United States Patent [19]

Schwarz et al.

[11] **3,754,702**

[45] **Aug. 28, 1973**

[54] **CALCULATING DEVICE**

[75] Inventors: **Walter K. Schwarz; David J. Schlink,** both of Peoria, Ill.

[73] Assignee: **The Peoria Journal Star, Inc.,** Peoria, Ill.

[22] Filed: **July 13, 1972**

[21] Appl. No.: **271,629**

[52] **U.S. Cl.** ..... **235/71 A,** 235/64.3, 235/89 R, 235/86

[51] **Int. Cl.** **G06g 1/04,** G06c 19/02, G06g 1/12

[58] **Field of Search** ..... 235/71 A, 70 A, 89 R, 235/86, 70 R, 64.3

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Primary Examiner—Stephen J. Tomsky
Attorney—Donald G. Leavitt et al.

[57] **ABSTRACT**

A calculating device for making mathematical calculations comprises a body including first and second panels joined along an edge for folding them from an open to a closed position with the second panel overlaying the face of the first. A belt is carried by the first panel and is movable with respect thereto substantially parallel to the joining edge. There is a mathematical scale on the belt extending longitudinally thereof and a stationary mathematical scale located on the outside face of the second panel so as to be parallel and adjacent the belt mathematical scale when the panels are in the closed position. The stationary scale has the same unit dimension as the belt scale and includes an identity operator index. A computatin based on the relationship $z=f(x,y)$ may be made by setting x_1 on the belt mathematical scale adjacent the identity operator on the stationary mathematical scale and reading z_1 on the belt scale adjacent y_1 on the stationary scale.

