Dec. 10, 1963 M. McCLAY 3,114,126

COMBINED VARIABLE RESISTANCE DEVICE AND MECHANISM FOR DRIVING SAME

Filed April 2, 1962 2 Sheets-Sheet 1

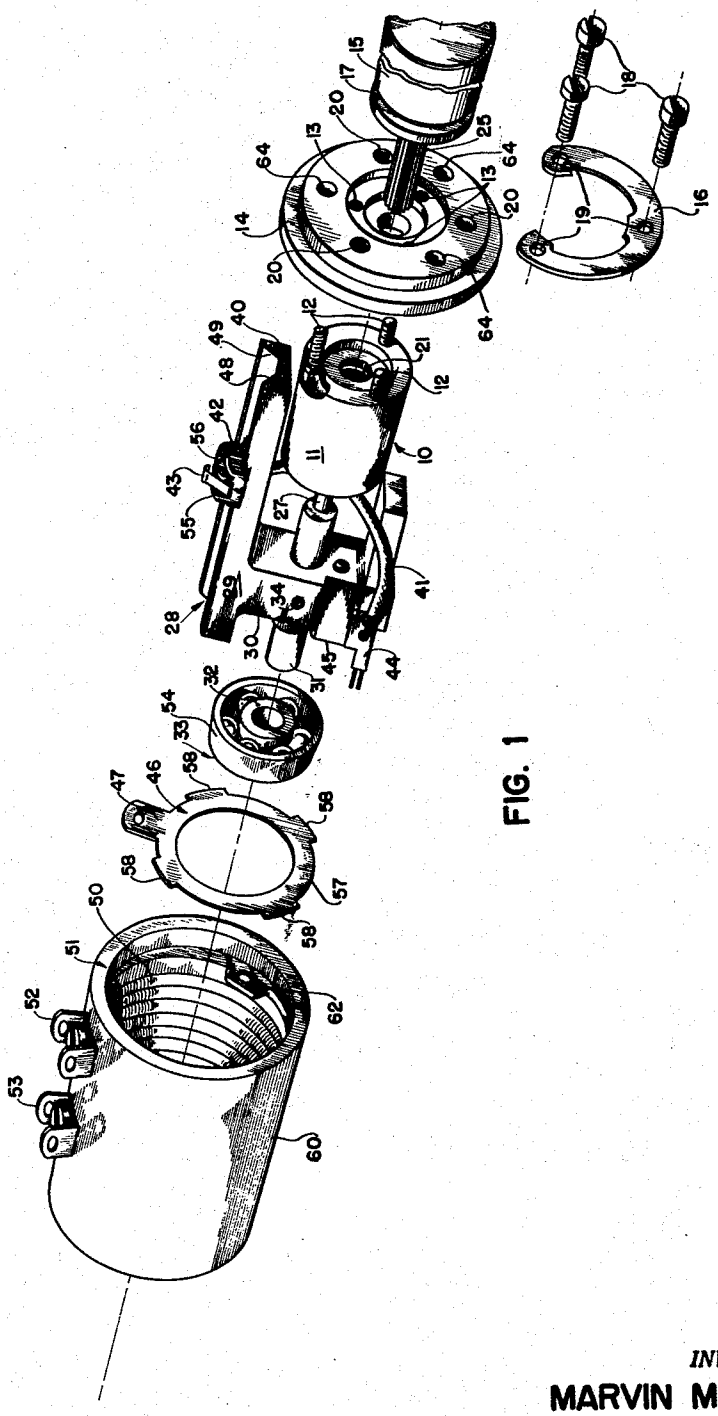


FIG. 1

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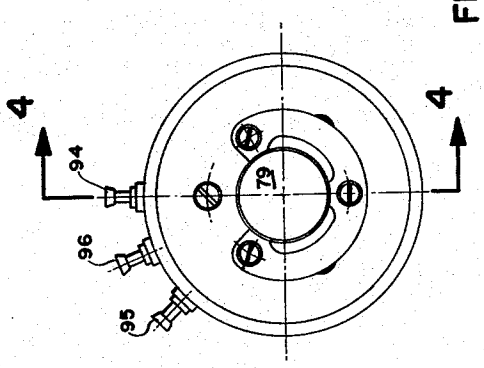
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Filed April 2, 1962 2 Sheets-Sheet 2

