

Dec. 9, 1958

D. M. BARTON
POTENTIOMETER

2,863,972

Filed Oct. 4, 1954

2 Sheets-Sheet 1

FIG. 1.

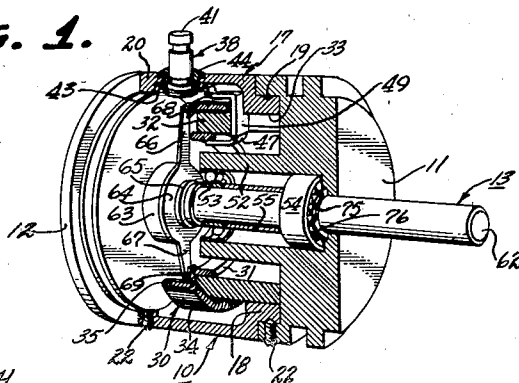


FIG. 2.

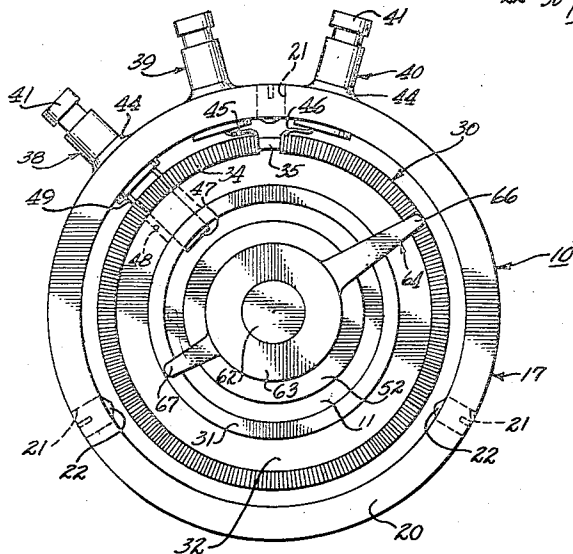


FIG. 4.

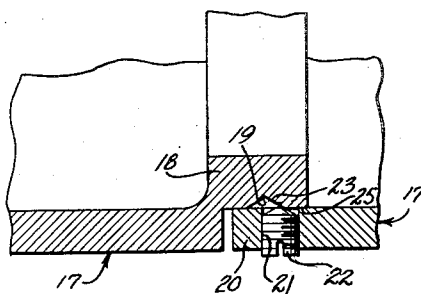
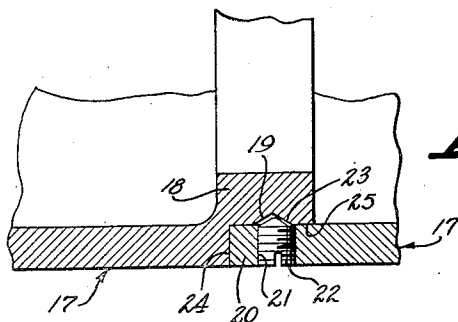


FIG. 5.



