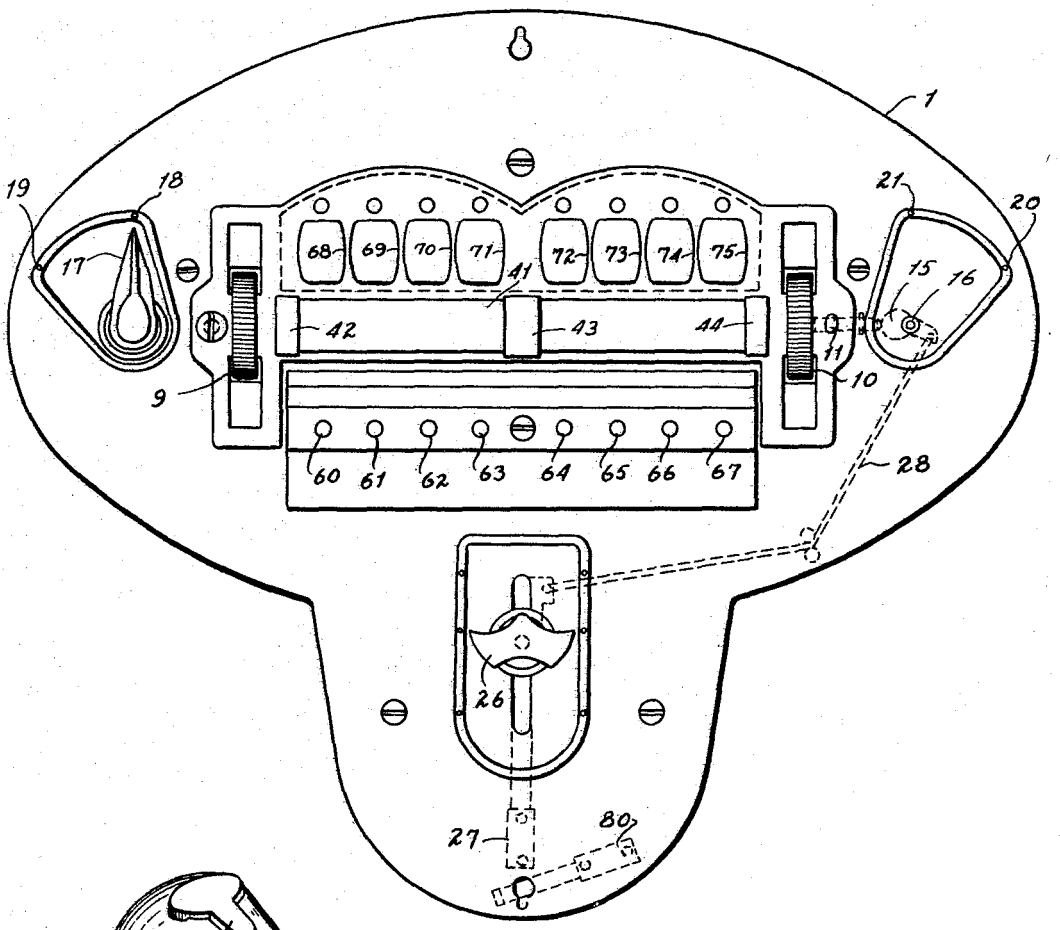
Sept. 20, 1955 A. SANDOR 2,718,357

LOGARITHMIC CALCULATORS

Filed April 2, 1951 3 Sheets-Sheet 1

FIG.1



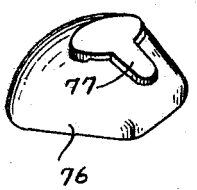
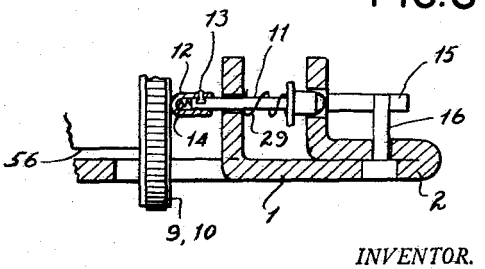


