Nov. 26, 1968 R. L. FERRELL 3,413,588

SINGLE-TURN ROTARY VARIABLE RESISTOR

Original Filed May 18, 1964

FIG. 1.

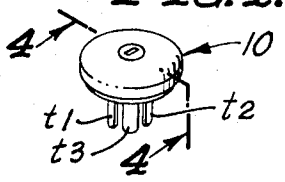


FIG. 2.

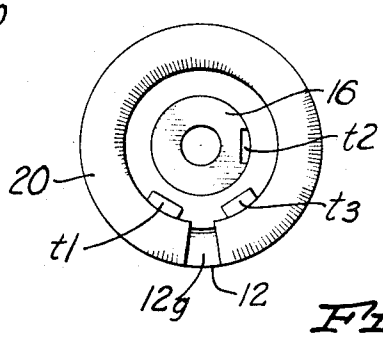


FIG. 3.

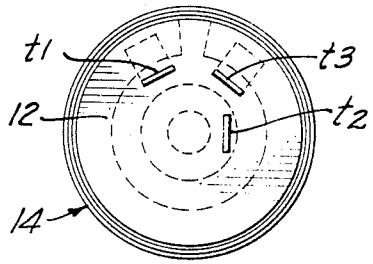


FIG. 4.

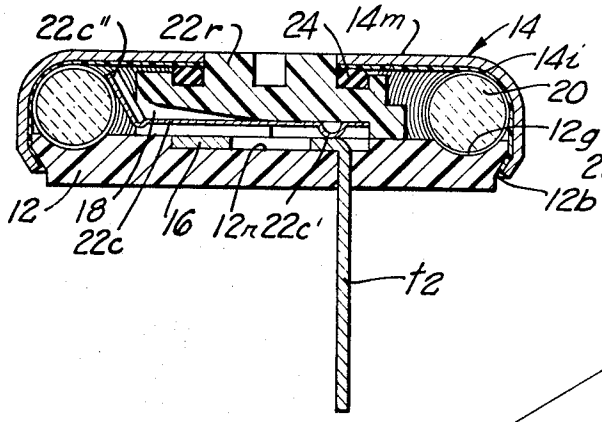


FIG. 7.

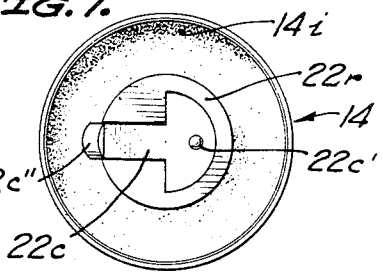


FIG. 5.

