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G. W. MacKENZIE, T. C. SLOANE & W. P. HANNA.

CALCULATING MACHINE.

No. 573,228. Patented Dec. 15, 1896.

Fig. 1.

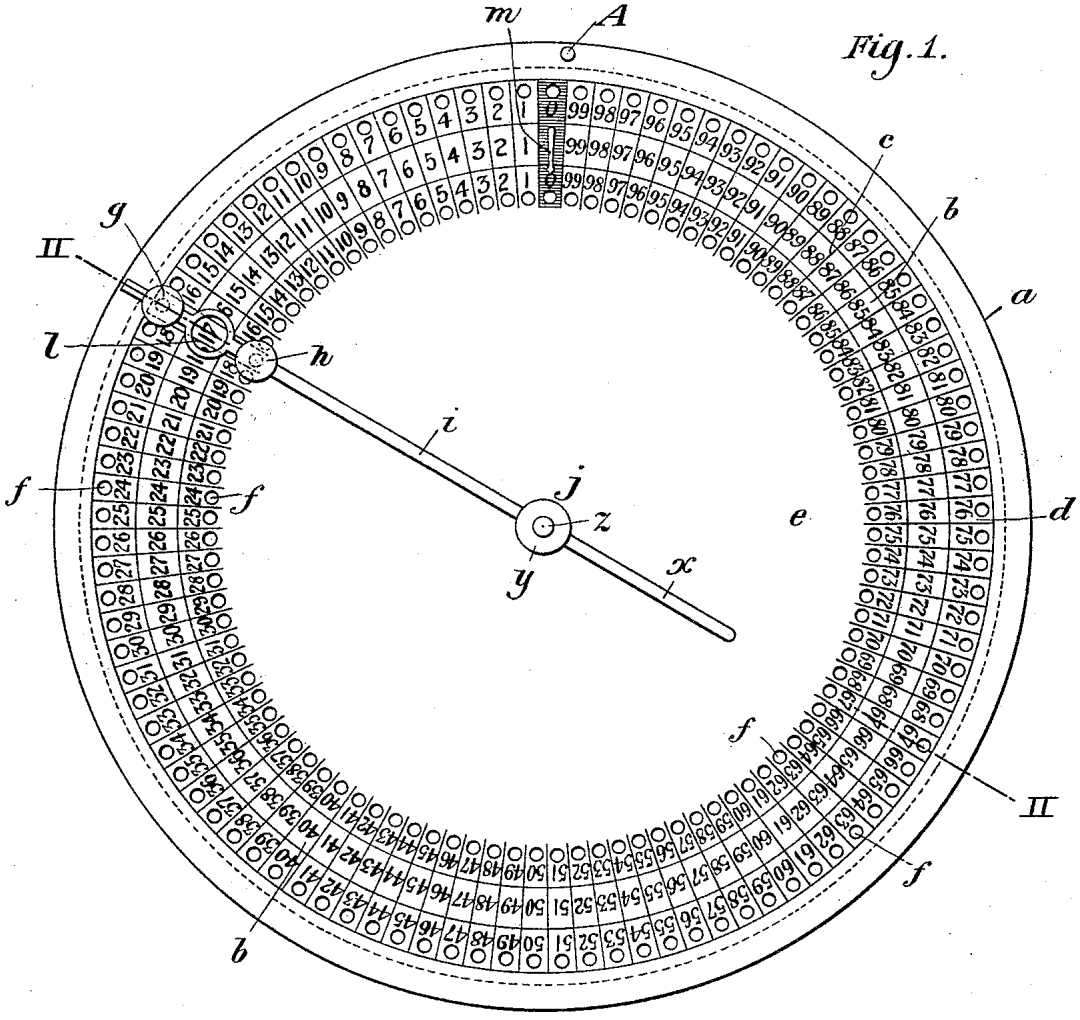
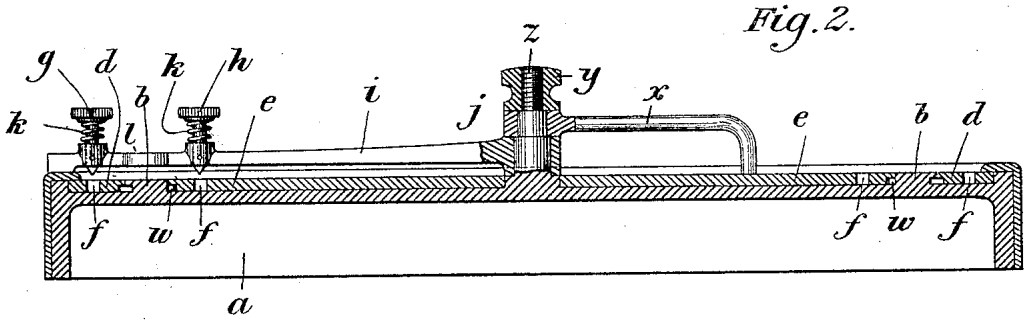


Fig. 2.



