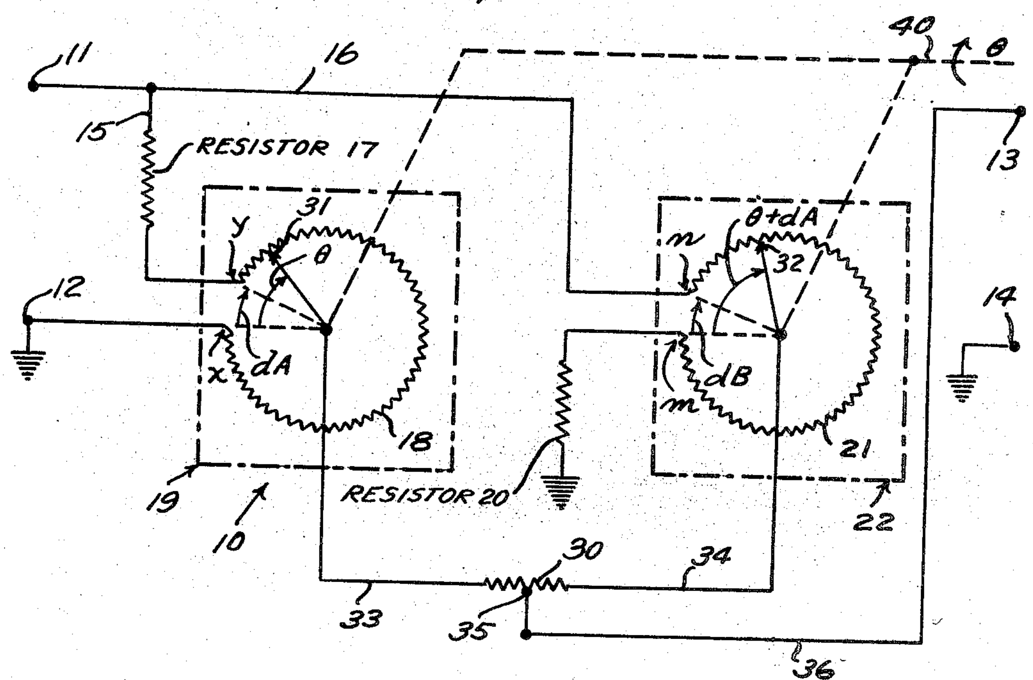
Sept. 2, 1958 L. H. ROWLEY 2,850,604
CONTINUOUS ROTATION POTENTIOMETER
Filed Feb. 8, 1957

Fig. 1.



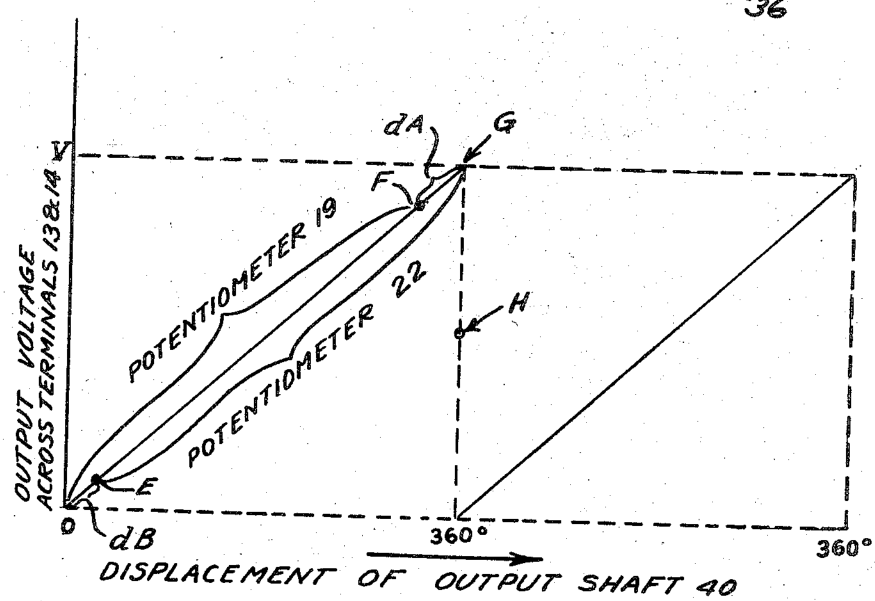


Fig. 2.

