

Dec. 23, 1958

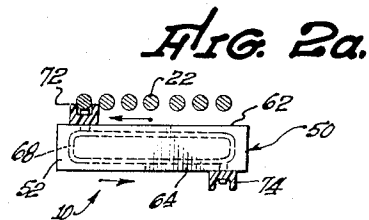
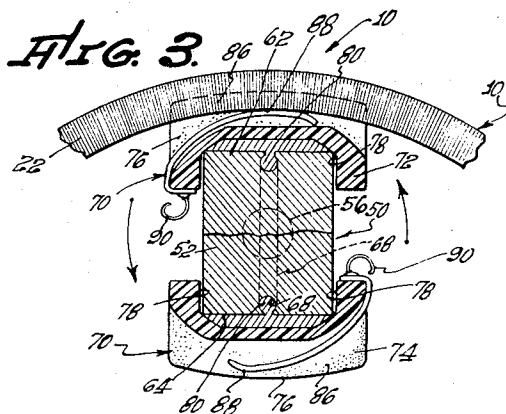
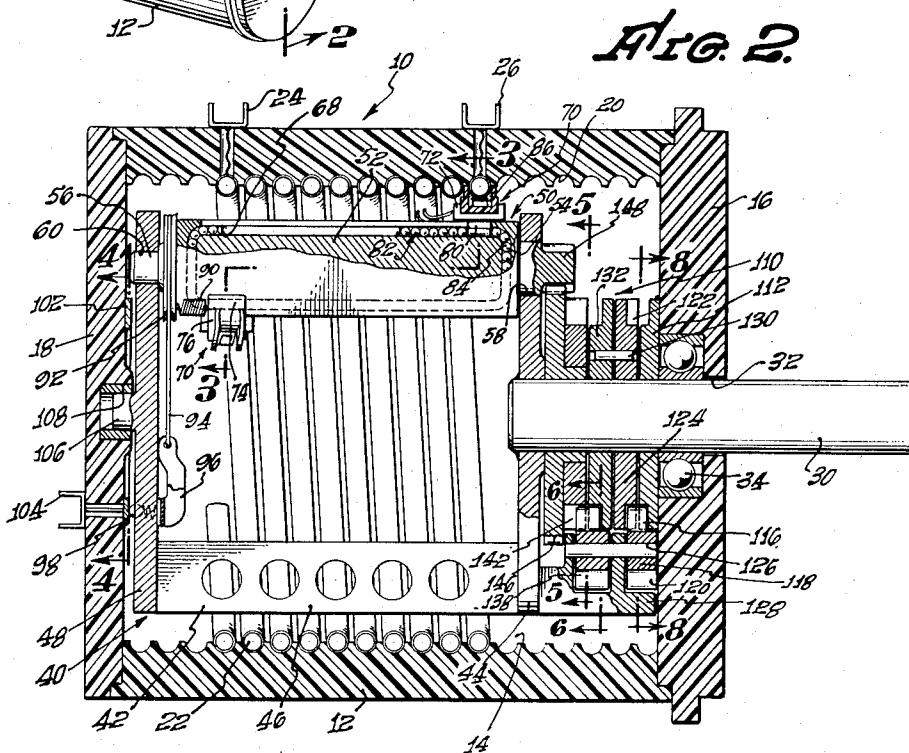
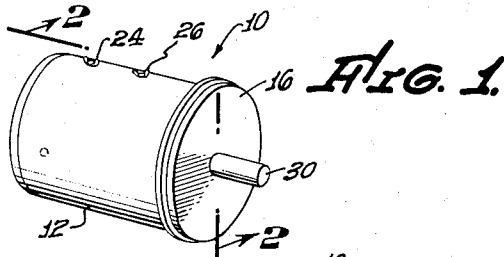
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2,866,056

MULTIPLE TURN STOPLESS POTENTIOMETER

Filed Sept. 12, 1955

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 7.