WITNESSES

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(No Model.) 5 Sheets—Sheet 2.

G. W. MacKENZIE, T. C. SLOANE & W. P. HANNA.

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Fig. 3.

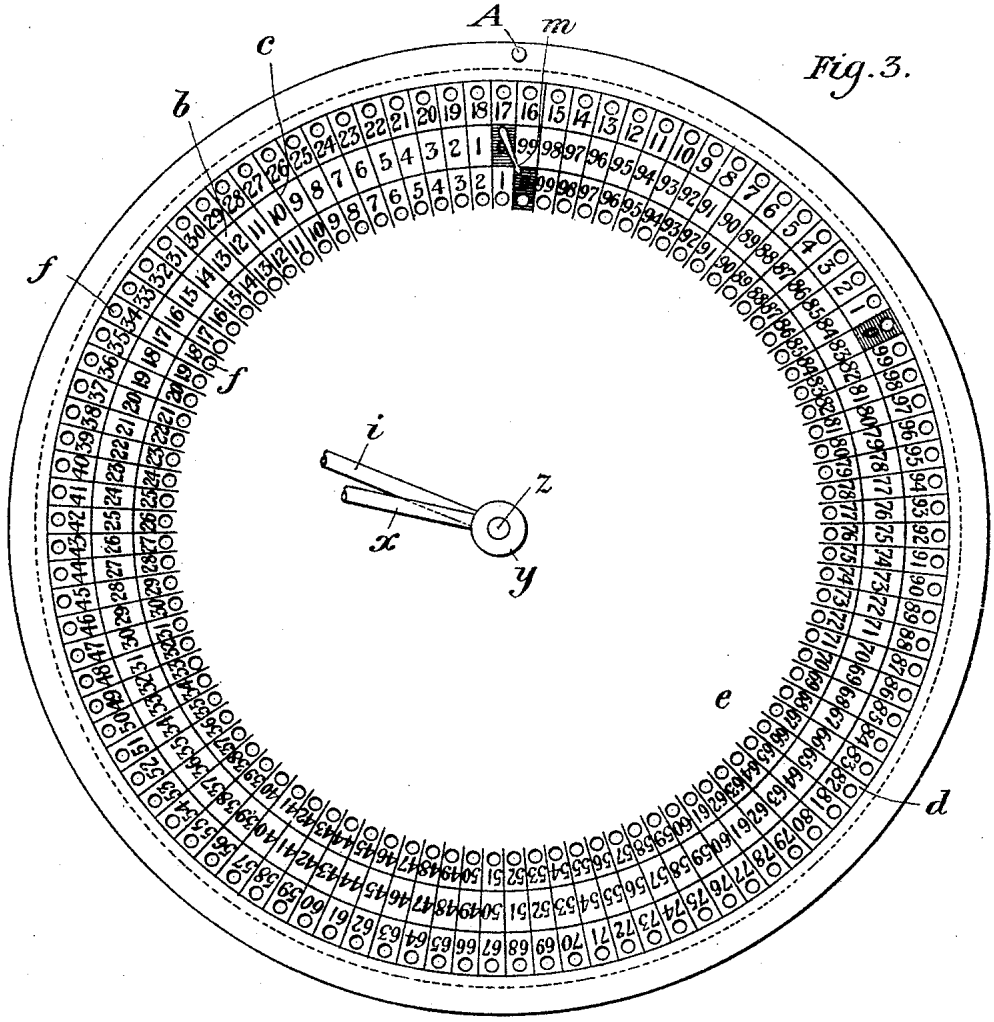


Fig. 4.

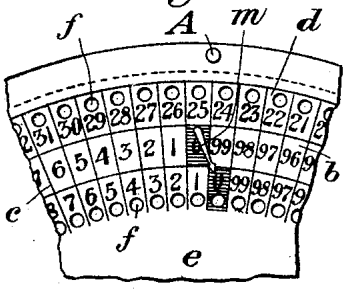


Fig. 5.

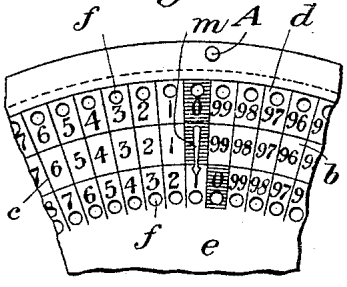
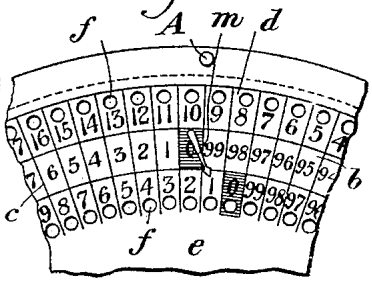


Fig. 6.



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G. W. MacKENZIE, T. C. SLOANE & W. P. HANNA.

CALCULATING MACHINE.

No. 573,228. Patented Dec. 15, 1896.