FIG.7

FIG.8



INVENTOR.
AURELIUS SANDOR

BY

ATTORNEY

Sept. 20, 1955 A. SANDOR 2,718,357

LOGARITHMIC CALCULATORS

Filed April 2, 1951 3 Sheets-Sheet 2

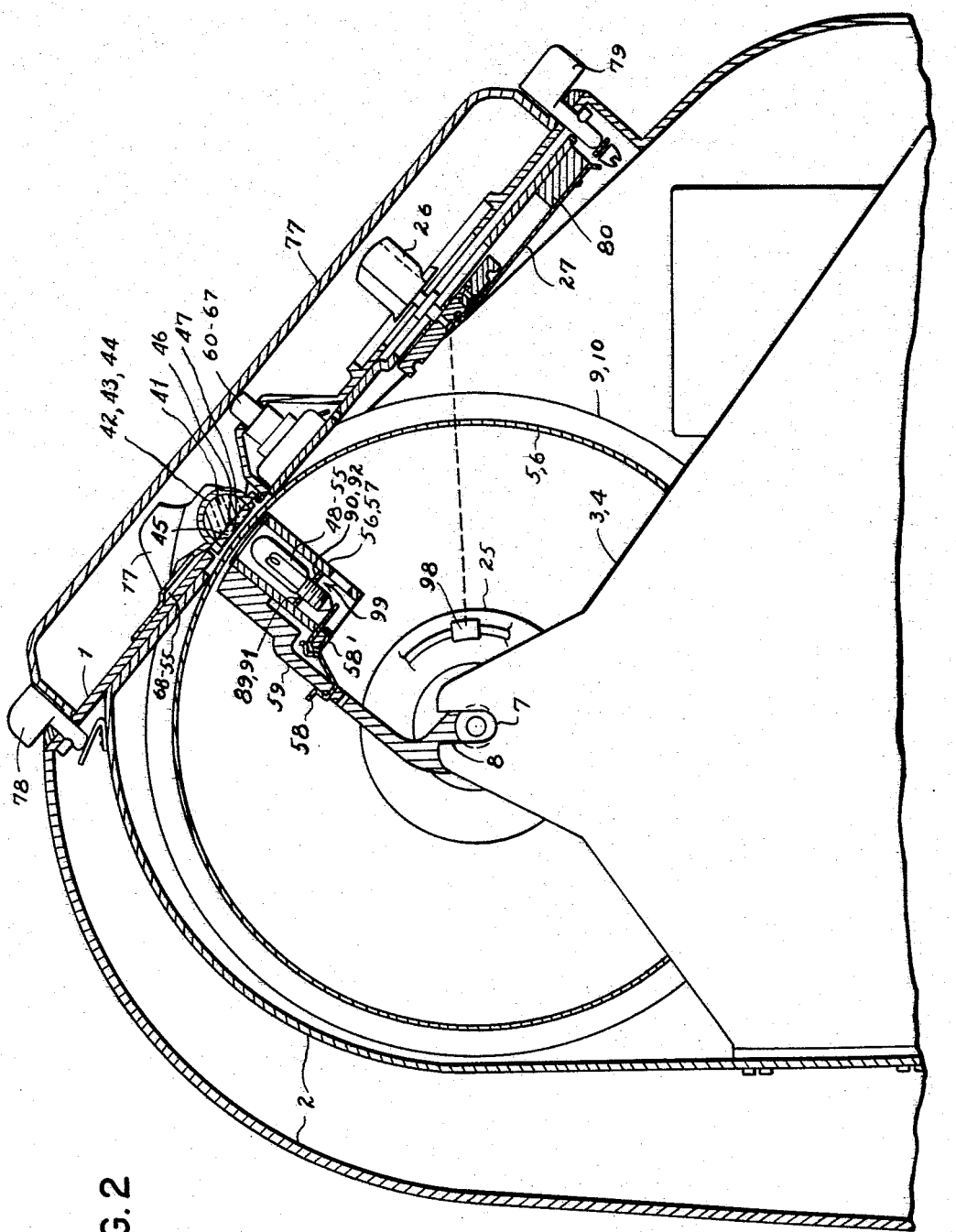


FIG. 2

INVENTOR.
AURELIUS SANDOR

BY Theodor Hafner

ATTORNEY

Sept. 20, 1955 A. SANDOR 2,718,357

LOGARITHMIC CALCULATORS

Filed April 2, 1951 3 Sheets-Sheet 3

FIG. 3

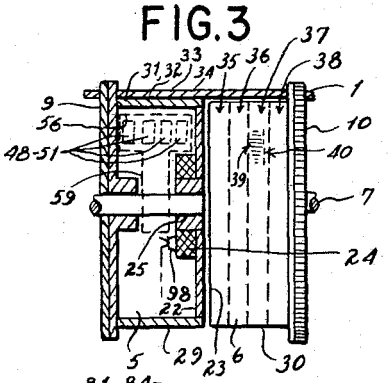


FIG. 4

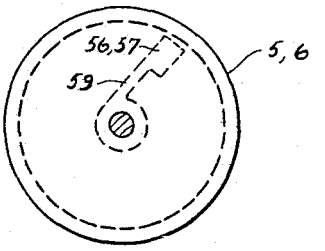


FIG. 5

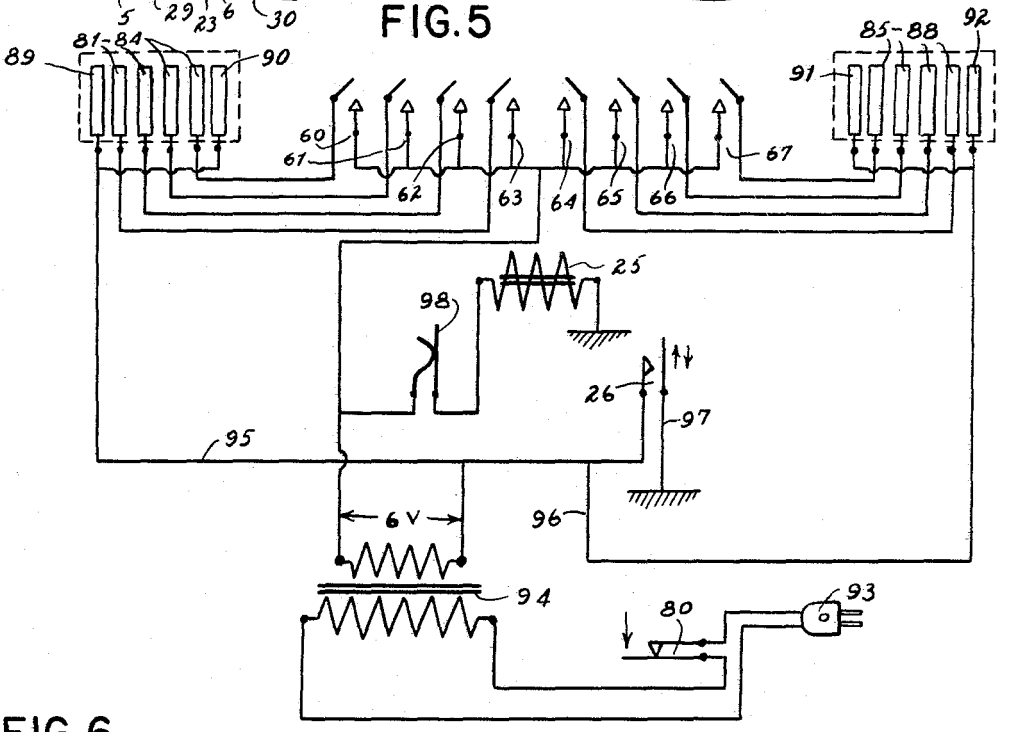
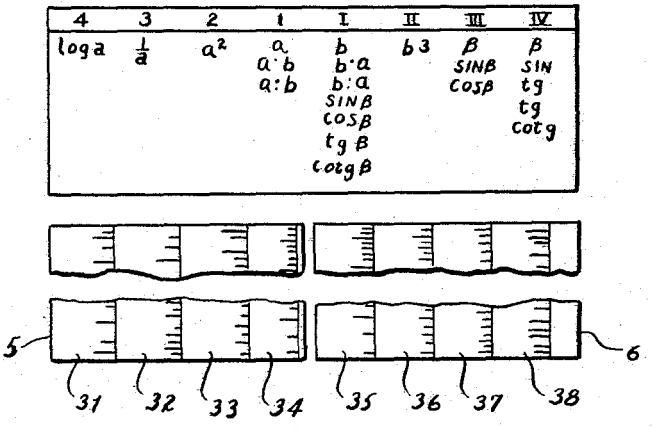


FIG. 6



INVENTOR.
AURELIUS SANDOR

BY

ATTORNEY

United States Patent Office

2,718,357

Patented Sept. 20, 1955

2,718,357

LOGARITHMIC CALCULATORS

Aurelius Sandor, New York, N. Y.

Application April 2, 1951, Serial No. 218,831

26 Claims. (Cl. 235—79.5)

This invention relates to calculators, especially of the logarithmic type.

One of the objects of this invention is a logarithmic type calculator permitting a great number of operations with the least amount of effort and a great amount of accuracy, not affected by wear and tear.

A more specific object of the invention is to reduce the size of the calculator to a minimum in spite of an increased accuracy.

A further object of the invention is a logarithmic type calculator in which the scales to be compared are arranged on cylinders, the translatory motion between the logarithmic scales—customary in calculators and used hitherto—being replaced by a rotary motion.

The rotary motion is also supplied to calculations which can be based on fixedly coordinated scale values having constant relation to each other.

These and other objects of the invention will be more fully apparent from the drawings annexed hereto, in which Figure 1 represents a top view of a calculator embodying certain features of the invention.

Figure 2 represents a corresponding side view, partly in cross section.

Figures 3 and 4 represent certain essential parts of the calculator, partly in cross section and in front and side views, respectively, at a reduced scale.

Figure 5 represents a circuit diagram for controlling operations in the course of a calculating process.

