Aug. 9, 1960 K. W. JARVIS 2,948,874

VARIABLE RESISTOR

Filed Aug. 21, 1959 4 Sheets-Sheet 1

FIG. 1

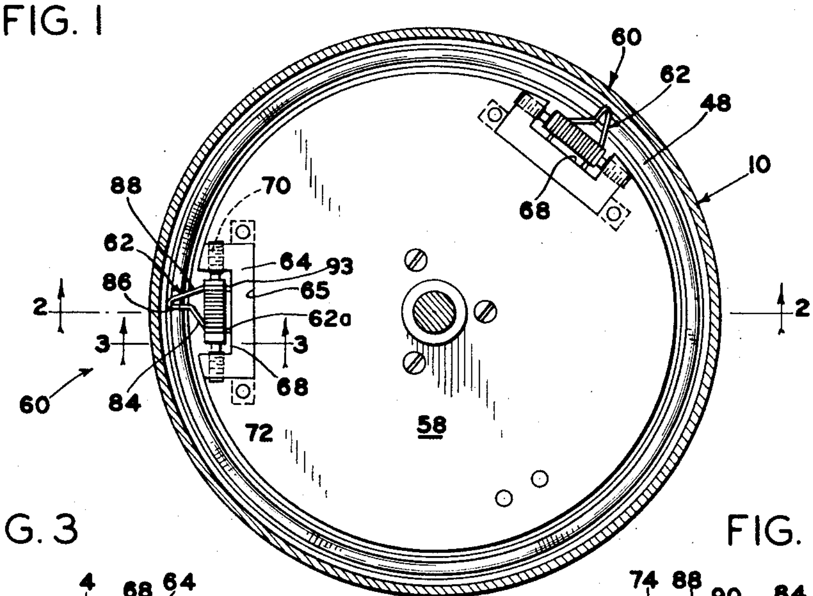


FIG. 3

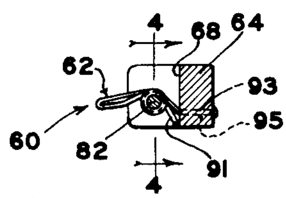
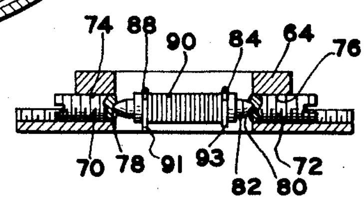


