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M. E. BOURNS ET AL

2,998,587

LINEAR MOTION VARIABLE RESISTOR

Original Filed April 30, 1953

FIG. 1

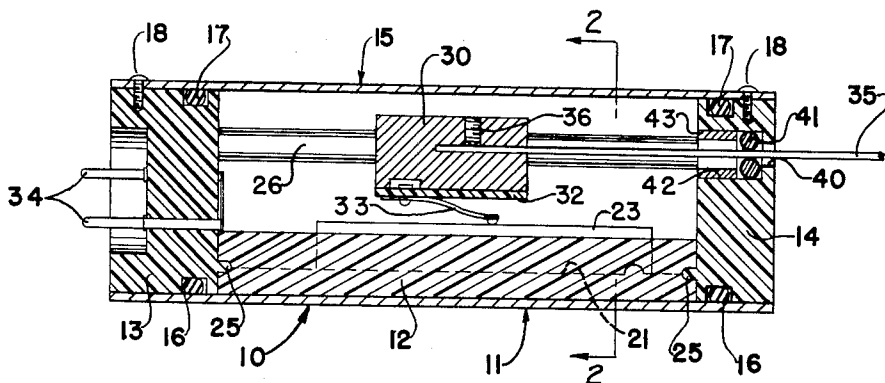


FIG. 2

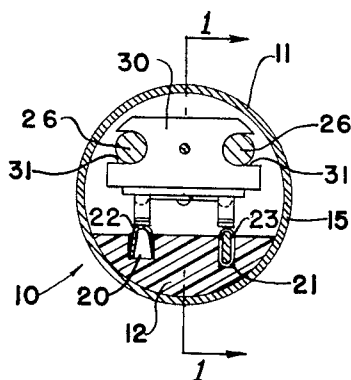


FIG. 3

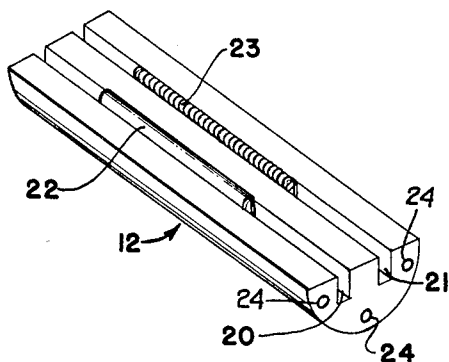
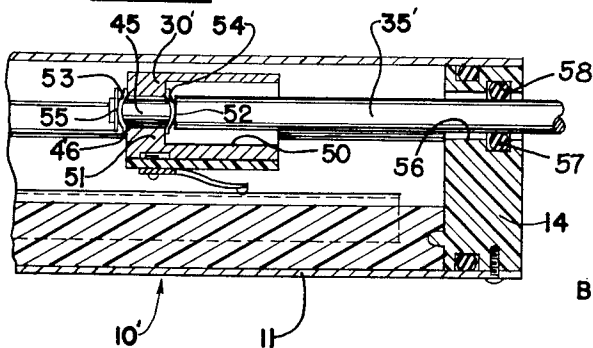


FIG. 4



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LINEAR MOTION VARIABLE RESISTOR

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Original application Apr. 30, 1953, Ser. No. 352,215. Divided and this application Mar. 3, 1958, Ser. No. 718,563

3 Claims. (Cl. 338—183)

The present invention relates to variable resistors or potentiometers, and more particularly to that type of instrument wherein a contact-carrying member is moved along the length of a resistance element by rectilinear or reciprocating movement of an operating member. This invention is a division of our co-pending application, Serial No. 352,215, filed April 30, 1953, now Patent Number 2,857,497 entitled Linear Motion Variable Resistor.

Heretofore, linear motion resistors have usually been made with the contact-carrying slider fixedly mounted on one end of a reciprocating operating rod, and the latter has been slidably supported on the instrument housing for longitudinal movement. The other end of the rod projects from the housing and is attached to a movable actuating member on the device with which the resistor is associated. Movement of the said actuating member causes the contact-carrying slider to be shifted along the length of the resistance element.

