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Zdanys

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[45] **Nov. 4, 1975**

[54] **VARIABLE RESISTANCE CONTROL AND METHOD OF ASSEMBLYING THE SAME**

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[73] Assignee: **CTS Corporation,** Elkhart, Ind.

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[21] Appl. No.: **413,162**

[52] **U.S. Cl.** **338/180;** 338/202; 29/610

[51] **Int. Cl.**[2] **H01C 10/40;** H01C 10/42

[58] **Field of Search** 338/180, 202, 181, 118, 338/160, 176, 68, 161, 184; 29/610

[56] **References Cited**

UNITED STATES PATENTS

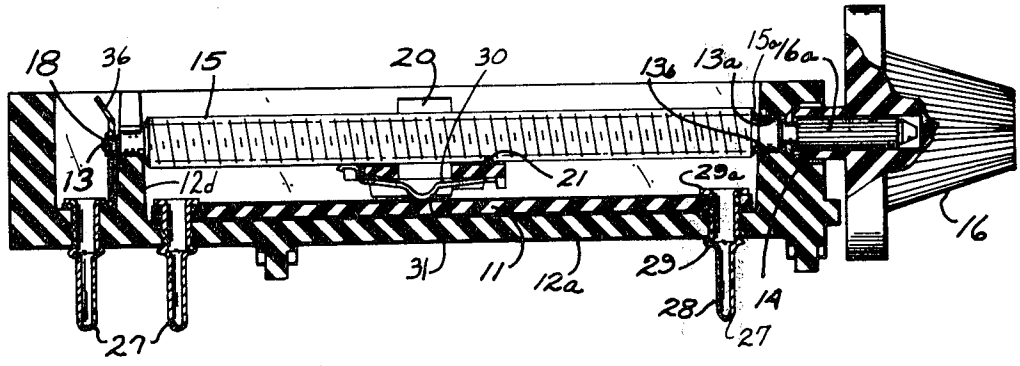
2,921,284	1/1960	Fosdick et al.	338/180 X
3,576,513	4/1971	Mathison et al.	338/180
3,639,879	2/1972	VanRooijen	338/180
3,693,062	9/1972	VonVick	338/180 X
3,732,520	5/1973	VanBenthuysen et al.	338/180
3,742,421	6/1973	VanRooijen	338/180

Primary Examiner—Bruce A. Reynolds

[57] **ABSTRACT**

A housing encloses a lead screw, a collector, a slider containing a contactor and driven by the lead screw, and a resistive path wipingly engaged by the contactor. A spring tab on the contactor securely attaches the contactor to the slider for handling and transporting the contactor and the slider as a complete unit for assembly into the housing of the control, the lead screw pressing upon the spring tab to release the contactor from rigid engagement with the slider upon the assembly of the lead screw, slider, and contactor into the housing, the tab maintaining continuous electrical contact with the lead screw. The release of the contactor from rigid engagement with the slider allows the contactor to float with the slider and smoothly engage the resistance element. The slider has a horizontal surface supporting the lead screw, the horizontal surface containing a motion conversion means disposed transverse to the lead screw and interfitting the threads of the screw, to convert the rotational motion of the lead screw into the translational movement of the slider. The lead screw is supported at one end by a journal bearing in the housing and at the other end engages a thrust bearing and a spring support, the end of the lead screw snapping into engagement with the spring support upon assembly of the control, the spring support facilitating the assembly of the lead screw into the housing and ensuring positive electrical contact between the lead screw and a collector terminal.

