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Lee

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[54] **BLEND CALCULATOR**

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[52] **U.S. Cl.** **235/78;** 235/84

[51] **Int. Cl.**[2] **G06C 27/00**

[58] **Field of Search** .... 235/78, 88, 70 R, 70 A, 235/61 B, 84, 85

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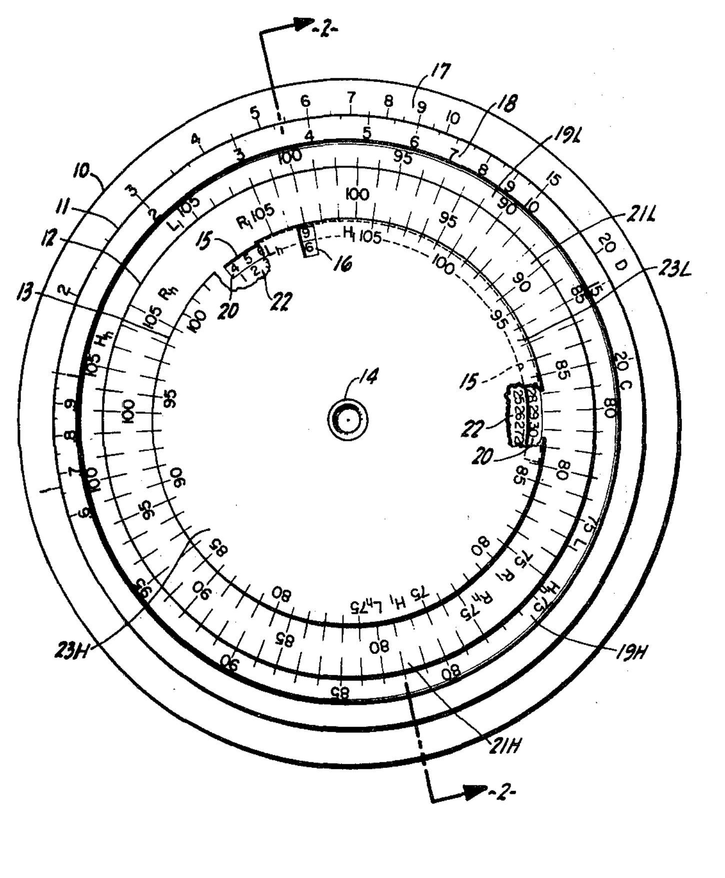
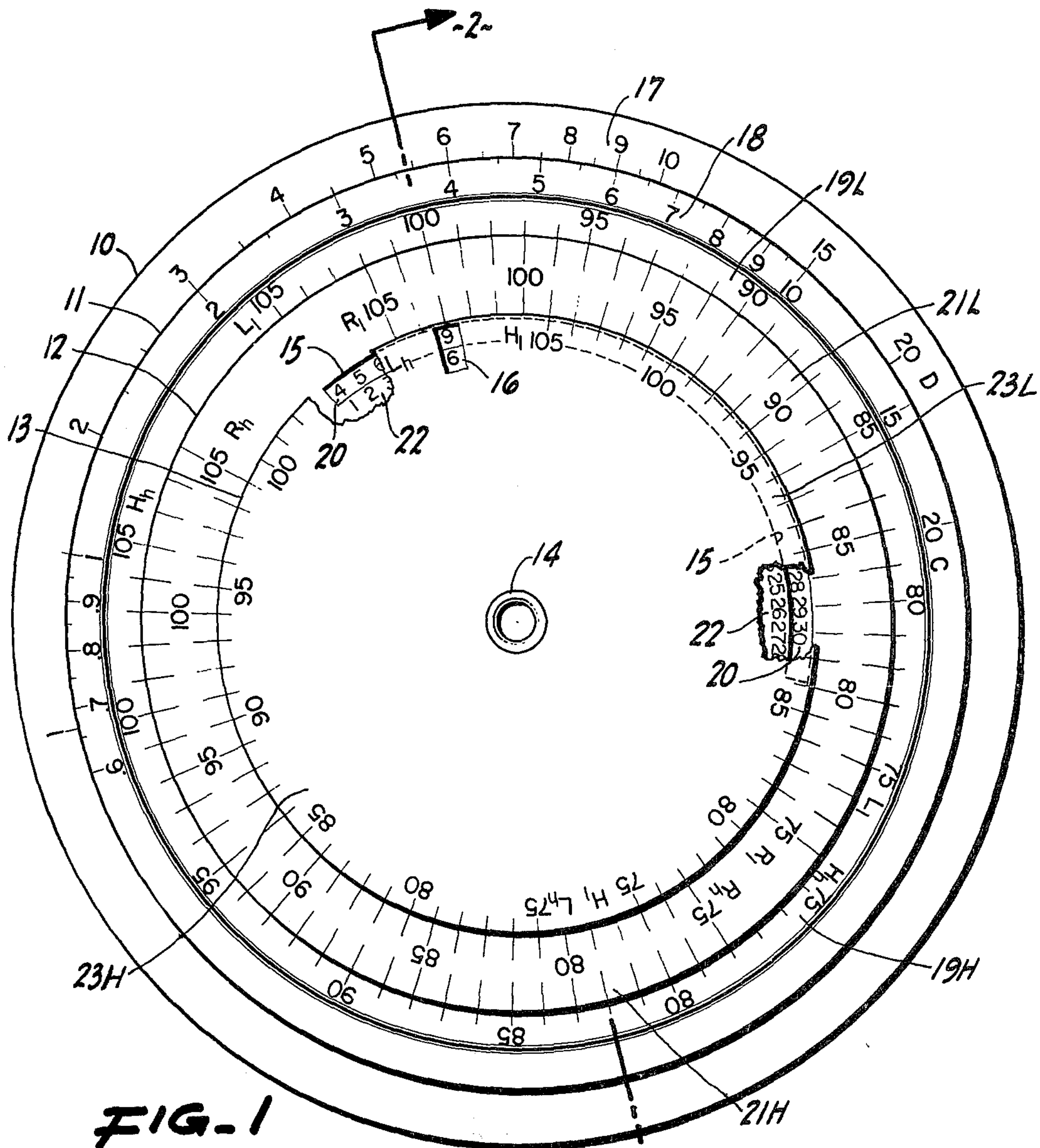
[57] **ABSTRACT**

