March 3, 1959 R. O. HELD 2,876,319

VOLTAGE DIVIDER

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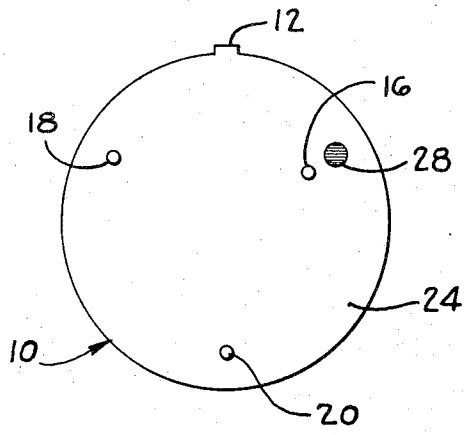


FIG. 3.

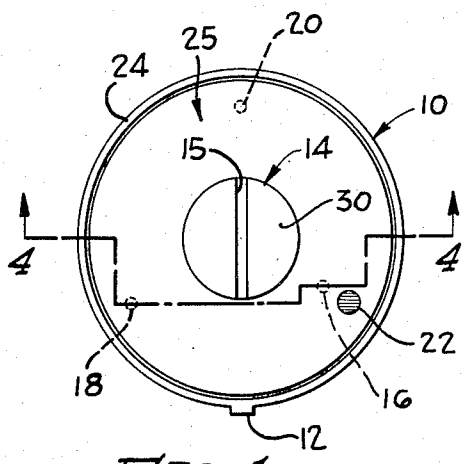


FIG. 1.

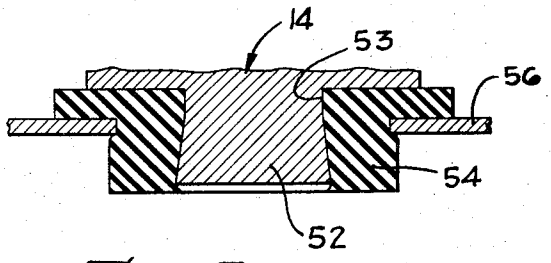


FIG. 7.

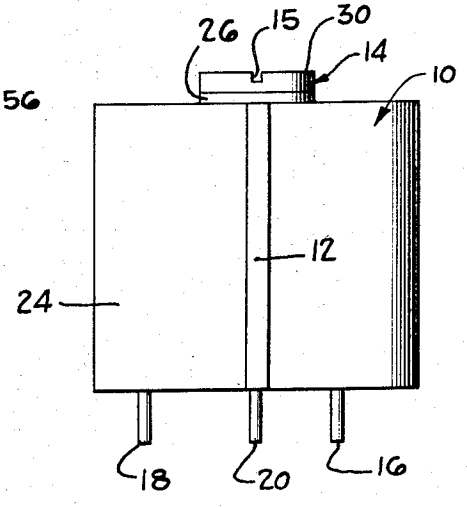


FIG. 2.

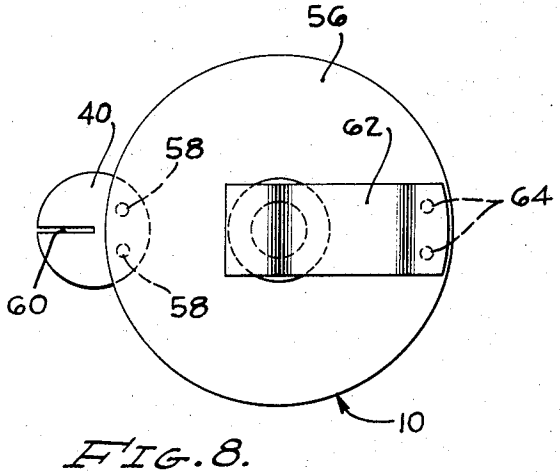


FIG. 8.