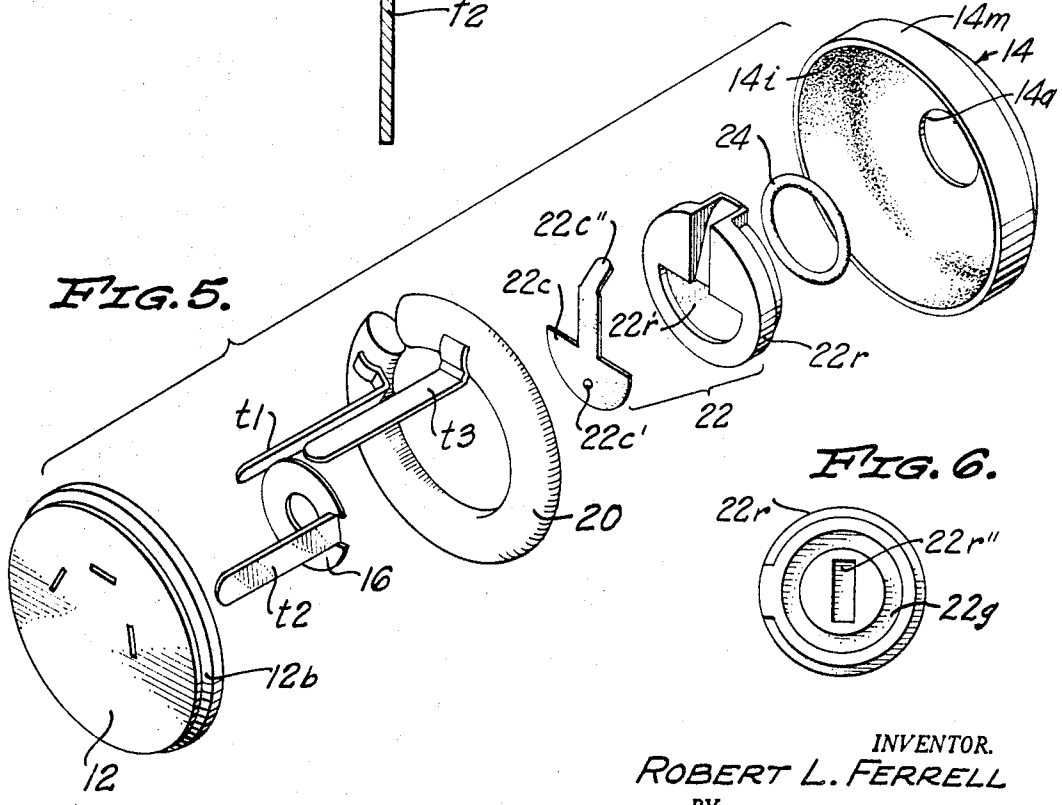


FIG. 6.

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SINGLE-TURN ROTARY VARIABLE RESISTOR

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Continuation of application Ser. No. 368,208, May 18, 1964. This application Oct. 11, 1967, Ser. No. 674,681
9 Claims. (Cl. 338—174)

ABSTRACT OF THE DISCLOSURE

A sealed variable resistor includes a flat insulative base beveled around its periphery. An insulated and centrally-apertured metal cover of shallow cup-like form is peripherally crimped onto the beveled periphery of the base. A rotor has a flat outer lower face bearing on the upper surface of the base and includes a portion rotatable in the cover aperture. An arcuate resistance element is sealed in a groove in upper face of the base and is engaged by a contact seated in a recess on the bottom of the rotor. Terminal means extend through the base. The cover compressively retains the resistance element on the base.

This application is a continuation of application Ser. No. 368,208, filed May 18, 1964, and now abandoned.

The invention herein disclosed pertains to single-turn potentiometers or variable resistors. Single-turn potentiometers or variable resistors of a wide variety of constructions are known and used, a commonly encountered type being such as are used as so-called volume-controls in radio and television receivers. Commonly, such devices, hereinafter called variable resistors for convenience, comprise a housing or case with a bushing, an arcuate resistance element, a rotary carriage or rotor and a wiper or contact carried thereon to brush along the resistance element, a shaft rotatable in the bushing for supporting and rotating the carriage or rotor, terminal connections to the wiper and to respective ends of the resistance element, and insulation as required to insulate the resistance element and the terminal connections. The present invention comprehends improvements whereby the variable resistor may be made of substantially minimum physical dimensions for a commercially practicable unit while concurrently providing a relatively large resistance element compared with prior-art units of much larger dimensions, and providing extremely good heat dissipation whereby despite the small physical size the unit has a high power rating. Further the invention comprehends improvements whereby the variable resistor is simple, comprises but a few and only simple parts, may be easily and automatically assembled, and is sealed against contamination by external agents.

The aforestated meritorious improvements, and others hereinafter made evident, the invention accomplishes or provides in part by forming the case or housing of the variable resistor in the shape or form of a small round button with a base portion of the housing formed of insulative molded material and a metal cap that is crimped or spun around the base and serves to hold operating parts in position while providing an excellent heat path away from the resistance element. Also in part the improvements are attained by forming the resistance element as a nearly-complete segment of a circle, and of generally circular cross-section, whereby a maximum degree of resolution and a maximum length of resistive element can be had with minimum diametral dimension and minimum expense. By making the base and cap of circular plan form an optimum length of resistance element can be disposed therein, with the rotary parts of the resistor substantially completely disposed within the exterior outline of the resistance element, whereby the height of the instrument may be very small so that the general configuration of the

housing is disc-like. By making the base of the case or housing of insulative material, very simple bare terminals may be employed to produce a "pin-mounted" unit; and further, use of an insulative rotor for directly rotating the wiper or contact is permitted without danger of electrical shorting or contact with the resistor circuit by the operating tool which usually is a conductive screwdriver. The aforementioned improvements are in part thus achieved, and are in part achieved by means and methods hereinafter made apparent.