14 Claims, 12 Drawing Figures



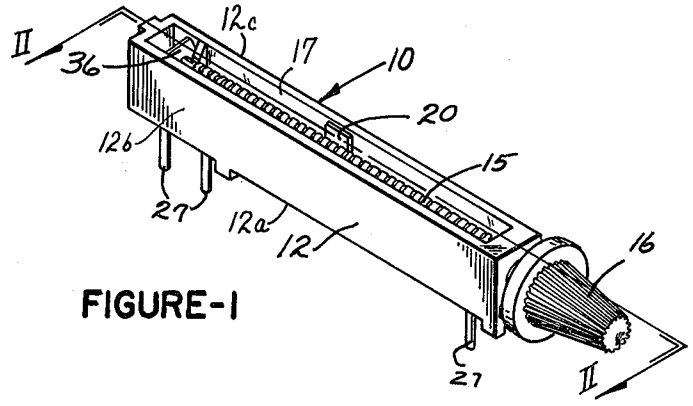


FIGURE-1

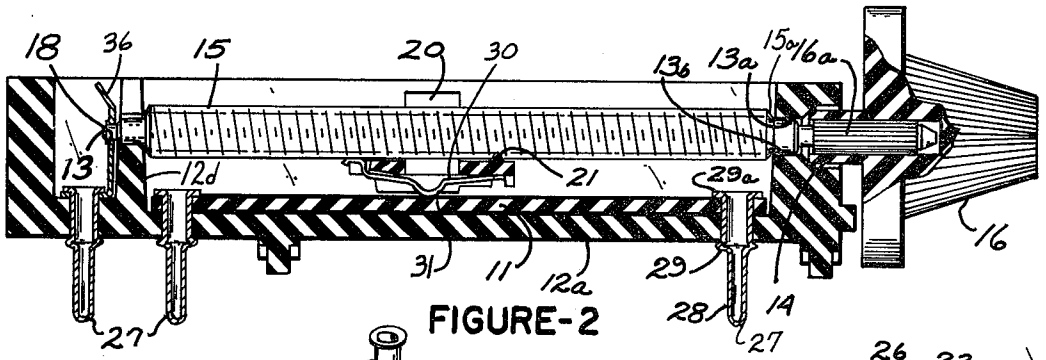


FIGURE-2

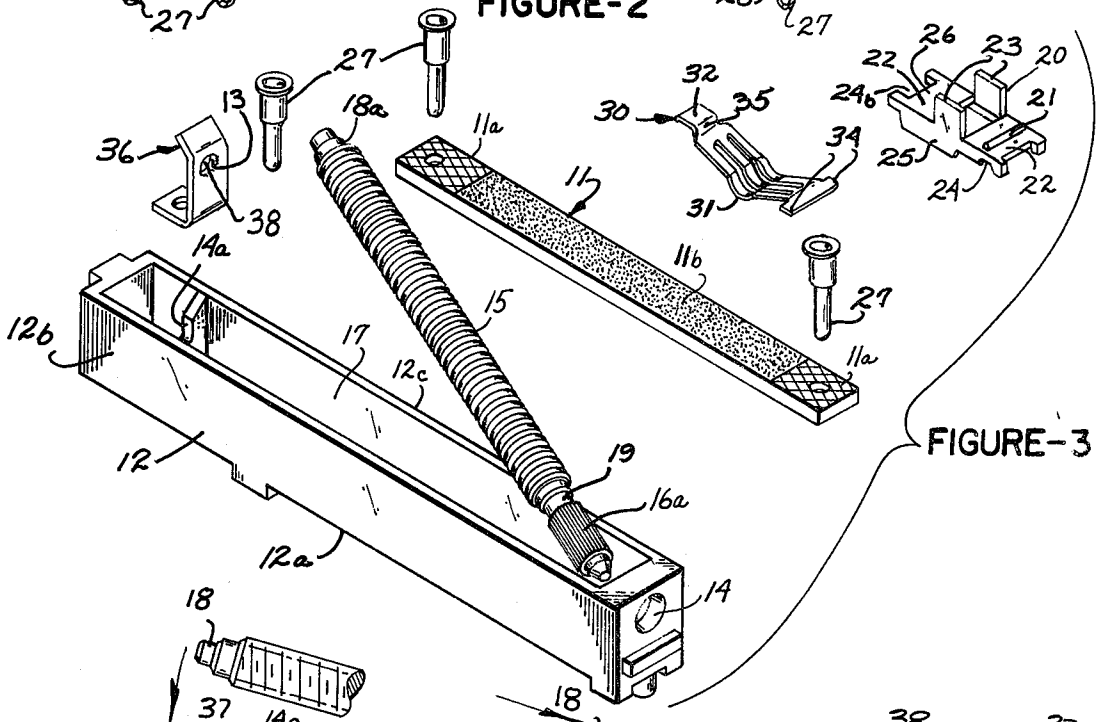


FIGURE-3

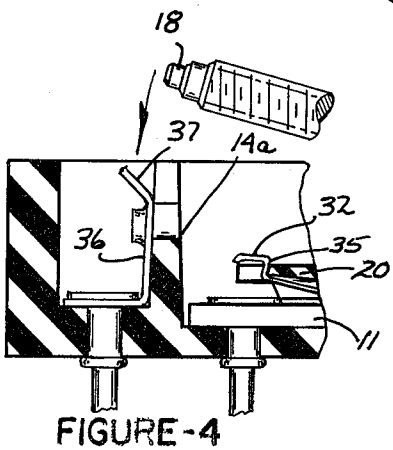


FIGURE-4

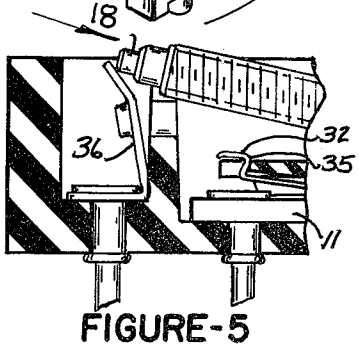


FIGURE-5

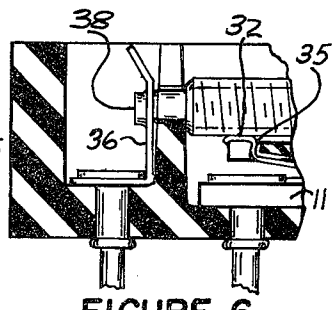


FIGURE-6

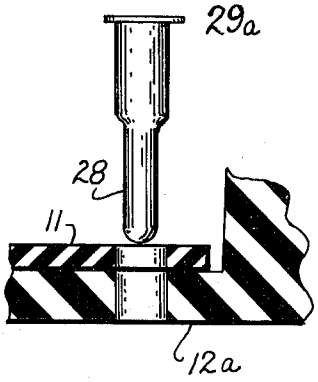


FIGURE-7

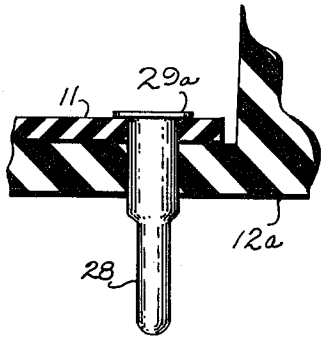


FIGURE-8

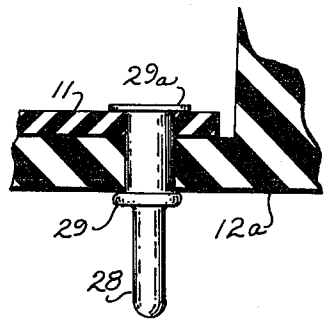


FIGURE-9

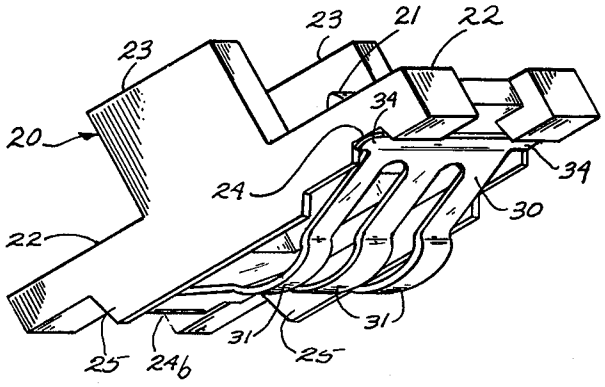


FIGURE-10

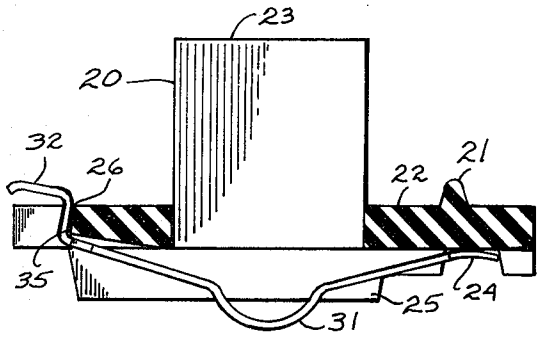


FIGURE-11

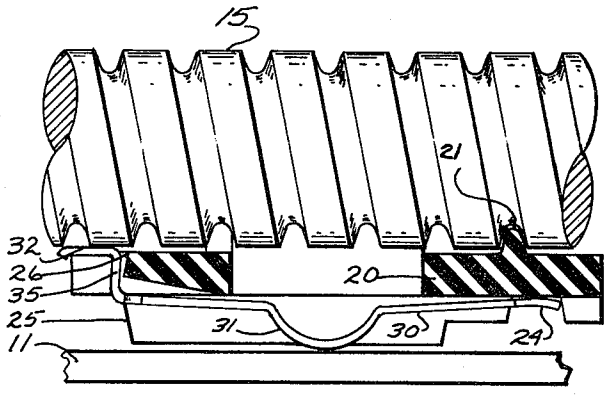


FIGURE-12

VARIABLE RESISTANCE CONTROL AND METHOD OF ASSEMBLYING THE SAME

The present invention relates to variable resistance controls and more particularly to improvements in a variable resistance control of the lead screw adjusted rectilinear type and to a method of assembling such controls.

In general, lead screw adjusted controls are provided with a lead screw drivingly engaging a contactor assembly constrained to make wiping contact with a resistive path, some lead screw adjusted controls requiring electrical contact between the lead screw and the contactor and between the lead screw and a collector. To assemble such controls on a high volume basis requires that component parts be relatively simple and easy to assemble, in particular, that the contactor assembly and the lead screw assembly be simple and easy to assemble with a minimum number of steps. Therefore, it would be desirable to provide a lead screw assembly and a contactor assembly that provide reliable electrical contact between the lead screw and the contactor and collector and yet are simple and easy to assemble on a high volume basis.

An example of a prior art lead screw adjusted rectilinear control is shown in U.S. Pat. No. **3,639,879** wherein a thin metal wire contact spring is contained in a parallelopiped shaped drive block or slider. The metal wire is folded into a U shape with a portion of the contact spring extending through a slot in the slider for making mechanical and electrical