Dec. 15, 1959 W. L. KELVER ET AL 2,917,721

HERMETICALLY SEALED VARIABLE RESISTOR

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Fig. 1.

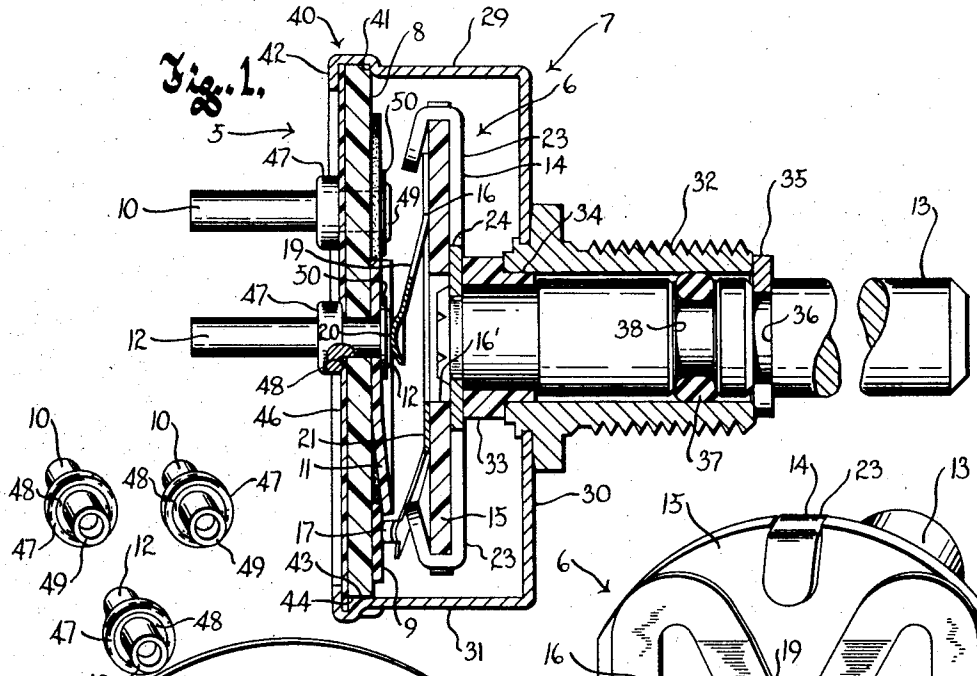
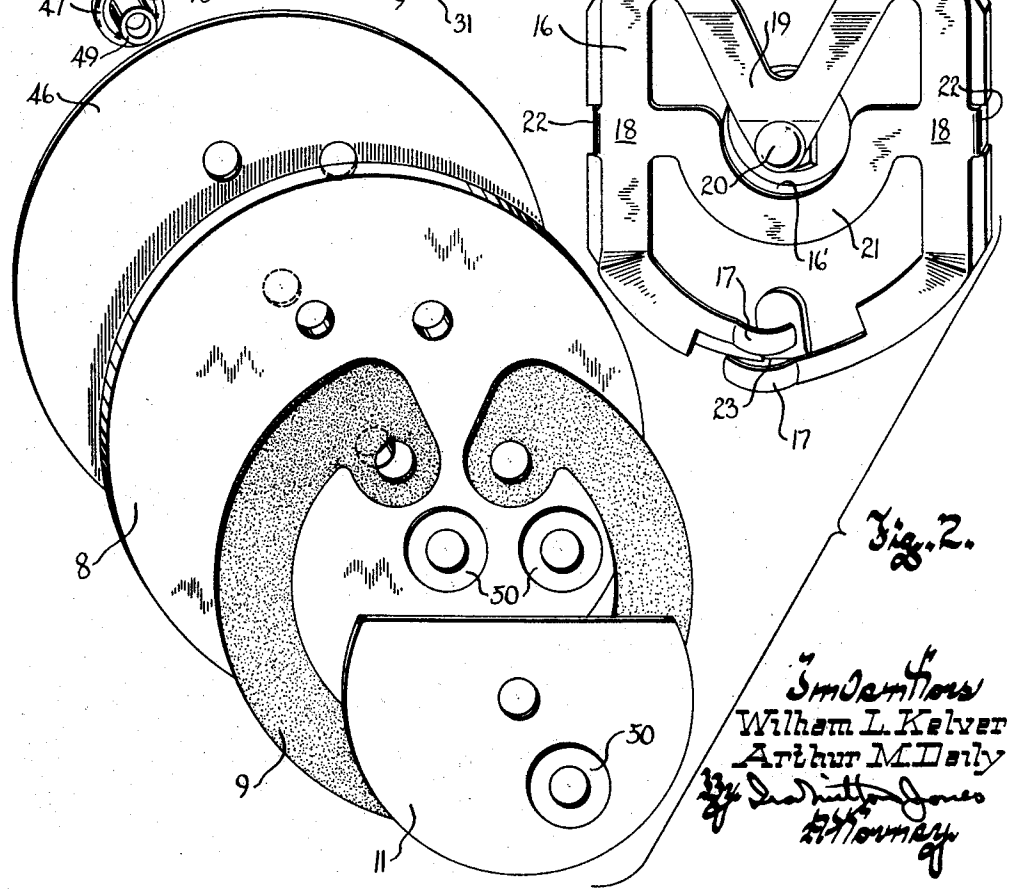


