March 31, 1964 M. W. HUDSON ETAL 3,127,583

VARIABLE RESISTOR

Filed Jan. 12, 1962 3 Sheets-Sheet 1

Fig. 1

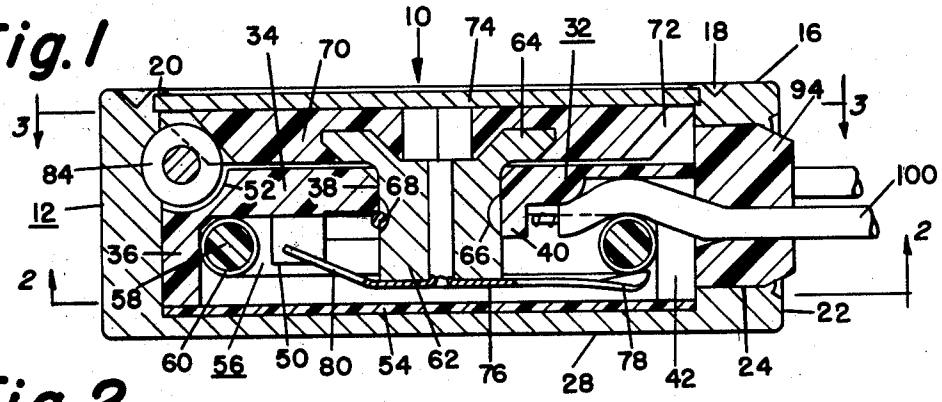


Fig. 2

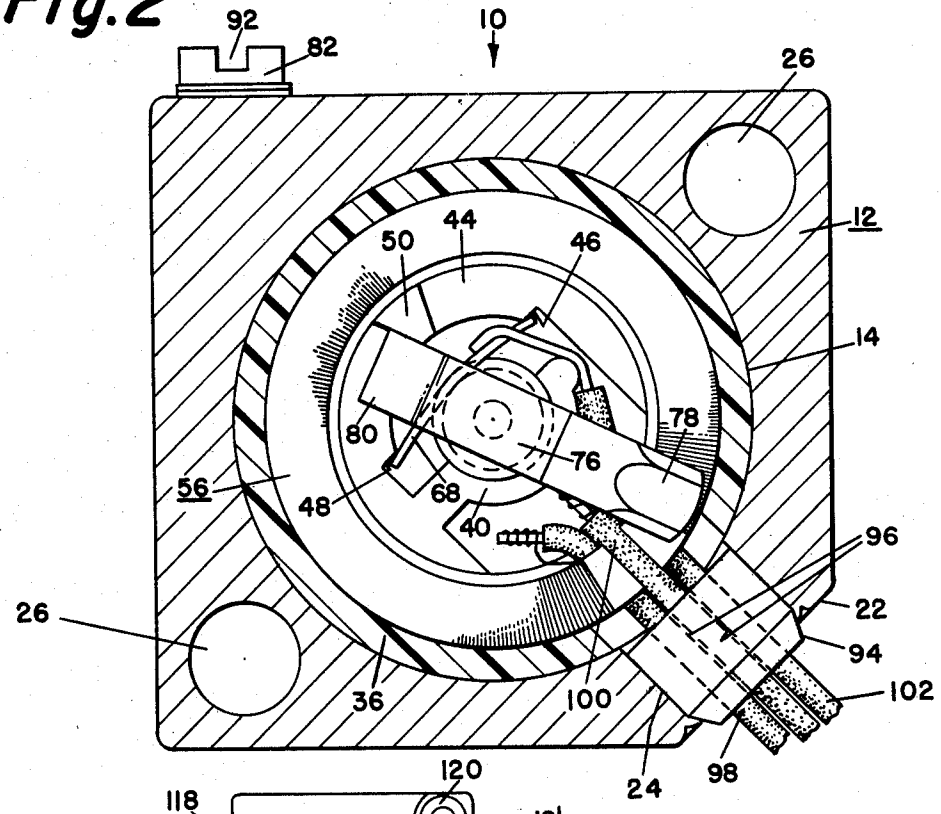
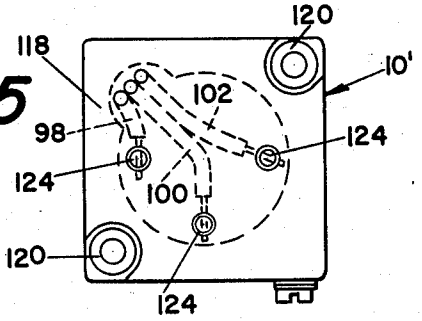