FIG. 4



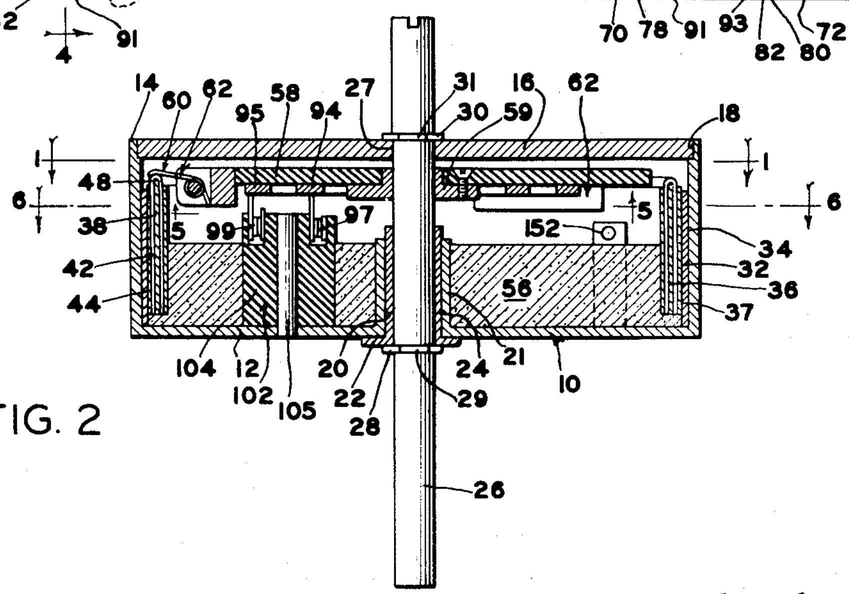


FIG. 2

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FIG. 5

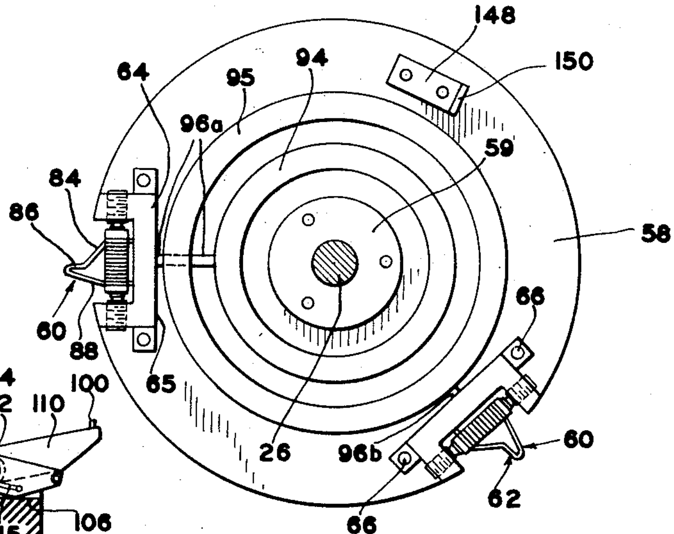


FIG. 7

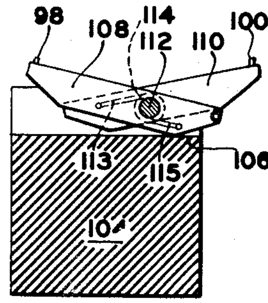
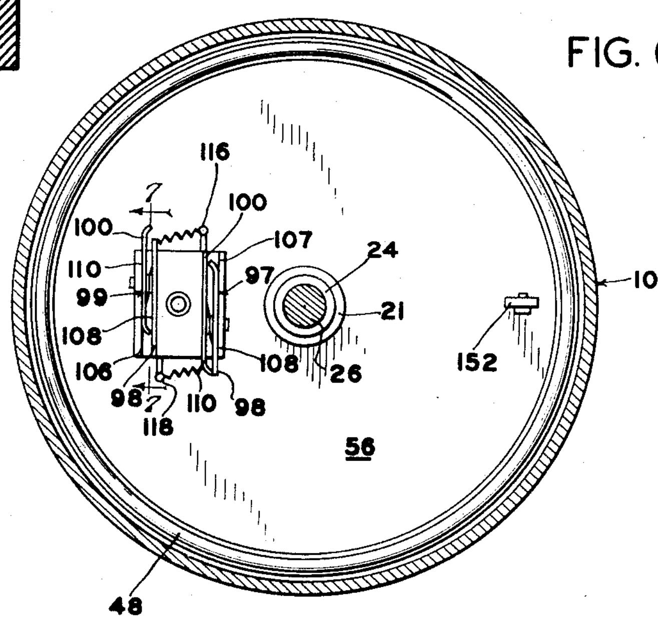


FIG. 6



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Aug. 9, 1960 K. W. JARVIS **2,948,874**

VARIABLE RESISTOR

Filed Aug. 21, 1959 4 Sheets-Sheet 3

FIG. 8

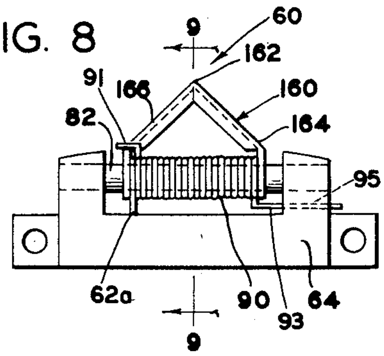


FIG. 9

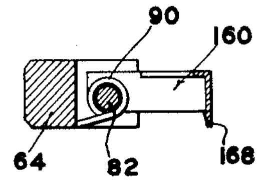


FIG. 11

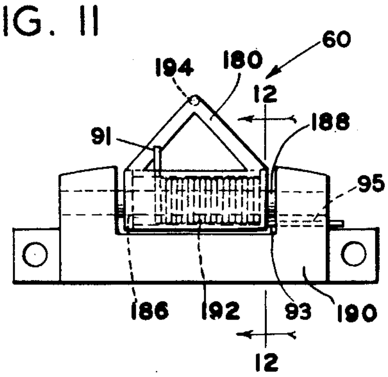


FIG. 3A

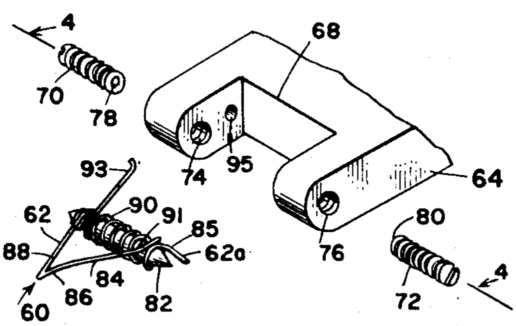


FIG. 12

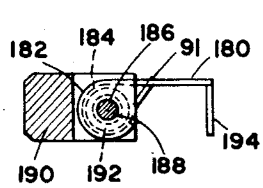
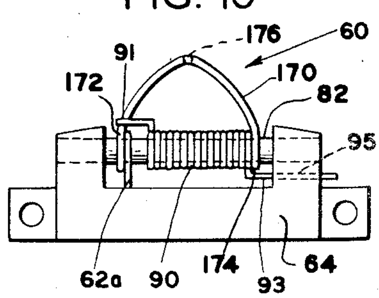