13 Claims, 14 Drawing Figures

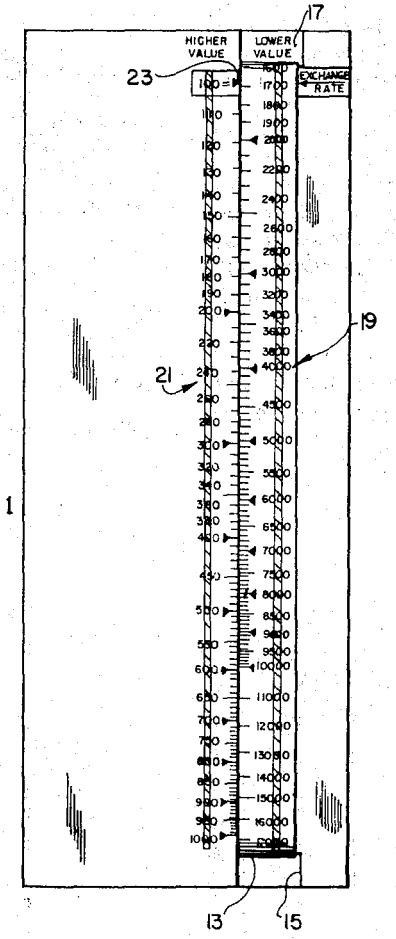


FIG. 3

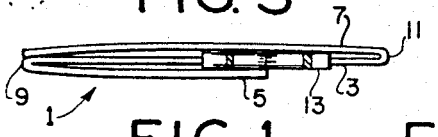


FIG. 1

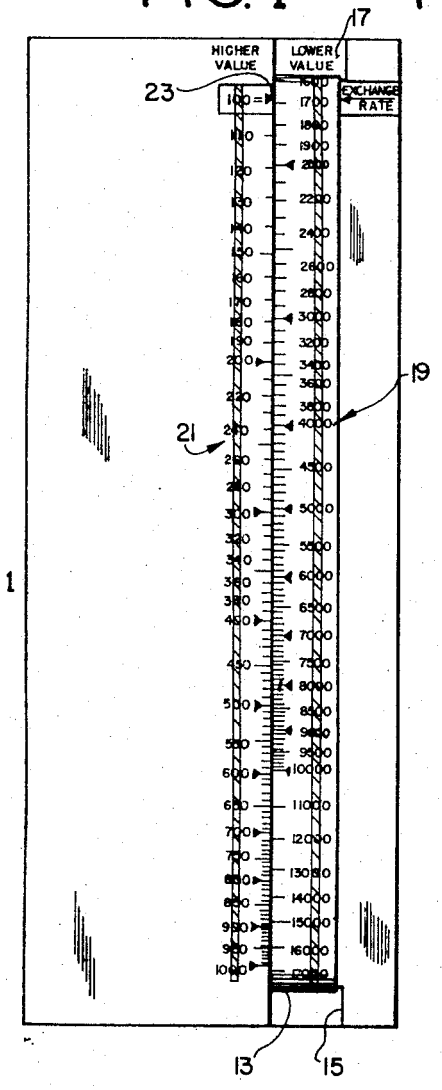


FIG. 5

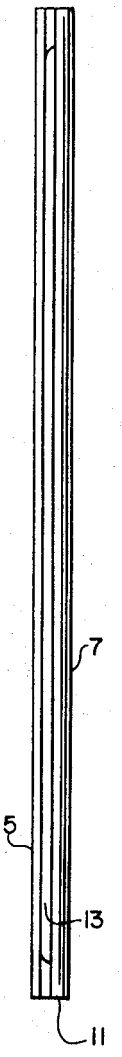


FIG. 4

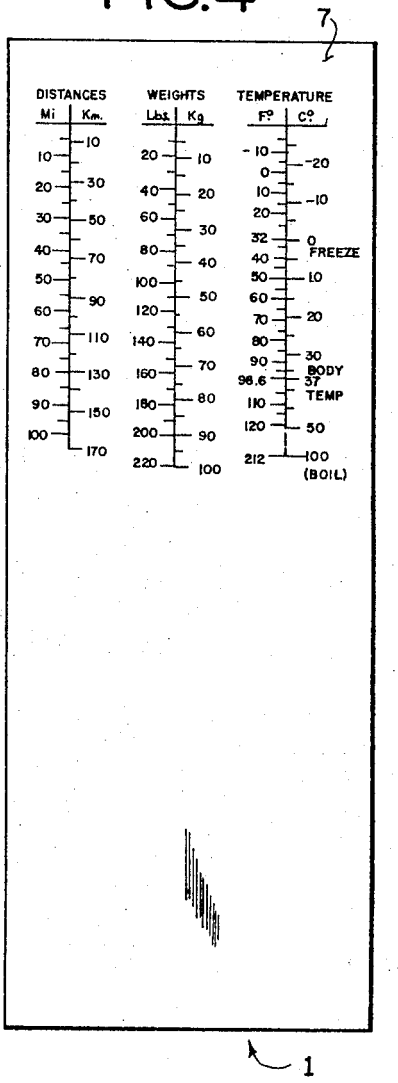


FIG. 6

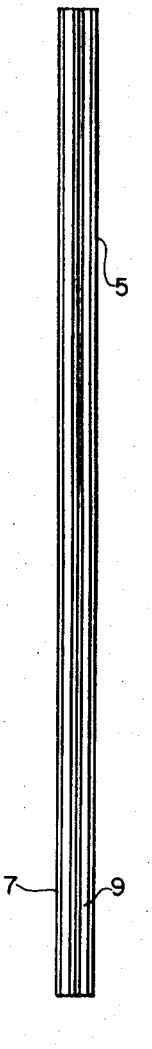
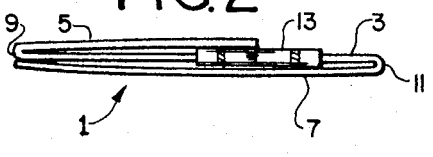


