Sept. 7, 1954 E. NYYSSONEN 2,688,681

SQUARING POTENTIOMETER

Filed June 12, 1953

Fig. 1

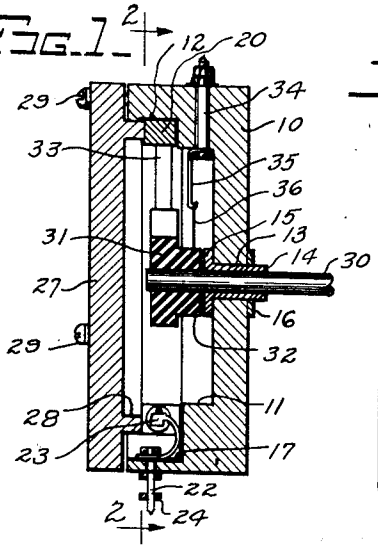


Fig. 2

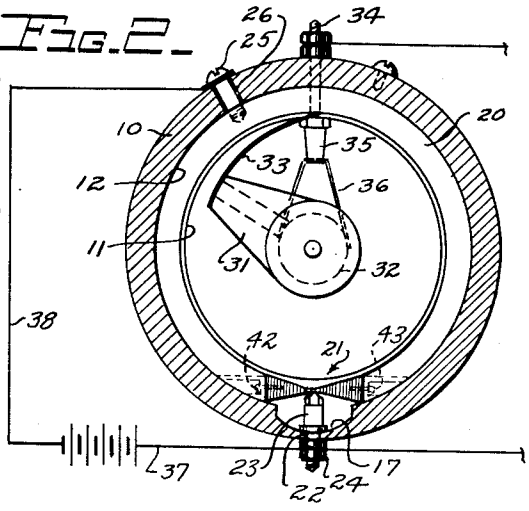
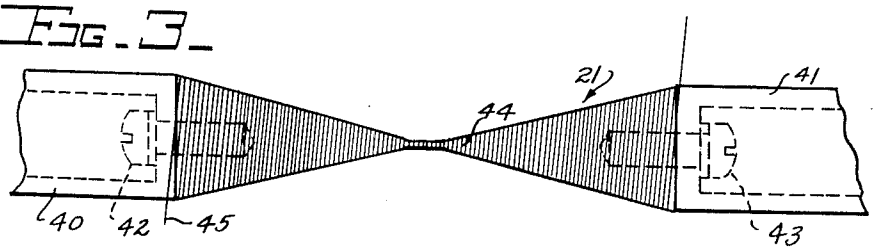


Fig. 3



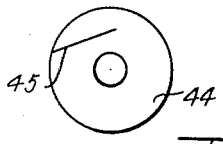
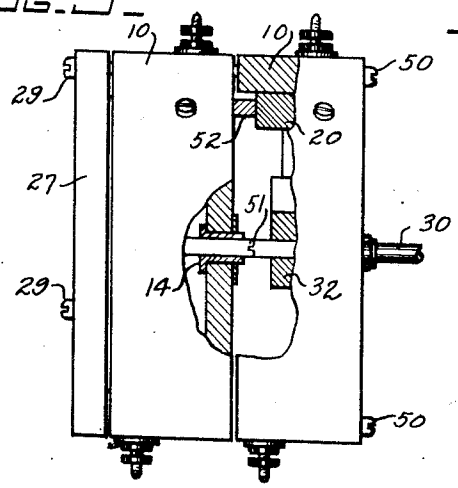


Fig. 4

Fig. 5



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SQUARING POTENTIOMETER

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8 Claims. (Cl. 201—60)

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This invention relates to potentiometers for electrical circuits and more particularly to potentiometers for obtaining a voltage variation proportional to the square of the displacement of the movable tap.

Heretofore potentiometers have been constructed to provide a variable voltage divider where the voltage variation is directly proportional to the displacement of the movable tap and if a voltage variation proportional to the square of the tap displacement is desired, two or more linear potentiometers operated in bank are used to accomplish this purpose. In the present invention a conically wound resistance element was found to provide a variation in voltage proportional to the square of a movable tap or brush displacement operative longitudinally over the side of the resistance element. A spool of metal, or other suitable material, providing a double cone with the apexes thereof adjacent has a resistance wire wound thereon and the spool resistance element bent to complete a portion of a circular ring element in a potentiometer housing or support. A brush element on a rotatable shaft contacts the inner surface of the circular ring and the double cone resistance element. Voltage is supplied to the resistance wire at a point centrally of the spool or cone apexes and to the circular ring to provide a circuit through both conical resistances. The output of the potentiometer is taken from the movable tap or brush and the center tap of the resistance spool. Potential is then adjustable either way from the center position of the resistance element in similar manner as a double voltage divider. The resistance element being conical provides a voltage variation proportional to the square of the tap or brush displacement, and the tap or brush being rotary provides a means to obtain voltage variations in accordance with angular brush movements. It is therefore a general object of this invention to provide a squaring potentiometer of the rotary tap or brush type for providing a voltage variation in either direction from a central brush contact which voltage is proportional to the square of the displacement of the brush.