FIG. 10



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VARIABLE RESISTOR

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Fig. 13

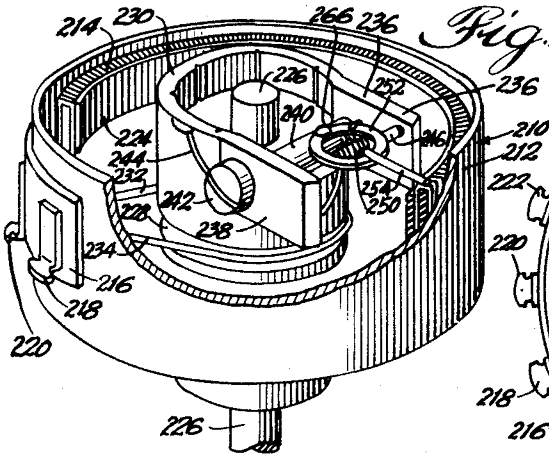


Fig. 14

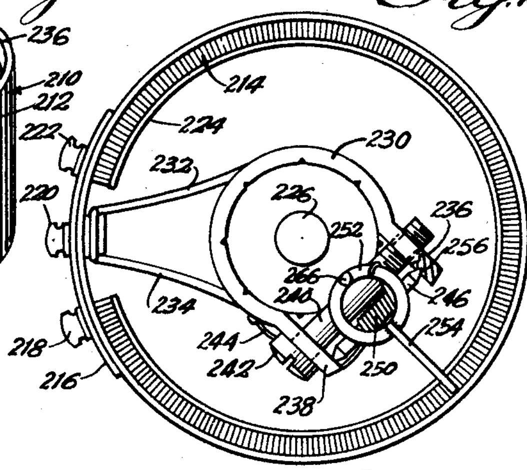


Fig. 15

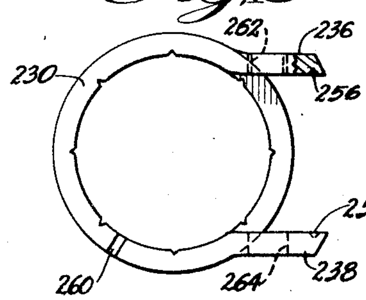


Fig. 16

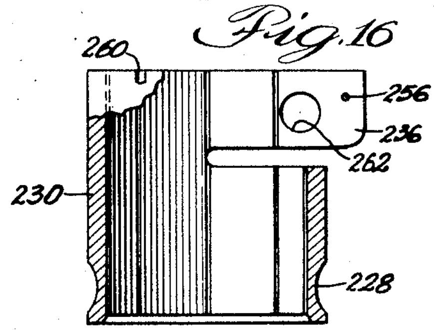


Fig. 17

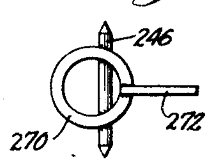


Fig. 18

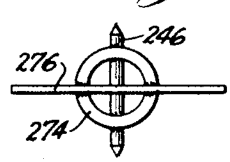
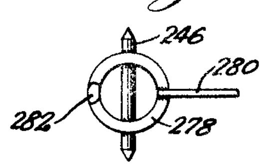


Fig. 19



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United States Patent Office

2,948,874

Patented Aug. 9, 1960

2,948,874

VARIABLE RESISTOR

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Filed Aug. 21, 1959, Ser. No. 835,819

10 Claims. (Cl. 338—167)

The present invention relates to variable resistors, particularly variable resistors for use in devices requiring relatively small currents, such as electronic equipment.

Generally speaking, the present invention relates to that type of variable resistor wherein a contact is slidably disposed abutting the surface of a resistance element. The resistance element generally employs a strip of electrically insulating material, and a plurality of turns of resistance wire are disposed generally parallel to each other about the strip. In most variable resistors for electronic devices the strips are disposed in an annular form and placed within a cylindrical casing, and the slidable contact is mounted to a shaft rotatively disposed on the axis of the casing.

In recent years, resistors of this type have been called upon to operate at relatively high rotation rates. One of the difficulties that arises in operating a variable resistor at high rotation rates is that the slidable contact fails to remain in abutment wtih the resistance element due to unevenness of the surface of the resistance element. It is almost impossible to fabricate a resistance element which is completely even, and as a result of the mass of the contact, the contact tends to skip turns of the resistance wire on the resistance element when moving at relatively high speeds.

Another difficulty experienced in operating variable resistors at relatively high speeds is that the electrical noise introduced into the circuit as a result of the contact sliding across the resistance element increases with increased contact speed. The increased noise is the result of poor electrical contact between the slidable contact and the resistance element. Both bouncing and noise which occur with high speed operation of a variable resistor may be reduced by placing a higher tension upon the slidable contact, however this increases the wear of the resistance element with rotation of the contact of the variable resistor. Also, wear of the resistance element itself is a difficulty which is experienced with high speed operation of variable resistors, even when relatively small contact pressures are employed.

It is one of the objects of the present invention to provide a variable electrical resistor which is suitable for operation at relatively high rates, particularly a variable resistor which does not wear excessively with high contact speeds.

There are actually at least two slidable electrical contacts in certain types of variable resistors, the one contact abutting the resistance element, and the other slidable contact being mounted to a stationary support member and slidably abutting an electrically conducting ring or groove which is coaxially mounted to the shaft of the resistor and electrically connected to the first sliding contact. The first slidable contact often is a source of difficulty, and particularly when the variable resistor is used in an environment of shock and vibration. The second slidable contact also introduces many difficulties into the operation of the variable resistor at high speeds

in addition to the difficulties that are introduced by the first slidable contact.

It is therefore a further object of this present invention to provide a slidable electrical contact for variable electrical resistors which is suitable for use between the rotatable contact and a stationary support member.

It is another object of this invention to provide a new and improved variable resistor having a contact assembly which advantageously is balanced and/or compensated to resist shock and vibration of substantial magnitude.

