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METHOD FOR RECONDITIONING WORN PISTONS

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FIG. 1.

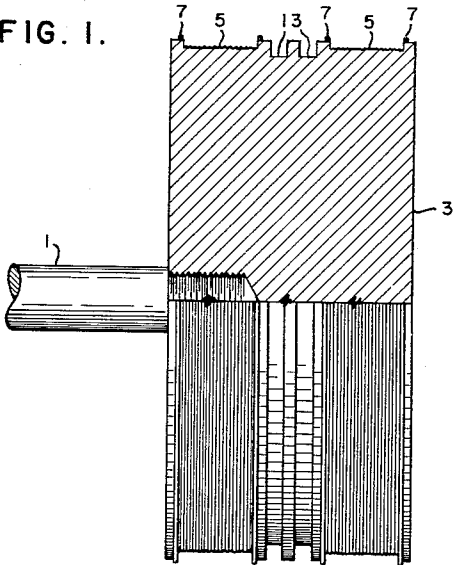


FIG. 2.

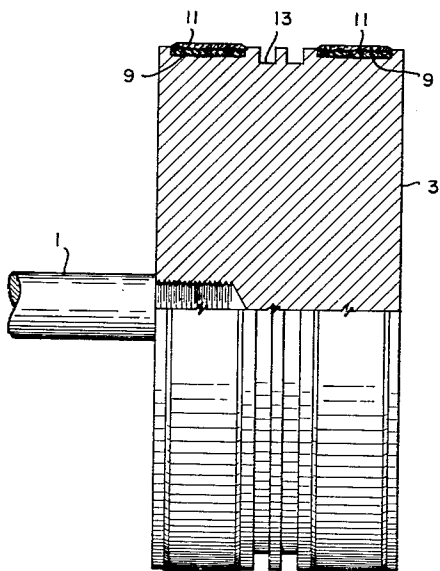
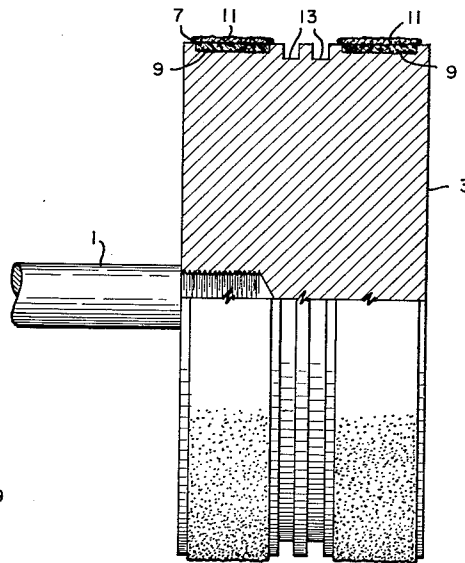


FIG. 3.

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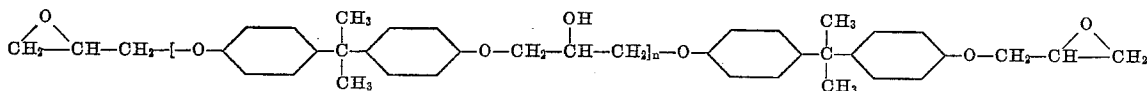
METHOD FOR RECONDITIONING WORN PISTONS

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6 Claims. (Cl. 29—401)

This invention relates to the reconditioning of worn pistons, and more particularly to a method for increasing the circular diameter of a cylindrical piston.



Reciprocating pistons, such as are found in pumps and compressors, become badly worn in service so that it is desirable to build them up to their original diameter. The method that has been used in the past for this purpose involves the spraying of molten metal on the curved cylindrical surface of the piston. This operation involves the use of an expensive, special-purpose machine and the use of techniques involving critical, difficult operations. The sprayed metal must be bonded to the base metal of the piston; often the operation must be attempted several times before a satisfactory plating is obtained. After each unsuccessful attempt to bond the sprayed metal to the base metal of the piston, a portion of the piston must be removed before a new operation can be attempted. Should the built-up piston later become so badly worn that it is desirable to build up the diameter again, all of the original plating and a portion of the base metal of the piston must be removed before a new metalizing operation can be initiated. Manifestly, after a few attempts have been made to increase the diameter of a piston by metalizing, there will not be remaining sufficient base metal of the piston to make it worthwhile to attempt another metalizing operation.

Accordingly, an object of this invention is to provide an improved, inexpensive method of reconditioning of worn pistons.

Another object is to provide a simple method for reconditioning a worn piston that may be utilized with equipment ordinarily available in a machine shop.