contact with a lead screw. That portion of the contactor making contact with the lead screw interfits between the threads of the lead screw and operates to drive the slider longitudinally as the lead screw is rotated, another portion of the contactor containing two wire members wipingly engaging a resistance element as the slider is driven longitudinally. With this type of construction, when the slider reaches the end of its path, upon continued rotation of the lead screw, that portion of the contactor engaging the spindle will temporarily jump out of the thread of the lead screw but will return when the lead screw is turned in the opposite direction. One difficulty, however, with this type of clutching or indexing action at the end of travel of the slider is that when the contactor jumps out of engagement with the lead screw, there is intermittent electrical contact between the lead screw and the contactor. It would therefore be desirable to provide a rectilinear control in which the indexing action at the end of travel of the slider does not result in intermittent contact between the lead screw and the contactor.

Another difficulty with the use of a thin contactor wire is that the minuteness of the contactor wire in engagement with the screw threads and the tolerance necessary to permit the wire to interfit the screw threads allows for intermittent electrical contact as the direction of the contactor is reversed. That is, for example, if the pitch of the screw thread is twice the diameter of the contact wire and the contactor wire is engaging the lead screw near the crest of the threads, then a change in direction of rotation of the lead screw necessitates that the lead screw must travel a distance of almost ½ the pitch of the screw before electrical contact is made between the contact wire and the screw spindle. This intermittent electrical contact results from the fact the pitch of the screw must be great enough to permit interfitting of the contact wire and the fact that the contact wire is engaging the lead screw to move the slider rather than the slider engaging the lead screw to move the