One of the serious disadvantages of this arrangement lies in the fact that the instrument must be precisely aligned with the actuating member of the associated device; otherwise, misalignment will cause bending of the operating rod or binding of the instrument, or will cause excessive wear of the operating rod bearing in the instrument, or of the device actuating the instrument. The misalignment problem in conventional linear motion resistors, as heretofore constructed, is further magnified by the fact that the contact-carrying member is rigidly fixed to the operating rod, and therefore any deflection or bending of the rod under side thrust results in displacement of the contact toward or away from the resistance element. The consequence of this is that the contact bears harder against the resistance element at one end thereof than at the other. The increased pressure at the one end causes increased wear of the contact and element, while the decreased pressure at the other end of the element tends to make the instrument more susceptible to vibrational error.

The primary object of the present invention, therefore, is to provide a linear motion variable resistor wherein the contact-carrying slider is accurately guided along a path parallel to the resistance element by a guide means on the housing entirely independent of the operating member, and the latter is connected to the slider by means providing for a limited amount of relative movement of the operator with respect to the slider to accommodate misalignment between the actuating member and the operator. The principal advantage of this arrangement is that it eliminates the problem of maintaining parallelism and alignment between the operating member and the slider, and insures accurate alignment and uniform pressure of the contact with respect to the resistance element at all times.

Another object of the invention is to provide a variable resistor of the class described, wherein the operating member is connected to the slider by means providing for a limited amount of relative movement by the operator with respect to the slider, so as to accommodate

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lateral displacement of one with respect to the other. This eliminates side thrust of the operating rod against its bearing, and prevents excessive bearing wear, binding, and abnormal wear of the contact and resistance element.

A further object of the invention is to provide a linear motion variable resistor wherein the cooperating guide means on the housing and slider may readily be manufactured to such close tolerances and perfection of fit that vibration of the slider with respect to the resistance element is substantially eliminated, thereby eliminating "hash" or "noise." "Hash," or "noise," may be defined as electrical fluctuations in resistor output resulting from intermittent electrical discontinuities between the contact and the resistance element, and is a serious problem with linear motion resistors of conventional design owing to the fact that it is practically impossible to make the operating rod and its bearing with such close tolerances and perfection of fit that the rod will not vibrate within the bearing under conditions encountered in aircraft and missile use. Such vibration of the operating rod causes the contact assembly, which is attached thereto, to chatter on the resistance element and thereby produce the electrical discontinuities referred to. Accuracy and precision of guiding the slider are further enhanced in the present invention by slidably supporting the slider immediately adjacent the point of contact with the resistance element. In prior resistors, the housing slidably supports the operating rod, and there is sometimes a considerable overhang of the rod and attached contact beyond the point of support.

Another object of the invention is to provide a construction wherein the mass of the contact-carrying slider is reduced to the minimum, thereby minimizing inertia for better response, and also minimizing the effect of acceleration.

The foregoing and other objects and advantages of the present invention will become apparent to those skilled in the art upon consideration of the following description of two preferred embodiments thereof, reference being had to the accompanying drawings, wherein:

FIGURE 1 is a vertical sectional view through a linear motion resistor embodying the principles of our invention, taken at 1—1 in FIGURE 2;

FIGURE 2 is a transverse vertical section through the same instrument, taken at 2—2 in FIGURE 1;

FIGURE 3 is a perspective view of the base member of the instrument; and

FIGURE 4 is a fragmentary sectional view through a modified form of the invention.

Referring first to FIGURES 1 to 3 of the drawings, the instrument is designated in its entirety by the reference numeral 10. The instrument 10 is seen to comprise a housing 11, which includes a base member 12, with ends 13 and 14, which are enclosed within a tubular sleeve or casing 15. The ends 13, 14 have circumferential grooves 16 formed therein, and seated within these grooves are O rings 17, which seal the clearances between the ends and the casing 15. The casing 15 is secured to the ends by screws 18.

