June 18, 1968 W. H. BUDD ETAL 3,389,364

ELECTRICAL CONTROL HAVING A NONCERAMIC BASE AND CERAMIC SUBSTRATE SUPPORTED CERMET RESISTANCE FILM SUPPORTED THEREON

Filed March 7, 1966

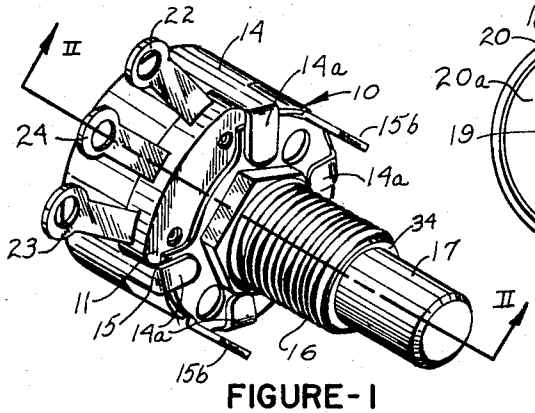


FIGURE-1

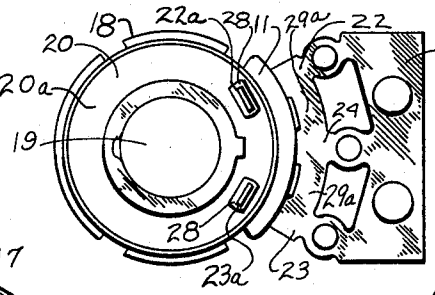


FIGURE-3

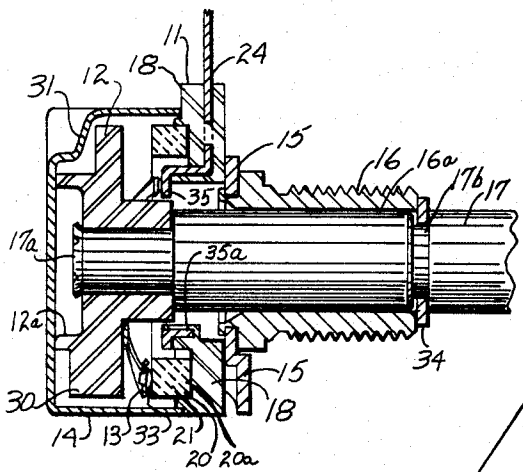
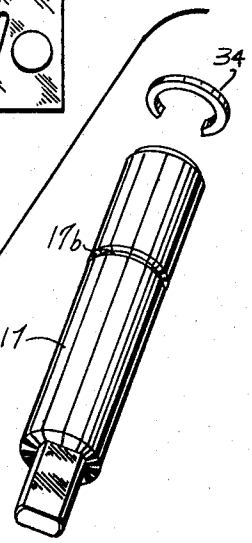
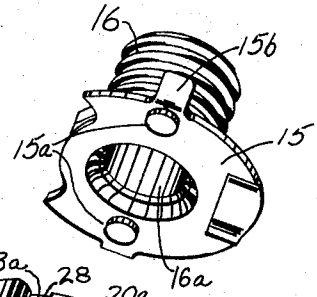
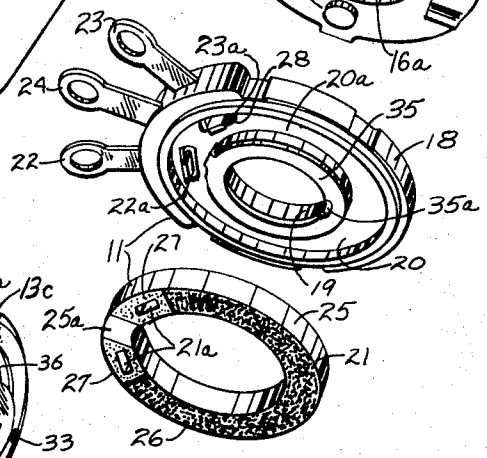


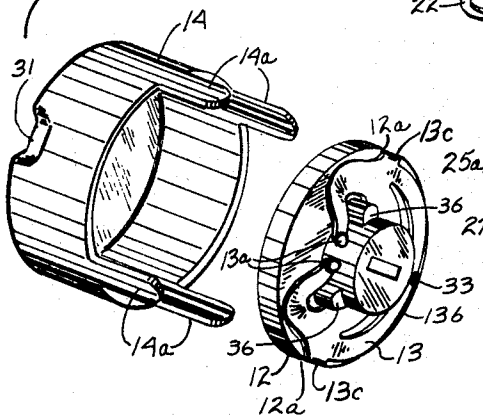
FIGURE-2

FIGURE-4









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ELECTRICAL CONTROL HAVING A NONCERAMIC BASE AND CERAMIC SUBSTRATE SUPPORTED CERMET RESISTANCE FILM SUPPORTED THEREON