Fig. 5



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VARIABLE RESISTOR

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Fig. 3

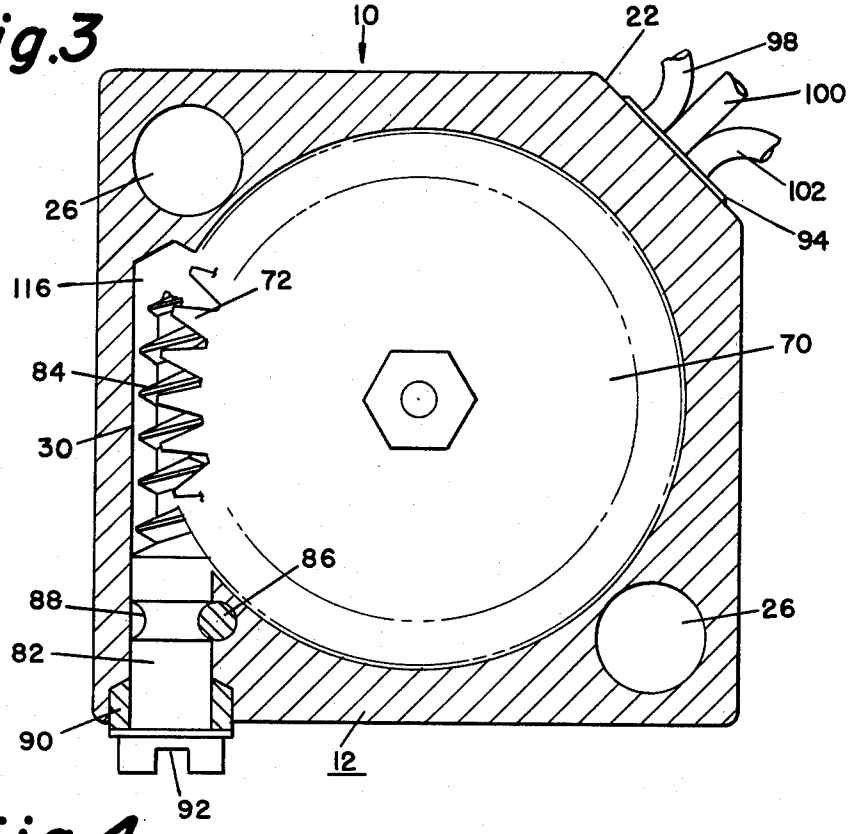
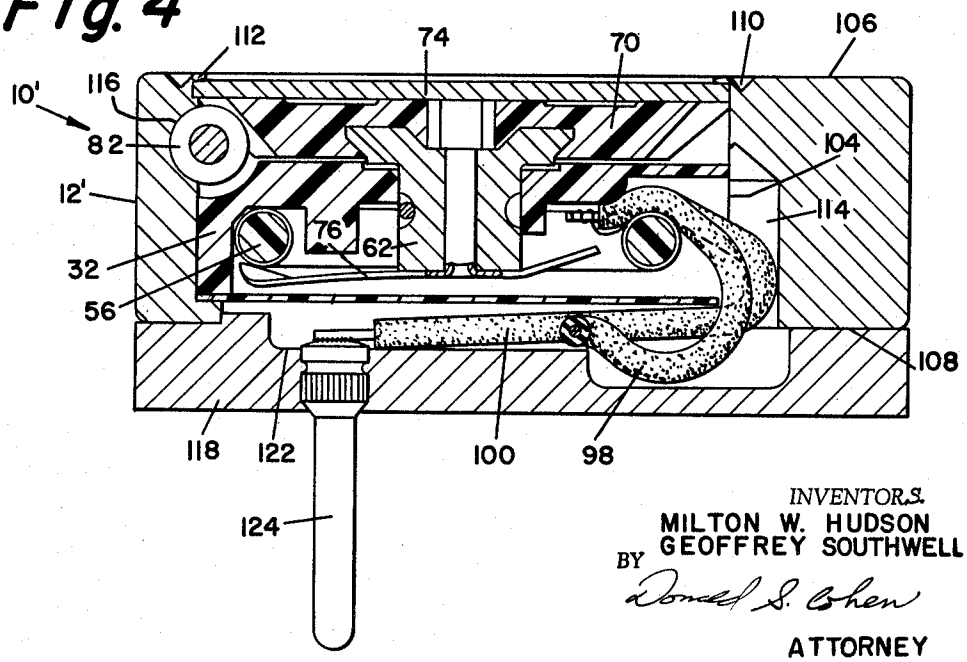