contactor. Another difficulty with the use of a thin wire contactor is that there is only a minimal area of contact between the contactor and the resistance element. It would therefore be desirable to provide a rectilinear control in which the slider engages the lead screw and the contactor follows the motion of the slider and wherein there is a substantial area of contact between the contactor and the resistance element.

An example of a prior art lead screw adjusted control wherein the slider engages the lead screw and the contactor follows the longitudinal motion of the slider is shown in U.S. Pat. No. **3,732,520** assigned to the same assignee as the present invention. In that particular control, the slider comprises a horizontal member supporting two vertical members, the inside of the vertical members containing threads for engagement with the lead screw. The difficulty with the slider in this particular construction, however, is that the threaded vertical members must be rigid enough to maintain mechanical engagement with the lead screw since no other external force is exerted on the threaded vertical members to hold them in engagement with the lead screw. On the other hand, the rigidity of the vertical members of the slider results in some deformation of the threaded members after the slider has reached the end of its travel, upon continued rotation of the lead screw. Thus repeated rotation of the lead screw when the slider is at the end of its travel could result in a permanent deformation and damage to the control. If, on the other hand, the threaded vertical members are too resilient, sporadic disengagement of the threaded vertical members with the lead screw could result, particularly since no other external force is exerted on the threaded vertical members to ensure their engagement with the lead screw. It would therefore be desirable to provide a rectilinear control in which the indexing or clutching action at the end of the travel of the slider does not result in permanent deformation of the slider and wherein there is an external pressure holding the slider into engagement with the lead screw.

