Feb. 1, 1972 H. W. McCARD 3,639,639

CERMET HAVING LUBRICATING PROPERTIES AND PROCESS

Filed March 11, 1969 2 Sheets-Sheet 1

Fig. 1.

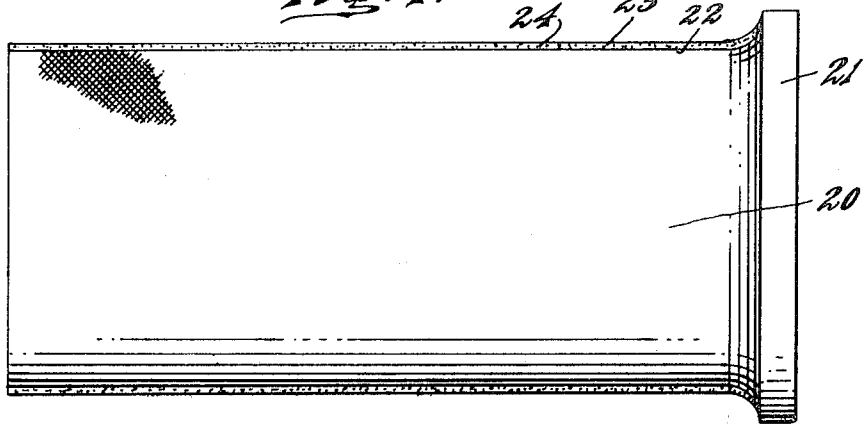


Fig. 2.

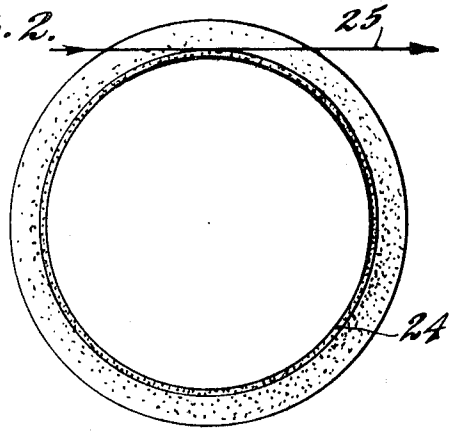
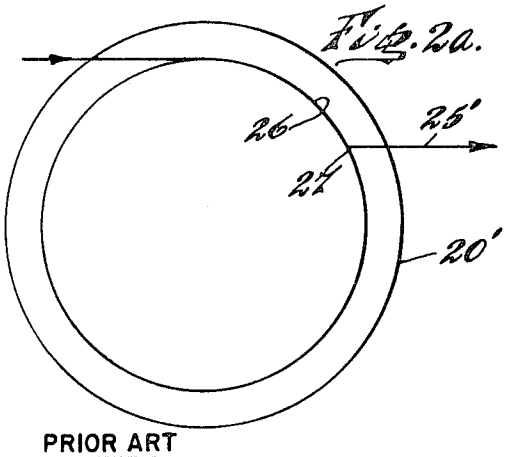


Fig. 2a.



PRIOR ART

Fig. 3.

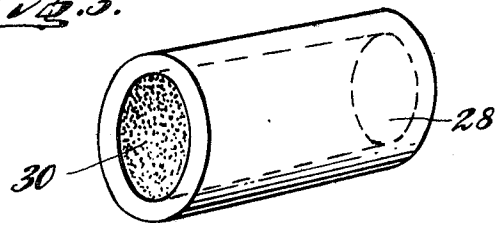
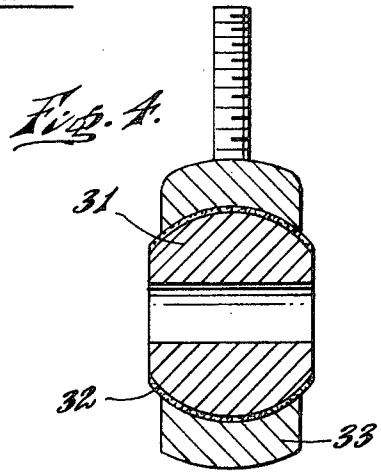


Fig. 4.



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CERMET HAVING LUBRICATING PROPERTIES AND PROCESS

Filed March 11, 1969 2 Sheets-Sheet 2

Fig. 5.