Fig. 4



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VARIABLE RESISTOR

Filed Jan. 12, 1962 3 Sheets-Sheet 3

Fig. 6

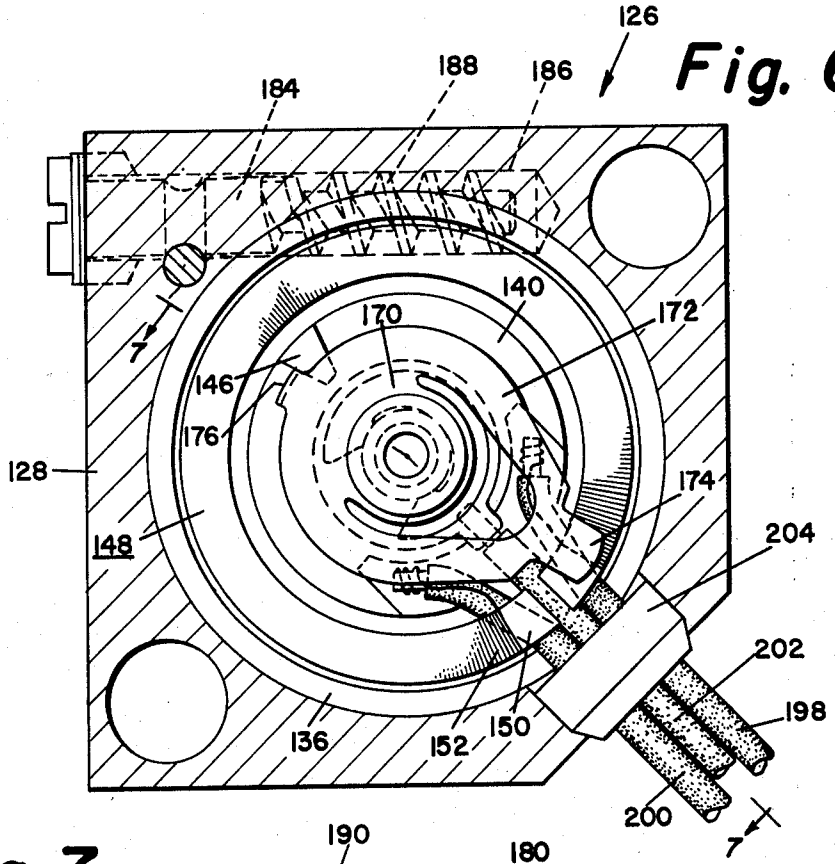
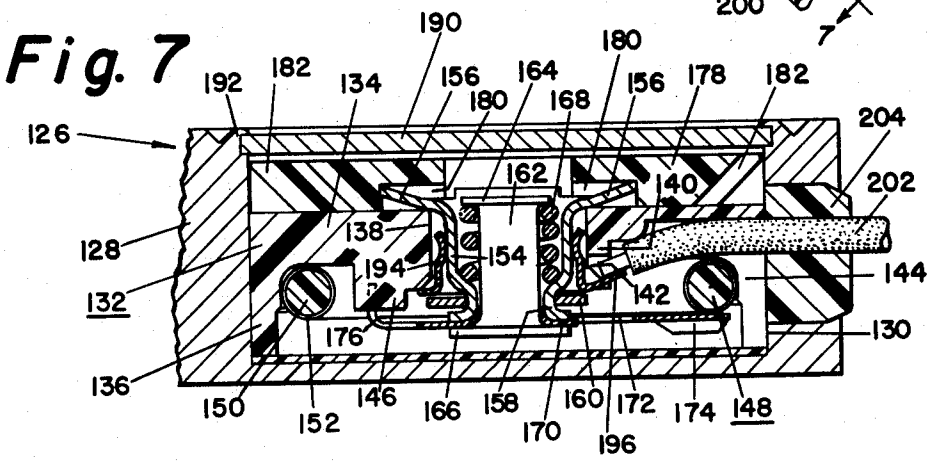


Fig. 7



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3,127,583

VARIABLE RESISTOR

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9 Claims. (Cl. 338—174)

The present invention relates to a variable resistor, and more particularly to a miniature variable resistor which can be accurately adjusted to a desired setting, and which will maintain such setting even when subjected to shock or vibration.

With the trend in the electronics industry to more complex electronic equipment which utilize a greater number of electrical components, it has been found necessary to provide miniaturized electrical components, such as resistors, so that the electronic equipment can be made as small as possible. In particular, there has been found a need for variable electrical resistors which are small and compact, and which can be easily mounted on a chassis to occupy a minimum amount of space. Not only must such variable resistors be small and compact, but they also must be capable of being easily and accurately adjusted to a desired setting. Furthermore, it is desirable for the variable resistors to maintain a desired setting even if subjected to shock and vibration. In addition, the variable resistors must be capable of being easily assembled so as to be inexpensive to manufacture.

It is an object of the present invention to provide a novel variable resistor.

It is another object of the present invention to provide a small, compact variable resistor.

It is still another object of the present invention to provide a small, compact variable resistor which can be easily and accurately adjusted to a desired setting, and which will maintain the setting even if subjected to shock or vibration.

It is a further object of the present invention to provide a small, compact variable resistor which is easy to assemble so as to be inexpensive to manufacture.

It is still a further object of the present invention to provide a small, compact variable resistor having a stop and slip clutch to insure against an open circuit, but without damage to the operating means.

Other objects will appear hereinafter.

For the purpose of illustrating the invention there is shown in the drawings forms which are presently preferred; it being understood, however that this invention is not limited to the precise arrangements and instrumentalities shown.