Still another object is to provide a method for reconditioning a worn piston that may be repeated as often as necessary without removing appreciable portions of the old piston.

Other objects and features of the invention will become apparent upon consideration of the following description thereof when taken in connection with the accompanying drawing, wherein:

Figs. 1, 2, and 3 are partial cross-sectional views of a piston illustrating the steps involved in the method of the present invention.

In accordance with the teachings of the present invention, a coating is applied to a worn piston utilizing a

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tough, machinable substance adapted to "wet" the metal surface of the piston. The material may comprise a mixture of an epoxy resin, granular or particulated steel, a dry lubricant, and a hardening agent for the resin. The hardening agent should be adapted to harden the resin at relatively low temperatures. Preferably, the resin should be hardened at room temperatures and pressures. The piston may be machined to a rough finish before the coating is applied to provide a surface to which the resin will most firmly adhere. It has been found that the resulting composition may be machined to any desired diameter, and that the reconditioned piston will be at least as satisfactory in operation as the original piston.

The epoxy resins suitable for use with the invention may comprise organic compounds having at least two reactive epoxy groups in their molecule represented by the formula:

where n is an integer having a value of 1 or a greater number. The resin may be used as such or in a solvent therefor such as in butyl carbitol. Such material, when containing a catalytic hardening agent, will set up to a hard mass. The polyepoxides may be saturated or unsaturated, aromatic or heterocyclic, aliphatic or cycloaliphatic, and may be substituted, if desired, with non-interfering substituents. The resin should be of the low-molecular weight group normally in the form of a liquid at room temperature and pressure, such as that marketed under the trade name Epon 828.

Suitable catalysts or curing agents, for use in connection with the invention, are diethylene triamine, pyromellitic dianhydride, and *m*-phenylenediamine.

The invention will be best understood with reference to the figures of the drawing. In Fig. 1 there is shown a piston 3 to be reconditioned in accordance with the method of the present invention. The piston is shown connected to a piston rod 1, which rod may be disconnected before beginning the operations to be described. Initially, the worn surface of the piston may be machined as shown at 5 to a rough finish and to a depth slightly less than the depth to which the piston had been worn. For the purpose of providing a mold for the slurry to be described below, a plurality of wires or rods 7 are butt-welded around the circumference of the piston at the edges of the groove 5 between piston ring grooves 13 and groove 5, and between the top and bottom of the piston and the groove 5. The diameter of rod 7 should be such that the diameter of the major axis of the circle defined by the rods is greater than the final diameter to which it is desired to build up piston 3.

A metal wetting, heat hardening slurry is then applied between the pairs of rods 7 to a diameter slightly greater than the diameter of the circle defined by the rods. The slurry may be formed of between 35% and 65% by weight of particulated steel, up to 5% of particulated aluminum, and between 30% to 65% of an epoxy resin and a hardening agent therefor. Preferably, the hardening agent should be one that will harden the epoxy resin at room temperature. If a temperature controlled oven is available, a curing or hardening agent may be used that

hardens the resin at elevated temperatures. A specific example of a slurry that has been found to be satisfactory is a mixture of 50% by weight of particulated steel, 5% particulated aluminum, and 45% of a mixture of equal portions of epoxy resin and an amine hardening agent.

The metal particles included in the slurry may be of steel, as described, or of other metals having high tensile and compressional strength. Aluminum may be added to the slurry when it is desired to decrease the weight of the slurry; however, the amount of aluminum must be restricted in order not to adversely affect the strength of the hardened slurry.

The slurry 9 is applied to the piston between the wire forms until it is of a thickness of approximately two-thirds the thickness of the desired coat. At this point, up to approximately 5% by weight of a dry lubricant, preferably molybdenum disulfide is added to the slurry and thoroughly admixed therewith. The coat is built up with the slurry 11 including the molybdenum disulfide, until the thickness of the coat is above the forms.

The piston and the slurry may be put aside for eight hours to a day so that the slurry can harden, or the piston may be placed in an oven that is at a temperature of 200 to 350° F. to accelerate the hardening process. When the slurry is thoroughly hardened, the piston may be placed in a lathe and the hardened slurry machined down to the desired thickness. Fig. 3 illustrates the appearance of the piston and slurry after the machining operation.

If it is desired, the dry lubricant may be added to the initial slurry and the entire coat will be formed of the slurry including the lubricant. However, the two-coat process described above has the advantage of not wasting the dry lubricant by restricting it to the portion of the coat where it will be most useful.