FIG. 2



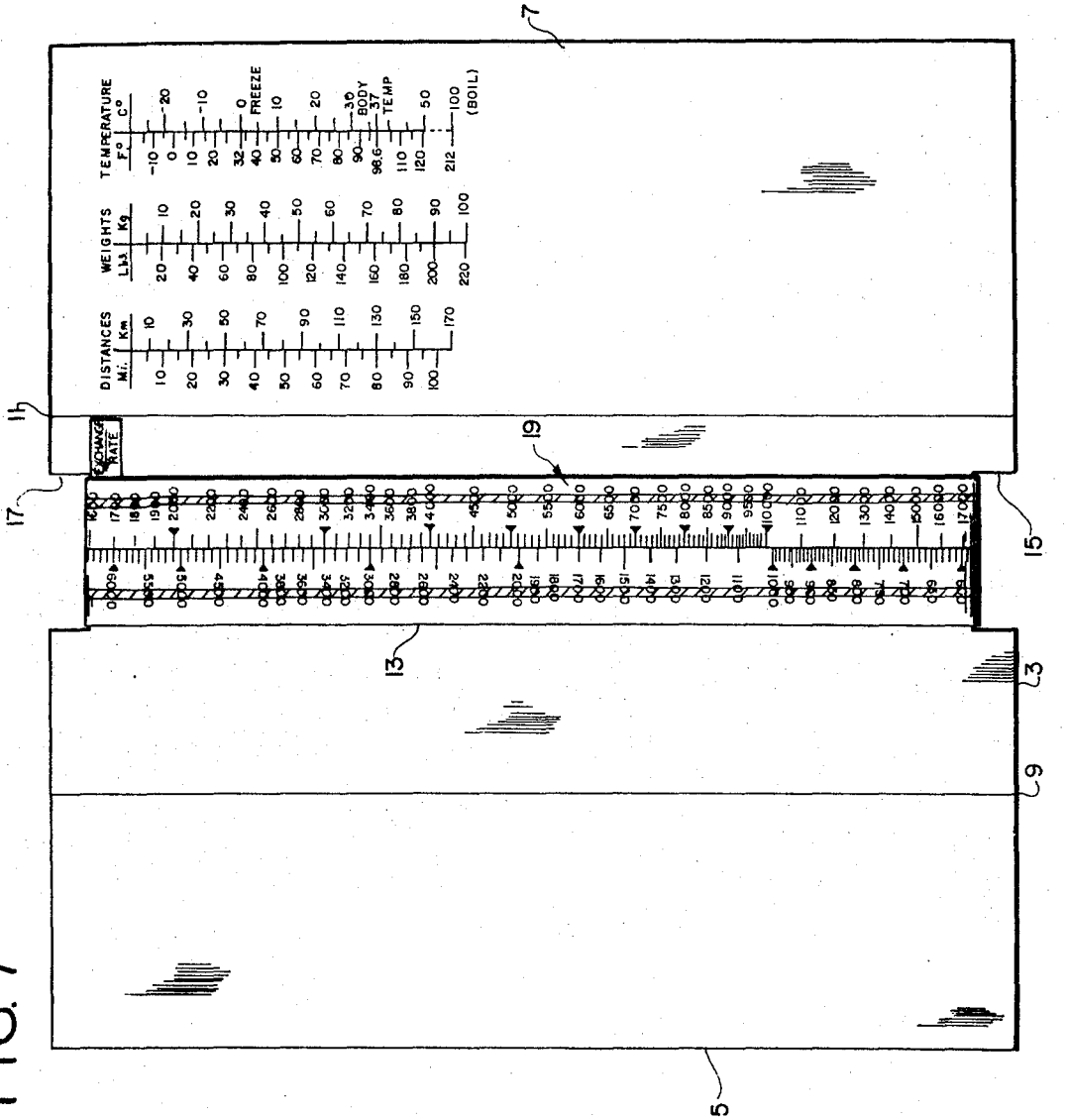

7
TEMPERATURE C°
F°
FREEZE
BODY TEMP
(BOIL)
WEIGHTS Kg
Lbs
DISTANCES Km
Mi.
EXCHANGE RATE
11
17
19
15
13
3
9
5

FIG. 7

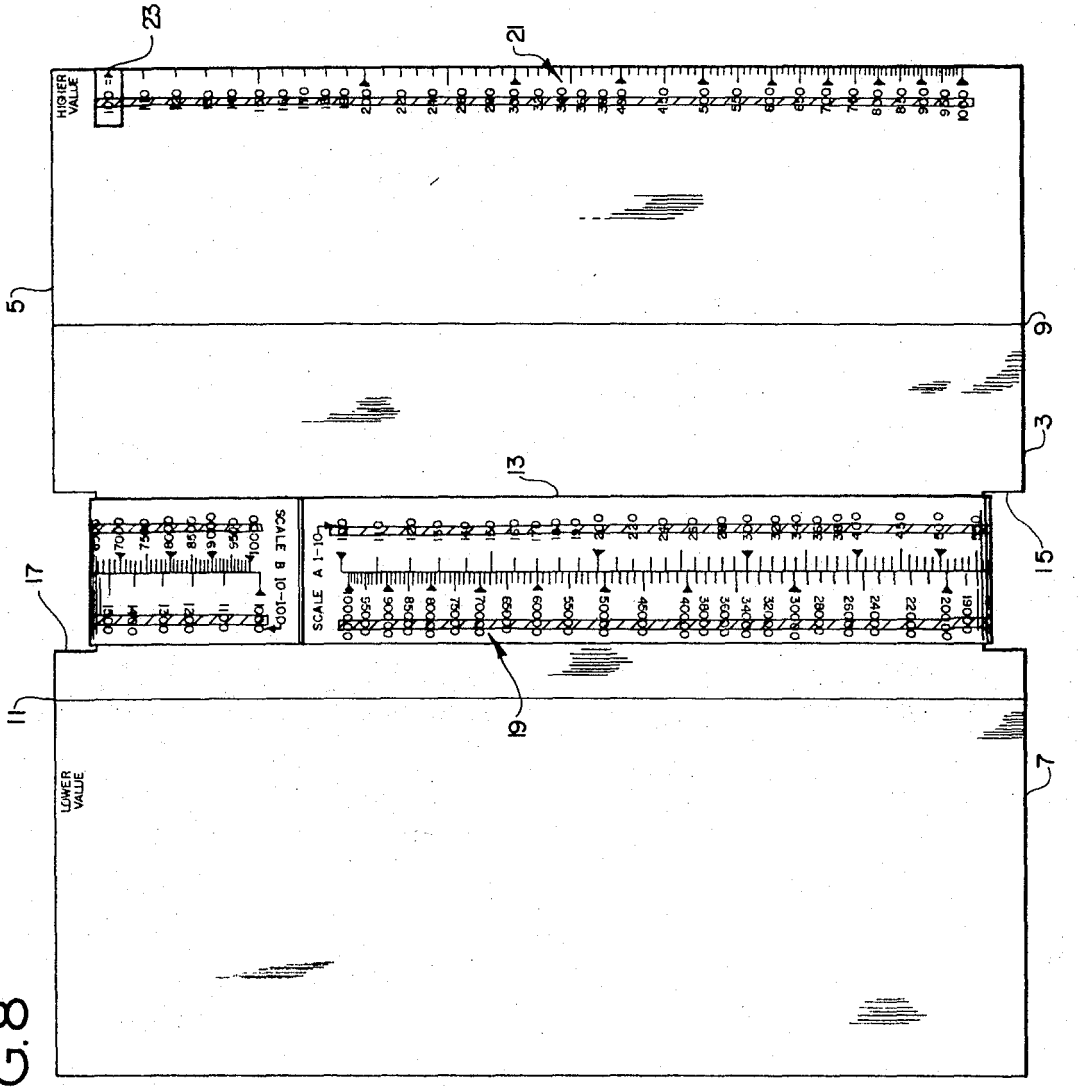

23
21
HIGHER VALUE
5
6
3
13
SCALE B 10-100
SCALE A 1-10
15
17
19
11
LOWER VALUE
7

FIG. 8

FIG. 9

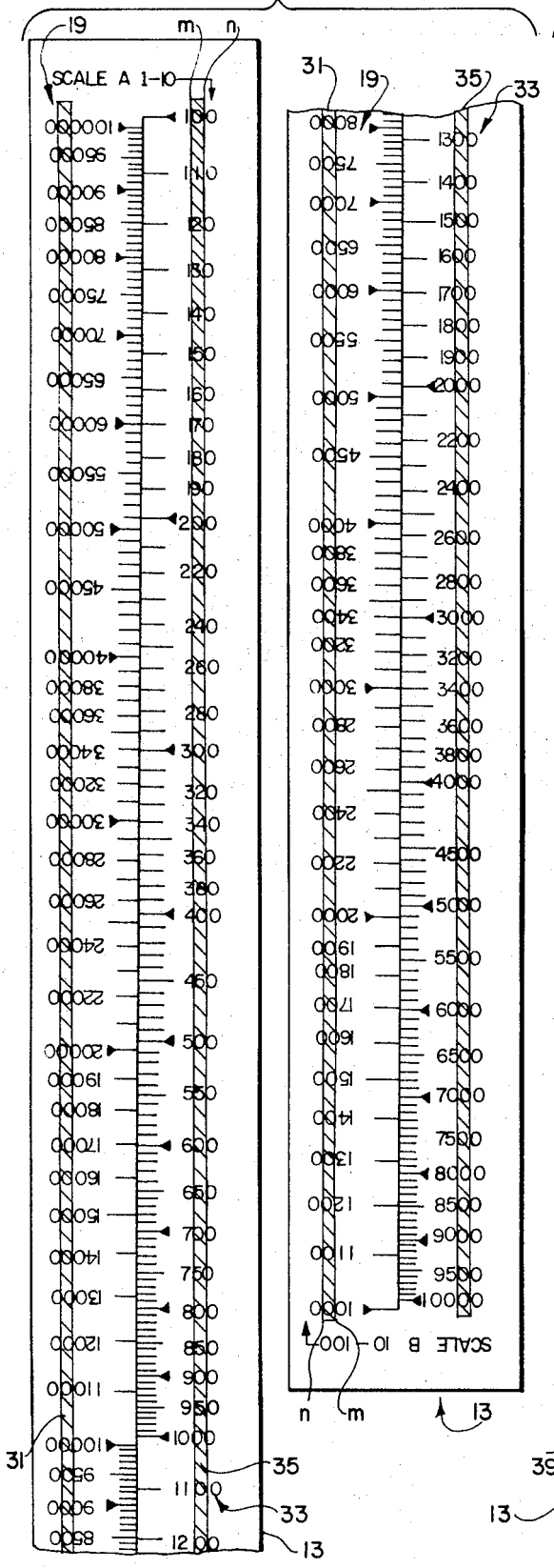

19
m
n
SCALE A 1-10
31
19
35
33
SCALE B 10-100
n
m
13
31
35
33
13

FIG. 10

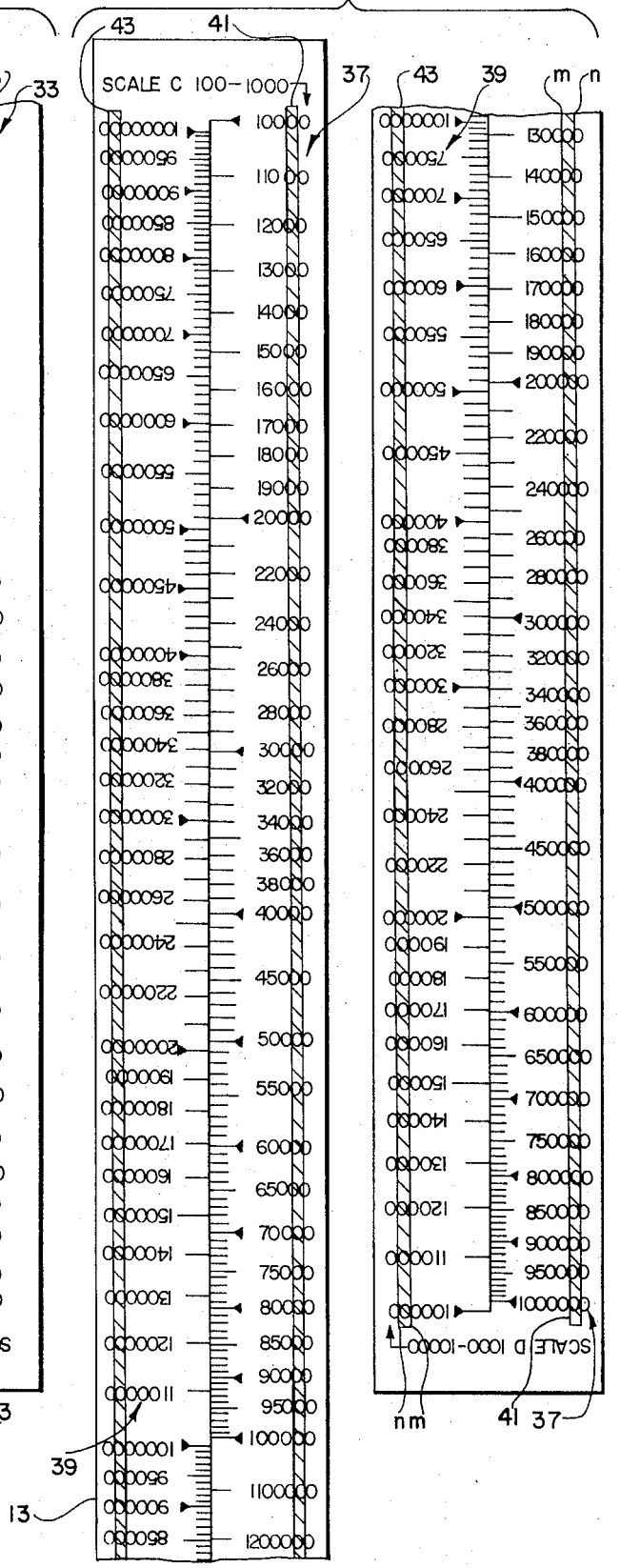

43
41
SCALE C 100-1000
37
43
39
m
n
SCALE D 1000-10000
39
13
n
m
41
37

FIG. 13

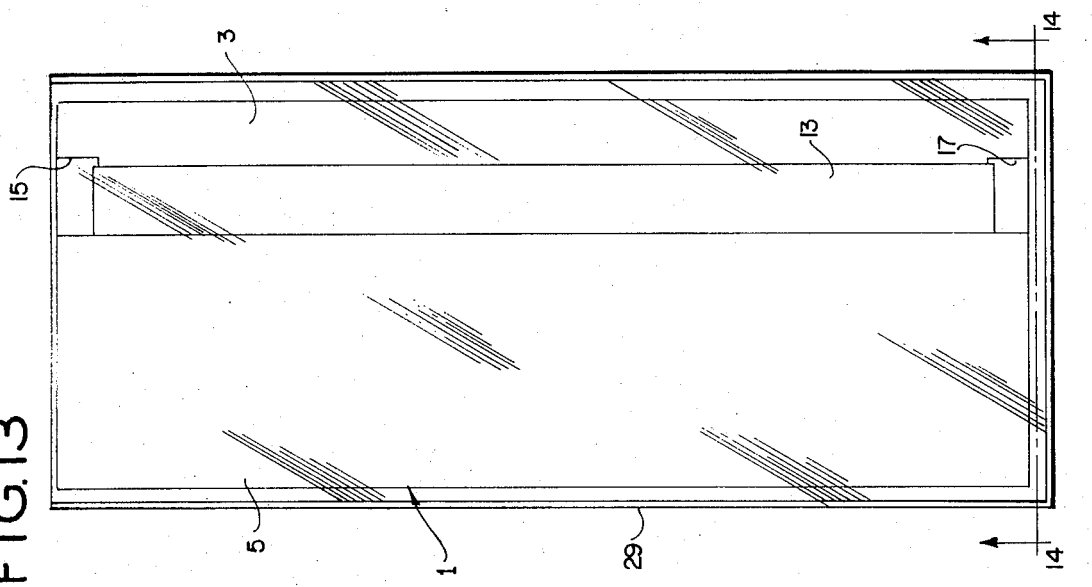


FIG. 12

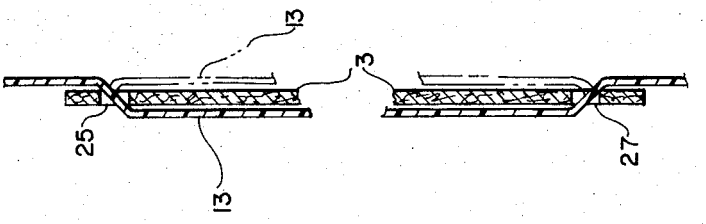


FIG. 14

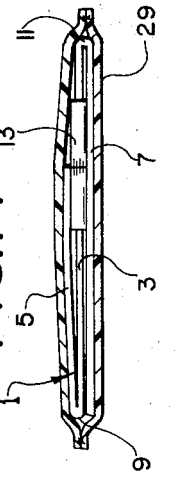
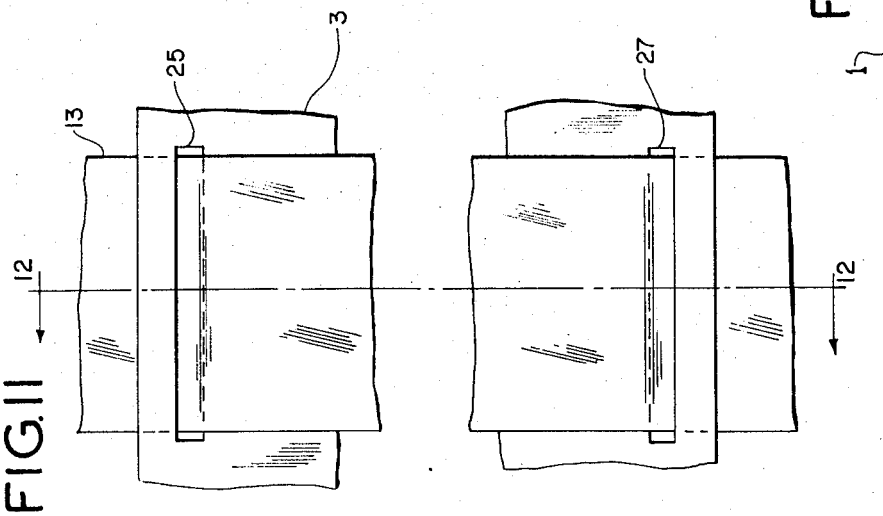


FIG. 11



CALCULATING DEVICE

BACKGROUND OF THE INVENTION

This invention relates to a calculating device, and more particularly to a device for making linear conversions such as currency conversions.