Figure 6 represents an example of number and type of operations permissible in accordance with the invention with a calculator of the type shown in Figures 1 and 2.

Figure 7 represents a perspective view at a greatly reduced scale of a complete calculator such as shown in Figures 1 and 2 in non-operative or closed condition.

Figure 8 represents on an enlarged scale a part of the adjusting mechanism of a calculator such as shown in Figures 1 and 2.

In Figures 1 and 2, 1 represents a top panel, preferably made of plastic, arranged at an angle with respect to a horizontal plane and attached to the metal (or plastic) case 2 supporting the entire calculator. Inside case 2, there is arranged horizontally spaced a pair of vertical metal (or plastic) brackets 3, 4 attached to case 2 which support therebetween a pair of coaxial cylinders or drums 5, 6 (Figures 1, 2 and 3), rotatably supported on axis 7, which in turn is fixedly supported in slots 8 provided in brackets 3, 4 at portions centrally located with respect to the axis of cylinders 5 and 6 so as to permit independent rotation of cylinders 5 and 6 about axis 7.

At the outer side walls of each of cylinders 5 and 6, there are attached driving wheels 9, 10, respectively (Figure 3), which are provided with peripheral grooves and which slidingly project from top panel 1 to permit independent rotation of cylinders 5, 6 under the thumb of an operator utilizing the machine.

Once one of the cylinders 5, 6 under control of wheels 9, 10 is placed into a desired angular position, it is possible to fix that particular cylinder into that predetermined

angular position by means of braking pins engaging the outer side walls of wheels 9, 10, as is shown at least for one of the cylinders in Figure 1 and in greater detail in Figure 8.

In Figures 1 and 8 the braking pin, engaging driving wheel 10 at a portion of its side wall lying beneath top panel 1, is indicated at 11. Pin 11 does not engage the side wall of driving wheel 10 directly, but through the intermediary of a cap 12 which is slidingly attached over the free end of pin 11 by means of a side pin 13 and which is pressed by pin 11 towards the side wall of wheel 10 against the force of a spring schematically indicated at 14 and arranged in the hollow space between cap 12 and the end of pin 11.

