April 28, 1931. G. H. MORSE 1,802,440

CALCULATING MACHINE

Filed Sept. 7, 1927 4 Sheets-Sheet 1

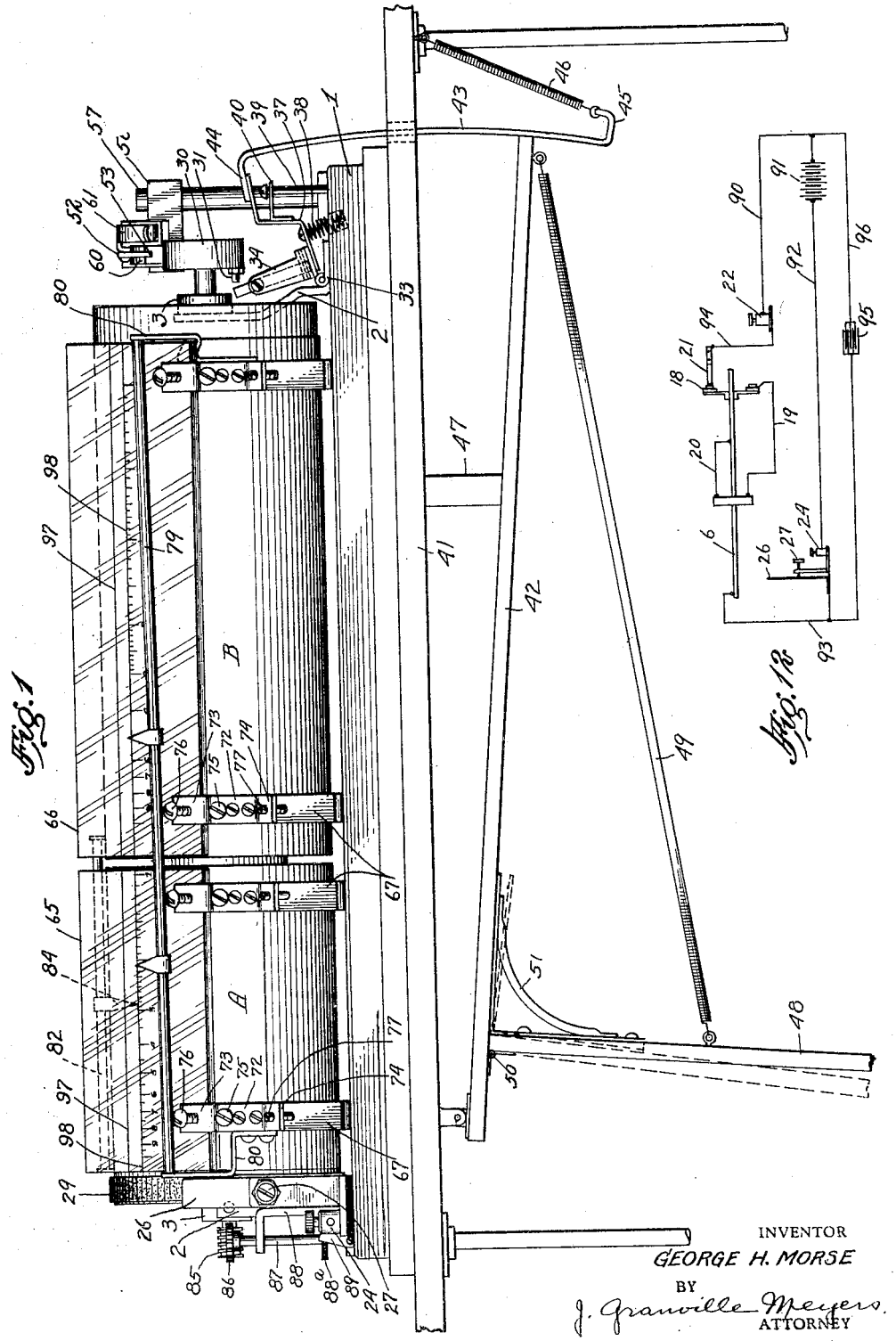

Fig. 1

Fig. 1a

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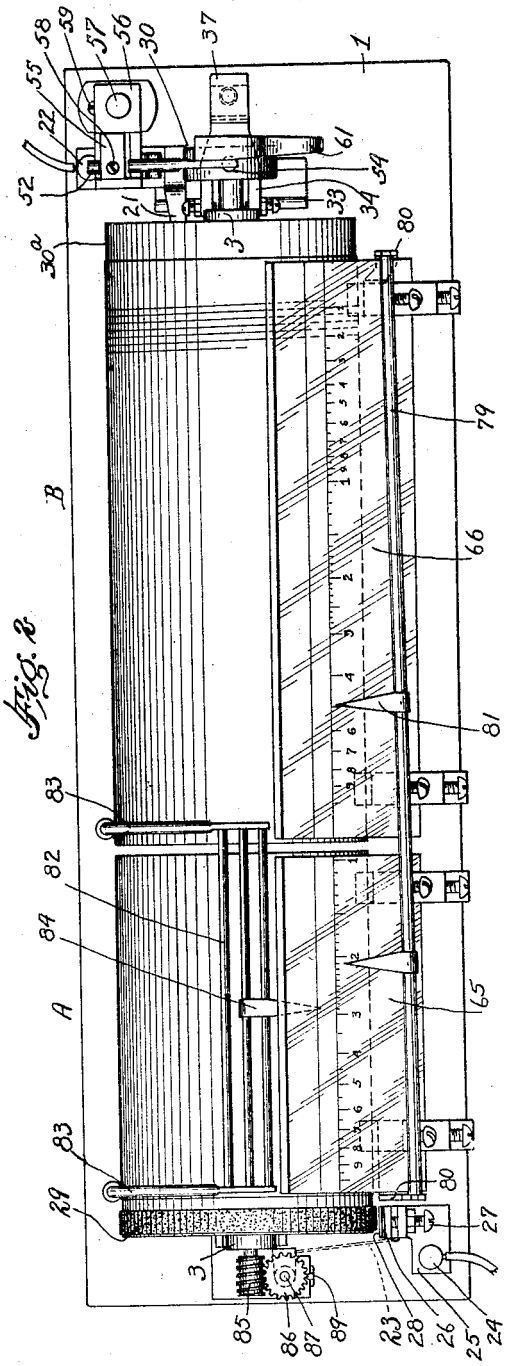