FIGURE 1 is a sectional view of the variable resistor of the present invention.

FIGURE 2 is a sectional view taken along line 2—2 of FIGURE 1.

FIGURE 3 is a sectional view taken along line 3—3 of FIGURE 1.

FIGURE 4 is a sectional view of a modification of the variable resistor of the present invention.

FIGURE 5 is an elevational view of the bottom surface of the variable resistor shown in FIGURE 4.

FIGURE 6 is a sectional view of still another modification of the variable resistor of the present invention.

FIGURE 7 is a sectional view taken along line 7—7 of FIGURE 6.

Referring initially to FIGURES 1–3, the variable resistor of the present invention is generally designated as 10.

Resistor 10 comprises a rectangular, metal casing 12 which may be as small as ½ inch square by 5/16 inch thick. Casing 12 has a circular recess 14 in the center of the top surface 16 thereof. The top surface 16 of the casing 12 is also provided with a shallow, V-shaped groove 18 extending around the edge of the recess 14 so as to provide a lip 20 around the edge of the recess. One corner of the casing 12 is chamfered so as to provide the flat surface 22. A hole 24 extends through the casing 12 from the flat surface 22 to the recess 14. A pair of mounting holes 26 extend through diagonally opposite corners of the casing 12 from the top surface 16 to the bottom surface 28 thereof. At the corner of the casing 12 diagonally opposite the flat corner surface 22, a blind hole 30 extends through the casing from an edge thereof. As shown in FIGURE 3, the blind hole 30 is substantially tangential to the wall of the recess 14, with a portion of the length of the blind hole 30 opening into the recess 14.

A cup-shaped resistance element housing 32 having a circular base 34 and a cylindrical peripheral flange 36 is mounted within the recess 14 in the casing 12 with the open end of the housing 32 facing the bottom of the recess 14. The housing 32 is of an electrical insulating material, such as a plastic, and the outer diameter of the peripheral flange 36 is substantially equal to the diameter of the cylindrical wall of the recess 14 in the casing 12. The base 34 of the housing 32 has a central hole 38 therethrough, and a bearing projection 40 extends from the inner surface of the base 34 around a portion of the hole 38. The peripheral flange 36 of the housing 32 has an opening 42 extending radially therethrough adjacent the hole 24 in the casing 12. The base 34 of the housing 32 has an arcuate projection 44 extending from the inner surface thereof which provides a pair of spaced, aligned shoulders 46 and 48 which are in a plane which is substantially tangential to the hole 38 in the base 34 (see FIGURE 2). A stop lug 50 projects from the arcuate projection 44, and is positioned on the side of the hole 38 in the base 34 diametrically opposite the opening 42 in the peripheral flange 36. The base 34 of the housing 32 has a rounded groove 52 extending across the portion of its outer surface which extends across the opening between the hole 30 and the recess 14 in the casing 12. Thus, the surface of the rounded groove 52 forms the missing portion of the wall of the hole 30 in the casing 12. A sheet 54 of an electrical insulating material, such as a plastic, is provided across the bottom of the recess 14 in the casing 12, and is sandwiched between the bottom of the recess 14 and the end of the peripheral flange 36 of the housing 32.

An arcuate resistance element 56 is mounted within the housing 32 along the junction of the base 34 and the peripheral flange 36. As shown in FIGURE 2, the ends of the resistance element 56 are spaced apart, and are positioned at the opening 42 in the peripheral flange 36 of the housing 32. The resistance element 56 comprises a core 58 of an electrical insulating material, and a resistance wire 60 helically wound around and along the core 58.

As shown in FIGURE 1, a shaft 62 of an electrically conductive metal extends through and is rotatably supported in the hole 38 in the base 34 of the housing 32.

The shaft 62 is provided at one end with a radially outwardly extending flange 64 which extends across the outer surface of the base 34 of the housing 32. Shaft 62 also has an annular groove 66 in its outer surface. The shaft 62 is of a length so that it does not extend beyond the end of the peripheral flange 36 of the housing 32. A relatively rigid wire 68 of an electrically conductive metal extends across and through the annular groove 66 in the shaft 62, and the ends of the wire 68 are seated against the shoulders 46 and 48 of the housing 32. Thus, the wire 68 secures the shaft 62 to the housing 32, but permits rotation of the shaft with respect to the housing.

A gear 70 of an electrical insulating material, such as a plastic, is mounted on the flange 64 of the shaft 62, and extends across the outer surface of the base 34 of the housing 32. The gear 70 is mounted on the shaft 62 by molding the gear directly around the flange 64 of the shaft. Although there is sufficient friction between the gear 70 and the flange 64 of the shaft 62 so that rotation of the gear will normally rotate the shaft, if the shaft 62 is held against rotation, the gear 70 can be rotated with respect to the shaft for reasons which will be explained later. Gear 70 is provided with teeth 72 around its outer periphery, which teeth are tapered radially inwardly toward the base 34 of the housing 32.