A blend calculator for determining the quantity ratios in which a higher per cent and a lower per cent solution and/or mixture must be mixed to provide a predetermined quantity of solution and/or mixture having a per cent intermediate such higher and lower per cents. The calculator comprises a plurality of scale components movable relative to each other and certain of which are respectively calibrated in higher, lower, and required per cents, and certain others of which are calibrated in amounts. The per cent scales are linear and the amount scales are logarithmic. Manipulation of the linear scales relative to each other produces operator numbers that serve as a transfer medium between the linear and log scales to enable direct reading of the relative quantities of the lower per cent and higher per cent solutions necessary to provide a predetermined total quantity having an intermediate per cent.

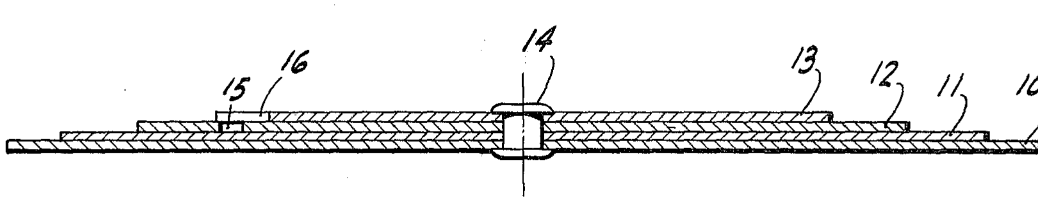
7 Claims, 2 Drawing Figures





-2-
10
11
12
13
14
15
16
17
18
19L
19H
20
21L
21H
22
23L
23H
L1 105
R1 105
H1 105
Rh
Hh
Lh
20 D
20 C

FIG. 1



10
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15
16

FIG. 2

BLEND CALCULATOR

This invention relates to calculating devices and, more particularly, to a blend calculator for establishing the relative quantities of a plurality of solutions and/or mixtures having certain predetermined characteristics that must be mixed or blended to provide a fixed total quantity of a solution or admixture having predetermined characteristics derived from those of the individual solution and/or mixture contained in the resulting solution or mixture.

There are many environments in which it is necessary to provide a total quantity of a solution having certain particular characteristics by mixing two or more solutions of differing characteristics which, when blended in a particular ratio, will provide the characteristics required for the derivative quantity. As a specific example, liquid chemicals, such as alcohols, are often blended in this manner and fuels are similarly blended to provide one having certain desired characteristics. As a more particular example, fuel to internal combustion engines consist of iso-octane and n-heptane and may be blended, one with another, to create a fuel having a particular per cent of iso-octane (octane rating-anti-knock quality). The fuel octane rating is often expressed in the term "octane number" (ON).

The ON is numerically equal to the volume per cent of iso-octane in a blend of iso-octane (100 ON) and n-heptane (0 ON) that matches the given fuel in anti-knock characteristics.

Considering the mixture of iso-octane and n-heptane or gasoline as an environment in which the invention is of particular utility, it is commonly known that most filling stations patronized by the general public sell two grades of gasoline, generally defined as regular and premium, which only differ in their octane rating. Usually, in the United States, a regular gasoline has an octane rating somewhere in the range of 90 to 96 and the premium has an octane rating in the range of 97 to 103. Which particular gasoline is selected by the customer depends upon the requirements of his automobile and, for the most part, is a compromise in the sense that the octane requirements for his automobile seldom correspond precisely to one or the other of the octane ratings of the regular and premium and he simply selects the grade most closely approximating his automobile engine requirements. Further, the octane requirements for any particular engine vary with altitude and, for example, an engine that might require gasoline having an octane rating of 95 at sea level will have its octane requirements reduced to 75 at an elevation of 10,000 feet.

In this respect, the normal combustion process in an internal combustion engine consists of an air and fuel mixture being drawn into a cylinder and compressed to some value at which it is ignited by an electrical spark. Heat generated by the initial combustion of fuel causes adjacent portions of the mixture to burn and a consequent flame front propagates smoothly across the combustion chamber with the result being the heat-induced expansion of gases which produces thrust upon the piston. Thermal radiation, hot-pockets, and rising pressure may produce premature ignition or self-explosions, causing a sudden pressure in the unburned fuel in the fuel-air mixture. Such pressure increases cause undesirable knocking, especially during acceleration and other loadings of the engine.

Such knocking may occur in varying intensities, and if it is sufficiently loud to be audible, the engine may overheat, have a loss of power, and engine parts may suffer considerable mechanical damage. This condition can be avoided by using gasoline enriched by an anti-knock ingredient such as tetraethyl lead; and the octane rating of a gasoline is numerically equal to the volume by per cent of iso-octane in a blend of iso-octane (which has a 100 octane rating) and n-heptane (which has a 0 octane rating) that matches the anitknock characteristics of a particular fuel. As the octane rating of gasoline is increased, the ignition rate is decreased so as to obviate the condition of self-or premature ignition.

Using a fuel having a higher octane rating than that required by the engine to produce smooth efficient operation is disadvantageous. Since the antiknock characteristic of gasoline is related to the lead content thereof, using a fuel having an octane rating greater than that required leads to the accumulation of lead deposits in the combustion chamber, resulting in higher compression ratios and surface ignition or abnormal combustion knock. The excessively high octane fuel also leads to the release of lead emissions, which contaminate the environment, and also to lead deposits on engine parts. Ordinarily, premium or higher octane fuels generally are substantially more expensive than the lower octane fuels, thereby increasing operational costs unnecessarily.

