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VECTOR CALCULATING BOARD

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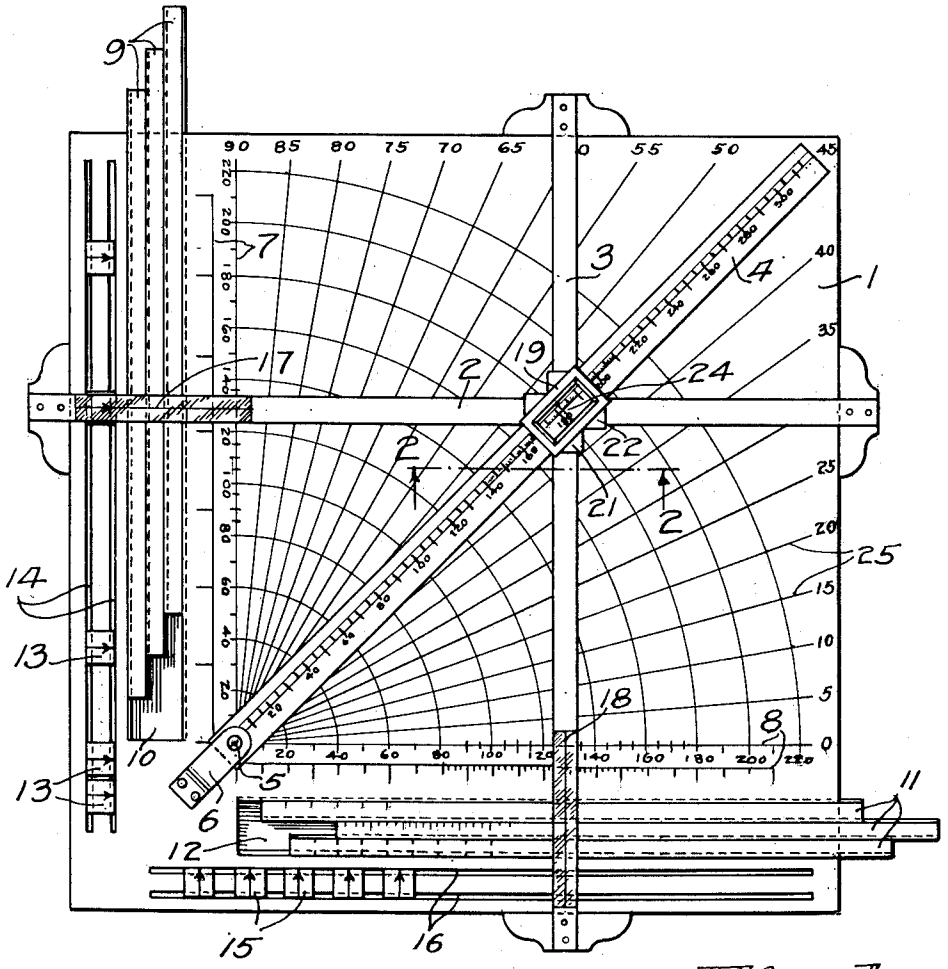
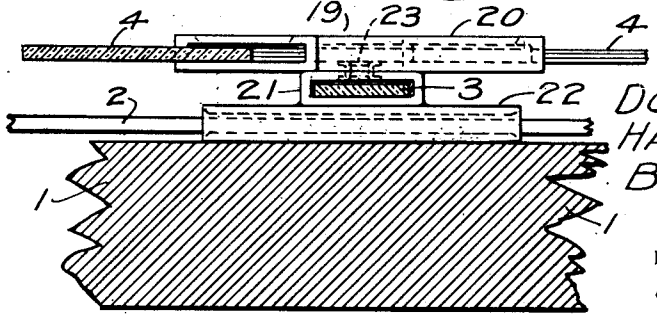


Fig. 1.

Fig. 2.



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VECTOR CALCULATING BOARD

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5 Claims. (Cl. 33—97)

(Granted under the act of March 3, 1883, as amended April 30, 1928; 370 O. G. 757)

The invention described herein may be manufactured and used by or for the Government of the United States for governmental purposes without the payment to us of any royalty thereon in accordance with the provisions of the act of April 30, 1928 (Ch. 460, 45 Stat. L. 467).

This invention relates to a mechanical calculating board for the addition and subtraction of vector quantities. In the allied fields of electrical engineering and mechanics vector quantities or vectors such as impedances, displacements, velocities, forces, etc. (all of which are quantities involving the idea of direction as well as amount) must be dealt with in the treatment of many problems. Problems involving addition and subtraction of vectors may be solved either mathematically or graphically. The instant invention relates to devices for readily solving such problems by graphic methods without the necessity of laborius computation.

An object of this invention is to provide a mechanism having intersecting elongated members movable with respect to suitable coordinate scales, together with a graduated elongated member pivoted at the point of origin of or the effective intersection of said scales together with means for maintaining the swinging portion of said graduated pivoted member above the point of intersection of said elongated members and a protractor scale associated with said graduated member whereby the distance between the point of origin of said scales and the point of intersection of said movable members may be read on the pivoted graduated member while the direction of the line established by these two points with respect to a suitable reference axis may be read on said protractor scale.

