Nov. 28, 1961 J. MAIR 3,011,142

POTENTIOMETER

Filed Dec. 8, 1959 2 Sheets-Sheet 1

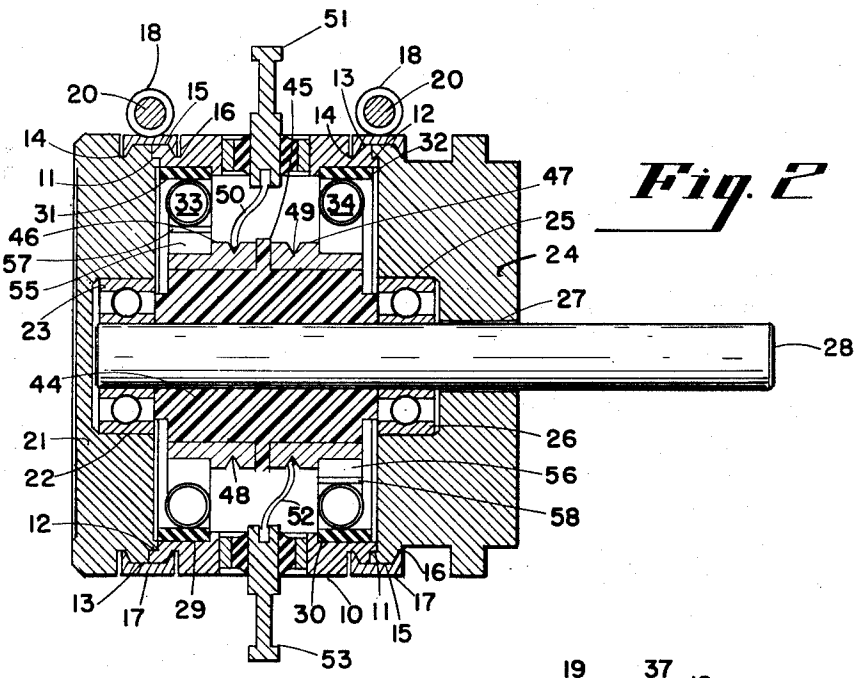


Fig. 2

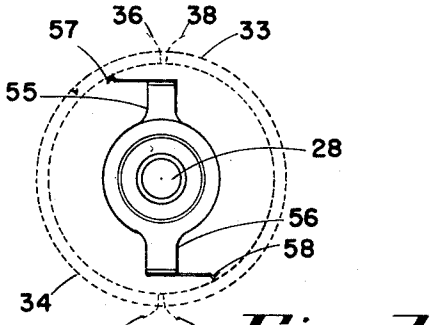


Fig. 3

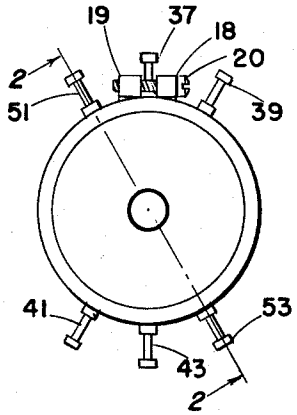


Fig 1

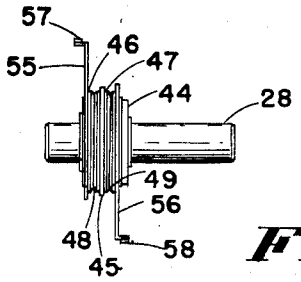


Fig. 4

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Nov. 28, 1961 J. MAIR 3,011,142