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VOLTAGE DIVIDER

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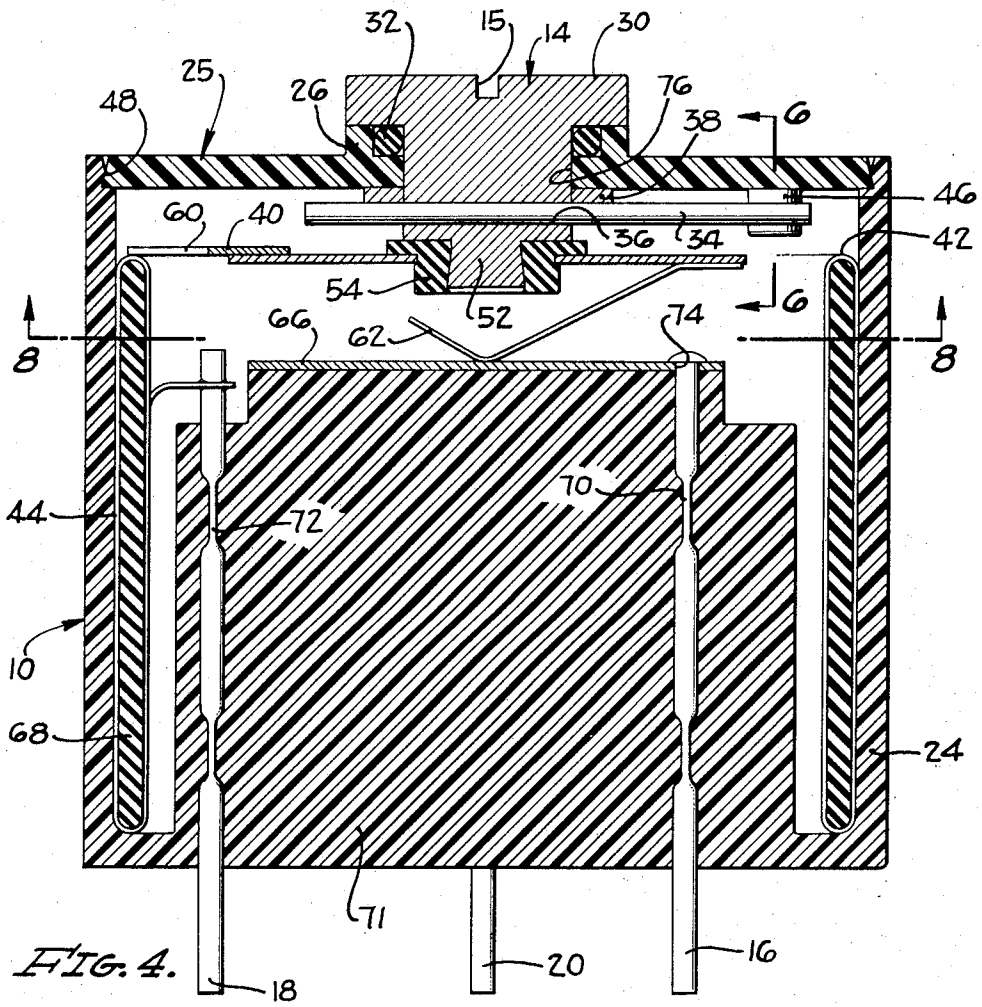


FIG. 4.

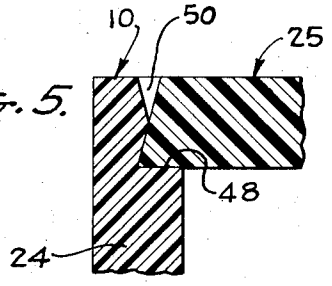


FIG. 5.

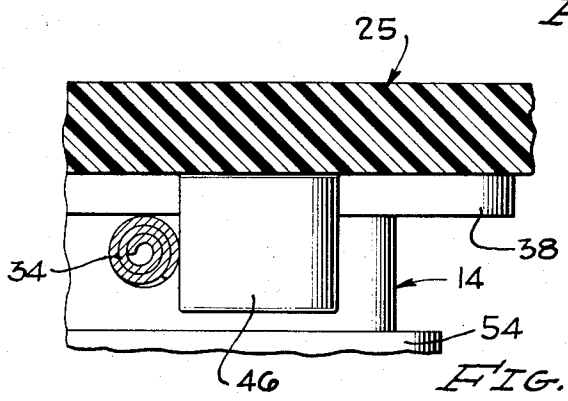


FIG. 6.

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VOLTAGE DIVIDER

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7 Claims. (Cl. 201—48)

This invention relates to voltage dividers, and more particularly to a voltage divider of an improved mechanical and electrical construction.

