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[56]

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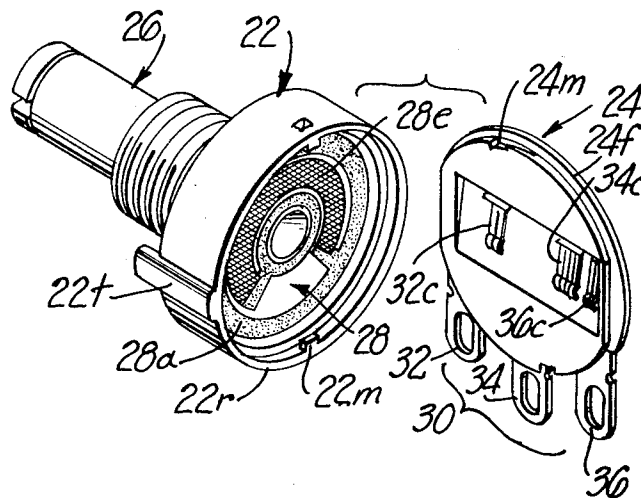
[54] SIMPLE HIGH-PERFORMANCE SINGLE-TURN POTENTIOMETER
7 Claims, 6 Drawing Figs.

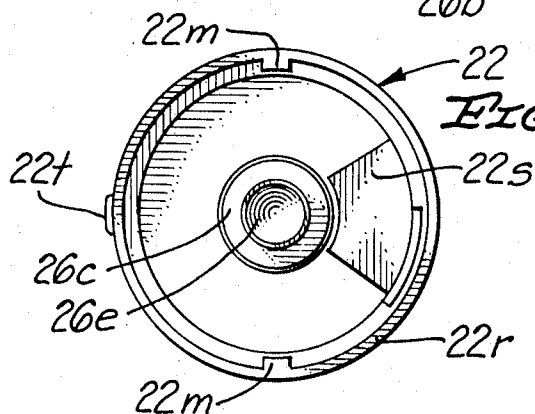
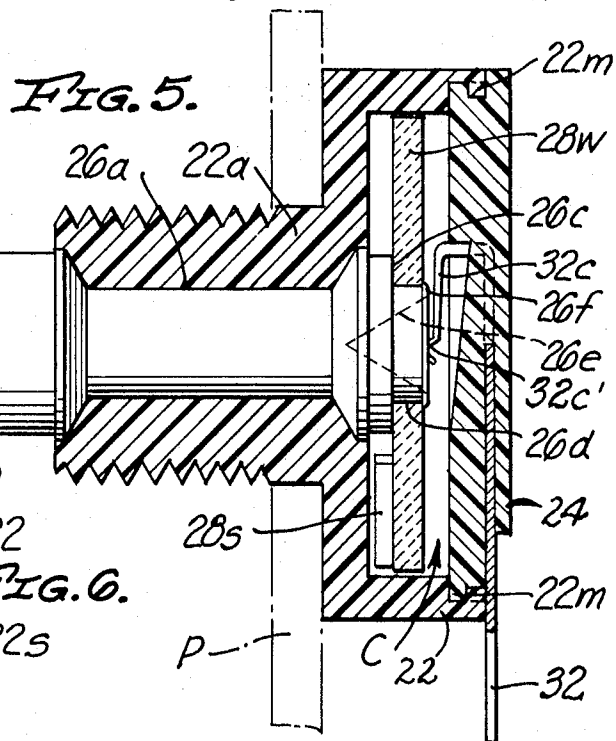
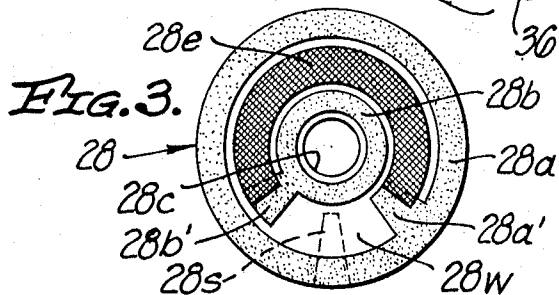
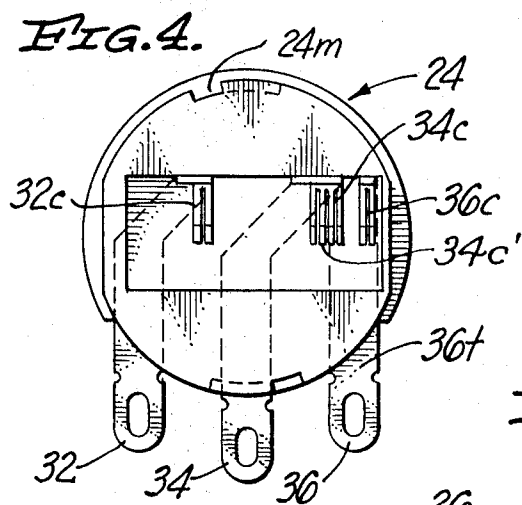
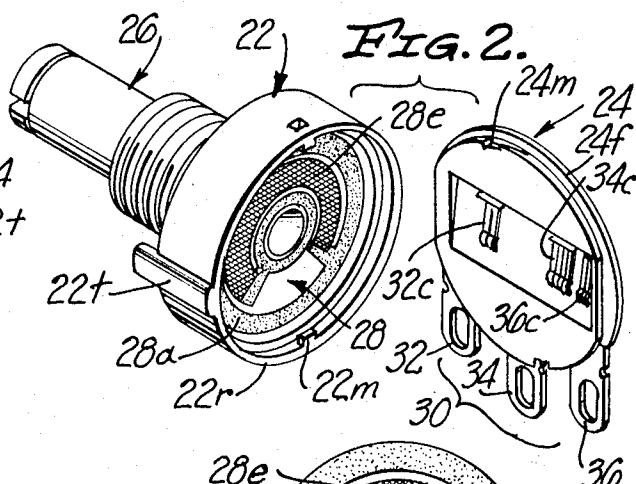
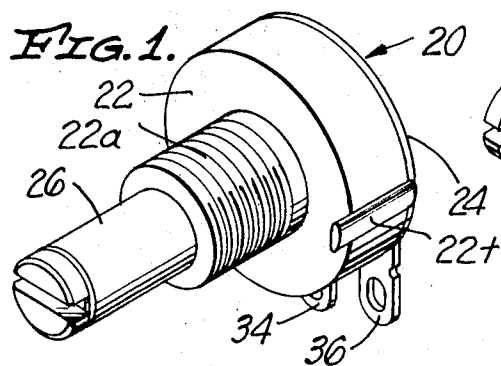
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ABSTRACT: A simple one-turn potentiometer having a housing, an adjustment shaft molded in place in the housing, a rotary ceramic chip element on the interior end of the shaft to give high heat dissipation, and integral contact and terminal members molded in place in the end cap with contacts on the interior of the housing and juxtaposed to brush on a shaft-carried disc and with terminals exposed on the rear exterior.





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SIMPLE HIGH-PERFORMANCE SINGLE-TURN POTENTIOMETER

BRIEF SUMMARY OF THE INVENTION

1. The Prior Art

In the field of potentiometers in which this invention reposes, it is usual to produce a potentiometer comprising a housing or enclosure of two or more parts or members to enclose and protect the operating components, to incorporate in the principal housing member a bushing or bearing for reception of a rotary actuating shaft, to mount in the housing a resistance element and a return conductor, and to mount on the shaft, in the housing, a rotary contact usually retained in a plastic rotor attached to the shaft to brush on the resistance element incident to rotation of the shaft. Provisions are made for electrical connections, usually in the form of terminal members affixed on or in one of the housing members and connected, as by means of solder, wires, or rivets, to respective ends of the resistance element and the return conductor. Such potentiometer constructions entail much labor in assembling and adjusting the components, and involve a relatively large number of parts. Additionally, in the absence of added special means, such constructions are of limited electrical power rating because of inability to accommodate the large amount of heat generated when appreciable current passes through the element. The bushing, which permits the potentiometer to be affixed to a panel and which serves as a bearing for the adjusting shaft, necessitates use of a retaining device such as a snap ring on the shaft, which in turn requires a special precision forming operation on the shaft, and assembly of the retainer thereon. Thus it is evident that many components and many assembly operations which affect performance and reliability of the assembled unit are involved in the construction.