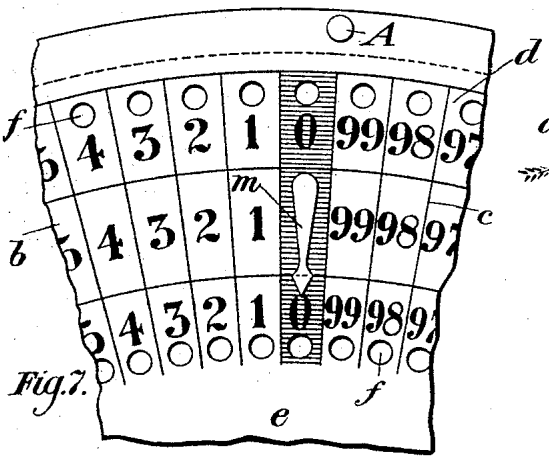

Fig. 7.

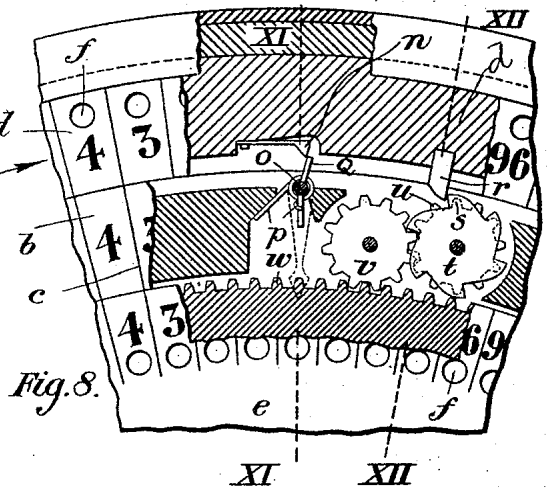

Fig. 8.

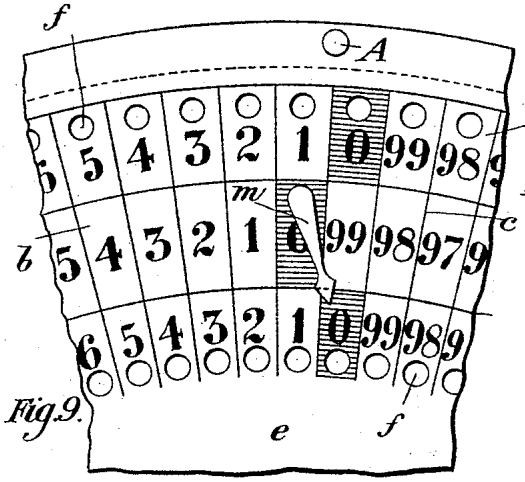

Fig. 9.

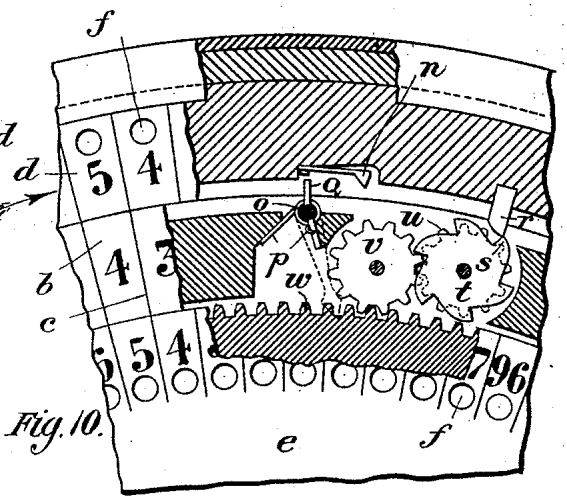

Fig. 10.

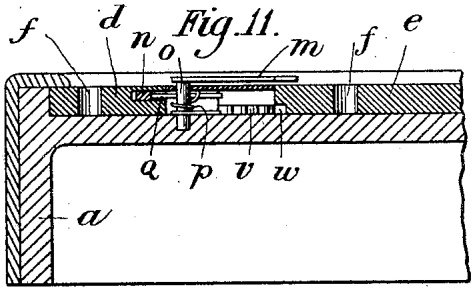

Fig. 11.

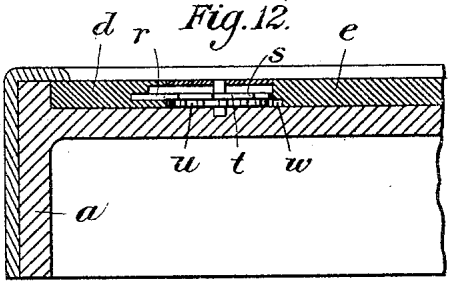

Fig. 12.

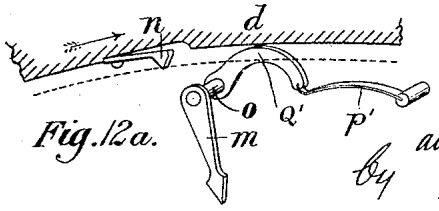

Fig. 12a.