FIG. 5



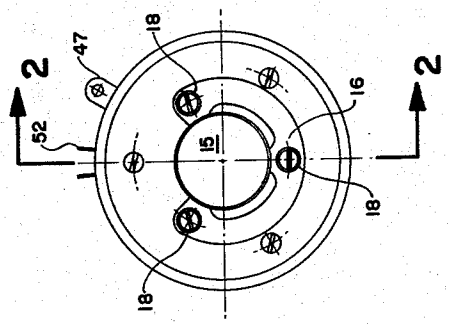


FIG. 3

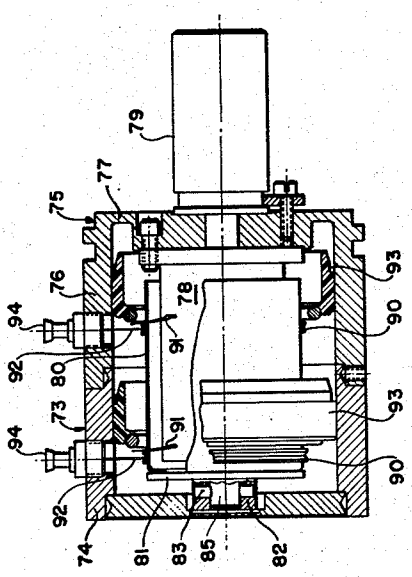


FIG. 4

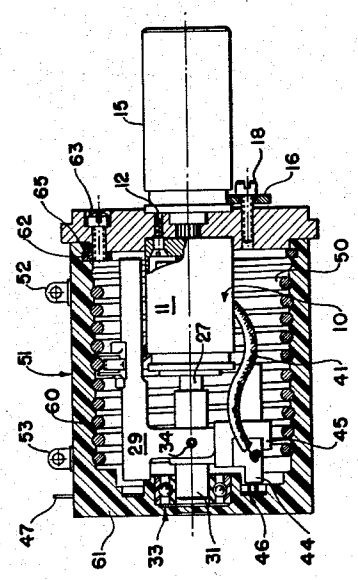


FIG. 2

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3,114,126

COMBINED VARIABLE RESISTANCE DEVICE AND MECHANISM FOR DRIVING SAME

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Filed Apr. 2, 1962, Ser. No. 184,026
11 Claims. (Cl. 338—116)

This invention relates to a combined variable resistance device and mechanism for driving same and, more particularly, a device of this general description in which the driving mechanism is mounted substantially within the confines of the variable resistance device.

Variable resistance devices, particularly those known in the art as precision potentiometers, are commonly employed as displacement to voltage transducers in many fields of contemporary endeavor. By way of specific example, servo loop systems oftentimes includes servo motor driven potentiometers in which the output of the potentiometer provides a voltage indicative of the mechanical rotation of the servo motor. Such an arrangement of components finds wide utility, for example, in airborne and space craft, both vehicles however offering environments in which space utilization and weight are most critical.

It is accordingly, an object of the present invention to provide a combined variable resistance device and mechanism for driving same which requires a minimum amount of space and weight.

Furthermore, the combined variable resistance device and driving mechanism should be such that a minimum number of structural changes are required in each of these components so as to facilitate manufacture thereof. The provision of such an apparatus is a further object of this invention.

Other and further objects, features and advantages of the invention will become apparent as the description proceeds.

Briefly, in accordance with a preferred embodiment of the present invention a suitable driving mechanism is coupled to a movable electrical contact carrier assembly. Suitable driving assemblies are presently available requiring little if any structural modification, these components ordinarily including a servo motor mounted within a generally cylindrical housing and a gear reduction device mounted in a generally similar cylindrical housing. Depending upon the size of these components, at least one and possibly both thereof may be mounted within a modified prior art variable resistance housing as described below. The movable contact assembly preferably comprises a generally L-shaped member with the horizontal leg thereof fixedly mounted transverse to the output shaft of the driving mechanism. The vertical leg of the L-shaped member is then located parallel to the shaft and extends closely adjacent the cylindrical housing of the gear reduction apparatus. An electrical contact is translatably mounted upon the latter leg and engages a multi-turn helical resistance element which surrounds both the movable contact carrier assembly and the driving mechanism. A generally cylindrical housing both supports the resistance element and covers all or most of the other components.

