Sept. 7, 1943. F. Q. SAUNDERS 2,328,881

FUEL ENGINEER'S CALCULATOR

Filed July 9, 1941 2 Sheets-Sheet 1

Fig. 1.

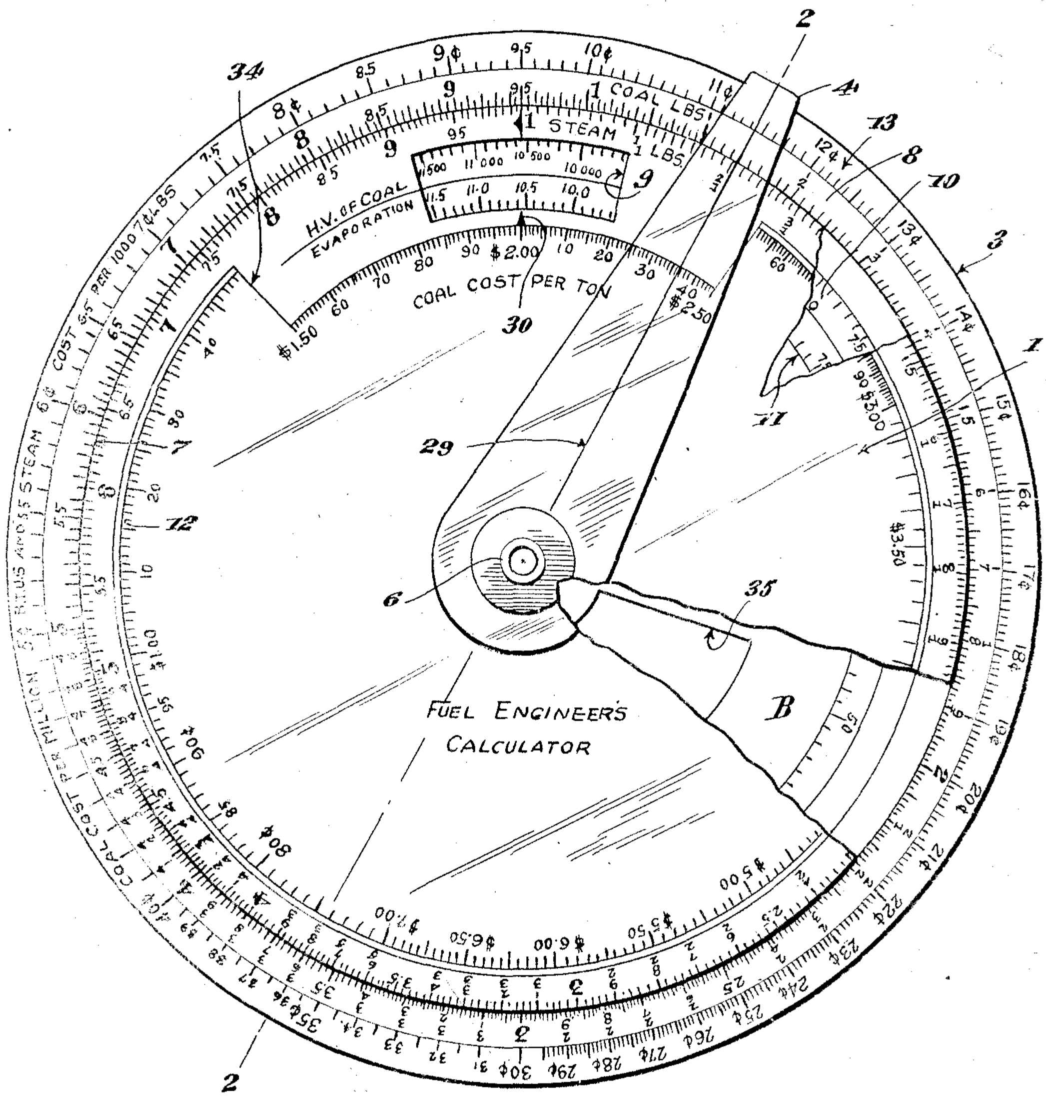

Fig. 2.