Accordingly, it is an object of the present invention to provide a new and improved variable resistance control. Another object of the present invention is to provide a variable resistance control having an electrically nonconductive slider engaging the lead screw with the contactor following the motion of the slider. An additional object of the present invention is to provide a slider and contactor assembly that permits indexing action at the end of travel of the slider that does not result in discontinuous electrical contact between the lead screw and the contactor. An additional object of the present invention is to provide a contactor having a substantial area in contact with a resistance element. Still another object of the present invention is to provide a slider and contactor assembly wherein an external pressure is applied to the slider to maintain the slider in mechanical engagement with the lead screw. Another object of the present invention is to provide a contactor wherein a contactor tab maintains continuous electrical contact with the lead screw during the movement of the driver in relation to the lead screw. Another object of the present invention is to provide an improved method of assemblying component parts in a variable resistance control. Still another object of the present invention is to provide a contactor secured to

the slider as a unit for ease of handling and assembly of the unit in the housing. Another object of the present invention is to provide a method for releasing the contactor from rigid engagement with the slider upon assembly of the slider, contactor, and lead screw in the housing. An additional object of the present invention is to provide a lead screw that snaps onto a spring support for ease of assembly and support of the lead screw in the housing. 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 housing having a resistive path, a flexible collector, a lead screw, a slider and contactor supported therein. An electrically nonconductive motion conversion means integral with the slider interfits between the threads of the lead screw and translates the rotational motion of the lead screw into the longitudinal motion of the slider, the contactor following the motion of the slider. The contactor comprises a tab portion engaging the lead screw, a slider engagement portion disposed underneath the motion conversion means to urge the motion conversion means into engagement with the lead screw and three contacts connecting the tab portion and the engagement portion and wipingly engaging the resistance element, the tab portion of the contactor extending through a recess in the slider to maintain continuous electrical contact with the lead screw. The tab portion on the contactor is rigidly secured to the slider for handling of the slider and contactor as a unit during assembly of the control, but is unlocked from the slider by the lead screw upon assembly of the slider, contactor and lead screw into the housing of the control, the tab portion freely floating to make electrical contact with the screw spindle and establishing a spring bias from the lead screw through the contacts to the slider engagement portion. the present method comprises the assembly of the slider and contactor as a unit into engagement with the lead screw, inserting one end of the lead screw outwardly through an aperture in the housing, and snapping the other end of the lead screw into engagement with the flexible collector, the engagement of the lead screw onto the collector causing the lead screw to press upon the tab portion of the contactor and unlock the tab portion from rigid attachment with the slider.

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 made in accord with the present invention;

FIG. **2** is a sectional view taken along linew II—II in FIG. **1**;

FIG. **3** is an exploded isometric view of the control shown in FIG. **1**;

FIGS. **4–6** show an end portion of the sectional view shown in FIG. **2** illustrating the steps of positioning the lead screw on the flexible collector in accord with the present invention;

FIG. **7–9** show another portion of the sectional view of FIG. **2** illustrating the assembly of the terminals to the control and the securing of the resistance element to the bottom wall of the housing;

FIG. **10** is an isometric view of the slider and contactor made in accord with the present invention;

FIG. **11** is an enlarged sectional view of the slider and contactor in accord with the present invention; and

FIG. **12** is an enlarged sectional view showing in detail the lead screw engaging the driver and contactor assembly in accord with the present invention.

