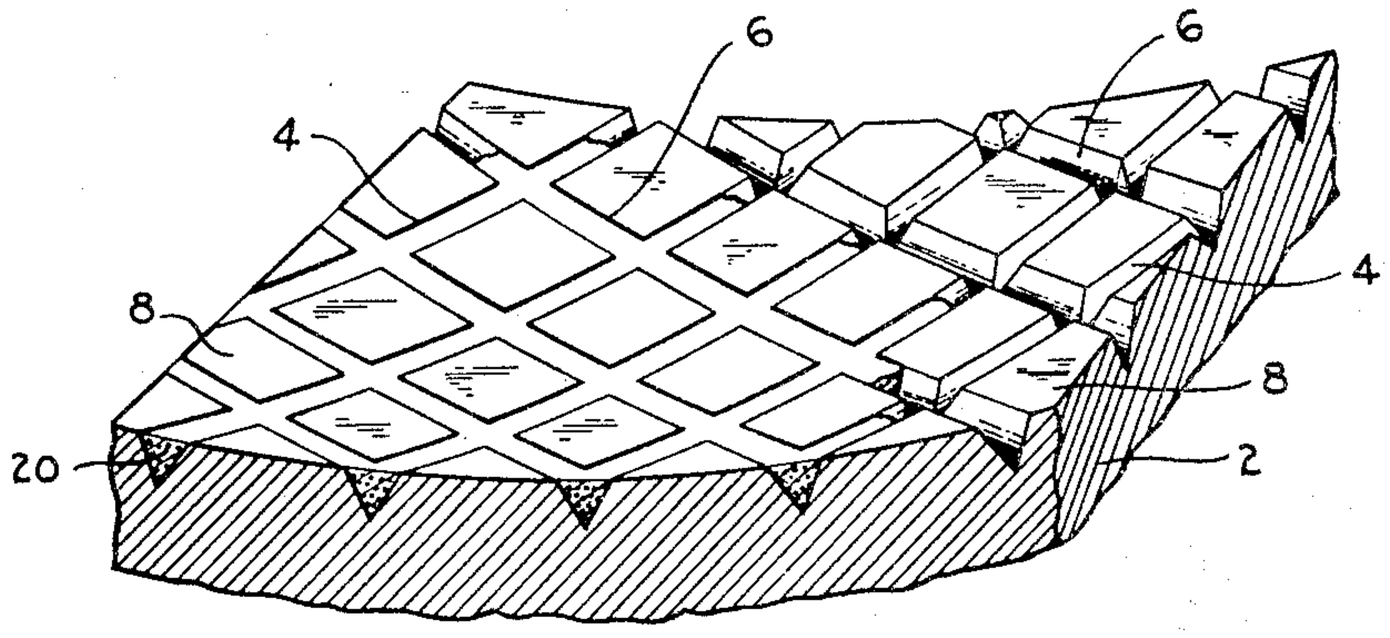
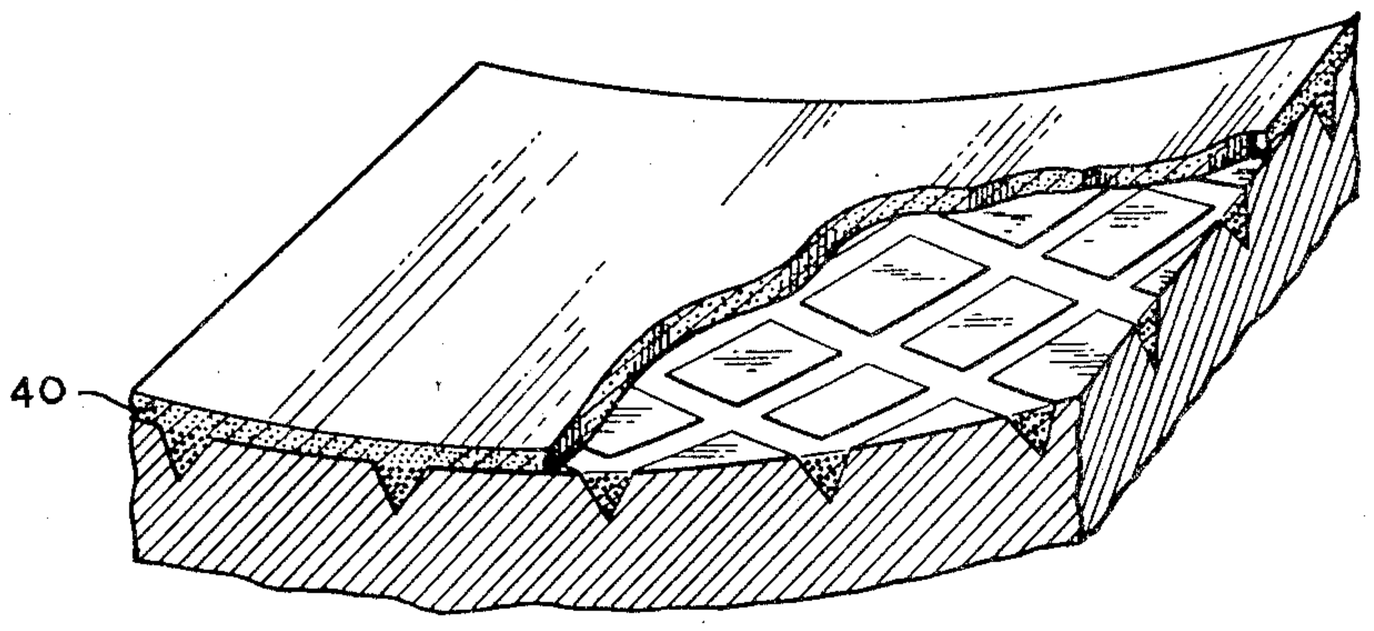
Dec. 19, 1950 H. M. BRAMBERRY 2,534,408

