Oct. 29, 1957 G. J. MUCHER ET AL 2,811,621

CONTROL STRUCTURE AND METHOD OF FORMING THE SAME

Filed May 6, 1954

Fig. 1

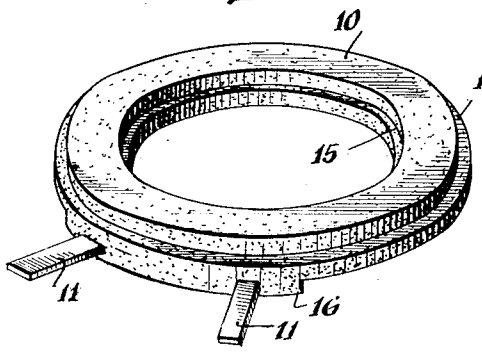


Fig. 6

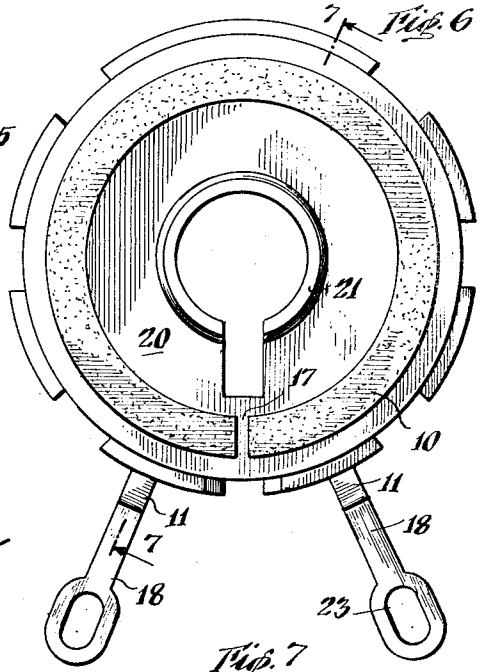


Fig. 2

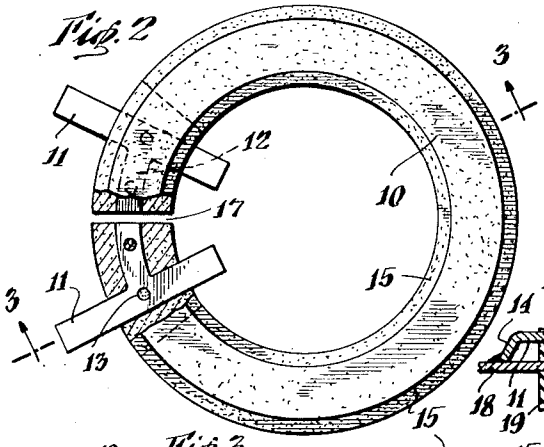


Fig. 7

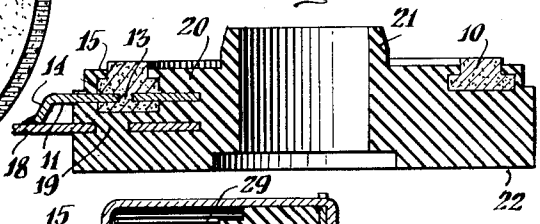


Fig. 3

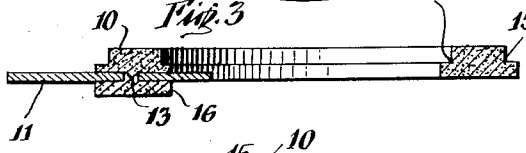


Fig. 4

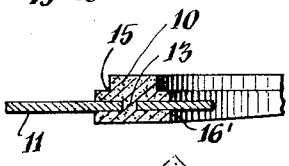


Fig. 5

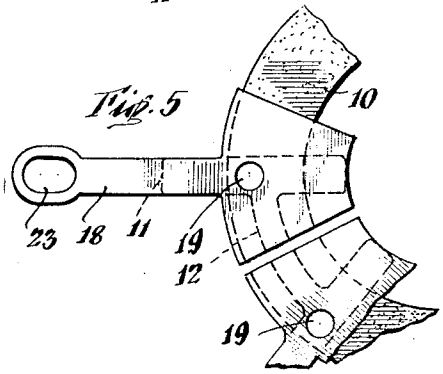
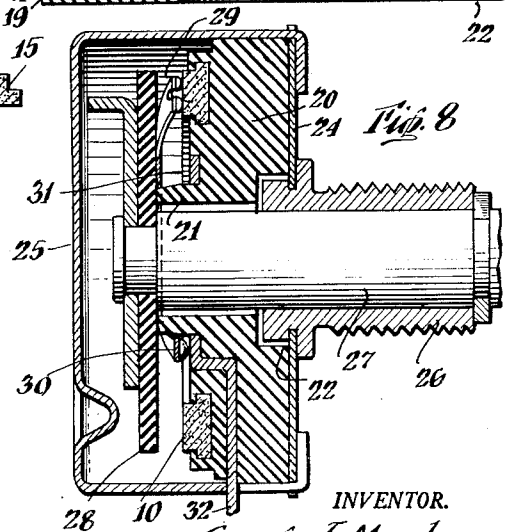


Fig. 8



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CONTROL STRUCTURE AND METHOD OF FORMING THE SAME

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Application May 6, 1954, Serial No. 428,005

6 Claims. (Cl. 201—63)

This invention relates to a structurally and functionally improved control and also teaches a method by means of which that control may be provided.

As is well known in the manufacture of electrical controls, such as potentiometers and variable resistances, considerable difficulty has been experienced in maintaining desired resistance values, especially where the variable resistance has embraced a conductive path such as a strip or unit incorporating graphite or similar materials. In the past that unit or element has been produced simultaneously with and as an integral part of the control stator, as shown in Patent No. 2,269,136, issued to B. F. Tellkamp on January 6, 1942. When such a technique was employed, it was frequently found that the required precise electrical values had not been embodied in the overall assembly or that the operation of the unit was otherwise defective. Under these circumstances the entire assembly has had to be discarded or salvage of the parts has been possible only by resorting to expensive and wasteful procedures.

In accordance with the present invention it is proposed to manufacture a molded composition resistance element with integral axial securing means. This element will have short electrical leads incorporated therewith, substantially in a plane perpendicular to the axis of the element. Accordingly, there is formed a properly cured unit that is mechanically and electrically complete, that