POTENTIOMETER

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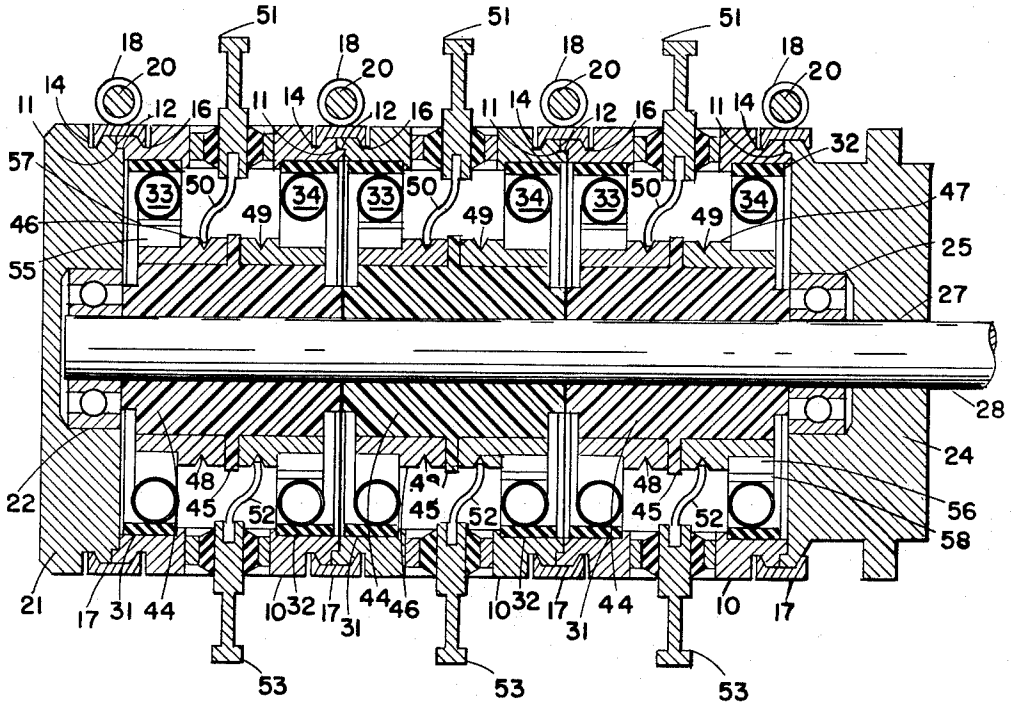


Fig. 5

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POTENTIOMETER

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7 Claims. (Cl. 338—174)

This invention relates to variable resistance devices of the class of potentiometers and more particularly relates to a rotary type dual potentiometer or variable resistance apparatus for use in computers, aircraft, guided missiles and similar mechanisms.

A precision type of potentiometer should not only have a high linearity characteristic and a low "noise" characteristic, but it should be simple in construction, rugged, compact, light in weight and should be relatively immune to shock. It should also be highly responsive to a low torque so as to insure accurate performance.

An objective of the present invention is to provide a compact rotary type of dual potentiometer that efficiently utilizes the space that is normally available in single unit potentiometers more advantageously, thereby reducing the space requirement of such a potentiometer to about 50% of that normally required by two single potentiometer units.

Another objective of this invention is to provide a dual potentiometer that can materially reduce the weight requirement by one third over the weight normally required by two single potentiometers in separate units.

A further objective of this invention is to provide a novel rotary type of dual potentiometer wherein the wipers that cooperate with their respective resistance units are mounted on a shaft so that they are angularly 180° apart at all times. This balances the drag of the wipers and reduces the torque, both starting and running, that must be applied to the shaft to vary the resistance of each unit as required.

An additional objective is to provide a dual potentiometer unit having an external construction adapted to permit ganging any desired number of dual potentiometer units so that these will all be operated by a single shaft; this external construction including appropriate grooves adapted to receive circular clamps adapted to secure the ganged units together in phased relationship.

Another objective of the invention is to provide a rotary type of dual potentiometer wherein the external clamping arrangement is designed to permit the annular clamps to be flush with the external surface of the casing when the clamps are in place, with the exception of the end clamps that hold the ends of the clamp together. This arrangement permits easy external phasing of the dual individual potentiometer units whenever it is desired to gang a number of dual units together.

The rotary type of dual potentiometer unit according to this invention comprises an external casing which is closed at one end by a cooperating end plate having an internal axial bearing or bushing housing. The opposite end of the casing is closed by a second cooperating end plate that also is provided with an internal axial bearing or bushing housing and has a central bore adapted to permit passage of a shaft. A pair of circular resistances are mounted within the casing so that each one of the resistors is located near one end of the supporting casing, each of the resistors being in spaced relationship to the other and each resistor being insulated from the casing. The circular resistors are placed within the casing so that they are axially positioned; each circular resistor substantially fills the entire circle and the small gaps formed by the ends of the resistors are positioned angularly so that the small gap of one resistor is located 180° from the gap of the second resistor of each dual potentiometer unit.