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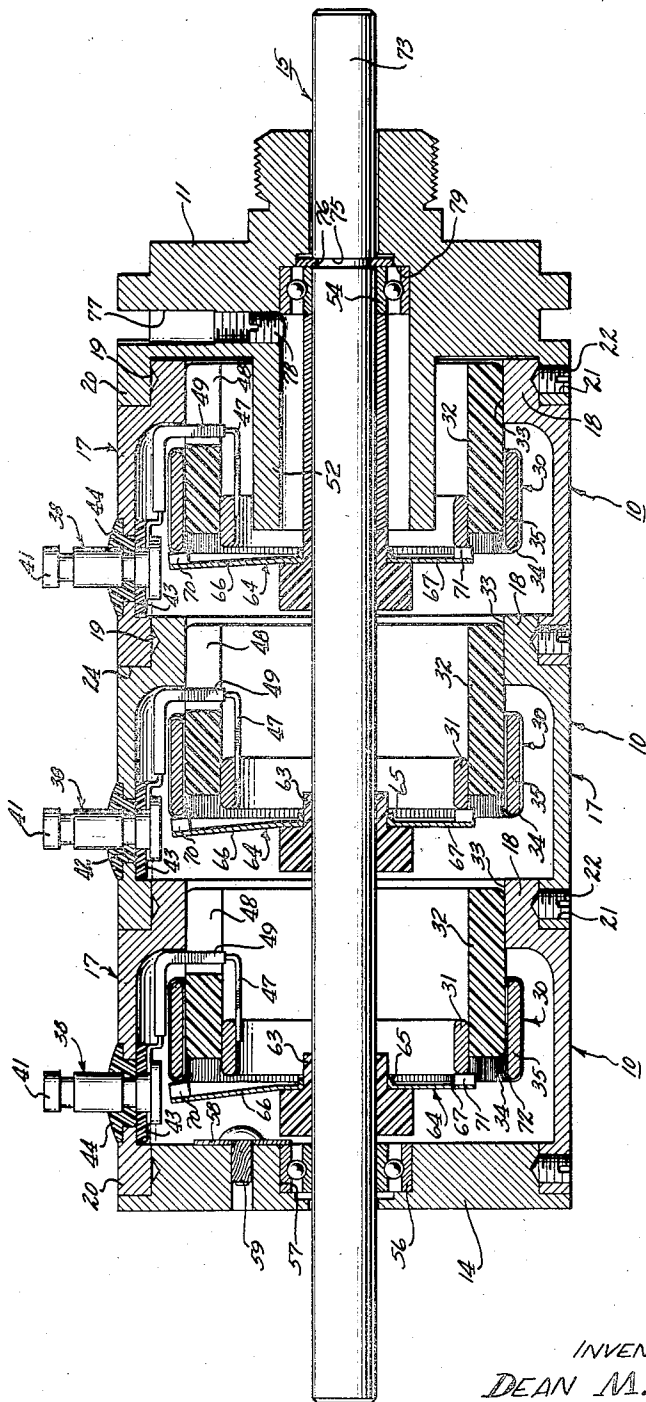
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FIG. 3.



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POTENTIOMETER

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14 Claims. (Cl. 201—48)

This invention relates to variable resistance devices such as potentiometers and, more particularly, relates to a rotary type variable resistance device or potentiometer that is especially suited to use in multiple or ganged units. Accordingly it is an object of the invention to provide a case unit which may be assembled with a number of similar case units into a composite case assembly that is rigid in construction and accurately aligned and yet has the individual case units rotatably adjustable with respect to one another.

Another object of the invention is to provide such a case unit which is adapted to support a resistance element and a rotating shaft.

A further object of the invention is to provide such a case assembly in which cone-pointed set screws are mounted in one case unit and are tightened against one side of V-shaped grooves in an adjacent case unit in order to draw the mating case units together.

A still further object of the invention is to provide end caps and anti-friction bearings for such case units which are held in position by similar cone-pointed set screws.

An important object of the invention is to provide a rotor for slidably contacting a resistance element and a contact ring which may be mounted in conjunction with a number of similar rotors on the shaft of a variable resistance device and which is adapted to be rotatably adjusted on the shaft with respect to the other rotors.

Another object of the invention is to provide such a rotor which may consist of a single piece of resilient electrical conducting material.

A further object of the invention is to provide an intermediate housing assembly including a resistance element and insulated mounting means which assembly is easily handled for the purposes of applying taps, shorting sections, testing and the like, and which may be inserted into a case as a unit.

Yet another object of the invention is to provide apparatus which is equally suitable for use in single resistance element potentiometers and multiple resistance element potentiometers.

Another object of the invention is to provide a variable resistance device which is inexpensive to manufacture, easy to assemble and adjust and rugged, and one that can be made very small. For example, certain embodiments of the invention can be made having their maximum outside dimensions less than one inch.

The invention also comprises novel details of construction and novel combinations and arrangements of parts, which will more fully appear in the course of the following description. However, the drawings merely show and the description merely describes preferred embodiments of the present invention as applied to rotary variable resistance devices, which are given by way of illustration or example only.

In the drawings:

Fig. 1 is an isometric view, shown partly in section, of one embodiment of the invention;

Fig. 2 is an elevation of the embodiment of Fig. 1, viewed from the end opposite the shaft extension and with the end cap removed;

Fig. 3 is a longitudinal sectional view of another embodiment of the invention;

Fig. 4 is an enlarged view of a portion of Fig. 3 with the set screw loosened; and

Fig. 5 is a similar view with the set screw tightened.