The base member 12 is preferably formed of a thermosetting dielectric plastic material, such as phenolic resin, which may be molded, extruded, or machined to the form shown. In cross section, the member 12 has the shape of a segment of a circle; the underneath surface of the member being cylindrically curved, and the top surface being flat. Two laterally spaced, parallel grooves 20 and 21 are formed in the flat, top surface of the member 12, and seated within these grooves are a collector strip 22 and wire wound resistance element 23, respectively. Three angularly spaced locating holes or cavities 24 are drilled

or otherwise formed in the ends of the member 12, and these are engaged by projections 25 extending inwardly from the faces of the end members 13, 14. This arrangement permits the base member 12 and the end members 13, 14 to be assembled in accurately located relationship

Mounted in and extending between the ends 13, 14 are two laterally spaced guide rods 26, which are parallel to the electrical members 22, 23. Slidably supported on the guide rods 26 is a contact-carrying slider 30. The slider 30 may be formed, as shown in FIGURE 2, with outwardly facing grooves or channels 31 formed in opposite sides thereof, which receive the guide rods 26. A flat plate 32 of dielectric plastic material is mounted on the bottom side of the slider 30, and attached to the plate is a U shaped contact member 33, the ends of which wipe on the collector strip 22 and resistance element 23. The electrical signal is as picked up from the resistance element 23 and transferred over to the collector strip 22 by the contact member 33, and the latter is insulated from the slider 30 by the dielectric plate 32.

Mounted in the left-hand end member 13 are three angularly spaced connector pins 34, which are adapted to receive a connector plug. Two of the pins 34 are connected to opposite ends of the resistance element 23; while the third pin 34 is connected to the collector strip 22. By this means, a voltage difference may be applied to the ends of the resistance element, and the voltage at any intermediate point engaged by the contact 33 will be transferred to the third pin.

The slider 30 is accurately guided along a path parallel to the electrical elements 22, 23 by the guide rods 26. The slider 30 is moved along the length of the elements 22, 23 by means of an operating member 35, which, in FIGURES 1 to 3, comprises a flexible wire. One end of the wire 35 is inserted into a hole in the end of the slider 30 and is secured therein by a set screw 36. The wire 35 passes through a hole 40 in the right-hand end member 14, which is sealed against the entrance of dirt by an O ring 41. The O ring 41 is seated within a counterbore 42, and is backed up by a tubular retainer 43. The other end of the wire 35 is attached to the movable actuating member (not shown) on the device with which the instrument is associated, and movement of the said actuated member is transmitted to the slider 30 to produce an electrical signal.

The operating member 35, being a flexible wire, provides a flexible connection between the actuating member and the slider 30 which eliminates any problem of misalignment between the two parts. If the instrument 10 should be misaligned with respect to the actuating member on the associated device, any non-parallelism in the travel of the actuating member and slider 30 is compensated for by the resilient operating member 35.

In the embodiment shown in FIGURE 4, the instrument is designated by the reference numeral 10', and is seen to be generally similar to the construction just described. In this form, however, the operating member 35' comprises a cylindrical rod, one end of which is reduced in diameter at 45 and extends through a hole 46 in slider 30'. The hole 46 is somewhat larger than the reduced portion 45 of the operating rod, so that there is a substantial amount of clearance between them. A hole 50 is bored into the end of the slider 30', leaving a relatively thin wall 51, through which the hole 46 extends. By thus reducing the length of the hole 46, a substantial amount of looseness can be obtained between the operating rod 35' and the slider 30'.

Wavy spring washers 52 and 53 are interposed between the operating rod 35' and the opposite sides of wall portion 51. Spring washer 52 bears against the right-hand side of wall portion 51, and seats against a shoulder 54 at the junction of the reduced neck 45 with the main body of the rod 35'. Spring washer 53 bears against the left-hand side of the wall portion 51, and seats against a regular flat washer 55, which is fastened to the reduced neck 45 in any suitable manner. The spring washers 52,

53 permit a limited amount of angular deflection of the rod 35' with respect to the slider 30', yet at the same time, take up a clearance so that there is no backlash between them. The connection between the operating rod 35' and the slider 30' is, in effect, a universal joint, permitting angular deflection of the rod with respect to the slider.