Fig. 2

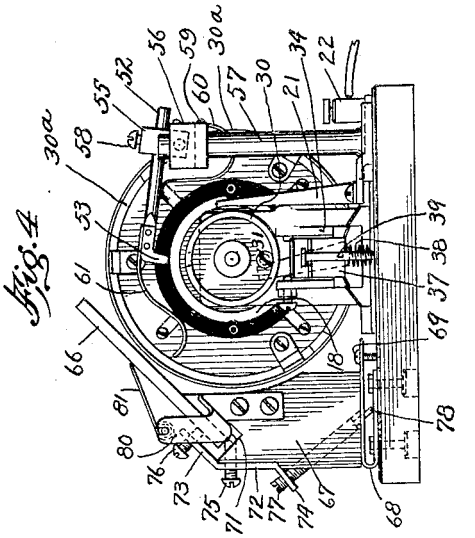

Fig. 4

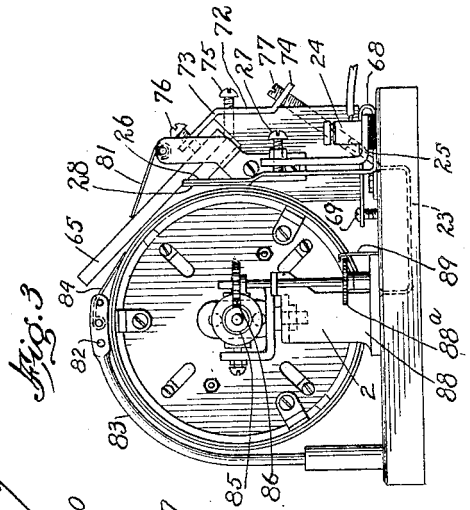

Fig. 3

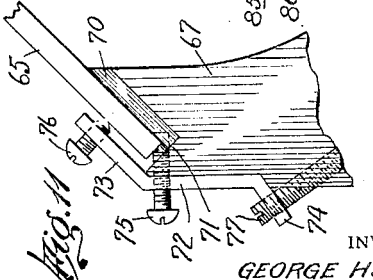

Fig. 11

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CALCULATING MACHINE

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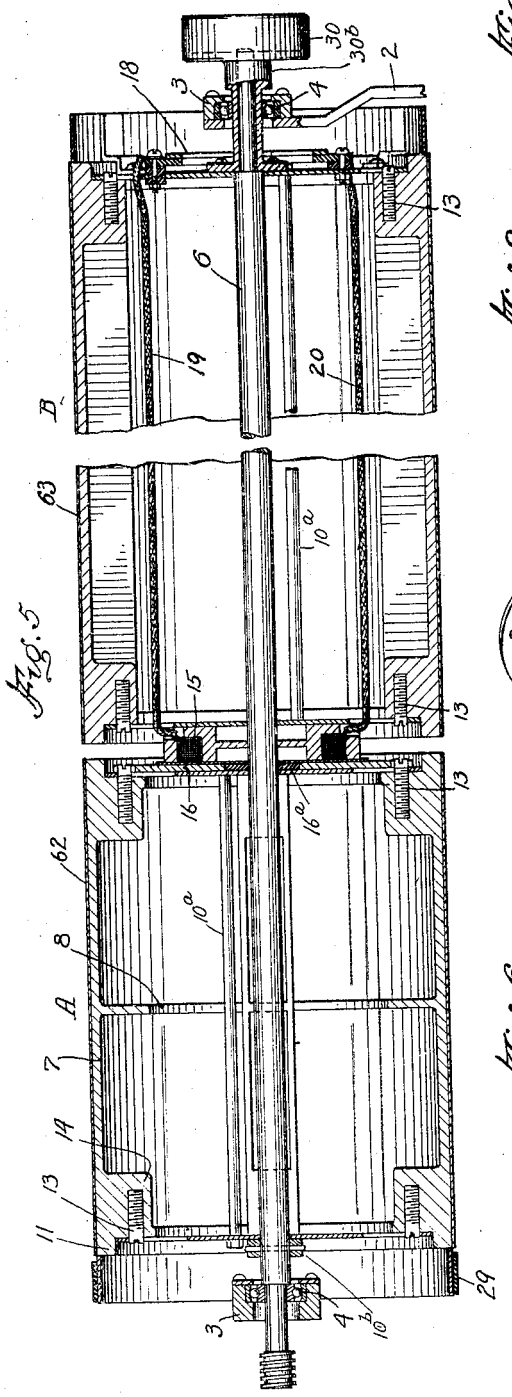