Fig. 1 shows a rotary variable resistance device or potentiometer having a single resistance element and consisting of a casing assembly 10, a front end cap 11, a back end cap 12, and a shaft and rotor assembly 13.

Fig. 3 shows a potentiometer having three resistance elements and consisting of three casing assemblies 10, a front end cap 11, a back end cap 14, and a shaft and rotor assembly 15. Potentiometers may be assembled using the teachings of the invention to have any desired number of resistance elements by coupling together the desired number of casing assemblies 10.

The casing assembly includes a hollow shell or casing 17 which may be cylindrical in cross section. A shoulder 18 is provided at one end of the shell 17 and in the embodiment illustrated the shoulder is square in cross section, this shape providing for the most accurate alignment. The shoulder 18 contains a groove 19 which is transverse to the rotational axis of the potentiometer and, in the preferred practice of the invention, the groove 19 is V-shaped and extends around the entire circumference of the cylindrical shell.

A rim 20 is provided at the end of the shell opposite the shoulder 18. The rim 20 is designed to slide over the shoulder of an adjacent shell and in order to obtain the best performance of the invention it should be dimensioned to provide a tight sliding fit. The rim contains a plurality of radial threaded openings 21 and in the embodiment shown in Fig. 2, three openings equally spaced around the circumference of the rim are used. A screw 22 is inserted into each of the threaded openings 21. The end of each set screw 22 is shaped to mate with a sidewall 23 of the groove 19, and when the preferred V-shaped groove is utilized, the ends of the set screws will be conical.

When two casing assemblies are to be joined, the rim of one is slid over the shoulder of the other into the position shown in Fig. 4. Then the screws 22 are tightened, bringing the shaped ends of the screws into contact with the groove sidewall 23. Further tightening of the screws produces a component of force acting parallel to the longitudinal axis of the potentiometer which urges the two shells into rigid contact along a surface 24 (Fig. 5). This condition may be achieved by making the distance from the surface 24 to the center line of the V-shaped groove less than the distance from the surface 24 to the center line of the opening 21. The relation of these dimensions may be seen in Fig. 5 wherein a shoulder 18 and a rim 20 are shown rigidly coupled together by a screw 22 having its shaped end mating with and exerting a force against the surface 23.

This arrangement has a number of advantages. In previous designs for ganged potentiometers it was the practice to connect adjacent elements by screws which passed through clearance holes in one element into threaded holes in the adjacent element. Then the alignment of the elements was dependent on the accuracy of the location of the various holes. In the present invention the alignment of the shells is controlled by the surfaces 24 and by surface 25 on the shoulders 18. It is much easier and more economical to maintain the desired accuracy when forming the shoulders and rims

than it was when aligning and drilling the holes required by the other methods.

Another important advantage of the present invention lies in the fact that the shells may be rotated relative to one another without requiring removal of the screws 22. When two or more resistance elements are assembled in a potentiometer it is often necessary that certain angular relationships be maintained between them. One way of meeting this requirement is to mount each resistance element in an individual casing which is angularly positionable with respect to the other casings. In the present invention adjustment is made very simply by a slight loosening of the screws 22. There the shells may be rotated to any desired angular position after which the screws are tightened, again forming a rigid composite casing for the ganged resistance elements.

The resistance element is contained in the shell or casing 17 and in the embodiments illustrated is a part of an intermediate housing assembly including a curved resistor 30 and an electrically conducting contact ring 31, both frictionally retained on an electrically insulating mounting ring 32 fitting in a cavity bounded by a cylindrical surface 33. It is preferred to make this mounting a press fit so that the intermediate housing assembly may be removed and replaced. The curved resistor 30 may consist of a length of insulated resistance wire 34 wound on a core 35. The resistance wire may be wound on a curved core or it may be wound on a straight core which is then formed to the desired curvature. The curved resistor 30 is pressed over an outside mounting surface of the mounting ring 32 and the contact ring 31 is pressed into the mounting ring to engage an inner mounting surface. The contact ring 31 could have a larger diameter than the curved resistor 30 and therefore be mounted to the outer surface of the mounting ring 32. However, it is usually desired to obtain the maximum length of resistance wire and hence the arrangement illustrated is ordinarily utilized.