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G. W. MacKENZIE, T. C. SLOANE & W. P. HANNA.

CALCULATING MACHINE.

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Fig. 13.

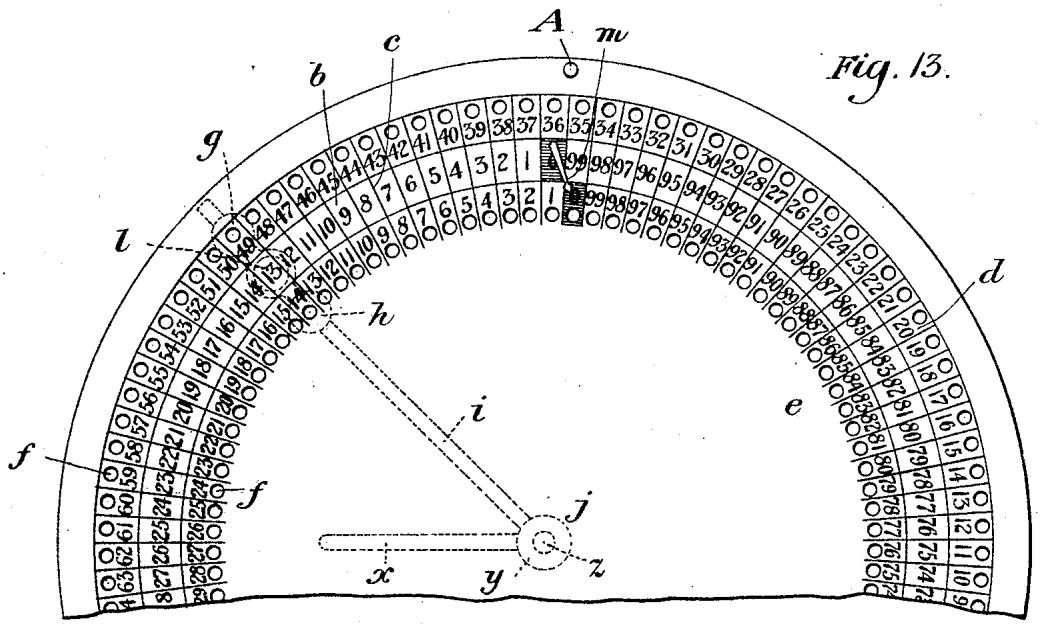
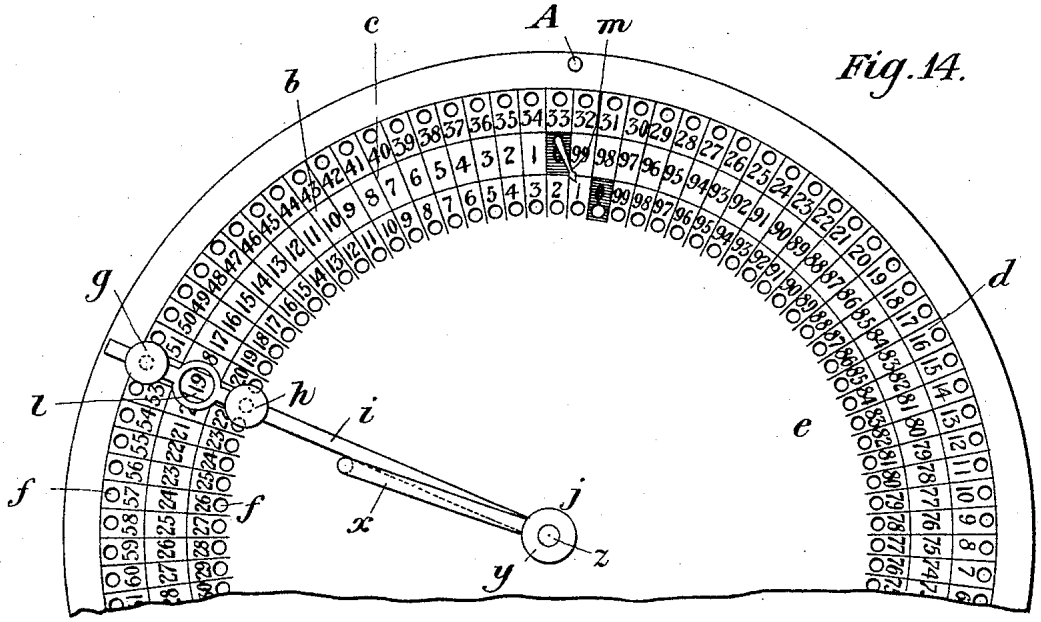


Fig. 14.



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CALCULATING MACHINE.