Although many features of the invention may be employed in voltage dividers of any size, the invention is particularly useful in sub-miniature voltage dividers, or more commonly potentiometers, for use in large quantities in printed, painted or etched circuits.

Several pressing problems currently exist in the art of making sub-miniature potentiometers. One of the most important problems relates to their automatic and economical fabrication and installation. To the present time, potentiometer construction has not kept pace with automatic machinery and assembly methods. Hence, sub-miniature potentiometers cost very little, if any, less than potentiometers of average size.

Another problem relates to the construction of sub-miniature potentiometers having good and low noise wiper contacts.

A third problem relates to the difficulties encountered in mounting a potentiometer on a perforated printed circuit board. For example, it is at present the practice to use screws or other means to mount them, although all other elements are provided with simple wire leads, all the elements having their leads projecting through metal walled apertures in a single board in which they are soldered by dipping all the leads simultaneously in melted solder.

The invention overcomes these and other disadvantages of the prior art by providing several construction features which permit automatic manufacture and installation of voltage dividers.

The first of these features comprises a cap assembly to support a wiper in a rotatable position. This cap assembly comprises a housing cover having a cylindrical aperture therein, resilient means to urge the body out of the aperture, and means to maintain the body in a fixed axial, but rotatable angular position through the aperture to stress the resilient means. Preferably, the resilient means comprises an O-ring located around the shaft between the flange and the housing cover. The housing cover may be constructed to snap tight over a housing body so that it may be easily assembled. The O-ring serves two purposes. In the first place, it keeps the voltage divider housing liquid tight. Secondly, it serves as friction drag means to resist rotation of the shaft.

According to a specific feature of the invention, means for maintaining the shaft in a fixed axial, but rotatable angular position includes a retaining pin to project through a transverse hole in the shaft below the housing cover provided for that purpose. The shaft is thus easily fixed in position in the housing cover simply by inserting the retaining pin through it. The resilient character of the O-ring may serve to keep the pin in place. Preferably a washer is located around the shaft between the pin and the housing, and the pin is made of a coiled strip of the spring steel material. This construction may provide an additional force to maintain the pin in a fixed transverse position.

In accordance with one aspect of the invention, a stop may be molded integrally with the housing cover and engage the pin to limit the rotation of the shaft, provided that the pin is placed in a suitable transverse position. This arrangement has an additional advantage in that if the pin is sufficiently short, it may be adjusted either to avoid or to engage this stop. This means that the same component parts of the potentiometer may be employed to meet either one of these two specifications, viz. (1) that stop means must be provided or (2) that stop means must be omitted.

Another sub-assembly of the potentiometer of the invention which may be easily and quickly assembled includes an arrangement for fixing a wiper assembly on the shaft. This arrangement comprises a wiper shaft having a circumferential groove therein, an annular insulator disposed about the shaft in the groove, the insulator being sufficiently resilient to pass over the length of the shaft included between one end and the groove, and a member having an annular opening through it to fit around the insulator, the opening being sufficiently small in diameter to maintain the insulator in radial compression.

According to another aspect of the invention, a potentiometer is provided comprising a housing having a radial projection to act as a guide for a machine installation thereof in mounting the potentiometer on a printed or etched circuit board.

According to still another feature of the invention, a potentiometer is provided comprising a housing having a mark thereon at least on one end thereof to identify the physical position of the structure internally of the housing. In a particular use of such a potentiometer, the mark may be employed on the top of the potentiometer housing to identify the angular position at which the wiper lead emanates from the bottom of the housing. All the potentiometer leads emanating from the bottom of the housing may then be easily manually inserted in holes in a printed circuit board.

Good wiper contact is provided in accordance with the invention by another arrangement for use in a potentiometer having a housing including a cover and a shaft extending therethrough in a fixed axial, but rotatable angular position, a stationary element in a fixed position in said housing providing a contacting surface below the inner end of the shaft, and a winding having a wiping surface disposed concentrically with the shaft. The arrangement then includes a conductive disc insulated from but fixed to the shaft internally of the housing in a plane substantially perpendicular to the axis of the shaft, the disc having an upper surface adjacent the housing cover and an opposite lower surface, resilient means fixed to the disc at a point on its periphery and extending downwardly therefrom, and means fixed to the resilient means to contact the stationary element, the resilient means urging said disc upwardly at the one point, and a wiper having one end fixed to the disc at another point on the periphery thereof diametrically opposed to that of the one point and contacting the wiping surface of the winding, whereby the action of the resilient means forces the contact means against the stationary contact element, and the wiper against the wiping surface of the winding.