It is still another object of this invention to provide a variable resistor, as described above, which is characterized by its efficient operation, its reliability, and its high resistance to wear, particularly at high speeds, and in shock and vibration environment.

Further objects of the present invention, and additional advantages and features thereof, will be apparent from a further consideration of this disclosure, particularly when viewed in the light of the drawings, in which:

Figure 1 is a sectional view of one embodiment of variable resistor constructed according to the teachings of the present invention, the section being taken along the line **1—1** shown in Figure 2;

Figure 2 is a sectional view taken along the line **2—2** of Figure 1;

Figure 3 is a transverse sectional view of one of the slidable contacts shown in Figures 1 and 2;

Figure 3A is an enlarged isometric view showing the elements of the slidable contact shown in Figures 1 and 2;

Figure 4 is a sectional view taken along the line **4—4** of Figure 3;

Figure 5 is a sectional view taken along the line **5—5** of Figure 2;

Figure 6 is a sectional view taken along the line **6—6** of Figure 2;

Figure 7 is a sectional view taken along the line **7—7** of Figure 6;

Figure 8 is a plan view of a modified form of contact member for the variable resistor shown in Figures 1 through 7;

Figure 9 is a sectional view taken along line **9—9** of Figure 8;

Figure 10 is a plan view of another modified form of contact member for the variable resistor shown in Figures 1 through 7;

Figure 11 is a plan view of still another modified form of contact member for the resistor shown in Figures 1 through 7;

Figure 12 is a sectional view taken along line **12—12** of Figure 11;

Figure 13 is a perspective view, partially broken away, of another illustrative embodiment of the invention;

Figure 14 is a top plan view of the illustrative embodiment shown in Figure 13;

Figures 15 and 16 are top plan and side elevational views, respectively, of the rotor advantageously used in the embodiment of Figure 13; and

Figures 17, 18, and 19 are illustrative views of several different types of contact assemblies which advantageously may be used in the illustrative embodiment of Figure 13.

This application is a continuation-in-part of my pending application, Serial No. 606,406, filed August 27, 1956, now abandoned. For a better understanding of the invention, reference is now made to the drawings, and more particularly to Figures 1 through 7 thereof.

The specific illustrative embodiment of variable resistor illustrated in Figures 1 through 7 has a hollow cylindrical casing **10** with a closed end **12** and an open end **14**. A cover 16 is secured to the open end 14 of the casing 10 by press fitting the cover 16 within an indentation 18 in the open end 14 of the casing 10. The closed end 12 of the casing 10 is provided with a central aperture 20, and has a sleeve 21 which extends toward the open end 14 of the casing 10. A bushing 22 is secured to the casing 10 and disposed within the aperture 20 and sleeve 21. The bushing 22 has a hollow cylinder 24 which extends into the sleeve 21 of the casing 10 coaxially therewith. A shaft 26 is journaled within the cylinder 24 of the bushing 22 and extends through an aperture 27 in the cover 16. The shaft 26 is provided with a C-washer 28 secured within a groove 29 and abutting the bushing 22, and a second C-washer 30 disposed within a groove 31 and abutting the cover 16, thereby preventing translation of the shaft 26 within the bushing and limiting its motion to rotation.

The interior of the casing 10 is lined with an annular strip 32 of electrical insulating material which is secured to the interior surface of the casing 10; for example by a layer of cement 34. A resistance card 36 extends about the periphery of the interior of the casing 10 and is secured to the strip 32 by a layer of cement 37.

The resistance card 36 is provided with a strip 38 of electrical insulating material which is disposed in an annular form within the casing 10. The strip 38 supports a plurality of turns of resistance wire 42. The resistance wire 42 is provided with a coating 44 of electrically insulating material, except for the edge 48 of the resistance card 36 which confronts the open end 14 of the container. This edge 48 is free of all insulation. The interior of the casing 10 contains a layer 56 of potting compound from the closed end 12 of the casing 10 to a level adjacent to the end of the sleeve 21.

A disc 58 of electrically insulating material has a hub 59 at its center which is secured to the shaft 26 between the cover 16 and the sleeve 21, and a pair of spaced electrical contact members 60 are mounted to the disc 58 adjacent to its periphery. Each contact assembly member 60 has a wire shaped contact 62 which is disposed abutting the exposed portion of the turns of resistance wire 42 on the edge 48 of the resistance card 36.

Each contact member 60 has a support bar constructed of electrically conducting material which is secured to the electrical insulating disc 58 in a peripheral indentation 65 and is disposed generally parallel to the periphery of the disc 58, for example, by a pair of screws 66 disposed at the ends of the support bar 64. The support bars 64 are each provided with an indentation 68 on the side confronting the resistance card 36, and a pair of aligned screws 70 and 72 parallel to the axis of the support bar 64 are threadedly engaged within apertures 74 and 76 extending through the support bars 64 into the indentation 68. The screws 70 and 72 are provided with indentations 78 and 80 in their confronting ends, and a pin 82 is pivotally disposed between the indentations in the screws 70 and 72.