Pin 11 is operated by means of an eccentric cam 15 rotatable about shaft 16 under the control of a finger lever. There are two finger levers, on both sides of the machine, each operative on one of driving wheels 9, 10.

Figure 1 only shows finger lever 17 operative on driving wheel 9, while the corresponding finger lever operative through shaft 16, cam 15, and pin 11 upon driving wheel 10 is not shown for the sake of clarity.

The different on and off positions of the finger lever not shown and operating on shaft 16 are capable of assuming the corresponding on and off positions 20 and 21, respectively.

It is also possible and necessary in accordance with this invention to drive the two drums 5 and 6 simultaneously in a predeterminedly fixed relative angular position as determined by the two positions imparted to each of the cylinders 5, 6 by operation of one of the shaft cam and pin assemblies such as indicated at 11 through 16, respectively, under control of one of the levers, such as shown at 17.

This simultaneous movement of the two cylinders 5, 6 in accordance with the invention may be achieved electromagnetically, as schematically indicated in Figure 3, where the inner side walls of cylinders 5, 6 schematically indicated at 22, 23, are made of soft iron and at least one of these side walls, for example 22, is provided with an inner flange 24 which supports a magnetizing coil 25. Magnetization of coil 25 will magnetize disk 22, which in turn will attract disk 23 and thereby cause simultaneous movement of cylinders 5, 6 under control of one of the driving wheels 9, 10.

Magnetization of coil 25 is effected under control of a three-finger member schematically indicated in Figures 1 and 2 at 26, which may be moved upward and down to close and open switch spring 27 attached inside case 2. Magnetizing and demagnetizing movements of three-finger member 26 also operate under string 28 to rotate cam 15 about axis 16 and to disengage braking pin assembly 11 through 14 under control of spring 29 out of contact with driving wheel 10, thereby releasing cylinders 5, 6 for simultaneous rotation.

Now it is possible under control of one of the driving wheels 9, 10 to move the two cylinders simultaneously into any predetermined read-out position to effect a certain calculation.

Three-finger member 26 may assume the following three switching positions (Figure 1):

Position I: Base position: Drums 5, 6 free running; finger brakes 16, 17, independently adjustable.

Movement from I to III causing magnetic coupling of drums 5, 6 and automatic release of finger brakes 16, 17.

Movement from III to I leaving drums 5, 6 magnetically coupled while permitting fixation through any of finger brakes 16, 17.

Movement from II to I: Automatic release of magnetic drum coupling; in this position of switch 26 contact spring 27 is electrically disconnected from chassis 97 (Figure 5) by sliding from conducting contact piece A

(Figure 2) onto insulating piece B. Detenting of switch **26** is caused by contact spring **27** elastically engaging corresponding grooves in contact pieces A, B.

Instead of causing simultaneous movement of cylinders **5**, **6** by electromagnetic means, it is also possible without exceeding the scope of the invention to effect this movement by any appropriate mechanical coupling, otherwise well known in the art.

For similar reasons, it is also possible without exceeding the scope of the invention to replace the mechanical braking and releasing members, such as represented by an assembly such as shown at **11** through **16** and **28** by electromagnetic brakes of the type shown in Figure 3 operating on side walls such as shown at **22** through **25**. In this case, it will be necessary to provide magnetizable side walls for driving wheels **9**, **10** and to replace the braking pin arrangement **11** through **16** and release string **28** by a magnetic coil of the type indicated at **25**, the magnetization and demagnetization of which under control of a switch similar to that indicated at **27** will cause the desired instantaneous braking or releasing actions.

All this may be achieved within the framework of this invention.

In order to effect a great number of calculations, each of the cylinders **5**, **6** is provided on its periphery with a Celluloid or plastic strip or a glass coating, indicated, for example, on cylinder **5** at **29** in cross section, and for cylinder **6** at **30** in front view. In the example of Figure 3, each of the Celluloid strips or any other transparent cylinder coat has imprinted thereon four logarithmic scales, one on each of the parallel spaces schematically shown at **31**, **32**, **33**, **34**, and **35**, **36**, **37**, **38**, respectively. Each of these spaces, for example **35**, **36**, **37**, **38**, shows a logarithmic scale schematically indicated, for example, at **39**, and close thereto the numerical value for each line of scale **39**, such as schematically indicated at **40**.

All scales with the exception of goniometric or special mathematical functions start with 1 and end with 1, or 10, or 100, or 1000, as the case may be, whereby start and end exactly coincide as a result of the cylinder type surface development. This closed arrangement of scales is essential for facilitating calculation and based on the nature of the logarithmic system.

Reading will be effected through a cylindrical lens **41** mounted parallel to a common generatrix of cylinders **5**, **6** and attached to panel **1** by straps schematically indicated at **42**, **43**, **44**. Accuracy of reading is enhanced by mounting cylindrical lens **41** over a plane parallel glass or transparent plastic plate also extending substantially across a generatrix of the two cylinders as schematically indicated in Figure 2 at **45**.

Plate **45** is provided at opposite sides thereof with two hairlines schematically indicated at points **46**, **47**.

By reading the logarithmic scales on cylinder **5**, **6** in such a way that the two hairlines **46**, **47** are seen in coincidence or with a minimum of thicknes, parallax error will be reduced to a minimum.