A cover plate 74 extends across the open end of the recess 14 in the casing 12 over the gear 70. The lip 20 of the casing 12 is preened over the cover plate 75 to secure the cover plate in the casing. The cover plate 74 secures the housing 32, shaft 62 and gear 70 in position within the casing 12.

A wiper 76, which is a strip of an electrically conductive metal, extends across the free end of the shaft 62, and is secured to the shaft such as by welding, soldering or the like. One end of the wiper 76 is provided with a lip 78 which extends over and slidably engages the resistance wire winding 60 of the resistance element 56. The other end of the wiper 76 is bent to provide a stop finger 80 which extends across the sides of the stop lug 50. Thus, upon rotation of the shaft 62, the lip 78 of the wiper 76 slides along the resistance wire winding 60 of the resistance element 56 until the stop finger 80 of the wiper engages a side of the stop lug 50. The stop lug 50 is positioned so that when the stop finger 80 of the wiper 76 engages a side of the stop lug, the lip 78 of the wiper is at an end of the resistance element 56. Thus, the rotation of the wiper 76 and the shaft 62 is limited to the circumferential length of the resistance element 56.

As shown in FIGURE 3, a drive shaft 82 is provided in the blind hole 30 in the casing 12. Drive shaft 82 has a worm gear 84 at one end which meshes with the teeth 72 of the gear 70. A retainer pin 86 extends through the casing 12 and across an annular groove 88 in the drive shaft 82 to secure the drive shaft in the hole 30, but permit rotation of the drive shaft. An annular packing ring 90 is provided around the drive shaft 82. The end of the drive shaft 82 which is outside of the casing 12 is provided with a transverse slot 92 which is adapted to receive a screw driver or a similar tool for the purpose of rotating the drive shaft. Rotation of the drive shaft 82 rotates the gear 70, and thereby rotates the wiper 76.

As shown in FIGURES 1 and 2, a bushing 94 of an electrical insulating material is secured in the hole 24 in the casing 12. Bushing 94 has three holes 96 therethrough which three insulated wires 98, 100 and 102 extend. The wires 98, 100 and 102 extend into the housing 32 through the opening 42 in the flange 36 of the housing. The ends of the wires 98 and 100 are bared, and are secured to the ends of the resistance wire 60 of the resistance element 56. Thus, the wires 98 and 100 are the terminals for the resistance element 56. The end of the wire 102 is bared, and is secured to the wire 68. Thus, the wire 102 is electrically connected to the wiper 76 through the wire 68 and shaft 62 so as to be the terminal for the wiper 76.

In the use of the variable resistor 10 of the present invention, the wiper 76 is rotated by rotating the drive shaft 82. As the wiper 76 is rotated, the lip 78 of the wiper slides along the resistance wire winding 60 of the resistance element 56 to vary the resistance measured between the terminal wire 102 and either of the terminals wires 98 and 100. By the use of the gearing arrangement to rotate the wiper 76, fine adjustments of the position of the lip 78 of the wiper 76 along the resistance element 56 can be obtained to accurately obtain any desired resistance value. The gear drive will also maintain any desired setting the lip 78 of the wiper 76 along the resistance element 56 even if the variable resistor 10 is subjected to shock or vibration. As previously stated, when the wiper 76 is rotated to a position where the lip 78 of the wiper is at an end of the resistance element 56, the stop finger 80 of the wiper engages the stop lug 50 to prevent further rotation of the wiper 76 in that direction. Thus, the lip 78 of the wiper 76 never leaves the resistance element 56 so as to prevent an open circuit of the variable resistor 10. However, when the wiper 76 has been rotated to its limit position, further rotation of the drive shaft 82 in the same direction will rotate the gear 70. As previously stated, the gear 70 can rotate with respect to the shaft 62 when the shaft is held against rotation. Thus, there is provided a slip clutch between the gear 70 and the shaft 62 which permits rotation of the drive shaft 82 after the wiper 76 reaches a limiting position without damage to the operating means for the variable resistor 10.

In the assembly of the variable resistor 10 of the present invention, the resistance element 56, shaft 62, gear 70, wiper 76 and terminal wires 98, 100 and 102 are assembled on the resistance element housing 32. This provides an electrically complete subassembly of the operating parts of the variable resistor 10 of the present invention. The sub-assembly can then be electrically and mechanically tested to insure that it operates properly before the sub-assembly is mounted within the casing 12. By pre-testing the sub-assembly prior to mounting the sub-assembly in the casing 12, if the resistance element 56 is not of the proper resistance value or linearity, or there is any mechanical defect, the resistance element can be changed or the defect corrected before the sub-assembly is mounted and secured within the casing 12. This eliminates the need for disassembling the completed variable resistor 10 in the event of any defect in the variable resistor so as to save considerable time and expense in the manufacture of the variable resistor 10 of the present invention. Furthermore the construction of the variable resistor 10 of the present invention permits the sub-assemblies to be made up and placed in stock to be later assembled with the drive shaft 82 in the casing 12 as required to fill orders. When the variable resistors 10 of the present invention are completely assembled, the sub-assemblies can again be tested to insure that they are in operating condition.