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ABSTRACT OF THE DISCLOSURE

Nonceramic molded base with a pair of end terminals and a center terminal embedded therein provided with a flat surface supports a cermet resistance element comprising a cermet resistance film deposited and fired onto a flat surface of a ceramic substrate. Inner end portions of the end terminals project upwardly from the supporting surface of the molded base and terminate in slots provided in the ceramic substrate with conductive material connecting the ends of the terminals with the cermet resistance film. Relieved surface areas in the nonceramic base accommodate build-ups of nonceramic material around the terminals and prevent build-ups of material from being interposed between the flat supporting surface of the nonceramic base and the ceramic substrate. A contactor wipingly engageable with a collector and the cermet resistance film is rotatably mounted in the control and drivingly connected with a control shaft projecting externally from the control housing.

The present invention relates to electrical controls, and, more particularly, to a variable resistance electrical control of the type employing a cermet resistance element.

One of the difficulties in making a cermet variable resistance control such as disclosed in Snyder Patent No. 3,184,696, issued on May 18, 1965 and assigned to the same assignee as the present invention, is to design a structurally strong, but yet economical, base having a flat surface for supporting the cermet resistance element. Such base also contains a plurality of curves, cavities, and the like to facilitate mounting and securing of a collector ring, terminals and cover to the base. Since a cermet resistance element is made by depositing and firing a cermet resistance film on a high temperature resistant supporting surface, the base is preferably of a ceramic dielectric material, such as alumina or steatite. Complex tools and dies are necessary for pressing such bases from ceramic powder. The high cost of such complex tools and dies is further magnified since the abrasive action of the ceramic powder employed in pressing the ceramic bases causes rapid wear to the tools and dies necessitating frequent replacement thereof. Elaborate means for securing the terminals to the ceramic base is necessary when the control is sealed since the terminals must be insulated from the metal mounting plate and the metal cover. The terminals also must be firmly anchored to the base to prevent loosening or straining of the connection between the end portions of the terminals and the ends of the cermet resistance element. Furthermore, since an unfired substrate shrinks approximately 25 percent when fired, warpage and camber of the supporting surface of a ceramic base increase with the number of curves and cavities provided therein. But any attempt to reduce warpage and camber by decreasing the complexity of the ceramic base is offset by the increased cost of securing terminals and the like to the base. The demand for cermet variable resistance controls is, however, increasing rapidly since such controls have many well-known advantages over the metal film or carbon composition or carbon film

controls. It would, therefore, be desirable to provide a variable resistance control having a cermet resistance element wherein some of the problems associated with pressing and firing complex ceramic bases have been obviated.

Accordingly, it is an object of the present invention to provide an improved variable resistance control having a cermet resistance element. An additional object of the present invention is to provide a variable resistance control having a cermet film deposited and fired onto a flat surface of a ceramic element base mounted on a molded base of nonceramic material. Another object of the present invention is to provide a variable resistance control having a plurality of terminals embedded in a molded nonceramic base supporting an annular ceramic resistance element. A further object of the present invention is to provide a variable resistance control with means for controlling the pressure of the contactor against the cermet resistance element. Still another object of the present invention is to provide a variable resistance control with a nonceramic base having a ceramic element base supported thereon in a closed cover. 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 cermet variable resistance control having a molded base of suitable nonceramic material. A pair of end terminals and a center terminal integral with a collector are embedded in the molded base. The base is provided with a flat supporting surface preferably in a cavity and supported on the supporting surface is a cermet resistance element preferably of circular configuration comprising an element base having an arcuate cermet resistance film deposited and fired onto a flat surface thereof. The inner end portions of the end terminals project upwardly from the supporting surface of the molded base and engage the element base. Suitable conductive epoxy and conductive paths electrically connect the end terminals to the ends of the cermet resistance film. A contactor wipingly engageable with the cermet resistance element and the collector is secured to a driver rotatably mounted in the control. The driver is provided with control means for controlling the pressure of the contactor against the resistance element. A cover secured to the molded base encloses the driver, the contactor, and the cermet resistance element.

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: FIGURE 1 is an isometric view of an improved variable resistance control; FIGURE 2 is a sectional view taken along lines II—II of FIGURE 1; FIGURE 3 is a top plan view of a molded base; and FIGURE 4 is an exploded view of the control shown in FIGURE 1.