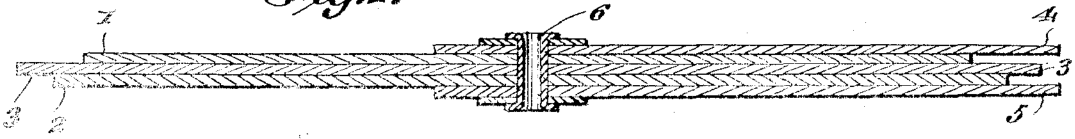

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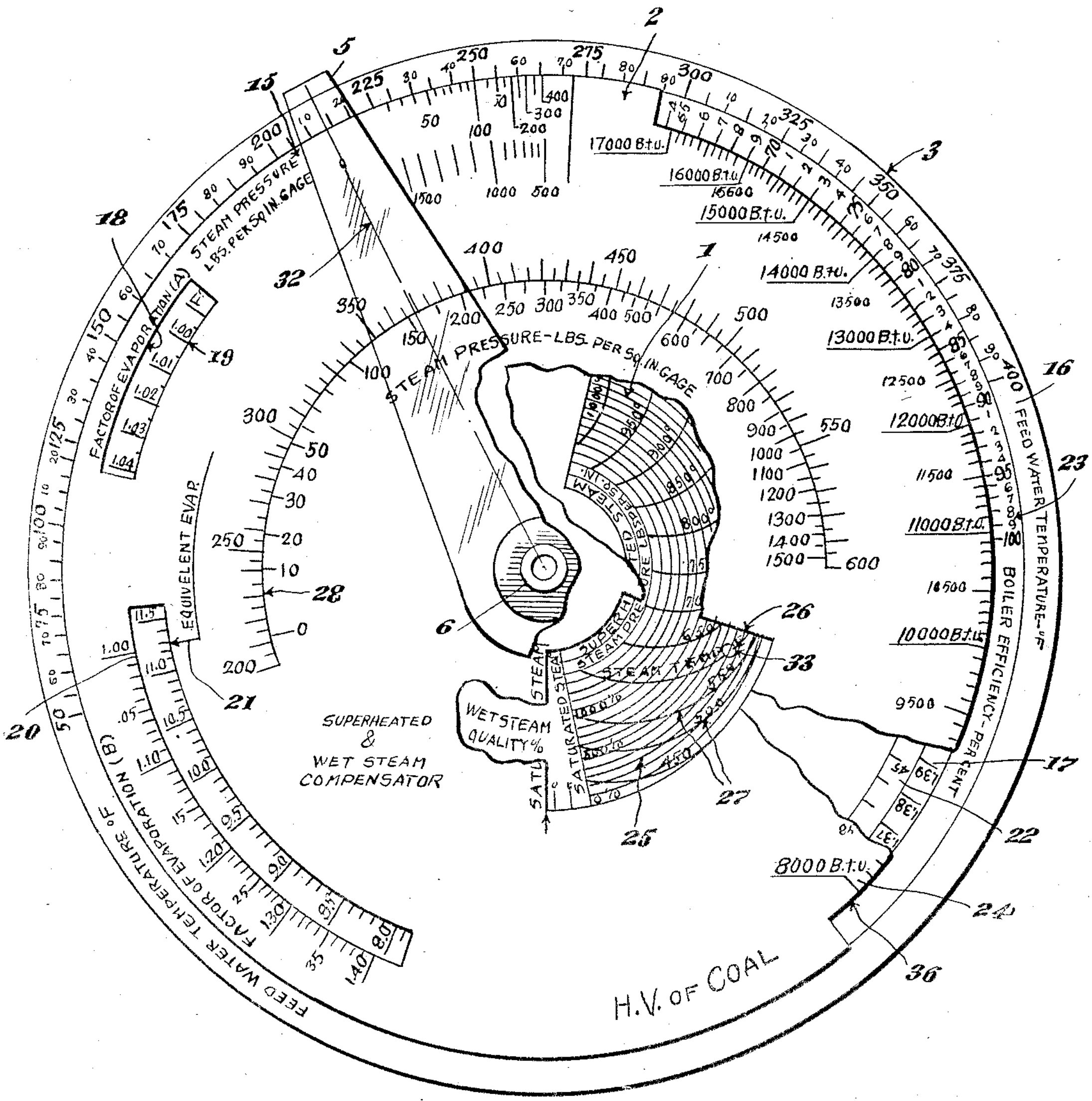
Fig. 3.



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FUEL ENGINEER'S CALCULATOR

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Application July 9, 1941, Serial No. 401,664

2 Claims. (Cl. 235—78)

This invention relates to a fuel engineer's calculator.