Numerous everyday transactions and other problems require the conversion of various quantities from one unit to another. To facilitate making such conversions, various calculating device have been developed. Since it is frequently necessary to make such conversions at a time and place in which standard calculating machines are unavailable, a substantial amount of effort has been devoted in the art to the provision of portable calculating devices.

A portable calculating device should be lightweight and compact so that it may be readily carried in a pocket or purse. Preferably, the device should be easy to manipulate and its operation should be simple and readily understandable. Where adapted primarily for use in making linear conversions, a type of simple calculation frequently encountered in ordinary problems or transactions, the device should be relatively particularly One highly satisfactory calculating device which corresponds to the above criteria is that disclosed in applicants' copending application Ser. No. 133,586 filed Apr. 13, 971, now U.S. Pat. No. 3,680,775. A continuing need has existed, however, for a calculator which is even less expensive than that described in the aforesaid application, so that it may be available to those of even minimal means, yet possess the same portability, ease of manipulation and simplicity of operation as the device described in the former application.

SUMMARY OF THE INVENTION

It is an object of the present invention, therefore, to provide an inexpensive, readily portable calculating device. It is a further object of the present invention to provide such a device which may be readily utilized by a person of ordinary education without the need for extensive instruction or complex manipulation. It is another object of the present invention to provide such a calculator which is useful as a currency converter. And it is a particular object of the invention to provide such a calculator which may be produced and sold at relatively low cost. Other objects and features will be in part apparent and in part pointed out hereinafter.