Fig. 2.



Inventors
William L. Kelver
Arthur M. Daily
By Smith, James & Mowrey
Attorneys

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Fig. 3.

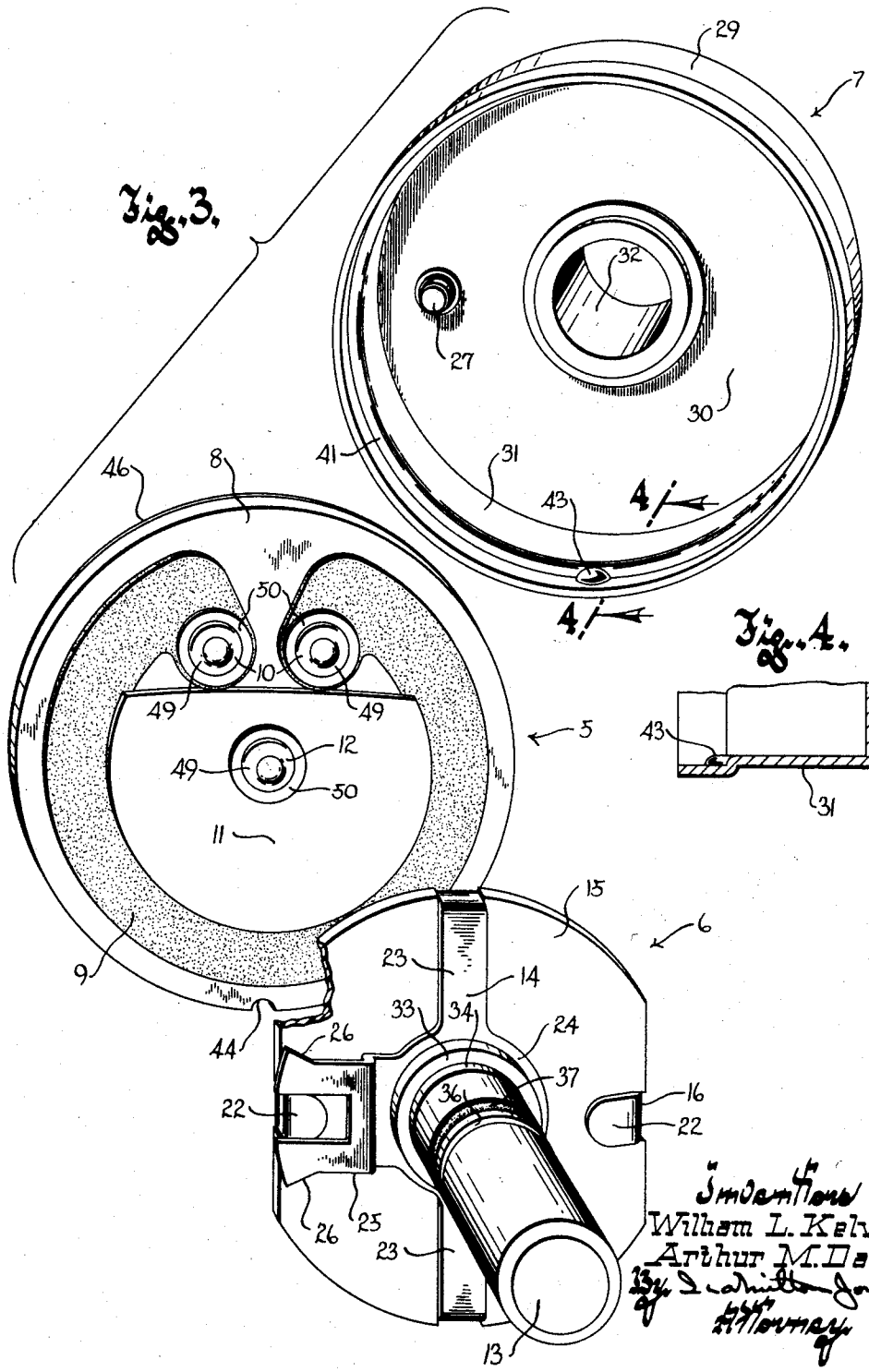


Fig. 4.

Inventors
William L. Kelver
Arthur M. Daily
By Smith-Jones
Attorney

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HERMETICALLY SEALED VARIABLE RESISTOR

William L. Kelver, Cassopolis, and Arthur M. Daily, Edwardsburg, Mich., assignors to Chicago Telephone Supply Corporation, Elkhart, Ind., a corporation of Indiana

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3 Claims. (Cl. 338—164)

This invention relates to variable resistors of the type widely used in radio and television receivers and other equipment having electric circuits to be controlled, and has as its purpose to provide a hermetically sealed variable resistor.

In variable resistors of this type, the resistance path ordinarily is of the carbonaceous variety and, hence, is deleteriously affected by fumes such as those emanating from certain varnishes and lacquers. It follows, therefore, that for a variable resistor to maintain its rated performance in such an environment, its instrumentalities must be protected from contact with the objectionable fumes or gases. This can, of course, be done by providing the variable resistor with a hermetically sealed housing, but this alone will not assure the desired results.

Enclosing the instrumentalities of the resistor in a hermetically sealed housing will protect them from contact with fumes in the surrounding atmosphere, but it will not guard against the consequences of fumes created within the enclosure itself. The lubricant employed in conventional variable resistors to lubricate the rubbing or sliding engagement between the contactor and its terminal gives off fumes when heated, and if those fumes are confined they can be as deleterious as those in the surrounding atmosphere; and in variable resistors of this type heretofore available, lubrication has always been necessary between the spring fingers or paddles on the contactor and the collector ring upon which they ride.

It is, therefore, an object of this invention to provide a variable resistor which is not only hermetically sealed against the bad effects of fumes and gases in the surrounding atmosphere, but which is so designed and constructed as to obviate all need for lubrication, so as to preclude the possibility of fumes being generated within the enclosure itself.

It is also the purpose of this invention to achieve this general objective in a way which does not objectionably increase the cost of the control, nor complicate its design and construction.

With the above and other objects in view, which will appear as the description proceeds, this invention resides in the novel construction, combination and arrangement of parts substantially as hereinafter described and more particularly defined by the appended claims, it being understood that such changes in the precise embodiment of the hereindisclosed invention may be made as come within scope of the claims.