RELIEVED AND FILLED CYLINDER SURFACE

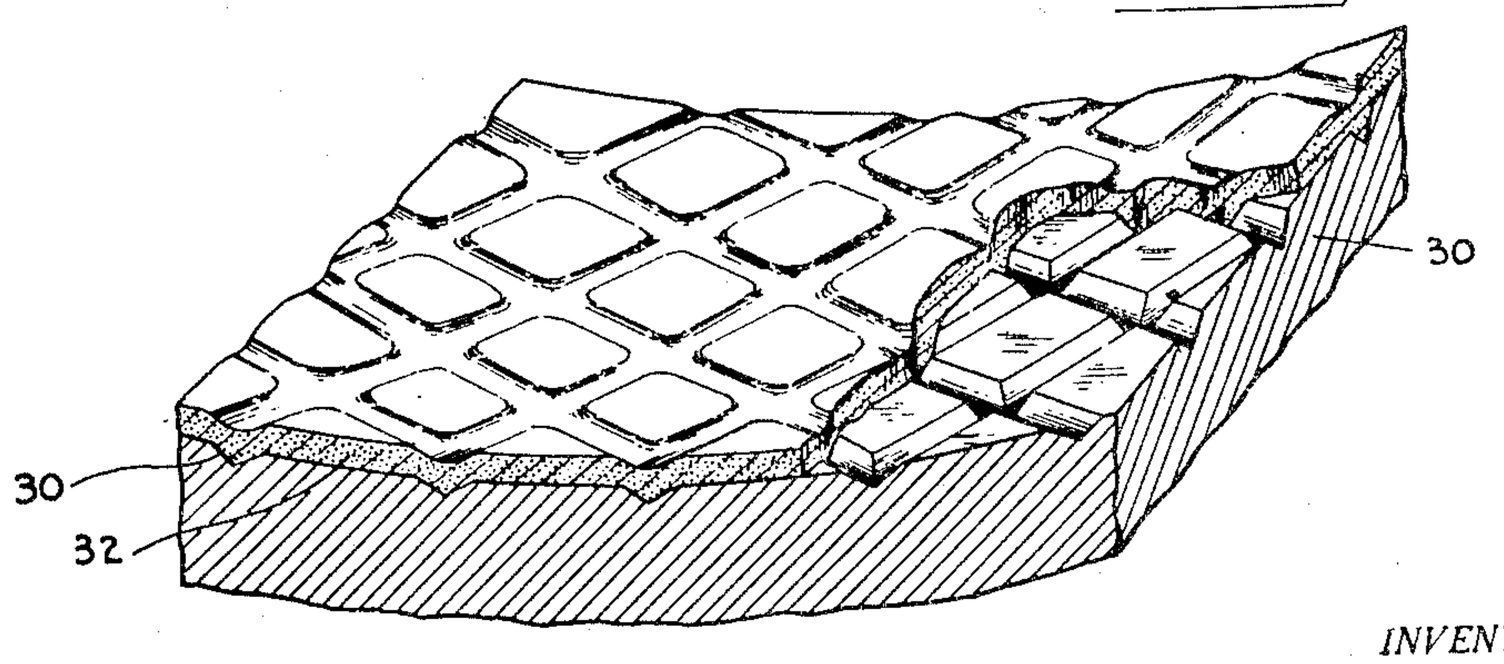
Filed Oct. 17, 1947



Fig—1



Fig—3



Fig—2

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2,534,408

RELIEVED AND FILLED CYLINDER SURFACE

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Application October 17, 1947, Serial No. 780,399

11 Claims. (Cl. 309—2)

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This application is a continuation-in-part of my copending application Serial No. 555,377, filed September 22, 1944, for Wear Surface Filling.

In my United States Letters Patent No. 2,434,880, issued January 20, 1948, for Cylinder Surface Character, I have described and claimed a cylinder for an internal combustion or other compression engine having a wear surface having increased load-carrying capacity and improved compatibility with the piston and piston rings. These results are achieved by providing a ring-travel surface which is negatively relieved in a uniform manner by removing a substantial part of the wear surface leaving a very great number of minute, isolated radially inwardly extending protuberances spaced substantially uniformly over the wear surface, each of which terminates at its radially inward end in a plateau area which forms part of the wear surface, thus forming what I call a "negative pattern in relief." Such a negative pattern in relief is to be differentiated from a positive pattern in relief in which a continuous wear surface has a plurality of spaced, isolated depressions formed therein and an example of which is found in the U. S. patent to Boggs, No. 974,854.

The invention described and claimed in this and my co-pending application Serial No. 555,377 has to do with negatively relieved cylinder wear surfaces of the structure of those described and claimed in my United States Letters Patent No. 2,434,880. It has been the principal object of this invention to improve the operating characteristics of a cylinder having such a negative pattern in relief, for example by increasing the load-carrying capacity of the cylinder surface, reducing the initial run-in time, reducing the oil consumption and blow-by, permitting starting at sub-zero temperatures at full load without scuffing or scoring, eliminating scuffing and scoring of the cylinder, piston and ring surfaces under all conditions, and compensating for out-of-round cylinder surface conditions throughout the running life of the cylinder. I achieve these objects by inlaying the negatively relieved area of a cylinder wear surface with a material which is of such a character and physical structure that it will physically retain lubricant therein and will release this to the wear surface during operation of the engine to provide lubrication for the relatively moving parts. This material should be one which will resist the temperatures developed within the cylinder during normal operation of the engine, and which may be sufficiently bonded to the material of the cylinder to resist the mechanical action of the moving piston and rings. Further, it should be insoluble in water and in the usual lubricating oils and resistant to heat and the chemical actions of combustion and detergent oils.