Reading and identification of the particular scales will be still further facilitated by providing separate illuminations for each of the eight scales on two cylinders **5**, **6** in the form of eight lamps, four for each cylinder, schematically indicated in Figure 2 at **48** through **55** and in Figure 3 at **48** through **51**. Each of the quadruples **48** through **51** and **52** through **55** is supported within cylinders **5**, **6**, respectively, in such a manner as to illuminate each of the scale spaces schematically shown in Figure 3 at **31** through **38**, respectively. Each of these lamp quadruples is supported in a lamp housing schematically shown in Figure 3 in dotted lines at **56** and in Figure 2 in greater detail at **56**, **57** (one lamp housing being supported inside each of the cylinders **5**, **6**).

Each of the lamp housings **56**, **57** is supported easily removable as schematically indicated—for each housing—by a set of spring brackets shown at **58** in Figure 2 supported on arm **59**, which in turn is fixedly attached to axis **7**.

Each lamp is associated with a spring **58** on a bracket **58'** so that each lamp house lies on four springs. These springs, Fig. 5, **81** to **84**, and **85** to **88**, respectively, constitute mechanical supports as well as electrical contacts for the lamps. The two side portions (**89**, **90**, and **91**, **92** respectively, in Figure 5) of panel **99** provide each lamp house with a second electric pole.

In order still further to distinguish between the readings on the different scales, it is possible, without exceeding the scope of the invention, to provide differently colored light filters in the path of the light from lamps **48** through **55**. Such filters may be in the form of colored Celluloid strips attached to the back of plane parallel transparent plate **45** or inserted between plate **45** and lens **41**. Alternatively, the different lamps **48** through **55**, or the corresponding portions of plate **45** and lens **41** may be differently colored.

Each of lamps **48** through **55** is operated by push button switches schematically indicated in Figures 1 and 2 at **60** through **67**, respectively to illuminate independently from each other any one or more of the eight scales on cylinders **5**, **6**.

There are further provided on top plate **1** a number of windows, schematically indicated in Figure 1 at **68** through **75**, to indicate the type, number, or other characteristic of the scale represented on the corresponding space of cylinders **5**, **6**.

Figure 7 shows on much reduced scale the entire machine housing at **76** provided with a cover **77** fitting over top panel **1** and closed by bolts schematically indicated, for example, in Figure 2, at **78**, **79**, respectively.

Closing of cover **77** may be used to automatically disconnect the entire machine from the current supply over a switch schematically indicated at **80**.

The operation of the machine will be explained by means of the circuit diagram of Figure 5.

After cover **77** has been removed from machine housing **2**, the two scales on the two cylinders which are to be added, subtracted, or otherwise compared for a certain calculation operation are illuminated by pressing predetermined ones of switches **60** through **67** to illuminate corresponding lamps **48** through **55**.

In the circuit diagram of Figure 5, the corresponding switches are also designated by **60** through **67**, respectively, while the corresponding lamps are connected by means of separated contact brackets **58**, Figure 2, and terminals **81** through **88** in Figure 5 and ground or chassis terminals **89** through **92** of the same constructional shape, respectively.

The opening of cover **77** also closes automatically main switch **80** (Figures 1, 2, 5) since key-bolt **79** is lifted and so the elastic tension of contact spring **80** retained before by **79** is now released which presses it against the coordinated point contact. So the main plug **93** is connected with the primary circuit of the transformer **94** which transforms the 110 or 220 volt system voltage to a lower voltage of say, six volts, required for safer operation of lamps, magnetizing coil, and any other electrical equipment in the machine.

For magnetizing coil **25** (Figures 2, 3, 5) one of the secondary terminals of transformer **94** (Figures 2, 5) is connected over line **95**, three-finger switch **27** (Figures 1, 2, 5) to ground (chassis), and is also steadily connected over lines **95** and **96**, respectively, to the common lamp panel **99** in Figure 2 over the contact springs **89**, **90** and **91**, **92**, respectively. Different terminals (**58** in Figure 2) **81** through **84** and **85** through **88**, respectively, of lamps **48** through **55** shown in Figure 2 are connected to the other terminal of the transformer **94** over the push-button switches **60** through **67** (Figures 1, 2, 5).

Switch **26** connects the terminal of the transformer **94** as mentioned before over the contact spring **27** (Figures

1, 2) to ground or chassis of the machine such as case or housing **2**.

The apparatus may be either directly connected to an A. C. or D. C. light system or operated on battery. In the latter two cases, transformer **94** is replaced by suitable ohmic resistors to reduce the line voltage.

