United States Patent

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[54] **IMPROVED ELECTRIC SWITCH CERAMIC CONTACT SUPPORTING MEMBER**
11 Claims, 4 Drawing Figs.

[52] U.S. Cl. 200/11, 252/12
[51] Int. Cl. H01h 19/58
[50] Field of Search 200/11D; 252/12

[56] References Cited

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ABSTRACT: An electric switch having a dry electrically insulating film bonded permanently to one of two proximate facing surfaces of a pair of relatively movable ceramic members, such as facing generally cylindrical surfaces of rotor and stator members. The film reduces friction while acting as an electrical insulator and serves a very important function in preventing interengagement of the surfaces to thereby prevent the formation of ceramic dust particles which might otherwise engage between electrical contacts carried by the ceramic members. The film preferably is heat bonded to the surface and may comprise a tetrafluoroethylene (Teflon) combined with either a bonding resin material or a water base with modifiers, or a molybdenum, tungsten or other metal sulfide combined with a sodium silicate or with isopropanol. Further important features relate to methods by which dry film lubricants of superior qualities are obtained, firmly bonded to the surface.

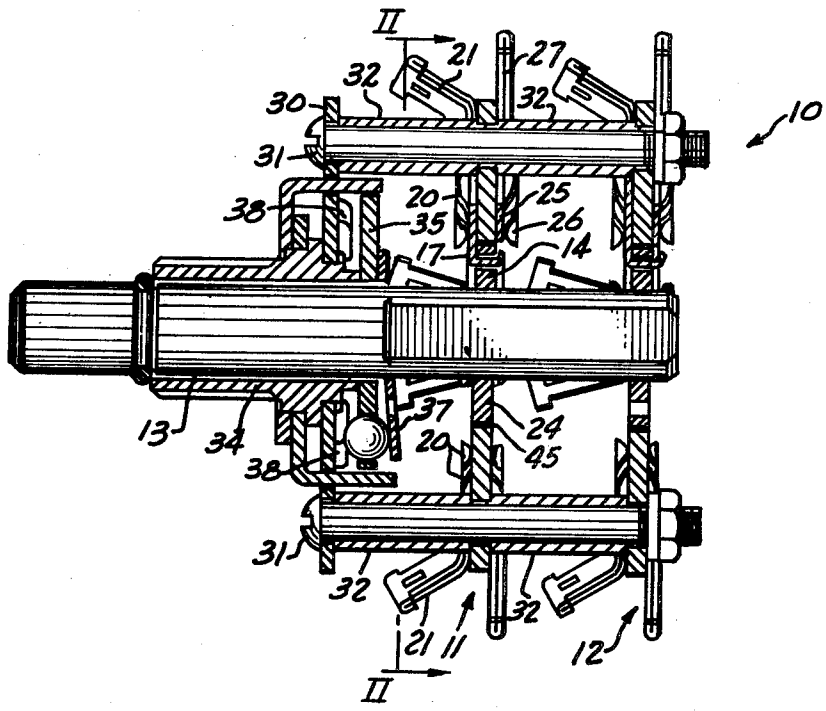


Fig. 1