2. The Present Invention

Many of the assembly operations, and several of the components, involved in the prior-art potentiometer constructions are avoided or simplified in the present invention. Thus the actuating or adjusting shaft is permanently mounted for rotation in an externally threaded protrusion formed integrally with one molded member of the housing by the shaft being molded in place in that member. Thus manual assembly of those two parts is avoided with considerable reduction in the clearance between the parts; and the retaining ring or the like is eliminated. Further, rather than affixing the resistance element to the housing, that element, in accord with this invention, is mounted on an electrically insulative heat-conducting ceramic carrier that is directly attached to the adjusting shaft. Thus heat is rapidly conducted away from the resistance element via the ceramic carrier to the shaft from which it is readily radiated and/or conductively removed both through the normal mounting panel and the knob. As a consequence, the heat dissipation, temperature rating, and resistance stability of the potentiometer are grossly improved. Additionally, in accord with the invention, the contact devices are each made integral with the respective terminal, thus forming what are herein in instances termed terminal-contact members; and assembly of contacts to a rotor and soldering or spotwelding of connections are concurrently avoided or eliminated by molding the terminal-contact members in place in a molded housing member which conveniently may be the cap or cover piece of the housing. The terminal-contact members are preferably made of a material which hardens and gains resiliency when cold-worked, which material can be coined, and which does not require plating or other treatment generally required for facilitating soldering. The terminal-contact members are thus very simply formed, and by shearing and coining contact fingers and shaping and bending them, they are rendered resilient although formed from material which initially is preferably in annealed condition. Further the terminal-contact members are so arranged as to occupy only a very small space, are initially exposed to view to permit easy adjustment and inspection, and are locked in position with no possibility

of displacement due to vibration or shock. The terminal-contact members are preferably formed from annealed work-hardenable alloy, such as, for example, ASTM-B122-60 Alloy 4, containing 55percent copper, 27percent zinc and 18percent nickel. It will be herein made evident that no manual assembly of the terminals, nor the contacts, is required. The above-detailed novel features permit easy and inexpensive construction of a high-rating reliable potentiometer of minimum volume from only seven members, it being considered that the ceramic base and resistance element constitute a single member.

As illustrated herein in a preferred form, the resistance element is a cermet film formed on one face of a preferably circular ceramic wafer whose central aperture receives a reduced diameter short section of the inner end of the adjusting shaft; and the wafer is rigidly secured to the shaft by peening over the inner end of the short section of the shaft. Additionally, adhesive may also be utilized if desirable. Conveniently and most effectively, the principal or body member of the housing is formed as a shallow cup-shaped body with a threaded protrusion at its exterior, and with an upstanding projection protruding from the interior bottom of the cup, whereby to form a rotation limiting device herein termed a fixed stop. The ceramic wafer similarly is provided with a complementary protrusion or abutment on the face opposite from the cermet element, which abutment is herein termed a rotary stop. The stop devices thus provided are dimensioned so that rotation of the adjusting shaft is limited to that necessary to carry the entire length or extent of the arcuate resistance element past the contact points of the respective terminal-contact member. As will be made evident, each terminal-contact member is formed, for example, from a strip of resilient material, and with a plurality of resilient fingers or limbs at its inner end, with each finger terminating in a contact point that engages with one of the active (resistive or conductive) components on the rotary ceramic wafer. Thus contact-resistance variation (CRV) and contact noise in the electrical sense are minimized.

The foregoing brief general description of the invention makes it evident that it is a principal broad object of the invention to provide an exceptionally inexpensive potentiometer characterized by high electrical rating.