Referring now to the drawings, a variable resistance control **10** is illustrated in FIG. **1** comprising a rectangular shaped housing **12** having a bottom wall **12***a* and side walls **12***b* and **12***c* enclosing a hollow interior or cavity **17.** A resistance element **11** is secured to the bottom wall **12***a* of the housing between side walls **12***b* and **12***c*, as seen in FIG. **2** and **3,** the resistance element **11** comprising conductive pads **11***a* and a resistive path **11***b*, the resistance element preferably of a laminated or suitable dielectric material. A plurality of terminals **27** secure the resistance element to the housing **12,** the terminals comprising a tubular extension **28,** as best seen in FIG. **9,** a circular shoulder **29** rolled and pressed against the bottom wall **12***a* of the housing **12,** and a terminal head **29***a* abutting the element **11,** the pressure between the shoulder **29** and the head **29***a* evenly pressing the element **11** against the bottom wall **12***a*. As seen in FIGS. **2** and **3,** two of the terminals **27** are electrically connected to the conductive pads **11***a* of the resistance element **11** at opposite ends of resistive path **11***b*, and a third terminal **27** is electrically connected to collector element or spring support **36,** and secures the spring support **36** to the bottom wall **12***a*.

When the control **10** is assembled, as best illustrated in FIGS. **2** and **12,** a lead screw **15** engages a contactor assembly comprising a slider **20** and a contactor **30.** As seen in FIGS. **2** and **3** the lead screw **15** is supported in the housing at one end by a rear bearing **13** on the spring support **36** and a thrust bearing **14***a* integral with the housing **12,** and at the other end by a front bearing **13***b*, the bearing **13** supporting the journal **18** on lead screw **15,** the thrust bearing **14***a* supporting the journal **18***a*, and the bearing **13***b* supporting the journal **19.** At one end of the housing an aperture **13***a* as seen in FIG. **2** permits the insertion of the lead screw **15** into the aperture from within the housing, the shoulder **15***a* of lead screw **15** preventing the further insertion of the screw into the aperture. The housing also includes a tapered bearing area **14** as seen in FIG. **3** and the lead screw **15** has a control adjustment portion **16***a* extending through the bearing area **14** outside the housing **12** for attachment of a knob **16.**

According to the present invention, as best seen in FIGS. **2, 3, 10, 11** and **12** the slider **20** contains a horizontal surface **22** and an electrically nonconductive motion conversion means **21** integral with the surface **22** and forms a rectangularly shaped member for receiving the lead screw **15,** the guides **23** being disposed adjacent the side walls **12***b* and **12***c* of the housing to prevent the rotation of the slider **20** upon rotation of the lead screw. The motion conversion means **21** interfits between the threads of the lead screw **15** and translates the rotational motion of the lead screw into the longitudinal motion of the slider. Preferably, the motion conversion means **21** is molded with the slider **20.** However, it should be understood that the term integral also means that the motion conversion means **21** could

be secured to the slider by adhesive or any other conventional means. The slider **20** also contains a pair of spaced runners **25** extending from the horizontal surface **22** and engaging the resistance element **11**, the runners **25** engaging the element **11** to minimize the rocking motion of the slider **20** and give a smooth and uniform movement of the slider along the resistance element.

According to the present invention, a contactor **30** as best seen in FIGS. **3** and **10** has a plurality of contact fingers **31** and is secured to the slider **20**, the contactor **30** following the longitudinal movement of the slider **20** to wipingly engage the resistance element **11**. The wide contact fingers **31** permit a substantially large area of contact with the resistance element **11**. A pair of ears **34** integral with the contact fingers **31** are disposed in a pair of recesses **24** contained in the slider **20**. A lead screw engagement tab **32** as seen in FIGS. **3**, **11** and **12** integral with the fingers **31** engages the lead screw **15** by extending through the indentation **24***b* in slider **20** and electrically connects the lead screw to the resistance element. The engagement tab **32** contains a latchable portion **35** secured to the slider **20** by snapping onto the latching section **26** of the slider **20**. The engagement of the latchable portion **35** of the contactor to the slider latching section **26** fixedly secures the contactor to the slider, until the slider **20** and contactor **30** are assembled into the housing and the lead screw snapped into engagement with the flexible spring support **36**. The snapping of the lead screw **15** into engagement with the spring support **36** as seen in FIGS. **4** through **6** results in the latchable portion **35** being dislodged by the lead screw from engagement with the latching section **26** of slider **20**. This permits the engagement tab **32** of the contactor **30** to float or freely move during the longitudinal movement of the slider, allowing for a smoother slide of the contactor along the resistance element **11**. A spring force urging the motion conversion means **21** into engagement with the lead screw **15** is created at the point of contact of the engagement tab **32** with the lead screw **15** and carried through the contact fingers **31** up to the point of engagement of the ears **34** of the contactor with the slider **20**, the spring pressure of the contactor further maintaining the engagement of the ears **34** within the recesses **24** of the slider **20** to allow the contactor **30** to follow the motion of the slider.