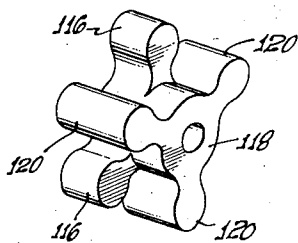


Fig. 4.

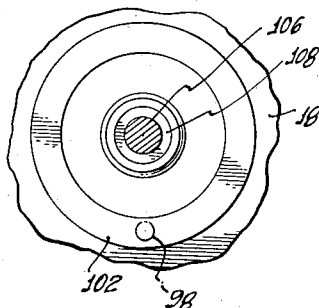


Fig. 5.

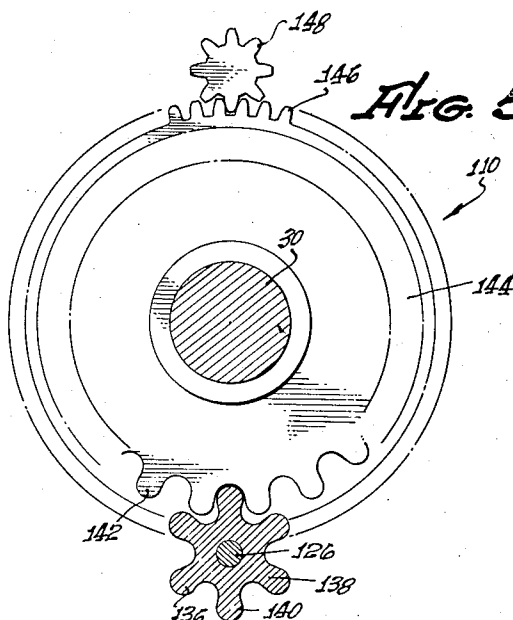


Fig. 9.

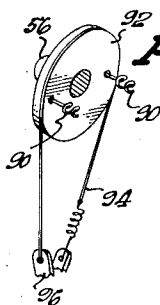


Fig. 6.

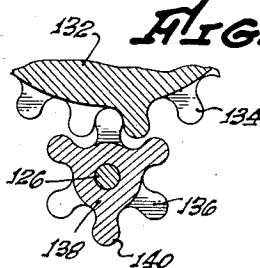
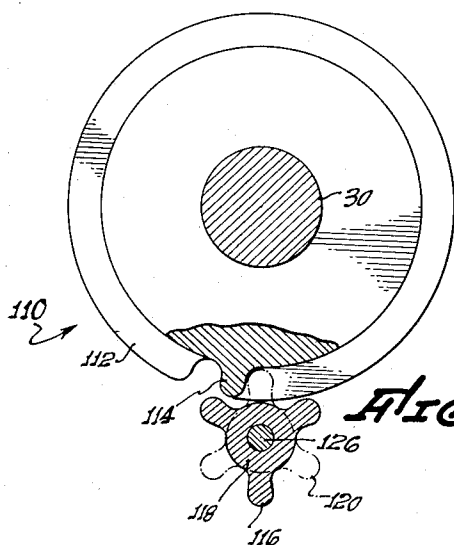


Fig. 8.



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MULTIPLE TURN STOPLESS POTENTIOMETER

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9 Claims. (Cl. 201—56)

This invention relates to a multiple turn, stopless potentiometer and is exemplified as embodied in a multiple turn potentiometer of the helical type.

During recent years, large numbers of accurate potentiometers have been utilized in such applications as computer circuits, fire control circuits, and a variety of similar applications wherein the accuracy of the potentiometer, from a linearity standpoint, or its accuracy from the standpoint of precisely dividing voltage in direct proportion to shaft rotation has been adapted in various computer applications.