Briefly, then, the variable resistor of the invention is composed of but a few parts, all of inexpensive construction and so shaped and disposed that a very small, sealed, efficient and effective unit is easily and inexpensively assembled. Preferably and as hereinafter described in detail the variable resistor consists essentially of an insulative base with a centrally-apertured generally circular metallic cap secured thereon and holding in place therebetween rotatable operative means including an exposed insulative rotor and a conductive contact device rotatable thereby along an extent of an arcuate resistance element disposed between the cap and the base, and pin-terminal conductors extending from the base and connected to respective ones of the ends of the resistance element and the rotary contact.

From the foregoing it is evident that a principal object of the invention is to provide improvements in single-turn rotary variable resistors.

Another object of the invention is to provide a very small inexpensive, easily-assembled single-turn rotary variable resistor.

An additional object of the invention is to provide a very small, simple, single-turn rotary variable resistor.

Another object of the invention is to provide a very small variable resistor having a high power rating due to having excellent heat-dissipation characteristics.

Other objects of the invention and advantages thereof will hereinafter be set out in the appended claims or made evident in the following description of a preferred exemplary embodiment of the invention, the description referring to the accompanying drawings in which the exemplary embodiment is illustrated in magnified form and to various convenient scales. In the drawings:

FIGURE 1 is a pictorial or isometric view of the preferred exemplary embodiment of the invention, the variable resistor therein being shown enlarged;

FIGURE 2 is a top view of a subassembly of the variable resistor depicted in FIGURE 1, to a larger scale;

FIGURE 3 is a bottom view of the variable resistor depicted in FIGURE 1, to the same scale as FIGURE 2;

FIGURE 4 is a transverse sectional view in elevation of the variable resistor depicted in FIGURE 1, to a much larger scale, the section having been taken as indicated by broken line 4—4 in FIGURE 1;

FIGURE 5 is an exploded view in isometric to a convenient scale, showing details of parts of the variable resistor depicted in FIGURE 1;

FIGURE 6 is a top view of a rotor member comprised in the variable resistor and depicted in opened form in FIGURE 5; and

FIGURE 7 is a view of a subassembly used in the resistor of FIGURE 1.

Referring to the drawings, the variable resistor **10** (FIGURE 1), is depicted as a potentiometer of thin button-like configuration with downwardly projecting terminal lugs or pins *t1*, *t2* and *t3*. As is indicated in FIGURE 4, the resistor comprises a case or housing formed principally by a base **12** and a cover or cap means **14**. Base **12** is formed as a perforated disc of insulative material, and as is indicated in FIGURE 5, the base may be inexpensively formed in finished state by a simple molding pro-

cedure. The base thus is preferably molded of a thermoplastic or heat-setting resin, and is an indicated formed with apertures therethrough of configuration complementary to respective ones of the aforementioned terminals and of dimensions to receive the respective terminals with a press fit. The base **12** is provided with a peripheral bevel **12***b* (FIGURES 4 and 5) against which the cap means **14** is adapted to be spun to hold the resistor parts together.

Base **12** is provided at its top face with a shallow recess **12***r* (FIGURE 4) complementary to and adapted to receive with a snug fit the ring-like flat portion of a conductive collector **16** that serves as an electrical return member of the resistor. Collector **16** is electrically connected to terminal *t*2; and most conveniently that terminal is formed integral with the collector by a striking and punching operation. Thus terminal *t*2 and collector **16** are preferably integral, as shown in FIGURE 5, and may be installed in place on base **12** with a single simple mechanical pressing action. The base also is provided with a shallow circular groove **12***g* (FIGURE 4) on its upper face, the groove being concentric with the outer rim of the base and thus uniformly spaced from the axial center of the disc. The collector **16** is such as to provide a circular contact path that is also disposed about the axial center of the disc.

As is indicated in FIGURES 4 and 5, the cap means **14** of the resistor includes principally a rigid shaped member **14***m*, preferably of ductile metal, of cup-like form. Preferably also the cap means comprises means whereby a portion of the interior surface at least of the member **14***m* is insulated and whereby the interior of the interior chamber of the housing may be sealed against ingress of foreign material. To that end the cap means preferably includes an interior layer or ply of insulative material, **14***i*. The insulative material may be an applied layer of material such as resin adhesively secured to member **14***m*. Thus when the lower peripheral rim of the cap means is swaged or spun onto base **12**, the insulative material **14***i* is slightly compressed and forms a tight seal. The cap means **14** is also provided with a centrally disposed aperture **14***a* (FIGURE 5) for a purpose presently to be made evident.