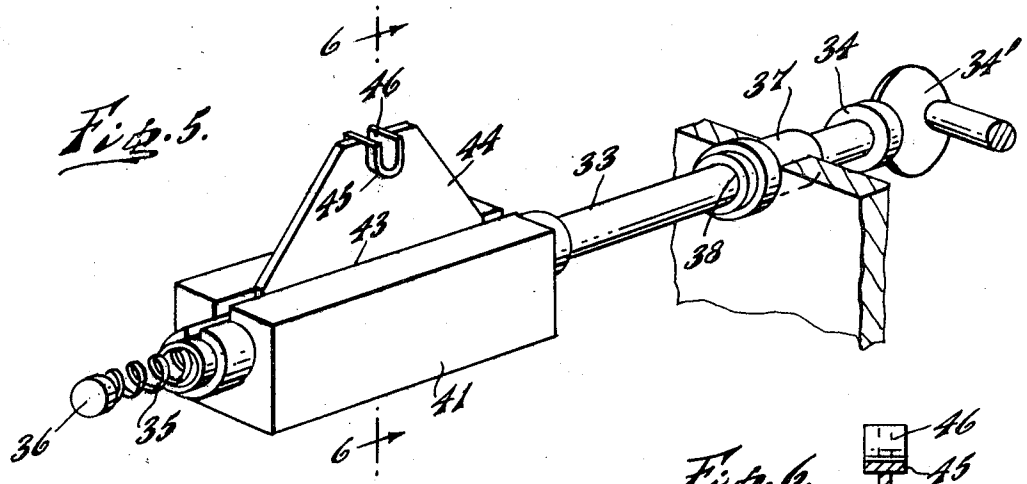


Fig. 6.

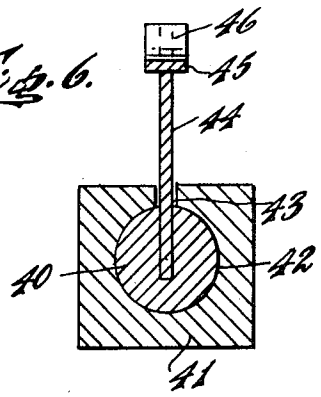


Fig. 7.

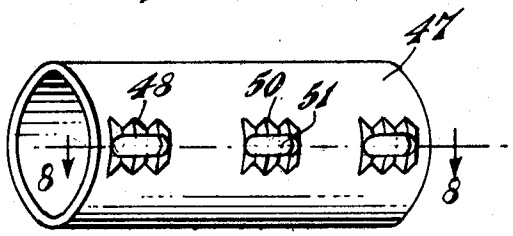


Fig. 8.

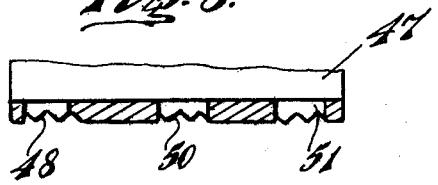
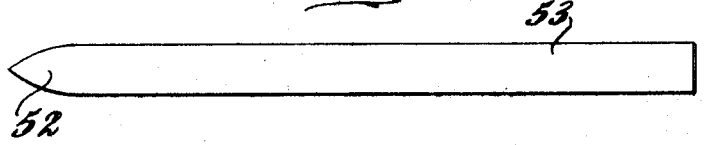


Fig. 9.



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3,639,639

CERMET HAVING LUBRICATING PROPERTIES AND PROCESS

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U.S. Cl. 117—71 R 13 Claims

ABSTRACT OF THE DISCLOSURE

An antifriction object having a porous cermet surface and a lubricating plastic such as Teflon impregnated in the pores. In applying the process to make the object, the lubricating plastic may be burnished to penetrate the pores. The cermet impregnated with the lubricating plastic is heated just below the off-gassing temperature for the plastic.

The present invention relates to an antifriction surface which can be applied to an object and a process of creating the same.

A purpose of the invention is to deposit a cermet surface on an object, and to impregnate the surface with an antifriction material such as Teflon.

A further purpose is to make up the cermet by 5–95% by weight of metal particles, preferably 5–70% by weight and most desirably 5–15% by weight, incorporating 95–5% by weight of ceramic particles.

A further purpose is to increase the content of metal in the cermet to the order of 70% by weight to obtain coefficients of friction of the order of 0.5, or to lower the content of metal in the cermet to of the order of 5% by weight in order to obtain coefficients of friction of about 9.2 with most synthetic fibers.

A further purpose is to employ as the metal in the cermet, nickel, chromium, titanium, tungsten or copper (preferably with titanium hydride) or mixtures thereof.