An object of the invention is to provide a simple yet accurate means of calculating boiler efficiency, steam cost, coal value, and other calculations necessary in connection with the operation of a boiler plant; a calculator designed so as to require but little technical knowledge on the part of its operator. This calculator will be of great help to purchasing agents in the purchase of coal, particularly if the coal is bought on specifications; to consulting engineers in the design and testing of boilers and coal; to boiler plant operators in quickly and accurately arriving at cost and efficiency results of the boiler plants; to stoker and boiler engineers in the testing of their respective equipment; and to fuel engineers in comparing and testing coals and coal burning equipment.

Another object of this invention is to accomplish the following results, which can be calculated with the fuel engineer's calculator: (1) Coal cost per million B. t. u.'s, (2) steam cost per 1,000 pounds, (3) boiler evaporation (pounds of steam generated per pound of coal burned), (4) quick method of arriving at the total cost of a given weight of coal where the weight is in pounds, and the unit cost in dollars per ton are known, (5) factor correction for meters, (6) logarithm scales for multiplying and dividing, (7) factor of evaporation regardless of quality or superheat of steam, (8) equivalent evaporation, (9) efficiency of boilers regardless of size, operating pressure, steam temperature or feed water temperature, (10) saturated steam temperature scale.

The accuracy of this calculator is within ½ of 1%.

With the foregoing and other objects in view, the invention comprises certain novel constructions, combinations, and arrangements of parts as will be hereinafter fully described, illustrated in the accompanying drawings, and more particularly pointed out in the appended claims.

In the drawings:

Figure 1 is a plan view of a calculator constructed in accordance with the present invention, parts being broken away.

Figure 2 is a transverse sectional view taken on line 2—2, Figure 1.

Figure 3 is a plan view, parts being broken away, of the side of the calculator opposite to that shown in Figure 1.

Referring to the drawings, in which the preferred embodiment of this invention is illustrated, 1 and 2 designates outer discs and 3 is a central disc, and 4 and 5 are guides. The discs and guides are riveted together at 6, Fig. 2, and in such a way that each of the discs and guides can be rotated independent of the other, and in such a way that when a guide is set, there is enough friction between the guide and its adjacent disc that the guide will remain in a fixed position with respect to its adjacent disc if that disc be moved with respect to another disc.

The discs 1, 2 and 3 should be made of either a light metal or other translucent or opaque material. Guides 4 and 5 should be made of transparent material as shown in Figures 1 and 3.

Referring particularly to Figure 1, the disc 1 has for its outside scale a logarithmic scale 7. This scale 7 is used as a steam scale in connection with a second logarithmic scale 8 extending around the periphery of disc 3. This scale 8 is termed the coal scale and is used in calculating boiler evaporation. These two logarithmic scales are also used to compensate for meter factors and in the ordinary way for operations involving multiplication and division. The logarithmic scales are direct scales, that is they read clockwise. The scale 7 has its origin at "1" and the scale 8 likewise has its origin at "1." The calibration of the scale in each instance is arrived at by multiplying the logarithms to the base 10 of the successive numbers desired to be laid out by 360° and marking off the corresponding angle in a clockwise direction from the point of origin. Thus, the location of the division line representing 2.15 (21.5, 215.0 etc.) is arrived at as follows:

Log $2.15 \times 360° = 0.33244 \times 360 = 119.68$ and the required line is laid off at 119.68° from the starting point of the scale. This method of calibration holds true for all direct and inverted scales, the only difference being that the angular distance is measured counterclockwise for inverted logarithmic scales. As is common in all logarithmic scales starting at "1" the numerical values assigned to a given scale may be 1×10^X where the exponent X is a whole number, either positive or negative. Thus, the scales may start at 10, 100, 1000, etc. or at .001, .01 or .1 in a device of this character without departing from the method of laying out the divisions. Near the top of disc 1 is a window 9 through which scales 10 and 11 on disc 3 can be seen. Scales 10 and 11 are both inverse logarithmic scales laid out on disc 3 in such a way that the starting points of both scales are radially aligned with each other and with the starting point "1" of scale 8 on disc 3. Scale 10 is calibrated in thousands of B. t. u.'s per pound of coal. This scale is used in connection with scales 12 and 13 to calculate coal cost per million B. t. u.'s. Scale 11 is calibrated in boiler evaporation (pounds of steam generated per pound of coal burned). This scale 11 is used in connection with scales 7 and 8 to calculate boiler evaporation direct. The scale is also used in connection with scales 12 and 13 in calculating steam cost per thousand pounds. Scale 13 is a straight logarithmic scale with the same angular origin as scale 8, and is calibrated in cents from 5¢ through 49¢. Such a range of calibration is adopted for the sake of convenience and practical cost calculations.