Fig. 5

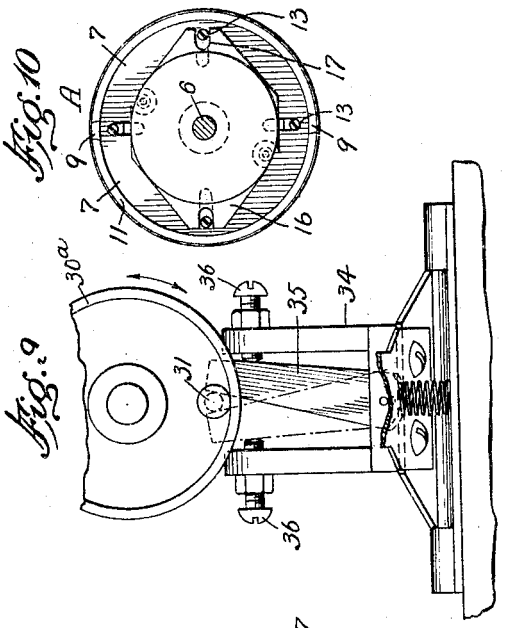

Fig. 10

Fig. 9

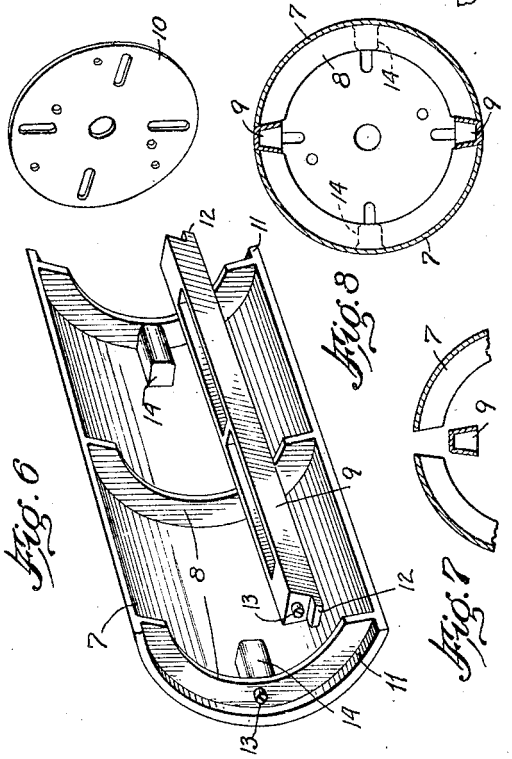

Fig. 8

Fig. 6

Fig. 7

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CALCULATING MACHINE

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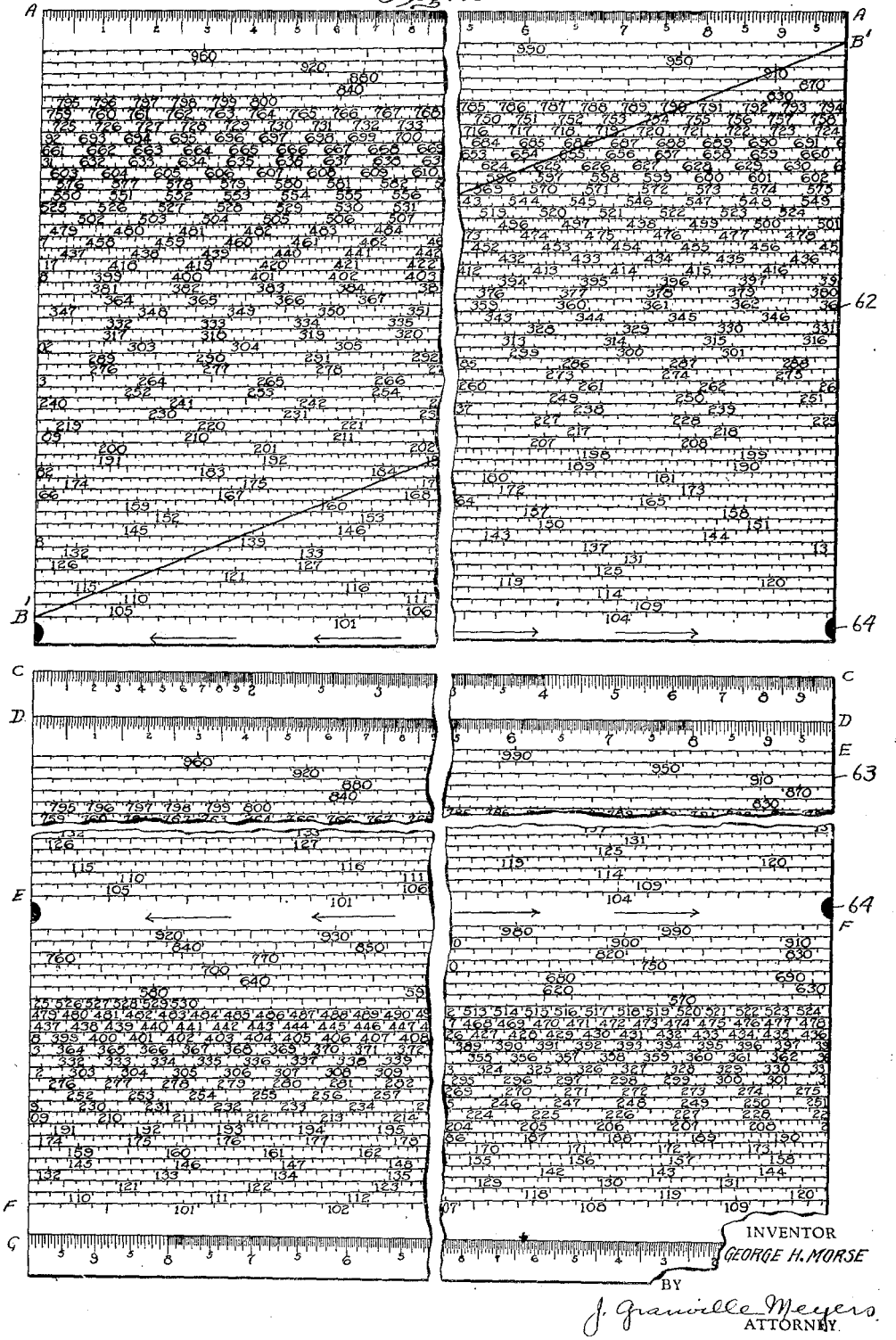
Fig. 13



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Patented Apr. 28, 1931 1,802,440

UNITED STATES PATENT OFFICE

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CALCULATING MACHINE

Application filed September 7, 1927. Serial No. 217,922.

This invention is an improvement in calculating machines, and more particularly in machines embodying the principle of the slide rule.

In known machines of this type a plurality of wheels is provided, rotating on a common axis, and designed to move together when adding or subtracting factors. At the completion of each adding or subtracting operation the connection between the wheels is released. One wheel is then returned to zero position while the other is held fixed, to enable the addition or subtraction of another factor.

One of the primary objects of the present invention is the provision of a connection between the rotating elements of a nature such that the elements are normally constrained to rotate together without the possibility of any relative angular movement.

Another object is the provision of means for stopping one of said elements and holding it against rotation in a fixed position, operating in alternation with the mechanism for constraining the elements to rotate together.