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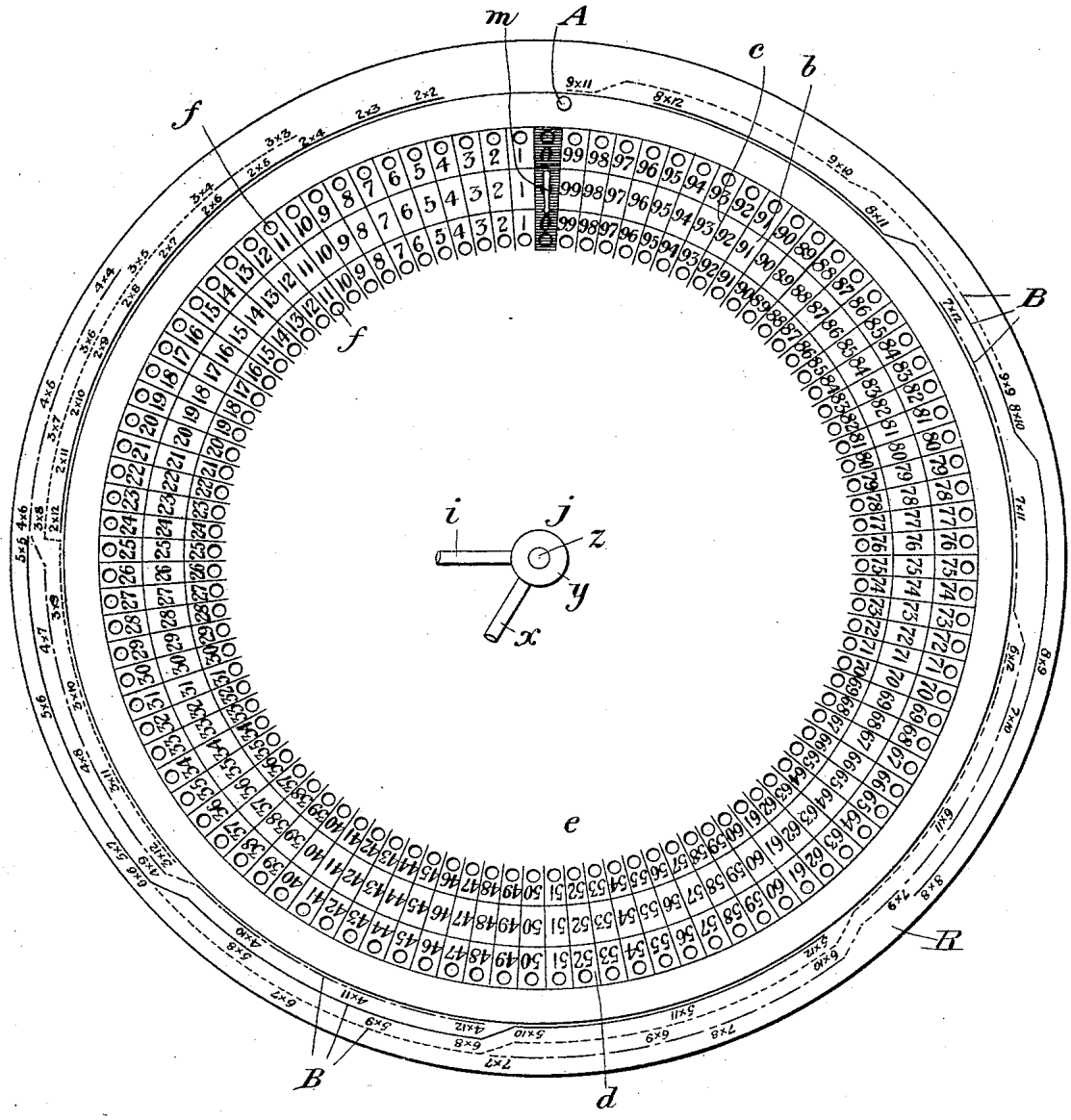
Fig. 15.



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F. K. McLaucr

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UNITED STATES PATENT OFFICE.

GEORGE W. MACKENZIE AND THOMAS C. SLOANE, OF BEAVER, AND WILLIAM P. HANNA, OF PITTSBURG, PENNSYLVANIA; SAID MACKENZIE AND SAID SLOANE ASSIGNORS OF ONE-FOURTH OF THEIR RIGHT TO SAID HANNA.

CALCULATING-MACHINE.

SPECIFICATION forming part of Letters Patent No. 573,228, dated December 15, 1896.

Application filed April 11, 1895. Serial No. 545,404. (No model.)

