March 12, 1957 A. ROBERTS 2,785,261

POTENTIOMETER OR THE LIKE

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FIG. 1.

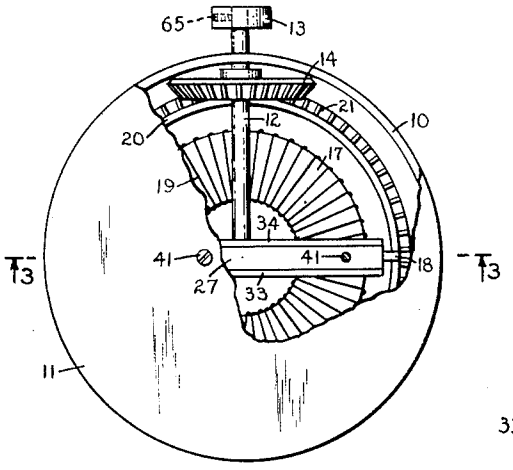
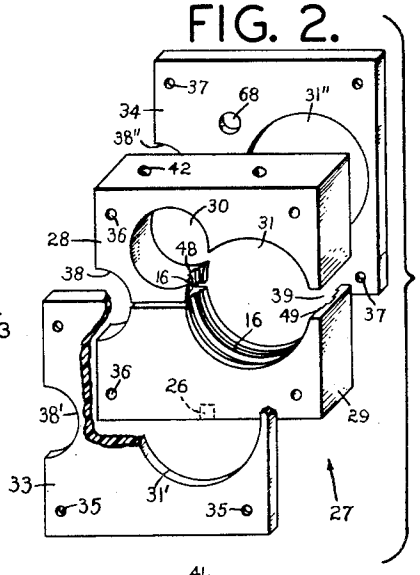


FIG. 2.



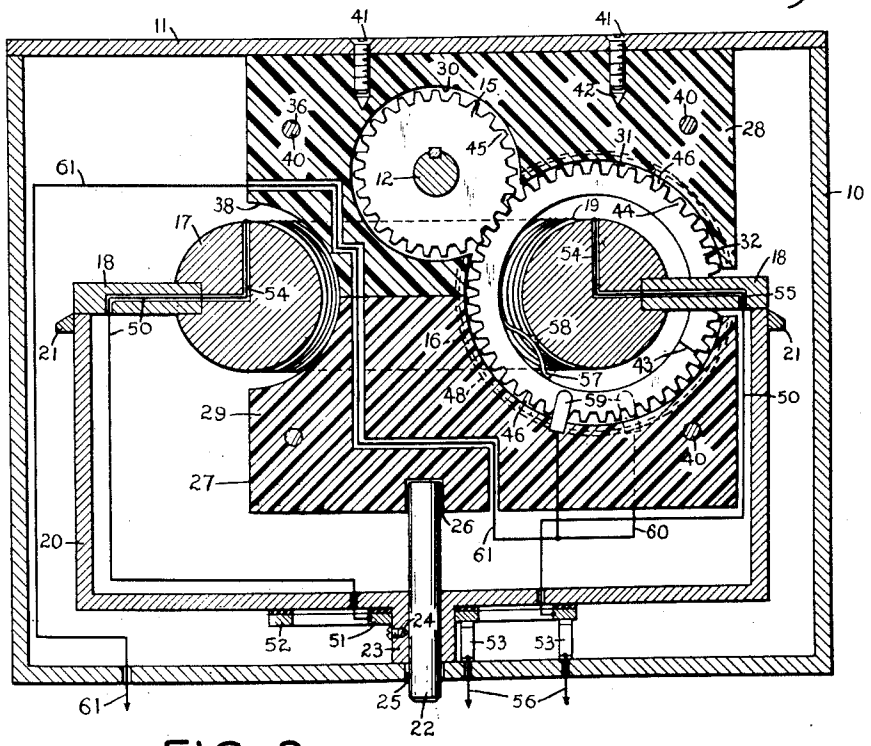


FIG. 3.

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FIG. 4.

