Dec. 28, 1937. W. W. MAYFIELD 2,103,332

POLE AND GUY CALCULATOR

Filed Aug. 11, 1936 2 Sheets-Sheet 1

Fig. 1.

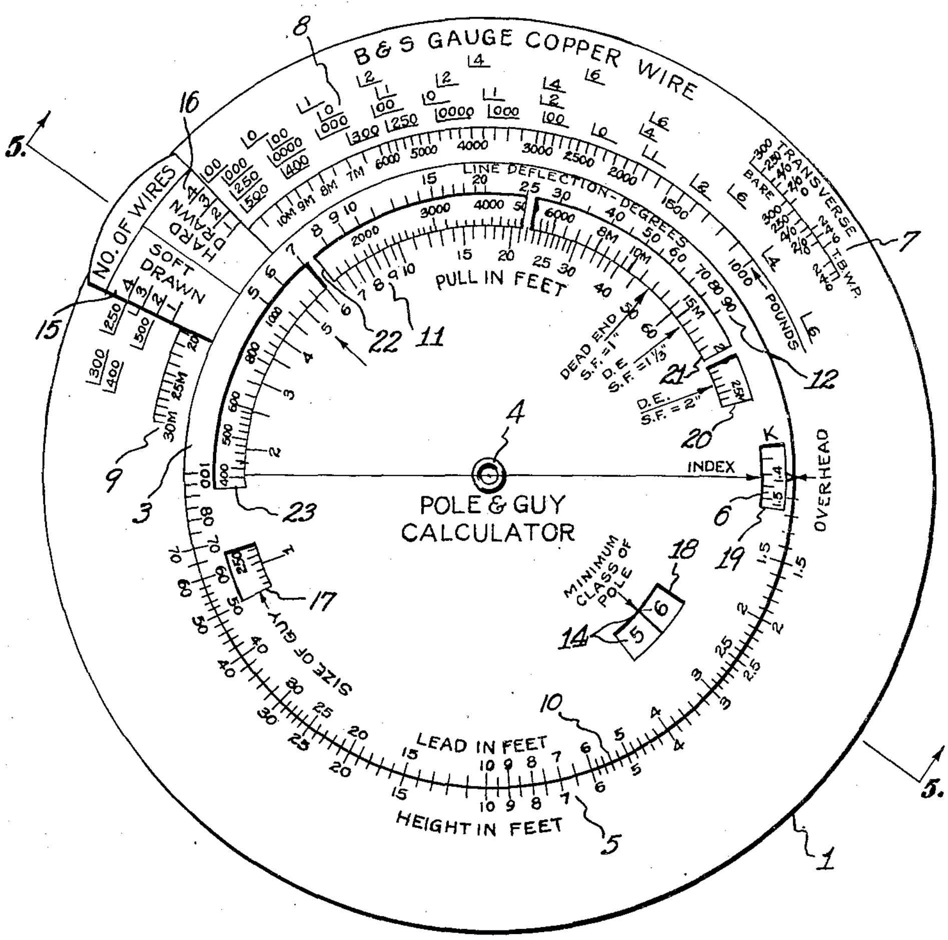
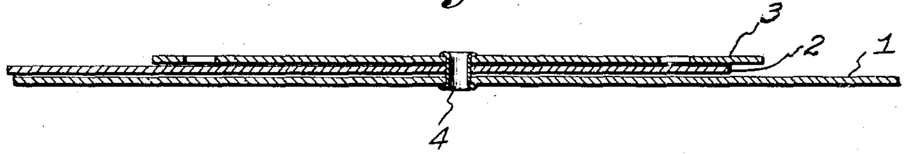


Fig. 5.



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POLE AND GUY CALCULATOR

Filed Aug. 11, 1936 2 Sheets-Sheet 2

Fig. 2.