There is mounted on the shaft, for each dual unit operated by the shaft, a rotor made of insulating material on which are carried, in spaced relationship to each other, two conductive slip rings provided with a preferably V-shaped groove. These two slip rings are insulated from each other. A stationary brush element rides in its appropriate slip ring groove and is connected to a suitable brush terminal, secured to the wall of the casing and projecting therefrom. Each rotor is also provided with a suitable wiper support or arm for each resistance element. The wipers or wiper supports are in electrical contact with the respective slip ring and the wipers or the wiper supports as the case may be are positioned in each dual unit so that they bear to each other an angular relationship of 180°. The ends of each circular resistance unit are connected to appropriate terminals respectively, each of the corresponding end terminals are adjacent to its fixed brush terminal. This provides in a dual potentiometer unit two groups of three terminals each; these protrude from the outer surface of the casing at opposite ends of a respective diameter.

The foregoing and subsequent description can be better understood and visualized by referring to the accompanying drawings in which:

FIG. 1 is an end plan view showing a dual potentiometer unit with an axial shaft extending through the casing and further showing the conventional position of the two sets of three terminals.

FIG. 2 is a cross section view of a single dual potentiometer unit with the end caps in place taken on the line 2—2 of FIG. 1.

FIG. 3 is an end elevation of a rotor, shaft and resistor wipers when viewed from the extending shaft end. The resistors are shown by the dotted lines and show how the ends are in opposition.

FIG. 4 is a side elevation showing the relationship of the shaft, rotor, slip rings, wiper arms and wipers that were shown in FIG. 3.

FIG. 5 is a cross section view illustrating how a plurality of dual potentiometer units may be ganged on a single shaft.

Referring to the drawings, FIGS. 1 and 2 show a single dual potentiometer unit comprising a casing **10** having a narrow internal circumferential groove **11** counterbored from one end; the opposite end of the casing has a corresponding external circumferential groove **12**. Groove **11** is adapted to receive cooperating groove **12** of a second casing or end plate. Adjoining the inner end of groove **12** there is a narrow groove **13** that is larger in diameter than groove **12** and terminates in a slightly deeper narrow groove **14** which does not extend to the surface of groove **12**. The outer external surface of casing **10**, from the end that counterbore **11** commences, is provided with a groove **15** corresponding in depth to groove **13**. Groove **15** also ends in a narrow slightly deeper groove **16**. An annular clamping ring **17**, having a transverse cross section that corresponds to the configuration of grooves **13**, **14**, **15** and **16**, when two casings or a casing and its ends are mated together, secures the casings or the casing and its ends together whenever the clamping ends of annular rings **17**, designated in FIG. 1 as **18** and **19**, are secured together by means of a suitable fastener such as screw **20**, after the clamp has been properly seated in the grooves. Since the inner surface of the longer ends of the clamp that fit in grooves **14** and **16** are slightly tapered, they tend to clamp the two casings radially and longitudinally together whenever the clamping annulus is pulled tightly around the grooves by screw **20**.

End cap **21** has an axial bearing or bushing recess **22** in which there is seated a ball bearing or bushing **23**. The outer external surface of cap **21**, adjacent the end

from which bushing recess 22 extends, is also provided with a mating groove 12 and a shallower groove 13 that corresponds to groove 13 on the casing and also ends in a slightly deeper groove 14. This permits clamping ring 17 to secure end cap 21 to the cooperating end of a casing 10.

A second end cap 24 having a counterbored groove 11 at one end is also provided with a narrow external groove 15, corresponding to groove 15 of a casing, that extends inwardly and terminates in a slightly deeper groove 16. This permits cap 24 to close the other end of casing 10. The end of cap 24 from which counterbore 11 extends, is provided with an axial bearing or bushing recess 25 in which there is seated a ball bearing or bushing 26. A bore 27 extends axially through the center of bearing recess 25 and continues through the end of the cap. Bore 27 permits passage of a shaft 28 which is supported by bearings or bushings 23 and 26, and is slightly larger than the diameter of the shaft so as not to bind it.