A general object of the present invention is to provide a quick, easy, and reliable means enabling the average automobile driver to determine the quantities of premium and regular gasolines of known octane ratings that he should purchase to obtain a total predetermined gallonage having an octane rating matching the octane requirements of his automobile engine. For example, should an automobile engine require use of a fuel having an octane rating of, say, 90, and the driver desires to purchase twelve gallons of gasoline at a station having a premium fuel with an octane rating of 96 and a regular fuel with an octane rating of 87, 4 gallons of the premium grade and 8 gallons of the regular grade fuel should be purchased.

Additional objects, among others, of the present invention are in the provision of a blend calculator having relatively movable scales enabling one ot select the quantity of a plurality of solutions and/or mixtures which should be added to a mixture thereof to provide a total predetermined quantity of a solution and/or admixture having particular characteristics derived from an admixture of such fluids in predetermined per cents; a blend calculator that is simple to operate, that accommodates a wide range of input information and provides specific numerical answers based thereon, and is characterized by requiring only a minimal manipulation; a blend calculator that is particularly adaptable for use in determining the quantities of gasoline of given octane ratings that must be mixed to provide a total gallonage having a required octane rating; and a blend calculator having a plurality of scales, certain of which are divided into linear increments representing per cent values and others which are divided in logarithmic increments representing quantities manipulation of the linear scales in accordance with known input information providing operator numbers that serve as a transfer medium between the linear per cent and logarithmic quantity scales to enable derivation of the quantity requirements from the input information.

Additional objects and advantages of the invention, especially as concerns particular features and characteristics thereof will become apparent as the specification continues.

An embodiment of the invention is illustrated in the accompanying drawing in which:

FIG. 1 is a top plan view of a calculator embodying the invention; and

FIG. 2 is a sectional view of the calculator taken along the line 2—2 of FIG. 1.

The blend calculator, illustrated in the drawing, includes a plurality of circular scale structures stacked one upon another in superimposed juxtaposition. In the form shown, four individual scale structures are provided and they are respectively denoted from bottom to top with the numerals **10** through **13.** The scale structures are of different diameters progressively decreasing in extent from bottom to top so that each successive underlying scale structure has an exposed area projecting outwardly beyond the next successive overlying scale structure, as is most evident in FIG. **2.**

The calculator further includes connector structure interconnecting the scale structures **10** through **13** for relative angular diplacements. The connector structure may take various forms and, in the present illustration, it constitutes a hollow rivet **14** having laterally swaged ends that respectively underlie and overlie the scale structures **10** and **13.** The connector rivet **14** is disposed at the geometric centers of the scale structures **10** through **13** and permits each to be displaced angularly relative to the others while constraining the structures in stacked juxtaposition against bodily displacements.

The scale structure **12** is provided with an elongated arcuate opening **15** underlying the immediate successive overlying scale structure **13** so as to be generally concealed thereby. The opening **15** may have different angular lengths depending upon the particular environment and, in the form shown, has an angular extent of the order of 140°. The opening **15** is relatively narrow in a radial direction and is sufficiently large in such dimension to reveal a scale disposed therebeneath, as described hereinafter.

The uppermost scale structure **13** is disposed in immediately successive overlying relation with the opening-equipped structure **12** and is provided with a viewing window **16** disposed for overlying alignment with the opening **15** in certain relative angular positions of the scale structures **11, 12** and **13.** The window **16** is short or narrow, in an angular sense, but has a radial dimension substantially twice that of the opening **15** to permit concurrent viewing of two underlying scales, as is shown in FIG. **1.**

The bottom or lowermost scale structure **10** is provided therealong with a circular scale generally denoted with the numeral **17.** The scale **17** is disposed along the area of the structure **10** that extends beyond the next successive overlying scale structure **11** and the scale **17** is subdivided logarithmically into numerical increments extending, in the particular calculator being considered, from **1** through **20.** The scale **17** is denoted in FIG. **1** as the "D" scale and it represents quantities of solutions and, in particular, the total quantity desired or required by one using the calculator.