Scale 12 is a logarithmic scale laid out on disc 1 in such a way that "2" of this logarithmic scale is radially aligned with the starting point "1" of scale 7. This scale is calibrated for dollars and cents and is used in arriving at steam costs per thousand pounds, coal costs per million B. t. u's, and total coal costs.

Refering to Figure 3, the steam pressure scale 15 is laid out in the following manner: 0 pounds per square inch gauge (14.8 pounds per square inch absolute) is used as the origin. The space between the points designating the various pressures and the origin (0 pressure) represents the difference in heat content of saturated steam at the various pressures shown and saturated steam at 0 pressure. Each one degree clockwise from point of origin represents a difference of two B. t. u.'s per pound in heat content of saturated steam. Therefore, to arrive at the location representing any pressure, the following is the procedure used: The heat content of saturated steam at the considered pressure minus the heat content of steam at 0 pressure gauge (14.8 pounds per square inch absolute) divided by two equals the number of angular degrees clockwise from 0 pressure calibrated on the steam pressure scale at which to locate other pressures on the scale.

Scale 16 is the feed water temperature scale, laid out on disc 3 allowing each angular degree to represent a difference of 2 B. t. u.'s per lb. in heat content of water at the temperatures considered. This scale has the same modulus with respect to difference in heat content as scale 15.

The factor of evaporation scale 17 on disc 3, as seen through window 18 of disc 2 is laid out in the following way: This scale 17 is laid out in a counter-clockwise direction beginning at 1.00. Each angular degree in a counter-clockwise direction from the origin representing a difference of two B. t. u.'s per pound of heat content in steam. The location of 1.01 with respect to 1.00 is arrived at in the following manner:

$$\frac{(1.01\times970.2)-(1.00\times970.2)}{2}=4.85^\circ$$

The point 1.01 is located 4.85° counter-clockwise from 1.00. The location of the other factors are established in the same way. The angle between the location of factor of evaporation 1.00, scale 17 and the feed water temperature 212 degrees located on scale 16 must be the same as the angle between the index arrow 19 of window 18 and the line representing 0 pressure of scale 15. From foregoing procedure of calibrating scale 17 it will be apparent that this scale can also be calibrated directly in B. t. u.'s, allowing one angular degree for a difference of 2 B. t. u.'s. If calibrated in B t. u.'s, 970.2 as the scale reference point would assume the same relative position as 1.00 does on the factor of evaporation scale.

The factor of evaporation (B) scale over window 20 is an inverse logarithmic scale calibrated as factor of evaporation. The equivalent index arrow 21 of window 20 on disc 2 is radially aligned with the point "1.00" of the factor of evaporation (B) scale.

The scale 22 on disc 3 as seen through window 20 of disc 2 is a logarithmic scale calibrated for evaporation factors (pounds of steam evaporated per pound of coal burned). The location of scale 22 on disc 2 is arbitrary with respect to scale 17.

The boiler efficiency scale 23 on disc 3 is a logarithmic scale calibrated in percentage units. The heating value of coal scale 24 on disc 2 is an inverse logarithmic scale calibrated to be read in 1,000's of B. t. u.'s. The location of scale 23 on disc 3 and 24 on disc 2 must be made in such a way that when the equivalent evaporation arrow of window 20 lies opposite 10.0 read from the evaporation scale 22, the 10,000 B. t. u. line of scale 24 will lie opposite 97% read from scale 23. In other words, the angle on disc 2 between the equivalent evaporation index arrow 21 of window 20 and 10,000 of scale 24 must be the same as the angle on disc 3 between 10.0 of scale 22 and 97.0% of scale 23.

The scales 25 are located on the back of disc 1 and seen through a slot 26 cut in disc 2 and through a slot 35 in disc 3 (Fig. 1). The curves 27 counter-clockwise from the saturated steam line are the superheated steam compensating curves. These curves are laid out with the circular lines representing steam pressure in pounds per square inch and the curved lines 27 representing steam temperature in degrees F. The steam pressure lines are laid out in a circle with equal distance between each line. The locations of the temperature curves are determined in the following way: The heat contents of the steam at the temperature considered for each of the pressures considered are obtained from steam tables. The heat contents of saturated steam at each of the pressures are obtained in a similar way. To arrive at each of the temperature points on the pressure curves, subtract the heat content of saturated steam at the pressures considered from the heat contents of steam at the same respective pressures and at the steam temperature considered. These differences are the heat added to each pound of saturated steam in raising it from saturated steam to the temperature considered at the various pressures considered. Divide these differences by two. This will give the number of angular degrees counter-clockwise on the circular pressure curves from the saturated steam line at which to locate points on the steam pressure curve to make the steam temperature curve considered. As before, each angular degree represents a difference of two B. t. u.'s per pound in heat content of the steam. Each steam temperature curve is plotted in the same way.