Inside and adjoining the coupling portions 11 and 12, the inner surface of the casing is provided with a groove 29 and a groove 30 in which are fitted insulating rings 31 and 32. A first circular resistor, preferably in the form of a mandrel wound resistance element 33, is supported by insulator 31 and a second circular resistor 34 in the form of a mandrel wound resistance element is supported by insulator 32. The inner surfaces of the circular resistance elements 33 and 34 are coaxial with shaft 28. One end 36 of circular resistance element 33 is connected to insulated terminal 37 of FIG. 1, and the other end 38 of circular resistor 33 is connected to insulated terminal 39. Similarly one end 40 of circular resistor 34 is connected to insulated terminal 41 and the other end 42 of circular resistor 34 is connected to terminal 43. The gaps between the ends of circular resistor elements 33 and 34 are positioned within the casing on their respective insulator so that the gaps bear an angular relationship of 180° to each other. While the preferred resistor element is a mandrel wound circular coil it is intended that any other suitable type of circular resistor could be employed in place of resistors 33 and 34.

A rotor element 44 made of suitable nonconducting insulating material is secured on shaft 28 by any suitable means such as keying, press fitting, splining, or a locking screw. Rotor element 44 is substantially cylindrical and has a central projecting annulus 45 that is narrow in width and serves to insulate and separate slip rings 46 and 47 from each other when these are in position on the outer surface of rotor 44. Slip rings 46 and 47 are made of an electrical conducting material having a low resistance and each slip ring is provided with a preferably V-shaped groove designated by the numerals 48 and 49 respectively.

A resilient brush is secured to a terminal 51 which extends from casing 10 and is adjacent terminals 37 and 39 as shown in FIG. 1. Resilient brush 50 rides in V-shaped groove 48. A second resilient brush 52 is secured to terminal 53 that extends from casing 10 and is adjacent terminals 41 and 43; brush 52 rides in V-shaped groove 49.

A wiper arm support 55 extends radially outwardly from one end of rotor 44 and makes contact with slip ring 46. A second wiper supporting arm 56 extends radially outwardly from the other end of rotor 44 and makes electrical contact with slip ring 47. Arm 55 is positioned diametrically opposite to arm 56 but at the opposite end of the rotor. A first wiper 57, preferably of low resistance precious metal, is secured to the end of arm 55 and a second and similar wiper 58 is secured to the end of arm 56. That portion of each wiper that comes in contact with the inner surface of the circular resistance elements is preferably shaped to resemble a V and is preferably located near or at the end of the wiper.

The bottom of each V is curved slightly and assists the wiper in sliding smoothly along the circular resistor contact surface with a minimum of drag. The length of the wipers is uniform and this is adjusted so that the V-shaped contact portions press against the inner surface of the circular resistor element with sufficient pressure; this is preferably adjusted so that the wipers will exert approximately 4 mg./inches of force. Arms 55 and 56 may be long or short depending on the diameter of the particular potentiometer casing that is employed. Since the arms are 180° apart, the wipers that are secured to the arms will also have the V-shaped contact portions located 180° apart.

FIG. 5 shows a cross section view of a combination of three rotary type dual potentiometer units ganged on a single shaft. This arrangement provides six individual potentiometers. As many dual units can be ganged on one shaft as can be satisfactorily supported by that shaft. Combinations have been assembled that contained thirty dual potentiometer units; such an arrangement made available sixty individual resistances which could all be operated by a single shaft after they had been properly phased in.

The phasing of each potentiometer unit is accomplished by simply loosening screw 20 of the appropriate annular clamp 17 and rotating the casing until that particular unit showed the proper resistances for the setting of the shaft.

The operation of the dual potentiometer according to this invention is as follows: wipers 57 and 58 ride against the inner surface of the circular resistance means as the shaft is rotated and since the circular resistance means is coaxial with the shaft the wiper will exert the correct pressure at all times. The current that will flow at any position is controlled by the amount of resistance that is between the wiper contact and the end of the circular resistor. The fixed resilient brush being always in contact with its respective slip ring, will complete the circuit between the wiper contact and the terminal at the end of the resistor.

