250," it can be accomplished as follows: After first moving the exposure-slide (see Fig. 4) to the right so that its openings 4^a shall register with the progressively-numbered surfaces of the indicator-disks and with the right-hand end of the openings 2 of the top plate the progressively-numbered seventh and fifth keys of the units-column are depressed to impart a total of twelve steps to the units-indicator wheel, and thereby expose through the registering opening the number "2." This operation through the medium of the train of gearing described imparts one step to the tens-wheel. Consequently the numeral "1" is exposed through the registering opening of the slide. The progressively-numbered seventh, sixth, second, and fifth keys of the tens-column are now depressed, which causes said disk to make two complete revolutions and at the same time impart two steps to the hundreds-wheel, leaving the number "1" exposed through the registering opening of the tens-wheel and the number "2" through the registering opening of the hundreds-wheel. The progressively-numbered keys 6, 4, 3, and 2 of the hundreds-wheel are now depressed, and thereby impart fifteen steps to said wheel and one step to the thousands-wheel, so that the number so far reads "1,712." The progressively-numbered keys 8 and 3 of the thousands-column are now operated and impart to the thousands-disk a total of eleven steps and one step to the ten-thousands disk, thus exposing through the opening of the thousands-disk the numeral "2" and through the opening of the ten-thousands disk the numeral "1," the sum total of said numbers—viz., "12,712"—being thus exposed to view simultaneously with the depression of the key representing the last figure.

If preferred, instead of depressing successively all of the units, all of the tens, &c., the numbers may be added by depressing the progressively-numbered sixth key of the hundreds, the seventh key of the tens, the eighth key of the thousands, the fourth key of the hundreds, the sixth key of the tens, the seventh key of the units, &c., until all of the figures of each number have been depressed.

If it be desired to subtract from a given number, the latter is first caused to appear through the openings of the exposure-slide by the manipulation of the retrogressively-numbered keys, the exposure-slide being first shifted so as to bring its openings 4^a over the retrogressively-numbered faces of the indicator-disks. Supposing the given number is "6,374," the operator starting, for instance, with the retrogressively-numbered sixth key of the thousands-column, a distinction being made between the progressive and retrogressive numbers by making the former heavy and the latter light, (see Fig. 2,) viz: The sixth key from the front or lower end of the column causes the corresponding disk to rotate until the numeral "6" of the retrogressive numbers appears opposite the slide-opening, it being apparent that this retrogressively-numbered key is identical with the progressively-numbered fourth key, which therefore imparts to the wheel only four steps, which steps move the disk from zero four steps and bring the number "6" into view. The retrogressively-numbered third key of the hundreds-column, the retrogressively-numbered seventh key of the tens-column, and the retrogressively-numbered fourth key of the units-column are then operated, and the given number "6,374" is disclosed.

To subtract a given number—say "465" from the number "6,374"—it is only necessary to depress the progressively-numbered keys 5, 6, and 4 of the units, tens, and hundreds columns, respectively. When this operation is completed, the number "5,909" is exposed as the remainder.

It will thus be seen that to obtain a given number from which to subtract another number the slide is shifted to the left and the keys are manipulated retrogressively and that after said number is obtained all that is necessary is to manipulate the keys as numbered progressively, when the machine exposes the remainder to view, the operator being subjected to practically no mental strain irrespective of the size of the number.

In order to quickly and easily return all of the indicator-disks to zero at any time, we provide a cipher-key, which preferably is constructed precisely the same as keys 30 and has its bifurcated stem 42 (see Fig. 2) seated astride of the lever 25, so that by the simple depression of said lever through the medium of said key the rigid cog-wheel 22 is rotated

to impart a corresponding movement to the shaft 7, this rotation of the shaft causing the collars 8 to turn.

All of the registered disks presenting ciphers to view through the disclosure-slide by preference have the pawls 11 engaging the periphery of the collars 8 one step back of the notches 9 of said collars. Consequently the shaft may be turned nine-tenths of a revolution before the notch 9 and the pawl 11 engage. In other words, if the shaft 7 be turned nine-tenths of a revolution the disks which originally presented ciphers to view through the disclosure-slide are not moved, because the pawls 11 slide inoperatively on the peripheries of said collars. If, however, one or more of the wheels stand with the progressive number "1" exposed, it is clear that their pawls 11 are engaged with the notches (see Fig. 6) and that the nine-tenths of a revolution imparted to the shaft will turn said disks a corresponding distance or until their ciphers appear through the disclosure-slide. Again, supposing that the numeral "5" of one or more disks appears through the disclosure-slide and the shaft 7 is turned nine-tenths of a revolution, it will be understood that the pawl is four steps in advance of the notch of the collar, and consequently that the shaft will turn that distance before said notch engages the pawl of said disk and rotates the latter until the shaft has completed its nine-tenths revolution and the cipher of the disk appears through the disclosure-slide. Thus it will be seen that irrespective of the positions of the disks upon the shaft the rotation of the latter nine steps brings all of said disks back to their initial or zero positions, said disks being turned more or less, accordingly as a low or high number at the beginning of the operation appeared through the disclosure-slide.

As a precautionary measure to always reliably stop the disks when the ciphers reach their positions opposite the disclosure-slide we journal within the casing, at a suitable point, the rod 44, carrying rigidly thereon the sleeve 45, provided with arms 46, equal in number to the disks, and with an arm 47. When this rotary stopping device is not in operation, it occupies the position shown in Fig. 3, with the arm 47 held by the weight of the arms 46 below the pin 48, depending from the cipher-key lever 25, (see Fig. 1,) so that as the cipher-key is depressed to return said disks to their initial positions the rod 44 is rotated and the arms 36 thrown and held in the path of the pins 14 of the disk until said pins strike said arms and the disks are arrested. As said lever is reëlevated the arms 46 by specific gravity drop back to their inoperative positions and reëlevate the arm 47, leaving the disks free to operate when the cipher-key is again depressed.

