Dec. 26, 1967 E. C. WAHLBERG 3,360,757

ELECTRONIC DEVICES FOR PROVIDING INFINITELY VARIABLE ELECTRICAL VALUES

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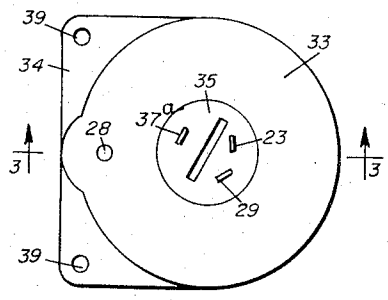


FIG. 1

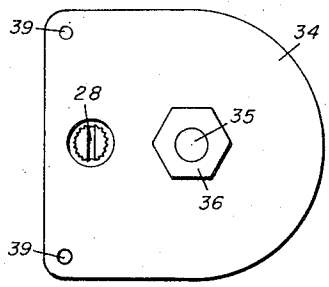


FIG. 2

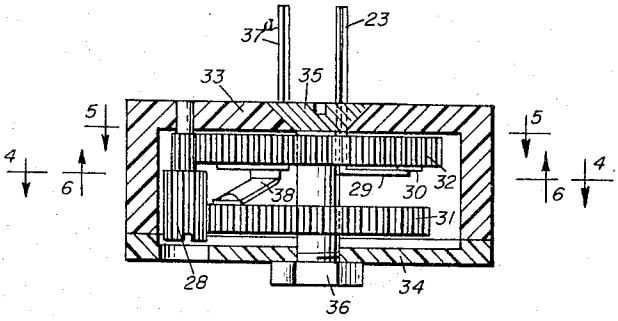


FIG. 3

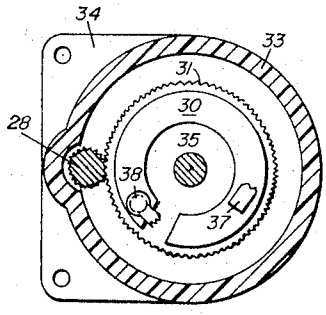


FIG. 4

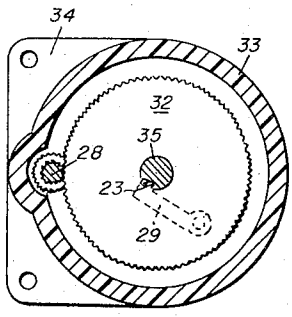


FIG. 5

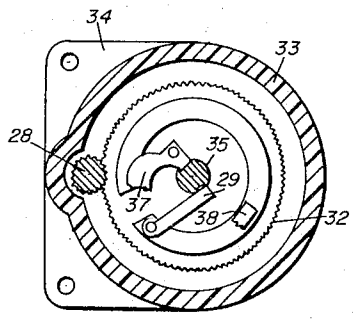


FIG. 6

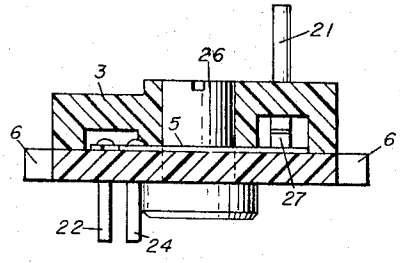


FIG. 7

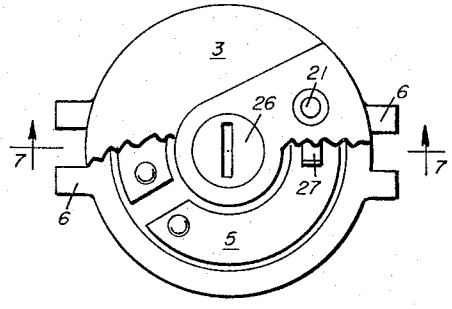


FIG. 8

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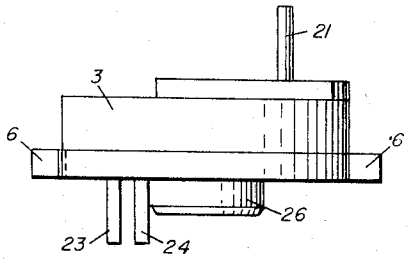


