Nov. 19, 1968 H. GRAWE 3,412,364

CONTACT DEVICE

Filed April 29, 1966 2 Sheets-Sheet 1

FIG. 1

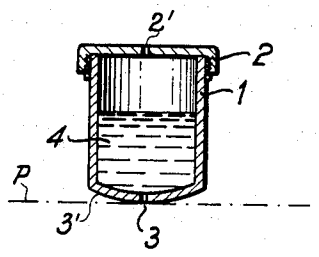


FIG. 2

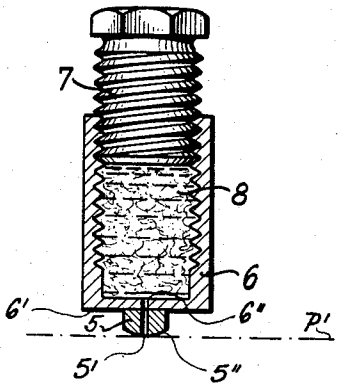


FIG. 3

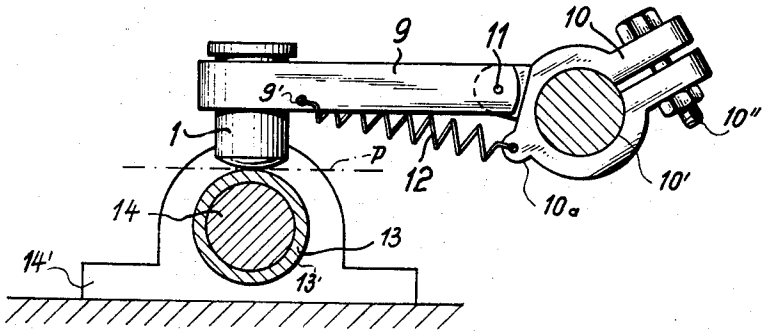
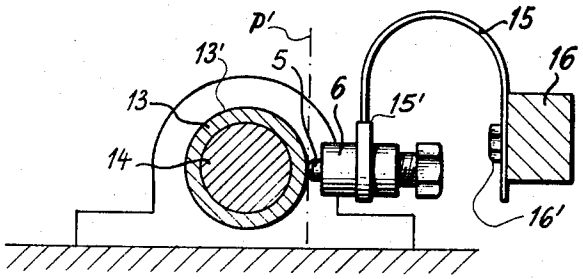


FIG. 4



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Nov. 19, 1968 H. GRAWE 3,412,364

CONTACT DEVICE

Filed April 29, 1966 2 Sheets-Sheet 2

FIG. 5

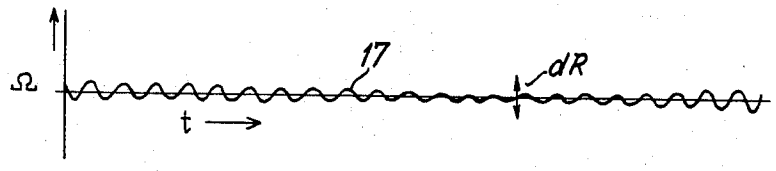


FIG. 6

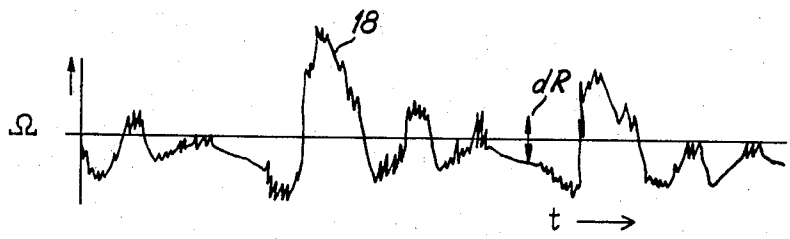
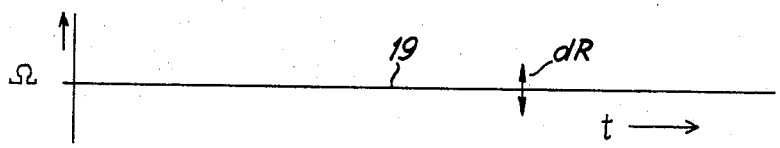


FIG. 7



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3,412,364

CONTACT DEVICE

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5 Claims. (Cl. 339—5)

ABSTRACT OF THE DISCLOSURE

A lubricated sliding contact in which a tabular liquid lubricant container is held by axial spring force radially against a rotating surface and bears upon the latter with a noble-metal contact part having a passage dimensioned with respect to the viscosity of the liquid lubricant to dispense the lubricant in a film only by adhesion to the moving surface and preventing flow of the lubricant from the container in the nonrotating condition of the surface.