A bifurcated wiper contact, which is employed in the potentiometer of the invention, minimizes noise. In fact, the noise figure of conventional contacts may be reduced as much as 20% by utilizing the bifurcated wiper contact.

Leads to the wiper and potentiometer winding are molded integrally with the housing in accordance with another feature of the invention, whereby the leads may be easily soldered to a printed circuit board.

In accordance with another related feature of the invention, a portion of the length of each lead has an irregular cross-section to prevent each of them from slipping outwardly of the housing.

It is therefore an object of the invention to provide a voltage divider having a plurality of component parts which may be fabricated, assembled and installed automatically.

It is another object of the invention to provide a voltage divider including means to provide good and low noise wiper contacts.

It is still another object of the invention to provide a voltage divider having wire leads with a strong attachment construction to a housing therefor to permit the leads to be soldered to a printed, painted or etched circuit board in a most efficient manner.

These and other objects and advantages of the invention will be better understood when considered with the following description taken in connection with the accompanying drawings made a part of this specification, wherein several embodiments are illustrated by way of example. The device of the present invention is by no means limited to the specific embodiments illustrated in the drawings since they are shown merely for purposes of description.

Fig. 1 is a plan view of one embodiment of the voltage divider of the invention;

Fig. 2 is a front elevational view of the voltage divider shown in Fig. 1;

Fig. 3 is a bottom view of the voltage divider;

Fig. 4 is an enlarged sectional view of the potentiometer taken on the line 4—4 shown in Fig. 1;

Fig. 5 is a broken away enlarged sectional view of the voltage divider;

Fig. 6 is a sectional view of a retaining pin taken on the line 6—6 shown in Fig. 4;

Fig. 7 is an enlarged broken away sectional view of a wiper shaft assembly shown in Fig. 4; and

Fig. 8 is a bottom view of the wiper shaft assembly taken on the line 8—8 shown in Fig. 4.

In the drawing in Fig. 1 a voltage divider is shown including a housing **10** having a key projection **12** extending longitudinally of and at a point on the periphery of the housing **10**. The key projection **12** may be employed to guide the housing **10** in an automatic installing operation of the voltage divider on a printed or etched circuit board. The voltage divider also includes a wiper shaft **14** having a slot **15** which is employed to carry a wiper, not shown, in Fig. 1, the wiper being connected to a lead emanating from the bottom surface of the housing **10** and indicated in a dotted circle **16**. Two other leads **18** and **20** also emanate from the bottom surface of the housing **10** and are connected internally of the housing **10** to opposite ends of a winding, which is not shown in Fig. 1.

A colored dot **22** is disposed adjacent the position of lead **16** to identify its position so that when the leads extend in substantially parallel directions from the bottom surface of the housing and, as shown in Fig. 2, the voltage divider may be easily mounted on a printed circuit board.

The housing **10** includes a body portion **24** and a cover **25** including an upwardly extending short hollow cylindrical projection **26**. The projection **26** is employed to house an O-ring, not shown in Figs. 1 and 2, but which is shown in detail in Fig. 4. The projection **26** need not necessarily be employed although it may serve to keep the voltage divider liquid tight in that it cooperates with the O-ring to provide a better liquid tight seal around the shaft **14** and between the shaft **14** and the housing **10**.

Fig. 3 is a bottom view of the housing **10** including the key projection **12**, wiper lead **16**, and winding leads **18** and **20**. A colored spot **28** is also provided on the bottom surface of the housing **10** as shown in Fig. 3 to identify the wiper lead **16**. It may be desirable to identify some other structure internally of the housing **10**. According to the invention either of the spots **22** or **28** may be used for this purpose.

In Fig. 4, it is to be noted that shaft **14** is provided with an outwardly extending radial flange **30** to engage the upper surface of projection **26** and also to overlie an O-ring **32** which is compressed between the flange **30** and the housing cover **25**. The O-ring **32** tends to urge the shaft **14** outwardly of the cover **25**. This force is resisted by a retaining pin **34** that extends through a transverse cylindrical passageway **36** through the shaft **14**. A washer **38** is preferably disposed about the shaft **14** between the housing cover **25** and the pin **34** to facilitate movement of the pin **34** relative to the housing cover **25**.