The present invention is therefore directed to a calculating device for making mathematical calculations comprising a body including first and second panels joined along an edge for folding them from an open to a closed position with the second panel overlying one face of the first. A belt is carried by the first panel and movable with respect thereto substantially parallel to the edge about which the panels are joined. A mathematical scale is located on the belt extending longitudinally thereof and a stationary mathematical scale having an identity operator index is located on the outside face of the second panel so as to be parallel and adjacent to the belt mathematical scale when the panels are in the closed position. The stationary mathematical scale has the same unit dimension as the belt mathematical scale. A computation based on the relationship $z=f(x,y)$ may be made by setting x_1 on the belt mathematical scale adjacent the identity operator on the stationary mathematical scale and reading z_1 on the belt scale adjacent y_1 on the stationary scale.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a plan view of a preferred embodiment of the invention;

FIGS. **2** and **3** are end views of the embodiment shown in FIG. **1**;

FIG. **4** is a bottom plan view of the embodiment shown in FIG. **1**;

FIGS. **5** and **6** are side views of the embodiment shown in FIGS. **1** and **4**;

FIG. **7** corresponds to FIG. **4** but shows the device in open position;

FIG. **8** corresponds to FIG. **1** showing the device in the open position;

FIGS. **9** and **10** are developed views on a larger scale showing both faces of the belt member included in the device shown in the other figures;

FIG. **11** is a partial plan view of an alternative embodiment of the invention with the belt extended and indicia deleted;

FIG. **12** is a sectional view along the line **12—12** of FIG. **11**;

FIG. **13** shows the device of FIG. **1** encased in a sleeve constructed of resilient material; and

FIG. **14** is a sectional view along the line **14—14** of FIG. **13.**

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Using the calculating device of the present invention, linear conversions or other mathematical computations may be quickly, confidently and accurately made. The device is lightweight and portable and may readily be carried in a pocket or purse. Adapted for construction from materials such as cardboard and flexible plastic, the device of the invention may be manufactured and sold at relatively low cost. Additionally, a particularly preferred embodiment of the invention provides for the definitive location of the decimal point of the product of a given linear conversion, being in this respect particularly superior to a conventional slide rule.

Referring now to FIGS. **1–8** of the drawings, the calculator is constituted by a body **1** which includes three flat panels **3, 5** and **7.** Panel **3** is joined to panel **5** along edge **9** so that these two panels may be folded from an open to a closed position with panel **5** overlaying panel **3.** Similarly, panel **7** is joined to panel **3** along edge **11** so that the latter two panels may also be folded from an open to a closed position. Edge **11** is substantially parallel to edge **9** and the fold about edge **11** is in the angular direction opposite from the fold about edge **9.** FIGS. **1–6** show both panel pairs in the closed position while FIGS. **7** and **8** show them in the open position.

An endless belt **13** is trained about panel **3** and is received by notches **15** and **17** in the ends of the panel. These notches stabilize the belt against lateral movement and maintain it in substantially parallel relationship to edges **9** and **11.** Inscribed on the belt **13** and extending longitudinally thereof is a two-cycle logarithmic scale **19.**

Panel **5** is of lesser width than panel **3,** so that scale **19** remains uncovered when panels **3** and **5** are in the closed position. The width of panel **5** is sufficient, however, so that it laps a margin of the face of belt **13** in-

ward of scale **19**. A logarithmic scale **21** is inscribed on the outside face of panel **5** and is parallel and adjacent to scale **19** when panels **3** and **5** are in the closed position. Scale **21** has the same unit dimension as scale **19** and includes an identity operator index **23**.

FIGS. **11** and **12** illustrate an alternative embodiment of the invention in which the belt passes through slits **25** and **27** near the ends of panel **5** rather than through notches in the ends. The belt is thus received by the slits and is slidable therethrough. In this embodiment, it is preferred that belt **13** either be open, as indicated in FIG. **11** where the belt is shown as extended, or include detachment means at some point along its circumference. The endless belt alternative is indicated by the phantom view of FIG. **12**.

To make a linear conversion using the calculating device of the invention, the conversion factor for converting a quantity in a first unit to a quantity in a second unit is found on belt scale **19** and the belt adjusted so that this quantity is set adjacent the unity index **23** on scale **21**. The quantity in the second unit is then read on scale **19** adjacent the corresponding quantity in the first unit on scale **21**.

Though the preferred embodiment of the present invention is a device having logarithmic scales, and is consequently adapted for making linear conversion, other mathematical scales can be substituted for the logarithmic scales to transform the device into one adapted for other types of computations. Thus, for example, if linear scales are employed, the device may be used for simple addition and subtraction; or, if square root scales are used, the device may be utilized to find the length of the hypotenuse of a right triangle. Provided that the arrangement of numbers on the stationary and belt scales both correspond to a particular mathematical function, and have the same unit dimension, the device can be used for making calculations related to that function. This is the meaning of the term "mathematical scale" as used herein.

The operation of the device, as described abve, is essentially one of adding lengths on the scales of the device. In the preferred embodiment of the invention, where logarithmic scales are used, the adding of lengths corresponds to the adding of logarithms and the operation is one of multiplication. Thus, if the multiplier on the belt scale set adjacent the unity index on the stationary scale is defined as x_1, the multiplicand on the stationary scale is defined as y_1, and the product on the belt scale read adjacent y_1 is defined as z_1, the computation is simply $z_1 = x_1 \cdot y_1$. If a linear scale is used, on the other hand, $z_1 = x_1 + y_1$. If a square scale is used, $z_1 = (\sqrt{x_1} + \sqrt{y_1})^2$. If a square root scale is used, the relationship is $z_1 = \sqrt{x_1^2 + y_1^2}$. Generally, therefore, mathematical computations of the type $z = f(x,y)$ can be made using the device of the invention, with the nature of the functional relationship of z to x and y depending on the mathematical arrangement of x and y on the belt and sleeve scales, respectively.