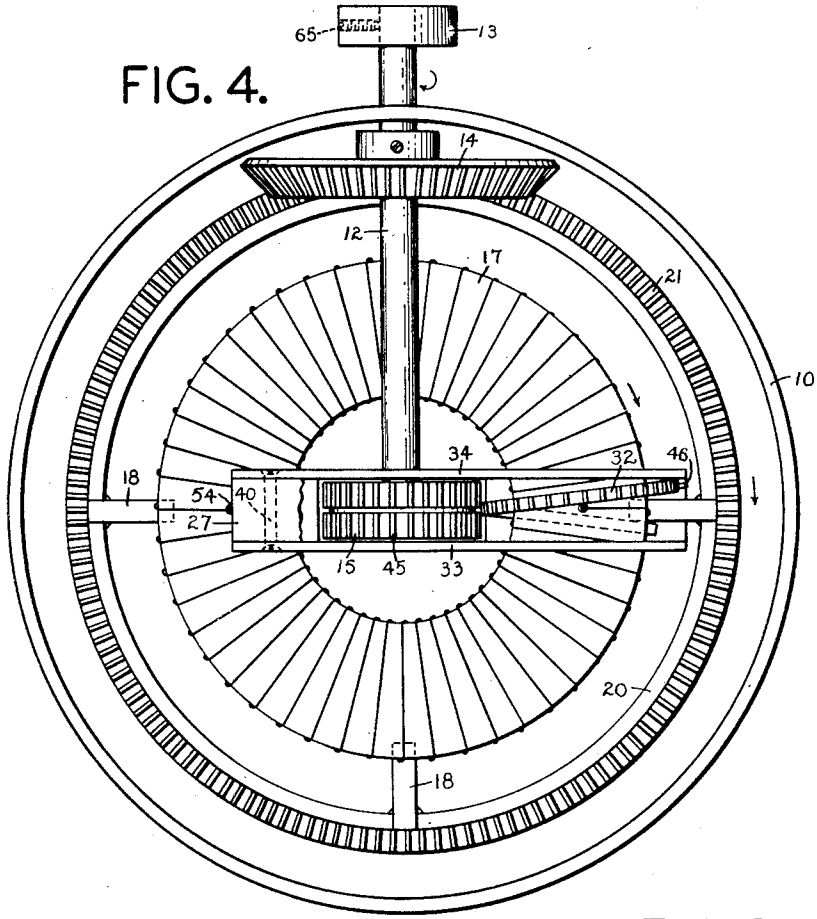


FIG. 5.

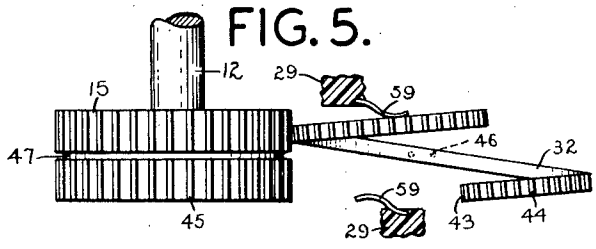
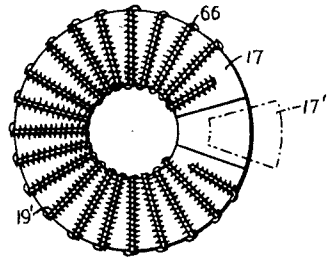


FIG. 6.



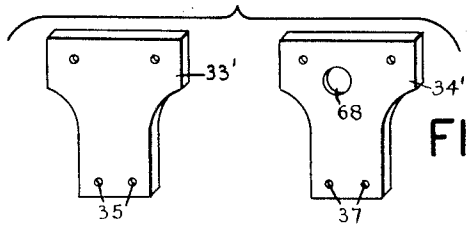


FIG. 7.

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2,785,261

POTENTIOMETER OR THE LIKE

Albert Roberts, New York, N. Y.

Application May 3, 1954, Serial No. 427,010
12 Claims. (Cl. 201—48)

This invention relates to the art of variable electrical elements and particularly concerns a novel potentiometer, rheostat, variable impedance or the like.

It is one object of the invention to provide a rheostat or potentiometer providing a finer control and resolution of resistance for a given size than is generally obtainable.