By the use of this structure the voltage divider may be maintained liquid tight. In addition, the O-ring **32** may serve to resist movement of the shaft **14** so that vibration will not cause the position of a wiper contact indicated at **40** to move over a wiper surface **42** of a resistive winding indicated at **44**.

The function of pin **34** in one instance is simply to provide means to resist the axial force on shaft **14** provided by O-ring **32**. Another function is to provide stop means; this stop means including a downwardly directed projection **46** which may be made integrally with housing cover **25**. As stated previously, the transverse position of pin **34** may be adjusted to either engage or to avoid projection **46** where, by using the same parts, the voltage divider may be constructed to meet two specifications, i. e. to either provide stop means for the shaft **14**, or not to provide a stop means for the shaft **14**.

Body portion **24** of housing **10** is preferably constructed of a plastic and therefore somewhat resilient material. If the upper end of the body portion **24** is provided with a groove as indicated at **48** in Fig. 5, the cover **25** may be snapped into position in the groove **48**. Preferably a space **50** is left between the cover **25** and the body portion **24**, whereby a sealing fluid may be deposited between them to insure a liquid tight seal for the voltage divider.

In Fig. 6 a cross-section of the pin **34** is shown. The pin may have a spiral cross-section and be made of spring steel. The expansion force of the spring will thus maintain the pin **34** in a substantially fixed position in the passageway **36** of shaft **14**. This means that the pin **34** need not be provided with an additional retaining means.

In Fig. 7 a lower portion or axial projection **52** of the shaft **14** is shown in an enlarged sectional view. The projection **52** is preferably tapered as shown providing substantially a groove at a point along the length of the shaft indicated at **53**. An annular body **54** which may be made of a resilient material is then slip fit over the projection **52**. After the body **54** is then slipped in position on the projection **52**, a conductive disc is slip fit over the body **54** to maintain it in radial compression. The disc may serve to support the bifurcated wiper **40** to which it is connected by two spot welds **58** as shown in Fig. 8. Wiper **40** is bifurcated as indicated at a slot **60** which may be two mills in thickness. A leaf spring **62** which is fixed to the opposite side of the disc **56** by means of spot welds **64** has a dual function. In the first place it causes the wiper **40** to positively engage the wiping surface **42** of winding **44**, and in addition it, itself, positively engages a stationary element or wiping contact **66** shown in Fig. 4. The leaf spring **62** is made of a conductive material and therefore directly connects wiper **40** to element **66**. Element **66** is in turn electrically connected to the inner end of wiper lead **16**. The fact that disc **56** maintains body **54** in radial compression makes it impossible for body **56** to slip off of body **54** from the effects of vibration or shock. In addition, leaf spring with wiper **40** tends to keep the disc **56** in a stable mechanical position about the body **54**.

The inner ends of leads **18** are connected to opposite ends of winding **44** which is preferably wound simply

on a dielectric card, the card being disposed in a cylindrical card-shaped form **68** inside the body portion **24** of housing **10**.

It is to be noted that body portion **24** of housing **10** includes a central portion **71** which extends upwardly toward cap **25**. The leads **16**, **18** and **20** are thus molded integrally with this extension. Leads **16** and **18** are preferably provided with irregular cross-section through an intermediate length extending through the extension **71**. These irregular cross-sections are indicated at **70** and **72** respectively. Lead **20** also is provided with a similar irregular cross-section in its intermediate portion in the extension **71**, although this is not shown. By the use of this arrangement the voltage divider may be mounted directly from the leads **16**, **18** and **20**, they serving as structural supports as well as lead in wires.

It will therefore be seen that the manufacture and assembly of the voltage divider shown in Fig. 4 may be made with a minimum amount of time and expenditure of labor, and a minimum number of inexpensive component parts. For example, the housing cover **25** may be easily fabricated from a plastic material. The leads **16**, **18** and **20** may be bought simply as wires in commercial quantity and may subsequently be mashed irregularly on their intermediate portions as at **70** and **72**. Leads **16**, **18** and **20** are then supported in a mold suitable for making the body portion **24** of housing **10** and the plastic material employed in the body portion **24** may then be poured to mold the leads **16**, **18** and **20** therewith. After this is accomplished, stationary element **66** may be bonded to the top of the extension **71** by means of glue or other convenient means. Preferably it is provided with an aperture at **74** through which wiper lead **16** may extend. The wiper lead may then be peened over to make good electrical contact with element **66**. Resistive winding **44** may be easily wound on the flexible card **68** in a conventional manner. The card is then inserted in the body portion **24** and preferably the ends of the winding **44** are spot welded to the inner portions of winding leads **18** and **20**.

