NASA Case No. LEW-14,474-1

PRINT FIG. 4

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Serial No.: 720,133

Filed Date: 6/24/91

LeRC

(NASA-CASE-LEW-14474-1) PRETREATMENT OF [illegible] WITH SPUTTERED CADMIUM [illegible] (NASA) [illegible]

CSCL 11C

63/27 [illegible]

Unclas

NASA CASE NO. LEW-14,474-1

AWARDS ABSTRACT

PRETREATMENT OF LUBRICATED SURFACES WITH SPUTTERED CADMIUM OXIDE

Cadmium oxide is used with a dry solid lubricant on a surface to improve wear resistance. The surface topography is first altered by photochemical etching to a predetermined pattern. The cadmium oxide is then sputtered onto the altered surface to form an intermediate layer to more tightly hold the dry lubricant, such as graphite.

Inventor: Robert L. Fusaro
Employer: NASA Lewis Research Ctr.
Serial No.: 720,133
Filed: 6/24/91

NASA CASE NO. LEW-14,474-1

PATENT

PRETREATMENT OF LUBRICATED SURFACES WITH SPUTTERED CADMIUM OXIDE

Origin of the Invention

The invention described herein was made by an employee of the United States Government and may be manufactured and used by or for the Government for governmental purposes without the payment of any royalties thereon or therefor.

Technical Field

This invention is concerned with a surface pretreatment for solid lubricant films. The invention is particularly directed to the use of sputtered cadmium oxide to bond graphite more tightly to a selectively altered surface topography of a material for improved wear resistance.

Solid film lubrication provides low friction and wear by separating relatively moving surfaces with a solid material which has a low shear strength. The most widely used solid lubricants with low shear strengths are the layer-lattice or laminar solids, such as graphite or molybdenum disulfides.

Surfaces need to be prepared for the application of solid lubricant films. Present methods are either mechanically roughening or chemically pretreating. The surfaces may be mechanically roughened by sandblasting and chemically pretreated by zinc phosphate, gas nitriding, or the like.

Both of these methods tend to roughen the surface to aid in the bonding of the solid lubricant to the surface and to provide a reservoir for solid lubricant material. Chemicals on the chemically pretreated surface can, in addition, mix with the solid lubricant material to form a lubricating layer of the two constituents. No attempt has been made to ascertain the optimum ratio of reservoir area to sliding contact area.

Many times these methods will not provide adequate endurance lives or minimal wear protection because the solid lubricant does not readily adhere to the surface. It is desirable to have a solid lubricant to provide the longest life possible before it has to be replaced.

It is, therefore, an object of the present invention to provide an

intermediate layer to aid in bonding a solid lubricant to a selectively altered surface topography thereby lengthening the endurance life and lowering component wear.

Background Art

U.S. patent No. 2,108,616 to Schaefer discloses a surface treatment of materials to make them nonwetable by oil and to improve their oil-resistance. Among the materials utilized for this purpose is cadmium stearate. Queneau et al U.S. patent No. 2,237,314 is directed to a process of making cadmized bearings. Cadmium is applied from a vapor state and improves the anti-friction properties of the bearings.

Lamson et al U.S. patent Nos. 3,079,204 and 3,198,735 teach the use of solid lubricants in bearings. The concept of providing bonded film compositions whereby inorganic binders are employed to hold the solid lubricants on a surface to be lubricated is taught in the first of these patents while the second teaches that a cadmium compound may be used as a solid lubricant.

U.S. patent No. 3,308,524 to Moyer is concerned with a method of making a die bushing with a replaceable liner wherein steam pressure is utilized to apply cadmium. U.S. patent No. 3,517,974 to Eklund describes a bearing which has a fluoridized surface.

Orkin et al U.S. patent No. 3,711,171 describes ceramic bearings which include a body of ceramic material and a film of solid lubricant on the surface. This ceramic material may be applied with the lubricant by plasma spraying.

Bhushan U.S. patent Nos. 4,227,756 and 4,253,714 are directed to high temperature low friction surface coatings. Both of these patents disclose cadmium oxide and a surface lubricant coating for bearing surfaces.

Disclosure of the Invention

This invention is concerned with a surface pretreatment for a solid lubricant film. The surface topography of the material to be lubricated is first selectively altered. Photochemical etching is employed to selectively determine contact area and shape to maximize the proper ratio of reservoir area to sliding contact area.