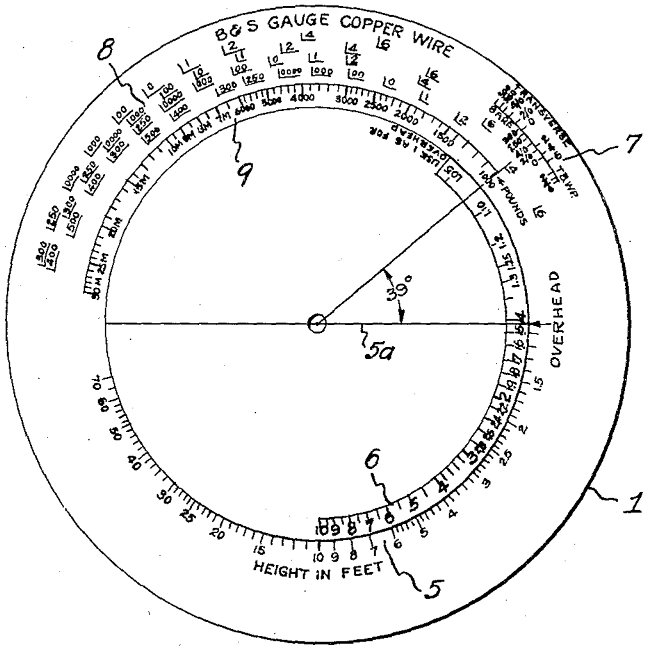


Fig. 3.

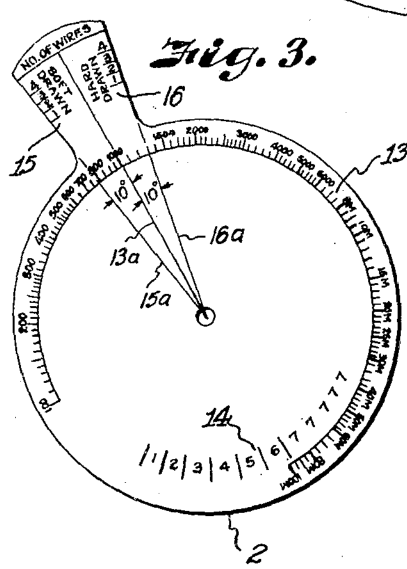
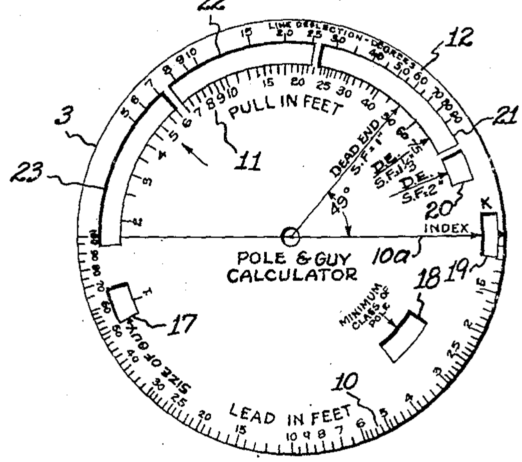


Fig. 4.



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UNITED STATES PATENT OFFICE

2,103,332

POLE AND GUY CALCULATOR

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Application August 11, 1936, Serial No. 95,316

3 Claims. (Cl. 235—84)

This invention relates to calculating apparatus and has for its principal object the provision of an apparatus for determining data relative to pole line construction, guying of stacks, and the like.

In the construction of pole lines carrying telephone, telegraph or power transmission wires, it is important that certain constants of the line be accurately calculated so as to insure that the line, when constructed, will be strong enough to withstand conditions encountered. Heretofore the data used in such computations have been available in table or chart form, which at best are somewhat cumbersome to use. The factors to be considered in the calculations vary through such wide limits, because of the conditions encountered along the line, that it is frequently desirable to make calculations at the site of the construction of the line. This has been inconvenient heretofore because tables and charts do not lend themselves well to use in the field, and, as a result, calculations have been made in the office, and allowance made for factors not definitely known.