At this stage of the manufacture the body portion **24** is immediately ready to be assembled with the cover **25** of the housing. All the remaining elements in the voltage divider are then fixed to the cover **25**. This assembly may be performed in a convenient manner. All the component parts of the cover assembly including the cover **25** may be stamped except shaft **14** which must be turned on a lathe and pin **34** which must be specially made. O-ring **32** and resilient body **54** may be easily bought on the open commercial market. If the configuration of body **54** cannot be purchased, it can obviously be easily fabricated. Wiper **40** is preferably bifurcated by two mill grinding wheel which is often employed in watch making. Wiper **40** and leaf spring **62** are then spot welded to disc **56**. O-ring **32** is then mounted beneath the radial projection of flange **30** of shaft **14** and the shaft **14** is inserted into an aperture **76** in the cover **25** provided therefor. Washer **38** is then placed over the shaft, and pin **34** is pushed through passageway **36**. Body **54** is then press fit over the axial projection **52** of shaft **14** and disc **56** is press fit over the body **54**, wiper **40** and leaf spring **62** having been spot welded in a sub-assembly step. Cap or cover **25** of housing **10** is then snap fit into the groove **48** as illustrated in Fig. 5 and the voltage divider is completely assembled.

Although one specfic embodiment of the invention has been shown and described, it will be obvious to those skilled in the art that other changes and modifications may be made therein without departing from the true scope of the invention as defined in the appended claims.

What is claimed is:

1. In a voltage divider, a cap assembly to support a wiper in a rotatable position, said cap assembly comprising: a housing cover having a cylindrical aperture therein, a rotatable body to project through said aperture, said body having an outer radial flange larger in diameter than said aperture, a resilient O-ring located around said body between said flange and said housing cover on one side of said housing cover, and means for connection with said body on the other side of said housing cover to maintain said body in a fixed axial, but rotatable, angular position through said aperture to compress an O-ring between said flange and said housing cover for expeditious assembly thereof and for providing a fluid tight seal between said body and said housing cover.

2. The invention defined in claim 1, wherein said body is provided with a transverse hole below said housing cover and wherein said means includes a retaining pin to project through said hole.

3. The invention as defined in claim 2, wherein said pin is made of a coiled strip of a resilient material.

4. The invention as defined in claim 3, wherein said pin is made of spring steel, and wherein a washer is located around said body between said housing cover and said pin.

5. The invention as defined in claim 2, wherein stop means are provided on said housing cover to engage said pin when it is set in a first transverse position to limit the rotational movement of said body, and to avoid said pin when it is set in a second transverse position.

6. In a potentiometer, the combination comprising: a housing cover; a wiper shaft having a circumferential groove, said shaft extending through said cover; means to maintain said shaft in a fixed axial, but rotatable angular position; an annular insulator disposed about said shaft in said groove, said insulator being sufficiently resilient to pass over the length of said shaft included between one end of said grooves; and a member having an annular opening through it to fit around said insulator, said opening being sufficiently small in diameter to maintain said insulator in radial compression.

7. A voltage divider comprising: a housing including a cover, a shaft extending through said cover in a fixed axial but rotatable angular position, a stationary element in a fixed position in said housing providing a contacting surface directly below the inner end of said shaft, a winding having a wiping surface disposed concentrically with said shaft, a conductive member insulated from but fixed to said shaft internally of said housing in a plane substantially perpendicular to the axis of said shaft, a leaf spring having one end fixed to said conductive member at a point around and spaced from said shaft and another end spaced from and located directly below the lower end of said shaft in line with the vertical axis of said shaft to be forced into electrical contact with said stationary element at a point directly below the lower end of said shaft, and a wiper having one end fixed to said conductive member at another point around the periphery of said shaft diametrically opposed to said one point and contacting the wiping surface of said winding.

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