It is well known to those skilled in the art that the inherent accuracy obtainable in a single turn potentiometer was found inadequate for some applications and the multiple turn potentiometer came into wide use. By the adoption of the multiple turn potentiometer, it became possible to obtain long resistance windings coiled helically or in a spiral within a housing of moderate size, for example, the length of resistance wire now installed inside a two-inch diameter multiple turn potentiometer in which the resistance is wound in ten helical turns would require a single turn potentiometer having a housing approximately eighteen inches in diameter. A housing of this size would normally be considered too large to be practical for any production application, particularly in view of the miniaturization trend in many industries.

In single turn potentiometers there was no necessity for the use of mechanical stops and it was, therefore, possible and is possible to continuously rotate the actuator shaft of the potentiometer in a clockwise or counterclockwise direction continuously or intermittently, as dictated by the circuit application. However, when multiple turn potentiometers of either the spiral or helical type were introduced into a circuit, the advance of continuous rotation was lost and it became necessary to provide mechanical stops which would limit the movement of the contact sliders when the sliders reached the last turn of the resistance wire. In order to return the contact slider of a potentiometer of this conventional type, it was necessary to provide relatively complex mechanisms for reversing the direction thereof, including additional gearing, brackets, bearings, shafts, and the like which entailed the provision of larger envelope size, weight, and slower action of the system in which the potentiometer was incorporated, due to the necessity for reversing the direction of the slider.

It also became necessary to incorporate limit switches, or the like, to prevent the mechanical potentiometer stops from being damaged and to prevent injury to the contact slider itself. Furthermore, in many cases it has been necessary to utilize reversible actuator motors which were not necessary with the prior art single turn potentiometers.

In order to overcome the above-referred to disadvantages of conventional multiple turn potentiometers, I provide by my invention a stopless, multiple turn potentiometer which eliminates the necessity for the provision of mechanical or electrical stops and limit switches in association with the potentiometer and which also eliminates

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the necessity for the provision of complex reversing mechanisms of the character referred to hereinabove. Thus, with a potentiometer constructed in accordance with the teachings of my invention it is possible to rotate the actuator shaft in either direction, clockwise or counterclockwise, continuously or intermittently in the same manner as the prior art single turn potentiometers.

It is, therefore, an object of my invention to provide a multiple turn, stopless potentiometer which includes a primary carrier for contact slider means incorporated in said potentiometer and a secondary carrier for said contact slider means operatively connected to said primary carrier whereby, when a predetermined number of revolutions of the primary carrier has taken place, the secondary carrier will be energized to cause one of a plurality of contact sliders constituting the contact means to be moved into engagement with the helical resistance wire incorporated in the potentiometer and the other of the contact sliders to be moved from engagement therewith.

Therefore, continuous movement in either direction of the contact sliders constituting the contact means of the potentiometer is attained and there is no necessity for the provision of mechanical or electrical stops to limit the movement of the contact sliders. Moreover, there is no necessity for providing complex gearing and the like to accomplish reversal of the movement of the contact slider to return the contact slider to its original position.

An additional object of my invention is the provision of a multiple turn potentiometer of the aforementioned character wherein the aforesaid secondary carrier is provided with third carrier means for supporting and moving the contact sliders constituting the contact means of the potentiometer in a predetermined relationship and in synchronism with each other so that the contact sliders will be properly located when movement of the secondary carrier with respect to the primary carrier occurs to place one or the other of the contact sliders in operative engagement with the helical resistance.

It should, of course, be understood that, while I describe my invention as embodied in conjunction with a potentiometer incorporating a helical resistance, it is conceivable that the principles of the invention may be applied with equal cogency to a potentiometer incorporating a resistance formed in a spiral wherein the individual convolutions of the spiral are arranged one within the other and in the same plane surface.

A further object of my invention is the provision of a multiple turn, stopless potentiometer of the aforementioned character wherein the movement of the primary carrier is accomplished by an actuator operatively connected thereto and wherein the movement of the secondary carrier with respect to the primary carrier is accomplished by indexing means energizable by the movement of the primary carrier to cause the movement of the secondary carrier in a predetermined ratio to the movement of the primary carrier so that, as movement of the primary carrier in a major sense occurs, ultimate movement of the secondary carrier in a minor sense determined by the number of turns in the helical resistance will take place.

