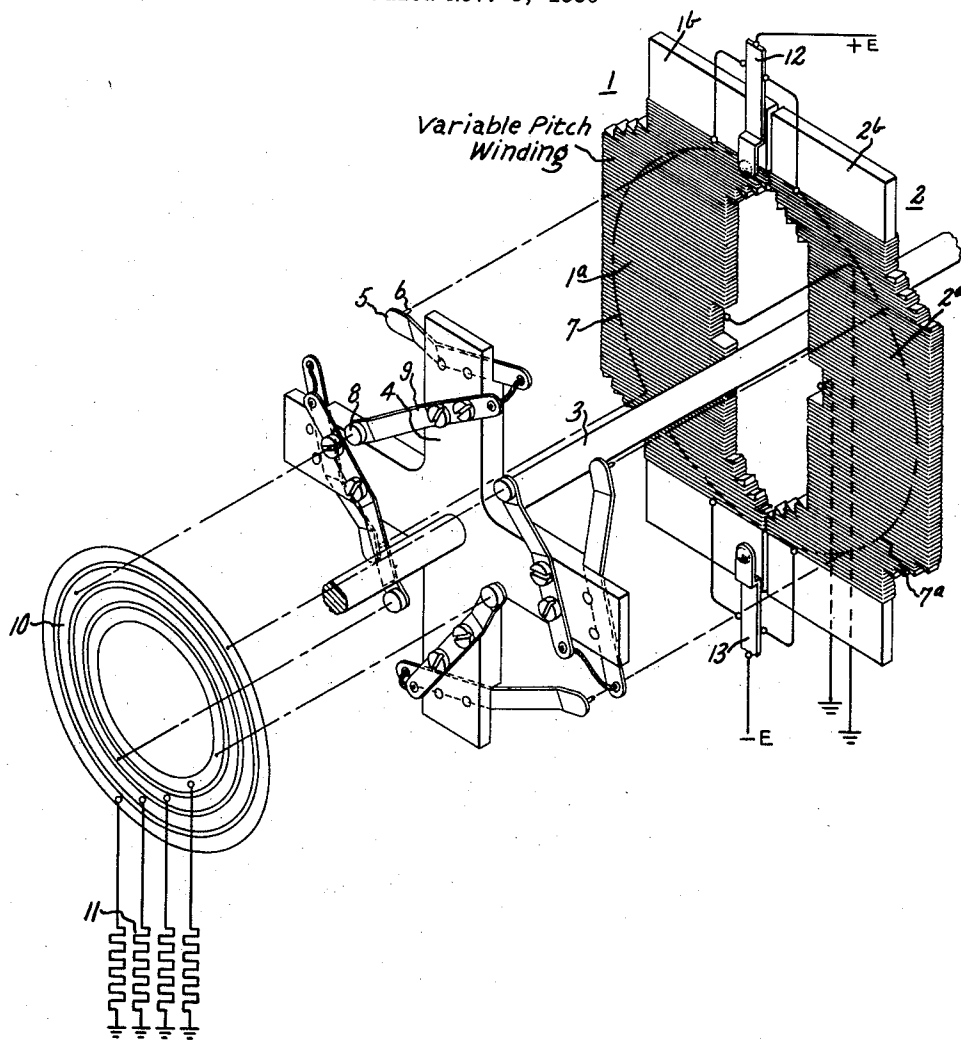


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R. G. MURDICK ET AL
COMPUTING DEVICE

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Inventors:
Robert G. Murdick,
Alexander G. Robbins,
by *Correll & Mack*
Their Attorney.

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COMPUTING DEVICE

Robert G. Murdick and Alexander G. Robbins,
Schenectady, N. Y., assignors to General Elec-
tric Company, a corporation of New York

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This invention relates to computing devices and more particularly to D.-C. resolvers in which positive and negative values of the sine and cosine of an input angle are continuously indicated in terms of an electric current or voltage.

An object of this invention is to provide a new and improved device for computing electronically the positive and negative values of the sine and cosine of an angle through which a shaft rotates.

Another object of this invention is to provide a new and improved D.-C. resolver having a highly accurate output which is substantially unaffected by changes in the load.

A further object of this invention is to provide a new and improved D.-C. resolver suitable for ganging to a plurality of similar resolvers.

For further objects and advantages and for a better understanding of this invention, attention is now directed to the following description and accompanying drawing and also to the appended claims. The drawing is illustrative of a D.-C. resolver constructed according to this invention.

Referring to the drawing, a pair of non-linear resistance cards 1 and 2 are provided with variable pitch windings 1a and 2a. Windings 1a and 2a are mounted on notched or irregularly shaped winding supports 1b and 2b. The notched supports and the variable pitch windings effect a nonlinear resistance card which is further described hereinafter. The notches in cards 1 and 2 are such that each of the cards is substantially a half ring. Cards 1 and 2 are mounted in juxtaposition in the same plane to form a substantially closed ring. Windings 1a and 2a are electrically connected together at adjacent ends of cards 1 and 2 and the center taps of the windings are electrically connected to ground. Sources of equal positive and negative voltage are connected to opposite ends of windings 1a and 2a. A rotatable shaft 3 is located transverse to the principal plane of the ring formed by cards 1 and 2 and passes through the center of rotation of the ring. Mounted on shaft 3 is a star-shaped bracket 4 having four extensions mutually perpendicular to the longitudinal axis of shaft 3 and spaced 90 degrees apart. Bracket 4 is a support for four identical brush assemblies utilized in deriving quadrature voltage signals from cards 1 and 2. For convenience, only one of these assemblies is described herein.