The wet steam compensating scale extends clockwise from the saturated steam line of scale 25. This scale is laid off in per cent quality decreasing in a clockwise direction from the saturated steam line. Each point representing per cent quality was arrived at in the following way: The average latent heat of vaporization for pressures from 0 to 500 pounds was determined. The location of the 99% quality line was arrived at by multiplying the average latent heat of vaporization by .01. This product was divided by two which gave the number of degrees clockwise from the saturated steam line to locate the 99% quality point. In this case as before, one degree represents a difference of two B. t. u.'s per pound in heat content of the steam.

The saturated steam scale **28** of disc **2** is a scale laid out with equal spacing for temperature ranging from 200 degrees F. to 600 degrees F. with their corresponding saturated steam pressures as shown in Figure 3.

In order to better explain the uses and operation of the fuel engineer's calculator, a typical set of results are taken from an average boiler plant from which cost and efficiency results will be calculated: (1) Boiler pressure: 400 pounds per square inch gauge, (2) steam temperature: 600° F., (3) feed water temperature: 230° F., steam generated over a 24-hour period: 1,200,000 pounds, coal burned over a twenty-four hour period: 113,500 pounds. Heating value of coal burned: 14,500 B. t. u.'s per pound, coal cost, (dollars) per ton delivered: $3.50.

The following are typical calculations which can be made with the fuel engineer's calculator using the above data and other assumed data:

1. Actual evaporation (pounds of steam generated per pound of coal burned): Refer to Figure 1, scales **7** and **8**: Scale **7** is the steam scale and scale **8** the coal scale. Guide line **29** is set on the weight of steam generated in pounds on scale **7**. Disc **1** and the guide **4** are rotated until the guide line **29** lies over the weight of coal burned read from scale **8**. The actual evaporation in pounds of steam generated per pound of coal burned is read from scale **11** opposite the index arrow **30** of window **9**. Figure 1 shows the correct settings to calculate the average evaporation using the results given above. Guide **4** is set over "120" (1,200,000) of scale **7** and the guide line **29** lies over "1135" (113,500) on scale **8**. The evaporation 10.57 is read from scale **11** opposite the index arrow **30** of window **9**. It will be noted in setting the guide line over either the steam generated or the coal burned in pounds that the decimal point is not considered. This setting is made in the same way as the setting on a slide rule.

2. Steam cost per 1,000 pounds (based on coal cost per ton): The steam cost per 1,000 pounds is arrived at by setting the index arrow **30** of window **9** opposite the evaporation considered and as read on scale **11**. Holding discs **1** and **3** together, set guide **4** over the coal cost per ton on scale **12**. The steam cost per 1,000 pounds is then read direct from scale **13** in cents per 1,000 pounds. Therefore, referring back to the above example, it will not be necessary to move discs **1** and **3** after arriving at the evaporation 10.57. Holding discs **1** and **3** together, set guide **4** over $3.50 on scale **12**. The steam cost per 1000 pounds 16.6¢ is read from scale **13**. The same above procedure can be used in calculating the evaporation necessary to give a predetermined steam cost per 1,000 pounds for a given coal cost.

3. Meter factors: To correct for a meter factor, set the guide **4** over the meter factor on scale **7**. Rotate disc **1** and guide **4** until the index arrow of scale **7** lies opposite the difference in meter readings read from scale **8**. The corrected meter reading is read under the guide line and from scale **8**. Assuming that the meter factor is 1.20 and that the difference in meter readings is 95, the corrected quantity is 113.5. If in the case of a steam flow meter, the total steam equals the meter reading times 1,000, with a meter factor of 1.20. The correct amount of steam would be 113,500 pounds.

4. Total coal cost of a given weight of coal: If a definite weight of coal in pounds and the coal cost per ton are known, the total cost of that quantity of coal can be quickly determined in the following way: Set the guide **4** over the coal cost per ton on scale **12**. Rotate disc **1** and the guide **4** until the index arrow of scale **7** lies opposite the pounds of coal read from scale **8**. The total cost of the coal is read under the guide line on scale **8**. The decimal point must be determined by the operator. Assume the weight of coal considered to be 95,000 pounds and the coal cost to be $2.37 per ton. By reading under guide **4** from scale **8** the coal cost would be $112.30. The figures 1123 are obtained by the reading on scale **8** and a short mental consideration will determine that the total cost would not be $11.23 nor would it be $1123.00 but $112.30.