Cadmium oxide is then sputtered onto the altered surface. The cadmium

oxide acts as an intermediate layer to more tightly bond the solid lubricant, such as graphite, onto the material surface.

Brief Description of the Drawings

The advantages and novel features of the invention will be more fully apparent from the following detailed description when read in connection with the accompanying drawings in which:

FIG. 1 is an enlarged vertical section view of a substrate having a surface to be lubricated in accordance with the present invention;

FIG. 2 is an enlarged vertical section view of the substrate shown in FIG. 1 after the surface topography to be lubricated is altered in accordance with the invention;

FIG. 3 is an enlarged vertical section view of the substrate shown in FIG. 2 after cadmium sulfide has been sputtered onto the altered surface;

FIG. 4 is an enlarged vertical section view of the substrate shown in FIG. 3 after a solid lubricant has been applied to the cadmium sulfide; and

FIGS. 5-10 are plan views of substrates having surfaces to be lubricated altered by chemically etching various patterns thereon.

Best Mode for Carrying Out the Invention

Referring now to the drawings, there is shown in FIG. 1 a metal substrate 10 having a surface 12 to which a solid lubricant is to be applied. It will be appreciated that while a substantially flat surface 12 is illustrated, this surface can be of any configuration, such as curved. In fact it is contemplated that the substrate 10 may be a metal shaft.

The surface 12 is first altered as shown in FIG. 2. This altered surface topography provides improved adhesion for the lubricant and increases the reservoir capability. This surface topography altering is achieved by photochemical etching to maximize the proper ratio of reservoir area to sliding contact area and to achieve a desired contact area and shape.

Most procedures for roughening surfaces produce random roughening and sharp asperity tips. Photochemical etching is employed to selectively determine the area and shape of the sliding contact areas as well as the depth of the reservoir areas.

A cadmium oxide film 14 is then sputtered onto the altered surface 12

as shown in FIG. 3. This cadmium oxide film 14 provides an intermediate layer to increase the bonding of a solid lubricant material to the substrate 10 thereby increasing the performance and endurance of the lubricant.

A film of solid lubricant 16 is then applied to the cadmium oxide layer as shown in FIG. 4. The solid lubricant in the film 16 is preferably graphite for long endurance lives and lower component wear. The solid lubricant material of the film 16 can be applied by rubbing, by sputtering, or in conjunction with a binder material.

Referring now to FIGS. 5,6,7,8,9 and 10 there is shown various patterns which can be chemically etched into the surface of the substrate 10. The sliding direction is shown by the arrow S in each FIG.

The preferred pattern is shown in FIG. 5. A mask having a plurality of V-shaped openings therein is used to chemically etch the surface to be altered thereby providing indentations 18 in a chevron pattern to capture the lubricant.

A mask having a pattern of round holes is used to form the round depression 20 shown in FIG. 6. Surface material is removed in a pattern of rectangular depressions 22 in the embodiment of FIG. 7. In the embodiment shown in FIG. 8 a plurality of crosses 24 replaces the rectangles of FIG. 7.

Another pattern is shown in FIG. 9 in which triangular depressions 26 are relied on to hold the solid lubricant. One point of the triangle faces away from the sliding direction. In FIG. 10 a number of V-shaped depressions 28 are arranged in a compound chevron configuration.

While the preferred embodiment of the invention has been disclosed and described, it is contemplated that various modifications may be made to the process and coated article without departing from the spirit of the invention and the scope of the subjoined claims. By way of example, cadmium oxide films may be sputtered onto the surfaces of ceramic materials to increase the endurance lives and lower component wear when a solid lubricant film is employed. Also, other films and solid lubricants may be employed where a better bond between coatings or films and a substrate are desired.

NASA CASE NO. LEW-14,474-1

ABSTRACT OF THE DISCLOSURE

PRETREATMENT OF LUBRICATED SURFACES
WITH SPUTTERED CADMIUM OXIDE

Cadmium oxide is used with a dry solid lubricant on a surface to improve wear resistance. The surface topography is first altered by photochemical etching to a predetermined pattern. The cadmium oxide is then sputtered onto the altered surface to form an intermediate layer to more tightly hold the dry lubricant, such as graphite.