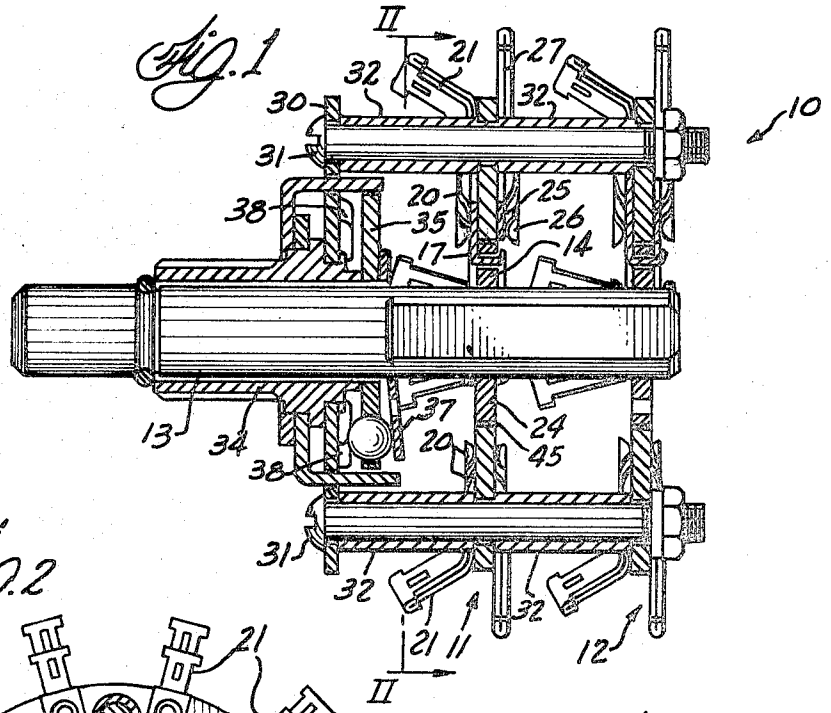


Fig. 2

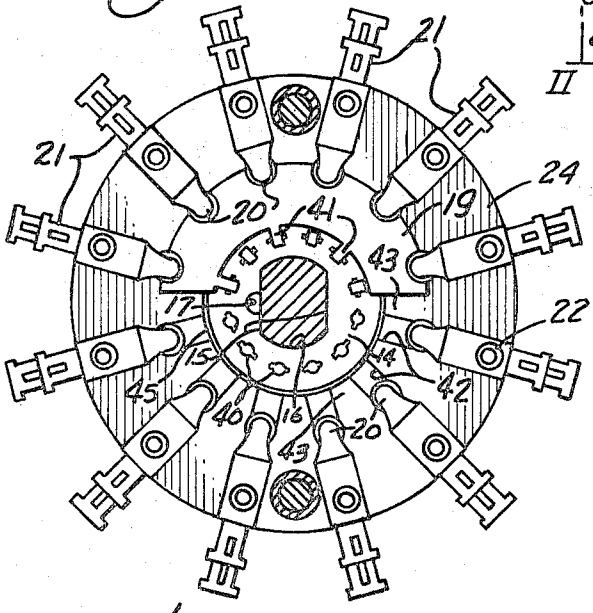


Fig. 3

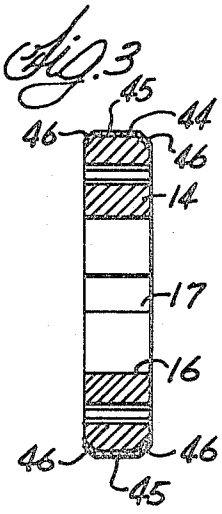
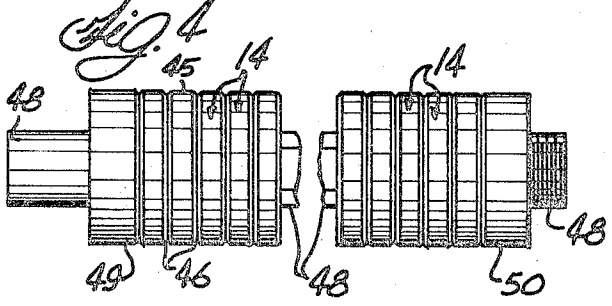


Fig. 4



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IMPROVED ELECTRIC SWITCH CERAMIC CONTACT SUPPORTING MEMBER

This invention relates to electric switches and methods of making the same to obtain extremely long life and a high degree of reliability with minimum energy being required for actuation, without requiring close manufacturing tolerances and with manufacturing expense being minimized.

Ceramic switches, i.e. switches wherein interengageable contacts are carried by ceramic parts, have advantages over other types of switches, but difficulties have been encountered with ceramic switches. In particular, the electrical switching action has not always been reliable and troubles have been experienced with regard to the force required to actuate the switches and with respect to noise.

This invention was evolved with the general object of overcoming the disadvantages of prior switch constructions and of providing switches which are quiet and easily operated while having high reliability.

Another object of the invention is to provide switches and methods of making the same to provide such advantages, but with minimum manufacturing expense and trouble.