Another embodiment of the invention described hereinafter incorporates ganged single-turn resistance elements which are mounted to an outside cylindrical housing and which surround the movable contact's support assembly and the drive mechanism.

When constructed in the manner of this invention, very compact combined variable resistance and drive mechanisms are provided which require little if any additional space over that required by the variable resistance device per se. Moreover, many of the elements utilized in the present invention may be identical or only slightly modified from those presently employed to construct the individual variable resistance devices, gear reduction units and servo motors. Accordingly, a more compact device may be constructed without a substantial increase in cost of manufacture.

A more thorough understanding of the invention may be obtained by a study of the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is an exploded view of an embodiment of the present invention involving a multi-turn precision potentiometer;

FIG. 2 is a cross-sectional view in which certain parts are shown in elevation, taken at line 2—2 of FIG. 3;

FIG. 3 is an end view of the apparatus of FIG. 1 as assembled;

FIG. 4 is a cross-sectional view in which certain parts are shown in elevation, taken at line 4—4 of FIG. 5; and

FIG. 5 is an end view of an alternative embodiment of the present invention, involving ganged single-turn potentiometers.

Referring now to FIGS. 1, 2 and 3, the drive mechanism **10** is mounted within a generally cylindrical case or housing **11** including projecting threaded bolts **12** adapted for extending through mating holes **13** of the cover member **14**. The drive mechanism will usually incorporate a reduction gear assembly and, if sufficient space is available, an electromotive apparatus such as a servo motor. With the unit shown, it is assumed that there is insufficient room inside the usual potentiometer housing for including both the reduction gear assembly and the servo motor and as a result the servo motor **15** is shown attached to the outside of the cover **14** by way of a C-type clamping ring **16** engaging an annular groove **17** in the outside wall of the servo motor. Screws **18** extend through suitable hole **19** of the ring **16** and mate with threaded apertures **20** of the cover member **14**. The servo motor shaft **25** is formed as a spline gear and extends through the cover **14** into an opening **21** of the reduction gear assembly. A spur gear (not shown) within the opening **21** engages the splined shaft **25**.

The drive shaft **27** of the driving mechanism component **10** is fixedly attached to a movable contact carrier assembly **28**. Movable contact carrier assembly **28** includes a generally L-shaped rotor member **29** of which the horizontal leg **30** incorporates a transverse cylindrical bushing **31** attached at one end to the driving mechanism shaft **27** by a roll pin **34** or other suitable means, and at the other end to the inner race **32** of ballbearing **33**. Attached to and integral with horizontal leg member **30** is a vertical bar **40** located parallel to the shaft **27** and extending proximate the housing of component **11**. A contact carrier **42** rides upon this bar for movement substantially parallel to the axis of rotation of the shaft. The bar **40** has flat walls **48**, **49** whilch lie in planes that intersect at a line substantially parallel to the axis of the shaft **27**. The contact carrier **42** has corresponding flat walls for surface engagement with the walls **48**, **49** of the bar **40**. These walls serve as a guide groove for the contact carrier and preferably converge toward the shaft **27**.

A flexible contact **43** for electrically engaging the turns of the helical coil **50** is carried on the contact carrier **42** by suitable means. An external electrical connection is made to the sliding contact **43** through a flexible lead **41**, a slip ring wiper **44** and a slip ring **46**. Wiper **44** is attached to the rotor member **29** by an insulating member **45**. The slip ring **46** includes an elongated tongue **47**, an annular section **57** and four ears or tabs **58** extending outward from the periphery of the annular section **57**. The slip ring is preferably made from a single flat piece of electrically conducting metal and is mounted in the base of housing **51** by passing the tongue **47** outward

through slot in the wall of the housing (not shown) and then pressing the annular section **57** into an annular shoulder formed in the end of the housing (not shown), the ears **58** engaging the inner surface of this shoulder and fixing the slip ring in position.