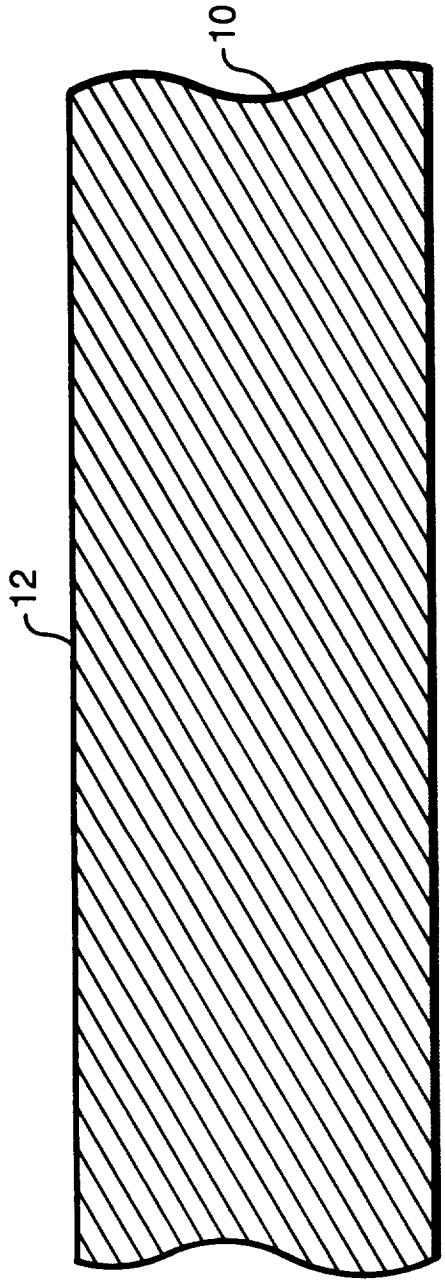

FIG. 1

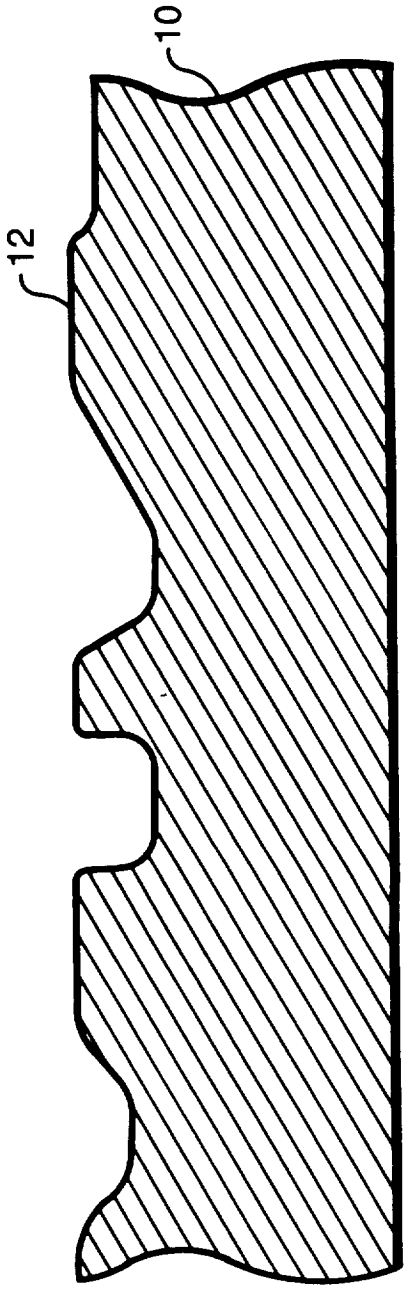

FIG. 2