A further purpose is to use as the ceramic in the cermet, titanium oxide, aluminum oxide, magnesium oxide, zirconium oxide, barium titanate or calcium boride or mixtures thereof.

A further purpose is to utilize the antifriction objects of the invention for textile contacting elements such as rolls, and for bearings and skis.

A further purpose is to secure the antifriction surface by applying a layer of lubricating plastic to the porous cermet surface, burnishing or spraying the lubricating plastic to make it penetrate the pores, and subjecting the object including the surface to a temperature just below the off-gassing temperature for the plastic so as to firmly bond the plastic in the cermet.

Further purposes appear in the specification and in the claims.

In the drawings I have chosen to illustrate a few only of the numerous embodiments in which the invention may appear, selecting the forms shown from the standpoints of convenience in illustration, satisfactory operation and clear demonstration of the principles involved.

FIG. 1 is a side elevation partly in central axial section showing the invention applied to a textile draw roll.

FIG. 2 is a diagrammatic end elevation of FIG. 1 showing the draw roll in action with a textile end passing around the roll.

FIG. 2*a* is a view similar to FIG. 2 showing the somewhat different operation of a draw roll of the prior art.

FIG. 3 is a perspective view of a bushing according to the invention.

FIG. 4 is an axial section of a spherical bearing according to the invention.

FIG. 5 is a diagrammatic sectional perspective of the invention applied to a high speed textile winder.

FIG. 6 is a diagrammatic section on the line 6—6 of FIG. 5.

FIG. 7 is a diagrammatic perspective of a scutcher applying the principles of the invention.

FIG. 8 is a section of FIG. 7 on the line 8—8.

FIG. 9 is a bottom plan view of a ski embodying the principles of the invention.

It is well known in the art to incorporate Teflon TFE into porous ceramic coatings in order to produce antifriction surfaces on textile rolls, cooking pans, bearings, and the like. See The Boeing Company British Patent 944,836, published Dec. 18, 1963, for Improvements in or Relating to the Bonding of Fluorinated Polymeric Coatings; English et al. U.S. Patent 3,080,134, granted Dec. 5, 1963, for Textile Filament Guide; and Steijn U.S. Patent 3,080,134, granted Mar. 5, 1963, for Textile Apparatus.

Such coatings, while useful for many purposes, are lacking in desirable properties. While they are very hard, they lack ductility, impact resistance and shock resistance so that they are not suitable for applications where a bearing or the like may be subjected to any sudden change in load which could apply impact, or subject it to pounding.

Furthermore, these prior art coatings are of very low heat conductivity and very low electrical conductivity.

In the present invention, cermets consisting of metal particles and ceramic particles are used to provide a porous backing in which a lubricating plastic is impregnated. As a consequence, the antifriction surfaces are possessed of much more ductility, impact resistance and shock resistance than in the prior art ceramic coatings. Furthermore, the presence of the metal particles in the cermet greatly increases the heat conductivity, thus removing heat if heat may be developed. Furthermore, the cermet surfaces are of enhancing electrical conductivity and this is very useful where static electricity may develop in textile operations, since the roll or other object of the invention is capable of removing the static electric charge. The heat conductivity is also useful where it is desired to use the roll or the like as a means of imparting heat to a textile, as for example for imparting loft to yarn.

Since the application of cermet surfaces to objects, such as metal rolls and the like, is well known in the art, it will not be explained in great detail. The surface of the metal object to receive the cermet deposit is suitably roughened, and the cermet is applied by flame spraying so as to create a porous deposit or layer, having a porosity of the order of 5–20% by volume.

In making up the cermet of the invention, the content of metal should vary from 5–95% by weight, the balance being ceramic. Normally, it is desired, particularly in textile rolls or the like, to obtain a coefficient of friction of the order of about 0.2 with a synthetic fiber, and for this purpose I find it best to reduce the quantity of metal to a quantity within the range of 5–15%. On the other hand, while much superior ductility and impact resistance and heat and electrical conductivity are obtained in a cermet of this character as compared to a ceramic coating, there are many installations where it is important either to obtain still higher ductility, impact resistance or heat or electrical conductivity, or to obtain a higher coefficient of friction. I find that with most of the synthetic fibers, a cermet used in the invention having a metal content of the order of 70% by weight and impregnated with the lubricating plastic, gives a coefficient of friction of about 0.5, with of course enhanced ductility, impact resistance and heat and electrical conductivity.