The assembly consisting of the curved resistor 30 and the insulating ring 32 provides a unit that is easily handled and stored. It is during this stage of the manufacturing process that any required tap leads are applied to the resistance wire intermediate the ends thereof, that sections of the resistance wire are shorted out when necessary, and that the various tests on resistance tolerances and linearity are performed. By this method a manufacturer is enabled to produce potentiometers having various special characteristics from standardized subassemblies, thereby avoiding maintenance of a large stock of various types of instruments and also avoiding the usual long period of time involved when special items have to be made from the beginning.

The potentiometers of Figs. 1-3 have three terminals 38, 39, 40 for the interconnection of each resistance element with an external electric circuit. A potentiometer may have more or fewer terminals depending upon the particular application of the instrument. Each terminal may consist of an electrically conducting stud 41 extending through an opening 42 in the shell 17. The stud 41 is separated from the shell by an insulating washer 43 and may be held in place by a suitable cement 44. Ends 45, 46 of the resistance wire 34 are connected, as by soldering or spot welding, to the bases of the studs 39, 40.

The contact ring 31 is connected to the terminal 38 by a conductor 47 which may be a length of wire but which is preferably a flat strip of conducting metal which may be formed into the desired shape and which will rigidly maintain this shape during any vibration and shock to which the instrument may be subjected. In its preferred form one end of the conductor is clamped between the base of the stud 41 and the washer 43 and the other end is welded or soldered to the inner surface of the contact ring 31. A slot 48 is provided in the

insulating ring for the passage of the conductor 47 and serves also to facilitate the friction fit with the cylindrical surface 33. A sleeve of insulating material 49 may be placed over the conductor to prevent undesired electrical contacts with other components.

Each potentiometer is normally provided with two end caps which support the shaft and rotor assembly and supply means for mounting the potentiometer to other equipment. These end caps 11, 12, 14 have shoulders and rims mating with the shoulder 18 or the rim 20 of the shell 17, as required, and they are mounted to a single casing assembly or a composite casing assembly in the same manner that adjacent shells are connected.

In the embodiment of Fig. 1, the front end cap 11 has a hollow boss 52 which extends into the space surrounded by the curved resistor 30 and the contact ring 31. The shaft and rotor assembly 13 is rotatably supported within this boss by two anti-friction bearings 53, 54 which are separated by a spacer 55. This type of construction whereby the waste space within the curved resistor is utilized to provide a bearing surface results in a smaller axial dimension and a reduction in over-all size of the potentiometer.

When a plurality of casing assemblies 10 are mounted end-to-end it sometimes becomes necessary to support the shaft and rotor assembly near each end thereof. Such an arrangement is shown in Fig. 3, where the shaft and rotor assembly 15 is rotatably mounted in anti-friction bearings 54, 56. The bearing 56 is inserted into an opening 57 in the end cap 14 and is held in place by a washer 58 and a drive screw 59. The mounting of the bearing 54 will be explained in detail subsequently.

The shaft and rotor assembly 13 of Fig. 1 includes a shaft 62 which is positioned within the bearings 53, 54. A sleeve 63 of electrically insulating material is pressed over the inner end of the shaft 62. A rotor 64 is mounted on the sleeve 63 and is adapted to form an electrical circuit between the curved resistor 30 and the contact ring 31, the rotor being angularly adjustable on the shaft because of the friction fit between the sleeve 63 and the shaft. In its preferred form the rotor is made from a single piece of resilient electrically conducting material, such as beryllium copper or the like. The rotor 64 consists of a central portion with an opening and a flange 65 around the opening, and long and short opposed arm portions 66, 67. The tip portions of the arms 66, 67 may be bent to form a smooth contact surface as seen at points 68, 69 of Fig. 1, or blocks of suitable contact material 70, 71 (Fig. 3) may be soldered to the tip portions. The insulation is removed from the resistance wire 34 around the edge 72 of the curved resistor 30 thus enabling the rotor to make electrical contact with the resistance wire.

The rotor and shaft assembly 15 of Fig. 3 includes a longer shaft 73 positioned between the bearings 54, 56. Three of the sleeves 63, each carrying a rotor 64, are pressed on the shaft 73 in positions corresponding to the uninsulated edges of the three curved resistors.