The amount of rotation that the rotor and wiper assembly make in reaching from one end of the resistor to the other varies depending on the particular specifications for various sized potentiometers. This usually varies from 351° to 358° and is partly dependent on the size of the potentiometer as well as the diameter of the resistance wire forming the circular resistor.

The novel dual potentiometer unit makes it possible to utilize two resistors in the space that is normally required for a single resistance element due to the improved construction. This reduces the space requirement about 50% and the weight requirement about 33%. Balancing the drag of wipers on opposite sides of the rotor also reduces the starting and continuing torque and permits smoother, delicate and more sensitive adjustment of the resistances required.

It is to be understood that various alterations may be made in the details of construction without departing from the scope of the present invention as defined by the following claims.

I claim:

1. A rotary variable resistance device comprising: a casing having a longitudinal axis; a first circular resistance means carried in said casing, concentric with said axis and insulated from said casing; a second circular resistance means carried in said casing, concentric with said axis and insulated from said casing, said first and second circular resistance means being in spaced relationship with each other, the ends of the first circular resistance means being positioned in said casing so that they bear an angular relationship of 180° to the corresponding ends of the second circular resistance means; a shaft axially supported within said casing and capable of rotation therein; an insulator rotor secured to said shaft; a first slip ring and a second slip ring concentrically mount-

ed on said insulator rotor, said first and second slip rings being insulated from each other; a first brush means adapted to engage said first slip ring; a second brush means adapted to engage said second slip ring; a first wiper means connected to said first slip ring and adapted to make contact with said first circular resistance means; a second wiper means connected to said second slip ring and adapted to make contact with said second circular resistance means, said first and second wiper means bearing an angular relationship of 180° to each other; means for making external connection with each end of the first circular resistance means and with said first brush means; and means for making external connection with each end of the second circular resistance means and with said second brush means.

2. A rotary variable resistance device comprising: a casing having a longitudinal axis; a first circular resistance means carried in said casing, concentric with said axis and insulated from said casing; a second circular resistance means carried in said casing, concentric with said axis and insulated from said casing, said first and second circular resistance means being in spaced relationship with each other, the ends of the first circular resistance means being positioned in said casing so that they bear an angular relationship of 180° to the corresponding ends of the second circular resistance means; a shaft axially supported within said casing and capable of rotation therein; an insulator rotor secured to said shaft; a first slip ring and a second slip ring concentrically mounted on said insulator rotor, said first and second slip rings being insulated from each other; a first brush means adapted to engage said first slip ring; a second brush means adapted to engage said second slip ring; a first wiper means connected to said first slip ring and adapted to make contact with said first circular resistance means; a second wiper means connected to said second slip ring and adapted to make contact with said second circular resistance means, said first and second wiper means bearing an angular relationship of 180° to each other; a terminal means externally associated with said casing adapted to make connection with one end of the first circular resistance means; a terminal means externally associated with said casing adapted to make connection with the other end of the first circular resistance means; a terminal externally associated with said casing adapted to make connection with said first brush means; a terminal means associated externally with said casing adapted to make connection with one end of the second circular resistance means; a terminal means externally associated with said casing adapted to make connection with the other end of said second circular resistance means; and terminal means associated externally with said casing adapted to make connection with said second brush means.

3. A rotary variable resistance device comprising; a casing having a longitudinal axis; a first circular resistance means carried in said casing, concentric with said axis and insulated from said casing; a second circular resistance means carried in said casing, concentric with said axis and insulated from said casing, said first and second circular resistance means being in spaced relationship to each other, the ends of the first circular resistance means being positioned in said casing so that they bear an angular relationship of 180° to the corresponding ends of the second circular resistance means; a first closure member adapted to engage one end of said casing; a second closure member adapted to engage the other end of said casing, said second closure member being provided with an axial bore; a shaft; means associated with said first and second closure members for axially and rotatably supporting said shaft within said casing, said shaft extending through said axial bore in said second closure member; an insulator rotor secured to said shaft between said first and second closure members; a first and a second slip ring secured to said insulator rotor and in spaced relationship to each other and insulated from each other; a first brush means adapted to engage the first slip ring; a second brush means adapted to engage the second slip ring; a first wiper means connected to the first slip ring and adapted to make contact with the first circular resistance means; a second wiper means connected with the second slip ring and adapted to make contact with the second circular resistance means, said first and second wiper means bearing an angular relationship of 180° to each other; means for making external connection with each end of the first circular resistance means and with the first brush means; and means for making external connection with each end of the second circular resistance means and with the second brush means.