These and other objects, advantages, features, and uses will become more apparent as the description proceeds when considered in conjunction with the accompanying drawing in which:

Fig. 1 is a cross-sectional view of a squaring potentiometer taken diametrically thereof;

Fig. 2 is a cross-sectional view of the squaring potentiometer taken on the line 2—2 of Fig. 1;

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Fig. 3 is an enlarged view of the resistance spool with the resistance wire thereon shown mounted in arbor members;

Fig. 4 is an end elevational view of the resistance spool element; and

Fig. 5 is a side elevational view of potentiometers in bank.

Referring more particularly to Figs. 1 and 2, there is shown a potentiometer housing 10 having two concentric counter-bores 11 and 12. In the end wall of the housing 10 is a central bore 13 through which is passed a bushing 14 fixed therein by an end flange 15 and a nut 16 screw-threaded on the outer end of the bushing. The counter-bores 11 and 12 are uninterrupted in their circular extent except for a cut-out portion 17 at the bottom of the housing.

Positioned against the housing 10 in the counter-bore 12 is an electrically conductive C-shaped ring sector 20 with the open section thereof completed by a double coned resistance element 21, later to be more fully described. The housing 10 may be of some electrically non-conductive material or the C-shaped ring sector 20 can be electrically insulated from the housing 10, if the housing is of electrically conductive material, by inserting electrical insulation material between the C-shaped ring sector and the housing in any well known manner. In the cut-out portion 17 is a terminal post 22 extending through a hole in the housing 10 in an electrically insulated manner and supporting a spring contact element 23 with the outer end in contact with the center of the double-coned resistance element 21. The outer end of the terminal post 22 is screw threaded for receiving terminal nuts 24 to secure electrical conductors. A terminal screw 25 passing through an opening 26 in the housing 10 and insulated therefrom is threaded into a threaded opening in the C-shaped ring sector 20 to provide an electrical terminal connection thereto. The C-shaped ring sector 20 is retained in the counter-bore 12 by a face plate 27 having an annular extension 28 engaging the ring 20, the face plate 27 being retained on the housing 10 by screws 29.

Extending through the bushing 13 in the housing 10 is a shaft 30 on the inner end of which is fixed a brush holder 31 of electrically non-conductive material. The brush holder 31 has a contact slip ring 32 electrically connected to a brush or contact element 33 supported by the brush holder 31. The outer end of the brush 33 has a tip portion which is held in brush contact with the C-shaped ring sector 20 and re-

sistance element 21 by the inherent resiliency of the brush 33. A terminal post 34 also insulatingly passing through the housing 10 enters into the counter-bore 11 and supports a contact strap 35 which in turn supports a contact yoke 36 having its outer ends riding against the slip ring 32. Rotation of the shaft 30 causes the brush 33 to travel over the inner surface of the C-shaped ring sector 20 and resistance element 21. As illustrated in Fig. 2, voltage input is supplied at the terminals 22 and 25 through the conductors 37 and 38 from some battery or other voltage source. The output is connected to the terminals 22 and 34.

Referring to Figs. 3 and 4, the resistance element 21 is shown on an enlarged scale and connected in the arbors 40 and 41 by the screws 42 and 43. The arbors may be used for turning down the spool 44 of the resistance element 21 to the desired present form and for winding the resistance wire 45 thereon. The spool 44 is turned, as shown, in the form of a double cone with the apexes joined by as small a portion as mechanically feasible in order to approach a theoretical zero for the resistance in the center portion. The spool 44 may be of metal and varnished before winding the varnished resistance wire 45 thereon. After winding the resistance wire 45 thereon, the resistance element 21 is varnished to hold the resistance wire 45 in place. The resistance element 21 is removed from the arbors 40 and 41 and placed in the open section of the C-shaped ring sector 20 by the same or similar screws 42 and 43 as shown in Fig. 2. To fit the resistance element 21 in the open section of the C-shaped ring sector 20, the resistance element 21 is bent in the reduced central portion sufficiently to provide a substantial chord-like continuation of the circular inner surface of the C-shaped ring sector 20. The varnish is scraped from the surfaces of the resistance wire 45 to be engaged by the brush 33 and the contact 23. The varnish is also removed from the ends of the resistance wire 45 and these ends bent over the ends of the spool 44 as shown in Fig. 4 in order that a good electrical connection is established between the resistance wire 45 and the C-shaped ring sector 20. The deviation from the strict circular path along the two sides of the double-cone resistance element 21 produces no ill effects since the resiliency in the brush 33 causes it to follow these straight resistance portions. Any errors as a result of the change from a strict circular path to the short straight path are so small as to be negligible. Where the slight deviation from the circular sweep of the brush 33 over the chord-like sides of the resistance element 21 is critical, the brush 33 could be made to sweep over the front or back side of the C-shaped ring sector 20 and the resistance element 21, it only being necessary to bend the central portion of the resistance element 21 sufficiently to make the sides of the two conical portions along a longitudinal portion thereof straight and in alignment with the side of the C-shaped ring sector 20 swept by the brush, as readily understood by a mechanic of ordinary skill.