Other objects and advantages of my invention will be apparent from the following specification and the accompanying drawings which are for the purpose of illustration only and in which:

Fig. 1 is a perspective view showing the housing of a helical potentiometer constructed in accordance with the teachings of my invention;

Fig. 2 is a longitudinal sectional view taken on the broken line 2—2 of Fig. 1;

Fig. 2a is a schematic view showing the reversal in the

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positions of the contact sliders constituting the contact means of the potentiometer;

Fig. 3 is an enlarged, fragmentary, partly sectional view taken on the broken line 3—3 of Fig. 2;

Fig. 4 is a plan view showing a commutator means incorporated in the potentiometer;

Fig. 5 is an enlarged, fragmentary view taken from the broken line 5—5 of Fig. 2;

Fig. 6 is an enlarged, fragmentary, partly sectional view taken from the broken line 6—6 of Fig. 2;

Fig. 7 is a perspective view showing one of the compound pinions incorporated in the indexing means for operating the secondary carrier of the potentiometer;

Fig. 8 is a vertical, sectional view taken from the broken line 8—8 of Fig. 2; and

Fig. 9 is a perspective view of a conductor means incorporated in the secondary carrier of the potentiometer.

Referring to the drawings and particularly to Figs. 1-3 thereof, I show a helical potentiometer 10 which is incorporated in a cylindrical housing 12 formed from a phenolic plastic, or the like, and defining an interior chamber 14.

The opposite ends of the housing 12 have top and bottom cover plates 16 and 18, respectively, secured therein and the interior wall of the chamber 14 is provided with a continuous helical groove 20 which is adapted to receive the superimposed convolutions or turns of a continuous helical resistance wire 22. It will be observed that the length of the groove 20 is such that helical resistance wires having different numbers of convolutions or turns can be inserted in the groove 20 and thus the capacity of the potentiometer 10 can be adapted for particular applications.

The opposite ends of the helical resistance 22 are connected to input terminals 24 and 26 which project from the side of the housing 12 and by means of which current can be supplied to the helical resistance 22.

An actuator shaft 30 projects through a bore 32 in the top cover plate 16 and is supported by a bearing 34 located in said cover plate adjacent said bore. Since it is common practice to connect the actuator shaft 30 to electrical motors, or linkages of various types, no attempt has been made herein to describe those portions of a system in which the potentiometer 10 would be incorporated but it is, of course, to be understood that so far as the potentiometer 10 is concerned the shaft 30 constitutes the actuator therefor.

Disposed within the chamber 14 defined by the housing 12 is a primary carrier 40, said carrier being constituted by what is substantially a yoke 42. Incorporated in the yoke 42 is a disc 44 which is secured to the inner extremity of the actuator 30 and which is operatively connected by means of a plurality of connecting bars, such as the connecting bar 46, to a circular bottom plate 48. Therefore, energization of the actuator shaft 30 will cause concomitant rotation of the primary carrier 40 constituted by the yoke 42 in a major sense in that the yoke will be rotated bodily within the chamber 14 of the housing 12.

Mounted for movement by and in the primary carrier 40 is a secondary carrier 50, said secondary carrier being constituted by an elongated block 52 of substantially rectangular cross section which is provided with journals 54 and 56, respectively, at its opposite ends. The journal 54 is received in a bore 58 in the disc 44 and the journal 56 is received in a bore 60 in the bottom plate 48. The block 52 constituting the secondary carrier 50 is fabricated from an insulative material such as phenolic plastic to prevent the secondary carrier 50 from acting as a conductor.

Formed in the opposite faces 62 and 64 of the block 52 constituting the secondary carrier 50 and running through the opposite ends of said block is a continuous groove 68 in which is supported the contact means 70 of the potentiometer, said contact means being constituted by a pair of contact sliders 72 and 74, which are adapted

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to move in the groove 68 with respect to their associated faces 62 and 64 of the secondary carrier 50, the contact slider 72 being associated with the face 62 and the contact slider 74 being associated with the face 64 of the block 52 constituting said secondary carrier.