Referring now to FIGURE 1 there is illustrated an electrical control of the semiprecision type generally indicated at **10** and preferably employed in complex or accurate electrical equipment, e.g., instruments. The control **10** comprises a base assembly **11**, a driver **12**, a contactor **13**, and a cup-shaped cover **14** provided with a plurality of ears **14***a* folded over the base assembly **11** to secure the cover **14** to the base assembly.

For the purpose of mounting the control **10** to a not-shown panel or the like, a mounting plate **15** having a pair of protuberances **15***a* (see FIGURE 4) alignable with a pair of circular cavities in the base assembly **11** is secured to the base assembly **11** by the ears **14***a*. Extending forwardly of the mounting plate **15** and fixedly secured

thereto is an externally threaded bushing **16** provided with a hollow bore **16***a* rotatably supporting a shaft **17** staked to the driver **12** at **17***a* (see FIGURE 2). A suitable not-shown fastener threadedly engageable with the bushing **16** secures the control to the panel. To orient the control **10** on the panel, the mounting plate **15** is provided with an outwardly extending tab **15***b* (see FIGURES 1 and 3) insertable into a slot provided in the panel.

The base assembly **11** comprises a molded nonceramic base **18** of suitable dielectric material such as phenolformaldehyde or polyester molded compound and a cermet resistance element **21**. As best shown in FIGURES 3 and 4 of the drawings, the molded base **18** is generally of circular configuration having a central aperture **19** extending therethrough, and an annular cavity **20** concentric with the aperture **19** nestedly receives the cermet resistance element **21**. A pair of radially outwardly extending end terminals **22** and **23** and a center terminal **24** are embedded in the base **18** with the inner end portions **22***a* and **23***a* of the end terminals extending upwardly from the bottom surface of the annular cavity **20** and into a pair of slots **21***a* provided in the ceramic resistance element. More specifically, the cermet resistance element comprises an element base or substrate **25**, preferably of annular configuration pressed from ceramic powder and fired. The general process of transforming the ceramic powder into a ceramic substrate is to compact the powder under high pressure into a so-called "green" substrate and fire the green substrate to improve its mechanical strength for handling, polishing and the like. It is critical and essential that the substrate **25** be made from ceramic material, i.e., a dielectric material capable of withstanding temperatures in excess of 800° F. at least for several hours without deforming, such as alumina or steatite. After the top surface **25***a* of the substrate **25** has been polished, an arcuate cermet resistance film **26** is deposited, for example, by screening, onto the top surface thereof. The ceramic substrate **25** is then fired at temperatures in excess of 600° F. to fuse the resistance film **26** to the substrate to produce a cermet resistance element **21**. Suitable conductive paths **27** also are deposited onto the top surface **25***a* around the slots **21***a* and in overlapping relationship with the ends of the resistance film **26**. Conductive epoxy electrically connects the inner end portions **22***a* and **23***a* of the terminals projecting into the slots **21***a* provided in the annular substrate **25** to the conductive paths **27**. The inner end portions **22***a* and **23***a* of the terminals disposed in the slots **21***a* also aid in providing proper register between the cermet resistance element **21** and the molded base **18**. A suitable bonding material secures the cermet resistance element **21** in the annular cavity **20**. In a preferred form of the invention the bottom surface **20***a* of the annular cavity **20** is provided with a pair of recesses **28** circumposing the inner end portions **22***a* and **23***a* of the end terminals and communicating with the annular cavity **20**. Thus any build-up of molding material due to adhesion of the material to the inner end portions of the terminals remains in the recesses below the bottom surface **20***a* of the annular cavity **20**. The upper edges of the slots **21***a* in the substrate **25** are preferably beveled to increase the space between the sides of the slots **21***a* and the inner end portions of the end terminals to provide sufficient space and contact area for the conductive epoxy connecting the conductive paths **27** to the end terminals.

For the purpose of facilitating molding of the base **18** to the end terminals as well as to the center terminal, the terminals are partially blanked out from a strip with the ends of the terminals secured to a terminal carrier strip **29** (see FIGURE 3). After the base **18** has been molded to a group of terminals consisting of a pair of end terminals and a center terminal, the carrier strip **29** and the bridging members **29***a* are severed from the terminals to produce a molded base with embedded terminals as shown in the drawings. A plurality of groups of terminals are generally attached to the carrier strip **29**.