To all whom it may concern:

Be it known that we, GEORGE W. MACKENZIE and THOMAS C. SLOANE, residing at Beaver, in the county of Beaver, and WILLIAM P. HANNA, residing at Pittsburg, county of Allegheny, State of Pennsylvania, citizens of the United States, have invented or discovered a new and useful Improvement in Calculating-Machines, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part of this specification, in which—

Figure 1 is a plan view of our machine, showing the annuli or disks in a normal position. Fig. 2 is a cross-sectional view on the lines II II of Fig. 1. Fig. 3 is a view similar to Fig. 1, but showing the annuli or disks in an altered position. Figs. 4, 5, and 6 are detail views showing different combinations of the annuli or disks. Figs. 7 and 8 are detail views, on an enlarged scale, illustrating the shifting or tens-carrying mechanism ready to operate. Figs. 9 and 10 are similar detail views showing the annuli or disks in an advanced position in the process of operating. Fig. 11 is a sectional detail view on the line XI XI of Fig. 8. Fig. 12 is a similar view on the line XII XII of Fig. 8. Fig. 12ª is a detail view in perspective illustrating a modification of the indicator-operating mechanism. Fig. 13 is a partial face view of the machine, illustrating an operation in subtraction. Fig. 14 is a similar view illustrating an operation in multiplication. Fig. 15 is a view of the machine provided with an additional outside annulus constituting a factor-scale.

The same letters of reference refer to the same or like parts wherever used throughout this specification.

The object of our invention is to facilitate mathematical calculations and computations by mechanical means. It consists in an arrangement of concentric annuli surrounding a disk bearing inscriptions and equal divisons upon their faces, designed to produce combinations and results when certain of the movable annuli or disks are caused to rotate with relation to other stationary annuli or disks and to be brought into register or alinement with predetermined divisions on said stationary annuli.

In the various applications of our device the general principle of its operation is found in the relation of one or more movable annuli or disks bearing inscribed thereon numerals and equal divisions, which, in one position, correspond to like numerals and divisions on a stationary annulus, but which, in combination with the inscriptions on the stationary annulus, are capable of producing certain results when the relative positions of the stationary and movable annuli and disks are changed.

It also consists in certain other additional features and modifications of construction relating to the operative mechanism which will be hereinafter described.

In the machine illustrated in the drawings the inscriptions and divisions on the stationary and movable annuli and disks extend from one to one hundred, and we have found in practice that such an arrangement and extent of numbers is quite within the range of all the ordinary calculations to which our machine is applicable. Especially in computations of any decimal system of money is such an arrangement suitable, although it will be found to operate equally well with other arrangements suited to different systems, and we wish to be understood as not confining ourselves to the inscriptions shown in the drawings, since these may be varied to suit different requirements and conditions of use within the scope of our invention.

An especial and important feature of our device consists in mechanism for shifting one of the disks and in an indicator acting in conformity with such shifting mechanism, as shall be more fully described hereinafter.

Our apparatus is capable, within reasonable limits, of performing calculations in addition, subtraction, multiplication, and division in an accurate and rapid manner, and in the hands of a skilled operator is capable of performing in a short time and with absolute accuracy such of those arithmetical calculations in bookkeeping, change-making, estimating, &c., as are ordinarily laborious, te-

dious, and subject to error. Many additional applications will suggest themselves in the course of operating our machine which are not at first apparent, and we shall now describe some of the principal uses to which it may be put.

Referring to the drawings, *a* is the base of the machine, to which is permanently secured or made integral therewith the stationary annulus *b*, on which are inscribed the equal division-marks *c* and the numerals, as shown, from "1" to "99," inclusive, the hundredth division being designated by a zero-mark. Outside the stationary annulus *b* is the rotating annulus *d*, inscribed, like the stationary annulus *b*, with a similar arrangement of equal divisions and numerals, and which we usually employ for making computations in the units and tens of any number. Inside of the stationary annulus *b* is the rotating hundreds-disk *e*, inscribed with the same number of equal divisions as the annuli *b* and *d*, and it is used for computing the hundreds and tens of hundreds. Each movable annulus or disk is furnished with an annular row of holes *f*, which may be engaged by a pin *g* or *h*, mounted in an arm *i*, pivoted in the center of the disk *e*, as at *j*. These pins are preferably mounted with a coiled spring *k* to hold them out of engagement with the holes *f* until depressed by the hand of the operator, when the hole will be engaged by the pin and the annulus may be rotated at will. An opening *l* is left in the hand *i* in register or alinement with the row of numerals on the stationary annulus, so that they may be read by the operator in the act of locating any desired number.

Any other desirable or preferred form of operating-arm may be employed, if desired, since we do not wish to confine ourselves to the construction illustrated in the drawings, and in fact the annulus or disk may be rotated by hand, the point of a lead-pencil, or other convenient means. A stop A is inserted in the frame to limit the travel of the arm *i*, thus insuring an accurate stop at the zero-point. It will be observed that the top surfaces of all of the annuli and disks are on a plane, due to the concentric arrangement, the inner edge of each additional annulus from the center outwardly bearing on the outer edge of the inner annulus or disk, thus preventing any lapping over, as would be the case if all the dials had a common central bearing, but giving a truly circular rotation for each movable annulus or disk and securing a plane level surface, which is a very desirable feature.