After having illuminated the desired scales, the operator adjusts one of the drums **5**, **6**, into a predetermined angular position while leaving the other drum in its rest position, for example, on "1," the latter drum having been fixed in its arbitrary position (here, i. e., on "1") through the corresponding finger member such as **17** and by operation of the associated pin cam assembly **11** through **16**. After having fixed the first drum through the corresponding finger member such as **17** and by operation of the associated pin cam assembly **11** through **16**, the three-finger member **26** and switch **27** are operated first to magnetize the magnetic coil (schematically shown, for example, in Figure 3 at **25** and in Figure 5 also at **25**) over collector ring contact **98** attached to coil **25** by pulling down switch **26** from position "I" to "III." Immediately thereafter and practically simultaneously, by operation of a string such as shown at **28**, the associated pin cam assemblies of the type shown at **11** through **16** are released. Thus it becomes possible to turn both cylinders **5**, **6** under control of one of the driving wheels **9**, **10**, simultaneously into a desired reading position in which it is possible to read the end result from the corresponding scale, while switch **26** may be pulled from position "III" to "II" so that in spite of maintaining the existing magnetic coupling drums **5**, **6**, thus coupled may be fixed by means of one of the finger brakes **17** through operation of parts **11** to **16**. This insures stable reading of end values. Further pulling of switch **26** from position "II" to "I" causes demagnetization of coil **25** by breaking electric contact for the magnetizing circuit on spring **27**, so that drums **5**, **6** will again become independent from each other. Similar operations may, of course, be started with a rotation of the other one of drums **5**, **6**. If the calculation takes place only between two or more scales of the same drum, then just the finger brake **16** or **17** of drum **5** or **6** is caused to fix the drum in the adjusting and reading position under the reading-out hair lines **46**, **47** in Figure 2. (There is no magnetic coupling.) Decoupling is caused by switching the same finger lever **16** or **17** (Figure 1) from position **18** over to **19** or from **21** to **20**, respectively.

On the assumption that log a; c; b are given and that the following term is sought:

$$\frac{a.\sqrt[3]{c.}\ \cos\beta}{tg\beta}$$

the following operations will take place.

First the basic position is adjusted for any calculation: Left and right finger knobs **17** in positions **19** and **20** respectively; three-finger switch **26** in position I (see Fig. 1).

Illuminating button **60** is pushed corresponding to the log a-scale located opposite the indicating window **68**; also button **63** coordinated with the a-scale below window **71**, also further button **61** belonging to the b-scale below window **72**, button **65** belonging to the b^3-scale below window **73**, as well as button **66** belonging to the first β-scale and push button **67** coordinated with the second β-scale below window **75**. In this way, the scales of all mathematical functions involved in the problem are brought into prominence by differently colored illuminations.

Drum **5** is tuned by using the left hand thumb and turning drum flange **9** until the scale value of the given log a under window **68** coincides with the orthogonal projection of the double index hair lines used below read-out lens **41**; then the left index finger turns knob **17** into position **18** which brakes drum **5**; thumb is lifted. The right hand is used to adjust the scale value "1" on the b-scale of drum **6** to coincide with the index hair lines under window **72** by turning drum flange **10**; then drum **6** is fixed by turning the right hand knob **17** (shown only on left side of panel in Fig. 1) to the braking position **21**.

Three-finger knob or switch **26** is pulled into position III locking both drums **5**, **6** together and releasing automatically by string mechanism **28** the drum brakes (knobs **17**). Knob **26** is then brought into position II giving the drum brake detents free so that they could be readjusted, if desired; both drums still remaining locked together.

Then flange **9** is turned until the scale value of the given figure c on the b^3 scale under window **73** coincides with the common index hair lines; knob **17** is then turned into braking position **18** and the partial result

$$a.\sqrt[3]{c}$$

appears on the a-scale under window **71**.

Now, knob **26** is pushed back into base position I unlocking drums **5**, **6**, "1" of the b-scale under window **72** is turned by flange **10** below the index lines and the right knob **17** (not shown in Fig. 1) is turned into position **21** blocking drum **6**. Knob **26** is pulled into position III, then from here to II, locking both drums and releasing the drum brake detents. The locked drums are turned until the scale value for the given angle β coincides under window **74** with the index lines; the freed left side brake knob **17** is now thrown into fixing position **18**. The partial result

$$a.\sqrt[3]{c.}\ \cos\beta$$

can be read out on the a-scale under window **71**.

Knob **26** is drawn back to position I unlocking the drums. Then β is adjusted under window **75** by throwing right hand knob **17** (shown only on left side in Fig. 1) into position **21** braking drum **6**. Knob **26** is pulled to III, then back to II. The locked drums are turned by thumb driven flange **9** or **10** until "1" of the b-scale under window **72** coincides with the index lines. Either one of the brake knobs **17** is then operated (position **18** or **21**) and the fixedly adjusted end result

$$\frac{a.\sqrt[3]{c.}\ \cos\beta}{tg\beta}$$

can be read out on the a-scale under window **71**.

Then again all six illuminating buttons **60**, **63**, **64**, **65**, **66**, **67** are pushed to switch off the selective lights.

Each section of the different scales, as apparent from the associated read-out window can be caused to differ in color from the other with the description window arranged thereabove showing a characteristic number or sign.

Thus over each read-out window at any time, the corresponding operation indication is identifiable (**68** through **75** in Figure 1) and the basic adjustment of a calculating operation—i. e. making visible the corresponding scale—is caused by means of a push-button switch arranged immediately below the corresponding scale.

In place of the the push button switches for the lamps, pull buttons or pull levers may be used for the operation of mechanical screen plates to cover or free the different read-out windows for desired calculation operations. It is not necessary to look sidewise for head numbers and to remember for a long time intermediate values as in the operation of a slide rule.

As a result of the illumination of the scales from below, calculations may be made under any light conditions, for example, during experiments in a dark room, etc.

Scales and numbers can be applied to these drums by printing or if necessary photographically; there is no wear and tear by touching.

The scale bands based on logarithmic relationship are closed in themselves so that beginning and end of the division—i. e., "1" and "10" or "100" or "1000" are exactly in coincidence. It is possible, therefore, to operate at multiplications and divisions only with a single base line.