Thus for most purposes it is preferred to employ a content of metal particles in the cermet of between 5 and 70% by weight.

In making up the cermet of the invention, any one of a number of different metal particles can be employed alone or in mixtures with one another. I prefer to make the metal content of the cermet of nickel particles. Chromium particles are my second choice. Other metal particles which may be used very effectively are titanium, tungsten or copper. When copper is employed it is very desirable to incorporate 1 or 2% by weight of titanium hydride in the copper particles in order to obtain a more coherent deposit. It should be recognized, however, that other metal particles than those mentioned above may be used.

While the size of the metal particles will vary in various flame spraying operations, I prefer to spray metal particles having a size of about 170 to 250 mesh per linear inch or below.

As to the ceramic composition of the cermet, any one of a wide variety of metal oxides, titanates or borides can be used. I have obtained good results with titanium oxide (TiO_2), aluminum oxide, magnesium oxide, zirconium oxide, barium titanate, and calcium boride. I prefer to use aluminum oxide as one of the ceramic ingredients because of its extreme hardness. In many cases, however, particularly for textile rolls, it is desired to avoid building up static, and I prefer to use titanium oxide with aluminum oxide so as to eliminate the static because titanium oxide increases the electrical conductivity and the heat conductivity. Thus the preferred composition comprises equal parts by weight of aluminum oxide and titanium oxide to make up the ceramic content of the cermet.

In some cases it is desirable to obtain a high electrical insulating property in the cermet, and where this is desired, I use a relatively low proportion of metal and use zirconium oxide as the ceramic, since this has very good electrical insulating properties.

While various sizes of particles may be employed for the ceramic, I prefer to use ceramic particles in the size range between 125 and 250 mesh per linear inch or finer.

Example 1

A mixture of 5% by weight of nickel particles, 47.5% by weight of titanium oxide and 47.5% by weight of aluminum oxide are flame sprayed on a suitably roughened steel roll surface. This produces a very desirable cermet according to the present invention, having some ductility and impact resistance, and great hardness, and, because of the titanium oxide, favorable electrical conductivity. If impregnated with Teflon TFE as later described, it will give a coefficient of friction of about 0.2 with a synthetic fiber such as nylon, rayon or cellulose acetate.

Example 2

In this case the composition flame sprayed on the metal roll backing is 5% chromium and 95% zirconium oxide. After impregnation with a lubricating plastic, this gives a favorable surface as a bearing or a releasing surface for a textile and has high electrical insulating properties for applications requiring this.

Example 3

70% by weight of nickel particles, 15% by weight of titanium oxide and 15% by weight of aluminum oxide are mixed and flame sprayed on a steel backing which has been suitably prepared. This gives a coefficient of friction after impregnating with Teflon TFE of about 0.3 with most synthetic fibers. The layer in this case is of high heat and electrical conductivity and is very ductile and resistant to impact.

The lubricating plastic preferred for use in the present invention is Teflon TFE, polytetrafluoroethylene. Other fluoroethylenes may be used, for example, Teflon FEP, the copolymer of tetrafluoroethylene and the hexafluoropropylene. Kel-F, which is monochlorotrifluoroethylene, may be employed, less desirably. CTFE Kynar, which is a polymer of vinylidene fluoride containing more than 59% of fluorine by weight, can be used, but less desirably. Still less desirably, nylon may be employed as a lubricating plastic.

The lubricating plastic should be applied to the surface of the cermet which has cooled to approximately room temperature. One way to apply the plastic is simply to pour or spray on the ceramic coating a stream of finely divided plastic particles, preferably in the size range of 0.01 to 0.5 micron, with an average particle size of 0.2 micron. Another procedure which can be used effectively is to spray or dip the cermet coating with a dispersion of the desired plastic in water or another medium, for example a dispersion of Teflon TFE, nylon, or the like as well known.

The lubricating plastic particles have amazing power to penetrate the cermet layer. For example, I have found that it is very easy to cause penetration of Teflon TFE or other lubricating plastic to a depth of at least 0.005 inch simply by burnishing with the fingers, that is, rubbing them over the surface. I also find that if the cermet surface is ground off in the process of reducing it to size and desired smoothness, the grinding accomplishes burnishing and the lubricating plastic penetrates into the cermet a considerable distance beyond the surface produced by finished grinding, thus assuring adequate penetration. For example, in a case in which the cermet layer extended 0.01 inch beyond the metal backing, and in which the lubricating plastic consisted of Teflon TFE dispersion sprayed on it two layers on the surface, the surface was then ground down to make a finish machined outer surface by removing 0.005 inch, it was found that the burnishing incident to the grinding caused the polyfluoroethylene to penetrate into the pores to a depth in excess of 0.005 inch so that the finished surface had high lubricity and antistick properties due to polyfluoroethylene which had not been removed by the grinding.