It is a further object to provide a continuously variable electrical element in which an endless helical conductive winding on a toroidal core is rotated on an axis of the toroid while a metal wiper is enabled to move in the same direction, without return or reverse movement, along the winding. Such an element may be a variable resistance, reactance, inductance, impedance, etc.

It is a further object to provide a potentiometer or the like having a relatively long winding so as to minimize the effect of lost motion in the wiper contact of the potentiometer.

It is a further object to provide a potentiometer or the like which is basically simple in construction, so that it may be manufactured relatively inexpensively.

Other and further objects and advantages of the invention will become apparent from the following description.

Basically the invention includes a toroidal core on which is wound a helical resistance winding. The core is supported on a cylindrical case which carries a circumferentially disposed gear. A control shaft is geared to the circumferential gear and to a geared split ring which carries a wiper contact along the winding in a helical path. As the control shaft is rotated, the winding rotates on the central axis of the toroid and the split ring simultaneously rotates carrying the wiper along the winding.

In prior known potentiometer structures including a rotatable helical resistance winding and movable contact wiper, the resistance winding has been directly driven by a control means while the wiper frictionally followed the resistance winding. Some lost motion between winding and wiper has been inevitable. The present invention insures positive, direct and minute control of relative position of resistance winding and contact wiper because both winding and wiper are gear driven by the same control shaft. The invention will be better understood when considered with reference to the drawing wherein:

Fig. 1 is a plan view of a device embodying the invention with a portion broken away to show internal construction.

Fig. 2 is a perspective view showing details of a gear housing embodied in the structure of Fig. 1.

Fig. 3 is a sectional view taken on lines 3—3 of Fig. 1.

Fig. 4 is a plan view on an enlarged scale showing details of the structure of Fig. 1.

Fig. 5 shows details on an enlarged scale of a split ring gear and drive gear shown in Fig. 4.

Fig. 6 shows a modified form of toroidal core.

Fig. 7 shows modified forms of end plates for the gear housing.

In Fig. 1 is shown the cylindrical casing **10** having a circular cover plate **11**. The plate **11** is shown partially broken away to reveal the control shaft **12** which carries

a control knob or handle **13** at one end, a bevel gear **14** at an intermediate position and a spur type gear **15** lodged in the gear housing **27** at its other end. Gear **15** is best shown in Figs. 3, 4, 5 and will be further discussed later. A toroidal core **17** is supported by a plurality of radial spokes **18**. A resistance element is wound on core **17** to form the helical winding **19**. Spokes **18** are welded, soldered or otherwise attached to a rotatable cylindrical cup member **20** which carries the bevel gear **21** fitted to the outer wall of the cup member.

In Fig. 3 is shown the cylindrical cup member **20** provided with a collar **23** at its lower end in which is locked the shaft **22**. Shaft **22** is journaled in the aperture **25** of cylindrical casing **10** and in a recess **26** of the housing **27**.

Housing **27** is a substantially rectangular block structure formed of plastic fiber or other insulation material. It has an upper section **28** and a lower section **29**. A plurality of bore holes are provided in the several sections. In hole **30** is lodged the gear **15**. Hole **31** is formed by the upper and lower sections of housing **27**. Through this hole passes the toroidal core **17**, and around the core in hole **31** rotates the split ring gear **32**.

In Fig. 4 is shown clearly the housing **27**. The two part structure **28**, **29** is necessary in order to mount the toroidal core in hole **31**. The walls of holes **30**, **31** overlap so that the teeth of split ring gear **32** engages those of gear **15**. End plates **33** and **34** hold the several housing sections together since they are provided with apertures **35** and **37** which register with apertures **36** in the housing sections to receive suitable bolts or screws **40**. A hole **68** is provided in plate **34** through which passes shaft **12**. Plates **33**, **34** are also provided with holes **31'**, **31''** which register with hole **31** in housing **27**. At one side of housing **27** is a recess **38** through which passes the toroidal core **17**. Registering recesses **38'** and **38''** are provided in plates **33**, **34** respectively. At the opposite side of the housing a slot **39** is provided between the sections **28**, **29** opening into hole **31** through which passes spokes **18** during movement of the toroidal core. Screws **41** are threaded in apertures **42** of housing section **28** and serve to secure the housing to cover plate **11** as shown in Figs. 2 and 3.