The contact carrier **42** preferably includes means for engaging the turns of the helical resistance element **50** to advance the carrier along the bar **40** as the contact carrier assembly is rotated. These means may include parallel ribs **55**, **56** of insulating material extending outward from the contact carrier for engaging the sides of the turn which is being electrically contacted by the contact **43**. The ribs **55**, **56** are preferably skewed to the helix angle of the major helix of the resistance element **50** for better alignment with the turns of the coil. This and other details of the contact carrier **42** and slip ring **46** are fully described in Letters Patent of the United States No. 2,887,555 entitled "Potentiometer," filed by Gabriel Marason, Jr., and assigned to Beckman Instruments, Inc., assignee of the present invention.

Resistance element **50** preferably comprises a relatively fine wire closely wound in numerous turns on a core, which core in turn is wound in turns to form a second spiral. The resistive wire may be said to have the form of a double spiral in which the turns of relatively small diameter on the core form a minor spiral and the turns of the core of larger diameter form a major spiral.

The second or outer housing **51** preferably comprises a cylindrical portion **60** closed by an end wall **61** (FIG. 2). The inner surface of the cylindrical portion **60** provides a helical shallow groove into which is expanded the helical resistance element **50**. One or both ends or other taps of the resistance element may be connected to external terminals on the outer surface of the cylindrical portion **60**. In the construction shown, two such terminals **52**, **53** are provided. The end wall **61** fixedly retains the outer race **54** of bearing **33**, thereby rotatably supporting the movable contact carrier assembly.

The open end of the housing is closed by the cover **13** secured to an annular ring **62** by three bolts **63** passing through openings **64** of the cover (FIG. 2). Ring **63** is retained in an annular groove **65** formed in the inner surface of the cylindrical portion **60** near the open end of the housing **51**. Additional details of the housing and cover may be found in the aforementioned Leters Patent of the United States No. 2,887,555.

In operation, the drive mechanism **10** causes the movable contact carrier assembly to rotate about the axis defined by shaft **27**, the bearing **33** and the bearings of the drive mechanism. The electrical contact **43** is thereby caused to slidably engage the resistance element **51** and follow the turns of its major spiral. The resistance between either of the contacts **52**, **53** and the contact formed by the elongated tongue **47** of the slip ring **46** is a precise indication of the angular position of the output shaft **27** of the drive mechanism **10**.

It will be apparent from the foregoing description that the present invention affords a very compact variable resistance device and mechanism for driving the movable contact carrier assembly since the component **10** is located completely inside and is surrounded by the movable contact carrier assembly and the resistance element. Moreover, the total weight of the completed device is substantially the same or even less than the combined weight of the individual components.

In FIGS. 4 and 5 is shown another embodiment of this invention incorporating two single-turn variable resistance elements. As shown, a generally cup-shaped housing **73** includes a cylindrically member **74** connected to a generally cup-shaped member **75** having a cylindrical portion **76** and an end wall portion **77**. A driving mechanism **78** is fixedly mounted to the end wall portion. This driving mechanism may incorporate a servo motor, a servo motor and gearhead, or as shown in FIG. 4, a gearhead coupled to an externally located servo motor

79 also attached to the end wall **77**. The output shaft **85** of the driving mechanism **78** is affixed to a thin wall cylinder **80** having an end wall **81**. The end **81** includes an extending bushing **82** which is affixed to the shaft **85** by a roll pin **83**. Cylindrical member **80** may, for example, be constructed of stainless steel having a layer of insulating material such as an epoxy plastic upon its outer surface.

An annular conductive ring **90** is located upon the outer surface of cylindrical member **80** proximate each of the single-turn resistance elements. These rings may be constructed of a brass which has been hard gold plated and provide a slip ring electrical contact for the movable contact **91** connected thereto. A generally V-shaped groove in each of the conductive rings is engaged by a conductive wire spring contact **92**. Each of these conductive wire contacts are connected to an external terminal **94** extending outwardly from the outer surface of the housing **73**. The movable contacts **91** engage the single-turn resistance elements **93** fixedly retained to the inner surfaces of the respective cylindrical portions **74**, **76**. These resistance elements may, for example, comprise a single-turn of a circular mandrel or core upon which are wound a number of turns of relatively small diameter resistance wire. As shown in FIG. 5, external terminals **95**, **96** are ordinarily connected to respective ends of these of the resistance elements.