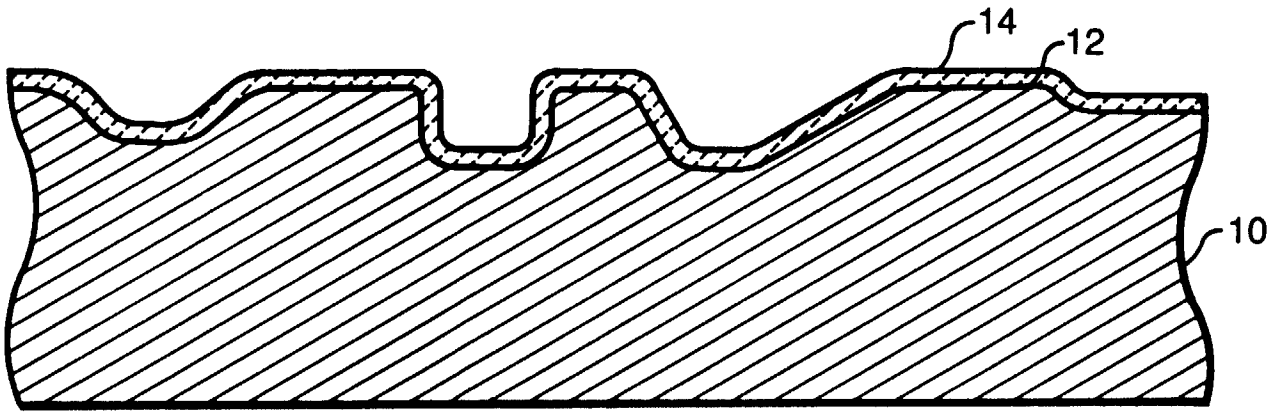

FIG. 3

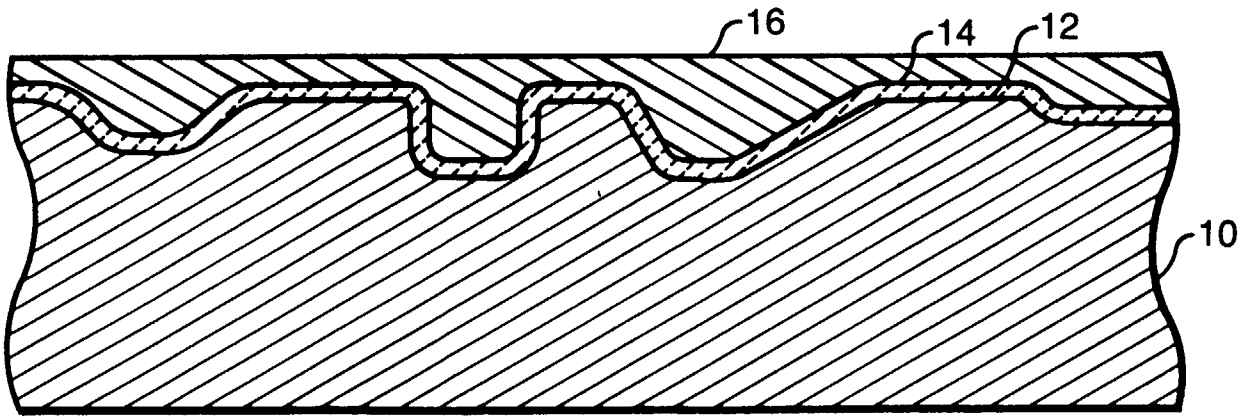

FIG. 4