In Figs. 4 and 5 are clearly shown the gears **15** and **32**. Gear **32** is in the form of a generally circular split ring with ends **43** spaced apart but overlapping circumferentially. The inner diameter of ring gear **32** is slightly larger than that of the toroidal core **17** with its winding **19**. The teeth **44** of gear **32** mesh with teeth **45** of gear **15**. The width or axial extent of gear **15** is at least equal to the greatest width of gear **32** at its ends **43**. In order to prevent sidewise movement of gear **32** it is provided with a pair of pins **46** which project radially from gear **32**. These pins slide in a circumferential single turn groove **47** disposed transversely of teeth **45** in gear **15**. A single turn groove **48** is provided in the wall of hole **31** in housing **27**. The pins **46** project into this groove, so that throughout movement of gear **32** at least one pin **46** is always either in groove **47** or **48**. Groove **48** is located at the bottom **16** of a wider groove having sides **49** between which ride the gear **32** so that it is continually constrained from sidewise movement during rotation.

The electrical system of the device will now be described. The helical coil **19** may be a continuous winding or may have separate terminations. The electrical conductors **50** are joined to winding **19** and pass through boreholes **54** in core **17** and boreholes **55** in spokes **18**. Conductors **50** terminate in circular slip rings **51**, **52** mounted rigidly outside cylindrical member **20**. Stationary brushes **53** mounted in case **10** contact the slip rings and are connected to conductors **56** which pass through case **10** for connection to a suitable electrical circuit. Although only two electrical leads are shown connected to

winding 19, as many leads as desired may be connected to the winding and brought out to slip rings. The split ring gear 32 has mounted on its inner periphery a spring member 57 shown in Fig. 3 which carries a wiper contact element 58. Contact element 58 slides on the resistance winding 19 as gear 32 rotates. A pair of spring wipers 59 are disposed on opposite sides of gear 32 and are carried by the housing 27. The wipers are joined electrically by conductor 60 which is connected to conductor 61 and the latter extends through the structure 28, 29 and thence out through casing 10 in the form of a lead.

In operation, handle 13 which is secured on shaft 12 by a set screw 65 is rotated causing rotation of gears 14 and 15. Gear 14 in engagement with bevel gear 21 causes rotation of the cylindrical cup member 20, and the toroidal core 17 rotates on the axis of the cup member in recess 38 and hole 31 of the housing 27. At the same time gear 15 causes rotation of the split ring gear 32 so that wiper contact 58 follows the winding 19 along its length. As wiper contact 58 traverses the winding 19, electrical current is conducted via wiper contact 58, gear 32 and either one of wipers 58, 59 through conductors 60 and 61. The electrical energy may be supplied to the winding via leads 56 which are connected in circuit with leads 50 and winding 19. As an alternative electrical arrangement one of leads 56 and the lead 61 may be connected to an outside source of electrical current. The electrical path will then be from lead 61 through gear 32, wiper contact 58, winding 19 and lead 50 to the lead 56 selected as the other circuit connection. Many other electrical arrangements are possible and will readily occur to those skilled in the art.

In Fig. 6 is shown a preferred form of toroidal core. The core 17 is provided with a removable segment 17' so that the slip ring gear 32 can be mounted over the core and the segment 17' is then replaced. Instead of providing a removable segment the core can be made in one piece as a complete toroid, and the ring gear 32 can be made of two parts secured together after being mounted on the core. The winding in Fig. 6 has the alternative form of a mandrel in the form of a helix 66 of non-conductive material on which is wound the resistance element 19'.

In Fig. 7 the alternative form of side plates 33' and 34' are shown which replace the plates 33, 34 respectively. These T-shaped plates 33', 34' serve the same functions as plates 33, 34 to join the several sections of housing 27 but they permit easier assembly of the several parts since apertures 31' and 31'' are omitted. Apertures 36 should be located in housing sections 28, 29 to register with the apertures 35, 37 in plates 33', 34'.