It is an object of the present invention to provide a simple and cheap calculating device which can be carried in the pocket for use in the field and which is constructed to facilitate calculation of the data required for the construction of a pole line or the like.

Another object of the invention resides in the provision of scales upon the calculating device upon which all measurements taken to determine the data required for the construction of a line may be read directly without computations other than those made by the calculating device.

Further objects of the invention, not specifically mentioned here, will be apparent from the detailed description and claims which follow, reference being had to the accompanying drawings in which a preferred embodiment of the invention is shown by way of example, and in which:

Figure 1 is a plan view of the calculator;

Figure 2 is a detailed plan view of the base member of the device;

Figure 3 is a detailed plan view of the intermediate member;

Figure 4 is a detailed plan view of the top member; and

Figure 5 is a cross sectional view through the device, taken substantially along the line 5—5 of Figure 1.

The calculating device shown by way of example, is constructed for computing the sizes of guy wires needed to brace a pole line, and to determine the minimum class of pole needed therefor under varying conditions. As shown, the device consists of three members, a base 1, an intermediate member 2, and an upper member 3, which members are held together by an eyelet 4 that serves as a pivot to permit the members to be rotated with respect to each other. Preferably the members are composed of material that is thick enough to be fairly rigid.

Upon the base member 1 there is provided a scale 5 designated as "Height in feet". This scale indicates the vertical height in feet of the point of attachment of the guy wire to the pole, which can be measured by ordinary methods. Scale 5 is located upon an arc centered at the center of the pivot 4, and having a radius the same as the radius of the upper member 3. Scale 5 is a logarithmic scale starting from a unity point that is located upon a diameter 5a, and progressing so that the value 10 is located 90 degrees from the starting point. That is the scale is laid out with a logarithmic cycle covering 90 degrees. Scale 5 is extended through 1.7 cycles to indicate heights up to 70 feet, the maximum height likely to be encountered in pole line construction.

The base 1 also carries a scale 6 which is graduated to denote the figure by which the tension of the wires or conductors are to be multiplied for a given ratio of lead to height. Lead of the guy wire is the term commonly used in the art to designate the distance from the pole to the point of entry of the guy into the ground. The ratio, lead divided by height, represents the tangent of the angle of the guy. To locate scale 6 with respect to scale 5, an angle of 45 degrees is assumed. The tangent of this angle is 1, and the reciprocal of the tangent is also 1. The reciprocal of the sine of the angle of 45 degrees which is the cosecant is found to be 1.414, and this value is located upon scale 6 opposite the unity point upon scale 5. Other points upon the scale 6 are located in a similar manner, scale 5 being extended past the base line and point 1 thereon for construction purposes, this extension being subsequently erased. Scale 6 need be extended only to include ratios as low as 1.05, for when the ratio of lead divided by height is less than 1.05, the scale is not needed, as will hereinafter appear. Scale 6 may be designated as the "K" scale.

The base member 1 is also provided with a scale 9 that is graduated in pounds pull. This scale is a logarithmic scale, increasing from 1000 to 10,000 in a 90 degree arc, and extending up to 30,000 pounds. The 1000 mark on scale 9 is located 39 degrees from the base line through unity on scale 5, this location being chosen for convenience. The radius of the arc upon which scale 9 is located is greater than the radius of the arc upon which scale 5 is located, so that scale 9 lies beyond the edge of upper member 3.