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I have found that a cylinder surface negatively relieved and filled in the manner disclosed in this application operates at a much lower temperature than an unrelieved cylinder surface or a positively relieved surface. The division of the cylinder surface, in accordance with my invention, into a great number of small areas isolated from each other by material of very low heat conductivity prevents the flow of heat along and over the cylinder surface and directs it radially outwardly from such surface to the outer part of the cylinder. Further, the negative relief and filling of the cylinder surface results in a great decrease in the metallic surface subjected to the friction of the moving piston and rings and consequently causes a reduction in the heat generated in the cylinder surface, it being remembered that the non-metallic material filling the relieved area does not generate friction heat as does the metallic surface. Further, the filling material, being porous and oil-absorbent, lubricates the relatively moving parts and thus reduces the friction of such parts and the heat due to friction.

Other objects and features of novelty of the invention will be made apparent by the following description and the annexed drawings which, it will be understood, are only illustrative of the invention and impose no limitation thereon not imposed by the appended claims.

In the drawings forming part of this application,

Fig. 1 is an enlarged perspective view of part of a negatively relieved cylinder wear surface which has been inlaid in the manner taught by this invention, part of the filler being removed to better illustrate the invention;

Fig. 2 is an enlarged perspective view of part of a negatively relieved cylinder wear surface having relatively shallow grooves therein which have been filled or inlaid by a method which causes the plateau areas to be covered, and

Fig. 3 is similar in all respects to Fig. 1 but shows a compensating layer superimposed on the inlaid cylinder surface.

In carrying my invention into effect I first form on all or a desired part of the ring-travel area of the inner wall of a cylinder a negative pattern in relief of the type and structure described in my co-pending application Serial No. 555,379,

and which comprises a plurality of substantially continuous, intersecting grooves which define and bound isolated radially inwardly-extending frusto-conical protuberances each of which increases in cross-sectional area from its base radially inwardly and each of which terminates at its radially inward end in a polygonal plateau area forming part of the wear surface of the cylinder. I then fill the relieved area of this wear surface, i. e., the grooves with a material which will absorb and release lubricating oil. This material should also be one which will adhere to the metallic surfaces with which it is in contact with sufficient adherence to resist the tendency of the reciprocating piston and the rings to remove it, which is insoluble in water and lubricating oils, and which is resistant to heat and the chemical actions of combustion and of detergent oils.

In Fig. 1 of the drawings there is disclosed part of the wall 2 of an internal combustion engine cylinder formed and treated in accordance with this invention and being relieved in the described manner within the ring-travel area. The relieved area is preferably formed in the manner taught in my United States Letters Patent No. 2,434,880 and accordingly is cross-hatched with grooves which remove from 15 to 60 per cent of the metal of the surface, when measured at the surface, and which have a depth of at least .0002 inch. These grooves are preferably formed by cutting or scratching into the wear surface of first group of parallel grooves 4 and then cutting or scratching into the surface a second group of parallel grooves 6 which intersect those of the first group, forming polygonal plateau areas 8 defined by the intersecting grooves. The grooves of each group may be evenly spaced and of the same depth as shown in Fig. 1, which is the case when they are formed by a specially prepared cutter, or may be unevenly spaced and of varying depths, which is the case when they are formed by abrasives and a honing tool. In a typical relieved wear surface formed on an internal combustion engine cylinder of 3⅞ inch bore in the manner taught by this invention, there would be 232 right-hand grooves and 232 left-hand grooves in the circumference at any section along the length of the relieved area. Each groove would be from .003 to .004 inch in depth and from .004 to .006 inch in width at the cylinder surface, forming diamond-shaped plateau areas each having a major dimension of approximately .045 inch and a minor dimension of .025 inch. In this cylinder the total plateau area will be approximately 70% of the surface covered by grooves and plateau areas.

In accordance with this invention the relieved area, i. e., the grooves, is filled with a material 20 having the physical and chemical characteristics and properties described hereinbefore.