may readily be tested for the desired electrical characteristics and may conveniently be stored without likelihood of damage prior to being subsequently assembled with the remaining elements of the control unit. The resistance assembly, a collector ring and suitable terminals or connectors, which also serves as heat dissipating means, are then employed as inserts in molding or forming a base unit of suitable dielectric material. This will have a mechanical composition, a curing temperature and pressure compatible with those of the resistance unit, whereby the several elements are permanently secured in their proper relationship. As a final step in the manufacture of the base unit, the electrical leads of the resistance element are soldered or welded to the connectors at points exteriorly of the base. Thereafter, the base unit is operatively related to a contact group, a base plate and a cover to form the complete control unit assembly.

Thus, the principal object of the invention is to improve the construction and method of manufacture of control units to provide a structure wherein a base of molded or case dielectric material embeds an insert of a mechanically and electrically complete resistance element. This will have electrical leads embedded therein whereby the separate terminals are embedded in the base and the resistance element leads and the terminals are connected at points exterior to the base.

A further object of the invention is to provide a molded composition resistance element for a control unit, said element having integral axial securing means and having electrical leads with inner frictional surfaces embedded generally in a plane perpendicular to its axis. Accordingly, there is provided a mechanically and electrically complete device that may be pre-tested for desired electrical characteristics and may be used as an insert in the molding of the base of the control unit.

Another object is to furnish a base for a resistance control unit, said base having embedded terminals with radially extending portions bonded to the base material and underlying substantial portions of the resistance element to distribute and dissipate heat.

