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2,866,054 12/1958 Purdy 338/202 X
 2,870,303 1/1959 O'Brian 338/202 X
 3,264,594 8/1966 Layland 338/174
 3,399,367 8/1968 Tumbusch 338/175
 3,416,119 12/1968 Van Benthuyssen 338/174

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[54] **MINIATURE VARIABLE RESISTANCE CONTROL**
14 Claims, 8 Drawing Figs.

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[51] Int. Cl. H01c 9/02

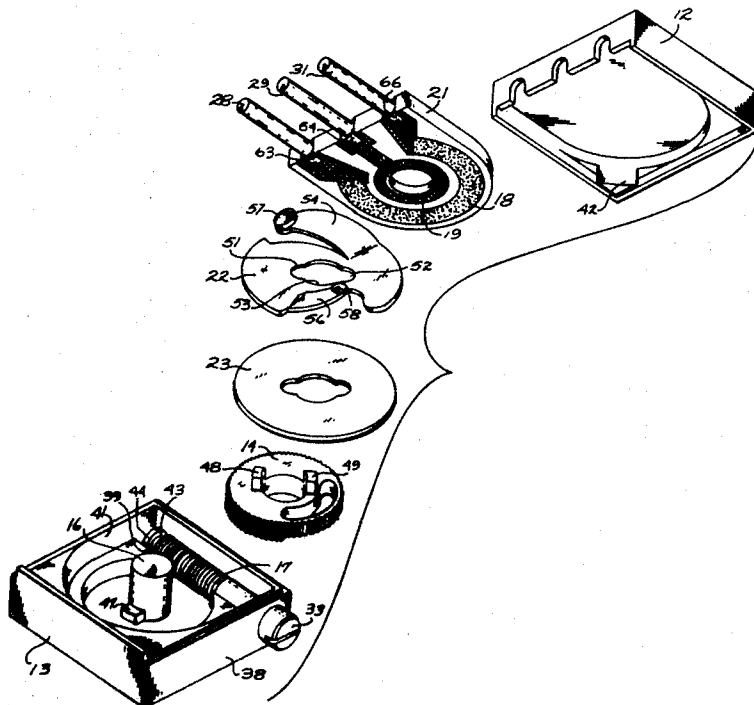
[50] Field of Search 338/162,
 164, 166, 174, 175, 202

[56] **References Cited**

UNITED STATES PATENTS

3,050,704 8/1962 Dickinson 338/180
 3,445,802 5/1969 Spaude 338/180 X

ABSTRACT: A contactor and lead screw driven gear are positioned on a spindle within a housing. Ears on the gear extend along the spindle and interfit with notches in the contact. A seat in the housing fits in a groove formed in the tail end of the lead screw, the screw head compresses a sealing member against a continuous bearing surface on the housing, a spacer limits lead screw movement away from the seat. A bulkhead compartmentalizes the control and inhibits movement of debris and foreign particles into the electrical section of the control. Pullout strength of lead wire terminals anchored in a ceramic base is increased by sandwiching a segment of the terminals between the base and a housing wall.