Disposed in the circular chamber **18** (FIGURE 4) formed by the cap means and the base means when assembled, and preferably also seated in the aforementioned groove **12***g*, is a resistance element **20**. The resistance element is of arcuate, nearly circular, configuration; and preferably is of substantially circular cross-section. It may be formed of resistive composition, or be of the mandrel and applied-film type, or, as shown in preferred form, a wire-wound element formed of an insulated wire mandrel with a winding of resistance wire. As is indicated in FIGURE 5, the inner ends of terminal members *t*1 and *t*3 are electrically connected to electrical ends of the resistance element **20**, as by welding or brazing; the terminals being so attached to the element as to be disposed to be driven directly into respective ones of the apertures formed in base **12**. Thus the resistance element means including the terminal members *t*1 and *t*3 is adapted to be mounted on base **12** to form therewith a subassembly comprising components **12**, **16**–*t*2, and **20**–*t*1–*t*3, as shown in FIGURE 2, or, alternatively, the resistance element with terminals is adapted to be secured to cap means **14** in a fashion suggested by FIGURE 4 and to thereby form part of a subassembly adapted to be applied onto another subassembly consisting essentially of base **12**, collector **16** and terminal *t*2.

Also disposed in the chamber **18** and held in proper operative position therein by the cap means **14** and base **12** is a rotatable means **22** (FIGURE 5) for effecting variation of resistance exhibited between the collector **16** or terminal *t*2 and either of the terminal members *t*1 and *t*3. The rotatable means comprises a rotor **22***r* preferably of molded insulation, and a conductive contact device **22***c*. The two noted components of the rotatable means are formed complementary, each to the other, as is evident from FIGURE 5, so that following assembly of the resistor, rotation of the contact device **22***c* can be effected by rotating the rotor **22***r*. As is indicated in FIGURE 4, contact device **22***c* functions to electrically interconnect collector **16** with a selected portion of resistance element **20**. To that end the contact device is provided with a dimple or tit **22***c*′ struck out from the body of the contact device and disposed to make sliding electrical contact with the upper surface of collector **16**, and the contact device is provided with a resilient arm or limb terminated by a contact **22***c*″ that is positioned to brush along a contact zone along the inner upper surface of the resistance element **20**. For direct positive nonfrictional drive of the contact device **22***c* the rotor **22***r* is provided with a recess **22***r*′ shaped to receive contact device **22***c*, as is made evident in FIGURES 4 and 5; however, other well-known modes of transmitting driving torque from rotor **22***r* to the contact **22***c*″ to brush the latter along the resistance element may in instances be desired and used.

The upper portion of the rotary means **22**, in particular the upper portion of rotor **22***r*, is formed as a cylinder of short length, dimensioned and formed to rotate snugly in the circular aperture **14***a* of the cap means and thus adapted to retain the rotatable means in operating attitude and position in chamber **18**. Further the upper portion of the rotor is provided with a tool-engaging device or depression, such as a screw-driver slot **22***r*″, whereby a driving tool such as a screwdriver may be used to rotate the rotatable means. The contact device **22**, as a part of the rotatable means, is held in operating position with dimple **22***c*′ in conductive contact with collector **16** and with contact **22***c*″ in brushing contact with resistance element **20**, by downwardly exerted pressure provided by cap means **14** and transmitted through a resilient seal **24** which may be of any suitable form but which as illustrated is in the form of a synthetic rubber O-ring. Seal **24** thus serves to hold the lower face of rotor **22***r* against the upper surface of base **12** despite some permissible variation of the vertical dimension or height of chamber **18**, and also serves to seal aperture **14***a* against entry of foreign material. As is evident, radial displacement of the rotatable means (rotor **22***r* and contact device **22***c*) is prevented by snug fit of the upper portion of the rotor in aperture **14***a* of the cap means.