FIG.9

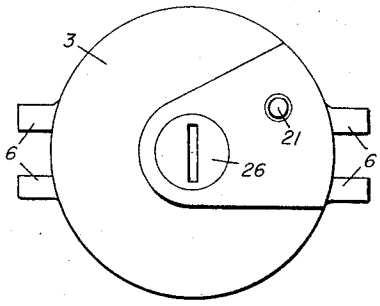


FIG.10

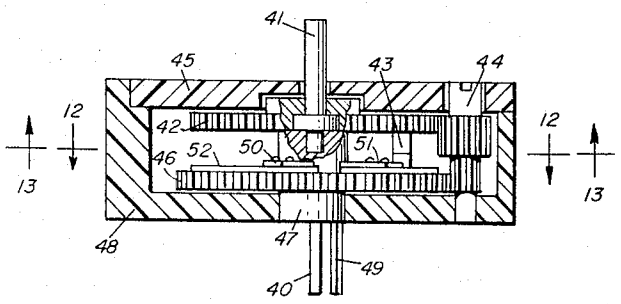


FIG.11

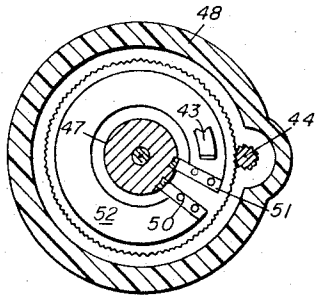


FIG.12

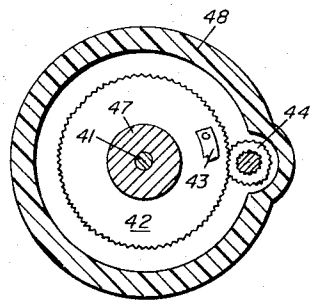


FIG.13

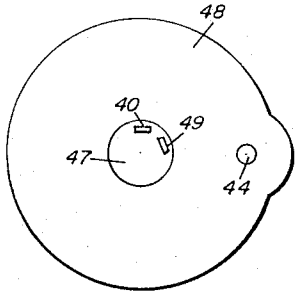


FIG.14

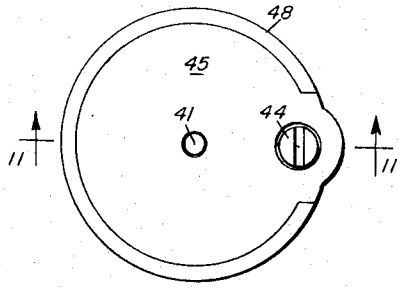


FIG.15

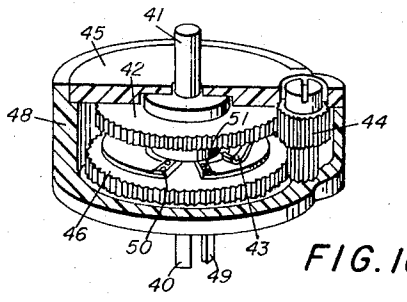


FIG.16

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3,360,757

ELECTRONIC DEVICES FOR PROVIDING INFINITELY VARIABLE ELECTRICAL VALUES

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Filed May 4, 1964, Ser. No. 364,538
5 Claims. (Cl. 338—162)

ABSTRACT OF THE DISCLOSURE

Two electrical elements are mounted for independent rotation in the same direction about a common rotary axis, said elements being in electrically coactive relationship whereby variable electrical values depend upon the relative angular displacement of the two elements.

This invention relates to electronic devices normally known as potentiometers, variable resistors, variable condensers, trimmers and the like but not limited thereto. In particular, as described herein but not limited thereto, the invention relates to providing a simple, economical, and miniature assembly which will result in extreme accuracies for electronic and other devices.

The present devices are limited in accuracies to either a direct connected knob or pulley arrangements which are subject to inadequate control due to uneven friction and slippage. One of the newer trimmers is positioned by means of a worm drive. This does not overcome the problem of accuracy entirely, since there is a certain amount of displacement due to the thrust imposed by the friction of the assembly. In addition, the assembly is not simple nor economical.