Before commencing an operation in addition the movable annuli or disks are brought into register or alinement with the stationary annulus, as shown in Fig. 1, that is, the movable annulus and disk are set at zero, when it will be seen that any number which may be read on the stationary annulus *b* will correspond to the same number on either movable annulus or disk. If now the arm *i* is brought around until the opening *l* is over any desired number—for instance, "17"—the pins *g* and *h* will register or aline with the holes *f* opposite the corresponding number in the movable annulus or disk, and if it is desired to add "17" in the units and tens columns the pin *g* is depressed by the hand of the operator, engaging the hole, when the annulus or disk *d* may be moved around until "17" is over the zero-point in the stationary annulus *b*, as shown in Fig. 3. It will be observed that now every number on the annulus *d* will be just seventeen greater than the number on the stationary annulus *b*, with which it registers, so that if now, in continuation, it is desired to add additional numbers in the units and tens column *l*, as, for instance, "8," the arm *i* is brought around until the opening *l* registers with "8" on the stationary annulus *b*, when it will be found that the pin *g* will register with the hole opposite the sum of "8" and the previously-added number, "17" or "25." This number is then brought around in the same manner as already described until over the zero-mark on the stationary annulus *b*, as illustrated in Fig. 4. The operation of adding units and tens may be continued in this manner until the number "99" in the units and tens annulus *d* is reached, which exhausts the available numbers on such annulus. It is then desirable to add "1" on the hundreds-disk *e* before starting on a second hundred with the units and tens annulus *d*, when the annuli and disks will stand in the position shown in Fig. 5 should an even hundred be added; but if the operation of adding the units and tens be continued the shifting device illustrated in detail in Figs. 7 to 12, inclusive, will operate to move the hundreds and tens-of-hundreds disk *e* one point, the spring-controlled arrow *m* being operated by a pawl *n* on the annulus *d* to swing back into the position shown in Fig. 1, indicating the true sum in the hundreds and tens-of-hundreds column, which, as shown in Fig. 1, before any addition has been made in such column is properly indicated by zero. If, however, an even hundred has been added and the annulus *d* is stopped at the end of a full rotation, the disk *e* will have been shifted one point and the arrow will indicate the proper amount, as shown in Fig. 5. Continuing, however, to make additions on the annulus *d* the pawl *n* will be disengaged from the arrow, when it will fly around by reason of the spring *p* in conformity with the shifting of the disk *e* and indicate the aggregate sum on the hundreds and tens-of-hundreds disk *e*, as shown in Fig. 6, the units and tens annulus *d* showing that an additional number—for instance, "10"—has been added in the second hundred. It will be observed that the shifting of the arrow back to the position shown in Fig. 1 is accomplished every time a full rotation is made by the annulus *d*, completing the one hundred, and that as soon as the next hundred is commenced on the units and tens

annulus *d* the arrow will be released and moves in conformity with the shifting of the disk *e*. Thus the shifting of the disk *e* is accomplished simultaneously with the rotation of the annulus *d* to register "1" or more up to "99" and the arrow will continue to point to the zero, as in Fig. 3, until, as already described, it shifts back on the completion of the hundred and again forward in conformity with the movement of the disk *e*, the arrow always pointing to the correct amount on the hundreds and tens-of-hundreds disk *e*. It will be seen that this operation will be repeated at the end of each complete rotation of the units and tens annulus *d*, registering the additional hundreds on the disk *e* and properly indicating the sum by the arrow. Thus at any time during the operation of adding or at the end of the operation the sum may be read in hundreds or tens of hundreds, as indicated by the arrow on the disk *e* and on the units and tens annulus *d* above the zero-point on the stationary annulus *b*. For the purpose of facilitating the reading of results we have shown the zero-divisions on each annulus and disk, as distinguished from the other divisions, by shading. This effect may be secured by using a different color or material, or otherwise, and is a valuable aid in operating the machine.

In Figs. 7 to 12ª, inclusive, we have illustrated the indicating and shifting mechanism. The arrow *m* is pivoted by its stem *o* in the stationary annulus *b*, provided with a spring *p*, tending to hold it constantly in the position shown in Figs. 9 and 10 until the pawl *n*, secured to the outer movable annulus *d*, engages the pin Q, integral with the stem *o*, throwing the arrow back into the position shown in Figs. 7 and 8.

In Fig. 12ª we have shown a modification of the arrow-shifting apparatus, in which the curved arm Q′ and flat spring *p*′ are substituted for the pin *q* and spring *p*, by means of which the arrow *m* may be operated by a movement of the pawl *n* in either direction. The arrow will be held in a vertical position, as shown in Fig. 7, when the pawl *n* is caused to stop over the top of the curved arm Q′. At the same time a tooth *r* in the annulus *d* engages a tooth *s* on wheel *t*, which transmits motion through the pinions *u* and *v* and rack *w* to the inner disk *e*, the gearing being so adjusted as to rotate the disk *e* one space for every rotation of the annulus *d*, and thus carry or transfer the hundreds from the annulus *d* to the disk *e*, as clearly shown in the drawings. When at the end of any operation it is desirable to return the annulus and disk to their normal position, each one may be rotated in either direction, separately without interference, when the tooth *r* is in any other position than that shown in Figs. 8 to 10, when the machine is again ready for a new operation.