The accompanying drawings illustrate one complete example of the physical embodiment of the invention constructed according to the best mode so far devised for the practical application of the principles thereof, and in which:

Figure 1 is a longitudinal sectional view through a variable resistor embodying this invention;

Figure 2 is an exploded perspective view of the essential instrumentalities of the resistor;

Figure 3 is a perspective view of the stator and rotor of the variable resistor shown separated from one another but in their proper order of assembly, and the cover portion of the enclosing housing; and

Figure 4 is a fragmentary cross sectional detail view taken through Figure 3 on the plane of the line 4—4.

Referring now more particularly to the accompanying drawings, it will be seen that the variable resistor of this invention, as is customary, has a stator indicated generally by the numeral **5** and a rotor indicated generally by the numeral **6**, and that these instrumentalities of the resistor are enclosed within a housing generally designated by the numeral **7**, with the rotor in front of the stator. The stator **5** comprises a circular disc of insulating material **8** which provides the base for the resistor and the rear wall of the housing, and has an arcuate resistance path **9** on its front or inner surface concentric to the axis of the rotor.

The resistance path may be produced in any suitable manner, and in the specific embodiment of the invention illustrated, it is provided by a conventional carbonaceous element separate and distinct from the base but held thereon by a pair of terminals **10** and a hold-down washer **11** which is drawn tight against the base by a third terminal **12**.

The rotor **6** consists of a control shaft **13**, a stop plate **14** fixed to the rear or inner end of the shaft, a drive arm **15** of insulating material attached to the stop plate, and a contactor **16** mounted on the drive arm and provided with rearwardly biased spring fingers or paddles **17** which bear against and traverse the resistance path as the rotor is turned.

In the embodiment of the invention illustrated, the rotor is made up of the several different separate elements enumerated, but as will be readily apparent, the shaft, the stop plate and the drive arm could all be one integral unit molded of suitable insulating material, such as Bakelite and, in any event, the stop plate and drive arm could be one unit provided, of course, that they were formed of insulating material, or at least that the contactor were suitably insulated from the shaft.

The contactor **16** is stamped of thin resilient sheet metal, and its spring fingers or paddles **17** which bear against the resistance element have their extremities spaced the maximum distance radially out from the axis of rotation, being formed as curved extensions of one end of a pair of side portions **18**. In addition to these spring fingers, the contactor has another rearwardly biased spring finger **19** which terminates in a smooth surfaced rearwardly facing contact button **20**. This spring finger **19** comprises a pair of arms extending radially inwardly from the opposite ends of the side portions **18** to converge and meet at the center of the rotor so that the contact button **20** is directly on the axis of rotation.

The side portions **18** and a bridging strip **21** which connects them, lie flat against the back of the drive arm and are secured thereto by tangs **22**. The junctions of the bridging strip **21** with the side portions **18** and the tangs **22** are at diametrically opposite sides of the contactor, but the medial portion of the bridging strip is substantially U-shaped to provide the metal for the spring finger **19** and also to assure adequate electrical clearance between the contactor and the adjacent rear end of the shaft **13** which is peened over the face of the stop plate and is accommodated by a hole **16'** in the center of the drive arm.

The stop plate **14**, like the contactor, is stamped from sheet metal but of considerably heavier gage metal. It consists, simply, of two diametrically opposite arms **23** radiating from a hub portion **24** and clinched over diametrically opposite notched edge portions of the drive arm which are equispaced from the tangs **22** by which the contactor is fixed to the drive arm. The stop plate also has a third arm **25** radiating from its hub with the

outer end portion thereof offset forwardly of the drive arm to provide stop shoulders **26** which coact with a fixed stop **27** to define the limits of rotation of the rotor, the fixed stop being carried by the adjacent front wall of the housing **7**.