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CONTINUOUS ROTATION POTENTIOMETER

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Application February 8, 1957, Serial No. 639,098

4 Claims. (Cl. 201—48)

This invention relates to potentiometers as used in electrical and electronic circuits and in particular to improvements in single turn potentiometers having a shaft driven sliding contact which can be angularly displaced beyond 360° in either direction.

As is presently known, a single turn potentiometer has a stator resistor which is disposed along a circular arc having a fixed radius, the circular arc being slightly less than 360°. Normally no restrictions are imposed upon the movement of the slider and the potentiometer shaft is free to rotate beyond 360°. In designing a conventional single turn potentiometer for shaft displacements up to and beyond 360°, a choice is normally made between either having a small dead space between the beginning and end of the stator resistor which produces a small open output circuit position as the slider approaches the 360° position, or allowing the sliding contact to short circuit the stator resistor over a small incremental displacement of the potentiometer shaft.

A principal object of this invention is to provide an improved single turn potentiometer having substantially no output dead space and no input short circuit position for continuous shaft displacements up to and beyond 360°.

Another object of this invention is to provide a potentiometer having an improved linear output response relative to input shaft displacements.

As presently contemplated, a potentiometer system comprises a pair of single turn potentiometers, each having open or dead space sectors, connected in parallel branch circuits across a pair of input terminals. Each branch circuit has included therein an impedance element to compensate for the impedance that was omitted when the dead space sector was established. The potentiometers are ganged with their shafts out of phase and an averaging circuit means is provided to average out errors of non-linearity, the averaging circuit means being normally responsive to both potentiometers and to only one potentiometer output when the other potentiometer output is open circuited over its dead sector interval.

These and other features, capabilities and advantages of the invention will appear from the subjoined detailed description of one embodiment thereof illustrated in the accompanying drawings in which:

Fig. 1 is a schematic diagram of a continuous linear single turn potentiometer; and

Fig. 2 is a diagram illustrating the principles of operation of the improved potentiometer.

Referring to Fig. 1, a potentiometer circuit **10** has two input terminals **11** and **12**, and two output terminals **13** and **14**, terminals **12** and **14** being connected to ground. Two branch circuits **15** and **16** are connected across input terminals **11** and **12**. Branch circuit **15** includes a fixed resistor **17** in series connection with a stator resistor **18** of a single turn potentiometer **19** having a dead space sector of dA degrees as measured clockwise from the end terminal x to the beginning terminal y of the stator resistor **18**, the resistor **17** being connected between terminal **11** and point y of the stator resistor **18**.

Branch circuit **16** comprises a fixed resistor **20** in series connection with a stator resistor **21** of a single turn potentiometer **22** having a dead space sector of dB degrees as measured clockwise from the end terminal m to the beginning terminal n of the stator resistor **21**, the resistor **20** being connected between end terminal m of the stator resistor **21** and the terminal **12** or ground. A resistor **30** is connected between the sliding contact **31** of potentiometer **19** and the sliding contact **32** of potentiometer **22** by conductors **33** and **34**, respectively. The resistor **30** has a tap **35** which is connected to the output terminal **13** by a conductor **36**.

The resistor **17** has a discrete resistive value corresponding to the product of the dead space sector dA expressed in degrees and the angular rate of resistance change along the stator resistor **18**, viz.,

$$R_{17}=\frac{R_{18}dA}{360-dA}$$

and for the branch circuit **16**,

$$R_{20}=\frac{R_{21}dB}{360-dB}$$

The shafts of potentiometers **19** and **22** are ganged so that sliders **31** and **32** are equally displaced by an angular displacement of a common output shaft **40** connected thereto. However, the sliders **31** and **32** are phase displaced by an angle equal to dA degrees, the slider **32** being advanced in a clockwise direction relative to the slider **31**. Hence, when the slider **31** is displaced θ from position x by a like displacement of the output shaft **40**, the slider **42** will be positioned at $(\theta+dA)$ degrees.