Each contact 62 is in the form of an electrically conducting wire which is secured to the ends of the pin 82 and makes electrical contact with the pin 82, for example, by soldering the contact 62 to opposite ends of the pin 82. Each contact 62 has three adjacent portions 84, 86, and 88. The central portion 86 is disposed essentially normal to the pin 82, and the end portions 84 and 88 are disposed between the central portion 86 and the pin 82. A helical spring 90 is also disposed about the pin 82 between the ends thereof, and one end 91 of the spring 90 is hooked over the portion of the contact 62 represented by numeral 84 or in any suitable mechanical manner. The other end 93 of the spring 90 is secured within an aperture 95 through the support bar 64 to place a spring bias upon the contact 62 in the direction of the resistance card 36. In this manner, the central portion 86 of each contact 62 is maintained in abutment with the exposed portion of the turns of resistance wire 42 on the ends 48 of the resistance card 36. The wire comprising contact 62 may be extended on one end as shown at 62A. This structure when adjusted to proper length and angle, serves to act as a stop so that the support 64 hitting the contact assembly member 60 prevents it from being displaced from the normal contacting position.

In a particular construction of the variable resistor, the contact 62 is constructed of 0.010 inch diameter wire and the junction of portions 86 and 88 of the contact 62 occurs at a distance of $\frac{3}{16}$ inch from the axis of the pin 82. Also, the angle between the portions 86 and 88 is approximately 30 degrees.

The tension applied by the spring 90 is determined by the number of turns of the spring 90 disposed about the pin 82. Because of the fact that the spring 90 is operatively secured at one end 91 to the pin 82 on its associated parts, the tension of the spring 90 may be increased during the manufacturing process by pulling a portion of one or more turns through the aperture 95 in the support bar 64, and then securing this end 93 of the spring 90, as by soldering for example. In the particular construction described above, the helical spring 90 comprised 30 turns of No. 28 spring wire.

The contact 62 has very little mass, and as a result very little inertia to prevent it following the contour of the exposed portions 48 of the turns of resistance wire 42 on the resistance card 36. As a result of this fact, the pressure applied by the contact 62 need be relatively small, thus minimizing wear of the contact 62 with continued use. Further, as illustrated in Figure 4, the cross section of the wire end portions 84 and 88 of the shaped contact 62 need not be round, but can be essentially oval, thereby making it possible for the contact 62 to tolerate a much greater amount of wear.

The electrical insulating disc 58 also supports a pair of concentric electrically conducting rings 94 and 95 which are coaxially disposed about the shaft 26 on the side of the disc 58 confronting the closed end 12 of the casing 10. The ring 94 is electrically connected to one of the contact assembly members 60 by wire 96*a* and the ring 95 is connected to the other contact member 60 by wire 96*b*.

The contact rings 94 and 95 are each in slidable contact with a pair of contact assemblies 97 and 99 which each have a pair of electrically conducting contacts 98 and 100, together forming a take-off assembly 102. The take-off assembly 102 has an electrically insulating block 104 which is mounted to the end 12 of the casing 10 confronting the contact rings 94 and 95 by a pin 105, as illustrated in Figure 2. A pair of parallel slots 106 and 107 generally parallel to the confronting surface of the contact rings 94 and 95 are disposed in the surface of the block 104 confronting the contact rings 94 and 95. Each of the contacts 98 and 100 are mounted to the ends of arms 108 and 110, respectively, which are constructed of electrically conducting material. Each pair of arms 108 and 110 is pivoted at a point between their ends and preferably at their respective centers of gravity on a pin 112 which extends into the block 104 of insulating material normal to the arms 108 and 110 and through one of the slots 106 in the block 104. A helical spring 114 is disposed about the pin 112 between each pair of arms 108 and 110. One end 113 of each spring 114 is attached to the end of arm 108 opposite to the contact 98, and the other end 115 of each spring 114 is attached to the adjacent arm 110 opposite the contact 100, thereby spring-biasing these ends of the arms 108 and 110 toward the slot 106, or in other words, spring-biasing the contacts 98 and 100 outwardly from the slot 106.

The arms 108 and 110 of each contact assembly 97 and 99 are electrically interconnected by the pins 112. Also, one of the arms 108 of contact assembly 97 is connected to a terminal 118, and the arm 98 of contact assembly 99 is connected to a terminal 116. Electrical contact to the other arm of each pair of arms is made through the pins 112. Electrical connections may be made to these terminals 116 and 118 and to one or more points on the resistance card, in the conventional manner.

It is of course difficult to provide perfectly flat surfaces on the contact rings 94 and 95, and as a result, rapid rotation of the shaft 26 requires the contact assemblies 97 and 99 to compensate for dips and rises in the surfaces of the contact rings 94 and 95 at very rapid rates. At the same time, the pressure applied to the contacts 98 and 100 by the arms 108 and 110 should be as small as possible in order to minimize wear of the contacts as they ride upon the rings 94 and 95. However, a low pressure between the contacts 98 and 100 results in a noisy variable resistor. The take-off assembly here provided however has the advantage that a bump appearing upon the contact ring in depressing one of the arms 108 or 110 has the effect of increasing the pressure exerted by the other arm upon the contact thereon and the contact ring. For example, contact assembly 97 rides upon the contact ring 95, and if it is assumed that the shaft 26 is rotating in a clockwise direction as viewed from the cover 16, a bump upon the contact ring 95 will depress contact 98 upon the arm 108, thus increasing the pressure between the contact 100 and the contact ring 95. As a result, a following dip in the surface of the contact ring 95 may result in contact 98 losing contact with the contact ring 95, however loss of contact by the contact 100 is extremely unlikely due to the increased pressure exerted by the contact arm 110 through the spring 114.