5. Coal cost per million B. t. u.'s: Set the index at the top of window **9** oposite the heating value of coal in B. t. u.'s per pound read from scale **10** (the top scale seen through window **9**). Set the guide over the coal cost per ton on scale **12**. The coal cost in cents per million B. t. u.'s is read directly from scale **13**. Assuming that the coal has a heating value of 10,570 B. t. u.'s per pound and the coal costs $2.39 per ton, the coal cost per million B. t. u.'s as read from scale **13** is 11.33¢.

6. Multiplying and dividing: Scales **7** and **8** can be used to multiply and divide. To multiply two numbers set the index arrow of scale **7** opposite one of the numbers to be multiplied as read from scale **8**. Set the guide line **29** over the other number on scale **7**. The product of the two numbers will be read under the guide line **29** and on scale **8**. To multiply 95×1.2, the index arrow of scale **7** is set opposite "95" of scale **8**. Guide **4** is set over "12" of **7**. The product 113.5 is read under the guide line and from scale **8**. To divide the reverse is the procedure. The guide is set over the denominator as read from scale **7**, and disc **1** and the guide **4** are rotated until the guide line **29** lies over the numerator as read from scale **8**. Assume that 113.5 is to be divided by 1.2. It is seen that the quotient is 95.

7. Factor of evaporation—saturated steam: Refer to Figure 3, set the guide **5** on the steam pressure considered as read from scale **15**. Rotate discs **2** and the guide **5** until the guide line **32** lies over the feed-water temperature considered and as read from scale **16**. The factor of evaporation or the difference in heat content of saturated steam at pressures considered and water at the temperatures considered will be read opposite the index arrow **19** of window **18** and on scale **17**. Considering the above example with a steam pressure of 400 pounds per square inch gauge and feed-water temperature of 230° F., the factor of evaporation is calculated to be 1.038.

8. Factor of evaporation—superheated steam: As before, the guide line **32** is set on the steam pressure considered and read from scale **15**. Disc **2** and guide **5** are rotated until the guide line **32** lies over the feed-water temperature considered and read from scale **16**. Holding discs **2** and **3** together, rotate disc **1** until the saturated steam line on **25**, seen through window **26**, lies directly under the saturated steam line which forms the left side of window **26**. Holding discs **1** and **3** together, rotate disc **2** counter-clockwise until the saturated steam line on disc **2** at window **26** lies over the intersection of the steam pressure and steam temperature lines considered. The factor of evaporation or difference in heat content of

steam and of water under conditions considered are read opposite the index 19 of window 18 and on scale 17. Referring to the above example in which the steam pressure is 400 pounds per square inch, feed-water temperature 230° F., and steam temperature 600° F., the guide line 32 is set over 400 pounds per square inch on scale 15. The guide and disc are rotated until the guide line lies over 230 on scale 16. Holding discs 2 and 3 together, disc 1 is rotated until the saturated steam line on 25 falls directly under the left edge of window 26. Holding discs 1 and 3 together, disc 2 is rotated counter-clockwise until the intersection of the 400 pound pressure line and the 600° steam temperature line on the superheated steam temperature curves of 25 falls directly under the left edge (saturated steam line) of window 26. This point is located at 33 on Figure 3. The factor of evaporation is then read directly from scale 17 opposite the index arrow 19 of window 18. In this case the factor of evaporation will be found to be 1.145.

9. Factor of evaporation—wet steam: The same procedure is followed in arriving at the factor of evaporation considering wet steam as was used in arriving at the factor of evaporation considering superheated steam with the exception of the last move of disc 2 with respect to discs 1 and 3. If the saturated steam lines of window 26 and scale 25 have been lined up as before, disc 2 is rotated clockwise, rather than counter-clockwise as before, until the saturated steam line of window 26 lies over the per cent quality read from the wet steam quality scale of 25. Refer to the example and assume the steam pressure to be 400 pounds per square inch, the feed-water temperature 230° F., and the steam quality 97%. The factor of evaporation will be found to be 1.010.