Example 4

The cermet layer according to Example 1 was coated with dry particles of Teflon TFE through 100 mesh, and the particles were burnished by rubbing with the fingers. The base metal and the polytetrafluoroethylene impregnated material were then heated just below the off-gassing temperature, in this case to a temperature of 750° F. for a time of at least one hour. This caused partial melting of the plastic and firm bonding in the cermet. Where very thin layers are concerned, a heating time of 15 minutes has been found to be adequate.

Where the polyfluoroethylene layer is Teflon FEP, the temperature for final heat treatment will suitably be 350° F. Where the polyfluoroethylene is Kel-F, the temperature for final heat treatment will be in the range of 600–750° F. Where the polyfluoroethylene is CTFE Kynar, the final heat treatment temperature will be about 350° F. Where the lubricating plastic is nylon, the temperature of final heat treatment will be about 425° F. All of these temperatures are approximate.

Example 5

The procedure of Example 1 is carried out and two layers of Teflon TFE water dispersion are applied by spraying on the cold surface of the cermet. This coating is allowed to dry and then heat treated at 750° F. for one hour. A very good penetration is obtained of the order of 0.005 inch.

The finished antifriction object has a thin lubricating plastic layer on the outside which rubs off very quickly, but has a latticelike cermet structure to which the lubricating plastic is firmly bonded by the partial melting and

curing of the plastic accompanying the heat treatment, and this is a very durable coating of suitably low and controllable coefficient of friction, acting like a dry bearing or a textile release surface.

FIG. 1 shows a draw roll for use in the production or processing of textile filaments, fibers or yarns, having a roll body **20** provided with a hub **21** at one end and a cylindrical outer surface **22** which is roughened to apply the cermet. On this outer surface **22** is applied a cermet layer **23** desirably by flame spraying, the layer **23** being shown in section in FIG. 1. After the cermet layer is applied and cooled, a lubricating plastic is impregnated into the layer **23** as suggested at **24**, the layer if necessary is burnished to cause penetration through the three-dimensional latticelike structure of the cermet, and the layer is heat treated.

FIG. 2 shows the draw roll of FIG. 1 in end view illustrating the takeoff of a textile end **25** passing around the roll. Since this is engaging the outer plastic impregnated cermet surface **24**, the textile end **25** comes off substantially tangentially from the roll surface.

This roll surface has great resistance to stains which might discolor the textile.

FIG. 2*a* shows at **25'** a comparable textile draw roll **20'** lacking the layer of the invention and as shown, the textile end follows the circumference of the roll at **26** before abruptly departing from the roll at **27**, since the roll does not have favorable release properties as imparted by the present invention. This has a tendency to create an abrupt jolt of stress concentration on the textile end which is likely to cause breakage.

FIG. 3 shows a steel or other metal bushing **28** of cylindrical shape having an interior cermet and heat treated plastic impregnated surface **30** adapted to engage a pin or shaft, not shown. This is particularly suitable for a bearing of the dry type, eliminating the likelihood that leakage of oil or grease could occur. This is especially suited for a bearing where the oil wedge type of lubricating cannot occur either because of very slow motion, or nonrotational type of motion. This is also particularly useful around machinery where the leakage of oil can do damage as by staining of textiles or otherwise.

FIG. 4 shows a spherical bearing having a metallic ball **31** which has a heat treated plastic impregnated cermet coating **32** deposited on the spherical surface of the ball according to the principles of the present invention. Fitting around the plastic impregnated cermet surface is a socket **33**, which may be fitted by any one of the well known techniques in the art, for example deforming a relatively soft socket to fit the ball.

This type of spherical bearing is applicable, for example, to the blade attitude control bearings of a helicopter which, even though in the prior art they were lubricated frequently, are essentially dry bearings. This undergoes an oscillatory motion in more than one plane of oscillation under conditions which do not build up and maintain an oil film, even if oil is present. There are various other dry spherical bearings and the technique of the present invention is intended to provide such bearings of improved resistance to impact and the like, replacing such bearings as impregnated cotton fabric or fiberglass on the surface of the balls. The heat treated impregnated cermet surface of the present invention is much more resistant to cold flow than such fabric bearings, the cermet greatly increasing the compressive strength of the overall assembly.