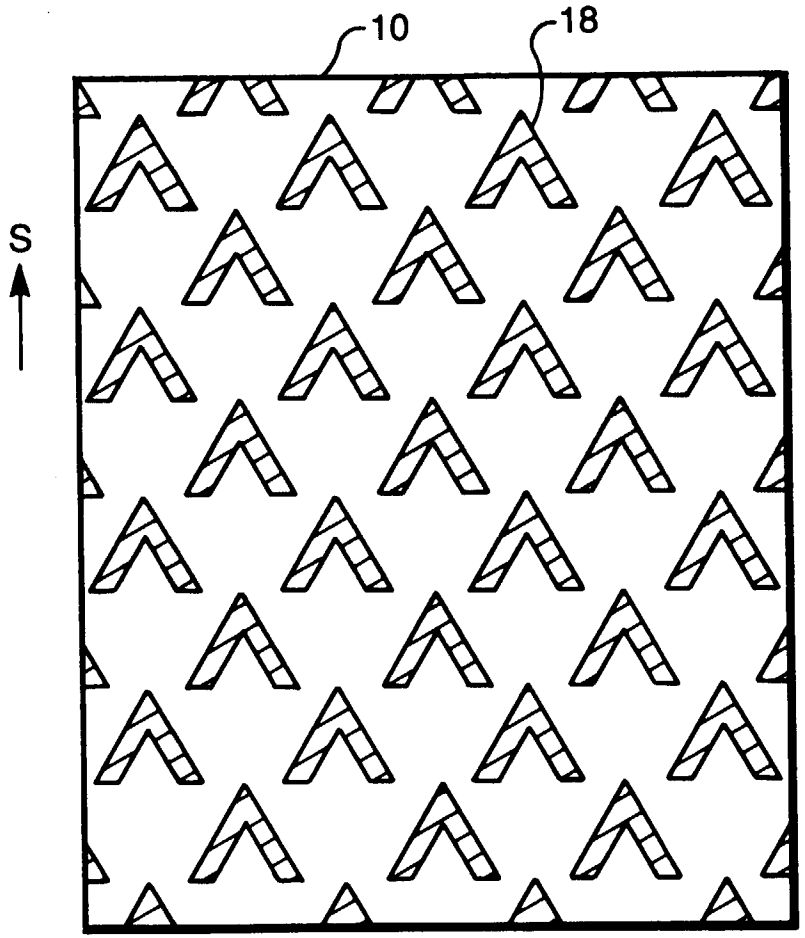

FIG. 5

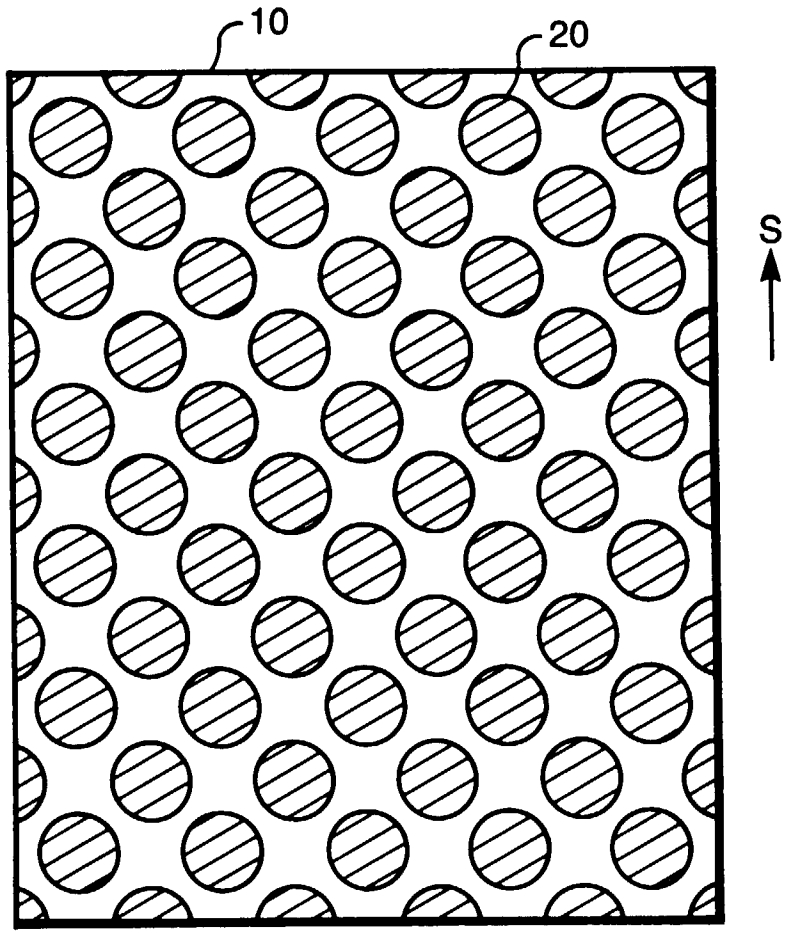

FIG. 6