In Fig. 2 is shown a diagram of the variation of the voltage across output terminals **13** and **14** for various displacements of the output shaft **40** when a reference voltage V is impressed upon input terminals **11** and **12** from a source not shown. On the assumption that potentiometers **19** and **22** are linear, the segment OF of the characteristic is covered by potentiometer **19** and the segment EG is covered by the potentiometer **22**, the dead space dA being represented by the segment FG and the dead space dB being represented by the segment OE. If the characteristics of the potentiometers **19** and **22** are not identical in regard to linearity, the segment EF will be a function of the individual characteristics of the potentiometers as a result of the averaging effect of the tapped resistor **30**.

As output shaft **40** and slider **31** approach the x position, which is both the 0° and 360° reference point, slider **32** will approach the point n. With selective adjustments, slider **32** will contact point n at a very small incremental displacement after slider **31** passes point x. With such a fine adjustment, the width of the zero voltage or "open" position can be very narrow without short circuiting the output circuit. In the event that slider **32** contacts point n at the same time that slider **31** contacts point x, the entire input voltage is absorbed by the resistance of resistor **30** and the output voltage across terminals **13** and **14** is momentarily equal to $V/2$ as represented by point H in Fig. 2 if the tap **35** on resistor **30** is at the center. When either slider **31** or **32** is in a dead space sector, the output from the other slider is conducted to the output terminal **13** through one-half of resistor **30**. However, the added resistance of one-half the resistance value of resistor **30** does not introduce any error in the output response when the potentiometer is driving a high impedance load. As an alternative adjustment the tap **35** on resistor **30** may be removed to either end. In this case point H does not exist and the voltage drops immediately from point G to zero.

From the foregoing, it will be seen that the characteristics of a standard commercial type of single turn potentiometer is improved by the addition of a second similar standard commercial potentiometer with associated circuitry such as had been disclosed herein.

It is to be understood that various modifications in the circuitry other than those above described may be effected without departing from the principle and scope of the invention as defined in the appended claims.

What is claimed is:

1. A potentiometer circuit means by which a substantially uninterrupted output is obtained from a single turn continuous rotation potentiometer, said circuit comprising a voltage source, a first potentiometer and a second potentiometer similar to said first potentiometer connected in parallel to one terminal of said voltage source; said first and second potentiometers each having an annularly disposed resistance element of slightly less than 360° thereby providing a dead space sector between the ends thereof, and a radially disposed rotatably mounted contact arm, said second potentiometer contact arm being angularly displaced from said first potentiometer contact arm in a clockwise direction by an amount substantially equal to said dead space sector, and means by which said first potentiometer contact arm and said second potentiometer contact arm are rotated in unison in a clockwise direction; conductor means by which the input ends of said first and second potentiometer resistor elements are connected in parallel to said voltage source and by which the other ends of said first and second potentiometer resistance elements are connected to a ground, a first trim resistor interposed in said conductor means in series with said first potentiometer, a second trim resistor interposed in said conductor means in series with said second potentiometer, the impedance of each of said trim resistors being a function of the total resistance of the resistance element and the dead space sector of the associated potentiometer, an electrical connection between the contact arms of said first and second potentiometer, a resistor interposed in said electrical connection and having a tap by which the output of said circuit means is adapted to be connected to a load.

2. A potentiometer circuit means as defined in claim 1 in which said first trim resistor is interposed in said conductor means between the input end of said first potentiometer resistance element and said voltage source

and said second trim resistor is interposed in said conductor means between the said other end of said second potentiometer resistance element and said ground.

3. A potentiometer circuit means as defined in claim 2, in which said first trim resistor has a resistance value equal to

$$\frac{dA \times Ra}{360° - dA}$$

and said second trim resistor has resistance value equal to

$$\frac{dB \times Rb}{360° - dB}$$

wherein the dead space sector of said first potentiometer is dA degrees, the dead space sector of said second potentiometer is dB degrees, the resistance of said first potentiometer resistance element is Ra, the resistance of said second potentiometer resistance element is Rb, and the relative displacement between the potentiometer contact arms is dA degrees.

4. A potentiometer circuit means as defined in claim 1, in which said first trim resistor has a resistance value equal to

$$\frac{dA \times Ra}{360° - dA}$$

and said second trim resistor has resistance value equal to

$$\frac{dB \times Rb}{360° - dB}$$

wherein the dead space sector of said first potentiometer is dA degrees, the dead space sector of said second potentiometer is dB degrees, the resistance of said second potentiometer resistance element is Rb, and the relative displacement between the potentiometer contact arms is dA degrees.

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