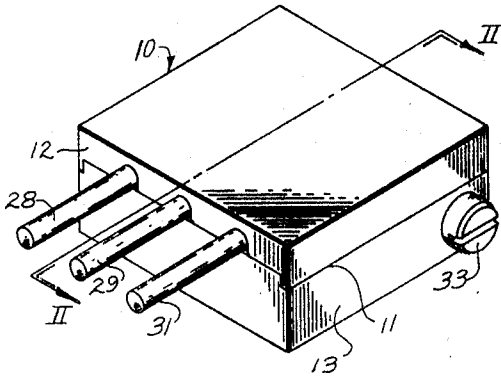


FIGURE-1

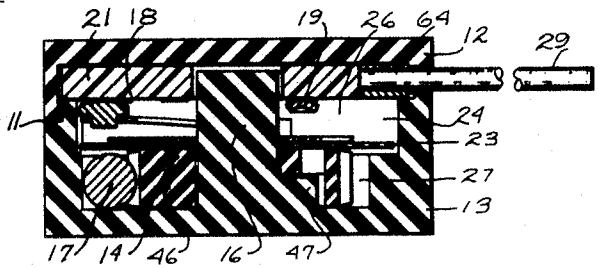


FIGURE-2

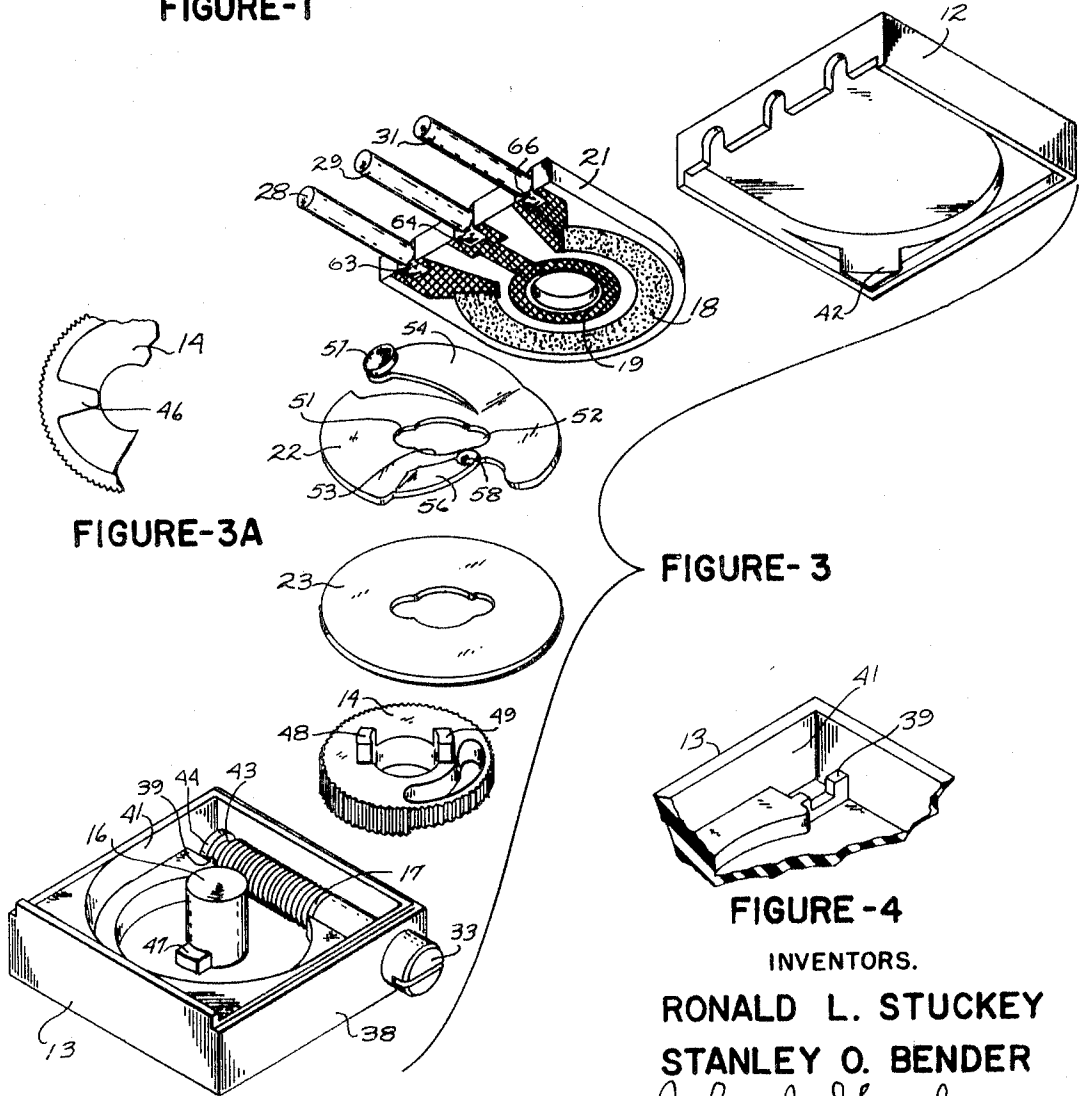


FIGURE-3A

FIGURE-3

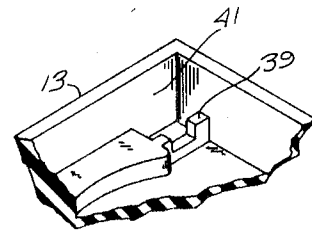


FIGURE-4

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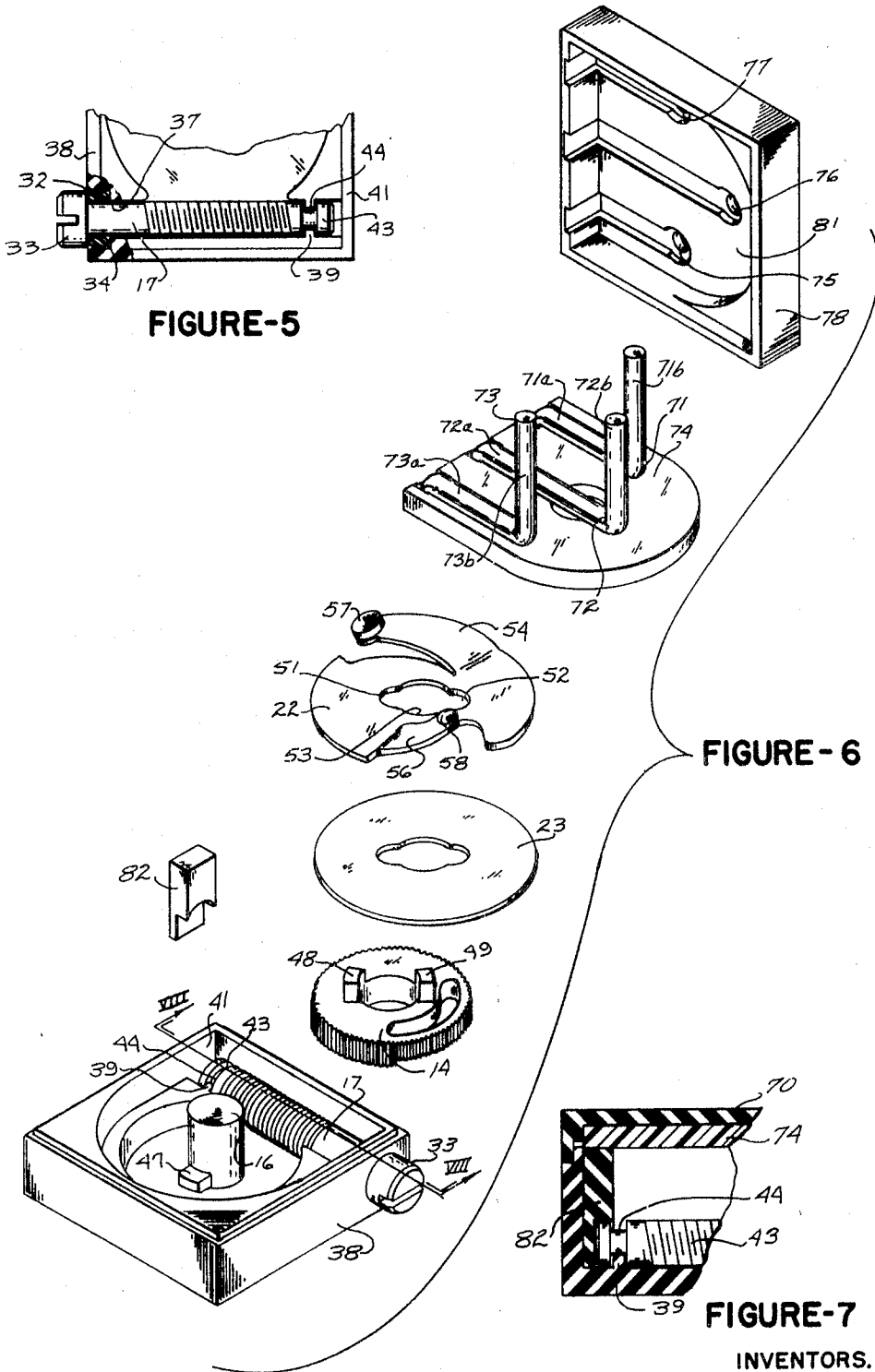


FIGURE-6

FIGURE-7

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MINIATURE VARIABLE RESISTANCE CONTROL

The present invention relates to variable resistance controls and, more particularly, to improvements in a miniature variable resistance control of the lead screw-type.