The invention is based in part upon the discovery that the problems encountered with ceramic switches are due in large part to the rubbing contact between surfaces of relatively rotatable or otherwise relatively movable ceramic members. In particular, it has been found that the failure of switch contacts is oftentimes due to the lodging of ceramic particles between the engageable contacts and that such ceramic particles are formed by the abrasive action of interengaging ceramic parts. In addition, it has been found that the energy required to actuate the switches is increased substantially by the rubbing contact and varies to a considerable extent, resulting in faulty switch action in many cases. Further, the rubbing of the surfaces has caused a gritting sensation, unpleasant to the ear and to the touch.

It is also found that it is extremely difficult and virtually impossible in practice to maintain manufacturing tolerances which are sufficiently close to prevent the rubbing contact.

According to this invention, a dry electrically insulating film lubricant is permanently bonded to one of two proximate facing surfaces of a pair of relatively movable ceramic members, such as one of the facing generally cylindrical surfaces of rotor and stator members. The film lubricant reduces friction while acting as an insulator and serves a very important function in preventing interengagement of the surfaces to thereby prevent the formation of ceramic dust particles which might otherwise engage between electrical contacts carried by the ceramic members.

In addition, close manufacturing tolerances are not required.

The dry film lubricant is particularly advantageous in switch assemblies of the type in which various types of contacts are assembled, according to the functions which the switching assemblies do perform. In such switches, and particularly in rotary switches, an electrical contact or contacts may be secured to a rotor member which is keyed to an actuating shaft and it is desirable to allow a relatively loose fit in order to permit ready assembly of the switch. At the same time, it is desirable to eliminate any binding action which might cause canting of the member or otherwise cause malfunction of the switch. With the dry film lubricant, such difficulties are minimized.

In accordance with an important feature of the invention, the dry film lubricant is heat bonded to the surface of a ceramic part, to minimize peeling and to obtain long life.

One preferred composition of the dry film lubricant is a tetrafluoroethylene material (teflon) which has excellent electrical and lubricating properties and which is tough with a long life. The tetrafluoroethylene material may be combined with a water base with modifiers and, after applying an air drain, may be fused and bonded to the surface by baking at a relatively high temperature. Preferably, however, the tetrafluoroethylene material is combined with a bonding resin, such as a phenolic resin or an epoxy resin, which, in accordance with the recommendations of suppliers, may be baked at a temperature on the order of from 300 to 350° F. It has been discovered, however, that superior results can be obtained by increasing the temperature to a temperature on the order of 500° F. or higher, or by performing a subsequent baking step at that temperature. Apparently, the resin material decomposes to a certain extent at the higher temperature and, in any event, a superior bonding of the material to the ceramic surface is obtained.

Another preferred type of composition of the dry film lubricant is a molybdenum, tungsten or other metal sulfide combined with sodium silicate and water or with isopropanol. With sodium silicate, the parts may be preheated to a temperature on the order of 350° F. and then allowed to air dry, while with isopropanol, a simple air dry cure may be used.

In accordance with further features of the invention, the dry film lubricant is applied to generally cylindrical peripheral surfaces of ceramic rotor parts in the form of flat discs having central openings for passage of a support shaft therethrough. To apply the dry film lubricant, the rotor parts are stacked on carrier rods in a manner such that only the peripheral surfaces to be coated are exposed, after which the dry film lubricant composition may be sprayed or otherwise applied on the exposed surfaces, the baking, drying or other processing steps being then performed.

This invention contemplates other objects, features and advantages which will become more fully apparent from the following detailed description taken in conjunction with the accompanying drawing which illustrates a preferred embodiment and in which:

FIG. 1 is a cross-sectional view of a switch assembly constructed in accordance with the principles of this invention;

FIG. 2 is a cross-sectional view taken substantially along line II–II of FIG. 1;

FIG. 3 is a cross-sectional view, on an enlarged scale, of a rotor part according to the invention; and

FIG. 4 illustrates the stacking of rotor parts on a support rod for application of a dry film lubricant and for other processing.