A resilient electron conducting brush holder 5 is mounted on an extension of bracket 4 and

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supports an electrical contact brush 6. Bracket 4 is so positioned on shaft 3 that rotation thereof causes brush 6 to wipe on windings 1a and 2a along a circular track 7. A contact brush 8 is supported by a brush holder 9 mounted on the back side of the extension of bracket 4. This brush wipes on a slip ring 10 which is connected through a load resistor 11 to ground. Windings 1a and 2a are generally formed of insulated wire and the insulation along track 7 is removed. The insulation is removed only from the exposed portion of the windings after the cards have been wound. Short-circuiting between turns is thus prevented. Resistance cards 1 and 2 are separated by grooves which may damage the brushes as they wipe thereon. Also, the windings may be damaged at these points of irregularity. Resilient members 12 and 13 positioned between the irregularities between cards 1 and 2 and bracket 4 intercept brush holder 5 as it is rotated thereby. Members 12 and 13 raise the brushes from track 7 at the irregularities between the cards and thereby prevent damage to the windings or to the brushes. Small nipples 14 and 15 are provided near the ends of members 12 and 13 to effect easy passage of the brush holders thereacross. Members 12 and 13 are formed of a conducting material and also serve as terminals whereby the heretofore mentioned direct voltages may be supplied to opposite ends of windings 1a and 2a. Because members 12 and 13 are connected to the ends of the windings, no electrical discontinuity is introduced thereby.

In operation shaft 3 is rotated and the magnitudes of the voltages across the load resistors are indication of different trigonometric functions of the angular position of the shaft. Because there is only one brush on any card between a voltage and ground at any one time, the cards may be tapered and irregularly wound to compensate for the resistance load to give a voltage proportional to $\sin \theta$, $\cos \theta$, $-\sin \theta$, and $-\cos \theta$ at different brushes. The load resistors are made equal so that the compensation of each card is the same for all of the brushes. Consequently, the output voltages for the different trigonometric functions are simultaneously and continuously obtained. The resistance of the windings between the center tap and any point on the card is given by the following equation:

$$xR = R \left(\left[\frac{1}{4} \left(\frac{a}{f} - 1 \right)^2 + a \right]^{\frac{1}{2}} - \frac{1}{2} \left(\frac{a}{f} - 1 \right) \right)$$

in which:

a = ratio of load resistance to the resistance of the card between the source of voltage and ground.

x =fractional resistance between the brush and ground.

f =ratio of the distance between the brush and ground to the distance between the end of the card and ground.

Although this device finds particular application in computers requiring highly accurate and sensitive resolvers, it is also useful in less sensitive apparatus. Because it is ring-shaped, it lends itself to ganging while being very compact. In the present state of the art, the width of nonlinear resistance cards is limited, and, therefore, this card has the further advantage over the square prior art type cards in that greater resolution per card is obtained.

Modifications of this invention will occur to those skilled in the art and it is desired to be understood, therefore, that this invention is not to be limited to the particular embodiment disclosed, but that the appended claims are meant to cover all the modifications which are within the spirit and scope of this invention.

What we claim as new and desire to secure by Letters Patent of the United States is:

1. In a D.-C. resolver, a pair of nonlinear resistance cards, said resistance cards being formed in the shape of semicircular rings and being positioned in the same plane to form a substantially circular ring, adjacent ends of said resistance cards being electrically connected together, and the center taps thereof being connected to ground, a shaft located normal to the principal plane of and through the center of said ring, a bracket fastened to said shaft to be rotated thereby, a number of extensions on said bracket, said extensions being spaced 90 degrees apart and the plane thereof paralleling the principal plane of said resistance cards, contact means mounted on each of said extensions to wipe on said resistance cards throughout a substantially complete rotation of said shaft, resilient conducting means positioned at the junction of said resistance cards to lift said contact means from said resistance cards as they pass the junction point thereof, said resilient conducting means being electrically connected to the ends of said resistance cards adjacent thereto, sources of equal positive and negative direct voltages connected to opposite ends of said resistance cards, a number of equal valued load resistors, and contact means connected to provide across each of said load resistors from one of said contact means a different voltage having a magnitude which is a trigonometric function of the angular position of said shaft.

2. In a D.-C. resolver, a pair of nonlinear resistance cards, said cards formed in the shape of semi-circular rings and having variable pitch windings, said resistance cards being mounted in the same plane to form a substantially circular ring, adjacent ends of said resistance cards being electrically connected together and the center taps of each of said resistance cards being connected to ground, a rotatable shaft located normal to the principal plane of and through the center of said ring, contact means connected to be rotated by said shaft about the faces of said resistance cards, equal valued resistors connected between ground and each of said contact means, and source of equal positive and negative voltages connected to opposite ends of said resistance cards to provide across each of said load resistors a voltage having a magnitude proportional to the angular position of said shaft.

3. A D.-C. resolver comprising first and second card-like insulating members, conducting wire being wound around the shorter dimension of each of said cards, said cards being notched along the entire length such that the length of the ordinate of said card corresponds to a function of the abscissa thereof, said notching projecting into said card at the center and along the outer portion at the ends thereof, said cards thereby being substantially in the shape of half rings, said cards being fastened together in the same plane to substantially form a complete ring, said windings on said cards being electrically connected at adjacent ends of said cards, the windings at the center of said cards being grounded, a source of positive direct voltage being connected to the windings at one end of said cards and a source of equal negative direct voltage being connected to the windings at the other end of said cards, a shaft located in a plane through the center of the ring formed by said cards and normal to the major plane of said cards, contact means connected to said shaft to be rotated thereby about the circumference of a circle of determinable radius, said contact means being positioned along said shaft to brush on said windings as said shaft is rotated, and loading resistors connected between said contact means and ground to provide a voltage across each resistor which is proportional to a trigonometric function of the angular position of said shaft.

ROBERT G. MURDICK.

ALEXANDER G. ROBBINS.

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