Variable resistance controls are frequently provided with a lead screw and a gear member in order to provide a multiturn trimmer-type control. Usually, this type of control is provided with a stop mechanism to limit the travel of a movable contactor within predetermined limits, normally near the ends of a resistive path within the control, as explained in Van Benthuyzen et al. U.S. Pat. No. 3,416,119, dated Dec. 10, 1968, and assigned to the assignee of the present invention. In miniature controls of the type wherein it is not desirable to permit relative motion between the gear member and the movable contactor, means such as interfitting ears and notches are often used to provide for constant and positive driving interengagement between the gear and movable contactor. Because of the small size of the various parts comprising a miniature control, it would be especially desirable to provide means that would facilitate mutual alignment of the contactor and gear member during assembly of the control and that would provide structural reinforcement for these parts.

In multiturn variable resistance controls known heretofore, a retaining pin inserted through a bore in the control housing has meshed with a groove in the lead screw and thereby prevented removal of the lead screw from the housing. In this type of construction, economy has generally dictated the use of a pin made from nonconductive material and, in order to maximize the bearing surface between the retaining pin and groove on the lead screw, it has been normal practice to contour the groove in the lead screw to correspond to the curvature of the retaining pin. In an effort to avoid the high cost associated with specially contoured lead screws, attempts have been made to form lead screw retainers integral with the housing. Examples of such construction are illustrated in U.S. Pat. Nos. 3,099,810 and 3,115,614 issued to Haberer on July 30 and Dec. 24, 1963, respectively. Although this approach has substantially eliminated the necessity for a retaining pin, it has made it more difficult to satisfactorily attain a dust excluding seal around the lead screw opening in the housing. Also, when following this approach, more care is required than has been heretofore necessary in order to prevent adhesives that are used to secure together portions of the housing from bonding the housing to either the lead screw or an elastomeric sealing member compressed between the housing and the head of the lead screw. It will, therefore, be appreciated that it would be desirable to provide means other than a retaining pin for preventing removal of a lead screw from a housing without adversely affecting the quality of the dust seal around the lead screw and without increasing the amount of care required to keep adhesives from bonding the housing to a sealing member or to the lead screw.

Trimmer-type variable resistance controls conveniently may be considered as comprising an electrical section to which voltages are applied and a mechanical section that is used to adjust the ohmic value of the electrical section. Although trimmer type variable resistance controls are not usually subjected to an extremely great number of adjustment cycles during their life, at least occasional adjustment of controls of this type is normally expected. When such adjustments are made, the surfaces of relatively movable parts in the mechanical section of the control may erode and thus produce debris that can interfere with the proper operation of the electrical section of the control. Typically, such interference would occur when a particle of debris became entrapped between the resistive path or the collector and a wiper carried by the movable contactor. If particles do become entrapped in this manner, the resistor may become objectionably noisy during operation. Accordingly, it would be desirable to provide means for compartmentalizing an electrical control and thereby provide a barrier that restricts or retards the movement of debris or foreign particles from the mechanical section to the electrical section of a variable resistance control.

One characteristic of variable resistance controls that is frequently of concern to users of such controls is known as terminal pullout strength. This is normally considered to mean the amount of tensile force required to separate a terminal lead wire from a control. It will be appreciated that it would also be desirable to provide for improvement of the terminal pullout strength of such controls.

Accordingly, it is an object of the present invention to provide a new and improved variable resistance electrical control wherein means are provided to facilitate the alignment of parts within the control during assembly and to provide structural reinforcement for such parts both during and after assembly. Another object of the present invention is to provide a new and improved variable resistance control having improved means for retaining the lead screw in the housing thereof. A further object of the present invention is to provide a new and improved variable resistance control wherein means within the control housing retain a lead screw properly seated in the housing. An additional object of the present invention is to provide a new and improved variable resistance control wherein means within the control compartmentalize the control and provide a barrier that restricts the movement of debris or foreign matter from the mechanical section to the electrical section of such control. A still further object of the present invention is to provide a new and improved variable resistance control characterized by improved terminal pullout strengths. Further objects and advantages of the present invention will become apparent as the following description proceeds, and the features of novelty characterizing the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