If the grooves are more than .001 inch in depth they are preferably inlaid in such a way and with such a material that they are substantially filled but the plateau areas are not covered, such a filling being shown in Fig. 1. A so-called "base" compound is used in performing such filling and a preferred form of such compound is more fully described hereinafter. If the grooves are .001 inch or less in depth the filling or inlaying is preferably performed by spraying a substantially liquid compound on the relieved cylinder area, whereby the grooves 30 are filled and the plateau areas 32 covered, as clearly shown in Fig. 2 of the drawings. A so-called spraying compound is used in performing such filling by spraying and a preferred form of such compound is more fully described hereinafter. In the inlaying of a cylinder surface having deeper grooves, as described in connection with Fig. 1, it is often desirable to cover the plateau areas and the filled relieved areas with a superimposed layer of material in order to cause the reciprocating piston and rings to wear the cylinder surface to a shape which will exactly accommodate these parts. Such a superimposed layer also causes the piston and rings to come into metal-to-metal contact with the cylinder surface at a slow and controlled rate, thereby permitting the parts to establish gradually, highly satisfactory surface characteristics. This very materially reduces the initial run-in time. Such a superimposed layer is shown at 40 in Fig. 3, overlying the relieved areas which have been inlaid in the manner shown in Fig. 1 and also overlying the plateau areas. The superimposed layer may preferably be the spraying compound described in connection with Fig. 2 and the ingredients of a preferred form of which are set forth hereinafter.

A preferred base compound provided by my invention has the following ingredients in the following proportions:

Phenol-formaldehyde resin	grams	100
Finely ground calcined petroleum coke	grams	50
Thinner for phenol-formaldehyde resin	c. c	50
Plasticizer (e. g. glycerine)	grams	5

These ingredients are thoroughly mixed at room temperature, forming a paste which may be trowelled into the relieved area under pressure, leaving the plateau surfaces substantially bare. The filling material is then allowed to dry, after which it is heated for 15 to 60 minutes at 350° to 500° F. If the superimposed layer of Fig. 3 is to be added, it is applied after the base compound dries but before the heating takes place. In such case, after the two fillers are in place, the superimposed layer (which preferably has a thickness of .0003 inch to .001 inch over the plateau surfaces) is allowed to dry at room temperature and the described heating step is then performed. In a preferred method the heating is continued until the superimposed layer of spraying compound is insoluble in acetone.

A preferred spraying compound provided by my invention has the following ingredients in the stated proportions:

Phenol-formaldehyde resin	grams	100
Finely ground graphite	do	30
Thinner for phenol-formaldehyde resin	c. c	100

These ingredients are thoroughly mixed at room temperature, forming a liquid which may be sprayed on the relieved wear surface in a suitable manner (preferably to a thickness of approximately .0003 to .001 inch over the plateau surfaces). After application to a cylinder surface the spraying compound is allowed to dry at room temperature and is then heated at 350°–500° F. for 15 to 60 minutes. In a preferred method the heating is continued until the filling material is insoluble in acetone.

The proportions of the two compounds given above are those for conventional cylinder application and may be varied to suit the requirements of a particular engine. For example, the ratio of

graphite or carbon to phenol-formaldehyde controls the hardness of each compound, which decreases with increase of the graphite or carbon content. The presence of graphite in the spraying compound produces a very low coefficient of friction during the initial run-in period. Further, the oil-absorbing value or ability of each compound may be controlled by varying the ratio of thinner to phenol-formaldehyde. This value or ability increases with increase in the amount of thinner used.

The materials described herein, as well as those described in my co-pending applications Serial Nos. 555,377 and 555,378 now Patent #2,470,136, as well as others, have the characteristics and properties referred to hereinbefore. That is, they will physically retain usual lubricating oils and release this to the wear surface when heated during operation of the engine, they will form a firm and tenacious bond with the metal surfaces of usual engine cylinders and when so applied will not be removed by action of the moving piston and rings. Further, they are insoluble in water and usual lubricating oils and are resistant to heat and the chemical action of combustion and of detergent oils.