It was noted hereinabove that it is desirable to pivot the contact arms 108 and 110 at their respective centers of gravity. This construction renders the assembly almost completely immune to shock and vibration, as there is no moment arm between the center of gravity and the point of pivoting to give any rotational movement. Hence this structure cooperates with the low mass of the contact 62 and is associated with the contact assembly member 60 to decrease the possibility of open contact due to severe shock and vibration. It is also contemplated that a counterweight mass 85 may be applied and rigidly affixed to the pin 82 so that the mass of the contact 62 will be balanced and compensated. Thus, the center of gravity of the pin 82 and its associated structure will be positioned in the center line of the support bar 64 of the pivot screws 70 and 72 at the indentations 78 and 80, respectively. When this refinement of balance is provided, this contact assembly member 60 will resist shock and vibration of substantial magnitude.

If a stop on rotation of the shaft is desired, an angle bracket 148 is secured to the disc 58 confronting the closed end 12 of the casing 10, and the bracket is provided with an outwardly extending portion 150 which is generally normal to the disc 58. A post 152 is secured to the closed end 12 of the casing 10 and projects above the level of the potting compound 56 to abut the portion 150 of the bracket 148, thus providing the desired stop.

It is to be noted that the end portions 84 and 88 restrain central portion 86 of the contact 62 from motion in the plane of the disc 58, but permits motion of the central portion 86 normal to the plane of the disc 58. This action is achieved by pivoting a pair of rigid arms angularly disposed relative to each other, portions 84 and 88, about an axis generally normal to the radius intersecting the contact 60 central portion 86. In effect, the contact 60 is a triangular shaped framework which is pivotally mounted at two corners about a common axis and supports the contact 62 central portion 86 which abuts the resistance card 36 at the third corner.

Another embodiment of the invention is shown in Figures 8 and 9. This embodiment of the invention is a modification of the device shown in Figures 1 through 7 and replaces each wire shaped contact 62 with an L-shaped angle bracket 160. Each angle bracket 160 has a central bend 162 forming a pair of straight arms 164 and 166 which are angularly disposed relative to each other. A contact slider 168 is mounted to the angle bracket 160 at the bend 162 and extends outwardly therefrom to abut the resistance card 36. The ends of the angle bracket are bent parallel to each other and secured to the pin 82, the pin 82 and support bar 64 being constructed in the same manner as described above. The spring 90 is again employed to place the desired spring tension on the contact slider 168.

Figure 10 illustrates still another embodiment of the present invention. In this figure, the contact assembly member 60 is constructed similar to that shown in Figures 8 and 9, but the contact is in the form of a curved round rigid member 170. The ends 172 and 174 of the member 170 are secured to the pin 82, as in Figures 8 and 9, and a contact slider 176 is affixed to the member 170 about mid-way between its ends. Here again, the axes from the point of attachment of the slider through the points of attachment to the pin 82 are angularly disposed relative to each other.

The contact assembly member 60 is shown in Figures 11 and 12 in still another modified form. Here a triangular shaped plate 180 is provided with a rolled edge 182 forming a channel 184 therethrough. The two corners at the end of the rolled edge 182 are bent normal to the plane of the plate 180 and provided with apertures 186 on an axis parallel with the plane of the plate 180. A pin 188 is secured to a support member 190, similar to the support members 64, and journaled within the apertures 186. A helical spring 192 is disposed about the pin 188, secured operatively to the pin 188 or the plate 180 at one end and to the support member 190 at the other end. The spring 192 places a spring bias on the plate 180 in the direction of the resistance card 36. A contact slider 194 is mounted the third corner of the plate 180 and slidably abuts the resistance card 36.

These various assemblies of a pin and contact assembly member 60 are alike in that while the assembly is free to rotate in the axis of the supports 64 for the pin 82, a rigid assembly between the contact member 60 and the pin 82 prevents any motion at right angles to this plane of rotation. This construction provides no positional error due to torsional distortion in the contact support means whereby any drag along the contact surface portion 48 cannot distort the desired contact position.

Another illustrative embodiment of the invention is shown in Figures 13 and 14 of the drawing. As illustrated in these figures, this embodiment of the invention comprises a hollow, cylindrical casing 212 having a closed end and an open end adapted to be closed by a suitable cover in the manner described with respect to the other illustrative variable resistor embodiments above. The closed-end of casing 212 is provided with a central aperture and a suitable bushing through which a rotatable shaft 226 is positioned.

The interior of the casing 226 advantageously is lined with electrical insulating material and a cylindrical resistance card 214 having a plurality of turns of resistance wire is positioned about the periphery of the casing interior adjacent the insulating lining. In addition, a cylindrical electrical insulating strip 224 advantageously may be provided adjacent the side of resistance card 214 remote from the casing interior to increase the insulation of the resistance card.