An object of this invention is to provide a means whereby the positioning of the pick-off contact is extremely accurate.

Another object of this invention is to provide a locking means which is not dependant on the driving means.

Another object of this invention is to provide a product with a minimum of parts designed for simple and quick assembly.

Further objects of the invention will become apparent from the broad interpretation of the specification and the drawings.

These and other objects of the invention are achieved in an arrangement wherein two discs of different diameters are free to rotate about a common shaft center. The rotation may be caused by the rotation of a third member having two different diameters mating with the circumferences of the aforementioned discs. The radius of one disc added to the radius of that portion of the third member which cooperates with that disc must equal the radius of the other disc added to the radius of the portion of the third member which cooperates with the other disc and, as a result, the relative speed of rotation of one disc with respect to the other disc will be determined by the ratio between their respective radii. Proper mounting of conducting coatings, terminals, and sliding pick-offs on the discs provide an assembly which may be compactly contained in a housing to form a completed product according to this invention.

One embodiment of this invention is illustrated in FIGURES 1–6 in which;

FIGURE 1 illustrates the top view;

FIGURE 2 illustrates the bottom view;

FIGURE 3 is a cross-section taken on the line 3—3 of FIGURE 1;

FIGURE 4 is a cross-section taken on line 4—4 of FIGURE 3;

FIGURE 5 is a cross-section taken on line 5—5 of FIGURE 3;

FIGURE 6 is a cross-section taken on line 6—6 of FIGURE 3;

A second embodiment of this invention is illustrated in FIGURES 7–10 in which;

FIGURE 7 is a cross-section taken on line 7—7 of FIGURE 8;

FIGURE 8 is a top view with a portion cut away to show the relative position of parts;

FIGURE 9 is a side view;

FIGURE 10 is a top view;

A third embodiment of this invention is illustrated in FIGURES 11–15 in which;

FIGURE 11 is a cross-section taken on line 11—11 of FIGURE 15;

FIGURE 12 is a cross-section taken on line 12—12 of FIGURE 11;

FIGURE 13 is a cross-section taken on line 13—13 of FIGURE 11;

FIGURE 14 is a bottom view of the device shown in FIGURE 11;

FIGURE 15 is a top view, and;

FIGURE 16 is an isometric view with a portion cut away to show the relative position of the several parts.

Other embodiments of this invention are afforded with variable condensers, impedances, etc. in which similar mounting of the stationary and rotating part on the respective discs so that when they are rotated they are properly identified with each other as to electrical properties and mechanically. It is therefore important not to limit the scope of this invention to those embodiments illustrated but consider it in the broad aspect.

Reference is now made to the first embodiment of the invention and the FIGURES 1–6 which illustrate it. Included in the embodiment is case **33**, cover **34**, shaft **35**, nut **36**, upper disc **32**, lower disc **31**, pinion shaft **28**, terminals **29**, **23**, sliding contact **38**, sliding contact **37**, mounting holes **39**, conductive layer **30** and resistive layer **25**.

Sliding contact **37** is mounted on the lower side of the upper disc **32**. One end extends along shaft **35** to the outside of the case **33** to form terminal **37**. The other end contacts conductive layer **30** on the upper side of the lower disc **31**. The sliding contact **38**, attached to conductive layer **30** on disc **31**, contacts resistive layer **25** on the underside of the upper disc **32**. Terminal **29** is mounted to resistive surface **25** on the under side of the upper disc **32**. One end of terminal **29** extends along shaft **35** out of housing **33** to form a second terminal. Terminal **23** is mounted to the other end of the resistive layer **25** on the under side of the upper disc **32**. One end of terminal **23** extends along shaft **35** to the outside of housing **33** to form the third terminal. Thus all terminals extend out along shaft **35** and rotate with it. Upper disc **32** may therefore be fixed to the shaft as it must rotate with it.

Following now the electrical path we find that terminal **29** may be used as one connection point from where current will travel to resistive layer **25** to terminal **23**. Also it may travel to resistive layer **25** thence to sliding contact **38** through conductive layer **30** to sliding contact **37** which becomes terminal **37***a* outside the case **33**. The amount of resistance included in the second path is dependant upon the position of sliding contact **38** on resistive layer **25**. This in turn is dependent on the position of the discs **31** and **32**. Their positions are determined by the turning of pinion shaft **28**.