In operation, the motion conversion means **21** converts the rotational motion of the lead screw **15** into the longitudinal motion of the slider **20**. Therefore a change of direction of rotation of the lead screw and thus a change of longitudinal movement of the slider **20** will not result in discontinuous electrical contact between the contactor **30** and the lead screw **15** since there is continuous electrical contact between the engagement tab **32** of the contactor **30** and the lead screw **15**. Furthermore, during the movement of the slider, there is a continuing spring force urging the motion conversion means into engagement with the threads of the lead screws, the spring force extending from the point of contact of the engagement tab **32** with lead screw **15** through the contact fingers **31** to the ears **34** underneath the motion conversion means **21** on the horizontal surface **22**. At the end of the travel of the slider **20**, the slider will abut the end wall **12***d* of the housing as seen in FIG. **2**. Thereafter, continued rotation of the lead screw will result in the motion conversion means **21** and the horizontal surface **22** being pushed downwardly, the motion conversion means becoming disengaged from the threads of the lead screw **15** and ratcheting across the threads of the lead screw **15** until the direction of rotation of the lead screw is reversed. This indexing or clutching action at the end of travel of the slider **20** will not result in any discontinuous electrical contact between the contactor **30** and the lead screw **15**, since the engagement tab **32** of the contactor **30** maintains continuous electrical contact with the lead screw during the clutching action. Since the contactor **30** follows the motion of the slider **20**, the motion conversion means **21** engaging the threads of the lead screw **15**, the contactor need only make electrical contact with the lead screw **15** and the resistance element **11** and is not subject to the additional stress of engaging the lead screw for converting the motion of the lead screw into longitudinal motion of the slider and contactor assembly.

To assemble the control, the resistance element **11** is aligned with the bottom wall **12***a* of the housing as seen in FIGS. **7–9** and the terminals are inserted through the holes in the resistance element and the bottom wall of the housing, the head **29***a* of the terminal abutting the resistance element and the circular shoulder **29** being uniformly pressed against the bottom wall of the housing to fasten the resistance element to the housing. The contactor **30** is fixedly secured to the slider **20** by snapping the latchable portion **35** of the engagement tab **32** onto the latching section **26** of the slider **20** as seen in FIGS. **10** and **11**, the ears **34** being compressed into engagement with the contactor recesses **24**. The slider and contactor are then handled as a single unit for engagement with the lead screw **15**. The control adjusting portion **16***a* of the lead screw **15** is inserted into the aperture in the housing defined by the tapered bearing area **14** as seen in FIGS. **2** and **3**, the control adjustment portion being inserted from within the housing, the shoulder **15***a* on the lead screw **15** being of larger diameter than the aperture **13***b* and therefore abutting the end wall of the housing adjacent the aperture **13***b*. As seen in FIGS. **4–6**, the other end of the lead screw is then snapped into engagement with the spring support **36**, the end of the lead screw engaging the guiding portion **37** of the spring support means **36** and flexing the spring support means **36** rearwardly until the end journal **18** snaps into engagement with the spring support aperture **38** on spring support **36**, the spring tension of the spring support means **36** on the lead screw **15** allowing for uniform and continuous electrical contact between the lead screw **15** and the spring support means **36**.

what is claimed is:

1. In a variable resistance control, the combination of a housing, a resistance element disposed in the housing, a an electrically conductive lead screw rotatably supported by the housing, an electrically conductive collector element supported in the housing and electrically connected to the lead screw, a contactor for making wiping contact with the resistance element, a slider for moving the contactor intermediate the ends of the resistance element, an electrically nonconductive motion conversion means connected to the slider and engaging the lead screw for converting the rotational motion of said lead screw to the translational motion of the slider, said contactor being disposed in relation to the motion conversion means urging the conversion means

into engagement with the lead screw and comprising a tab portion in electrical engagement with the lead screw.

2. The variable resistance control of claim **1,** wherein said slider is provided with a horizontal surface and said conversion means comprises an electrically nonconductive horizontal member carried by said horizontal surface and interfitting the threads of said lead screw and wherein said horizontal surface is provided with an indentation, said tab portion of said contactor extending through said indentation and making electrical contact with said lead screw.