The cylindrical cup member 20 may be made of conductive or non-conductive material. If it is made of conductive material such as copper, aluminum or the like, the bottom of the cup should be made of insulation material or the insulation spacers 67 should be provided between slip rings 51, 52, 62 and the bottom of cup member 20. If cup member 20 is made of insulation material, the insulation spacers may be omitted. All leads such as 50, 56, 60, 61, 64 should be insulated conductors. Resistance elements 19 and 19' are bare wire. Core 17 as well as housing 27 including sections 28, 29 and plates 33, 34 or 33', 34' are made of insulation material such as plastic, fiber and the like.

In order to insure that sliding contact 58 follows the path of the helical resistance element 19 as closely as possible, the pitch of the helix should be small relative to its length. It is also possible to modify the circular cross section of the toroid in a manner which compensates for any deviation between the path of the sliding contact and that of the helix.

Although the invention has been described with reference to a potentiometer or rheostat which is a variable resistance, it will be readily apparent to those skilled in the art that the device is adapted to serve as a variable inductance, impedance or other variable electrical element.

Although only a limited number of embodiments of the invention have been disclosed it is not intended that the invention be limited thereto since they are only illustrative of the invention. The scope of the invention is defined in the appended claims.

I claim:

1. A potentiometer or the like comprising a shaft, a pair of gears carried by the shaft, a cylindrical member carrying a circular gear engaged with one of said gears, a helical conductive coil carried by the cylindrical member, a split ring gear encircling the coil and engaged with another of said pair of gears, and an electrical contact carried by the ring gear to contact the coil along its length during rotation of said shaft.

2. A potentiometer or the like comprising a member carrying a conductive coil and a circular gear disposed circumferentially around the coil, a split ring gear encircling the coil and in electrical contact therewith, and means engaging the circular and ring gears to rotate the coil and ring gear simultaneously.

3. A potentiometer or the like comprising a shaft, a bevel gear and spur gear carried by the shaft, a circular gear in engagement with the bevel gear, a ring gear in engagement with the spur gear, said ring gear encircling a toroidal helical conductive coil and electrically contacting the coil.

4. A potentiometer or the like comprising a rotatable shaft, a pair of gears carried by the shaft, a circular gear in engagement with the bevel gear and operatively connected to a toroidal helical conductive coil, a ring gear in engagement with the other of said pair of gears, and encircling said coil, said ring gear electrically contacting said coil and a non-conductive housing provided with means for confining movement of said ring gear in a circular path during rotation of said shaft.

5. A device according to claim 3, wherein said coil is disposed transversely of said housing and passes therethrough during rotation of said shaft.

6. A device according to claim 5, wherein said other gear rotates within said housing.

7. A device according to claim 3, further comprising a cylindrical member carrying said circular gear and supporting slip rings electrically connected to said coil and ring gear, said member being rotatably mounted in a case, and stationary electrical contacts carried by the case and contacting said slip rings.

8. A device according to claim 3, wherein said conductive coil is an electrical resistance element.

9. A variable electrical element, comprising an annular core, a helical conductive member wound on the core, the axis of said helical conductive member comprising a circular line which is equidistant at all points from the central axis of the annular core, a ring encircling said core and conductive member and carrying an electrical contact, the axis of the ring being tangential to said circular line, and means for rotating said ring about its said axis to move the contact along the conductive member in a substantially helical path.

10. A variable electrical element, comprising a toroidal helical conductive member whose central axis comprises a circular line, a ring encircling said helical conductive member and carrying an electrical contact engageable with said helical conductive member, the central axis of said ring being tangential to said circular line, and means for rotating the ring about its said axis to move said electrical contact along said helical conductive member in a substantially helical path.

11. A potentiometer or the like, comprising a toroidal helical conductive member whose axis comprises a circular line, a ring encircling and contacting said helical conductive member, the axis of the ring being tangential to said circular line, and means for rotating the ring about its

said axis to effect contact with the helical conductive member along its entire length.

12. A potentiometer or the like, comprising a toroidal conductive helix, a ring encircling and contacting the helix, the width of the ring being at least equal to the width of a single convolution of said helix and the axis of the ring coinciding with the convolution which it encircles, and

means for rotating the ring in a helical toroidal path to move it along and in contact with said toroidal conductive helix.

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