FIGS. 5 and 6 show a traverse rod bearing of a type used, for example, in a yarn winder of well known character. In this instance, a rod **33** has at one end a follower **34** riding a cam **34'** and urged toward it in any suitable manner, as for example, under the action of a spring **35** acting from a suitable abutment **36**. The rod **33** at one end has a circular portion which rides in a bushing **37** having an internal heat treated plastic impregnated cermet coating **38** according to the invention. At the other end a somewhat enlarged circular portion **40** rides in a bearing **41**, the portion **40** having a heat treated plastic impregnated cermet layer **42** on its outside surface. The enlarged portion **40** has a longitudinal slot **43** which receives therein a textile guide bracket **44** which at the top mounts a hollow textile guide **45** moving back and forth and provided with a heat treated plastic impregnated cermet surface **46** in accordance with the invention.

FIGS. 7 and 8 show a tubular scutcher **47** having upwardly extending serrated surfaces **48** which are provided with heat treated plastic impregnated cermet surfaces **50** thereon. Among the serrated surfaces **48** there are vacuum slots **51** connected to vacuum maintained in the interior, the vacuum serving to dry textile filament or the like passing transverse to the plane of the paper against the serrated surfaces.

FIG. 9 shows the sole plate of a ski **52** which has on its surface **53** a layer of cermet impregnated with plastic according to the principles of the present invention, and heat treated. The base metal can to advantage be aluminum or other very light metal or alloy. This imparts improved lubricity to the sole plate for the purpose of sliding on snow or ice.

In view of my invention and disclosure variations and modifications to meet individual whim or particular need will doubtless become evident to others skilled in the art, to obtain all or part of the benefits of my invention without copying the structure and process shown, and I therefore claim all such insofar as they fall within the reasonable spirit and scope of my claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. An antifriction device having an antifriction surface thereon consisting of a porous cermet surface having a metal content of approximately 5% and a metal oxide content of approximately 95%, and a lubricating plastic impregnated in the pores thereof, the coefficient of friction being approximately 0.2.

2. An antifriction device having an antifriction surface thereon consisting of a porous cermet surface containing between 5 and 15% of metal particles and equal parts by weight of titanium oxide and aluminum oxide particles and a lubricating plastic impregnated in the pores thereof.

3. An antifriction device having an antifriction surface thereon consisting of a porous cermet surface having a metal content of approximately 70% and a metal oxide content of approximately 30%, and a lubricating plastic impregnated in the pores thereof, the coefficient of friction being approximately 0.5.

4. A textile roll having contact with and release from textile filaments, fibers and yarns, having an antifriction surface consisting of a cermet of which the metal content is approximately 5% and the metal oxide content is approximately 95%, and a lubricating plastic impregnated in the pores thereof, having a coefficient of friction which is approximately 0.2.

5. A textile roll of claim **4**, in which the impregnating plastic comprises polytetrafluoroethylene.

6. A textile roll of claim **4**, in which the impregnating plastic comprises nylon.

7. The process of making an antifriction surface on an object, which comprises flame depositing on an object a porous cermet surface consisting of a metal and an oxide, cooling the surface, and applying to the surface a lubricating plastic.

8. The process of claim **7**, which further comprises subjecting the object having the cermet surface and the lubricating plastic on the surface to a temperature just below the off-gassing temperature of the lubricating plastic.

9. The process of making an antifriction surface on an object, having a predetermined coefficient of friction of

about 0.2, which comprises flame depositing a cermet surface on the object consisting of 5 to 15% of metal particles and equal parts by weight of titanium oxide and aluminum oxide particles, applying to the surface a lubricating plastic, and subjecting the object having the cermet surface to a temperature just below the off-gassing temperature of the lubricating plastic.

10. The process of claim **9**, which comprises burnishing the surface before heat treating.

11. The process of claim **9**, in which the lubricating plastic is polytetrafluoroethylene.

12. The process of claim **9**, in which the lubricating plastic is nylon.

13. The process of claim **9**, in which the metal is nickel.

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29—132; 38—62, 100; 117—71 M, 75, 72, 132 CF, 161 UF, 161 P, 105.2