A still further object is that of providing an electrical unit such as a potentiometer or variable resistance in which precise values will be incorporated. Therefore, the resultant mechanism may be placed on the market with assurance that it embodies predetermined characteristics; the unit, moreover, functioning in a perfect manner so that it will be unnecessary to discard a relatively high percentage of assemblies on the basis that they do not meet the required specifications or otherwise incorporate defective parts.

An additional object is that of providing a structure which will be relatively quite simple and which will include parts each embracing rugged characteristics, capable of ready assemblage with each other to furnish a unitary mechanism operating over a long period of time with freedom from all difficulties.

Still another object is that of teaching a method of constructing the individual units of an assembly as well as the combining of those units, such method being capable of being practiced without especial skills.

With these and other objects in mind, reference is had to the attached sheet of drawings illustrating practical embodiments of the invention and in which:

Fig. 1 is a perspective view of the variable resistance unit incorporated in the control;

Fig. 2 is a bottom plan view of that unit with certain of the parts broken away to disclose underlying construction;

Fig. 3 is a transverse sectional view taken along the line 3—3 in the direction of the arrows as indicated in Fig. 2;

Fig. 4 is a fragmentary sectional view showing an alternate form of resistance element that may be employed with the invention;

Fig. 5 is a schematic bottom plan view showing the relationship of the resistance element and the base terminals;

Fig. 6 is a top plan view of the complete stator parts of a control mechanism;

Fig. 7 is a transverse sectional view taken along the line 7—7 in the direction of the arrows as indicated in Fig. 6; and

Fig. 8 is a similar view showing a complete control assembly.

Referring to the drawings, a body **10** (see Fig. 1) providing a variable resistance path has been illustrated and which body is generally ring-shaped in configuration. This unit is formed of one of a number of suitable compositions. For example, it may embody a plastic which is substantially non-conducting and particles of carbon embedded therein. The latter are arranged according to a predetermined density, such that an electrically conductive path is provided by the element and which incorporates a precise degree of resistance either throughout its entire length or within given zones. As will be appreciated, such a resistance body is formed in a mold, usually under conditions of predetermined pressures and temperatures.

According to the present teachings electrical end leads are associated with this element. Additional leads might, of course, be associated with the same at predetermined points intermediate its ends. To avoid unnecessary and confusing illustration, merely end leads have herein been

shown. These may include bodies formed of various different metals arranged in diverse manners, including solid or braided wire. However, in accordance with the present teachings, it is preferred that flat metallic stock be utilized for convenience in inserting in a mold. In the case of end leads, a U-shaped strip is employed as especially shown in Fig. 2. The arms **11** of the strip are arranged so that they extend beyond the wall of a mold. The center portion **12** of the strip is preferably arranged in the mold cavity in a plane above the base of the latter, at a point below the level of the upper surface of the resistance element material which is introduced in the mold.

The center portion **12** is preferably provided with a number of openings **13**. The arms **11** extending outwardly from the center portion are preferably arranged in a plane of flat configuration to extend radially outwardly through the base portion of the control unit, as shown in Fig. 3. The arms at points beyond body **10** may also be formed with a bent part **14** (as in Fig. 7) which furnishes a downward extension to which suitable terminals may subsequently be attached in a plane below the lower face of body **10**. Additionally, as illustrated, that body is conveniently formed with recessed edge portions **15** defining its upper face or other high friction retaining surfaces that serve to key the body to the base portion, as described below. It may also include a thickened or downwardly extending part **16** adjacent that segment of its body from which leads **11** extend. It should be noted that part **16** may be of any suitable configuration and extent to provide the electrical characteristics required of the resistance element for a given application. That is part **16** may be annular to provide a resistance element of constant cross-section, it may be tapered as at **16'** in Fig. 4 to produce gradual resistance transition in the hop-off area, or it may be formed at will in a manner to produce any functional or non-linear range of resistance values desired.