Briefly, the present invention is concerned with a variable resistance control comprising a two piece housing defining therewithin a cavity. A driven member is journaled on a spindle within the cavity and engaged by the lead screw. A substrate supporting a resistive path and center collector bounds one side of the cavity and a contactor constrained to rotate with the driven member wipingly engages the resistive path and center collector. The contactor and driven member are provided with interfitting notches and ears that are prealigned during assembly and are structurally reinforced by the spindle. A barrier located between the major portion of the driven member and contactor divides the cavity into two compartments and impairs the free movement of debris and foreign particles from the mechanical section of the control to the electrical section of the control. When the barrier member is formed of insulative material, it also serves to electrically insulate the mechanical section from the electrical section. The lead screw is provided with a groove near the tail end thereof and retaining means integral with the housing fit in the groove and prevent axial movement of the lead screw relative to the housing. Spacer means engageable with the lead screw limit displacement of the lead screw laterally away from the retaining means. In one embodiment, terminal pullout strength is increased by sandwiching a portion of each of a plurality of lead wires between the substrate and a wall of the housing.

For a better understanding of the present invention, reference may be had to the accompanying drawings wherein the same reference numerals have been applied to like parts and wherein: FIG. 1 is an isometric view of a variable resistance control built in accord with the present invention; FIG. 2 is a sectional view taken along line II-II of FIG. 1; FIG. 3 is an exploded isometric view of the control of FIG. 1; FIG. 3A is a fragmentary bottom plan view of a driven member shown in FIG. 3; FIG. 4 is a fragmentary isometric view of a portion of the control housing; FIG. 5 is a plan view of a portion of the control shown in FIG. 1; FIG. 6 is an exploded isometric view of another embodiment of the invention; and FIG. 7 is a fragmentary sectional view taken along the line VII-VII of FIG. 6, assuming that the control of FIG. 6 is assembled.

Referring now to the drawings, there is illustrated a variable resistance control, generally indicated by the numeral 10, comprising a housing 11 having an upper portion 12 and a

lower portion 13, a driven member 14 rotatably journaled on a spindle 16, a driving member in the form of a lead screw 17 drivingly engaging the driven member, a resistance element comprising a cermet resistive path 18 and a center collector 19 supported on a substrate 21 of ceramic material, a contactor 22 constrained to rotate with the driven member and wipingly engage the resistive path and center collector, a bulkhead or barrier member 23 interposed between the driven member and contactor so as to separate the cavity 24 of the housing into an electrical compartment 26 and a mechanical compartment 27, and a plurality of terminal wires 28, 29, 31 anchored in the substrate.

The top and bottom portions of the housing are molded from a suitable electrically insulating material such as diallyl phthalate resin although any other suitable material may be used to fabricate the housing. The mechanical section of the control comprises the driven member 14, illustrated as a radially flexible gear that provides a clutching action in the manner disclosed in the aforementioned commonly assigned U.S. Pat. No. 3,416,119, and the lead screw 17. In order to prevent dust or other foreign matter from entering the housing around the lead screw, an elastomeric sealing member, best illustrated in FIG. 5 as a rubber O-ring 32 is compressed between the head 33 of the lead screw and a recessed bearing surface 34 surrounding a lead screw receiving bore 37 formed in the wall 38 of the housing. By recessing the bearing surface 34 and making this surface continuous, i.e., by avoiding the location of half of the bore in adjacent portions of the upper and lower housing portions 12, 13, epoxy or other adhesive material used to secure together the housing portions 12, 13 is prevented from bonding the O-ring 32 and the lead screw 17 to the housing. Since the control 10 may be subjected to severe mechanical shocks, particularly in aerospace and military applications, movement of the lead screw 17 relative to the housing is prevented by providing lead screw retaining means comprising a seat 39 formed adjacent to the wall 41 of the housing portion 13. A spacer member 42, integral with the upper housing portion 12 in the embodiment under consideration, bears against the tail end 43 of the screw and insures that a groove 44 formed in the lead screw is properly seated on the retaining means. Since the seat 39 partially surrounds the lead screw and thus provides an adequate bearing surface, it is not necessary to contour the groove in the lead screw.