Referring to FIGURES 4 and 5, a modification of the variable resistor of the present invention is generally designated as 10'. Variable resistor 10' is identical to the variable resistor 10 shown in FIGURES 1–3 except for the construction of the casing 12' which is of a construction to permit the variable resistor 10' to be easily mounted on a printed circuit panel.

Casing 12' is square and has a circular hole 104 extending completely therethrough from its top flat surface 106 to its flat bottom surface 108. The top surface 106 of the casing 12' is provided with a V-shaped groove 110 around the edge of the hole 104 to provide the lip 112. The wall of the hole 104 has a groove 114 extending longitudinally therealong from the bottom surface 108 of the casing 12' to a point short of the top surface 106. Casing 12' is also provided with a blind hole 116 which extends

from an edge of the casing substantially tangential to the wall of the hole **104**. The blind hole **116** is similar to the blind hole **30** in the casing **12** of the variable resistor **10** shown in FIGURES 1–3.

A square bottom plate **118** extends across the bottom surface **108** of the casing **12'**. Bottom plate **118** is secured to the casing **12'** by a pair of hollow rivets **120** which extend through aligned holes in the casing **12'** and the bottom plate **118** at diagonally opposite corners thereof (see FIGURE 5). The inner surface of the bottom plate **118** has a central shallow recess **122**. Three terminal pins **124** of an electrically conductive metal extend through and are secured to the bottom plate **118** with the inner ends of the terminal pins being within the recess **122**.

The sub-assembly of the resistance element housing **32**, resistance element **56**, shaft **62**, gear **70**, wiper **76** and insulated terminal wires **98**, **100** and **102** is mounted in the hole **104** in the casing **12'**. The ends of the terminal wires **98**, **100** and **102** which extend from the resistance element housing **32** extend along the groove **114** in the casing **12'** and the recess **122** in the bottom plate **118**. As shown in FIGURE 5, the bared end of each of the terminal wires **98**, **100** and **102** are secured, such as by soldering or welding, to the inner end of a separate one of the terminal pins **124**. A drive shaft **82** is rotatably secured in the blind hole **116** in the casing **12'** and mates with the gear **70** to rotate the gear **70**, shaft **62** and wiper **76**. A cover plate **74** extends across the top end of the hole **104** in the casing **12'** and across the gear **70**. The lip **112** of the casing **12'** is preened over the cover plate **74** to secure the cover plate to the casing **12'**.

The variable resistor **10'** of the present invention operates in the same manner as the variable resistor **10** of FIGURES 1–3. However, the variable resistor **10'** can be easily mounted on a printed circuit panel by inserting the terminal pins **124** through holes in the printed circuit panel until the bottom plate **118** engages the printed circuit panel.

Referring to FIGURES 6 and 7, another modification of the variable resistor of the present invention is generally designated as **126**.

Variable resistor **126** comprises a square casing **128** of a construction substantially identical to the casing **12** of the variable resistor **10** shown in FIGURES 1–3. Within the recess **130** in the casing **128** is a circular, cup-shaped resistor element housing **132** of an electrical insulating material. Housing **132** has a base **134** and a cylindrical peripheral flange **136**. The base **134** of the housing **132** has a central hole **138** therethrough, and an annular bearing boss **140** projects from the inner surface of the base **134** around the hole **138**. Bearing boss **140** and the peripheral flange **136** of the housing **132** have radially aligned openings **142** and **144** respectively therethrough. A stop lug **146** projects from the end surface of the bearing boss **140** on the side of the hole **138** diametrically opposite the opening **142**.

A resistance element, generally designated as **148**, is mounted in the housing **132** along the junction of the base **134** and the peripheral flange **136**. Resistance element **148** comprises a core **150** of an electrical insulating material, and a resistance wire **152** helically wound around and along the core **150**. As shown in FIGURE 6, the resistance element **148** is mounted in the housing **132** with the ends of the core **150** being spaced apart and adjacent the opening **144** in the peripheral flange **136** of the housing **132**.

A hollow metal shaft **154** extends through the hole **138** in the base **134** of the housing **132**. The shaft **154** is provided at one end with a plurality of drive fingers **156** which extend radially outwardly from the shaft along the outer surface of the base **134** of the housing **132**. The other end of the shaft **154** has an annular depression **158** which extends radially inwardly beyond the inner surface of the shaft. A C-shaped retaining ring **160** fits around the shaft **154** within the depression **158**. Retaining ring **160** extends radially outwardly across the end surface of the bearing boss **140** of the housing **132** to secure the shaft **154** to the housing **132**.