The housing **7** comprises a cup-shaped metal stamping **29** having a flat bottom or end wall **30** and a cylindrical side wall **31**. The bottom or end wall **30** constitutes the front end wall of the housing and, hence, has the stationary stop **27** fixed thereto. A bored thimble or bushing **32** fixed to the center of the wall **30** projects forwardly therefrom, to provide means by which the variable resistor may be mounted upon a supporting panel in the customary manner. The bore of the thimble has the control shaft **13** freely rotatably received therein with its outer end portion projecting beyond the thimble to have an operating knob (not shown) fixed thereto.

The forward end thrust imposed upon the rotor by the spring contactor fingers **17** and **19**, is carried by a combination thrust washer and bushing **33** of Teflon, or other suitable material, encircling the inner end of the shaft and interposed between the front face of the stop plate and the adjacent end of the thimble **32**.

Rearward displacement of the rotor is limited by a conventional C-washer **35** seated in a groove **36** in the shaft to bear against the front end of the thimble whenever a rearward end thrust is imparted to the shaft sufficient to overcome the tension in the spring fingers **17** and **19**. The C-washer thus guards against the imposition of objectionable pressure upon the contactor and the resistance element.

The connection between the thimble **32** and the wall **30** of the housing upon which it is mounted, may be made in any suitable manner, but it must be gas tight. By the same token, the mounting of the stationary stop **27** upon the wall **30** must not leave any opening through the wall.

To obviate the need for lubricants between the shaft and the bore of the thimble, which if present might constitute a source of harmful fumes within the enclosure itself, the diameter of the shaft is sufficiently smaller than the bore of the thimble as to assure a definite clearance therebetween. This clearance is maintained by supporting the shaft at its rear or inner end in a side thrust bearing provided by a forward projection **34** on the Teflon washer or bushing **33**, which enters the rear end of the thimble bore, and an O-ring **37** seated in an annular groove **38** in the portion of the shaft located in the fore part of the thimble bore. This construction not only assures the needed freely rotatable mounting for the rotor without recourse to lubricants, but in addition prevents leakage of fumes and gases into the housing through the clearance between the shaft and the thimble bore since the O-ring **37** effectively seals this clearance.

The rear wall of the housing, as already indicated, is provided by the base **8** which is joined to the cylindrical side wall **29** by a gas tight connection, indicated generally by the numeral **40**. This connection comprises a ledge or shoulder **41** on the side wall produced by an abrupt increase in its diameter, upon which the base is seated and against which it is clamped by rolling over the edge of the side wall, as at **42**. Correct rotational disposition of the base with respect to the permitted rotation of the rotor, results from the engagement of an indentation **43** in the side wall with a notch **44** in the edge of the base.

Although the clamping of the marginal edge portion of the base against the shoulder **41** provides a fairly tight junction between the base and the side wall **29**, this alone is not sufficient to assure against gas leakage at this point—especially since the coefficients of expansion and contraction of the material of which the base and side wall are formed are quite different. To provide the desired security against leakage at this point, a sealing disc **46** overlies the outer face of the base and has its marginal edge portion clamped between the inturned edge **42** of the side wall and the base. This sealing disc is formed of a high temperature polyester such as Mylar or Teflon (polytetrafluoroethelene, fluorocarbons or silicones) so that it possesses a high degree of elasticity and will maintain the desired seal, despite high temperatures and relatively great expansion and contraction of the parts forming the junction.

The terminals **10** and **12**, of course, also pass through appropriate holes in the sealing disc, as well as through holes in the base, but these holes are tightly sealed. To this end, each of the terminals has a flange **47** thereon medially of its ends to overlie the sealing disc, and these flanges are undercut, as at **48**, to provide rim portions which bite into the sealing disc when the terminals are secured in place. Such securement is effected by rolling over or swedging the inner end portions **49** of the posts, which are preferably tubular, washers **50** being interposed between the surfaces of the resistance element and the rolled over inner ends of the terminals **10**, and between the hold-down washer **11** and the inner rolled over end of the terminal **12**.