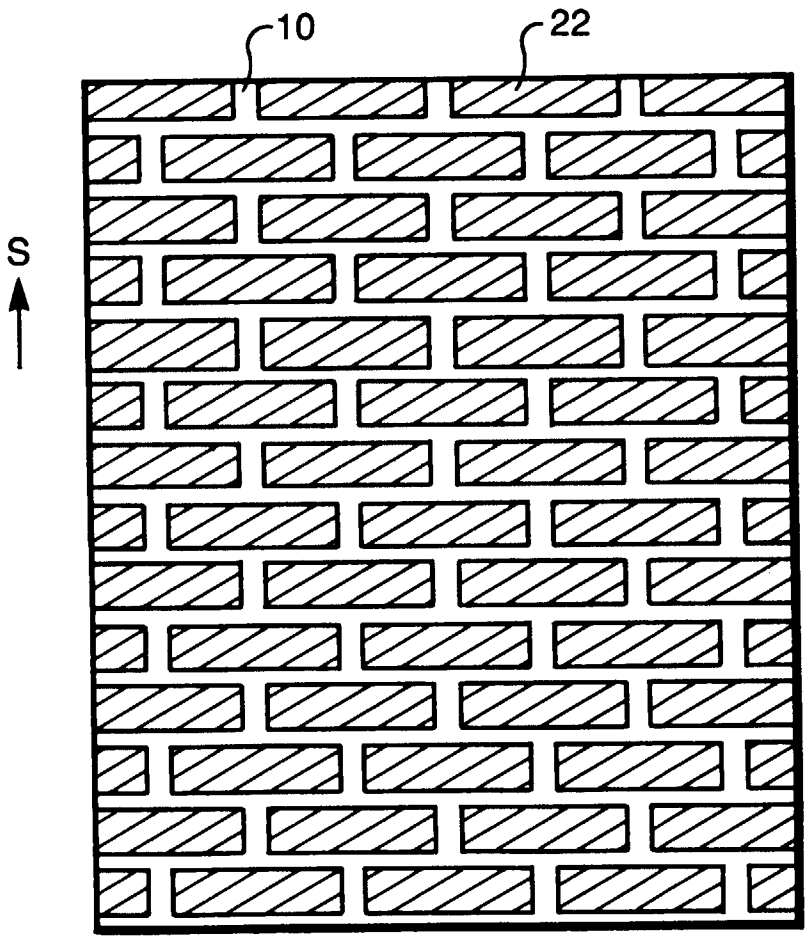

FIG. 7

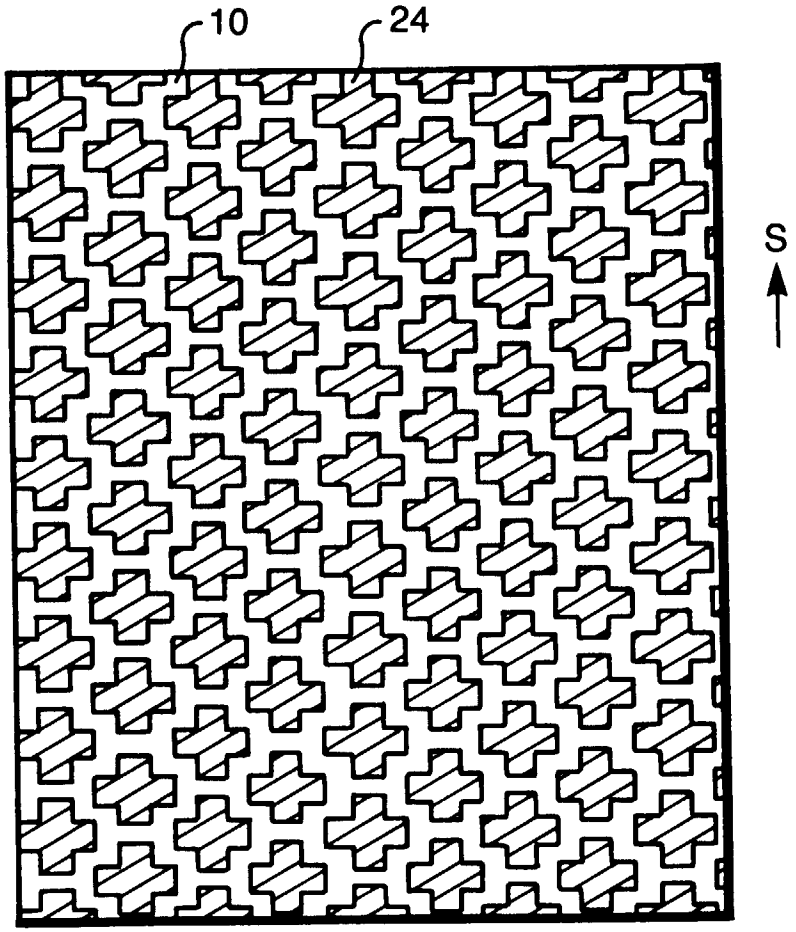

FIG. 8