Before applying any filling material the cylinder wear surface may be thoroughly degreased, which may be done by the vapor degreasing process, which is well known, and may further be treated with a cleaning and etching agent, or by vapor or sand blasting.

When the cylinder surface is treated in the manner described and disclosed in connection with Figs. 2 and 3 and the engine operated, the filler overlying the plateau areas is eventually removed by the action of the piston and rings, leaving the filler within the grooves flush with the plateau surfaces. In all cases the filler within the grooves will absorb and retain lubricating oil. One great advantage of this is that when the engine is started cold, for example at sub-zero temperatures, the heat due to friction of the piston and rings on the treated surface will cause the absorbed lubricant within the filler to come to the surface and provide a lubricating action, which is not present when an engine with untreated cylinder surfaces is started cold. This permits the engine to be operated at full power immediately upon starting without scoring or scuffing the piston, ring and cylinder surfaces, which is impossible with conventional cylinders when operated under identical conditions. After the engine has run for a sufficient time to cause the piston and rings to remove the filler from the plateau surfaces the lubricating oil which is present because of absorption and retention in the filler in the relieved areas causes the formation of a thin lacquer film on the wear surface. This establishes the fact that there is no surface disturbance of the metals surface taking place and the entire ring travel area is being wetted with a film of oil of minimum thickness under all operating conditions and particularly at high temperature and output, which is not possible with conventional cylinders.

The thickness of the filler above the plateau surface (of the order of .0003'' to .001'') and the inherent tenacity and wear-resistant qualities of the filler material, its ability to form a firm bond with the metal of the cylinder, and its ability to absorb and retain oil result in a very gradual wearing away of the filling material down to the plateau area, whereby the rings and piston are

very slowly let down onto the cylinder wall with resulting unusual compatibility.

By filling the cylinder in the manner described and disclosed in connection with Figs. 2 and 3 minute irregularities in the cylinder surface caused by error in machining the cylinder or due to distortion during operation are compensated for by the retention of the filler in the low areas. This is very important, since it is impractical to machine or otherwise form a cylinder ring travel surface which is perfectly symmetrical or will remain so under all operating conditions.

Cylinder surfaces, negatively relieved in manners other than by the scratched, cross-hatched method, may be filled in accordance with my invention. For example, I have filled cylinders in the manner disclosed herein which were provided with electrolytically relieved chromium surfaces, with excellent results. The invention is therefore not limited in its application to the filling of cylinder surfaces which are negatively relieved in any particular manner. The invention is furthermore not limited to the treatment of any particular type of metal cylinder and may be employed for treating cylinders of iron, steel, steel alloys, aluminum, bronze, chromium or hardened surfaces.

By "compatibility" I mean the lack of surface disturbance, scuffing or scoring of either of the two contacting, relatively-moving, metallic surfaces, whereby the parts in engagement operate together satisfactorily lubricated.

While I have disclosed certain ways in which my invention may be performed, it will be apparent to those skilled in the art that other ways and embodiments, as well as modifications of those disclosed, may be performed and made without departing in any way from the spirit or scope of the invention, for the limits of which reference must be had to the appended claims.

What is claimed is:

1. An engine cylinder having an internal ring travel surface 15 to 60 per cent of the area of which is removed to a depth of at least .0002 inch leaving a plurality of isolated radially inwardly extending protuberances distributed substantially uniformly throughout the removed area, and a material substantially filling the removed area and sufficiently bonded to the metal of the cylinder to resist the mechanical action of the moving piston and rings and being capable of physically retaining oil therein and being capable of remaining substantially unaffected by other materials and temperatures within the engine cylinder during normal operation of the engine.

2. An engine cylinder according to claim 1, in which the fiilling material is a compound comprising phenol-formaldehyde, a thinner for the phenol-formaldehyde, and a material selected from the group consisting of carbon and graphite.

3. An engine cylinder according to claim 1, in which the filling material is a compound comprising phenol-formaldehyde, a thinner for the phenol-formaldehyde, a material selected from the group consisting of carbon and graphite and a plasticizer.