The next successive scale structure **11** is provided with a plurality of scales respectively denoted with the

numerals **18, 19,** and **20,** the latter being a "first operator number" scale concealed beneath the scale stucture **12** but viewable through the opening **15** thereof and window **16** in certain relative positions of the structures **11, 12,** and **13.** The scale **18** is divided logarithmically into numerical increments extending from 0.6 through 20. The scale **18** is denoted in FIG. **1** as the "C" scale and it denotes quantities of solutions and, in particular, the quantity of solution required in a blend of a plurality of solutions totaling a particular amount on the scale **17.**

The scale **19** effectively constitutes two separate scales, differentiated one from the other with the letter suffixes "L" and "H", used in association with the numeral **19.** Each of the scales **19** has a linear scale subdivided into equal angular increments and designates, in numerical terms, the qualities or characteristics of one of the solutions to be combined to form the mixture including the same. In the calculator under consideration, the scales **19** are representative of octane ratings of gasoline and each scale extends from a lower octane number of 75 to an upper number of 105.

The operator number scale **20** is also a linear scale extending between the numerals **1** and **30** in the calculator illustrated. The scale **20** serves to provide a transition component between the linear and logarithmic scales of the blend calculator, as will be described in detail hereinafter. It will appear that the scales **18, 19,** and **20** are angularly disposed and are located at different radial distances from the center of the calculator. The scales **18** and **19** are disposed along areas of the scale structure **11** that project outwardly beyond the dimensional limits of the overlying scale structure **12,** whereas, the scale **20** underlies the structure **12.**

The scale structure **12** is provided with a plurality of scales respectively denoted with the numerals **21** and **22,** the first of which is disposed along the exposed surface of the structure **12** projected beyond the scale structure **13,** and the scale **22** being disposed so as to underlie the structure **14** and be substantially concealed thereby. The scale **21** is divided into two separate scales, differentiated by the application of the letter suffixes L and H. Each scale **21** is subdivided into linear increments extending from **75** to **105** and denoting the required octane number for particular quantity of gasoline. The scale **22** is also a linear scale and is the "second operator number" scale extending from 1 to 30 in the calculator illustrated. The scale **22** extends along the opening **20** inwardly thereof so as to be visible through the window **16** of the scale structure **13.**

The top or uppermost scale structure **13** is provided along the outer circumferential edge thereof with two scale segments, respectively denoted with the numerals **23L** and **23H.** Each scale **23** is linear and the subdivision thereof then, again, extends from 75 to 105 so as to denote octane ratings.

It may be observed that the scale segments **19L, 21L,** and **23L** are respective duplicates of the segments **19H, 21H,** and **23H.** Therefore, one or the other of such duplicate segments can be omitted, if desired, since the quantities of two solutions to be mixed in proper proportions by use of the calculator can be determined by use of the single scale segments. Such duplication, however, serves the convenience of enabling one operating the calculator to determine directly either the quantity of a lower octane gasoline that must be blended to provide a total predetermined gallonage having a certain desired octane rating or to determine directly the quantity of the higher octane gasoline that must be blended to provide such total gallonage of determinate octane rating. This facility, in use of the calculator, will become evident hereinafter when specific examples of its use are set forth.

Assume, by way of example, that a particular automobile requires gasoline having an octane rating of 94 and that a particular filling station has two kinds of gasoline pumps: a premium fuel with an octane rating of 100 and a regular fuel having an octane rating of 91. Assume further that the operator of the vehicle wishes to add a total of 15 gallons to the storage tank of the vehicle. Thus, his requirement is for 15 gallons of a 94 octane gasoline, but a fuel having such octane rating is not available. The precise octane rating could be obtained, nevertheless, if the operator knew the quantities of the premium and regular gasoline in convenient gallon terms required in a blend thereof to provide a total gallonage of 15 with the 94 octane rating.