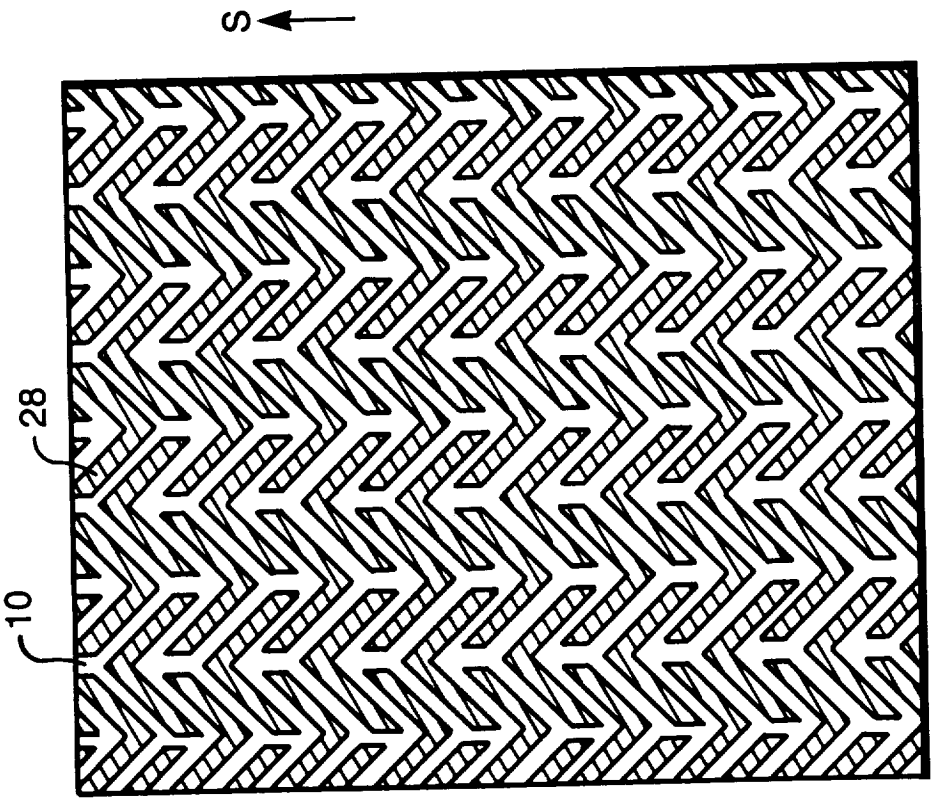

FIG. 10

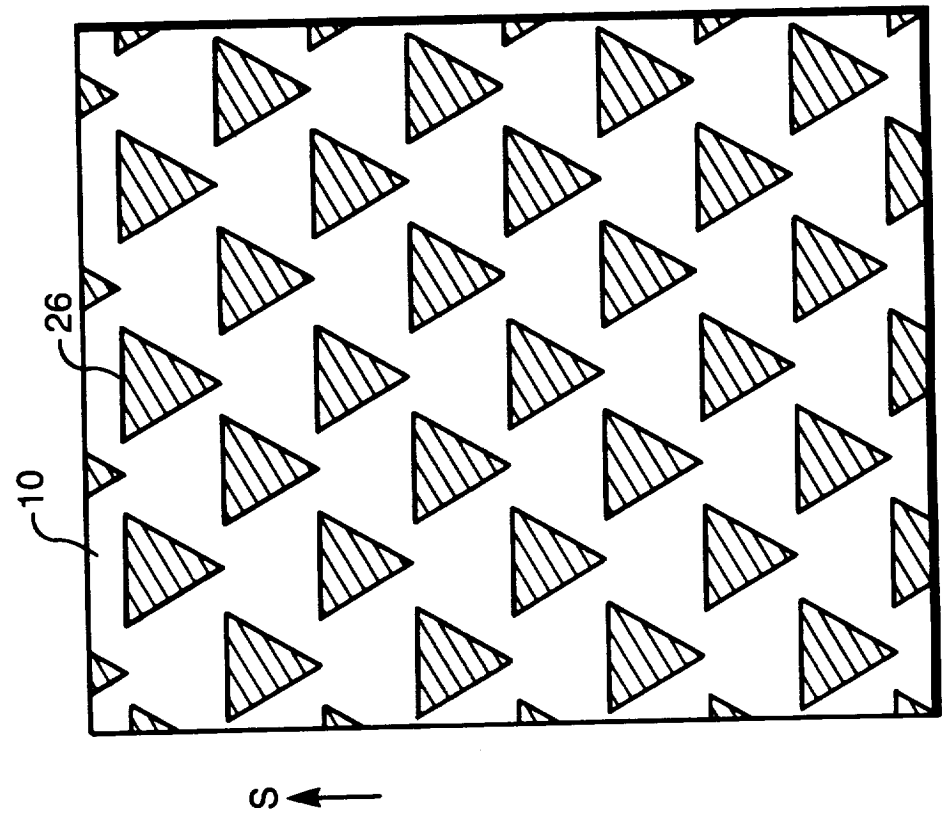

FIG. 9