10. Equivalent evaporation: Set the guide line 32 over the factor of evaporation as read from the factor of evaporation scale (B) of window 20. Rotate the guide and disc 2 until the guide line lies over the actual evaporation as read from scale 22 seen through window 20. The equivalent evaporation will then be read opposite the equivalent evaporation index arrow 21 of window 20, and from scale 22. Referring to the previous example in which the factor of evaporation was found to be 1.145 (superheated steam considered) and the actual evaporation 10.57, and by following the above instructions, the equivalent evaporation will be found to be 12.0.

11. Boiler efficiency: With the equivalent evaporation index arrow 21 of window 20 opposite the equivalent evaporation read from scale 22, set the guide over the heating value of coal read from the heating value of coal scale 24. The boiler efficiency will be read directly under the guide line and from scale 23. Refer to the previous example in which the equivalent evaporation was found to be 12.0 and assume the heating value of coal to be 14,200 B. t. u.'s per pound; the efficiency will be found to equal 82.2%. By reversing the above procedures the equivalent and actual evaporation of boilers can be quickly and accurately calculated for a given boiler efficiency. In other words, if the efficiency of a boiler is guaranteed, the steam rate and coal rate can be quickly and accurately calculated.

12. Saturated steam temperature: Scale 28 is a scale giving the saturated steam temperatures of the various operating boiler pressures. This scale was included for the convenience of calculating the degrees superheat of steam temperatures and other calculations where steam pressures and temperatures are involved.

As a résumé of the description and operation of the device it will be noted that in regard to the steam pressure scale—feed water temperature scale—superheated scale—Wet steam scale: All of these scales are laid out on the basis of a differential in heat content of 1 lb. of water or steam. One angular degree on each of these scales represents a difference of 2 B. t. u.'s per lb. in heat content of 1 lb. of water or steam, whichever is considered. Referring to the steam pressure scale (scale 15, Figure 3), the angular difference in degrees between the location of zero pressure (14.7 lbs. per square inch absolute) and 50 lbs. pressure multiplied by 2 represents the difference in heat content of saturated steam at zero lbs. per square inch pressure and 50 lbs. per square inch. The same is true of the feed water temperature scale (scale 16, Figure 3). The angular difference between any two temperatures (angular difference in degrees multiplied by 2 represents the difference in heat contents in B. t. u.'s per lb.) will represent the difference in heat content of water at the saturated temperatures considered. The superheated steam chart is arrived at in the same way (window 26, Figure 3). The angular difference (positive angle) in degrees between the saturated steam line (marked as such) and the intersection of the steam pressure line and the considered steam temperature line represents the difference in heat content in B. t. u.'s per lb. of the saturated steam at that pressure and the steam at the temperature considered (angular degrees $\times$ 2=B. t. u. diff.). In all cases, the heat content of the water and steam was taken from standard steam tables. The wet steam scale was arrived at by getting the average difference in heat content of 1 lb. of saturated steam and steam at the various per cent qualities and allowing each angular degree to represent a difference of 2 B. t. u.'s per lb. of the steam. This scale is the average between 50 lbs. and 300 lbs. and, therefore, is not exact. All other scales are as close as can be calibrated.

Steam temperature scale (scale 28, Figure 3).—This scale is merely a scale for arriving at the saturated steam temperature at the various pressures, or vice versa. Again the points for this scale were taken from steam tables.

Factor of evaporation scale.—The factor of evaporation, as considered here and as is generally accepted, equals the difference in heat content of steam in its final condition and the feed water in its original temperature, divided by 970.2. The factor of evaporation scale (scale 17, Figure 3) is laid out in the following manner: The difference between the factor of evaporation 1.0 and the factor of evaporation 1.01 represents the difference in heat content of 0.01 multiplied by 970.2 B. t. u.'s. The angular difference between 1.00 and 1.01 equals 0.01 multiplied by 970.2, divided by 2 (again each angular degree represents a difference of 2 B. t. u's per lb.).

Relative position of scales

Figure 1, disc 1.—Scale 7 and arrow 30 have the same angular origin. Scale 7 is a straight logarithmic scale. Scale 12, also a straight logarithmic scale, has its origin (10¢) "X" degrees counter-clockwise from the origin of scale 7, where "X" equals log 2 multiplied by 360°.

Figure 1, disc 3.—Scales 13, 8, 10 and 11 have the same angular origin. Scales 8 and 13 are straight logarithmic scales; scales 10 and 11 are inverse logarithmic scales.