With such a U-shaped lead assembly disposed within the mold cavity in the position stated, it follows that the material providing body **10** may be introduced into that mold to the required depth. Thereupon under the action of, for example, heat and pressure, the substance is converted into the finished resistance element with the leads extending therefrom, as shown in Fig. 1. To define the ends of that resistance element the latter is now slitted as at **17** (see Fig. 2) so as to provide a gap. This gap will not alone exist through the body **10** but will also divide the lead assembly **11—12** into two portions, one individual to each of the ends of the resistance element. Each of these parts will be prevented from moving with respect to the body of the element not alone because the lead is embedded in that body but because an actual anchoring of the leads has occurred. This is especially apparent when it is realized that the material providing body **10** will extend through the openings **13**, as shown especially in Fig. 3, to prevent any movement between the parts.

By the arrangement thus far described there is formed a resistance element assembly that is mechanically and electrically complete. It may conveniently be subjected to thorough tests to determine its precise electrical characteristics before it is assembled with the other elements of the control unit, thereby avoiding the delay and expense inherent in other methods in which it is impossible to test the resistance element until the assembly of the entire control unit is completed. Furthermore, since leads **11** are short and relatively flexible, the resistance elements may readily be transported and stored with little likelihood of the damage or breakage that is usually an incident to other methods in which much longer and more rigid terminals are attached to the resistance elements.

It should be noted that the step of splitting the resistance element after the molding operation is complete is a convenient expedient for forming separate leads from a single mold insert. However, such a step is not to be considered an essential step in the practice of this invention nor to constitute a limitation thereon. Obviously, the resistance element may be made as a solid ring by using separate lead inserts and placing non-conductive material between such leads in preparing the mold for the formation of the resistance element. The latter procedure, which is obviously within the scope of the present invention, has the advantage, in certain instances, of providing a more solid structure for convenience in handling, storing and testing, as described above, as well as in the molding of the base unit, described below.

After the molding operation, the resistance element assembly is subjected to testing operations such that there exists complete assurance it incorporates precisely the desired electrical characteristics. Thereafter, it is employed, together with suitable coupled terminals or connectors **18** (see Figs. 5, 6, 7) and, if desired, a collector ring **31** (see Fig. 8), as inserts in a second molding or casting operation wherein these elements are incorporated with a suitable dielectric material to form a base **20** for the control unit assembly.

Terminals **18** (see Fig. 5) are preferably made of flat metallic stock and are provided with arcuate segments having radially extending portions which, in their ultimate position, underlie substantial portions of the associated resistance element and thereby serve to dissipate the heat generated therein. Also, the inner ends of terminals **18** are preferably formed with openings **19** which will receive the material of the base **20** so that these parts also will be anchored against undesired movement.

The dielectric material forming base **20** may be of any convenient type having characteristics from the standpoint of heat, pressure and chemical composition that are completely compatible with the physical and electrical characteristics of the resistance element. Alkyds which cure at relatively high temperatures but low pressures have been found particularly advantageous for use when the base is to be molded. However, the base may satisfactorily be fabricated by the use of a casting process, with or without the application of heat and pressure, if so desired.

In the formation of base **20**, the finished and pretested body **10** is placed in a suitable mold upside down, with its leads **11** penetrating the side walls of the mold. Terminals **18** are conveniently arranged in apertures in the outer mold wall in a plane midway between body **10** and the lower surface of the mold. If desired, a suitable collector ring may also be employed as a mold insert at this stage of the operation.

When the desired mold inserts are properly arranged and if a casting operation is not contemplated, the base material is injected in the mold and the required heat and pressure, if any, is applied.

Under these circumstances, the dielectric material forming base **20** will envelop the side and lower surfaces of body **10** and key into the shoulder portions **15** to overlap the latter. Also, it will key into the openings **19** of the connector members as shown particularly in Fig. 7. The upper surface of body **10** will be exposed upon the upper face of base **20**. The latter has conveniently incorporated in it an upwardly extending collar portion **21**, downwardly extending edge flanges **22** and any other desired physical characteristics to provide suitable supporting shoulders or locating recesses for the remaining elements of the control unit assembly. In any event, it will be appreciated that as a result of the foregoing technique the base unit and resistance element are fixed with respect to each other, and against any possibility of accidental axial or radial shiftings occurring. The same is true of the leads **11** and the connector members or terminals **18**. The latter, in accordance with conventional construction, may define openings **23** adjacent their outer ends.