In use of the calculator to solve the problem posed of establishing the necessary quantities of the 91 octane and 100 octane gasolines to obtain a blend of 15 gallons having a 94 octane rating, the operator locates the octane number 94 on the scale segment **21** which is the "octane requirement" scale and is designated therealong with the letter "R" with the two separate scale segments thereof respectively differentiated with the denominations "R_l" and "R_h." If the operator desires to determine directly the gallonage of the lower octane fuel which must be purchased for the desired blend, the octane number is located along the scale segment **21**L (i.e., the scale segment R_l) and if he desires to determine directly the quantity of the higher octane fuel that must be used to arrive at the desired blend, the octane number **94** is located along the scale segment **21**H (i.e., the scale segment R_h).

Take the case in which the operator desires to establish directly the gallonage of the lower octane fuel required; the octane number 94 on the scale segment **21**L is aligned with the octane number 100 on the inner scale segment **23**L (i.e., the high octane scale segment H_l). Similarly, the octane number **91** on the scale segment **19**L (i.e., the low octane scale segment L_l) is aligned with the octane number **94** on the scale segment **21**L, thereby bringing into alignment the three octane numbers **91, 94,** and **100** respectively corresponding to the octane rating of the regular grade fuel available, the required or desired octane rating, and the octane number of the premium fuel available. The operator numbers "**9**" and "**6**" will then be visible through the window **16** and these numbers, which respectively appear on the scales **20** and **22,** are next used to provide the transition between the linear octane scales and logarithmic gallonage scales.

It will be evident that the octane numbers are readily alignable in the manner described by effecting relative rotation of the scale structures **11, 12,** and **13** about the axis of the rivet **14.** The two operator numbers "**9**" and "**6**" visible through the window **16** are then located along the scales **17** and **18** and are aligned with each other by effecting relative angular displacements of the scale structures **11, 12,** and **13** about the axis of the rivet **14.** In this respect, the relative dispositions of the numbers "**9**" and "**6**" in a radial sense, as viewed through the window **16,** is preserved in locating such numbers along the scales **17** and **18.** It is not essential that the scale structures **11, 12,** and **13** be maintained in the relative angular locations enforced thereon in aligning the three octane numbers when adjusting the two scale structures **10** and **11** to align the operator numbers along the scales **17** and **18** since the octane information is no longer required once the two operator numbers are established. However, there is no reason why the octane scales should become misaligned in adjusting the two scale structures **10** and **11** relative to each other.

Once the proper alignment is effected between the operator numbers along the scales **17** and **18,** the gallonage required for the lower octane fuel for a total gallonage having the desired octane rating (i.e., **15** gallons of a 94 octane fuel in the example being given), the correct gallonage for the lower octane fuel is read directly on the scale **18** in alignment with the total gallonage figure that appears along the scale **17.** Thus, in the specific example under consideration, the requirement for the lower octane fuel is 10 gallons, which appears in alignment with the total gallonage number **15** appearing on the scale **17.** The amount of the higher octane fuel required for the blend can then be found directly by subtracting the lower octane gallonage **10** from the total gallonage **15,** thereby arriving at a gallonage requirement of **5** for the higher 100 octane fuel. Once the operator numbers are determined and properly located along the scales **17** and **18,** any gallonage blend can be determined directly. For example, should the operator decide that he wants only a total of 10 gallons of fuel rather than **15,** he locates the total gallonage number "**10**" along the scale **17** and reads his requirement for 6.66 gallons of the lower octane fuel on the scale **18.**

Should the operator wish to check his computation or to determine the number of gallons of premium fuel required for the blend rather than perform the arithmetic subtraction explained, he aligns the required octane number **94** on the scale **21**H with the higher octane number **100** on the scale **19**H and with the lower octane number **100** on the scale **19**H and with the lower octane number **91** on the scale **23**H, whereupon the operator numbers "**9**" and "**3**" will appear in the window **16.** He then aligns the operator numbers "**9**" and "**3**" on the respective scales **17** and **18,** whereupon the number "**5**" on the gallonage scale **18** will appear below the total gallonage number **15** on the aggregate gallonage scale **17.** The operator then knows that he will be required to put 5 gallons of the premium gasoline, having the octane rating of 91, in order to obtain a total gallonage of **15,** having an octane rating of 94.