From the above description it will be apparent that we have produced an adding and subtracting machine which embodies the features of advantage enumerated as desirable in the statement of invention, and it is to be understood that while the drawings illustrate the preferred embodiment of our invention we reserve the right to make any changes in the form, proportion, arrangement, or detail construction of the parts which properly fall within the spirit and scope of the invention.

Having thus described the invention, what we claim as new, and desire to secure by Letters Patent, is—

1. An adding and subtracting machine, comprising a casing provided with openings, a shaft journaled therein, a series of notched collars rigid upon said shaft, a corresponding series of indicator-disks, provided with pins, journaled upon the shaft, and provided with pawls to engage the notches of said collars, a cipher-key lever geared to said shaft and adapted to rotate the latter and thereby cause the ciphers of the various disks to appear through the openings of the casing, a rotatable rod provided with arms to interrupt the movement of the disks when the ciphers thereof appear through said openings, and with an arm projecting into the path of descent of the key-lever, whereby the depression of the latter will throw the first-named arms in the path of said pins, substantially as described.

2. An adding and subtracting machine, comprising a casing, a shaft therein, indicator-disks peripherally numbered progressively and retrogressively from "0" to "9," inclusive and provided with ten ratchet-teeth, and journaled on said shaft, ratchet-wheels movable only with said disks and having their teeth disposed in the direction opposite to that in which the disks rotate on the shaft, cog-wheels journaled on the shaft, spring-actuated pawls carried by said cog-wheels and engaging said ratchet-wheels, key-levers formed with cog-segments engaging said cog-wheels, springs holding said levers normally elevated, pivoted spring-elevated stop-bars in the plane of the peripheral teeth of said disks, and a series of spring-elevated keys numbered progressively and retrogressively from "0" to "9," inclusive; said keys being seated upon said key-levers and provided with laterally-projecting pins to force the stop-bars into the path of the disk-teeth after the disks have been rotated by the key-levers the proper distances, substantially as described.

3. An adding and subtracting machine, comprising a casing provided with an opening, a shaft journaled therein, an indicator-disk, peripherally numbered, journaled upon the shaft and provided with oppositely-disposed ratchet-teeth, a pawl engaging one ratchet to prevent back rotation of the disk, a key-lever geared to the disk to operate the same, a stop-bar, and means to throw the stop-bar into engagement with the other

ratchet-wheel as the disk is rotated its proper distance by the depression of said key-lever, substantially as described.

4. An adding and subtracting machine, comprising a suitable casing provided with openings, a shaft therein, a plurality of peripherally-numbered indicator-disks journaled independently upon said shaft, and provided with ratchet-wheels whose teeth are disposed in the direction of rotation of the disk, a key-lever geared to each disk to rotate the same, a stop-bar arranged to operate in connection with each disk, and provided with an arm to operate in conjunction with the preceding disk, and a series of keys arranged in connection with each key-lever, either of which may be the instrument for depressing said lever and turning the indicator-disk, a pin projecting from each key and adapted, as the key is depressed, to throw the stop-bar into the path of the ratchet-wheel of its respective disk, and a pin projecting from each disk; the pin of the actuating-disk being adapted at the completion of its revolution to strike and depress the branch arm of the stop-bar of the next higher disk, and thereby cause said stop-bar to prevent said next higher disk from being moved more than one step when movement is imparted to the same through the instrumentality of the next lower disk, substantially as described.

5. An adding and subtracting machine, comprising a casing, a shaft journaled therein, indicator-disks journaled thereon and provided with laterally-projecting pins, and peripherally numbered and toothed; the numbers running progressively and retrogressively from "0" to "9," inclusive, cam-wheels 8 on the shaft, pawls carried by the disks and peripherally engaging said cams, actuating-keys for each disk except that representing the highest order of numbers, and means to automatically impart movement to the latter at the completion of each revolution of the preceding or next lower disk, a cog-wheel rigid on the shaft, a rock-shaft provided with a plurality of arms and an additional arm, and a cipher-key-actuated lever formed with a cog-segment engaging the cog-wheel and with a pendent arm, all arranged substantially as and for the purpose described.

6. An adding and subtracting machine, comprising a casing, a shaft journaled therein, indicator-disks journaled thereon and peripherally numbered progressively and retrogressively from "0" to "9," inclusive, and provided with peripheral teeth, depressible stop-bars each having a branch arm, a key-lever geared to each disk except that containing the highest order of numbers, a series of keys upon each lever and numbered progressively and retrogressively from "0" to "9," inclusive, each key of a series having a pin to depress its companion stop-bar into the path of one of the disk-teeth, means for automatically imparting movement to the disk containing the highest order of numbers as the preceding disk completes each revolution, a pin projecting from each disk and adapted at the completion of each revolution of said preceding disk to strike the adjacent branch arm, and, by depressing the corresponding stop-bar, limit the movement of the next higher disk to one step, a rock-shaft provided with arms, and a cipher-key-actuated lever to return the disks to their initial positions and arrest them in such position by operating the rock-shaft and disposing its arms in the path of the disk-pins, substantially as described.

In testimony whereof we affix our signatures in the presence of two witnesses.

ARTHUR R. BALL.
ALBERT T. RIGGS.

Witnesses:
S. S. ASHBY,
J. A. WALKER.