4. An engine cylinder having an internal ring travel surface at least part of which is formed into a negative pattern in relief by intersecting continuous grooves which remove from 15 to 60 per cent of the surface substantially uniformly throughout to a depth of at least .0002 inch leaving a plurality of radially inwardly extending protuberances distributed substantially uniformly within the relieved area, and a material substantially filling the relieved area of the ring travel

surface and sufficiently bonded thereto to resist the mechanical action of the moving piston and rings and being capable of physically retaining oil therein, being resistant to temperatures developed within the engine cylinder and to the action of engine fuels and engine lubricating oils, and being insoluble in water.

5. An engine cylinder having an internal ring travel surface at least part of which is formed into a negative pattern in relief by intersecting grooves which remove from 15 to 60 per cent of the surface substantially uniformly throughout to a depth of at least .0002 inch leaving a plurality of radially inwardly extending protuberances distributed substantially uniformly within the relieved area, and a material substantially filling said grooves and sufficiently bonded to the metal of the cylinder to resist the mechanical action of the moving piston and rings and being capable of physically retaining oil therein and being capable of remaining substantially unaffected by other materials and temperatures within the engine cylinder during normal operation of the engine.

6. An engine cylinder having an internal ring travel surface at least part of which is formed into a negative pattern in relief by intersecting continuous grooves which remove from 15 to 60 per cent of the surface substantially uniformly throughout to a depth of at least .0002 inch leaving a plurality of radially inwardly extending protuberances distributed substantially uniformly within the relieved area, and a material filling the relieved area of the ring travel surface and covering the unrelieved area thereof and being sufficiently bonded to the metal of the cylinder to resist the mechanical action of the moving piston and rings and being capable of physically retaining oil therein and being capable of remaining substantially unaffected by other materials and temperatures within the engine cylinder during normal operation of the engine.

7. An engine cylinder having an internal ring travel surface at least part of which is formed into a negative pattern in relief by the removal of 15 to 60 per cent of the surface substantially uniformly throughout to a depth of at least .0002 inch leaving a plurality of radially inwardly extending protuberances distributed substantially uniformly within the relieved area, a material substantially filling the relieved area of the ring travel surface and being sufficiently bonded to the material of the cylinder to resist the mechanical action of the moving piston and rings, and a second material covering said filling material and the unrelieved area of the ring travel surface and being bonded thereto, both said materials being

capable of physically retaining oil therein and being capable of remaining substantially unaffected by temperatures and other materials within the engine cylinder during normal operation of the engine.

8. An engine cylinder according to claim 7 in which the second material is a compound comprising phenol-formaldehyde, a thinner for the phenol-formaldehyde, and a material selected from the group consisting of carbon and graphite.

9. An engine cylinder having an internal ring travel surface at least part of which is formed into a negative pattern in relief by two series of continuous grooves which are at least .0002 inch in depth and .004 to .006 inch in width and which intersect to form radially inwardly extending protuberances terminating in plateau areas of polygonal shape, and a material substantially filling the grooves and sufficiently bonded to the metal of the cylinder to resist the mechanical action of the moving piston and rings and being capable of physically retaining oil therein and being capable of remaining substantially unaffected by other materials and temperatures within the engine cylinder during normal operation of the engine.

10. An engine cylinder having an internal ring travel surface at least part of which is formed into a negative pattern in relief by two series of continuous helical grooves which intersect at acute angles to form radially inwardly extending protuberances terminating in plateau areas of diamond shape and a material substantially filling the grooves and sufficiently bonded to the metal of the cylinder to resist the mechanical action of the moving piston and rings and being capable of physically retaining oil therein and being capable of remaining substantially unaffected by other materials and temperatures within the engine cylinder during normal operation of the engine.

11. An engine cylinder according to claim 1, in which the filling material is a non-metallic material of low heat conductivity.

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REFERENCES CITED

The following references are of record in the file of this patent:

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