My present invention relates to a contact arrangement for rotary devices and, more particularly, to a wiper-type contact or "brush" arrangement engageable with the rotating element for delivering an electric current to or receiving an electric current from a rotary part, such as a shaft, slip ring, commutator or the like.

Contact arrangements for connecting rotating elements with stationary members have been employed widely heretofore in motors, generators, measuring devices and the like and have generally included a "brush" in frictional engagement with the rotating part and biased thereagainst by spring means or another force for forming a sliding contact therewith. It has been proposed, in connection with such devices, to provide means for reducing the interfacial or transition resistance between the stationary element and the moving surface inasmuch as this interfacial or contact resistance significantly influences the results obtained or the characteristics of the electrical system, especially when the measurement or supply of relatively small currents is involved. It will be understood that work with relatively large current renders the comparatively small contact resistance at the surface of the rotating and stationary parts relatively insignificant; when however minute currents (in the milliampere and microampere range) are of interest even comparatively slight contact resistances and fluctuations in such contact resistances introduce errors and problems which are of considerable import.

Thus, for comparatively large current transfers, it has been proposed to use carbon "brushes" in which a carbon body bears directly against the moving surface. The wear of such "brushes" is of considerable disadvantage in that the contact parts themselves become soiled with the eroded residue of the brushes and, frequently, the irregular wear sharply influences the effective contact area and, consequently, the interfacial resistance. Thus, it has been suggested to provide a lubricant at the interfacial surfaces in the form of an electrically conductive oil, thereby reducing the wear and improving the uniformity of the voltage drop and resistance across the movable and stationary contact members. In another system designed to reduce wear of one or both contact members, it has been suggested to provide the contact members as a pair of rings between which a film of conductive lubricant is supplied centrifugally to constitute the actual current-conducting medium. A contact arrangement of the latter type, although having a relatively small frictional effect, requires a conductive fluid, such as mercury, which must be encapsulated at considerable expense and with complicated sealing means. Furthermore, the use of mercury limits the suitability of the materials for the contact members to a narrow range.

It is, therefore, the principal object of the present invention to provide an improved sliding contact for the electrical connecttion of a rotating member with a stationary member whereby the aforementioned disadvantages of prior systems can be obviated and a low-loss and low-resistance connection maintained with a minimum of wear and at a minimum of expense.

A further object of this invention is to provide an improved contact arrangement for connecting a stationary member with a shaft or other rotatable member which affords a uniformity of contact resistance in spite of the rotating member and which is free from the disadvantages and "noise" experienced hitherto in connection with graphite or carbon brushes and the like.

The above and other objects of this invention have been attained through the provision of a sliding-contact arrangement between a stationary member and a rotating member wherein the conductive cotnact body is hollow and is formed with a bottom portion substantially in osculating contact with the surface of the moving member and apertured for delivering an electrically conductive lubricant into the interface. According to a specific feature of this invention, therefore, a sliding-contact arrangement for the transmission of relatively small currents and with a uniform contact resistance comprises an electrically conductive oil-receiving bushing whose bottom is provided with an outlet bore for the lubricant and forms the contact face of this tubular body. I have found it to be an essential feature of this invention to provide means for urging this body axially against the rotating surface of the movable member with a uniform pressure and thus it is a key feature of this invention to journal the rotatable member for precise centered movement and provide a contact ring on the latter whose surface is precisely centered on the axis of rotation. Advantageously, the bore or aperture of the lubricant-containing bushing is so dimensioned that the lubrcant is drawn out of the interior of this bushing solely by adhesion to the rotating surface and cannot drip or flow through this opening in the absence of such surface adhesion. The arrangement thus constituted has been found to be highly advantageous not only because of its essential simplicity but because it fulfills all of the essential requirements for current transfer to or from the movable member. Thus, for example, the contact resistance is constant in spite of rotation of the movable member at high rate and is relatively small so as not to interfere with the measurement or delivery of relatively small electrical currents. When the device is used for the delivery of an electrical measurement signal, the contact "noise" even with low-power signals is reduced so substantially by comparison with earlier brush-type systems as to practically eliminate any falsification by "background" noise.