Each of the contact sliders 72 and 74 includes a substantially rectangular block 76 formed from phenolic plastic, or a similar insulating material. The blocks 76 are provided with recesses 78 in the backs thereof, as best shown in Fig. 3 of the drawings, which partially encompass the adjacent portions of the elongated block 52 constituting the secondary carrier 50 and which thus serve as guide means for the blocks 76 as they traverse the opposite sides of said carrier. Formed integrally with each of the blocks 76 at the bottom of the recess 78 is a key member 80 which is engaged in its associated groove 68 and which retains the block 76 in operative relationship with the adjacent face of the secondary carrier 50.

Located in the continuous groove 68, as best shown in Fig. 2 of the drawings, is a third carrier means 82 constituted by a plurality of abutting ball bearings 84 which are adapted to maintain the contact sliders 72 and 74 in predetermined, spaced relationship with each other and also to transmit the movement of the slider engaged with the helical resistance 22 to the slider which is not engaged with the helical resistance 22. Each of the rectangular blocks 76 constituting the body of one of the sliders 72 and 74 is provided with a groove 86 adapted to fit over an adjacent convolution of the helical resistance 22, as best shown in Figs. 2 and 3 of the drawings, and having located therein a conductor shoe 88 which engages the helical resistance 22 and is adapted to transmit current through an associated conductor 90 to a rotary conductor plate 92 mounted on the journal 56 on one end of the secondary carrier 50.

The rotary conductor plate 92 has a conductor 94 entrained thereupon which is, in turn, connected to a terminal 96 mounted in the bottom plate 48 of the yoke 42. The terminal 96 is electrically connected to a contact ball 98 which engages a commutator ring 102 mounted on the interior wall of the bottom cover 18 of the housing 12. The commutator ring 102 is, in turn, connected to the output terminal 104 of the potentiometer, as best shown in Fig. 2 of the drawings.

It will be noted at this juncture that the bottom plate 48 of the yoke 42 constituting the primary carrier 40 is provided with an integral boss 106 which is located for rotation in a bearing 108 provided in the bottom cover 18 of the housing 12.

As previously indicated, the actuator shaft 30 is secured positively to the primary carrier 40 to accomplish the rotation thereof. Thus, when the actuator shaft 30 is rotated in the bearing 34, concomitant rotation of the primary carrier 40 in its major sense or orbit will take place. In order to accomplish the movement of the secondary carrier 50 in and with respect to said primary carrier, there has been provided in the potentiometer 10 of my invention indexing means, indicated generally at 110, said indexing means being constituted by a modified form of Geneva movement.

Although I disclose a particular type of indexing means 110 as adapted to cause the movement and rotation of the secondary carrier 50 in a minor sense with respect to the primary carrier 40, it is, of course, obvious that the invention is not intended to be limited to the specific type of indexing means shown because various types of movements can be utilized to accomplish the result of moving the secondary carrier 50 in a predetermined ratio to the movement of the primary carrier 40.

The indexing means 110 includes, as best shown in Figs. 3-8 of the drawings, a primary indexing plate 112, said indexing plate, as best shown in Fig. 8 of the drawings, having a single advancing tooth or lobe 114 formed in the periphery thereof and engageable by one of the lobes or teeth 116 on a pinion 118 which is provided with

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secondary lobes or teeth 120 engageable with mating lobes or teeth 122 on an indexing gear 124. The pinion 118 is mounted for rotation on a shaft 126 mounted in a boss 128 provided on the outer surface of the disc 44 of the yoke 42.