Disc **31** is rotatably mounted on shaft **35**. Disc **32** is larger in diameter than disc **31** and is fixedly mounted to shaft **35** and located just above disc **31**. Each have for the purpose of this discussion gear teeth on their circumferences.

Pinion shaft 28 has two sets of gear teeth one set having a different diameter than the other set. The smaller diameter matches when assembled to the unit, with the larger upper disc 32 gear teeth and the larger diameter pinion gear matches the smaller disc 31 gear teeth. In each case the sum of the pitch radii of the pinion and disc gear teeth must equal the center line distance between the pinion shaft 28 center and the shaft 35 center. Thus when pinion shaft 28 is turned both discs will also rotate and in proportion to the circumferences of the contacting gears. Larger disc 32 will turn slower than smaller disc 31 in that the circumferential travel of the smaller pinion gear is less than that for the larger pinion gear which drives the smaller disc 31. Thus, though both discs are rotating, the smaller disc 31 will be going faster and after a predetermined number of turns of the pinion shaft 28 will lap disc 32. Thus, with proper design very high accuracy may be obtained from small increments of rotation of the pinion shaft applied to displace the discs 31 and 32.

The pinion shaft has a slot in the larger end for ease of operation. Other means such as knobs, motor drives, etc. may be substituted for convenience or remote control.

The above parts are assembled into case 33 and cover 34 is put on and held in place by nut 36 screwed on to threaded end of shaft 35. Nut 36 may also be used as a locking means to hold the setting of the discs in proper position independant of pinion 28. To readjust would require loosening of this nut 36 before moving pinion 28.

Instances may occur when continuous adjustment is required. In that case, nut 36 would serve to hold assembly together only.

Reference is now made to the second embodiment of the invention and FIGURES 7–10 which illustrate it. Included in the embodiment is case 3, lock screw 26, cover 6, resistive layer 5, terminals 21, 22, 24, sliding contact 27, and mounting lugs 6.

Sliding contact 27 is mounted to the inside of cover 3. One end of the contact is attached to terminal 21 which extends out of case 3. The other end slidably contacts the resistive layer 5 on the inside of the cover 6. One end of the resistive layer 5 has attached to it the terminal 24 while the other end has terminal 22. Both terminals extend outwardly through the cover 6. Lock screw 26 holds the cover to the case and locks it in position. To adjust this unit the lock screw 26 is loosened and the cover and case turned with respect to each other and then relocked in position as before. If accuracy is important, a fixture can be used which consists of a body in which is located a serrated pinion to cooperate with the case and the cover to provide the same advantages as the preceding embodiment. This is the simplest of the embodiments to manufacture.

Following now the electrical path we find that terminal 22 can be used as one connection point from where current will travel through the resistive layer 5 to terminal 24. Also it may travel to resistive layer 5 thence to sliding contact 27 and to terminal 21.

The amount of resistance included in the second path is determined by the position of the slidable contact 27 on the resistive layer 5. All of this is dependant on the relative position of the cover to the case.

As in the previous embodiment, a pinion gear arrangement can be added to provide a similar adjustment on the case and the cover by making the pinion assembly attach over the locking screw 26 and having the pinion gears mesh with the teeth that would be provided on the outside of the case and cover.

Reference is now made to the third embodiment of the invention and FIGURES 11–15 which illustrate it. Included in the embodiment is a case 48, having a cover 45. A shaft 47 is supported in the lower wall of the case for rotatably supporting a lower disc 46 having on its upper surface a resistive layer 52. An upper disc 42 is rotatably supported in the cover 45 and includes a terminal

41 which may also act as a shaft. The upper disc is also provided with a sliding contact 43 for operative engagement with the resistive layer 52, connections to the ends of this resistive layer being provided by terminals 50 and 51. The pinion shaft 44 serves as the driving means for the discs 42 and 46.