A stop member 46, best shown in FIGS. 2 and 3A, is formed on the bottom surface of the driven member 14 and is abutable with a stop arm 47 molded in the lower portion 13 of the housing adjacent to the spindle 16 to provide predetermined limits of travel for the driven member 14 and the contactor 22 constrained to rotate therewith. Since it is desirable to prevent slippage between the driven member 14 and the contactor 22, a pair of ears or bosses 48, 49 formed on the driven member 14 interfit with a pair of notches 51, 52 located along the periphery of an aperture 53 formed in the contactor 22. With the disclosed structural arrangement, the spindle 16 preliminarily centers the contactor 22 relative to the driven member 14 during assembly and the contactor 22 cannot be introduced into the cavity of the housing 11 without first being centered on the spindle 16. After the ears 48, 49 have been positioned in notches 51, 52, they are trapped between the body of the contactor 22 and the spindle 16. Thus, the spindle 16 structurally reinforces the ears 48, 49 and prevents deformation of the ears radially inwardly and out of the notches 51, 52. Although the control 10 is illustrated in grossly enlarged drawings, it will be appreciated that when the housing 11 measures only approximately three-eighths inch by three-eighths inch by three-sixteenths inch, the ears 48, 49 in reality are quite small and could be relatively easily deformed or damaged.

The contactor 22 is provided with a pair of wiper arms 54, 56 and, in the assembled control 10, the substrate 21 is nested in the upper housing portion 12 with a carbon button 57 and dimple 58 biased against the resistive path 18 and collector 19 by the arms 54, 56. In order to connect the control 10 to an

external electrical circuit, termination means in the form of lead wire terminals 28, 29, 31 connected to the collector and resistive path are anchored in slots 63, 64, 66 formed in the substrate 21 by means of solder, and extend through passages formed in the upper portion 12 of the housing.

It will be understood that during use of the control 10, debris may result from the interengagement of the lead screw 17 and the driven member 14. In addition, foreign matter may enter the control under particularly adverse environmental conditions notwithstanding the sealing effect of the O-ring 32. Since such debris and matter would initially enter into or occur in the mechanical compartment 27 of the control, the bulkhead 23, positioned on the spindle 16 between the driven member 14 and contactor 22, restricts the movement of such debris and matter into the electrical section of the control where such particles could interfere with the proper operation of the control. In addition, when the bulkhead 23 is formed of insulative material as preferred, arcing between the contactor and lead screw may be prevented even when relatively high voltages appear on the contactor.

In the embodiment of the invention illustrated in FIGS. 6 and 7, the control generally identified by the numeral 70 comprises several of the same parts as the control 10 illustrated in FIGS. 1—5. Accordingly, identical parts are identified with the same reference numerals throughout FIGS. 1—7 and further discussion of such elements is neither necessary nor desirable. The control 70 incorporates various features that result in improved terminal pullout strength. For example, the wire terminals 71, 72, 73 are provided with flattened segments 71a, 72a, 73a that extend along the substrate 74, and with end portions 71b, 72b, 73b that project through passages 75, 76, 77 formed in the upper portion 78 of the housing 70. As best illustrated in FIG. 6, relieved areas are formed in the upper housing portion 78 to provide nests for the flattened segments 71a, 72a, 73a of the terminals and to permit the substrate 74 to be seated against the surface 81 of the housing portion 78. When the control 70 is assembled, pull out forces applied to the terminals 71, 72, 73 are distributed against the housing portion 78 by the flattened segments of the terminals rather than being axially transferred to and localized at the solder connection between the terminals and substrate. The control 70 also differs from the control 10 in that the spacer 82, which serves the same purpose in control 70 as the spacer 42 in the control 10, is sandwiched between and lead screw 17 and a surface of the substrate 74 rather than the upper portion of the housing.

Although there are herein illustrated and described what is at present believed to be the preferred embodiments of the present invention for the purpose of exemplification, it will be appreciated that numerous changes and modifications are likely to occur to those skilled in the art and it is intended in the appended claims to cover all those changes and modifications which fall within the true spirit and scope of the present invention.

What we claim as new and desired to be secured by Letters Patent of the United States is:

1. A variable resistance control comprising a housing, a resistance element and a collector supported in said housing, a driving member supported for rotation in said housing, a driven member disposed in said housing and engageable with said driving member, and a contactor constrained to move in said housing upon movement of said driven member, said contactor engaging said resistance element and said collector, a seat for the driving member formed integrally with the housing, said driving member having a tail end with a groove formed therein interlocking with said seat preventing axial movement of the driving member relative to the housing, and spacer means bearing against said tail end maintaining said groove in said seat.