Therefore, as the actuator shaft 30 rotates the yoke 44, one of the primary lobes 116 of the pinion 118 will strike the actuator tooth or lobe 114 of the primary indexing plate 112 to cause partial rotation of the pinion 118 and to cause the secondary lobe 120 of the pinion 118 to engage one of the actuating lobes 122 on the indexing gear 124.

The indexing gear 124 is pinned, as best shown at 130, to a similar gear 132 which, as best shown in Fig. 6, is provided with a plurality of teeth 134 engageable with primary teeth 136 on a pinion 138 which is also provided with secondary teeth 140.

The primary and secondary teeth 136 and 140 of the pinion 138 are engageable with actuating teeth 142 on an indexing gear 144, said indexing gear being provided with a spur gear 146 engageable with a pinion 148 secured to the journal 54 on the secondary carrier 50.

The energization of the potentiometer 10 of my invention entails the initial rotation of the actuator shaft by associated means, not shown, and the movement of the primary carrier 40 within the chamber 14 defined by the housing 12. As the yoke 42 constituting the primary carrier is rotated within the chamber 14 by the actuator shaft 30, the slider 70 engaged upon the helical resistance 22 is carried upwardly or to the right, as best shown in Fig. 2 of the drawings, by the successive convolutions of the helical resistance 22. This causes both rotary movement of the slider 72 in the major orbit defined by the primary carrier 40 and longitudinal movement of the slider 72 in the groove 68 of the secondary carrier 50. Movement of the slider 72 in the longitudinal sense is transmitted to the associated slider 74 through the medium of the third carrier means 82 constituted by the plurality of ball bearings located in the continuous groove 68.

Thus, as the slider 72 is moved on the secondary carrier 50 in the longitudinal sense, simultaneous with its rotation in the major orbit defined by the primary carrier 40, the associated slider 74 is also moved synchronously therewith and to the same extent in the opposite direction.

As the slider 70 is carried to the right on the resistance winding 22 by successive rotations of the actuator shaft 30, the indexing means 110 is also operated by the continuous or successive rotation of the yoke 42 constituting the primary carrier 40. As each full rotation of the yoke 42 is accomplished, the pinion 118 and more particularly one of the primary or secondary teeth 116 or 120 thereof will strike the advancing lobe 114 on the primary indexing plate 112 causing a partial revolution of the pinion 118 which, in turn, causes rotation of the associated indexing gears 124 and 132. After ten full revolutions of the yoke 42 have taken place, the second pinion 138 is energized by the indexing gear 132 to cause rotation of the spur gear 146 to rotate the pinion 148 on the end of the secondary carrier 50.

When this occurs, the secondary carrier will be rotated bodily in a minor sense 180° to cause the slider 74 to register with the left-hand terminus of the helical resistance 22 so that reversing of the movement of the yoke 42 is not necessary. Therefore, rotation of the primary carrier unidirectionally indefinitely can be achieved since, at the time that the individual contact slider reaches the end of the resistance winding 22, automatic rotation of the secondary carrier 50 to place another slider in operative engagement with the resistance winding will take place.

Of course, it is possible to provide indexing means 110 adjusted for rotating the secondary carrier 50 in a predetermined ratio to any number of revolutions of the primary carrier 40 so that any number of convolutions on

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the spiral resistance 22 can be accommodated. The essential thing is that the number of turns of the spiral resistance 22, as counted by the indexing means 110, determines the time at which the secondary carrier 50 need be rotated on the primary carrier 40 to bring the slider contact out of engagement with the end of the helical resistance 22 and to bring its associated contact slider into engagement with the opposite end of the resistance winding 22.

Therefore, by my invention I eliminate the necessity for mechanical or electrical stops and permit continuous or reverse unidirectional movement of the contact sliders without providing complex gear change mechanisms and the like.

I claim as my invention:

1. In a multiple turn helical potentiometer the combination of: a housing; a helical resistance mounted in said housing; an actuator mounted in said housing, a yoke rotatable in said housing by said actuator; a contact carrier mounted for rotatable movement on and also relative to said yoke; and contact means mounted on said carrier and rotating therewith, said contact means being free to move longitudinally along said carrier.