As another example using the scales **19**H, **21**H, and **23**H in the relative positions thereof illustrated in FIG. **1,** it may be assumed that the operator again desires to fill his vehicle tank with **15** gallons of gasoline having an octane rating of 94. However, the station has only two grades of fuel available, one being a regular gasoline with an octane rating of 88 and the other being a premium fuel having an octane rating of 97. The operator manipulates the scale structures **11, 12,** and **13** so as to align the octane number 94 on the scale **21**H (i.e., the required octane scale "R_h") with the octane number **88** on the scale **23**H (i.e., the lower octane scale "L_h") and with the octane number **97** on the scale **19**H (i.e., the higher octane scale "H_h"). Such alignment of the octane numbers **97, 94,** and **88** will result in the appearance of the operator numbers "**9**" and "**6**" in the window **16.** The scale structures **10** and **11** are then manipulated to align the operator numbers "9" and "6" in the window **16.** The scale structures **10** and **11** are then manipulated to align the operator numbers "9" and "6" on the respective scales **17** and **18,** whereupon the operator can read directly on the scale **18** that he will require 10 gallons of the higher 97 octane fuel in order to provide a blend totaling 15 gallons, having an octane rating of 94.

It will be evident from the foregoing that the calculator is convenient and easy to use, providing a specific gallonage quantity for any admixture problem over a wide range. The solution to such a problem is attained with a minimum of manipulations, requiring only alignment of three octane numbers on the linear octane scales to obtain two operator numbers, the duplicate counterparts of which are aligned on the two logarithmic gallonage scales. The gallonage requirement for either the higher or lower octane fuel, depending upon which of these two unknowns one using the calculator wishes to determine, is then read directly on the scale **18** below any total or aggregate gallonage amount selected by the user along the scale **17.** Thus, the operator of a vehicle is able to calculate his requirements for both the higher and lower octane fuels in a very brief time — a matter of a few seconds — after being advised of the octane ratings of the premium and regular gasolines sold at any filling station.

As previously indicated, the calculator is applicable for use in determining the quantities for a great number of admixtures comprising a plurality of separate ingredients having particular characteristics, such as octane ratings in gasoline, and which characteristics are to be provided in a predetermined resultant form in the admixture. As respects such individual ingredients, they may be in fluid form, liquid or gaseous, or such ingredients in solid form; and the various characteristics may be defined in any convenient terms such as the numerical octane designations in the particular calculator being considered. Similarly, the quantities may be defined along the scales **17** and **18** in any convenient values including weight, volumes such as liquid measures, linear dimensions, etc.

These calculations are derived from the general algebraic expressions, used as the basis for the operation of the calculator, as follows:

$$C_H = D\,\frac{R-L}{H-L}\ (1),\quad C_L = D\,\frac{H-R}{H-L}\ (2)$$

where

C_H — the amount to be blended, by weight or volume, of the higher percentage component

C_L — the amount to be blended, by weight or volume, of the lower percentage component

D — the total amount of final product by weight or volume

H — higher percentage by weight or volume

L — lower percentage by weight

R — required percentage by weight or volume of final product

In formula 1, using the preferred embodiment of the calculator, the *R*, *L* and H operants of the algegbraic expression are found on the R_h, L_h and H_h segments of the respective scales on the calculator. Similarly, in formula 2, the *R*, *L* and *H* operants of the algebraic expression are found on the R_1, L_1 and H_1 segments of the respective scales on the calculator.