From the description thus far, it will be readily apparent that the housing in which the instrumentalities of the variable resistor are enclosed, is tightly and hermetically sealed so that harmful fumes and gases present in the surrounding atmosphere are positively precluded from entering the housing and adversely affecting the stability and performance of the resistor.

The one other source of difficulty, namely, lubricant inside the housing being heated to the point where it gives off fumes is eliminated, as in the case of the shaft bearing, by wholly obviating the need for any such lubricant within the housing. To this end, the smooth-surfaced button **20** on the spring finger **19** of the contactor, bears against and makes contact with its terminal **12** directly on or at least as close as possible to the axis of rotation of the rotor. In the specific embodiment of the invention shown and described, this contact between the button **20** and the rolled-over end **49** of the terminal **12**, is the small diameter circular line of tangency between the spheroidal surface of the button and the rounded inner edge of the rolled-over end of the terminal. The specific shape of these contacting surfaces, however, is not critical; the important thing being that the contact is confined to a very small area as close as possible to the axis of rotation. It should closely approach, but not reach, the theoretically ideal single point contact of a cone having its apex bearing against a flat surface; so that the rubbing engagement between the parts is confined to so small an area that lubrication is unnecessary.

From the foregoing description, taken in connection with the accompanying drawings, it will be readily apparent to those skilled in this art that this invention provides a variable resistor which, though of very simple, inexpensive design and construction, is fully capable of entirely reliable performance in atmospheres which contain fumes and gases such as those emanating from certain solvents of varnishes and lacquers and which are highly injurious to the resistance elements commonly used in variable resistors.

What is claimed as our invention is:

1. A hermetically sealed variable resistor having a stator which includes an arcuate resistance path and a rotor having a shaft and a contactor carried by the shaft to traverse the resistance path as the shaft is turned, said resistor comprising: a cylindrical cup-shaped metal housing having a hole in the center of its bottom wall; an annular ledge in the side wall of the housing axially spaced from the bottom wall thereof, said ledge being provided by an abrupt increase in the internal diameter of the housing side wall; a solid disc of insulating material having its marginal edge portion seated on said ledge, said disc providing the base of the resistor and carrying the resistance path; a sealing disc overlying the exterior of said solid disc, said sealing disc being of material impervious to gaseous fumes and possessing good elas-

ticity throughout a wide temperature range; a shoulder on the side wall of the cup-shaped housing overlying the marginal portion of said sealing disc and tightly clamping it and the marginal portion of the solid disc between the shoulder and the ledge to provide a gas-tight connection; a bored thimble fixed in the hole in the bottom wall of the cup-shaped housing, the shaft of the rotor passing loosely through the bore of said thimble, the bore being larger than the shaft portion received therein; an axially short bearing bushing of material which requires no lubrication, seated in the thimble bore and having the shaft journalled therein, said bushing projecting into the interior of the cup-shaped housing and abutting a portion of the rotor to support the same against end thrust in one direction, so that said bushing provides both an end thrust and a side thrust bearing for the rotor; and an O-ring confined between the shaft and the wall of the bore in the thimble outwardly of said bushing, said O-ring coacting with the bushing to freely rotatably support the shaft and by providing a free-running gas-tight seal between the shaft and the thimble, coacting with the sealing disc to hermetically seal the housing.

2. In a hermetically sealed variable resistor having co-

operating stator and rotor elements contained within a housing which has an end wall with a shaft hole therein; a bore thimble fixed in said hole and through which the shaft of the rotor enters the housing, the bore of the thimble being larger in diameter than the portion of the shaft received therein; an axially short bearing bushing of material which requires no lubrication seated in the inner end of the thimble and having the shaft journalled therein; and a free-running gas-tight seal between the shaft and the wall of the bore axially outwardly of said bushing and coacting with the bushing to freely rotatably support the shaft.

3. The variable resistor of claim 2 wherein said free running gas-tight seal is an O-ring confined between the shaft and the wall of the bore in the thimble.

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