For convenience in reading the device, the base 1 also carries scales 8 which are graduated in B. & S. gauge copper wire, and represent the pounds pull of the wire when stressed to one half the ultimate strength of the material. Scales 8 are located with respect to scale 9 in the following manner. From tables it is determined that a #2 B. & S. hard drawn copper wire has an ultimate strength of 3000 pounds. The National Safety code specifies that under certain conditions electric light and power wires shall not be stressed to more than 50% of the ultimate strength, so ½ of the ultimate strength is taken, that is 1500 pounds. A straight edge is laid through the center of member 1 and the 1500 mark on scale 9, and the inner #2 mark on scale 8 is located along this edge. This determines the scale point corresponding to the pull in pounds of a single #2 wire stressed 50%. The scale is moved around the center to the 3000 mark on scale 9 to locate the #2 mark on scale 8 corresponding to two #2 wires each stressed to 50%, then to the 4500 mark on scale 9 to locate the point on scale 8 corresponding to 3 wires, then to the 6000 mark on scale 9 to locate the point on scale 8 corresponding to 4 wires. This operation is repeated for the other sizes of wires. Thus scale 8 is formed to read pounds pull of the wires directly by setting the device to the desired point on the scale, and no calculations are necessary.

The base member 1 is also provided with a scale 7 located outside of scale 8 and graduated to indicate effective pull, in pounds, due to wind action upon wires of the sizes indicated. This force tends to overturn the poles, and the scale 7 is useful in determining the size of pole to be used as well as to determine the strengths of storm guys. This scale is located with respect to scale 9 so that 1.00 on scale 7 lies on a radius from the center through the 1000 mark on scale 9. Scale 7 represents in pounds, the values of scale 9 divided by 1000. From tables it is found that the transverse force on #0 stranded triple braided weatherproof wire is 1.08 pounds per linear foot, so the point on scale 7 is located by extending the radius on which 1080 pounds is indicated on scale 9 through scale 7. The other points on scale 7 are located in the same manner.

The intermediate member 2 is generally circular in shape and of a diameter such that its circumference falls just inside scale 6, when the members are together as described above. An ear or tab extends radially from the member and is long enough to overlie the scales 8. This ear carries a scale 15 located along the left hand edge thereof, Figure 3, indicating the number of soft drawn copper wires, and a scale 16 along the right hand edge indicating the number of hard drawn copper wires. The scales 15 and 16 cooperate with scale 8, as will presently appear. The edges of the ear or tab are formed as radii centered upon the center of the member and are 20 degrees apart.

The member 2 also carries a scale 13 located at the edge of the circular portion thereof. This scale is a logarithmic scale having a 90 degree cycle. The 1000 point on the scale is located on the median line of the ear, that is 10 degrees from the edge indicating hard drawn wires. The scale 13 is extended for one cycle below 1000 and two cycles above, a total of 3 cycles or 270 degrees, this span being necessary to cover the required range. Scale 13 indicates size of guy wire in terms of the pounds pull it will withstand.

The member 2 also has a scale 14 located within the scale 13 and graduated in terms of minimum class of poles. This scale is determined from tables giving the maximum strength that a class of pole will withstand and projecting that value from scale 13. As indicated on the scale, the stronger the pole, the lower its class number.

The upper member 3 is circular, and is provided with an opening or window 18 that overlies the scale 14, so that that scale may be viewed therethrough. The legend "minimum class of pole" is located adjacent to this opening, with an arrow pointing along the line on which the scale 14 is to be read.

The member 3 is also provided with an opening or window through which the "K" scale 6 on the base member may be read. An index arrow marks the line upon which the reading is to be taken, and there is a second arrow in line therewith and at the periphery of the disk, for a purpose that will be later noted.

The member 3 is provided with a series of openings or windows 20, 21, 22, 23, and 17, formed to overlie scale 13 on member 2, to permit that scale to be read therethrough. A single window would serve the same purpose as this group of openings, the solid separators between the windows being left to support the outer rim portion of the disk. The member 3 might be made of a transparent material, in which case a single window would replace this group of openings.

The scales 10, 11 and 12 are located upon the member 3 in the following manner. A base line is drawn through the index arrow and serves as a unity point upon the scale 10. This scale gives the lead of the guy wire in feet, that is the distance from the pole to the point where the guy enters the ground. The scale is logarithmic, covering a cycle in 90 degrees, and extended through two full cycles, so that leads up to 100 feet may be read upon it.