Another object is the provision of a common means for releasing the connection between the rotating elements and for braking one of the elements against rotation, operating in alternation one with the other, and of a nature such that the connection must be positively released before the braking mechanism comes into operation.

Another object is the provision of a mounting for the two rotating elements of a character such that the said elements are held in exact axial alinement.

Another object is the provision of mechanism for checking the movement of the free element at zero position, the said mechanism being in the nature of a coarse and a fine adjustment so that said element always may be stopped in exact zero position.

Another object is the provision of mechanism for supporting transparent plates carrying indicia cooperating with the rotating elements in a manner to enable universal adjustment of the plate with respect to the element.

Another object is the provision of a rotating element so constructed as to be capable of contraction and expansion, thereby to enable the setting and clamping of a cylindrical chart on said element.

Another object is the provision of means in connection with one of the charts and other means cooperating therewith for indicating that column of the chart in which the desired result will be found.

With these and other objects in view the invention consists in the construction and novel combination of parts fully described hereinafter, illustrated in the accompanying drawings, and pointed out in the claims appended hereto, it being understood that various changes in the form, proportion, size and minor details of construction within the scope of the claims, may be resorted to without departing from the spirit of the invention.

In the drawings:—

Fig. 1 is a front view of the improved machine.

Fig. 2 is a plan view.

Fig. 3 is an end view looking from the left of Fig. 2.

Fig. 4 is a similar view looking from the right of Fig. 2.

Fig. 5 is a longitudinal section through the cylinders.

Fig. 6 is a detail in perspective of sundry of the sections of which the cylinder is composed.

Fig. 7 is a detail in section showing the position of the cylinder parts prior to expansion.

Fig. 8 is a section of the cylinder showing it in expanded condition.

Fig. 9 is an end view of the cylinder at the right illustrating the stop mechanism.

Fig. 10 is a view looking at the corresponding end of the other cylinder, showing the mounting of the armature.

Fig. 11 is an enlarged detail of the plate glass mounting.

Fig. 12 is a diagram of the wiring.

Fig. 13 is a partial layout of the charts.

In the present embodiment of the invention the improved machine comprises a suit-

able base 1 having at each end a yoke or fork bracket 2, and a bearing block 3 is journaled between the arms of each fork or yoke. A bearing is arranged in each block, as indicated in Fig. 5, and each of the bearings 4 is of the self-alining type as shown.

A shaft 6 is journaled in the bearings of the two blocks, as shown in Fig. 5, the ends of the shaft being reduced as shown at the bearings. A pair of cylinders is mounted on the shaft, the said cylinders being arranged end to end, and being in the form of shells. The cylinders designated generally as A and B are similar in construction, and but one will be described.

Each cylinder is composed of two similar sections cooperating to form the greater portion of the cylinder, and two other similar sections interposed between the adjacent edges of the sections first mentioned. Each of the first named sections comprises an arc shaped plate or shell portion 7, reinforced by arc shaped transversely extending ribs 8 on the concave faces of the sections.

It will be noticed referring to Fig. 6, that the ribs are three in number, one near each end and one intermediate the ends. The end ribs are spaced from the ends of the portion 7 as clearly shown, for a purpose to be presently described. Each of the last named sections 9, which sections may be considered as expanders is arranged between the meeting edges of the sections 7—8, and the said sections 9 are wedge shaped in cross section, as shown in Figures 7 and 8, the adjacent edges of the sections 7 being shaped to cooperate with the wedge shaped faces of the sections 9, so that the sections 7 are moved apart into a predetermined relation when the sections 9 are moved into their normal position shown in Fig. 8.

The sections are held in expanded position by means of disks 10, a disk being arranged at each end of each cylinder against the face of the adjacent rib 8. Because of the fact that the ribs 8 are spaced inwardly from the ends of the shells 7, a lip 11 is formed at each end of each section 7, inside of which the perimeter of the disk 10 engages. Each section 9 has a similar lip 12 at each end for a like purpose. The disks 10 are connected together by rods 10*a* as shown in Fig. 5, the rods being threaded and engaged by nuts to releasably connect the disks. Each of the sections 7 and 9 is provided at each end with a pin 13, and each of the pins is adapted to engage in a radial slot in the adjacent disk 10. The shell portion of each section 7—8 is reinforced as shown at 14 at the center of each end rib 8, and at the point where the pin 13 engages, the said pin 13 in the present instance being a screw as shown.

The cylinders A and B are mounted on the shaft 6, the cylinder A being secured thereto by a collar and pin indicated at 10*b*, while the cylinder B is freely rotatable thereon. They are normally constrained to rotate together by a magnetic clutch consisting of a coil 15 and an armature 16. The coil 15 is secured to the end of the cylinder B, while the armature 16 has a lost motion connection with the cylinder A, being constrained to rotate therewith, but free to move axially thereof within limits. As shown more particularly in Fig. 10, the armature which is roughly diamond shaped, has notches 17 at its ends which receive certain of the screws or pins 13 before mentioned on the cylinder A. These pins enable the armature to move axially of the shaft, within limits defined by the coil 15 and the end of the cylinder A. The armature has an opening through which the shaft 6 extends, as shown in Fig. 10. A rubber disk indicated at 16*a* is interposed between the armature and the shaft. This provides flexibility to accommodate axial motion of the armature which otherwise might stick through clutch action.

One terminal of the coil is connected to a ring 18 held on the outer end of the cylinder B co-axial with the shaft 6 by means of a conductor 19, the said ring being of conducting material, as for instance copper, and insulated from the cylinder. The other terminal is grounded to the shaft and through the bearings to the forks or yokes 2 by means of a conductor 20. A brush 21 bears against the ring at its free end, the other end being secured to the base 1. The brush is of conducting material, and it is connected to a binding post 22 on the base. At the opposite end from the brush 21, the bracket 2 is connected by a conductor 23 with a binding post 24 connected to the switch arm 26.