It will be understood by those skilled in the art that the resistance wire of the card also is provided with a coating of electrical insulating material, except for an edge of the card that is free of all insulation so as to electrically engage a contact finger of the variable resistor.

A rotor 230 also is positioned within the hollow casing 212 and is secured to shaft 226 for rotation therewith. As shown in greater details in Figures 15 and

16 of the drawing, rotor 230 advantageously takes the form of a generally cylindrical member having a recessed groove 228 formed therearound at one end thereof and a pair of spaced-apart lugs 236 and 238 extending outwardly from the other end thereof.

In accordance with an aspect of this invention, a unique contact assembly is supportingly mounted between said lugs, which contact assembly is compensated and balanced to resist shock and vibration of substantial magnitude. In lieu of jeweled bearings, the lugs 236 and 238 are provided with the indentations 256 and 258 respectively, for receiving the ends of the pin 246 of the contact assembly.

One illustrative embodiment of contact assembly is shown in Figures 13 and 14. In this embodiment the contact assembly comprises an O-ring or washer member 252 having a contact finger 254 extending outwardly from one side thereof. Preferably, the washer member 252 is secured to pin 246 in some suitable manner, as by welding. The contact assembly is spring biased toward the resistance card 254 by means of the helical spring 250 wound around pin 246 and having one end thereof connected to the washer member. The other end of helical spring 250 is connected to the conductor 244 which is soldered, or otherwise fastened, to the rotor 230.

It now can be appreciated that the contact finger 254 is spring biased against the edge of the resistance card 214 as a result of the action of helical spring 250. It will be noted, in this embodiment, that the pin 246 is positioned on an off-center line of the washer member 252 so that the mass of the contact assembly is balanced with respect to the center of gravity of pin 246. This balanced construction renders the contact assembly almost completely immune to shock and vibration, and substantially decreases the possibility of open contact as a result of severe shock and vibration.

It is contemplated that the attainment of such balance may be facilitated, whenever necessary, by the addition of a counterweight mass 266 to the side of the washer member 252 opposite the side to which the contact finger 254 is connected.

In accordance with a further feature of this invention, an adjusting screw 240 is positioned through the apertures 262 and 264 of legs 236 and 238, respectively. One end of screw 240 is threadedly engaged with the leg 236 such that rotation of the screw head 242 permits adjustment between the lugs. This adjustment serves to minimize side play of the contact assembly and therefore, further increases the efficiency and accuracy of operation of the contact assembly.

As shown in Figure 13, the variable resistor casing 212 is provided with an insulating terminal strip 216 on its outside surface and three terminal lugs 218, 220 and 222 are supported thereon. One end of the resistance wire on card 214 is connected to terminal lug 218 and the other end of the resistance wire is connected to terminal lug 222. The contact finger 254 is electrically connected to the terminal leg 220 by means of the conductor 244, the rotor 230, and the spring wire contact 232 and 234 which are slidably engaged with the groove 228 at one end of the rotor 230.

The balanced and compensated contact assembly may take several alternative forms. As shown in Figure 17 the washer member 270 is off-center with respect to pin 246 and this unbalnce of the washer member is counterbalanced by the contact finger 272 extending outwardly from the washer member 270. In Figure 18 the washer member 274 is centered with respect to the pin 246 and the contact finger 276 extends outwardly, an equal amount, from each side of the washer member to provide complete balance of the contact assembly with respect to the center of gravity of pin 246. Also, if desired, the washer member may be balanced with respect to the pin, and the contact finger may extend from only one side of the washer member as compensating means are provided to compensate for the resultant unbalance.

Such a construction is shown in Figure 19 of the drawing wherein pin 246 is positioned along a center line of washer member 278 but the provision of the contact finger 280 on only one side of the washer member causes an unbalance of the assembly. This unbalance is compensated for by means of the counter-weight mass 282 placed on the washer member 278 at a position opposite to the contact finger but along the same diameter. As stated above, these various alternative constructions substantially reduce the effects of shock and vibration environments since the balance of the contact assembly with respect to the center of gravity of the pin eliminates any moment arm between the center of gravity and the point of pivoting of the pin.

As is clear from the above description, the inventor has provided a variable resistor which may be operated at relatively high speeds without introducing excessive noise, and at the same time with considerable durability. The man skilled in the art will devise modifications for the variable resistor described herein which are within the intended scope of the present invention. It is therefore intended that the invention be not limited by the foregoing disclosure, but rather only by the appended claims.

I claim as my invention:

1. A variable resistor comprising a mounting member, a resistance element secured to the mounting member, electrical contact means slidably abutting the resistance element including a generally shaped rigid member pivotally mounted at two corners on an axis generally parallel to the confronting surface of the resistance element, the third corner of the member having an electrically conducting surface in slidable contact with the resistance element, means coupled to the shaped member to exert a pressure on the resistance element, means secured to the mounting member to translate the contact means along the resistance element including an electrically conducting surface electrically connected to the contact of the contact means, and a second electrical contact means comprising a pin, a pair of electrically conducting arms journalled about the pin having electrical contacts at one end thereof in slidable engagement with the electrically conducting surface of the translating means, a helical spring disposed about the pin having outwardly extending legs at each end, one of said legs being attached to the end of each arm opposite to the electrical contact and spring biasing the spring attached ends of the arms toward each other, thereby exerting a pressure on the electrical contacts at the other ends of the arms against the electrically conducting surface.