Lower disc 46 is larger than upper disc 42. Lower disc 46 is mounted on shaft 47 and rotates with it. Both upper and lower discs have for the purpose of this discussion gear teeth around their circumference. A resistive layer 52 is located on the upper surface of disc 46. One end of the resistive layer 52 is attached to terminal 49 while the other end is attached to terminal 40. Disc 42 may be made of a conductive material or have a metallic coating on it. A terminal 41 is attached to the disc 42 and made electrically conductive to a slidable contact 43 either through the metallic disc or its coating. The slidable contact is mounted on the disc 42 and contacts the resistive surface 50 on the disc 46. The terminal 41 may extend out of the cover 45 as shown or extend through the shaft 47 to the outside of the case on the same side as the terminals 40 and 49. The pinion shaft 44 is mounted in the cover and case and has two sets of gear teeth one set on each of two different diameters and cooperate with the discs in the same manner as in the first embodiment of the invention.

Following now the electrical path we find that terminal 40 may be used as one connection point from which current will travel to resistive layer 52 to terminal 49. Also current will travel through resistive layer 52 to slidable contact 43 and to terminal 41. This unit may also be used as a voltage divider by placing voltage across terminals 40 and 49 and picking off voltage on terminal 41 from contact 43.

Reference is now made to FIGURE 16 which shows relative positions of the parts in particular of the third embodiment. This is explanatory by the above description and isn't repeated.

By mounting the stationary plates of the condenser on the disc 46 of the previous emobdiment and the movable plates on the disc 42 and holding their space relationship by locating discs 42 and 46 accurately from each other it is easily seen that this invention is applicable to these units as other electrical and mechanical assemblies where accurate variable positioning is important.

There has accordingly been described and shown herein a novel means for obtaining highly accurate positioning of various items particularly of electrical or electronic nature but not limited thereto. There has also been described and shown a novel means of accurately rotating two or more items at relative speeds to each other. The method is simple, economical, requires few parts, may be miniaturized, and may be operated manually, motorized and remotely controlled.

While I have described several embodiments of my invention in this application which have been concerned with electronic devices it is not the intent to limit the scope to these since the invention may be used to control pneumatic, hydraulic as well as mechanical devices with proper coordinating design. Therefore the appended claims should not be limited to the embodiments shown.

Accordingly, I claim in the broadest sense:

1. A device for connection in an electrical circuit for establishing a multiplicity of electrical values in said circuit, comprising support means, a pair of elements mounted on said support means in electrically coactive relationship with each other and for independent rotation while in said coactive relationship about a common axis, each of said multiplicity of electrical values being a function of the relative angular displacement of said pair of elements, and driving means for simultaneously rotating both of said pair of elements in the same direction, said driving means including a rotatable driving member engageable with each of said pair of elements for angular displacement of said members in response to rotation of

said driving member, the rate of angular displacement of both said pair of elements being less than the rate of angular displacement of said driving element but different with respect to each other.

2. The invention as defined in claim 1, wherein one of said pair of elements comprises a disc shaped body mounted for rotation about its central axis having an annularly disposed resistive path on a surface thereof, and the other of said pair of elements includes contact means rotatable therewith and in electrically operative engagement with said resistive path.

3. The invention as defined in claim 1, wherein each of said pair of elements comprises a disc shaped body mounted for rotation about its central axis, and said driving member is mounted for rotation about an axis parallel with said common axis of rotation of the pair of elements, said driving element having two circumferential driving portions of unequal radii, and means for driving engagement between said driving portions and a circumferential portion of a respective disc shaped element, the sum of the radius of one driving portion and the radius of a respective element being equal to the sum of the radius of the other driving portion and the radius of the other respective element.

4. The invention as defined in claim 3, wherein said two driving portions comprise spur gears, and the circumferential portions of the pair of elements include teeth for meshing engagement with said spur gears.

5. The invention as defined in claim 1, wherein said driving means comprises a pair of coaxial gear means mounted on an axis parallel with said common axis each having a different radius, and a pair of driven gear means of unequal radius in driven engagement with the first pair of gear means, and means for operatively connecting each of said driven gear means with a respective one of said first mentioned pair of elements for driving said elements.

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