The binding post 24 is supported by the base in insulated relation as shown, and the said post is secured to one of the arms of an angle bracket 25 of conducting material, the said arm being horizontal and beneath the binding post as shown in Fig. 3, while the other arm is vertical. A resilient switch arm 26 is connected to the base between the vertical arm of the bracket and the cylinder A, and this arm is normally in engagement with a set screw 27 of conducting material threaded through the vertical arm, and held in adjusted position by a lock nut.

That face of the switch arm adjacent to the wheel is provided with a facing 28 of material having a high coefficient of friction, which facing is adapted to cooperate with a ring 29 on the adjacent end of the cylinder, the said ring being also of material having a high co-efficient of friction, as for instance rubber. The switch arm is so arranged that when it engages the ring 29 it is out of engagement with the set screw 27, and when in engagement with the set screw it is out of engagement with the ring. Thus the switch arm is a means for simultaneously releasing the cyl-

inders from each other and for immobilizing the cylinder A.

In resetting, the cylinder B must be restored to zero position, that is with certain indications on the periphery thereof to be later described, cooperating or registering the certain indications on an indicator to be also later described. In order to enable this operation a wheel 30 is secured to the cylinder, the said wheel having a hollow hub portion 30*b* journaled on the shaft and secured to the cylinder. The ball bearing at this end of the shaft is raised between the hub and the block 3.

In this wheel a stop pin 31 is mounted for movement axially of the shaft, the pin being normally spring held in the position shown in Fig. 1, that is extended beyond the inner face of the wheel. A hinge 33 has one leaf connected with the base at the outer end of the cylinder B, and the other leaf carries a yoke 34, the body being secured to the hinge leaf, with the arms extending upwardly therefrom. A tongue 35 is pivoted to the body between the arms, and the free end of the tongue extends upwardly between the arms and beyond the free ends thereof as shown in Fig. 9. Set screws 36 are threaded through the arms of the yoke, and each set screw is provided with a lock nut as shown for holding it in adjusted position.

A plate 37 is secured to the opposite face of the hinge leaf from the yoke, and a spring 38 arranged between the plate and base normally holds the parts in the position of Fig. 1, that is with the tongue 35 out of position to engage the stop pin 31. The free end of the bracket 37 is offset upwardly as shown, to provide a finger piece for operating the tongue and associated parts. The swinging movement of the hinge leaf and the parts carried thereby under the urge of the spring 38 is limited by means of a headed stop 39 extending upwardly from the base, and passing through an elongated opening in an arm 40 extending laterally from the bracket 37.

Preferably mechanism is provided for operating the tongue 35 without requiring the use of the operator's hand or hands. In the present instance the base 1 is supported on a table 41 having the usual top and legs as shown. A plate 42 is hinged to the underside of the table, at the end remote from the wheel 30, and the free end of the plate is provided with a cross arm 43 extending through a slot in the table top. The upper end of the arm has an angular portion 44 overlying the upwardly offset end of the bracket 37, and the lower end has an angular portion 45 between which and the table top is arranged a spring 46, acting normally to hold the plate in the position of Fig. 1, that is against the stop 47 extending downwardly from the table top. A bar 48 is hinged to the plate 42 near the end remote from the arm 43, and the said bar is connected to the free end of the plate by a spring 49. The bar 48 is as previously stated hinged to the plate 42, the hinge connection being indicated at 50, and an angle bracket 51 is arranged between the bar and the plate, for limiting the swinging movement of the bar with respect to the plate under the urge of the spring 49, to the position of Fig. 1.

The arrangement of the stop pin 31 and the tongue 35 and its supports is such that when the cylinder B is turned with the tongue in position to engage the stop pin, the cylinder will always be stopped at a definite fixed point in its rotation. The set screws 36 are so arranged that the movement of the cylinder in either direction is always checked with the stop pin in position such that the cylinder is at zero. By means of the set screws such position may be exactly adjusted. The exact zero position is however liable to disturbance through the impact of the pin against the tongue or the tongue against the set screw, and mechanism in the nature of a fine adjustment is provided for insuring the positioning of the cylinder in the exact zero position, regardless of minor disarrangements due to rebound under impact.

Such mechanism is shown in Figures 2 and 4 and includes an arm 52 pivotally mounted at one end and provided at the other with a depending finger 53 slightly wedge shaped, and adapted to engage in a radial opening 54 in the rim of the wheel 30 before mentioned. The arm is slidable in a block 55, which is pivoted to a bearing block 56 slidably mounted on a post 57 uprising from the base. The arm 52 is slidable in the block 55, and is held in adjusted position by a set screw 58. The bearing block 56 is slidable and rotatable on the post and is held in adjusted position by a set screw 59. Thus a universal adjustment is provided for the arm 52. A plate spring 60 secured to the bearing block normally holds the lug 53 out of engagement with the wheel, and a finger piece 61 is provided for convenience in manipulating the arm.

In resetting, the yoke 34 is swung outward by knee through the mechanism beneath the table, to bring the tongue in position for engagement by the pin 31. The cylinder B is rotated manually, until the pin engages the tongue, and the tongue engages one of the set screws 36. This gives the coarse adjustment to zero position, and by depressing the finger piece 61, to cause the lug 53 to engage within the opening 54, the fine adjustment is provided which brings the cylinder to exact zero position. The cylinder B is rotated by means of the wheel 30, or by grasping the rim 30*a* attached to the end of the cylinder.

Each cylinder is completed by a shell of suitable material, as for instance paper, indicated at 62 and 63 for the respective cylinders A and B, and each of the paper cylinders constitutes a chart of logarithmic calculations to be later described, for enabling the work-

ing out of engineers' problems. These paper cylinders are fitted on the cylinders A and B, when they are in collapsed position as above described, and the cylinders are afterwards expanded to hold the paper coverings tightly in place. As clearly shown in Fig. 13, there is a zero point for each cylinder, the said zero points being indicated by the dark segments 64. Cooperating with the indications on the paper cylinders is a pair of plates 65 and 66 respectively, the said plates being of glass or other suitable material. The plates are independently but similarly mounted, each being supported by a pair of brackets 67. Each of these brackets is connected to the base by a substantially U-shaped spring 68, the spring being so bent that the outer ends of its arms tend to bear one upon the other. One arm of each spring is secured to the base as shown more particularly in Fig. 4, and the other to the lower end of the bracket 67. The arms of the springs extend toward the cylinder, and a set screw 69 threaded into the base 1 passes between the arms of a fork in the end of the upper spring arm. The arm is free to move downwardly over the body of the screw 69, but limited in its upward movement by the head of the screw, when stressed by the adjusting screw to be described. A principal function of the screw 69 is to attain lateral stability of the end of the spring 68.