Other and further objects will be apparent from the following detailed description when read in the light of the accompanying drawing in which—

Figure 1 is a top plan view of a preferred form of the device; and

Figure 2 is an enlarged section on the line 2—2 of Figure 1.

In the drawing reference numeral 1 designates the base of the device of wood, metal, or the like, having a flat top surface and parallel opposite edges resembling a rectangular drawing board. An elongated straight edge member 2 rests on the base 1. A second elongated straight edge member 3 rests on the base 1 atop the straight edge member 2 and perpendicular to it. The straight edge members 2 and 3 are provided with T square ends engaging the respective edges of the base 1 so that each straight edge member is capable of sliding movement to and fro over the base along one axis. (It is to be understood however that straight edge members 2 and 3 may be movably mounted with respect to the base 1 in a manner similar to the mounting of the straight coordinate members shown in United States patent to Trueblood et al. No. 1,440,510 or United States patent to Webster No. 1,442,710.)

A third straight edge member 4 is pivotally mounted on pin 5 carried by the bracket 6 mounted on the base 1. The straight edge member 4 overlies the straight edge members 2 and 3. The pivot pin 5 is so positioned that the straight edge member 4 pivots about the zero-zero point on the coordinate scales 7 and 8 engraved or otherwise marked upon the base 1. Adjacent to the ordinate scales 7 the base 1 is provided with grooved slots 10 carrying additional scales 9. Adjacent to the abscissa scales 8 the base is provided with grooved slots 12 carrying additional scales 11. The base 1 is also provided with two pairs of narrow parallel slots. The slots 14 are parallel to the ordinate scales and the slots 16 are parallel to the abscissa scales. The slots 14 and 16 are provided for the purpose of receiving the spring ends of U-shaped index tabs designated 13 and 15, respectively. The straight edge members 2, 3 and 4, while they may be made of wood, metal or the like, are shown as being made of transparent plastic. The members 2 and 3 are provided with hair line index markings 17 and 18, respectively, engraved thereon for association with the respective coordinate scales 7 and 8 on base 1. Encompassing the point of crossing of straight edges 2, 3 and 4 there is located a slide member 19 (Figure 2). This member includes a straight edge holding portion 20 provided with an aperture therethrough of such size as to snugly receive the straight edge member 4. The slide member 19 also includes second and third straight edge holding portions 21 and 22 having apertures therethrough of such a size as to snugly receive the straight edge members 3 and 2, respectively. The last mentioned portions are made integral and the apertures therein are at right angles to each other with the straight edge members 3 and 2 passing through their respective apertures. The straight edge holding portion 20 of the slide member 19 is pivotally fastened to the lower portion of this member by the pivot bolt or pin 23. The straight edge holding portion 20 of the slide member may be made of metal or transparent plastic. In the illustrated embodiment it is shown as being made of metal with a rectangular portion cut out as viewed in Figure 1, with a cross hair 24 stretched

thereover perpendicular to the straight edge member 4 carried thereby. When this member is made of transparent plastic or is provided with a transparent top of plastic or glass, a line taking the place of the cross hair 24 can be engraved or etched directly upon its top without the necessity of cutting out material to make the graduations on the straight edge member 4 visible. The pivoted straight edge member 4 is provided with one or more sets of graduations thereon corresponding to the coordinate scales to be used. The member 4 is also provided with a hair line marking longitudinally thereof. The line established by this marking passes through the pivot axes of the pivot pins 5 and 23. The pivot axes of the pins 5 and 23 are both normal to the plane of the upper face of the base 1 and the pivotal axis 23 passes through the point of intersection of the lines established by the hair line marks 17, 24, and 18. The top of the base 1 may be ruled to resemble polar coordinate graph paper with the pivotal axis of the pin 5 as the origin, or these rulings may be omitted, but in any event the top of the base 1 is preferably provided with the angular graduations thereon, as shown schematically by the scale 25.

In operation the straight edge members 2 and 3 are moved with respect to their coordinate scales, thus moving the slide member 19 in accordance with the resultant compound motion imparted thereto. As the slide member 19 is moved, the straight edge member 4 is moved thereby, pivoting about the fixed axis of the pivot pin 25. The device can also be operated by moving the slide member 19 to cause its cross hair 24 to overlie a selected graduation thereon and a desired angular setting of the straight edge member 4 may be made with respect to the angular graduations 25, in which case the straight edge members 2 and 3 will be moved to resolve the vector quantity represented by the distance read off on the scale carried by the straight edge member 4 and its direction into two components at right angles to each other.