According to a more specific feature of this invention, the bottom portion of the tubular receptacle is provided with a contact member of a highly conductive and relatively inert metal, e.g. one of the noble or "coinage" metals, which can be inset in the bottom of the tubular oil reservoir or affixed thereto. Suitable metals for this contact portion of the tubular body include gold, silver, platinum and alloys of these metals with copper, iridium, rhodium and like metals of the platinum group or the

When the contact portion of the body is provided at the bottom thereof, the present invention provides that the bore for delivery of the lubricant to the contact face be formed in this body and of a diameter such that surface adhesion is required to withdraw the fluid from the reservoir. The contact face of the body advantageously is convex to ensure that the contact between the body (directly or via the additional contact portion) is effected in oscu-

lating fashion and, therefore, substantially point contact, both the convex face of the body and the rotatable surface being tangent substantially to a common plane parallel to the axis of rotation and perpendicular to the axis of the body and its bore through the interface. Within the outlet bores, the cohesive force attracting the oil onto the surface of the movable member should, of course, be greater than the surface tension tending to retain the lubricant in the outlet passage. Moreover, the oil or contact fluid should have a relatively low viscosity which, however, is subject only to slight variation with a wide temperature range including the temperatures of intended use of the contact arrangements. Thus, the oil must not become excessively viscous at low temperature or upon exposure to air, thereby ensuring that a uniform flow of oil (by adhesion) from the reservoir will result even at extreme temperature conditions and that a buildup of a contaminant film with a consequent variation in resistance will not result. Experiments have shown that a contact arrangement of this character has the electrical properties of a solder joint and is highly suitable for the transfer of relatively small measuring currents. Furthermore, the device can be rapidly assembled and replaced and is of proportionally low cost.

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is an axial cross-sectional view through a contact body in accordance with one aspect of this invention;

FIG. 2 is an axial cross-sectional view through another contact body in accordance with a further aspect of this invention;

FIG. 3 is an elevational view of a contact arrangement incorporating the contact body of FIG .1;

FIG. 4 is a view similar to FIG. 3 but showing a device utilizing the contact body of FIG. 2; and

FIGS. 5–7 are graphs diametrically illustrating some principles of the present invention.

Referring first to FIGS. 1 and 3, it will be seen that the sliding arrangement of the present invention can include a generally cylindrical lubricant receptacle **1** whose cap **2** is threaded onto the open end of body **1** which is formed with a bottom portion **3'** of downwardly convex conguration. This bottom portion is provided with a throughgoing bore **3** along the axis of the body **1** and substantially at the location at which a plane P is tangent to the domed or convex bottom **3'**. The cap **2** is provided with a thread engaging a complementary thread at the upper end of the body **1** and is provided with an aperture **2'** permitting air to enter the interior of the receptacle **1**. The diameter of bore **3** is small enough to prevent oil from leaking from the receptacle or drops from forming at the outlet **3** while permitting an oil film to be formed on the surface **13'** by adhesion thereto under the cohesive forces of this lubricant **4**.

As indicated in FIG. 3, the entire body **1** is electrically conductive and its bottom **3'** serves as the contact portion in engagement with the precisely centered contact ring **13** carried by the shaft **14**. The latter is journaled for precise rotation about its axis via means represented as a pillow block **14'** and the receptacle **1** bears resiliently against the precision-machined and centered surface **13'** of the ring **13** in the radial direction so that both the periphery **13'** of the movable member and the bottom **3'** of the body **1** osculate one another at the contact zone and are tangent to the common plane P.

The body **1** is carried by the conductive arm **9** which extends parallel to plane P and is pivotally connected at **11** to a stationary clamping shell **10** locked into a fixed member of the contacting arrangement **10'** by a bolt **10''**. A tension spring **12** holds the arm **9** downwardly (FIG. 3) to bring the body **1** to bear against the periphery **13'** of the rotatable member. The spring **12** is anchored to a lug **10***a* of the clamp **10** and to the arm **9** at an aperture **9'** therein.

Upon rotation of the shaft **14** and the ring **13**, a conductive oil film is formed upon the surface **13'** which forms a positive and substantially constant electrical connection for the current transfer between the shaft **14** and the body **1** for further communication to a measuring device or other current collecting element which in any conventional manner can be connected to the body **1**. Thus, a separate stationary contact member can be connected to the body **1** by wire or current delivery can be effected through the arm **9** and the fixed member **10'**. The means connected to contact body **1** are conventional and have not, therefore, been further illustrated or described herein.