When the second molding operation is complete, the associated leads **11** and terminals **18** are soldered together exteriorly of the base unit, as in Fig. 7, to pro-

vide suitable connections whereby the resistance element may be embodied in a circuit.

The assembly thus furnished is conveniently incorporated in a control by mounting the base **20** upon a plate **24**. A cover **25** is conveniently coupled to this plate and thus encloses the working parts of the control. Plate **24** may carry a bushing **26** through which a shaft **27** rotatably extends. This shaft conveniently mounts a rotor **28** carrying arms **29** and **30**. The former traverses the surface of body **10**. The latter engages and moves over the surface of a collector ring **31** from which a terminal **32** extends. It may be noted that collector ring **31** may be incorporated in base **20** as part of the second molding operation, as indicated above, or may be assembled after the casting operation, as desired, the particular manner employed forming no part of the present invention.

As is apparent, when the parts are assembled in this manner and shaft **27** is rotated, arm **29** will move over the surface of the resistance **10**. Arm **30** will likewise move over ring **31**. The foregoing represents one preferred arrangement of parts incorporating the present teachings. It is apparent that other arrangements of parts according to the particular type of control and its specific design may be resorted to.

In any event, it will be appreciated that among others, the several objects of the invention as specifically aforenoted are achieved. It is apparent that numerous changes in construction and variations in the steps of the method might be resorted to without departing from the spirit of the invention as defined by the claims.

We claim:

1. In a control structure in combination a resistance element comprising a body consisting of a homogeneous mass of electrically conductive material, electrical leads incorporated in said body below the surface thereof, separate connectors secured one to each of said leads at points intermediate the ends of the connectors, said connectors lying below the lower surface of said body and having outer ends projecting beyond the same, a base of molded material enclosing the lower face of said body and side faces thereof, the leads and connectors also extending within and beyond said base and said leads and connectors providing surfaces into which the material of said body and base keys.

2. In a control structure in combination a resistance element comprising a body consisting of a homogeneous mass of electrically conductive material, electrical leads incorporated in said body below the surface thereof and separate connectors secured one to each of said leads at points intermediate the ends of the connectors, said connectors lying below the lower surface of said body and

having outer ends projecting beyond the same, a base of molded material enclosing the lower face of said body and side faces thereof, the leads and connectors also extending within and beyond said base and said body being formed with a recess into which the material of said base extends to lock said body and base against axial displacement with respect to each other.

3. A control structure as set forth in claim 2 wherein the recess in said body constitutes a shoulder portion on the upper side of said body.

4. A method of forming an electrical control which includes forming an electrically conductive resistance strip with a relatively recessed edge portion, applying an electrical lead to said strip, molding base material around said strip with the lead extending within and through said base and causing the base material to key into said recess to anchor the parts.

5. In a control structure in combination a resistance element comprising a body consisting of a homogeneous mass of electrically conductive material, electrical leads incorporated in said body below the surface thereof and separate connectors secured one to each of said leads at points intermediate the ends of the connectors, said connectors lying below the lower surface of said body and having outer ends projecting beyond the same, a base of molded material enclosing the lower face of said body and side faces thereof, the leads and connectors also extending within and beyond said base and the point of connection of each of said leads and connectors being exterior of said base.

6. In a control structure, in combination, a resistance element comprising a body having a track for traversal by a contact arm, said body consisting of a homogeneous mass of electrically conductive material, and electrical leads incorporated within said body below the surface thereof, separate connectors secured one to each of said leads at points intermediate the ends of the connectors, said connectors lying below the lower surface of said body and having ends projecting beyond the same, and a base of molded material enclosing the lower face of said body and side faces thereof, said leads and connectors also extending within and beyond said base.

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