While in the foregoing specification an embodiment of the invention has been set forth in considerable detail for purposes of making a complete disclosure thereof, it will be apparent to those skilled in the art that numerous changes may be made in such details without departing from the spirit and principles of the invention.

What is claimed is:

1. A blend calculator comprising: a plurality of circular scale structures stacked one upon another in superposed juxtaposition; connector structure interconnecting said scale structures for relative angular displacements; said scale structures being of different diameters, increasing in extent from top to bottom, so that each successive underlying scale structure has an exposed area projecting beyond the next successive overlying scale structure; one of said scale structures having an elongated arcuate opening underlying the immediately successive overlying scale structure so as to be generally concealed thereby; said immediately successive overlying scale structure being provided with a viewing window disposed for overlying alignment with said opening in certain relative angular orientations of said opening- and window-equipped scale structures; the scale structure underlying the opening-equipped scale structure being provided with a plurality of scales, one of which is a first operator number scale concealed beneath the overlying scale structure and viewable through the opening thereof in certain relative positions of the opening and the operator number scale; and the opening-equipped scale structure being provided with a plurality of scales, one of which is a second operator number scale extending generally along said opening and concealed beneath the overlying scale structure and viewable through the window thereof in certain relative positions of the window and second operator number scale, said viewing window being angularly narrow so as to reveal at one time essentially only a set of operator numbers respectively provided along said first and second operator number scales.

2. The calculator of claim **1** in which said arcuate opening is radially narrow to reveal essentially only the aforesaid first operator number scale.

3. The calculator of claim **1** in which said plurality of scale structures includes a fourth superposed scale structure, having at least one scale thereupon, and where certain of the aforesaid scales are subdivided into linear increments and others being subdivided into logarithmic increments, said operator number scales providing transition media between the linear and logarithmic scales.

4. The calculator of claim **3** in which said arcuate opening and window are both disposed in adjacency with the outer circumferential edge portion of the uppermost scale structure in said stack thereof.

5. An admixture calculator for establishing relative quantities of a pair of mixtures of materials having certain predetermined characteristics identified by a pair of numerical grade representations that must be mixed to provide a fixed total quantity of an end admixture having a predetermined characteristic derived from those characteristics of the end mixture of materials and identified by a numerical grade representation intermediate such pair of numerical grade representations comprising: a first linear scale having the numerical grade representations for a first mixture of materials; a second linear scale having numerical grade representations for a second mixture of materials; a third linear scale having a numerical grade representation for a third mixture of materials; a first integer scale defining operant numbers incorporated on the first linear scale; a second integer scale defining operant numbers incorporated on the second linear scale; indicator means incorporated on said third linear scale operable with respect to said first integer scale and said second integer scale; wherein said first, second and third linear scales are arranged in juxtaposition, enabling alignment of a selected numerical grade representation on said first linear scale with a selected numerical grade representation on said second linear scale and with a selected numerical grade representation on said third linear scale, said indicator means on said third linear scale cooperating to select an operant number on said first integer scale and an operant number on said second integer scale; a first logarithmic scale having numerical quantity representations for a first quantity of a mixture of material, and having numerical representations for

operant numbers; a second logarithmic scale having numerical quantity representations for a second quantity of admixture of material and having numerical representations for operant numbers; wherein said first logarithmic scale is arranged in juxtaposition to said second logarithmic scale, enabling alignment of a selected operant number transferred from one of said integer scales on said first logarithmic scale with a selected operant number transferred from the other of said integer scales on said second logarithmic scale.

6. The admixture calculator of claim **5** wherein said numerical quantity representations and said numerical representations for said operant numbers on said first and second logarithmic scales use common numerical representations.

7. The admixture calculator of claim **5** wherein said linear scales and said logarithmic scales are arranged in juxtaposition for convenient transfer of said operant numbers from said linear scales to said logarithmic scales.

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