The tips of the rotor arms are maintained in contact with the respective curved resistor and contact rings by positioning the shaft 62, 73 so that the arms 66, 67 of the rotors are continuously stressed in bending. The means for accomplishing the positioning of the shaft applies equally well to both shafts 62 and 73, and will be described in relation to shaft 73 of Fig. 3. The shaft 73 has a groove 75 in which a U-shaped spring washer or snap ring 76 is placed. The bearing 54 is positioned against the snap ring 76. A radial hole 77 in the end cap 11 opens into the interior of the hollow boss 52 and is threaded at its inner end. A set screw 78 having a tapered or conical shaped end and which may be identical to the screw 22, is inserted into the threaded opening and the shaped end of the screw is allowed to extend into the interior of the hollow boss and bear against the outer race of the bearing 54. The force exerted by the screw

78 locks the bearing 54 against the surface 79 of the cap 11. The forces exerted by the stressed arms 66, 67 of the rotors 64 press the snap ring against the bearing 54, thereby fixedly positioning the shaft and rotor assembly axially with respect to the casing assembly.

It is not necessary in the practice of the invention that the rotor 64 have opposed arms. For example it would be possible to position two arms side-by-side or even to place the contact ring and the curved resistor so they could be contacted by the same arm. However, the use of opposed arms which are substantially equally stressed provides a better balance of forces, reduces the torque requirements and allows smoother sliding contacts.

The flange 65 of the rotor 64 exerts an axial force on the sleeve 63 thereby reinforcing the grip of the sleeve on the shaft. This type of rotor also provides another manner of controlling the angular relation between resistance elements in a ganged potentiometer. Since the rotors are not fixedly mounted to the shaft but are maintained in place by the combination of a press fit and the spring pressure of the flange 65, the rotors may be rotated relative to the shaft and to each other to obtain any desired angular position. The flange pressures are such that the rotors will not move relative to the shaft during normal operation of the potentiometer.

Although several exemplary embodiments of the invention have been disclosed and discussed, it will be understood that other applications of the invention are possible and that the embodiments disclosed may be subjected to various changes, modifications and substitutions without necessarily departing from the spirit of the invention.

I claim as my invention:

1. In a rotary variable resistance device, the combination of: a casing; insulating means having two concentric mounting surfaces, said insulating means being removably positioned within said casing and having each of said mounting surfaces concentric with the longitudinal axis of said casing; a curved resistor mounted on one of said mounting surfaces; and a contact ring of electrically conducting material mounted on the second of said concentric mounting surfaces.

2. A resistance device as defined in claim 14 in which said rotor means is rotatably adjustable with respect to said shaft means.

3. A resistance device as defined in claim 14 in which said rotor means consists of a unitary piece of resilient electrical conducting material.

4. A resistance device as defined in claim 14 in which said rotor means consists of a unitary piece of resilient material having a contact block adhered to the end portion of each of said arms.

5. In a rotary variable resistance device, the combination of: a cylindrical casing having an open end; a cap means closing said open end of said cylindrical casing; a curved resistor within said casing concentric with the axis thereof, there being a zone radially within said curved resistor; a hollow boss on said cap means concentric with said axis and extending inwardly of said casing to a point within said zone; two axially-spaced bearings in said hollow boss; a shaft journaled in said spaced bearings and providing a portion extending beyond said hollow boss; and a rotor mounted on said portion of said shaft, said rotor providing a contact portion engaging said resistor.

6. In a rotary variable resistance device, the combination of: two casing members having respectively inner and outer telescoping portions, the inner portion providing outwardly facing V-groove means having sloping sidewall means intersecting at the bottom of said V-groove means, the outer portion providing a plurality of threaded openings with axes respectively displaced on the same side from said bottom of said V-groove means and directed toward one sloping sidewall means; a corresponding plurality of screw means having conical shaped ends

and respectively rotatable in said threaded openings, said ends bearing against said one sloping sidewall, means to shift said telescoping portions relative to each other when said screws are tightened; a curved resistor in at least one of said casing members; a rotatable shaft; means for mounting said shaft to turn about the axis of said curved resistor; and a rotor carried by said shaft and providing contact means engageable with said resistor.