A tubular metal eyelet **162** extends through the shaft **154**. Eyelet **162** has radially outwardly extending flanges **164** and **166** at its ends. A helical spring **168** surrounds the eyelet **162**, and is compressed between the flange **164** of the eyelet and the depression **158** of the shaft **154**. The spring **168** pulls the end flange **166** of the eyelet **162** toward the end of the shaft **154**.

A wiper ring **170** of an electrically conductive metal surrounds the eyelet **162** adjacent the end flange **166**. The spring **168** clamps the wiper ring **170** tightly between the flange **166** of the eyelet **162** and the end of the shaft **154**. As shown in FIGURE 6, wiper ring **170** has a U-shaped spring arm **172** extending radially therefrom. A wiper finger **174** extends from the spring arm **172**, and slidably engages the resistance wire winding **152** of the resistance element **148**. A stop finger **176** extends from the wiper ring **170** over and toward the end surface of the bearing boss **140** of the housing **132**. Stop finger **176** is on the side of the wiper ring **170** diametrically opposite the wiper finger **174**, and is adapted to engage the sides of the stop lug **146** on the housing **132** when the wiper finger **174** is at the ends of the resistance element **148**.

A gear **178** of an electrical insulating material is within the casing **128** over the outer surface of the base **134** of the housing **132**. Gear **178** has a plurality of recesses **180** in its surface which engages the housing **132**. Each of the recesses **180** in the gear **178** receives a separate one of the drive fingers **156** of the shaft **154** so that rotation of the gear **178** rotates the shaft **154**. Gear **178** is provided with a plurality of tapered teeth **182** around its peripheral edge. As shown in FIGURE 6, a drive shaft **184** is rotatably secured in a blind hole **186** in the casing **128**. Drive shaft **184** is similar to the drive shaft **82** of the variable resistor **10** of FIGURES 1–3. The drive shaft **184** is provided with a worm gear **188** which meshes with the teeth **182** of the gear **178** so that rotation of the drive shaft **184** rotates the gear **178**.

A cover plate **190** extends across the open end of the recess **130** in the casing **128** over the gear **178**. Cover plate **190** is secured to the casing **128** by a lip **192** which is preened over the cover plate **190**. A collector ring **194** of an electrically conductive metal is mounted around and slidably engages the shaft **154** (see FIGURE 7). Collector ring **194** has a terminal flange **196** extending radially outwardly therefrom through the opening **142** in the bearing boss **140**. Three insulated terminal wires **198**, **200** and **202** extend into the housing **132** through the opening **144** in the peripheral flange **136** of the housing. As shown in FIGURE 6, the ends of the terminal wires **198** and **200** are bared, and each end of the resistance wire **152** of the resistance element **148** is secured to a separate one of the terminal wires **198** and **200**. Thus, the terminal wires **198** and **200** are the terminals for the resistance element **148**. As shown in FIGURE 7, the end of the terminal wire **202** is bared, and is secured to the terminal flange **196** of the collector ring **194**. Thus, the terminal wire **202** is electrically connected to the wiper ring **170** through the collector ring **194** and the shaft **154**. The terminal wires **198**, **200** and **202** extend from the casing **128** through holes in an insulating bushing **204**, which is secured in an opening in the casing **128**.

In the operation of the variable resistor **126**, the wiper finger **174** is moved along the resistance element **148** by rotating the drive shaft **184**. Rotation of the drive shaft **184** rotates the gear **178**, which, in turn, rotates the shaft **154** through the drive fingers **156**. Since the wiper ring **170** is clamped tightly between the end of the shaft **154** and the flange **166** of the eyelet **162** by the spring **168**, rotation of the shaft **154** rotates the wiper ring **170** to move the wiper finger **174** along the resistance element **148**. When the wiper ring **170** is rotated to a position where the wiper finger **174** is at an end of the resistance

element **148**, the stop finger **176** of the wiper ring engages a side of the stop lug **146** to prevent further rotation of the wiper ring. However, further rotation of the drive shaft **184** will rotate the shaft **154** which will slide with respect to the wiper ring **170**. Thus, there is provided a slip clutch which permits rotation of the drive shaft **184** without causing damage to the drive mechanism of the variable resistor **126**, but does not drive the wiper finger **174** from the ends of the resistance element **148** so that the variable resistor **126** is open circuited.

The present invention may be embodied in other specific forms without departing from the spirit or essential attributes thereof and, accordingly, reference should be made to the appended claims, rather than to the foregoing specification as indicating the scope of the invention.