Each bracket is provided at its upper end with an inclined knife edge 70, the said edge being substantially tangential to the adjacent cylinder, and the plate 65 or 66 as the case may be rests upon the knife edges of the two brackets. A shoulder 71 is provided at the lower outer end of each knife edge, as an abutment for the plate, and the plates are adjusted along the knife edges.

Each bracket 67, which may be of wood has secured to the outer edge at the upper end, an angular bar of metal. This bar consists of three portions, a body portion 72 inset in the outer edge of the bracket, an upper portion 73 lying parallel with the knife edge in spaced relation, and a lower portion 74 extending outwardly at an angle from the bracket. A set screw 75 is threaded in the body portion of the bracket and engages the lower edge of the plate. A second set screw 76 is threaded in the portion 73 and bears against the upper outer face of the plate directly above the knife edge 70. A third set screw 77 is threaded in the portion 74 and has a reduced lower end 78 which engages the lower arm of the U-shaped spring 68. The bracket has an opening through which the screw 77 extends. It will be evident from the description that by means of the set screws a substantially universal adjustment is enabled for the plate. By means of the set screw 75, the plate may be moved longitudinally of the knife edge. By means of the screw 77 the bracket may be tilted so that the plate moves toward and from the cylinder, and may be brought into very close proximity thereto along a definite line extending longitudinally of the plate. When properly adjusted on the knife edge the set screw 76 holds the plate in adjusted position. Each plate has indicia thereon to be later described, cooperating with the indications on the adjacent cylinder.

A rod 79 is supported in front of the cylinders and in front of the plates, by means of angle arms 80 on the end brackets 67. This rod carries a pair of indicators or pointers 81 slidable on the rod, for cooperating with the indications on the plates. A plurality of rods, three in the present instance, indicated at 82 is supported by davit shaped arms 83 extending upwardly from the rear of the base and curving over the cylinder A to the top thereof, the intermediate rod being directly above the shaft 6. A pointer or indicator 84 is slidable on the intermediate rod, and extends across the front rod, lying thereon and cooperating directly with the cylinder.

The shaft 6 is provided at the end remote from the wheel 30 with a worm 85, meshing with a worm wheel 86 on a vertical shaft 87 journaled in the base and in an angle bracket 88 on the yoke 2 at the adjacent end. An index wheel 88*a* is mounted on the shaft, the said wheel having its edge knurled as shown, and turning with the shaft, but free and independently rotatable thereon manually. This wheel is of the character shown in my prior Patent No. 861,303, granted July 30, 1907, and is designed for the same purpose, that is the determination of the proper place for placing the decimal point in the result of any calculation. Due to the presence of the two outer rods 82, the pointer 84 cannot in any circumstances, be so positioned that the sharp end will rest upon the face of cylinder A.

As pointed out in this patent the wheel is customarily set before the beginning of the calculation in accordance with the characteristics of the problem presented. If the characteristics sum is a plus number, the wheel is turned in one direction with respect to the pointer 89 cooperating with the upper face thereof. If the characteristics sum is a minus quantity the wheel is turned in the opposite direction, and the position of the wheel at the end of the calculation shows the operator where the decimal point should be placed in the result.

Fig. 12 is a diagram of the electric wiring for the magnetic clutch. As shown in this diagram a lead wire 90 leads from the binding post 22 at the right end of Fig. 2 to the minus terminal of a suitable source of energy 91. A lead wire 93 connects the plus terminal with the binding post 24 at the left end

of Fig. 1. A lead wire 93 connects the switch arm 26 with the shaft 6, to which shaft the lead wire 20 before mentioned is also connected. The lead wire 19 is as before stated connected with the ring 18, while the brush 21 is connected with the binding post 22 by a lead wire 94. Preferably a condenser 95 is arranged in parallel in the circuit to prevent sparking, the said condenser being interposed in a lead wire 96, whose ends are connected with the minus terminal of the battery, and the switch arm 26 respectively, or with the lead wires 90 and 93 near these elements.

Referring to Figure 13 chart 62 is mounted on cylinder A, and chart 63 on cylinder B. These charts are bent into cylindrical form such that the axes of the cylinders lie at right angles to the lines of the scales.

The semi-circular black patches marked 64, are thus juxtaposed against the similar patches at the opposite edges thus completing the circular form. The centers of the black circles thus formed are in line with the zeros of all of the scales. In setting either cylinder on the zero point of any scale, the center of the small black circle is superimposed on line 97 Figure 1 etched into the glass plate. All indications and numerical settings of any of the scales are made in reference to this etched line 97.

All of the scales are in character the same as those found in an ordinary slide rule. Scales AA; DD; and G are in length just equal to the circumference of the cylinder, scales B′, B′; and E, E; are identical and in length equal to 50 times the circumference of the cylinder. Scale C, C; is repeated twice in one circumference and is used for problems involving the squares and square roots of numbers. Likewise, scale F, F; is used for squares and square roots and is in length 25 times the circumference.

Scale G differs from scales A, A; and D, D; only in that it is inverted and offers some conveniences in handling factors in the denominator although it is not absolutely essential, as the same work can be done by means of the other scales.

The means of bringing all of the scales of cylinder B to the zero point through stops manually operated have been described and will be assumed to be applied during the calculations about to be described.