In view of the foregoing description an operation in subtraction will be readily understood, and we have illustrated such an operation by Fig. 13 of the drawings. Thus if it is desired to subtract "13" from "49" a stylus is placed in the hole *f* opposite "49" in annulus *d*, and it is brought around opposite to "13" on the stationary annulus *b*, when the result "36" will be seen opposite the zero-point, as shown, it being obvious that if the numbers on the stationary annulus are reduced by thirteen any number on the movable annulus *d* by reason of the equal divisions will be reduced by a like amount, and a number of spaces equal to the desired reduction will intervene between the number to be subtracted from and the number to be subtracted, due to the arithmetical progression of numbers already shown.

Inasmuch as the process of multiplication corresponds to adding the same number as many times as is indicated by the multiplier, it follows that if the process of adding be carried on as many times as the multiplier indicates the result will stand indicated on the annulus and disk. Thus if it is desired to multiply "19" by "7" the stylus is made to engage nineteen spaces on the movable annulus *d* seven times, when the result "133" may be read on the annulus *d* and disk *e*, as shown in Fig. 14. One use of the arm *x* is illustrated in this operation such arm being pivotally attached in the center and free to swing around such center, it being set by the thumb-screw *y* on the stud *z*, so as to hold the arm in any predetermined position, in this case to stop the arm *i*, by striking against the downwardly-turned ends of the arm *x* at the proper position to engage just the required number of spaces, nineteen, thereby greatly facilitating the rapid operation of the machine.

In Fig. 15 we have illustrated a modification consisting of a stationary outside annulus R, which greatly facilitates the operation of multiplication. We call this a "factor-scale," and, as will be seen, it bears a table of factors constituting a limited multiplication table, which factors are arranged to register with and be opposite to the proper result of the factors when multiplied together, as inscribed on the stationary scale *b*. That is, opposite certain numbers on the stationary scale are placed the factors producing such numbers when multiplied together. For the purpose of isolating as far as possible and facilitating the reading of any desired result arising from any multiple of any factor on the scale the guide-lines B may be placed thereon, which follow and serve to distinguish quickly the same factor to any power up to the limit of the scale. These lines B may be made of different character by changing their color, construction, or appearance, so that they may be readily followed by the eye.

In operations of division the process of subtracting the divisor from the dividend, or find-

ing how many times one number is contained in another, is repeated until nothing, or a remainder less than the divisor, remains, the number of times being counted by the operator. Thus if it is desired to divide "13" into "85" the number "85" on an annulus *d* is placed at the top over zero. The arm *x* is so placed as to limit the hand *i* at "13" on the stationary annulus, and consecutive subtractions of thirteen spaces each are made until the operation will have been repeated six times, when there will remain above the zero-point the number "7," the result thus being a quotient of "6" with a remainder of "7."

Many changes and alterations may be made in the construction of the machine and inscriptions on the annulus and disk without departing from our invention. It will be found capable of many and various applications not herein described or shown, and in the hands of an operator of ordinary skill will perform numerous and different computations in a rapid and accurate manner.

Having described our invention, what we claim, and desire to secure by Letters Patent, is—

1. In a mechanical calculating-machine the combination with a series of movable circular concentric disks and annuli bearing scales, of an operating-arm *i* pivoted on a pin secured to the base at the center of the machine, and a similarly-pivoted controlling-arm *x* secured upon the pin, and having a downwardly-projecting end and capable of being set on the central pin by a thumb-nut, so as to rigidly locate the downwardly-projecting end in the path of the arm *i* for limiting the motion of such arm *i* substantially as set forth.

2. A mechanical calculating-machine consisting of a base provided with a circular concentric stationary disk, and a series of movable circular concentric disks and annuli, bearing scales, rotatably mounted on a base, an indicator *m* mounted on a stem *o* pivotally set on the stationary disk, a controlling-spring *p* and a pin *q* projecting from the stem *o* into the path of a pawl *n* mounted on the outside movable disk substantially as set forth.

3. A mechanical calculating-machine consisting of a base provided with a circular concentric stationary disk and a series of movable circular concentric disks and annuli bearing scales, rotatably mounted on a base, shifting or tens-carrying mechanism located in such base between the outer and inner disks consisting of a train of two intermeshing gear-wheels *s*, *r*, one of which is in mesh with a rack *w* on the inner disk and the other provided with a ratchet-wheel *t* the teeth of which project into the path of a tooth *v* mounted in the outer rotating annulus substantially as set forth.

In testimony whereof we have hereunto set our hands this 9th day of April, 1895.

GEORGE W. MACKENZIE.

his
THOMAS C. × SLOANE.
mark

WILLIAM P. HANNA.

Witnesses:
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