2. A variable resistor comprising a cylindrical resistance card, a shaft rotatably mounted on the axis of the resistance card, a disc mounted to the shaft having a periphery confronting the resistance card, an electrical contact means mounted to the disc and slidably abutting the resistance card including a pin rotatably mounted adjacent to the periphery of the disc normal to a radius thereof, set of dynamically balanced rigid arms angularly disposed relative to each other having their closer ends rigidly coupled together, the other end of each of the arms being secured to the pin, a helical spring attached to the pin at one end and disposed thereabout, the other end of said spring being attached to said disc, a support member mounted to the disc adjacent to the periphery and provided with an indentation confronting the resistance card, said support member being provided with aligned apertures confronting the indentation, and a pair of screws threadedly engaged within the apertures having ends confronting the indentation provided with indentations, said pin being rotatably disposed between the indentations in the screws.

3. A contact assembly for a variable resistor comprising a bar shaped mounting member having an indentation therein and a pair of aligned apertures extending into the indentation from opposite sides thereof, a pair of screws threadedly engaged within the apertures having ends con-

fronting the indentation provided with indentations, a straight pin disposed with its ends rotatably engaged within the indentations, and a contact member having a set of dynamically balanced rigid arms with their closer ends rigidly coupled together with their remote ends attached to the pin adjacent to opposite ends thereof.

4. A contact assembly comprising the elements of claim 3 wherein the support member is provided with an aperture entering the indentation normal to the pin, in combination with a helical spring disposed about the pin, one end of the spring being attached to the pin and the other end of the spring extending through the aperture and being anchored therein.

5. A variable resistor comprising, in combination, a cylindrical housing, a resistance card mounted within the housing adjacent to the periphery thereof, a shaft rotatably mounted to the housing on the axis thereof, a disc of electrically insulating material normally mounted to the shaft having a periphery confronting the resistance card, an electrical contact assembly mounted to the disc adjacent to the periphery thereof and in slidable contact with the resistance card including a bar shaped mounting member having an indentation therein and a pair of aligned apertures extending into the indentation from opposite sides thereof, a pair of screws threadedly engaged within the apertures having ends confronting the indentation provided with indentations, a straight pin disposed with its ends rotatably engaged within the indentations, a contact member slidably abutting the resistance card having a pair of rigid arms with their closer ends rigidly coupled together and their remote ends attached to the pin adjacent to opposite ends thereof, said support member having an aperture entering the indentation normal to the pin, and a helical spring disposed about the pin, one end of the spring being attached to the pin and the other end of the spring extending through the aperture and being anchored therein, an electrically conducting ring mounted coaxially to the disc and electrically connected to the contact member, and a sliding electrical contact mounted to the housing including a pin, a pair of electrically conducting arms journalled about the pin, a helical spring disposed about the pin having outwardly extending legs at each end, one of said legs being attached to one end of each arm and spring biasing the spring attached ends of the arms toward each other, the ends of the arms opposite to the spring attached ends of the arms being slidably engaged with the ring.

6. A variable resistor comprising a cylindrical resistance card, a shaft rotatably mounted on the axis of the resistance card, a rotor mounted to the shaft for rotation therewith and having a pair of spaced apart lugs extending outwardly therefrom, an electrical contact assembly pivotally supported between said lugs, said electrical contact assembly comprising a pin rotatably mounted between said lugs and normal to the axis of said shaft, washer means having a contact finger extending therefrom adapted to slidably abut said resistance card to vary the output resistance of said variable resistor upon rotation of said shaft, and helical spring means disposed about the pin, one end of said spring means being attached to said rotor and the other end of said pin being attached to said washer to bias said contact finger into abutting relation with said resistance card, said washer means and said contact finger being balanced with respect to the center of gravity of said pin to enhance resistance of said contact assembly to shock and vibration of substantial magnitude.

7. A variable resistor in accordance with claim 6 further comprising adjustable screw means extending between said lugs, and threadedly engaged therewith to permit adjustment of the spacing between said lugs for minimizing side play of said contact assembly.

8. A variable resistor in accordance with claim 6 wherein said pin is positioned along an off-center line of said washer means to divide the latter into two arcs of unequal size to thereby cause an unbalance, said unbalance being compensated for by positioning said contact finger on the smaller of said two arcs midway between the junction points of said pin and said washer means.

9. A variable resistor in accordance with claim 6 wherein said pin is positioned along a center line of said washer means and said contact finger is positioned along a center line of said washer means normal to said first center line, said contact means extending an equal amount from the opposite sides of said washer means to balance said contact assembly with respect to the center of gravity of said pin.

10. A variable resistor in accordance with claim 6 wherein said contact assembly comprises a pin positioned along a center line of said washer means, said contact finger extends outwardly from one side only of said washer means along a line normal to said center line to unbalance said contact assembly, and a counterweight mass positioned on said washer means at a side opposite said contact finger but along said line normal to said center line for balancing said contact assembly with respect to the center of gravity of said pin.

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