Scales 98, Figure 1, etched in to the glass plates cooperate with scales B′, B′; B, E; and F, F; in that, when a given quantity on one of these scales comes under the index line 97 this coincident point will be directly above the same quantity as read on scale 98. Hence scales 98 offer a ready means of determining where to look for a given quantity on the larger cylindrical scales. Pointers 81 offer a means of fixing such positions on scales 98, relieving the mind so that it can attend to looking for the quantity on the cylindrical scale.

A diagonal straight red line is drawn from B′ to B′ on chart 62. The red line from B′ to B′ forms a spiral when the chart 62 is bent into a cylinder. When index line 97 intercepts a given quantity on scale A, A, it also intercepts an imaginary line which is the trace of a plane passed through cylinder A, at right angles to its axis, and which intercepts the same quantity on scale B, B, said trace having a common junction with index line 97 and the red line. Thus when a product on scale A, A is under the index line 97 we have only to move pointer 84 out to the position which indicates the intersection of the red diagonal with the index line to mark the convolution upon which the same product will be found on scale B′, B′, when using this scale to solve the same problem with the greater accuracy which this larger scale affords.

To illustrate the use of the machine let us assume a problem for computation indicated as follows:

$$\frac{84.567 \times 4.306 \times 389.2}{67.4 \times 1.5678}$$

Applying the method of logarithms we find the resultant characteristic of this problem to be + 2 if the sum of the mantissas is neglected. Scale A, A, is set at zero and index wheel 88*a*, Figure 3 is set on plus two. The cylinders are then revolved toward the operator until factor 845 on scale A, A comes under the index line. Lever 26, Figure 12 is now depressed, braking cylinder A and releasing cylinder B which is brought to zero. Lever 26 is then released and the two cylinders being locked together magnetically they are turned until factor 430 in scale D. D. is under the index. The remaining factor or factors in the numerator are thus set up by the use of scale D. D. When we come to the denominator cylinder A is braked and cylinder B brought to zero as heretofore, but the factors in the denominator are set upon scale G. The numerical result may then be read from scale A. A. and the place to point it off ascertained from wheel 88*a*. We now have the answer to our problem with an accuracy equal to that obtained with an eighteen inch slide rule.

Even if the greater accuracy afforded by scales B′, B′, and E. E. is desired we proceed first as above. The answer thus obtained may be read and preserved to check against the more accurate answer about to be sought or it may not. The indicated characteristic of the result should, however, be kept in mind. In any case, before the final setting is disturbed pointer 84 should be run out to the point where the red diagonal crosses the index line. Now bring scale B′, B′, to factor 84567 roughly located by means of scale 98,

Brake cylinder A and bring cylinder B to zero. Release the brake and pick up factor 4306 on scale E. E. Treat factor 3892 in a like manner. Brake cylinder A and bring cylinder B to factor 674 of the denominator, then release the brake and turn both cylinders together until scale E. E. is at zero. Treat factor 15678 in like manner. The final highly accurate answer will now be found under the index line, on that convolution of scale B′, B′, indicated by pointer 84 although the intersection of the red line will in most cases have migrated along the index line to some point to right on left of pointer 84.

What is claimed as new is:—

1. In a calculating machine, a pair of cylindrical charts or tables mounted to rotate on alined axes, normally operative clutch mechanism for constraining the charts to rotate together, a brake in connection with one chart, and a common means for setting the brake and simultaneously releasing the clutch.

2. In a calculating machine, a pair of cylindrical charts or tables mounted to rotate on alined axes, normally operative clutch mechanism for constraining the charts to rotate together, a brake in connection with one chart, and a common means for setting the brake and simultaneously releasing the clutch, said common means resiliently held with the clutch engaged.

3. In a calculating machine, a pair of cylindrical charts or tables mounted to rotate on alined axes, normally operative clutch mechanism for constraining the charts to rotate together, a brake in connection with one chart, and a common means for setting the brake and simultaneously releasing the clutch, the clutch electrically controlled, and the clutch releasing means including a resilient switch arm, the cylinder having an antifriction ring for engagement by the arm.

4. In a calculating machine, a pair of cylindrical charts, a common shaft to which one of the charts is secured, the other being rotatable thereon, a normally operative mechanism for constraining the charts to rotate together, a common means to simultaneously release the mechanism and brake the first named chart, means to check the rotation of the other chart at a selected point, said means normally inoperative and manually controlled to operative position.

5. In a calculating machine, a pair of cylindrical charts, a common shaft to which one of the charts is secured, the other being rotatable thereon, a normally operative mechanism for constraining the charts to rotate together, a common means to simultaneously release the mechanism and brake the first named chart, means to check the rotation of the other chart at a selected point, and auxiliary means normally released from the chart for setting the same in a definite selected position.

6. In a calculating machine, a pair of cylindrical charts, a common shaft to which one of the charts is secured, the other being rotatable thereon, a normally operative mechanism for constraining the charts to rotate together, a common means to simultaneously release the mechanism and brake the first named chart, means to check the rotation of the other chart at a selected point, said means including a stop on the chart, a tongue adapted to engage with the stop, a support for the tongue normally spring held with the tongue out of engaging position, said tongue pivoted to the support to swing transverse to the axis of rotation of the chart at its free end, and adjustable means to limit the movement of the tongue.

7. In a calculating machine, a pair of cylindrical charts, a common shaft to which one of the charts is secured, the other being rotatable thereon, a normally operative mechanism for constraining the charts to rotate together, a common means to simultaneously release the mechanism and brake the first named chart, means to check the rotation of the other chart at a selected point, said means including a stop on the chart, a tongue adapted to engage with the stop, a support for the tongue normally spring held with the tongue out of engaging position, said tongue pivoted to the support to swing transverse to the axis of rotation of the chart at its free end, and adjustable means to limit the movement of the tongue, said stop axially movable and spring held in engaging position.

8. In a calculating machine, a cylindrical chart, a shaft on which the chart is mounted for rotation, a plate of transparent material arranged above and in front of the chart and having indications cooperating with data on the chart, and a universal adjustment for the plate, said adjustment including means to move the plate toward and from the chart with the planes of adjustment parallel.