Reference numeral **10** generally designates a ceramic switch assembly constructed in accordance with the principles of this invention.

The switch **10** has two sections **11** and **12** which, as illustrated, are of substantially identical construction each having a multiplicity of terminals which are interconnected in a particular manner under control of a rotatable operating shaft **13**. It will be understood that the contact arrangements and the number of sections may be changed according to the switching functions to be performed in the application for which the switch is designed.

The illustrated section **11** comprises a rotor disc **14** of ceramic material which is tightly fitted on and keyed to an end portion of the shaft **13** having two opposite flat portions **15** for indexing and keying. A small recess **17** in the central opening **16** is provided for visual orientation.

An arcuate contact segment **19** is carried from the front side of the rotor disc **14** and simultaneously engages six out of 12 contacts **20** formed integrally on the ends of clips **21** secured by rivets **22** on a stator disc **24** of ceramic material. If desired, a similar contact segment **25** may be carried from the rearward side of the rotor disc **14** to engage contacts **26** formed on the ends of clips **27** which are secured to the rearward side of the stator disc **24**. It will be understood that although front and back contact assemblies are illustrated, the design may be such that only one is provided and it will be further understood that different contact arrangements may be used, according to the switching operations to be performed.

The stator disc **24** of the assembly **11** and the stator disc of the assembly **12** are supported from a plate **30** by means of a pair of bolts **31** with suitable spacer sleeves **32** being disposed on the bolts **31**. The plate **30** is supported from a sleeve **34** which journals the shaft **13** and which carries a plate **35** disposed to the rear of the plate **30**. Plate **35** has an opening which receives a detent ball **36**, urged toward the plate **30** by a spring plate **37**. The plate **30** is formed with twelve rearward

projections **38** between which the ball **36** engages to releasibly lock the shaft **13** in a selected angular position.

It is desirable that different forms of contacts be attachable to the rotor disc **14**, as required, and in the illustrated arrangement, the rotor disc **14** is provided with twelve openings **40** in equiangularly spaced relation and at equal radial distances from the central axis, which receives tabs **41** extending from the inner edges of the segment **19**.

To insure good electrical contact, the contacts **20** and the clips **21** integral therewith are formed of a suitable resilient metal and in the unstressed condition thereof, the contacts **20** extend to the rear of the plane of the front surface of the segment **19** so as to obtain a pressure engagement between the contacts and the segment **19**. As illustrated, the stator disc **24** has radially extending slots **42** therein, aligned with the contacts **20** and defining radially inwardly projecting fingers **43** therebetween. The inner end surface portions of the fingers **43** are disposed in proximity to an outer cylindrical edge surface **44** of the rotor disc **14** and are of segmental cylindrical shape. The inner end surface portions of the fingers **43** thus together define an inwardly facing cylindrical surface which is interrupted due to the provision of the slots **42**. It will be understood, however, that an uninterrupted inwardly facing cylindrical surface may be provided on the stator disc, by reducing the extent of or by eliminating the slots **42**.

In accordance with this invention, a dry film lubricant **45** is affixed to the outer surface **44** of the rotor disc **14**. The lubricant **45** serves to prevent interengagement of the surface **44** with the surface portions on the ends of the fingers **43**, which is very important in preventing abrasive action and in preventing the formation of ceramic dust particles which might otherwise engage between the contacts **20** and **26** and the segments **19** and **25**. In addition, the lubricant **45** serves as an electrical insulator and it reduces friction, to reduce the energy required to rotate the shaft **13** from one position to another, as well as to obtain a more uniform and reliable action. The dry film lubricant **45**, in eliminating the rubbing of the ceramic disc, obviates a gritting sensation which is unpleasant to the ear and to the touch. Further, with the lubricant **45** it is not necessary to maintain extremely close tolerances, or to critically align and realign the parts, decreasing the labor and expense of manufacture, and extending the life of the switch.

According to a specific feature, the outer surface of the rotor disc **14** is formed with chamfered or beveled edges **46** to which the dry film lubricant **45** is affixed, to minimize the possibility of peeling of the lubricant from the rotor disc during assembly, and to otherwise improve the durability and effectiveness of the lubricant.