7. A combination as defined in claim 6 in which said casing members respectively provide stop faces engageable upon such relative movement of said telescoping portions before said axes of said openings come into alignment with said bottom of said V-groove means.

8. A combination as defined in claim 7 in which said telescoping portions are substantially cylindrical in form and in which said V-groove means is a single V-shaped groove in the inner telescoping portion whereby said casing members are relatively angularly adjustable by loosening said screw means.

9. In a rotary variable resistance device, the combination of: a cylindrical casing having an outside diameter and a shoulder of lesser diameter at one end thereof, said lesser diameter shoulder having a circumferential V-shaped groove; a curved resistor insulatedly mounted within said casing; cap means fitted over said shoulder and having a plurality of threaded radial openings; and a plurality of screw means having conically shaped ends, said screw means being inserted into said threaded openings, said conically shaped ends of said screw means bearing against only one side of said V-shaped groove thereby forcing said cap means against said casing, while allowing said casing to be rotatably adjusted with relation to said cap means when said screw means are loosened.

10. A resistance device as defined in claim 9 in which said cap means includes a hollow boss extending within the space surrounded by said curved resistor, and including shaft means rotatably mounted within said boss and concentric with said curved resistor.

11. In a rotary variable resistance device the combination of: a circular casing having an open end; a curved resistor within said casing concentric with the longitudinal axis thereof; a shaft having a rotor engaging said resistor; a cap means closing said open end of said casing, said cap means having a hollow boss through which said shaft extends, said hollow boss providing a shoulder; an anti-friction bearing in said hollow boss adjacent said shoulder for journaling said shaft, said bearing having an outside corner on the side away from said shoulder, said cap means having an opening extending radially from said hollow boss to the outer surface of said cap means, at least the inner portion of said opening being threaded; and screw means having a conically shaped end, said screw means being threaded into said inner portion of said opening so that said conically shaped end bears against said outside corner of said bearing to force same against said shoulder.

12. In a rotary variable resistance device, the combination of: a plurality of curved resistors; a corresponding plurality of cylindrical shells having outside diameters, said shells being positioned end-to-end to form a composite cylindrical casing, each of said shells supporting one of said curved resistors, each of said shells having a shoulder of lesser diameter at one end thereof and each of said shells having a stop face near its shoulder, said lesser diameter shoulder having a circumferential V-shaped groove, and each of said shells having a rim at the other end thereof fitted over said shoulder of the adjacent shell and engageable with said stop face, said rim having more than one threaded radial opening; and screw means threaded into said threaded openings, said screw means having conically shaped ends bearing against only one side of said V-shaped grooves thereby forcing said rim into tight contact with said stop face of the corresponding shoulder and permitting rotary adjustment

of one of said shells relative to another when said screw means are loosened.

13. In a composite casing for a plurality of variable resistors or the like, the combination of: a corresponding plurality of shells, each having a shoulder at one end thereof and a rim at the other end thereof, said shoulder having a groove which is transverse to the longitudinal axis of said composite casing, and said rim having more than one threaded radial opening and being fitted over said shoulder of another of said shells to form a composite casing composed of said plurality of shells mounted end-to-end; and screw means having ends shaped to mate with one side of said groove, said screw means being inserted into said threaded openings so that said shaped ends bear against said side of the corresponding groove to exert an axial force urging adjacent shells into tight engagement.

14. In a rotary variable resistance device, the combination of: a casing; insulating means having two mounting surfaces, said insulating means being removably positioned within said casing and having said mounting sur-

faces concentric with the longitudinal axis of said casing; a curved resistor mounted on one of said mounting surfaces; a contact ring of electrically conducting material mounted on the second of said mounting surfaces; shaft means rotatably mounted relative to said casing and journaled within the space surrounded by said insulating means; and rotor means insulatedly mounted to said shaft means, said rotor means having arms extending radially from said shaft means, the ends of said arms being respectively in contact with said curved resistor and said contact ring.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 2,863,972

December 9, 1958

Dean M. Barton

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 2, after "sidewall" strike out the comma.

Signed and sealed this 17th day of March 1959.

(SEAL)

Attest:

KARL H. AXLINE

Attesting Officer

ROBERT C. WATSON
Commissioner of Patents

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