Another object of the invention is to provide a potentiometer construction with superior ability to rapidly dissipate heat that may be generated in the resistive element.

Another object of the invention is to provide a simple procedure for manufacturing a potentiometer.

Another object of the invention is to improve the precision of construction and operation of a potentiometer while concurrently simplifying assembly of the potentiometer.

Other objects and advantages of the invention are hereinafter set forth or made evident in the appended claims and the following detailed description of the presently preferred illustrative embodiment of the invention illustrated in the appended drawings.

DESCRIPTION OF THE DRAWINGS

The presently preferred illustrative physical embodiment of the invention is depicted in assembled form and in components form in the accompanying drawings, in which:

FIG. 1 is a pictorial view, to no particular scale, of a potentiometer embodying the invention;

FIG. 2 is a partially exploded pictorial view of first and second housing members separated and with operating and active components exposed to view, the scale being arbitrary;

FIG. 3 is a face view, to a slightly larger scale, of a resistance element device comprised in the potentiometer illustrated in FIGS. 1 and 2, showing a centrally apertured ceramic wafer of disc form carrying an arcuate cermet resistance element with conductive terminations and collectors of film form;

FIG. 4 is an inner face view of a second or subsidiary housing member in the form of a cover or cap with three molded-

in-place terminal-contact members, the scale being approximately the same as that used in FIG. 3;

FIG. 5 is a longitudinal axial cross-sectional view of the exemplary potentiometer, on a considerably enlarged scale, illustrating constructional features; and

FIG. 6 is an end view of the principal housing member and molded-in rotary shaft of the exemplary potentiometer, viewed from the cap or terminal end, prior to addition of the ceramic wafer and cap, the scale being approximately the same as that chosen for FIGS. 3 and 4.

DETAILED DESCRIPTION OF THE INVENTION

The illustrated potentiometer 20 embodying the invention comprises a first and principal housing member 22 of cup shape and a subsidiary or second housing member 24 in the form of a platelike cap or cover. Both of these members are preferably formed of moldable thermosetting material. Preferably the body member 22 is formed of glass-filled nylon with a small percentage of a polytetrafluoroethylene such as that marketed under the registered trademark Teflon, and preferably the composition is 40percent glass fiber, 55percent nylon and 5percent Teflon, whereby strength and dimensional stability under adverse temperature is attained and good lubricating characteristics are concurrently attained. The cap member 24 is preferably formed of diallyl phthalate whereby excellent resistance to physical abuse and temperature effects is attained, with compatibility with the material of which body member 22 is formed. Both of the members are electrically insulative.

The first housing member 22 is molded around a rotary adjusting shaft 26, fabricated of aluminum alloy such as alloy 2011-T3. The shaft is provided with at least one section 26a (FIG. 5) of reduced diameter within the molded-in portion of its length, whereby the shaft is held captive by member 22 but is rotatable about its axis therein. To insure that the shaft is rotatable in the encircling housing member 22, the shaft is initially coated with a film of a mold-release material, such as a silicone compound well known in the molding arts, prior to the molding operation. As indicated, the reduced-diameter intermediate portion 26a of the shaft is thus rotatably enclosed or situated in an exteriorly threaded cylindrical protuberance 22a formed as an integral part of member 22; and an externally exposed actuator-receiving portion 26b of the shaft is left protruding from member 22, whereby a shaft-rotating means such as a knob or other driver may be applied to the shaft for facilitating rotation.

The inner or rear end of shaft 26 is provided during its manufacture with an annular face 26c (FIG. 5) and a portion of reduced diameter forming a seat 26d, which face and seat serve as supporting and positioning means upon which is received and held an insulative wafer 28w comprised in the device 28. The shaft 26 is counterbored at its inner end, as indicated at 26e, to provide a deformable circular edge portion which is spun or pressed outwardly and tightly against the surface of wafer 28w as indicated at 26f. The wafer is thus firmly secured to the inner end of the shaft, so as to be rotatable therewith without slipping or other relative motion therebetween.