In accordance with a further feature of the invention, the lubricant is heat bonded to the surface of the ceramic disc **14**. One preferred type of composition is a tetrafluoroethylene material (teflon) which may be combined with either a bonding resin material or with a water base with modifiers. Another preferred type of composition is a molybdenum, tungsten or other metal sulfide combined with a sodium silicate or with isopropanol. Although other types of compositions might be used, the following are given as examples:

EXAMPLE I

A colloidal tetrafluoroethylene resin is combined with a phenolic resin solution, preferably with a solid content of 50 percent tetrafluoroethylene and 50 percent of the resin, and the liquid dispersion so obtained is sprayed or otherwise applied to the surface of the ceramic part, after which it is baked at a temperature on the order of 300° F. for one hour. The dispersion material used may be that marketed under the Trademark EMRALON 310, a product of the Acheson Colloids Company. The baking temperature of 300° F. is suggested in the product data sheet of the manufacturer. It is found, however, that the film can be treated at a substantially higher temperature, on the order of 550° F. to obtain unexpected results including better adhesion or bonding of the material to the ceramic, and superior lubricating qualities. Apparently, a major portion of the resin is driven off at the elevated temperature. The treatment at the elevated temperature is preferably performed after initially baking the material at a temperature of approximately 300° F. in accordance with the manufacturer's data sheet.

EXAMPLE II

A colloidal tetrafluoroethylene resin is combined with an epoxy resin solution, preferably with a solids content of 50 percent tetrafluoroethylene and 50 percent of the resin, and a liquid dispersion so obtained is sprayed or otherwise applied to the surface of the ceramic part, after which it is baked at a temperature of approximately 350° F. for 1 hour. The dispersion material may be that marketed under the Trademark EMRALON 315, a product of the Acheson Colloids Company and the baking temperature of 350° F. is suggested by the manufactuere's data sheet. Here again, the treatment at an elevated temperature, on the order of 550° F., may be performed to obtain improved and unexpected results.

EXAMPLE III

Colloidal molybdenum disulfide is combined with sodium silicate and water, preferably with the solids content of the molybdenum disulfide being 20 percent, and the liquid dispersion so obtained is sprayed or otherwise applied to the surface of the ceramic part, after preheating the part to a temperature of approximately 350° F., the film being cured by drying in air. The molybdenum disulfide material is marketed as No. 206 by the Acheson Colloids Company.

EXAMPLE IV

This example is the same as example III except that isopropanol is substituted for the sodium silicate and water, and the preheating of the ceramic part is not performed. The dispersion is available as dispersion No. 210 of the Acheson Colloids Company.

EXAMPLE V

This example is the same as example III, except that a tungsten disulfide is substituted for the molydbenum disulfide, the dispersion being available from Acheson Colloids Company as dispersion EC-2321.

EXAMPLE VI

This example is the same as example IV, except that a tungsten disulfide is substituted for the molybdenum disulfide, the dispersion being available as dispersion EC-2325 of the Acheson Colloids Company.

EXAMPLE VII

Tetrafluoroethylene combined with 30 to 50 percent of water plus modifiers is sprayed or otherwise applied as a liquid dispersion to the surface of the ceramic part, is allowed to air dry for 15 minutes and is fused at a temperature on the order of from 725 to 800° F. for 15 to 25 minutes. The dispersion is available as No. 851-204 of E. I. DuPont de Nemours Company.

Of these seven examples, the composition of examples 1 and 2 appear to give the best test results, with regard to obtaining a low coefficient of friction, electrical insulation characteristics, temperature ranges of surface, surface adhesion of the bonding vehicles, abrasive resistance, ease of application and ability to control film thickness. However, the other compositions may be used and may have advantages in specific applications.

Further, with regard to film thickness, the film thickness is preferably on the order of from 0.0004 to 0.0006 inches.