Angular rotation of the driver **12** is limited by a stop arm **30** (see FIGURE 2) extending radially outwardly from the rear face of the driver and engageable with the stop **31** formed in the rear peripheral edge of the cover **14**. The contactor **13** has resilient contact fingers **13***a* and **13***b* biasing a thrust bearing **12***a* extending rearwardly from the driver **12** against the inner rear wall of the cover **14**. The contactor **13** is secured to the driver **12** with a pair of ears **13***c* folded over in slots **12***b* provided in the driver **12** and therefore constrained to rotate with the driver **12**. In a preferred form of the invention, a carbon button **33** wipingly engageable with the resistance film **26** is fixedly secured to the contact finger **33** of the contactor as best shown in FIGURES 2 and 3 of the drawings. The shaft **17** secured to the driver **12** is provided with a circumferential groove **17***b* having a C-ring **34** inserted therein for limiting inward axial movement of the shaft. A collector ring **35** is carried by the molded base **18** and preferably partially embedded therein. A section of the collector ring is integral with the center terminal **24** and a depending ear **35***a* anchors a diametrically opposite section of the collector ring **35** in the molded base **18**. For the purpose of prolonging the life of the control **10**, it is preferable that the pressure of the carbon button **33** against the cermet resistance element be controlled. To this end, the driver **12** is provided with control means **36** abuttable against the collector ring **35** for limiting forward axial movement of the driver. Current is transferred from the contactor **13** to the center terminal **24** by means of the fingers **13***a* wipingly engageable with the collector ring **35**. As the driver **12** is rotated by the shaft **17**, the contactor **13** wipingly engages the resistance film **26** and the collector ring **35** to alter the resistance between the center terminal **24** and the end terminals **22** and **23**.

While there has been illustrated and described what is at present considered to be a preferred embodiment of the present invention, 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 is claimed as new and desired to be secured by Letters Patent of the United States is:

1. In a variable resistance control the combination of a base of molded nonceramic dielectric material having a supporting surface, a ceramic substrate seated on the supporting surface, the ceramic substrate having a pair of slots therein, a fired cermet resistance film supported by a top surface of the ceramic substrate with the ends thereof positioned adjacent to the slots, a pair of terminals embedded in the base, the terminals having first and second end portions with the first end portions of the terminals extending upwardly above the supporting surface of the base toward the cermet resistance film and into the slots in the substrate to aid in providing proper mechanical registry between the base and cermet resistance film carried by the substrate, the second end portions extending away from the base, conductive means connecting the first end portions of the terminals to the ends of the resistance film whereby an electrically conductive path is completed between the second end portions of the terminals and the resistance film, a collector, a center terminal electrically connected to the collector, and a contactor wipingly engageable with the resistance film intermediate the ends thereof and the collector.

2. The control of claim 1, wherein the collector is embedded in the base, and an ear depending from the collector is embedded in the base thereby to assist in anchoring the collector to the base.

3. The control of claim 1, wherein the base is provided with an elongated cavity to aid in providing proper registry between the base and cermet resistance film carried by the substrate and the ceramic substrate is seated in the cavity on the supporting surface.

4. The control of claim 1, wherein the supporting surface is of arcuate configuration, the ceramic substrate is

of arcuate configuration, the collector is of arcuate configuration, and a shaft rotatably drives the contactor, the shaft extending externally of the control and being provided with means facilitating rotation thereof, whereby movement of the shaft imparts corresponding movement to the contactor.

5. The control of claim 1, wherein the base is provided with a pair of recesses communicating with the supporting surface and the end terminals extend upwardly from the recesses, the recesses providing relieved surface areas on the base to accommodate build-ups of the material around the end terminals.

6. The control of claim 1, wherein the top portions of the slots adjacent to the first end portions of the terminals and to the ends of the resistance film are larger than the bottom portions of the slots and are filled with the conductive means, the top portions of the slots communicating with the top surface of the substrate.

7. The control of claim 3, wherein the elongated cavity is of annular configuration, the ceramic substrate is of annular configuration, the collector is of annular configuration, and a shaft rotatably drives the contactor, the shaft extending externally of the control and being provided with means facilitating rotation thereof, whereby movement of the shaft imparts corresponding movement to the contactor.

8. The control of claim 7, wherein a driver carries the contactor, and control means is associated with the driver for controlling the pressure of the contactor against the resistance film.

9. A variable resistance control comprising a housing, a base of molded nonceramic material provided with an annular cavity and secured to the housing, an annular ceramic substrate nested in the annular cavity, a fired arcuate cermet resistance film disposed on the substrate, a center terminal and a pair of end terminals having first and second end portions embedded in the base and projecting therefrom, a collector connected to the center terminal, the ceramic substrate being provided with a pair of spaced openings, the first end portions of the end terminals terminating in the openings, said first end portions comprising means cooperating with the openings to provide proper registry between the base and cermet resistance film, conductive means electrically connecting the first end portions of the end terminals in the openings to the ends of the resistance film, contact means wipingly engageable with the collector and the resistance film, and a shaft rotatably supported in the housing for driving the contact means, the shaft and second end portions of the end terminals projecting externally of the housing.

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