While the arrangement of FIGS. 1 and 3 make use of a low-viscosity free-flowing liquid as the conductive lubricant, the arrangements of FIGS. 2 and 4 contains the lubricant in a pad or wick **8** received within the cylindrical conductive tubular body **6**. The latter is internally threaded and receives a plug-type screw **7** designed to close the open end of the sleeve **6** and to compress the pad **8**, thereby controlling the rate of flow of the conductive lubricant through an aperture **5'** formed in a contact piece **5** at the bottom **6'** of the body. This bottom portion **6'** is provided with an opening **6''** registering with the bore **5'** which opens at a convex contact face **5''** which is tangent at the opening **5'** to the plane P' extending perpendicular to the axis of the body **6**. The conductive body **6** is carried by a ring **15'** of a bowed spring **15** which urges the body **6** generally radially against the contact ring **13** of the rotating shaft **14**. In this case, the conductive means conducted with the body **6** can be the bowed spring **15** which is anchored to a stationary member **16** via a bolt **16'**. Again the contact body **6** osculates the periphery **13'** of the ring **13** at a plane P' which is tangent to both the convex contact surface **5''** and the periphery **13'** of the ring **13**. The contact portion **5** is composed of a low-friction inert and highly conductive noble metal, such as gold, silver, platinum, iridium, rhodium or alloys thereof.

In FIGS. 5–7, I show a graphic explanation of the significance of the present improvement. Thus, in FIG. 5, a plot **17** of the resistance against time for a periodic process is illustrated with the resistance value being measured as a function of current by a pen-type recorder or the like showing that the trace **17** has relatively small fluctuations with respect to a contact resistance arbitrarily represented at dR. The arrow dR represents an arbitrary resistance increment of, say, 0.02 ohm. It will be apparent from FIG. 5 and the trace **17** that very small currents are involved in the measurement and that variations of even the increment dR would be highly disadvantageous. When the measuring current is transmitted via a carbon brush and slip ring transmission, the contact "noise" gives rise to the resistance trace **18** represented in FIG. 6. From this figure it will be apparent that the background would completely obliterate the true measurement and that the results obtained would be meaningless. With the contact arrangement of this invention, however, the uniform and continuous trace **19** is obtained at the contact face so that measurements of a fraction of the type illustrated in FIG. 5 can be transmitted without difficulty. A comparison of the contact resistance traces **18** and **19** of FIGS. 6 and 7 demonstrate that the improved system of the present invention has a variation in contact resistance much less than dR (0.02 ohm) while the contact resistance of a carbon brush even with lubrication as previously described, is ineffective for measurement of fractions of resistances of even the order of 0.1 ohm. While such poor contact resistance characteristics do not effect high-current transfer, they are extremely damaging when low-current transmission is involved.

I claim:

1. In a sliding-contact arrangement for electrically connecting a stationary means with a movable member having a rotatable surface centered on an axis, an electrically

conductive contact body of said means forming a receptacle for a contact fluid and having a bottom portion bearing against said surface and provided with a passage for conducting said fluid onto said surface, the improvement wherein said passage is of a cross-section such that said fluid can be drawn therefrom by adhesion to said surface during rotation thereof but not by gravity.

2. The improvement defined in claim 1 wherein said bottom portion is provided with a contact part formed with said passage and engaging said surface, said part being composed of a noble metal, said bottom portion having a convex face osculating said surface and centered on an axis of said receptacle and said receptacle bearing axially against said surface along a radius thereof, said passage opening onto said surface at the center of said face.

3. The improvement defined in claim 2 wherein said fluid is a low-viscosity oil with a viscosity subject only to minor fluctuations within a wide temperature range.

4. The improvement defined in claim 2, further comprising spring means connecting said stationary means with said body for urging said face against said surface, said movable member being provided with means for accurately centering said surface on its axis of rotation, said face being composed of a noble metal selected from

the group consisting of gold, silver platinum, iridium, rhodium and alloys thereof, said passage being formed in said part.

5. The improvement defined in claim 4 wherein said body is a cylindrical tubular shell, further comprising a closure threaded into said shell remote from said face and a mass of compressible material adsorbing said fluid and said closure bears upon said mass for controlling the rate of flow of said fluid through said passage.

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