Referring now to FIG. **4**, the ceramic disc **14**, prior to application of the dry film lubricant, may be stacked on a carrier rod **48**, between a cylindrical part **49** affixed on the rod **48** and

a cylindrical part **50** which is preferably threaded on the rod **48** so that the planar faces of the disc **14** are tightly held together. With the ceramic disc **14** stacked on the carrier rod **48**, the dry film lubricant may be sprayed to cover the outer cylindrical surfaces **44** as well as the chamfered or beveled edge portions **46**, and they may then be cured, according to one of the examples as set forth above. The disc **14** may then be removed from the carrier rods, and it is noted that the provision of the beveled edges is an advantage in this respect, in that the film thickness is slightly less at the junction between adjacent discs and is more readily broken.

It is noted that the dry film lubricant can be applied to one of the interengageable surfaces of a pair of ceramic parts which are not relatively rotatable but are relatively movable otherwise, such as parts supported for relative reciprocable movement. It is further noted that although the dry film lubricant is applied in the illustrated embodiment to the outer cylindrical surface of the rotor disc **14**, it could be applied to the inner end surface portions of the fingers **43** and in applying the lubricant, a plurality of the stator discs **24** could be stacked to place the planar surfaces thereof in firm engagement, with the coating being applied inside the stator parts so stacked.

It will be understood that other modifications and variations may be effected without departing from the spirit and scope of the novel concepts of this invention.

I claim:

1. A ceramic contact-supporting member for an electric switch having a surface for disposition in proximity to a surface of another ceramic contact-supporting member movable relative thereto, and an electrically insulating film incorporating therein a polymeric bonding resin material and a dry lubricant and being permanently coated on and affixed to said surface of said member to prevent abrasive interengagement of said surfaces and to prevent the formation of ceramic dust particles which might otherwise engage between contacts carried by said members.

2. A ceramic member as defined in claim **1** in the form of a rotor disc with said surface being an outer peripheral portion thereof.

3. A ceramic member as defined in claim **1** with said dry film lubricant comprising a tetrafluoroethylene material.

4. A ceramic part as defined in claim **1** wherein said bonding resin material comprises a phenolic resin material.

5. A ceramic member as defined in claim **1** wherein said bonding resin material comprises an epoxy resin material.

6. A ceramic member as defined in claim **1**, wherein said dry film lubricant comprises a metal disulfide material.

7. The structure of claim **1** wherein the ceramic member to which said film is affixed is a stator.

8. A ceramic member as defined in claim **1** wherein said film comprises a colloidal dispersion of a dry lubricant in a matrix of a polymeric bonding resin material.

9. In an electric switch including two members of ceramic material and interengageable electrical contacts attached to said members, said members being relatively movable and having interengageable surfaces in close proximity, an electrically insulating film incorporating therein a polymeric bonding resin and a dry lubricant and being permanently coated on and affixed to one of said surfaces to prevent abrasive interengagement of said surfaces and to thereby prevent the formation of ceramic dust particles which might otherwise engage between said electrical contacts.

10. In an electric switch as defined in claim **9**, said ceramic members being in the form of relatively rotatable discs and said surfaces being generally concentric inner and outer facing surface portions of said discs.

11. A ceramic contact-supporting member for an electric switch having a surface for disposition in proximity to a surface of another ceramic supporting member movable relative thereto, and a dry electrically insulating film coated on and permanently bonded to the surface of said member, said film incorporating a polymeric bonding resin material and a dry lubricant, said polymeric bonding resin being at least partially decomposed, said film being effective to prevent abrasive interengagement of said ceramic contact-supporting member surfaces to prevent the formation of ceramic dust particles which might otherwise become disposed between the contacts carried by said members.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,553,394 Dated January 5, 1971

Inventor(s) ALDRICH JOHN ZIDLICKY

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 3, line 1, "releasibly" should be -- releasably --.

Column 4, line 19, "manufactuere's" should be -- manufacturer's --.

Column 4, line 44, "molydbenum" should be -- molybdenum --.

Column 4, line 63, "composition" should be -- compositions --.

IN CLAIM 6:

Delete "film" from the second line in this claim.

Signed and sealed this 15th day of May 1973.

(SEAL)
Attest:

EDWARD M.FLETCHER,JR.
Attesting Officer

ROBERT GOTTSCHALK
Commissioner of Patent