The scale 11, which gives pull of the guy in feet, is located upon the upper half of the member 3, within the inner edges of the windows. The pull in feet is determined by measuring down the line 100 feet in each direction from the pole to be guyed, connecting these points with a straight line, and measuring the vertical distance in feet from the pole to this connecting line. The 50 point on scale 11 is located 49 degrees above the base line through the index arrow. The scale is constructed from this point as a logarithmic scale covering a cycle in 90 degrees. From the tabulated data it is known that a lead of 50 feet is the equivalent of a dead end, with unity safety factor. The point on scale 11 corresponding to 75 is marked "Dead end, safety factor 1⅓" by suitable abbreviation, and the 100 mark on the scale is marked the same with a safety factor of 2.

The scale 12 is located on the opposite side of the windows from scale 11, and is graduated in degrees of line deflection. This scale is derived from the formula,

$$\frac{\text{"Pull in feet"}}{100} \text{ sine } \tfrac{1}{2} \text{ of angle of deflection.}$$

An angle of 60 degrees is equivalent to a pull of 50 feet on scale 11, and the point 60 on scale 12 is therefore in line with the point 50 on scale 11.

The calculating device thus constructed is used in the following manner. Assuming that two strands of #2 hard drawn wire are to be guyed, that the height of the point of attachment of the guy to the pole is 50 feet and that the lead of the guy is 20 feet, and that the pull of the guy is 50 feet, that is a dead end. The member 2 is turned to line the right hand edge of the ear so as to bring the scale point 2 on scale 16 into alinement with the scale point 2 in the second row of scale 8. The member 3 is then turned so as to bring the point 20 on scale 10 into registration with point 50 on scale 5. The constant "K" for this combination of lead and height is read from scale 6 through window 19 opposite the index arrow, and is 2.7. The member 3 is turned to aline the outer index arrow with the 2.7 mark on the scale 5. The size of guy wire required may then be read on scale 13 opposite the 50 mark on scale 11, and will be 8100, the proper size of guy wire for the above conditions with a safety factor of 1. If the problem is changed by increasing the safety factor to 2, the size of guy wire will be read opposite the arrow designated as "D. E.—S. F. =2," indicating "Dead end safety factor 2". If the angle of deflection of the line is less than a dead end, say having a pull in feet of 30, the size of guy wire required will be read opposite point 30 on scale 11.

Assume that in the example stated above it is necessary to run the guy wire to a stub pole, as would be the case where a street or obstruction prevents guying the pole directly to the ground. The ratio of height to lead will be small and the outer arrow on the member 3 is turned to the arrow marked "Overhead" on member 1. The size of guy wire then required will be read opposite the 50 point on scale 11 as before, and will be 3000.

The calculator may be used to determine the minimum class of pole required under American Standards Association ruling, in the following manner. Assume the pole is to support three #4/0 bare copper wires with a front span and a back span each of 250 feet and it is desired to know the minimum class of pole that will be required to withstand 8 pounds of wind per square foot on the wires when covered with ½ an inch of ice.

The right hand edge of the ear on member 2 is set at 4/0 on scale 7. The member 3 is turned to aline the index arrow with "Overhead" point on scale 5. The middle and rear members are held while the front member is turned to 2.5 (250 feet span) on scale 5. The front and middle members, 2 and 3 are held together and moved until the index arrow is again at "Overhead". The members 1 and 2 are held, and the member 3 is again moved to aline the index arrow at 3 (number of wires) on scale 5. With this setting, the minimum class of pole required will be indicated through the window 18 on scale 14 opposite the arrow. A class 7 pole is indicated. If it is desired to know the force in pounds on the wires, under the conditions assumed, this may be read on the scale 13 opposite the arrow at 5 on the scale 11, and will be 750 pounds.

Other types of problems arising out of other conditions can be solved readily with the calculator in substantially the same manner as indicated in the above example as is obvious from the above description.