It will be apparent from the above description that when either the scales 7 and 8 or other suitable scales are employed, this equipment may be used to perform vectorial addition, subtraction and many other allied problems. One example will be given illustrating the use of the equipment for the adding of vectors. In this example it will be assumed that it is desired to determine the impedance of an electrical circuit having three ohms of inductive resistance at a particular frequency and having four ohms of ohmic resistance. Here the magnitudes of the components are different and their directions differ by ninety degrees. Vectorial addition of these two components is established by moving the straight edge member 2 to bring its hair line mark 17 above the scale 7 to the numerical value 3 and then moving the straight edge member 3 to bring its hair line mark 18 over the scale 8 to the numerical value 4. With the movement of the straight edge members 2 and 3 the slide member 19 is moved so that its cross hair 24 lies directly over the numerical indication 5 on the scale carried by straight edge member 4 and the angular displacement of this quantity with respect to either the resistance or the inductance can be read on the scale 25. Where for instance it is desired to resolve a vector having a magnitude of 183 plus and a direction of forty-five degrees with respect to the horizontal and vertical axes, the straight edge member 4 may be moved to bring its hair line over the 45° graduation of scale 25 and then the slide 19 can be slid therealong to indicate the magnitude of this vector, whereupon the slide members 2 and 3 are moved to bring their respective hair lines 17 and 18 to overlie the values 130 and 130 on coordinate scales 7 and 8, respectively, thus resolving the vector of a given magnitude and direction into two components at right angles to each other.

In the above description simple numerical values have been assumed for the purpose of simplicity. It is to be understood that the scales shown on the instrument are not necessarily as accurately laid out or proportioned as the scale graduations in an actual instrument. For the solution of a great number of problems of this type the additional scales 9 and 11 could be graduated to represent ohms, amperes, volts or some other quantity. In impedance problems scales 8 or 11 would represent resistance values in ohms and scales 7 and 9 would represent reactance values. The total impedance therefore is read on the scale carried by the straight edge member 4. For voltage or current, scales 8 and 11 would represent real values while scales 7 and 9 would represent "imaginary" values. The magnitude of the resultant vector would be read on the scale carried by straight edge member 4 and the angular displacement by reading the angle between this member and the horizontal. Certain of the removable or interchangeable scales 9 and 11 could be graduated in other manners. For example, a certain size of conductor has a certain resistance and reactance per mile. Therefore, one of the scales of the set 11 could be graduated in miles for No. 4 conductor size resistance. Another could be graduated in miles of No. 6 wire, etc. Similarly, the scales 9 could be graduated in miles for conductor reactance. Then the total impedance could be found on straight edge scale 4 by simply applying the proper miles of the conductor on scales 9 and 11, without referring to either the resistance or reactance values. By the use of the tabs 13 and 15 this process can be conducted along the line if the conductor size changed, by placing the index of the proper conductor scale to the previous value of the preceding conductor at the distance where the change in conductor size occurs.

In lieu of the slide mechanism 19 the coordinate arms or straight edge members 2 and 3 and the pivoted straight edge member 4 could be maintained in proper relation by making these members slotted and by having a pin extend through all three. The device shown in the drawing is limited to a single quadrant, but it is to be distinctly understood that the idea could be carried forward where desired to include two or more quadrants, thus making possible the more ready handling of negative quantities. Other and further modifications could be made without departing from the spirit of this invention.

What we claim is:

1. A device for mechanically producing the addition and subtraction of vectors comprising a base, a pair of mutually perpendicular straight edge members mounted on said base and arranged for independent movement thereon in paths perpendicular to their respective longitudinal axes, a plurality of individually slidable differently calibrated coordinate scales mounted on said base associated with respective ones of

said straight edge members, a graduated straight edge member, means for pivoting one end of said graduated straight edge member at the effective origin of said coordinate scales, and means carried by the first two mentioned straight edge members for maintaining the graduated straight edge member in such a position as to always overlie the intersection of said members, whereby vectors in quadrature may be added or subtracted.

2. A device in accordance with claim 1, including index marker tabs and means for holding said tabs in predetermined selected locations with respect to said individually slidable differently calibrated coordinate scales whereby said scales may be readily set opposite said tabs to attain certain predetermined selected positions.

3. A calculating device comprising a frame having indicia thereon, members slidable on said frame and crossing each other at right angles to form opposed rectangles of lesser size than said frame, a plurality of individually slidable differently calibrated coordinate scales mounted on said frame associated with respective ones of said members, a divider pivotally mounted on said frame, means for moving said divider to intersect the point of crossing of said slidable members, at least one scale carried by said divider, and a protractor scale on said base, whereby the length and direction of a line extending between the pivot of said pivotally mounted divider and the point of intersection of said slidable members may be readily ascertained.

4. A device of the class described comprising a rectangular frame having a plurality of separately adjustable coordinate scales mounted on two of the adjacent sides thereof, a pair of elongated adjustable members mounted on said frame crossing each other at right angles, said members being movable with respect to the coordinate scales along the respective edges of said member, a graduated pivoted member pivoting at the effective intersection of said coordinate scales, and means for maintaining said graduated pivoted member above the intersection of said movable members.

5. A device in accordance with claim 4, including tabs for locating reference points on said coordinate scales, said tabs having means for holding them in predetermined selected positions on said frame whereby said separately adjustable scales may be readily set with respect to said predetermined selected positions occupied by said tabs.

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