As is indicated in FIGS. 2 and 3, the rotary resistance element device 28 comprising the insulative ceramic wafer 28w carries on its rear face an outer annular conductive film 28a and an inner annular conductive film 28b encircling but spaced radially outwardly from the central aperture 28c. The films are produced by applying on the wafer, by silk screen or like means, a conductor-containing ink or paste such as silver ink, and firing the wafer to reduce the ink to a metal film, in a manner well known in the ceramics art. Disposed between films 28a and 28b on the rear face of the wafer 28, but separated therefrom between its ends, is an arcuate resistance element 28e. While the element 28e is herein shown and described as a cermet element whereby high current ratings are accommodated, it is evident that other types of thin-film

resistance elements may be used in certain applications of the principles of the invention. The arcuate element 28e is electrically connected at one end thereof to the outer conductive annulus 28a by an inward extension 28a' of the latter which overlies or underlies the end portion of the element and forms a conductive termination for the element. Similarly the element 28e is electrically connected at the other end thereof to the inner conductive annulus 28b by a termination 28b'. The terminations are preferably integral with and concurrently formed with the respective films 28a and 28b.

The preceding description makes it evident that as the shaft 26 is rotated, within limits hereinafter explained, the element 28e will be traversed in a circular path past a specific station at which it may be brushed by a set of one or more fixed contact points.

The second housing member, 24, is molded as a platelike disc that is shaped and dimensioned to fit securely on the rim 22r (FIG. 2) of the cup portion of housing member 22, and to be secured and sealed thereto by adhesive means and to thereby form in conjunction with member 22 a closed chamber C (FIG. 5). To aid in easy attachment of cap member 24 to the complementary rim of member 22, the latter is produced with inwardly projecting lugs such as 22m (FIG. 2), and member 24 is formed with complementary recesses such as 24m into which the lugs enter and seat as the cap is brought against the rim 22r and rotated. The periphery of the cap 24 is formed with a flange 24f against which rim 22r is devised to seat, and seating is as indicated in FIG. 5.

Incorporated into the cap member 24 of the housing by insert-molding techniques is a set 30 (FIG. 2) of terminal contact members which are, for example, fabricated from 0.012 inches thick annealed 18 percent nickel silver. As is indicated in FIGS. 4 and 5, the exterior face of the cap is depressed to expose a portion of each of the terminal-contact members so that each of those members has an outer exposed end that can be bent out rearwardly or left as shown; the members thus forming or providing electrical terminals 32, 34 and 36. Each such member has its other or inner end coined to achieve approximately 0.004 inches thickness and a hardness equal to spring temper, and each is further deformed to provide a respective one of sets of contact fingers, 32c, 34c, and 36c. The ends of the contact fingers 32 provide contact points 32c' (FIG. 5) that are positioned to contact or brush on the inner collector 28b, and similarly the fingers 34 provide points 34c' positioned to brush on the resistance element 28e. A similar set of contact points at the ends of the contact fingers 36c are positioned to contact or brush on the annular conductive return or collector 28a. The general positioning and interrelationships of the films and contact points are as indicated in FIG. 5 with respect to the fingers 32c and contact points 32c'.

To limit rotation of the rotor assembly comprising shaft 26 and wafer 28 so as to restrict brushing of contact points 34c' to the extent of element 28e between the terminations 28a' and 28b', the wafer is produced or formed with a protruding rotary stop abutment 28s (FIGS. 3 and 5) on its face opposite the conductive and resistive films 28a, 28b and 28e; and the inner face or floor of housing body member 22 is produced with an outstanding fixed stop abutment 22s (FIG. 6), both ends of which are adapted to arrest the rotary stop abutment 28s at a respective extreme of movement of the latter. Thus as rotation of the shaft 26 is continued in one direction, the rotary stop abutment 28s is arrested by one end face of the fixed stop 22s and one electrical end of element 28e is contacted by points 34c'; and as the rotation is continued in the opposite direction, the abutment 28s is arrested by the other end face of stop 22s and the other electrical end of the element 28e is contacted by points 34c'. The element is adjusted by rotation of the shaft to a position intermediate the noted extremes to bring the resistance (or potential) exhibited between terminal 34 and a selected one of the other terminals to the desired value.