While I have chosen to show the invention in connection with guy calculations for copper wire, it will be apparent that scale 8 can readily be modified to adapt the calculator to other types of wire, such as aluminum, iron and steel, and the scale may be further modified to show loading constants other than the 50% of ultimate strength shown.

As was previously explained, the edges of the ear or tab on the member 2 are radii located 20 degrees apart, that is, each is 10 degrees from the center line of the ear. The 1000 pound mark on the scale 9 was noted as being 39 degrees from the unity point on scale 5, and the dead end position 50 on scale 11 was noted as being 49 degrees from the index arrow on member 3. The offset of the straight edges of the ear is therefore equal to the difference between the angles of offset of the scales with which the readings that are taken along these edges are combined, and the accuracy of the calculator is assured.

The one edge of the ear is used for hard drawn copper wires and the other edge is used for soft drawn copper wires. Soft drawn wires have a working strength of but 60% of the working strength of hard drawn wires. With the arrangement shown, soft drawn wire calculations are equally as accurate as are the hard drawn calculators.

From the foregoing it will be apparent that I have provided a new and improved calculating device that is possessed of many advantages. The date required for computation with device is simple data that may be acquired by direct measurement and without computation. By simple manipulation of the device the computation of that data is accomplished and the results read directly from the various scales on the device. The computator is simple and rugged and may be carried about without danger of destruction.

While I have shown my invention by illustrating and describing a preferred embodiment of it, I have done so by way of example, and am not to be limited thereby, as there are many modifications and adaptations that can be made by one skilled in the art, within the teachings of the invention.

What I consider new and desire to have protected by Letters Patent is:

1. A calculating device comprising a base member provided near its edge with a scale, an intermediate member movable with respect to said base and having a set of graduations thereon, an ear on said intermediate member, a set of graduations on said ear adapted to cooperate with said first scale, a set of logarithmic graduations on said base member, a second set of logarithmic graduations on said base member disposed concentrically within said first set, an upper member movable with respect to said base and intermediate member there being windows in said upper member through which are visible the set of graduations on said base member, a logarithmic scale on said upper member cooperating with the first one of said graduations on said base, and a second logarithmic scale on said upper member cooperating with the graduations on said intermediate member through said windows.

2. A calculating device comprising a base, a scale on said base, a second scale on the base opposite the first, a third scale on the base within the second, an intermediate member movable with respect to the base, an ear on said intermediate member overlying said first scale, a scale on said intermediate member at the edge thereof, a second scale on said intermediate member

within the first, an upper member movable with respect to the other members, there being a plurality of windows in said upper member, a scale on said upper member cooperating with the second one of said scales on said base, an index arrow on said upper member adapted to cooperate with the third one of said scales on said base through one of said windows, a second index arrow on said upper member adapted to cooperate with the second scale on said intermediate member through another one of said windows, and a scale on said upper member adapted to cooperate with the first scale on said intermediate member through the others of said windows.

3. A device for calculating pole line data comprising a base member, an intermediate member, an upper member, means for pivotally fixing said members together so that each may be rotated with respect to the others, scales on said base member located concentrically of said pivot, said scales being graduated to indicate pounds pull of wires, pounds pull of transverse winds on wires, heights of wires in feet above the ground, and cosecants of the angles between guy wire and pole, respectively, said intermediate member being circular and having a diameter equal to the diameter of said cosecant scale, an ear on said intermediate member projecting radially therefrom and overlying said pull of wires scales, a scale on said ear graduated in numbers of wires, a scale on the edge of said intermediate member graduated in size of guy wires, a second scale on said intermediate member disposed within said first scale and graduated in class of poles, said upper member being circular and having a diameter equal to the diameter of said height of wires scale, and having at least a portion thereof through which said size of guy wires scale, respectively, may be viewed and index arrows on said upper member adjacent the point through which said cosecant scale is visible.

WALTER W. MAYFIELD.