According to the invention there also is considerable

gain in linear extension of the scales because the scales are disposed in space (on cylinder covers), i. e. a diameter of 17 cm. against a linear extension of 100 cm. of an equivalent slide rule, assuming an enlargement by two by the read-out lens.

The accuracy can arbitrarily be changed by changing the dimensions of the scale drum (diameter), which also results in changing the apparatus dimensions.

The invention may permit, for example, twenty calculating operations (direct and inverse) (see Figure 6), as well as all raisings of the power and taking of roots. In principle, all operations may be executed which may be solved with logarithmic type scales and with those which can be based on fixedly coordinated scale values; that means: scales are situated only on one or on the other drum cover having constant and fixed value relations to each other.

Scale adjustments according to the invention involving thumb rotation in accordance with the invention are practically frictionless. The running seats of the apparatus are simple and are loosely situated on the drum axis.

In accordance with the invention, any type of braking may be applied, whether mechanical or electromagnetic. In the embodiments of the invention shown, the mechanical drum brakes can be operated by right and left index fingers, respectively. There is no necessity to remove the hands from the driving wheels. This facilitates fixation at predetermined scale values.

Illumination as well as all other electric apparatus functions are automatically switched off as soon as the cover is put over the apparatus, which also serves as protection against dust.

Identification of different scales may be facilitated in many ways without exceeding the scope of the invention. Lamps may be colored and scale bands may be colorless or transparent; or color filters may be arranged in front of colorless lamps and scale bands may also be colorless and transparent; in another alternative scale bands may be colored and lamps be colorless.

The apparatus in accordance with the invention may be used without electrical connection for daylight operation, for example by means of using a reflecting mirror, as is well known in microscopy, which takes the light from the outside. In this case, the magnetic coupling between the two drums may be replaced by a mechanical coupling, without exceeding the scope of the invention.

Non-transparent scale bands may be used, for example paper, and illumination may be applied from the top or through a daylight lens permitting examination from above.

Instead of the finger operated pin brakes, weak spring feelers may be used engaging the periphery of each drum, slightly releasing under rotation of the drum and becoming automatically semi-fixed by the elastic spring forces at predetermined positions of the drums by sliding into small indentations on the drum periphery. These indentations would be placed properly to obtain a slight stoppage of the drums at reading positions equal to the basic scale lines of the actual logarithmic scales which serve for multiplications and divisions (scale line "1" or "10" or "100" or "1,000," which are all identical in the cylindric scale arrangement). Thus for these predetermined scale positions an easy local fixation may be had which can be again superseded by rotation of the drum, all this without exceeding the scope of the invention.

I claim:

1. In a calculating apparatus at least two concentric scale bearing drums capable of moving singly, independent mechanical braking means for each of said drums, means for coupling said drums for simultaneous movement, and means under control of said coupling means for inactivating said braking means immediately after coupling of said drums is effected, and means under control of said coupling means for reactivating said braking means while said drums are coupled for simultaneous rotation.

2. Apparatus according to claim 1 comprising common means for controlling said coupling and inactivating means capable of assuming several positions including one position in which said coupling and inactivating means are inoperative permitting independent movement and independent stoppage of any drum and stoppage of both drums; a second position permitting common movement and stoppage of both drums; and a third position permitting common movement of both drums and no stoppage of either drum.

3. Apparatus according to claim 1 comprising an electomagnetic coupling between said drums and a three-position switch for operating said coupling, said inactivating means being under control of said three-position switch to inactivate said braking means immediately after coupling of said drums is effected to lock said braking means in one position and to release out of frictional engagement in a subsequent other position in which positions said electro-magnetic coupling is operated.

4. Apparatus according to claim 1 comprising for each drum a braking member under manual control frictionally engaging each of the drums to stop each of said drums independently from the other at predetermined angles of position.

5. Apparatus according to claim 4 comprising detents for said braking members and means under control of said drum coupling for locking and lifting the detents of said braking members out of frictional engagement in two subsequent predetermined positions of said drum coupling means.

6. Apparatus according to claim 5 wherein said detent lifting and locking means are flexibly coupled to said drum coupling means.

7. Apparatus according to claim 5 wherein said inactivating, locking and detent lifting means include a flexible string coupled to said switch to inactivate, to lock and to free subsequently said braking means out of frictional engagement in two subsequent and predetermined positions of said switch.

8. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member; the manual stopping members being disposed at both sides of the centrally located manual coupling member.

9. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member; said braking members having liftable detents, the manual braking members being disposed at both sides of the centrally located manual coupling member; and wherein each of the manual braking members has two angular positions one in which the associated drum is stopped and the other in which the associated drum is permitted to rotate; said manual coupling member having three positions of sliding motion including one position in which under control of said manual coupling member said manual braking members are locked in a position permitting simultaneous rotation of both drums; and another subsequent position of the manual coupling members in which the detents of said one or of both manual braking members are lifted while said drums are coupled for simultaneous rotation.

10. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member; said braking members having liftable detents; the manual braking members being disposed at both sides of the centrally located manual coupling member, and wherein each of the manual braking members has two angular positions one in which the associated drum is stopped and the other in which the associated drum is permitted to rotate; said manual coupling member having three positions of sliding motion including one position in which said drums are coupled to each other and in which under control of said manual

coupling member said manual braking members are fixed in a position permitting simultaneous rotation of both drums; and another subsequent position in which said drums are coupled together and in which under control of said manual coupling member the detents of said manual braking members are lifted ready to be operated to stop the simultaneous rotation of both drums.

11. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member, the manual braking members being disposed at both sides of the centrally located manual coupling member; all said three manual members being arranged substantially in a common plane.

12. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member, said manual braking members being disposed symmetrically at both sides of the centrally located manual coupling member, and all said manual members being arranged substantially in a common plane inclined with respect to the horizontal plane.

13. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member; the manual braking members being disposed on both sides of said two drums; the centrally located manual coupling member being disposed along the space separating the two drums and symmetrically with respect to the manual braking members.

14. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member; the manual stopping members being disposed at both sides of the centrally located manual coupling member; further comprising for each drum a manual member coupled to said drum for driving said drum, said manual driving member for each drum being disposed close to the associated manual braking member.

15. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member; the manual braking members being disposed at both sides of the centrally located manual coupling member; further comprising for each drum a manual member coupled to said drum for driving said drum, and disposed close to the associated manual braking member, all said manual stopping, driving and coupling members being disposed substantially in a common plane.

16. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member; the manual braking members being disposed at both sides of the centrally located manual coupling member; further comprising for each drum a manual member coupled to said drum for driving said drum, and disposed close to the associated manual braking member, all said manual braking, driving and coupling members being disposed substantially in a common plane arranged at an angle with respect to the horizontal plane of less than 90°.

17. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member, the manual braking members being disposed at both sides of the centrally located manual coupling member, and wherein each of said drums has an outer rim projecting therefrom to permit said drum to be manually driven.

18. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member, the manual braking members being disposed at both sides of the centrally located manual coupling member, and wherein each of said drums has an outer rim projecting therefrom to permit said drum to be thumb driven, said driving rims being arranged to project at a point adjacent the corresponding manual braking member to permit the latter to be operated by the index finger.

19. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member, the manual braking members being disposed at both sides of the centrally located manual coupling member, and wherein each of said drums has an outer rim projecting therefrom to permit said drum to be thumb driven, said driving rims being arranged to project at a point adjacent the corresponding manual braking member to permit the latter to be operated by the index finger, all said driving, braking and coupling members being arranged substantially in a common plane.

20. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member, the manual braking members being disposed at both sides of the centrally located manual coupling member, comprising an array of read out means corresponding to the number of scales on said drums and disposed along a line connecting said braking members.

21. Apparatus according to claim 1 wherein each of said stopping means and said coupling means comprises a manually operable member, the manual stopping members being disposed at both sides of the centrally located manual coupling member, comprising an array of read out means corresponding to the number of scales on said drum and disposed along a line connecting said stopping members, said read out means including a number of means for illuminating predetermined peripheral portions of each of said scales substantially independently from each other.

22. Apparatus according to claim 1 wherein each of said stopping means and said coupling means comprises a manually operable member, the manual stopping members being disposed at both sides of the centrally located manual coupling member, comprising an array of read out means corresponding to the number of scales on said drums and disposed along a line connecting said stopping members, said read out means including a number of means for illuminating predetermined peripheral portions of each of said scales substantially independently from each other, and in different colors.

23. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member, the mnuaal braking members being disposed at both sides of the centrally located manual coupling member, comprising an array of read out means corresponding to the number of scales on said drums and disposed along a line connecting said braking members, said read out means including a number of means for illuminating predetermined peripheral portons of each of said scales substantially independently from each other, and a pair of hair lines extending parallel to said array over said scale portions to permit reading with reduced parallax.

24. Apparatus according to claim 1 wherein each of said braking means and said coupling means comprises a manually operable member, the manual braking members being disposed at both sides of the centrally located manual coupling member, comprising an array of read out means corresponding to the number of scales on said drums and arranged along a line connecting said braking members, said read out means including a number of means for illuminating predetermined peripheral portions of each of said scales substantially independently from each other; all said manual locking and coupling members being disposed substantially in a common plane with said read out means; said coupling member being coupled to said braking members by a flexible string arranged substantially below said plane to prevent said braking members from braking the drums in a predetermined position of said coupling member.

25. Apparatus according to claim 1 comprising spring means for urging each of said braking members into braking position substantially independently from each other; said locking means being operative under control of said

coupling means in a predetermined position thereof to oppose the force of said spring means.

26. Apparatus according to claim 1 comprising spring means for urging said braking means into braking position; said locking means being operative under control of an elastic spring connected to said coupling means in a predetermined position thereof to oppose the force of said spring means.

References Cited in the file of this patent

UNITED STATES PATENTS

93,849	Wright	Aug. 17, 1869
1,306,379	Horine	June 10, 1919
1,400,363	Kennedy et al.	Dec. 13, 1921
1,597,483	Ritow	Aug. 24, 1926
1,802,440	Morse	Apr. 28, 1931
1,982,722	Zimmer	Dec. 4, 1934
2,172,802	Marshall et al.	Sept. 12, 1939
2,259,786	Sutton	Oct. 21, 1941
2,285,774	Horner	June 9, 1942
2,289,257	Fiala	July 7, 1942
2,301,591	Sutton	Nov. 10, 1942
2,358,479	Sassen	Sept. 19, 1944
2,375,878	Willens	May 15, 1945
2,407,106	Shelly	Sept. 3, 1946
2,486,945	Herrington	Nov. 1, 1949
2,526,408	Posson	Oct. 17, 1950
2,572,811	Jullien	Oct. 23, 1951

FOREIGN PATENTS

285,519	Switzerland	Jan. 5, 1953