In operation, the driving mechanism **78** causes the cylinder **80** to rotate about its cylindrical axis thereby slidably engaging each of the movable contacts **91** with its associated single-turn resistance element **93**.

Although an exemplary embodiment of the invention has been disclosed herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiment without departing from the spirit of the invention as defined by the claims which follow.

I claim:

1. A variable resistance device comprising:
a gear reduction apparatus mounted within a first housing and having a driven shaft extending therefrom;
a movable contact carrier assembly comprising
a base element located transverse said shaft and fixedly mounted thereto,
a grooved cantilever bar having one end mounted integral with one end of said base element, said bar being located parallel with said shaft and extending proximate the housing of said gear reduction apparatus, and
a movable electrical contact means having a support slidably engaging the groove in said cantilever bar;
a hollow second housing having a helical groove formed in its inside wall;
a multi-turn helical resistance element supported in said groove and in engagement with said electrical contact means, said element surrounding said gear reduction apparatus and said movable contact carrier assembly so that its helical axis coincides with the rotational axis of the driven shaft of said gear reduction apparatus; and
guide means on said movable electrical contact means associated with said helical resistance element for moving said contact means along said grooved cantilever bar as said movable contact assembly is rotated.

2. A variable resistance device comprising:
a gear reduction apparatus mounted within a first housing and having a driven shaft extending therefrom;
a movable contact carrier assembly coupled to and being rotatably driven by said driven shaft, said assembly including
a contact support member located substantially parallel to said driven shaft and extending prox-

imate the first housing of said rear reduction apparatus and

an electrical contact means mounted upon said contact support member;

an annular resistance element in engagement with said electrical contact and substantially encompassing said gear reduction apparatus and movable contact carrier assembly;

and a second housing substantially enclosing said gear reduction apparatus, movable contact carrier assembly and resistance element and fixedly mounting said resistance element relative to said movable contact carrier assembly.

3. The variable resistance device defined in claim 2 wherein:

said contact support member comprises a generally L-shaped rotor having a base element located transverse said driven shaft and fixedly mounted thereto and a bar having one end mounted integrally with one end of said base element, said bar extending substantially parallel with said shaft and extending proximate the cylindrical housing of said gear reduction appparatus, said electrical contact means being carried by said bar.

4. The variable resistance device defined in claim 3 wherein:

said housing is provided with oppositely disposed end walls

said driving mechanism is fixedly mounted to the interior of one end wall of said second housing; and

said horizontal member of said L-shaped rotor includes a bushing rotatably mounted in the opposite end wall of said housing.

5. The variable resistance device defined in claim 3 wherein:

said electrical contact means is slidably mounted upon said bar.

6. The variable resistance device defined in claim 5 wherein:

said resistance element comprises a multi-turn helical resistance element in engagement with said electrical contact means, said element surrounding said driving mechanism and said movable contact carrier assembly so that its helical axis coincides with the rotational axis of the driven shaft of said driving mechanism.

7. The variable resistance device defined in claim 2 wherein:

said movable contact carrier assembly comprises a generally cylindrical member fixedly mounted to and concentric with said driven shaft, the walls of said cylindrical member extending proximate the housing of said driving mechanism.

8. The variable resistance device defined in claim 7 comprising:

ganged single-turn resistance elements substantially encompassing said cylindrical member.

9. The variable resistance device defined in claim 8 comprising:

grooved annular conductive members fixedly attached to the outside surface of said cylindrical member adjacent respective ones of said ganged single-turn resistance elements;

said electrical contact means comprising at least one electrical contact fixedly mounted to each of said annular conductive members and engaging a respective one of said single-turn resistance elements; and

spring contacts carried by said second housing in slip-ring engagement with respective ones of said grooved annular conductive members.

10. The variable resistance device defined in claim 2 wherein said second housing comprises:

a generally cylindrical member supporting said resistance element upon the inside surface thereof, said second housing having an end cover fixedly mounting said gear reduction apparatus extending from the interior surface thereof.

11. The variable resistance device defined in claim 10 including:

a servo motor attached to the outside surface of said end cover and in driving engagement with said gear reduction apparatus.

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