In the operation of the potentiometer the shaft 30 is connected to a device in which voltage is to be controlled or measured proportional to the square of the angle of rotation. A zero position of the brush 33 is at the central point of the resistance element 21 directly over the contact element 23. An angular deviation in either direction from this zero point will produce a voltage change as above stated. In the form of the invention illustrated, the resistance element 21 constitutes about 40 degrees of the operative brush travel, or about 20 degrees each way from the central zero position although the length of the resistance element 21 may be made longer or shorter to meet particular conditions or demands.

The squaring potentiometer described above is readily adaptable to be used in bank as shown in Fig. 5 where two potentiometer housings 10 are held together by four or more screws 50. The shaft ends of the intermediate shafts 30 may be rotatively joined to rotate in unison by a tongue and slot coupling 51. The C-shaped ring sector 20 in intermediate housings 10 may be held in position by a separate supporting ring 52 which corresponds to the extension 28 on the end cover plate 27. In all instances, however, the C-shaped ring sector 20 must be electrically independent from the surrounding elements which it contacts so as to avoid the establishment of any circuits other than through the C-shaped ring sector 20, resistance element 21 and brush 35. While Fig. 5 shows a bank of two squaring potentiometers, it is to be understood that a bank of more than two may be made and the potentiometers may be of different types.

While the preferred form of the invention has been shown and described herein it is to be understood that various modifications and changes may be made in the constructional details and features without departing from the spirit and scope of the invention and I desire to be limited only by the scope of the appended claims.

I claim:

1. A squaring potentiometer comprising; a suport; a brush rotatably supported by said support; a ring supported by said support concentric with the axis of rotation of said brush with said brush slidably engaging the inner surface of said ring, said ring having a conical resistance means in a sector thereof; and means on said ring, said conical resistance means, and said brush adapted for coupling input and output conductors whereby an output potential will vary in accordance with the square of the displacement of the brush on said conical resistance means.

2. A squaring potentiometer as set forth in claim 1 wherein said conical resistance means is a double conical resistance spool with the apexes thereof adjacent and said means for coupling input and output conductors thereto is at the apexes.

3. A squaring potentiometer as set forth in claim 2 wherein said brush is on a shaft journaled in said support, said brush being electrically insulated from said shaft, and said means for coupling an output conductor to said brush comprising a slip ring on said brush slidably engaged by a terminal slip ring brush.

4. A squaring potentiometer as set forth in claim 3 wherein said support is a potentiometer housing.

5. A squaring potentiometer comprising; a housing; a shaft journaled through said housing and having a brush holder fixed to the inner end thereof, said brush holder having a brush and a slip ring thereon electrically connected with an electrical terminal slidably contacting said slip ring; a C-shaped conductive ring sector supported in said housing concentric with said shaft and having a zonal exterior portion there-

of slidably engaged by said brush; a conical resistance means supported by said C-shaped ring sector and between the open ends thereof with the side thereof in the path of said zonal exterior portion forming a smooth continuous surface with said C-shaped ring sector; and electrical terminals connecting each said C-shaped ring sector and said conical resistance means adapted for coupling to an electrical potential whereby an output electrical potential proportional to the square of the brush displacement is obtainable.

6. A squaring potentiometer as set forth in claim 5 wherein said conical resistance means is a double conical spool having the bases joined to the ends of said C-shaped ring sector with resistance wire wound thereon and the respective ends thereof each compressed between said spool base and the C-shaped ring sector end to provide a complete electrical circuit through said C-shaped ring sector and resistance wire.

7. A squaring potentiometer as set forth in claim 6 wherein said terminal connecting said conical resistance means makes contact with said resistance wire at the apexes of said double conical spool.

8. A squaring potentiometer comprising; a housing; a circular ring supported in said housing and electrically insulated therefrom, a sector of said ring comprising a double conical spool with the bases thereof extending outwardly joining in said ring with the geometrical center of each conical portion being misaligned sufficiently to provide a longitudinal portion along the side of each conical portion to lie substantially in a circular zonal path around said circular ring, said double conical spool having an electrical resistance wire wound thereon and electrically insulated therefrom with each wire end secured in said joint of said respective spool base in said circular ring to establish an electrical circuit around said circular ring through said resistance wire; and an electrical brush rotatably mounted in said housing and electrically insulated therefrom to slidably contact said ring throughout said circular zonal path whereby electrical potential may be varied in accordance with the square of the displacement of said brush along the zonal path over said double conical spool.

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