The operating rod 35' passes through an oversize hole 56 in the end member 14, and through an O ring 57 of rubber or other elastomeric material, which is seated in a circumferential groove 58 in the sides of the hole. The O ring 57 fits snugly around the operating rod 35' to seal the interior cavity against the entrance of dirt or moisture. At the same time, the resilience of the O ring allows a limited amount of lateral displacement of the operating rod so as to accommodate misalignment between the actuating member to which the rod 35' is connected, and the slider 30'.

In each of the two embodiments of the invention described, the contact-carrying slider is accurately guided along a path parallel to the resistance element and collector strip by guide means on the housing independent of the operating means. At the same time, the operating member is connected to the slider by a flexible form of connection which accommodates any misalignment between the instrument and the actuating device with which it is associated.

While we have shown and described in considerable detail what we believe to be the preferred forms of our invention, it will be understood that various changes may be made without departing from the scope of the broad claims appended hereto.

We claim:

1. A variable resistor comprising an elongated housing having an enclosed cavity provided therein, a rectilinear resistance element mounted on said housing within said cavity, a slider supported for linear movement along a path parallel to said resistance element, a contact on said slider wiping on said resistance element, an operating rod flexibly connected at one end to said slider for a limited amount of angular deflection with respect thereto, said operating rod extending from one end of said slider parallel to the line of travel thereof and passing through an oversize hole in one end of said housing, and an annular sealing member of elastomeric material encircling said operating rod and closing said hole, said annular sealing member being yieldable in the direction perpendicular to the axis of said operating rod so as to accommodate lateral displacement of the latter at the point where the operating rod passes through the end of said housing.

2. A variable resistor comprising a housing, a rectilinear resistance element mounted on said housing, a slider supported for linear movement along a path parallel to said resistance element, a contact on said slider wiping on said resistance element, said slider having a hole extending through it in the direction parallel to the line of travel, an operating rod disposed parallel to the line of travel of said slider and having one end extending loosely through said hole, and spring means bearing against said operating rod and engaging opposite sides of said slider adjacent the edges of said hole, said spring means permitting limited angular movement of said operating rod with respect to said slider while preventing relative movement of the operating rod with respect to the slider along the direction of travel of the latter.

3. A variable resistor comprising a housing, a rectilinear resistance element mounted on said housing, a slider supported for linear movement along a path parallel to said resistance element, a contact on said slider wiping on said resistance element, said slider having a hole extending through it in the direction parallel to the line of travel, an operating rod disposed parallel to the line of travel of said slider and having one end extending loosely through said hole, said operating rod extending through a hole in the end of said housing of larger diameter than the diameter of the rod, elastomeric sealing means disposed within said last-mentioned hole and slid-

ably engaging said rod to seal the same, said sealing means being yieldable in the plane perpendicular to the longitudinal axis of said rod to accommodate lateral displacement of the rod, and a pair of rippled spring washers interposed between opposite sides of said slider and opposed shoulder surfaces on said operating rod, said spring washers being slightly compressed to provide a yielding flexible connection between said operating rod and said slider.

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References Cited in the file of this patent

UNITED STATES PATENTS

2,596,503	Newnham	May 13, 1952
2,751,475	Gottschall	June 19, 1956
2,813,183	Gearheart et al.	Nov. 12, 1957
2,831,949	Bourns	Apr. 22, 1958
2,857,497	Bourns	Oct. 21, 1958
2,922,977	Gottschall	Jan. 26, 1960

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,998,587

August 29, 1961

Marlan E. Bourns et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 43, strike out "of elastomeric material".

Signed and sealed this 3rd day of April 1962.

(SEAL)

Attest:

ERNEST W. SWIDER

Attesting Officer

DAVID L. LADD

Commissioner of Patents

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