To add the lengths corresponding to x_1 and y_1 and accurately obtain z_1 where $z = f(x,y)$, it is evident that the index number on the stationary scale (defined, e.g., as y_0), adjacent which x_1 is set in making a computation, must be a number which converts x_1 to x_1 according to the function $z = f(x,y)$. Thus, in the case of linear conversions, this number (i.e., index **23**) is unity (1.0000...) so that $x_1 \cdot 1 = x_1$. In addition, on the other hand, this index number must be 0 so that $x_1 + 0 = x_1$. Generically, this index number is referred to as the "identity operator," i.e., that number which leaves unchanged every element in the domain of the function.

For certain purposes, particularly currency conversions, a single conversion factor is often utilized for a series of conversions. In such circumstances there may be substantial periods of use during which only a single conversion factor is utilized. For the convenience of the user, it is desirable to provide assurance that the relative setting of scales **19** and **21** remains constant during such period. A related need is to assure that panels **3** and **5** are maintained in the closed position so that the scales are adjacently aligned for accurate reading.

FIGS. **13** and **14** illustrate a preferred embodiment of the invention in which pressing means are provided to maintain panels **3** and **5** in the closed position and scale **19** in a preset position with respect to stationary scale **21**. The pressing means are constituted by sleeve **29** constructed of a transparent resilient material such as a flexible plastic. This sleeve, closed at one end, also serves as a carrying case and protects the body and belt of the device against dirt. The internal thickness of the sleeve is sufficiently large to allow body **1** to be inserted therein when both panels **5** and **7** are in the closed position with respect to panel **3**, yet small enough that the sleeve presses the lapping area of panel **5** against the underlying margin of belt **13**, and panel **7** against the opposite face of belt **13**. The pressing force thus imposed insures adjacent alignment of scales **19** and **21** and provides frictional resistance to the movement of belt **13** with respect to panel **5**, thus maintaining said scales in a preset position with respect to one another.

As the drawings show, it is preferred that panel **7** completely cover the back face of belt **13** so as to afford the maximal frictional resistance to the movement of belt **13** when body **1** is compressed by sleeve **29**. A satisfactory degree of compressive force may still be exerted, however, even if panel **7** laps only a margin of belt **13**. The latter construction might be advantageous in the embodiment described below wherein the belt has a second mathematical scale extending in the direction opposite from that of scale **19**. If desired, a second stationary scale can be inscribed on the outside face of panel **7** adjacent and parallel to such second belt scale.

In a preferred embodiment of the invention, belt scale **19** and stationary scale **21** are both provided with coded decimal point locating indicia. Indicia **31** on scale **21** is constituted by a lightly colored stripe superimposed on and extending lengthwise of the scale, with its left edge defining the decimal point between the first and second digits of the identity operator index, and its right edge defining the decimal point location between the second and third digits of the identity operator index. Lightly colored stripe **31** on scale **19** (scale B in FIG. **9**) is shown to be located so that its left edge lies between the second and third digits in the first cycle of scale **19**, and between the third and fourth digits in the second cycle of scale **19**. The right edge of stripe **31** lies between the third and fourth digits in the first cycle and the fourth and fifth digits in the second cycle. Depending on the range of orders of magnitude of interest, however, the stripe **31** may be located either further to the left or further to the right on scale **19**. The left edge of each stripe, indicated at *m* in FIG. **9**, is defined as the 10^0 position, while the right edge, indicated at *n* in FIG. **9**, is defined as the 10^1 position. It is essential that the

10^0 position be between the first and second digits of at least one of the factors involved in a conversion, preferably in the identity index **23**, as indicated in the drawing.

Where the decimal point indicia are thus located, and provided that at least one of the multiplier factor on the belt scale and the multiplicand factor on the stationary scale has its decimal point in the 10^0 position, the location of the decimal point in the product on the belt scale is the same as the right-most decimal point location of its two factors. Thus, if the decimal points in both the multiplicand and multiplier are in the 10^0 position, the decimal point location in the product is also in the 10^0 position. If the decimal point location in either the multiplier or in the multiplicand is in the 10^1 position, the decimal point in the product is also in the 10^1 position.

For simple correspondence to exist between the decimal point position in the product and the right-most decimal position in one of its factors, the decimal point location in the other factor must of course be in the 10^0 position. If neither of the factors has its decimal in the 10^0 position, the decimal point in the product may be still determined, as those skilled in the art will recognize. In such case, the exponent of the position designation of the decimal point in the multiplier is added to the exponent of the position designation of the decimal point in the multiplicand to give the exponent of the position designation of the decimal point in the product. Thus, if the decimal point in both the multiplier and multiplicand are in the 10^1 position, the decimal point in the product is in the 10^2 position, i.e., one digit to the right of the right-most margin of stripe **31**.

To avoid the necessity of adding exponents and counting digits, it is, of course, desirable that the decimal point in at least one of the multiplier and multiplicand be in the 10^0 position. By providing two cycles on scale **19**, two orders of magnitude, i.e., a 100-fold range of multipliers, are provided in which the decimal point is in the 10^0 position. The range of multipliers having the decimal point in the 10^0 position is expanded in a preferred embodiment of the invention wherein a second two-cycle mathematical scale **33** (scale A in FIG. **9**) is located on belt **13** parallel to and extending in the opposite direction from scale **19**. By locating decimal point locating stripe **35** in a position on scale **33** which differs from the position of stripe **31** on scale **19**, additional orders of magnitude of multipliers having their decimal point in the 10^0 position are afforded. Scale **33** is brought into parallel and adjacent relationship to scale **21** by end-to-end reversal of belt **13** from the orientation to panel **3** in which scale **19** is adjacent the stationary scale. In the embodiment wherein belt **13** is an endless belt, adaptability for end-to-end reversal of the orientation of belt **13** to panel **3** may be provided by constructing body **1** of a flexible material, for example lightweight cardboard.