Figure 3, disc 2.—Steam pressure scale 15 is laid out as described above. Arrow 19 and window 18 are located so as not to interfere with other scales. Scales 16 (feed water temperature scale) and 17 (factor of evaporation scale) are so located that when zero pressure on scale 15 lies opposite 212° on scale 16, arrow 19 will be directly opposite 1.00 of the factor of evaporation scale 17.

The factor of evaporation "B" scale (window 20) and arrow 21 are so located as not to interfere with other scales. The same is true of the heating value of coal scale 24. (Scales 24 and B are inverse logarithmic scales.)

Boiler efficiency scale 23 (straight logarithmic scale) and the evaporation scale 22 (straight logarithmic scale) are so laid out that when arrow 21 lies opposite 10.0 of scale 22, 97.00 read from scale 23 lies exactly opposite 10,000 read from scale 24.

Scale 28 is so located as not to interfere with other scales.

Scale 25 located on the back of disc 1 and seen through window 26 must have the same common center as the other scales on discs 2 and 3. Window 35 (Figure 1) does not have to be located exactly with respect to another reference line. It should begin at a line drawn from the center of the disc (Figure 3) through 100° F. of the feed water temperature scale 16 and extend counter-clockwise approximately 260°.

Window 26 does not have to be exactly located with respect to any other line, but should begin on a line extended from 400 lbs. per square inch on scale 15 through the center of disc 2 and extend counter-clockwise approximately 60°.

Advantages of the fuel engineer's calculator:

The fuel engineer's calculator relieves its operator of long and involved calculations in connection with calculating steam cost, unit coal cost, boiler efficiency, and other involved calculations in connection with coal burning equipment and boiler plant operation. This calculator relieves the necessity of using steam tables and slide rules in connection with the above calculations. It is laid out so that it greatly simplifies complicated calculations. This calculator can be manufactured at a relatively small cost. It can be made of such size that it can be carried conveniently yet at the same time be large enough to be read very accurately.

In the following claims the disc 1 may be referred to as the "primary disc"; disc 3 as the "intermediate disc," and disc 2 as the "auxiliary disc"; also these discs may be referred to in the claims as "first member," "second member" and "third member."

As shown in Fig. 1, a segment of the scale 12 is set inwardly along radial lines such as 34 so as to provide space for the window 9.

Referring to Figure 3, the auxiliary disc 2 is provided with a long marginal notch 36, between the ends of which is exposed the scale 23.

While I have described the preferred embodiment of my invention and illustrated the same in the accompanying drawings, certain changes or alterations may appear to one skilled in the art to which this invention relates during the extensive manufacture of the same and I, therefore, reserve the right to make such changes or alterations as shall fairly fall within the scope of the appended claims.

What I claim is:

1. In a calculator, a first member having a saturated steam pressure scale graduated in accordance with the difference in heat content of saturated steam at different pressures, said member also having an index point for cooperation with another scale; a second member having a water temperature scale graduated in accordance with the difference in heat content of water at different temperatures and having the same modulus as the saturated steam pressure scale of the first member and also having a function of the difference in heat content scale and having equal spaced graduations for cooperation with the index on the first member so that when a steam pressure of the saturated steam pressure scale of the first member is set opposite a water temperature of the water temperature scale of the second member, the index on the first member will indicate on the factor of evaporation or difference in heat content scale of the second member the factor of evaporation or the difference in heat content of saturated steam at the pressure considered, and of water at the temperature considered.

2. In a calculator, a first member having a saturated steam pressure scale graduated in accordance with the difference in heat content of saturated steam at different pressures, said member also having a first index point for cooperation with a scale on a second member and a second index point for cooperation with a chart on a third member; a second member having a water temperature scale graduated in accordance with the difference in heat content of water at different temperatures and of the same modulus as the saturated steam pressure scale of the first member, and also having a function of the difference in heat content scale of equal spaced graduations cooperating with said first index point; a third member having a graph with lines graduated in accordance with the difference in heat content of saturated steam and superheated steam at different pressures and having the same modulus as the saturated steam pressure scale of the first member, said third member also having a steam quality scale graduated in accordance with the difference in heat content of saturated steam and steam at different qualities, said steam quality scale being of the same modulus as the saturated steam pressure scale of the first member, the cooperation of the saturated steam pressure scale of the first member and the water temperature scale of the second member and of the second index of the first member and the superheat scales or quality scales of the third member providing the means for calculating the factor of evaporation or the difference in heat content of superheat steam at pressures and temperatures considered, or of steam at qualities considered, and of water at temperatures considered, such results appearing opposite the first index of the first member and on the factor of evaporation or difference in heat content scale of the second member.

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