9. In a calculating machine, a cylindrical chart, a shaft on which the chart is mounted for rotation, a plate of transparent material arranged above and in front of the chart and having indications cooperating with data on the chart, and a universal adjustment for the plate, said adjustment including means to move the plate toward and from the chart with the planes of adjustment parallel, said means comprising supports for the plate, a spring mounting for each support normally urging the support toward the shaft, and means for moving the support away from the shaft.

10. In a calculating machine, a cylindrical chart, a shaft on which the chart is mounted for rotation, a plate of transparent material arranged above and in front of the chart and having indications cooperating with data

on the chart, and a universal adjustment for the plate, said adjustment including means to move the plate toward and from the chart with the planes of adjustment parallel, said means comprising supports for the plate, a substantially U-shaped spring for each support, one arm fixed and the other secured to the support with the free ends of the arms toward the chart, said arms normally urged toward each other whereby to remove the support toward the shaft, and screws threaded through the supports and engaging the fixed arms to move the supports away from the shaft.

11. In a calculating machine, a cylindrical chart, a shaft on which the chart is mounted for rotation, a plate of transparent material arranged above and in front of the chart and having indications cooperating with data on the chart, and a universal adjustment for the plate, said adjustment including means to move the plate toward and from the chart with the planes of adjustment parallel, said means comprising supports for the plate, a substantially U-shaped spring for each support, one arm fixed and the other secured to the support with the free ends of the arms toward the chart, said arms normally urged toward each other whereby to move the support toward the shaft, and screws threaded through the supports and engaging the fixed arms to move the supports away from the shaft, U-shaped holders on the supports for receiving the edge of the plate, and screws having threaded engagement with the holders and engaging said edge.

12. In a calculating machine, a base, a cylindrical chart, a shaft supported by the base on which the chart is journaled for rotation, a plate of glass arranged above and in front of the chart and having indications cooperating with data on the chart, and an adjustment for the plate including supports resiliently connected with the base and normally urging the supports toward the shaft, and means for swinging the supports away from the shaft.

13. In a calculating machine, a cylindrical chart, a shaft on which the chart is journaled for rotation, a plate of transparent material arranged above and in front of the chart and having indications cooperating with data on the chart, and a universal adjustment for the plate, said adjustment including means to move the plate toward and from the chart with the planes of adjustment parallel, said means comprising supports for the plate, a substantially U-shaped spring for each support, one arm fixed and the other secured to the support, with the free ends of the arms toward the chart whereby the supports are mounted for bodily movement toward and from the axis of the chart, and means for fixing the plate in the holders.

14. In a calculating machine, a pair of cylindrical charts, a common shaft on which the charts are journaled for rotation, a magnetic between the adjacent ends of the charts, a circuit for the clutch including a source of energy, a switch for opening the circuit, said switch normally closed and arranged adjacent to the end of one chart, said chart having a brake ring positioned to be engaged by the switch when the clutch is released whereby to simultaneously brake the chart and release the clutch.

15. In a calculating machine, a pair of cylindrical charts, a common shaft on which the charts are journaled for rotation, a magnetic clutch between the adjacent ends of the charts, a circuit for the clutch including a source of energy, a normally closed switch for interrupting the circuit to release the clutch, a collecting ring at the outer end of one chart, a brush cooperating with the ring, the terminals of the circuit connected with the brush and ring respectively, the other chart having a brake ring, and the switch including an arm engaging the ring when the circuit is broken.

16. In a calculating machine, a shaft, a pair of cylindrical charts journaled on the shaft, a magnetic clutch between the charts, said clutch comprising a coil on one chart, an armature on the other, a circuit including a source of energy connected with the coil, a switch normally closed for interrupting the circuit, the armature having a limited axial movement with respect to its chart and constrained to rotate therewith.

17. In a calculating machine, a pair of axially alined charts, normally operative means for constraining the charts to rotate together, a common means to simultaneously release said means and to stop the operation of one chart and manually operated means to check the rotation of the other chart in either direction at a selected point.

18. In a calculating machine, a pair of axially alined charts, normally operative means for constraining the charts to rotate together, a common means to simultaneously release said means and to stop the rotation of one chart and manually operated means to check the rotation of the other chart in either direction at a selected point, said means including a stop on the chart, a tongue normally spring held out of position to engage the stop and manually moved into position, said tongue having a limited movement with the stop.

19. In a calculating machine, a chart journaled for rotation, manually operated means normally inoperative for checking the rotation of the chart at a selected point, and auxiliary means for centering the chart in the selected position.

20. In a calculating machine, a rotatable cylindrical chart carrying scales, one at the end of the chart and circumferentially there-

of, the other occupying the remainder of the chart with the indications arranged in a succession of circumferentially extending parallel columns, a fixed index line extending axially of the chart, a line extending diagonally of the chart from the beginning of the first scale to the end of the second, and a pointer having guided movement axially of the chart to indicate the intersection of the said line with the index line.

21. In a calculating machine, a rotatable cylindrical chart carrying slide rule calculations, one scale at the end of the chart and of a length equal to the circumference thereof, the other occupying the remainder of the chart with indications arranged in a succession of circumferentially extending parallel columns, a fixed transparent plate cooperating therewith and provided with an index line extending axially of the chart, a line on the chart extending diagonally thereof from the beginning of the first scale to the end of the second, and a relatively fixed pointer movable axially of the chart to indicate the intersection of the said line with the index line, to mark the column in which the product occurs.

22. In a calculating machine, a chart of selected dimensions in the form of a shell, and a support for the chart, comprising a cylinder having means whereby it may be contracted to fit within the shell and expanded to exactly fill the shell, the surface of said cylinder being intact and with no interstices between its segments when expanded.

23. In a calculating machine, a chart of selected dimensions in the form of a shell, and a support for the chart, comprising a cylinder having means whereby it may be contracted to fit within the shell and expanded to exactly fill the shell, and means for holding the cylinder expanded, the surface of said cylinder being intact and with no interstices between its segments when expanded.

Signed at Harrisburg, in the county of Dauphin and State of Pennsylvania, this 22nd day of July, A. D. 1927.

GEORGE H. MORSE.