As has now been made evident, the parts or components of the variable resistor of the invention are simple, few in number, and may be easily and inexpensively assembled. A subassembly comprising base **12**, collector **16**, element **20** and the terminals is readily assembled by light application of a self-curing resin adhesive to the terminals *t*1, *t*2 and *t*3 followed by pressing the terminals into the apertures in base **12** until the collector and element are seated in place in respective ones of recess **12***r* and groove **12***g*. A more secure integration of the components of this lower subassembly may obviously be attained by use of adhesive in the recess and groove, care being exercised that no excess of adhesive is used, whereby adverse flow of adhesive onto electrical contact surfaces is avoided. Electrical and mechanical inspection and test of the terminations comprised in the lower subassembly is thus facilitated, prior to final assembly of the resistor, by the open exposure of the components.

An upper subassembly, illustrated in FIGURE 7, comprises cap means **14**, rotor **22***r*, contact device **22***c*, and seal **24**; the components preferably being assembled with seal **24** in groove **22***g* (FIGURE 6) of the rotor **22***r* and with the components upside-down. Final assembly is then readily accomplished by bringing the inverted lower subassembly down onto the inverted upper subassembly, clamping the two subassemblies together, and crimping the cap means to the case as by a spinning operation. If desired, further assurance of effective sealing of the housing may be attained by application of sealant along the

exposed spun-in edge of the cap means at bevel 12*b* of the base.

The preceding detailed description of a preferred exemplary embodiment of the invention makes evident the attainment of the aforementioned objectives. In the light of the disclosure it is evident that changes and modifications within the true spirit and scope of the invention will occur to others, and hence it is not desired to restrict the invention to the exact details of the illustrated embodiment except as may be required by the appended claims.

I claim:

1. A single-turn rotary variable resistor consisting essentially of:

a base of circular plan form having a circular surface at the top thereof and a shallow arcuate groove in said surface adjacent the periphery of the base and a downwardly and inwardly extending bevel around the periphery of the base;

an arcuate resistance element seated in said groove on said surface adjacent the periphery of said base and extending over a major portion of the angular extent of said circular surface;

first and second terminal pins extending through and below said base and electrically connected to respective end portions of said resistance element;

a third terminal pin extending through and below said base and having a portion exposed thereabove;

a generally circular insulative rotor having a portion rotatable on the circular surface on the top of said base and said rotor having a recess in the bottom thereof and further having an upwardly-extending cylindrical portion adapted for positioning and driving said rotor;

a contact means disposed in part in said recess and engaged therein by said rotor for rotation by and with the rotor, said contact means having a conductive contact arranged to brush on said resistance element incident upon rotation of the rotor, and said contact means having a portion brushing said exposed portion of said third terminal pin;

a shallow cup-like ductile metal cover having a central aperture, inverted over said resistance element and said rotor, with the cylindrical portion of the rotor extending into the aperture of the cover to be positioned by the cover, said cover having a peripheral rim crimped inwardly into peripheral gripping relation with the peripheral bevel of said base whereby to secure said cover to said base and to grip said resistance element between said cover and said base; and

insulation means, including a resilient annular seal disposed around said cylindrical portion of said rotor and compressively engaged by said cover and said rotor to seal said aperture and to press the said rotor against the said base, said insulation means further insulating said resistance element from said cover.

2. A single-turn rotary variable resistor consisting essentially of:

a flat base of circular plan form having an arcuate surface at the top thereof adjacent the periphery thereof, and having an inwardly and downwardly extending bevel around the perphery thereof, and having means providing a flat annular bearing surface on the top face thereof;

first and second terminal pins extending through and below said base with upper ends exposed at the top of said base;

an arcuate resistance element seated on said arcuate surface adjacent the periphery of said base and having resistive means presenting an arcuate exposed contact surface between first and second end portions thereof and each of said end portions having fused thereto the exposed upper end of a respective one of said first and second terminal pins;

a cup-like cover of sheet material having a circular rim and a centrally-disposed aperture therethrough, said cover being inverted over said resistance element and having the circular rim thereof crimped inwardly along the said peripheral bevel of said base whereby to compressively press said resistance element against said arcuate surface at the top of said base;

a rotor having an upper cylindrical portion fitting in said circular aperture of said cover and having a flat arcuate lower surface extending along at least a major extent of the periphery of said rotor with said arcuate lower surface in bearing engagement with said flat bearing surface on the top of said base;

resilient means encircling said cylindrical portion of said rotor and disposed between said cover and said rotor and resiliently pressing said rotor toward said base, said resilient means further serving to seal said aperture around said cylindrical portion of said rotor;

terminal means including a third terminal pin extending through and below said base, said terminal means including conductive collector means connected to said third terminal pin and exposed at the top of said base;

a contact device engaging said rotor to be driven by the rotor, said contact device having a portion in electrical contact with said collector and having a contact in brushing engagement with said resistance element and brushed therealong incident to rotation of the rotor;

and insulation means for insulating said resistance element against unintended electrical connection with other conductive means in the resistor.