2. In a multiple turn helical potentiometer, the combination of: a housing; a helical resistance mounted in said housing; an actuator mounted in said housing; a yoke rotatable in said housing by said actuator; a contact carrier mounted for rotatable movement on and also relative to said yoke, an indexing mechanism operatively connecting said actuator and said carrier to cause the rotation of said carrier in a predetermined ratio to the rotation of said yoke; and contact means mounted on said carrier and rotating therewith, said contact means being free to move longitudinally along said carrier.

3. In a multiple turn, helical potentiometer, the combination of: a housing; a helical resistance mounted in said housing; an actuator on said housing; a major carrier rotatable by said actuator within said housing in a major orbit; a minor carrier secured to said major carrier and rotatable relative thereto by said actuator; and contact slider means mounted on said minor carrier for translation in its major orbit on said major carrier and for rotation with respect to said major carrier by said minor carrier.

4. In a multiple turn, helical potentiometer, the combination of: a housing; a helical resistance mounted in said housing; an actuator on said housing; a major carrier movable in said housing by said actuator in a major rotary sense; minor carrier on said major carrier movable by said major carrier in said major rotary sense and with respect to said major carrier in a minor rotary sense; and contact slider means on said minor carrier engageable with said helical resistance for movement by said major carrier in said major sense along said resistance and for movement in said minor sense with respect to said resistance by said minor carrier.

5. In an actuating mechanism for contact means in a helical potentiometer including a housing and a helical resistance in said housing, the combination of: an actuator in said housing; a first carrier rotatable in said housing by said actuator for moving said contact means in a major orbit; a second carrier rotatably mounted in said first carrier for moving said contact means in a minor orbit into or out of engagement with said resistance; and a third carrier connected to said second carrier and to said contact means for permitting movement of said contact means on the successive turns of said resistance.

6. In an actuating mechanism for contact means in a helical potentiometer including a housing and a helical resistance in said housing, the combination of: an actuator in said housing; a first carrier rotatable in said housing by said actuator for moving said contact means in a major orbit; a second carrier rotatably mounted in said first carrier for moving said contact means in a minor orbit into or out of engagement with said resistance; and a

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third carrier connected to said second carrier and to said contact means for permitting movement of said contact means on the successive turns of said resistance along an axis substantially parallel with the axes of said carriers.

7. In an actuating mechanism for contact means in a helical potentiometer including a housing and a helical resistance in said housing, the combination of: an actuator in said housing; a first carrier rotatable in said housing by said actuator for moving said contact means in a major orbit; a second carrier rotatably mounted in said first carrier for moving said contact means in a minor orbit into or out of engagement with said resistance; indexing means operatively connecting said actuator and said second carrier for causing the rotation thereof in a predetermined ratio to that of said first carrier; and a third carrier connected to said second carrier and to said contact means for permitting movement of said contact means on the successive turns of said resistance.

8. In an actuating mechanism for a pair of contact means in a helical potentiometer including a housing and a helical resistance in said housing, the combination of: an actuator in said housing; a rotatable yoke connected to said actuator; a carrier mounted for rotation in said yoke by said actuator; and movable supporting means on said carrier for supporting said pair of contact means in

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engagement with said resistance and in spaced relationship on opposite sides of said carrier.

9. In an actuating mechanism for a pair of contact means in a helical potentiometer including a housing and a helical resistance in said housing, the combination of: an actuator in said housing; a first carrier rotatable in said housing by said actuator for moving said pair of contact means in a major orbit; a second carrier rotatably mounted in said first carrier for moving said contact means in a minor orbit into or out of engagement with said resistance; and a third carrier connected to said second carrier and to said pair of contact means for permitting movement of said pair of contact means on the successive turns of said resistance, the individual ones of said pair of contact means being located on opposite sides of said second carrier by said third carrier.

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