3. The variable resistance control of claim **2,** wherein said contactor comprises a plurality of narrowly spaced fingers, said fingers maintaining electrical contact over a substantial portion of the width of the resistance element.

4. The variable resistance control of claim **1,** wherein said contactor comprises contact means making wiping contact with the resistance element and a slider engagement portion mechanically engaging the slider, said contact means being disposed between said tab portion and said slider engagement portion.

5. The variable resistance control of claim **4,** wherein said slider engagement portion engages the slider underneath the motion conversion means to urge the conversion means upwardly into engagement with the lead screw.

6. The variable resistance control of claim **5,** wherein said slider is provided with an indentation and said tab portion electrically engages the lead screw, said tab portion extending through said indentation.

7. A variable resistance control comprising a housing of electrically nonconductable material, a resistance element disposed in the housing, terminal leads connected to the ends of the resistance element, an electrically conductive lead screw rotatably mounted in the housing in spaced relationship to the resistance element and having a helical thread, a rotatable means connected to the lead screw, a flexible electrically conductive collector disposed in the housing and connected to the lead screw, a contactor making wiping contact with the resistance element, a slider for moving the contactor intermediate the ends of the resistance element, an electrically nonconductive motion conversion means connected to the slider and extending transversely to said lead screw, said contactor being disposed in relation to the motion conversion means urging the conversion means into engagement with the lead screw and comprising a tab portion in electrical engagement with a plurality of the peripheral edges of the helical thread of the lead screw, a slider engagement portion, and a contact portion wipingly engaging the resistance element, said slider engagement portion urging the motion conversion means into engagement with the lead screw.

8. The control of claim **7,** wherein said slider comprises a horizontal surface engaging the lead screw, said horizontal surface containing an indentation, said tab extending through said indentation, said motion conversion means being integral with said surface.

9. A variable resistance control comprising first and second elongated side walls and an elongated bottom wall forming a housing, an elongated resistance element disposed along the bottom wall of the housing, a plurality of terminals extending through the resistance element and the bottom wall of the housing and securing the resistance element to the bottom wall of the housing, a flexible electrically conductive collector element disposed in the housing, a collector terminal extending through the bottom wall of the housing and securing the collector element to the housing, an electrically conductive lead screw rotatably mounted in the housing in spaced relationship to the resistance element, one end of the lead screw being supported by a portion of the housing and the other end of the lead screw being supported by the collector element, a horizontal member and a plurality of vertical members secured to the horizontal member forming a slider engaging the lead screw, a contactor secured to the slider for making wiping contact with the resistance element intermediate the ends thereof, said contactor being disposed in relation to the slider to urge the slider into engagement with the lead screw, and an electrically nonconductive motion conversion means connected to the slider, said motion conversion means comprising an elongated member integral with said horizontal member and extending transversely to said lead screw, the elongated member interfitting the threads of the lead screw.

10. A method of manufacturing a variable resistance control containing a contactor having a flexible tab portion for electrically engaging an electrically conductive lead screw comprising the steps of:

a. securing a resistance element within a housing,
b. securing an electrically conductive collector within the housing,
c. locking the flexible tab portion to a slider to form a contactor assembly,
d. disposing the contactor assembly within the housing,
e. inserting one end of the lead screw into an aperture in the housing, and
f. snapping the other end of the lead screw into engagement with the collector to thereby secure the lead screw within the housing.

11. The method of claim **10** wherein the step of interlocking the contactor to the slider includes the step of snapping a flexible tab portion of the contactor onto a portion of the slider.

12. The method of claim **10,** wherein the step of snapping the other end of the lead screw into engagement with the collector comprises the step of pressing the lead screw upon the tab portion of the contactor to thereby unlock said tab portion from said slider, said tab portion being in electrical contact with said lead screw.

13. The method of claim **10** wherein the step of inserting one end of the lead screw into an aperture in the housing includes the step of tilting the lead screw and inserting one end of the lead screw from within the housing outwardly through the aperture of the housing.

14. The method of claim **10** wherein the step of snapping the other end of the lead screw onto the flexible collector includes the step of lowering the lead screw within the housing for engagement with the top of the flexible collector and then snapping the end of the lead screw into engagement with a bearing contained in the flexible collector.

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