To aid in securing the potentiometer in an aperture in a panel P (indicated in phantom form in FIG. 5), the body

member 22 is provided with a tang 22t (FIG. 2) that is adapted to be received in a small hole appropriately bored in the panel, in a manner known in the art. Also, the portion 22a of the body member is threaded, as indicated, for reception of fastener means such as a lockwasher and a nut. The thread may be formed by a threading tool, but is preferably produced during the molding operation.

It is evident from the foregoing description that the noted objects have been attained. By forming the resistance element on a highly heat-conductive ceramic disc firmly secured to a highly heat-conductive shaft extending to the ambient, heat dissipation is greatly facilitated and the potentiometer can be given a higher than ordinary operational rating. By forming the terminals and contacts of soft work-hardenable alloy and coining the contact fingers and points, the latter are given the resilience required and thus the formation and connection of separate terminals is obviated. Also, by forming the contact fingers with the respective terminals, and embedding or molding-in the terminals, a plurality of individual assembly operations and contact adjustments previously necessary have been eliminated and obviated. By molding the shaft in place in the principal housing member, some previously necessary assembling operations and parts, such as retainer means, have been made unnecessary and have been obviated or eliminated. Thus the potentiometer is much simpler than prior-art potentiometers of its class, and less expensive to produce. Further, high-performance characteristics are attained by the excellent heat-dissipating capacity provided and by the precision with which the assembly, as of the contact fingers and points, may be effected by the machinery used in molding the housing members.

Having described in detail the construction and assembly of a preferred form of the invention, it will be evident to others that features of the invention may vary in form and be used in potentiometers of other than the preferred illustrated form, and hence

I claim:

1. A potentiometer comprising:

- first means, including housing means including first and second insulation housing members;
- second means, including an actuating shaft rotatably mounted in said first housing member;
- third means, including an arcuate resistance element and return conductor means therefor and means supporting said element and conductor means on said shaft for rota-

tion therewith; and

fourth means, including a plurality of sets of resilient contact fingers supported by said housing means, one of said sets having contact points contacting said resistance element and another of said sets having contact points contacting said return conductor means,

whereby upon rotation of said shaft said resistance element is rotated past said one of said sets of spring contact fingers and the points thereof and varies the electrical resistance exhibited between said one set and said other set of contact fingers.

2. A potentiometer as defined in claim 1, in which said first housing member is of molded construction and said shaft has an intermediate portion rotatable in and retained in said first housing member by the latter being molded therearound, whereby usual parts and assembly operations are unnecessary.

3. A potentiometer as defined in claim 1, in which each of said sets of resilient contact fingers is integral with a respective conductive terminal member secured to and protruding from said second housing member by having an intermediate portion thereof molded in place in said second housing member, whereby usual parts and assembly operations are obviated and made unnecessary.

4. A potentiometer according to claim 3, in which at least one of said sets of resilient contact fingers is formed of work-hardening alloy whereby required resilience of said fingers is attained by operations inexpensively performed upon a soft easily worked alloy.

5. A potentiometer according to claim 1, in which said means supporting said resistance element is a ceramic wafer, and in which said wafer is secured to said shaft in good heat-conductive relation thereto, whereby optimum heat dissipation from said element is attained.

6. A potentiometer according to claim 5, in which said sets of resilient contact fingers are integral with respective conductive terminals of soft work-hardenable alloy and in which each of said terminals is permanently embedded in said second housing member.

7. A potentiometer according to claim 6, in which said wafer and said housing means comprise respective ones of movable and fixed stop means for restricting rotation of said wafer to the extent necessary to prevent rotation of either end of said resistance element past the contact points brushing thereon.

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