3. A resistor according to claim **2**, in which said rotor is formed with a substantially centrally located recess in the bottom face thereof, and in which recess said contact is disposed for driving contact with said rotor.

4. A miniature variable resistor comprising:

a flat disc base presenting a substantially flat insulative upper face with a flat annular surface encircling the center of said upper farce, and said base having a downwardly and inwardly extending bevel around the periphery thereof;

an arcuate nearly circular resistive element seated on said inslative upper surface next-adjacent the periphery of said base, said element presenting an exposed arcuate contact zone therealong;

first and second pin terminals extending through and below said base, the upper end of each of said pin terminals contacting and secured to a respective end portion of said resistive element and serving as an electrical terminal therefor;

a circular cover of cup-like fom, having a centrally disposed aperture and a rim, said cover overlying said resistive element and presenting an annular inner insulative surface and having said rim pressed inwardly into gripping engagement with said bevel around the periphery of said base, and said cover serving to press said insulative surface against said resistive element and said resistive element toward said base;

a rotor journaled in said aperture of said cover and having a flat lower arcuate peripheal suface beaing on said flat annular surface of said base;

terminal means including a third pin terminal extending through and below said base, and conductive collector means at the upper end of said third pin terminal; and

contact means including a brushing contact rotatable by said rotor incident to rotation of the latter to brush the contact thereof along said contact zone of

said resistive element, said contact means including means electrically connecting said contact to said collector means, whereby rotation of said rotor varies the electrical resistance exhibited between said third pin terminal and one of said first and second pin terminals.

5. A variable resistor according to claim 4 in which said cover is of ductile metal, and said resistor comprising a resilient coating on the inner surface of said cover between the rim of the cover and the bevel of said base, whereby to seal said cover to said base around the periphery of the latter.

6. A variable resistor according to claim 4, said resistor comprising a resilient O-ring disposed between said rotor and said cover around said aperture, said O-ring serving to seal said aperture and to press the flat lower surface of said rotor against said flat annular surface on said base.

7. A variable resistor according to claim 6 in which said rotor comprises an upper cylindrical portion extending into said aperture of said cover, said rotor having an annular groove in the upper face thereof around said cylindrical portion, said O-ring being seated in said groove.

8. A very small flat circular variable resistor, said resistor consisting essentially of:

a thin substantially flat circular base of electrical insulation presenting a substantially flat upper surface, said base having around the periphery thereof an inwardly and downwardly extending bevel, and having a flat annular area inward of the periphery thereof providing bearing means at the top thereof;

cover means, including a shallow circular cup-like ductile cover having an interior insulative surface and a centrally disposed aperture and having a rim portion pressed inwardly into engagement with said bevel around the periphery of said base;

an arcuate resistance element seated on said base adjacent the periphery of said base and compressively engaged by and between said cover means and said base, said resistance element having first and second end portions;

a rotor of insulation, said rotor having a cylindrical portion at the top thereof fitting in the said aperture in said cover, and having a peripheral arcuate flat lower face in bearing engagement at the bottom thereof with the said bearing means at the top of said base;

first and second pin terminals extending through and below said base, each having electrical connection with a respective one of the end portions of said resistance element; and

electrical means including a third terminal pin and a rotary contact device engaged and rotatable by said rotor, said third terminal pin extending through said base and having electrical connection to said rotary contact device, said contact device including a contact disposed to brush on said resistance element incident to rotation of said rotor,

whereby said variable resistor is of minimum height and is characterized by excellent heat-dissipation characteristics.

9. A variable resistor according to claim 8, in which there is included an O-ring seal encircling said cylindrical portion of said rotor, said O-ring seal being compressed between said cover means and said rotor and effective to seal said resistor at said aperture and to force said flat lower bearing surface of said rotor against said annular bearing area of said base.

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