2. The control of claim 1, wherein a spindle is formed integrally with the housing and disposed in the central portion thereof, the driven member comprises a gear journaled for rotation on the spindle and includes a pair of bosses extending

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along the spindle, the contactor includes a pair of notches interfitted with said bosses and a resilient arm wipingly engaging the resistive path, and termination means comprising a plurality of terminals connected to the resistive path and projecting outwardly from the housing through openings formed in the housing.

3. The control of claim 2, wherein the resistance element further comprises a ceramic substrate having a plurality of notches formed therein, and the terminals each comprise lead wires having a first end secured in one of the notches of the substrate, a second end extending outwardly from the housing, and a portion intermediate the first and second ends sandwiched between the substrate and the housing.

4. The control of claim 1, wherein the housing comprises a spindle centrally disposed therewithin, the contactor is provided with a pair of notches adjacent to the spindle, and the driven member includes a pair of bosses extending along the spindle and through the notches of the contactor.

5. The variable resistance control of claim 1, wherein a bulkhead is disposed between the driven member and the contactor thereby to compartmentalize the interior of the control and impede the movement of matter from the vicinity of the driving and driven members. To the vicinity of the resistive path, said bulkhead electrically insulating said contactor from said driving member.

6. The control of claim 1 wherein said housing comprises an upper portion and a lower portion, said seat being integral with said lower portion, and wherein said spacer means comprises a member integral with said upper portion.

7. The control of claim 1 wherein said housing comprises an upper portion and a lower portion, said seat being integral with said lower portion, said resistance element and said collector being supported on a substrate, and wherein said spacer means comprises a member sandwiched between the tail end of the lead screw and said substrate.

8. The control of claim 1 wherein insulative means is disposed between the contactor and the driven member for preventing arcing between the contactor and the driving member.

9. The variable resistance control of claim 1 wherein said housing comprises an upper portion and a lower portion, said lower portion having a bore formed in a wall thereof, said driving member being disposed in said bore, and said driven member comprises a gear rotatably supported in said housing.

10. A variable resistance control comprising a housing having a spindle formed therewithin, a resistive element and a collector supported in said housing, a lead screw supported for rotation in said housing, a driven member supported for movement in said housing upon rotation of said lead screw, and a

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contactor member disposed around said spindle and constrained to move in said housing upon movement of said driven member, said contactor engaging said resistance element and said collector, one of said members being provided with a pair of ears and the other of said members being provided with a pair of ear receiving notches whereby cooperation of said ears and said ear receiving notches interlock the contactor member and the driven member, said pair of ears projecting axially along the spindle and bearing thereagainst, whereby said spindle provides structural reinforcement for said ears and prevents deformation of said ears radially inwardly and out of said notches.

11. The control of claim 10, wherein the housing includes a pair of spaced, substantially parallel walls, a first one of said walls is provided with a bore and a bearing surface surrounding the bore, the housing further includes a driving member retaining means formed integrally therewith adjacent the second one of said walls, and the driving member comprises a lead screw disposed in said bore having a headed portion adjacent the bearing surface and a tail end with a groove formed therein interfitted with the driving member retaining means whereby the lead screw is restrained from axial movement relative to the housing.

12. The control of claim 10, wherein an insulative bulkhead compartmentalizes the interior of the housing thereby, to substantially isolate the driving member and driven member from the remainder of the interior of the housing.

13. A variable resistance control comprising a housing, a spindle supported within said housing, a resistive element and a collector supported in said housing, a contactor driver disposed around said spindle, a driving member disposed radially outwardly from said contactor driver and engaging said contactor driver, a contactor disposed around said spindle and constrained to move upon movement of said contactor driver, said contactor engaging the resistance element and the collector and having a surface facing said driving member, and insulative means disposed between the contactor and the contactor driver and constrained to move upon movement of said contactor driver preventing arcing between the contactor and the driving member and preventing movement of foreign particles between the driving member and the contactor, said insulative means shielding said surface from exposure to said driving member.

14. The control of claim 13, wherein the housing includes a spindle centrally disposed therewithin, the contactor is provided with a pair of notches adjacent to the spindle, and the contactor driver includes a pair of bosses extending along the spindle and through the notches of the contactor.

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