In a further preferred embodiment of the invention illustrated in FIG. **10**, the belt has two additional scales **37** (scale C) and **39** (scale D) inscribed on its reverse face. Scales **37** and **39** extend in directions opposite from each other and respectively include decimal point locating stripes **41** and **43**. Stripes **41** and **43** are located so as to provide further ranges of orders of magnitude of multipliers having the decimal point in the 10^0 position. Where the belt is an open belt scale **37** or **39** may be brought into adjacent alignment with scale **21** by simply turning the belt over. Where the belt is endless, use of scales **37** and **39** is effected by turning the belt inside out from the orientation in which scales **19** and **33** are used.

The embodiment of the invention shown in the drawings is a currency converter. To illustrate its operation, five U. S. dollars are converted to an equivalent amount of Austrian schillings in the following fashion. Because the conversion rate of schillings to dollars is 25.78, a number between 10 and 100, the belt is oriented so that the stationary scale **21** is adjacent scale **19** (scale B), i.e., the belt scale in which the 10^0 position of the decimal point locating indicia is between the second and third digits on the belt scale's first cycle. The conversion ratio of 25.78 on the first cycle of the belt scale is then brought into registry with index **23**. There is of course no line on the scale which exactly corresponds to the significant figures 2578. The point corresponding to these figures must be interpolatively estimated. Such estimation dictates that the index **23** be brought into registry with a point slightly past the mid point between the lines corresponding to the significant figures 2550 and 2600 respectively. Once the appropriate point is brought into registry with the unity index, the amount in Austrian schillings corresponding to five U. S. dollars is read on the belt scale adjacent 5 on the stationary scale. Since, in this instance, the decimal point locations on both multiplier and multiplicand are in the 10^0 position, the decimal point in the product is in the 10^0 position, and it may be seen that five U. S. dollars are equivalent to approximately one hundred and twenty-nine Austrian schillings.

Although the principal emphasis in the above discussion has been on the conversion of dollars to schillings, conversion from schillings to dollars may be made with equal facility. If, for example, it is desired to determine the dollar equivalent of 60 schillings, this may be accomplished by simply reading the equivalent quantity in dollars on stationary scale **21**, i.e., about $2.32, adjacent 60 on the belt scale.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A calculating device for making mathematical calculations comprising a body including first and second panels joined along an edge for folding them from an open to a closed position with the second overlaying one face of the first, a belt carried by the first panel and movable with respect thereto substantially parallel to said edge, a mathematical scale on said belt extending longitudinally thereof, and a stationary mathematical scale having an identity operator index located on the outside face of said second panel so as to be parallel and adjacent the belt mathematical scale when said panels are in the closed position, said stationary mathematical scale having the same unit dimension as said belt mathematical scale, whereby a computation based on the relationship $z=f(x,y)$ may be made by setting x_1 on the belt mathematical scale adjacent the identity op-

erator on the stationary mathematical scale and reading z_1 on the belt scale adjacent y_1 on the stationary scale.

2. A calculating device as set forth in claim **1** wherein said second panel laps a margin of said belt when said panels are in the closed position.

3. A calculating device as set forth in claim **2** further comprising means for pressing said margin between said first panel and said second panel so that said panels may be maintained in the closed position and the mathematical scale on said belt may be maintained in a preset position with respect to said stationary mathematical scale.

4. A calculating device as set forth in claim **3** wherein said pressing means comprises a sleeve constructed of resilient material having an internal thickness sufficiently large to allow the body to be inserted therein when the panels are in the closed position and sufficiently small to press the lapping area of said second panel against the margin of said belt when said body is inside said sleeve.

5. A calculating device as set forth in claim **3** wherein the body includes a third panel joined to said first panel along a second edge for folding them from an open to a closed position in the angular direction opposite from that of the fold about the edge joining the first and second panels, said second edge being located on the opposite side of the belt from the first edge, said third panel being adapted to overlay at least a margin of the belt when the first and third panels are in the closed position and said pressing means being adapted to press at least a margin of said belt between said first panel and said third panel to assist in maintaining the mathematical scale on the belt in a preset position with respect to the mathematical scale on said second panel.

6. A calculating device as set forth in claim **1** wherein said scales are logarithmic scales and said identity operator index is a unity index whereby a quantity expressed in a first unit may be converted to a corresponding quantity expressed in a second unit by setting a conversion factor on the belt logarithmic scale adjacent said unity index on the stationary logarithmic scale and reading the quantity in the second unit on the belt scale adjacent the corresponding quantity in the first unit on the stationary scale.

7. A calculating device as set forth in claim **6** having coded decimal point locating indicia on the stationary scale and corresponding coded decimal point locating indicia on the belt scale.

8. A calculating device as set forth in claim **7** wherein said decimal point locating indicia are constituted by the edges of stripes superimposed on the stationary scale and the belt scale.

9. A calculating device as set forth in claim **8** wherein said belt is adapted for end-to-end reversal of it orientation with respect to the first panel and has a second logarithmic scale alongside the first belt scale extending in the direction opposite therefrom, the second belt scale having its decimal point locating indicia arranged for a range of orders of magnitude different from the range of orders of magnitude provided by the decimal point locating indicia of the first belt scale.

10. A calculating device as set forth in claim **9** wherein the belt has a third logarithmic scale located on the face thereof opposite from the first two belt scales, the third belt scale having its decimal point locating indicia arranged for a range of orders of magnitude different from the ranges or orders of magnitude provided by the decimal point locating indicia of the first and second belt scales.

11. A calculator as set forth in claim **1** wherein said belt is an endless belt trained around the first panel.

12. A calculator as set forth in claim **11** wherein the ends of said first panel have notches receiving the belt.

13. A calculator as set forth in claim **1** wherein said first panel has slits located inward of its ends slidably receiving said belt.

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