We claim:

1. A variable resistor comprising:
a casing having a pair of flat opposed surfaces and a circular recess in one of said surfaces;
a circular, cup-shaped housing of an electrical insulating material within the recess in the casing with the open side of said housing facing the bottom of said recess, said housing having a central hole through the base thereof;
an arcuate resistance element mounted within said housing with the ends of the resistance element being spaced apart;
a shaft of an electrically conductive metal extending through and rotatably supported in the hole in said housing;
a wiper member of an electrically conductive metal mounted on the end of said shaft within said housing so as to rotate with said shaft, said wiper member having a wiper finger slidably engaging the resistance element;
a gear of an electrical insulating material within the recess in said casing over said housing, said gear being connected to said shaft so that rotation of the gear rotates the shaft;
a cover plate secured across the recess in the casing over said gear;
a drive shaft extending through the casing and rotatably secured therein, said drive shaft having a worm gear which meshes with the teeth of said gear to rotate said gear upon rotation of the drive shaft; and
three terminals extending from said casing, two of said terminals being electrically connected to opposite ends of the resistance element, and the third terminal being electrically connected to said wiper member through said shaft.

2. A variable resistor in accordance with claim 1 in which the housing has a stop lug projecting from the inner surface of the base thereof on the side of the shaft diametrically opposite the spaced ends of the resistance element, and the wiper member has a stop finger extending therefrom toward the base of he housing, said stop finger adapted to engage the stop lug when the wiper finger is at the ends of the resistance element to limit further rotation of the wiper member.

3. A variable resistor in accordance with claim 2 in which the end of the shaft to which the gear is connected is provided with an annular flange extending radially outwardly from the shaft over the housing, and the gear is molded around said annular flange, the engagement between the gear and the annular flange normally providing a drive connection therebetween but permitting slippage therebetween when the shaft is held against rotation by the engagement of the stop finger with the stop lug.

4. A variable resistor in accordance with claim 3 in which the housing is provided with a pair of aligned spaced shoulders which are in a plane substantially tangential to the shaft, the shaft has an annular groove in its surface, a relatively rigid wire of an electrically conductive metal extends through and across the groove in said shaft with the ends of the wire being seated against the shoulders of said housing, and the terminal for the wiper is electrically connected to said wire.

5. A variable resistor in accordance with claim 2 in which the recess in the casing extends completely through said casing, a bottom plate extends across and is secured to one surface of said casing, said bottom plate providing the bottom of said recess, and the terminals comprise three terminal pins of an electrically conductive metal secured to and projecting from said bottom plate, separate wires electrically connecting two of said terminal pins to separate ends of the resistance element, and a third wire electrically connecting the third terminal pin to the wiper member through the shaft.

6. A variable resistor in accordance with claim 2 in which the shaft is hollow and has a radially inwardly extending projection at its end within the housing, an eyelet extends through said shaft and has a radially outwardly extending annular flange at each end thereof, the wiper member extends around said eyelet between the end of the shaft within the housing and one of the flanges of the eyelet, and a helical spring around said eyelet and compressed between the other flange of the eyelet and the projection on said shaft, said spring clamping the wiper member between the end of the shaft and the flange of the eyelet so as to normally cause the wiper member to rotate with said shaft but permitting slippage between said wiper member and the shaft when the wiper member is prevented from rotating by the engagement of the stop finger with the stop lug.

7. A variable resistor in accordance with claim 6 in which the shaft has a plurality of fingers projecting radially outwardly therefrom over the housing, and the gear has a plurality of recesses therein, each of said shaft fingers fitting into a separate recess in the gear to provide a drive connection between the gear and the shaft.

8. A variable resistor in accordance with claim 6 including a contact ring of an electrically conducting metal surrounding and slidably engaging the shaft, and the terminal for the wiper is electrically connected to said contact ring.

9. A variale resistor comprising:
a casing having a pair of flat opposed surfaces and a circular recess in one of said surfaces;
a circular, cup-shaped housing of an electrical insulating material within the recess in the casing with the open side of said housing facing the bottom of said recess, said housing having a central hole through the base thereof;
an arcuate resistance element mounted within said housing with the ends of the resistance element being spaced apart;
a hollow shaft extending through and rotatably supported in the hole in said housing;
an eyelet extending through said shaft, said eyelet having a radially outwardly extending flange at each end thereof;
a wiper member of an electrically conductive metal mounted around said eyelet between the end of the shaft within the housing and one of the flanges of the eyelet; said wiper member having a wiper finger slidably engaging the resistance element;
spring means between the other flange of the eyelet and the shaft, said spring means clamping the wiper member between the end of the shaft and the flange of the eyelet so as to normally cause the wiper member to rotate with said shaft but permitting slippage between said wiper member and the shaft when the wiper member is prevented from rotating;
a gear within the recess in said casing over said housing, said gear being connected to said shaft so that rotation of the gears rotates the shaft but being electrically insulated from said shaft;
a cover plate secured across the recess in the casing over said gear;

a drive shaft extending through the casing and rotatably secured therein, said drive shaft having a worm gear which meshes with the teeth of said gear to rotate said gear upon rotation of the drive shaft; and

three terminals extending from said casing, two of said terminals being electrically connected to opposite ends of the resistance element, and the third terminal being electrically connected to said wiper member.

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