4. A rotary variable resistance device according to claim 3 wherein each end of the casing is provided with means for axially attaching another cooperating casing thereto; and locking means associated with each end of said cooperating casings adapted to hold each pair of cooperating casings in longitudinal and radial relationship with each other.

5. A rotary variable resistance device comprising; a plurality of cooperating casings, each casing having a longitudinal axis; a first circular resistance means, concentric with said respective axis in each of said casings, each of said circular resistance means being insulated from its respective casing; a second circular resistance means, concentric with said respective casing axis, in each of said casings, each of said circular resistance means being insulated from its respective casing, each of said first circular resistance means being in spaced relationship to its corresponding second circular resistance means, the ends of the first circular resistance means being positioned in its respective casing so that it bears an angular relationship of 180° to the corresponding ends of the second circular resistance means within said casing; a first closure member adapted to engage the open end of one of the end casings in said assembled plurality of cooperating casings; a second closure member adapted to engage the open end of the other of the end casings in said assembled plurality of cooperating casings, said second closure member having an axial bore; a shaft; means associated with said first and second closure members for axially and rotatably supporting said shaft within said plurality of cooperating casings, said shaft extending through said axial bore in the second closure member; a plurality of insulator rotors secured to said shaft, one rotor being adapted to cooperate with its corresponding casing; a first and a second slip ring secured to each of said insulator rotors, said first and corresponding second slip rings being insulated from each other; a first brush means associated with each of said casings and adapted to engage its corresponding first slip ring; a second brush means associated with each of said casings and adapted to engage its corresponding second slip ring; a first wiper means associated with each of said rotor insulators in contact with its respective first slip ring and adapted to contact its respective first circular resistance means; a second wiper means associated with each of said rotor insulators in contact with its respective second slip ring and adapted to contact with its respective second circular resistance means, each pair of cooperating first and second wiper means bearing an angular relationship of 180° to each other; means associated with each individual casing adapted to permit external connection with each end of each respective first circular resistance means and with each respective first brush means; and means associated with each individual casing adapted to permit external connection with each end of each respective second circular resistance means and with each respective second brush means.

6. A rotary variable resistance device according to claim 5 wherein locking means are associated with each end of

cooperating casings adapted to secure said casings in axial, longitudinal and radial relationship to each other.

7. A rotary variable resistance device comprising, a casing having a longitudinal axis; means at each end of said casing for coupling said casing to the cooperating ends of a corresponding casing and to cooperating closure members; a first circular resistance means carried in said casing, concentric with said axis and insulated from said casing; a second circular resistance means carried in said casing, concentric with said axis and insulated from said casing, said first and second circular resistance means being in spaced relationship with each other, the ends of the first circular resistance means being positioned in said casing so that they bear an angular relationship of 180° to the corresponding ends of the second circular resistance means; a shaft axially supported within said casing and capable of rotation therein; an insulator rotor secured to said shaft; a first slip ring and a second slip ring concentrically mounted on said insulator rotor, said first and

second slip rings being insulated from each other; a first brush means adapted to engage said first slip ring; a second brush means adapted to engage said second slip ring; a first wiper means connected to said first slip ring and adapted to make contact with said first circular resistance means; a second wiper means connected to said second slip ring and adapted to make contact with said second circular resistance means, said first and second wiper means bearing an angular relationship of 180° to each other; means for making external connection with each end of the first circular resistance means and with said first brush means; and means for making external connection with each end of the second circular resistance means and with said second brush means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,505,220 Sparrow ..... Apr. 25, 1950