A piston reconditioned as described above was placed in a compressor and the compressor was operated continuously for eight months. At the end of the eight-month period, there was no appreciable change in the operating characteristics of the compressor, indicating that the reconditioning of the piston was entirely successful.

Should the epoxy resin mixture wear during operation of the piston, it may be easily replaced by turning the piston on a lathe and applying a new coat of slurry, as described above. It is not necessary to remove an appreciable part of the metal of the piston itself in order to bond the epoxy resin mixture to the metal of the piston.

Another method that may be used for reconditioning a piston involves the use of fiberglass cloth. A mixture of epoxy resin and an amine hardening agent in equal portions and up to 10% molybdenum disulfide may be formed into a slurry and an initial coating applied to the piston. Thereafter, alternate layers of fiberglass cloth and the epoxy resin mixture may be applied to the piston, the epoxy resin being applied sufficiently thick to hold the fiberglass cloth in place. When the piston has been built up to the desired diameter, a fairly thick final layer of epoxy resin mixture may be applied. The epoxy resin mixture should then be allowed to harden either at room temperature or in a temperature controlled oven. After the resin has hardened, the piston may be turned on a lathe until it is the desired diameter. It will be found that the epoxy resin-fiberglass combination will machine readily. The fiberglass applied to the piston should be in the range 35-70% by weight of the combined weight of fiberglass cloth, epoxy resin, molybdenum disulfide, and the hardening agent for the resin.

Since certain changes may be made in the above-described invention without departing from the spirit and scope thereof, it is intended that the matter containing the above description and shown in the accompanying drawing, shall be considered as illustrative and not in a limiting sense.

What is claimed is:

1. A method for reconditioning a worn, generally cylindrical piston comprising the following steps: applying to the curved, cylindrical surface of the piston a substance comprising up to 5% by weight of molybdenum disulfide, approximately 50% by weight of particulate material having substantially the same tensile and compressional strengths as the material of the piston, and 45% by weight of a low molecular weight, normally liquid epoxy resin and a catalytic hardening agent adapted to harden the resin at temperatures not greater than 100° F.; allowing the substance to harden; and machining the hardened mixture to the desired diameter.

2. A method for increasing the circular diameter of a generally cylindrical piston to a desired diameter comprising the following steps: reacting a mixture of steel particles, molybdenum disulfide, and a low molecular weight, normally liquid polyepoxide with a catalytic hardening agent for the low molecular weight, normally liquid polyepoxide; applying the mixture to the curved, generally cylindrical surface of the piston; allowing the mixture to harden; and machining the hardened mixture to the desired diameter.

3. A method for increasing the circular diameter of a generally cylindrical piston to a desired diameter comprising the following steps: roughening the curved, generally cylindrical surface of the piston to a rough phonograph finish; reacting a mixture of steel particles, molybdenum disulfide and a low molecular weight, normally liquid polyepoxide with a catalytic hardening agent for the polyepoxide; applying the mixture to the curved, generally cylindrical surface of the piston; allowing the mixture to harden; and machining the hardened mixture to the desired diameter.

4. A method for increasing the circular diameter of a generally cylindrical piston to a desired diameter comprising the following steps: roughening the curved, generally cylindrical surface of the piston to a rough phonograph finish; reacting a mixture of 40 to 75% by weight of steel particles, up to 5% by weight of molybdenum disulfide, and 20 to 60% by weight of a low molecular weight, normally liquid polyepoxide and a catalytic hardening agent for the polyepoxide; applying the mixture to the curved, generally cylindrical surface of the piston; allowing the mixture to harden; and machining the hardened mixture to the desired diameter.

5. A method for increasing the circular diameter of a generally cylindrical piston comprising the following steps: machining the curved surface of the piston to a rough phonograph finish; butt-welding around the circumference of the curved surface at each end thereof a wire to make a circular form having an outer diameter greater than the diameter to which the piston is to be increased; applying to the curved surface of said piston and between said wires a material comprising about 50% of steel particles, about 5% molybdenum disulfide and about 35% of a low molecular weight, normally liquid epoxy resin and a catalytic hardening agent for the resin; smoothing the mixture flush with the wire forms; allowing the mixture to harden; and machining the hardened mixture to the desired increased piston diameter.

6. A method for reconditioning a generally cylindrical piston comprising the following steps: forming a mixture of 20% by weight of a low molecular weight, normally liquid polyepoxide, 50% of steel particles, 20% of a hardening agent for the polyepoxide, 5% by weight of a dry lubricant, and 5% by weight of aluminum particles; butt-welding a wire form around the circumference of said piston at each end thereof; applying said mixture to said piston between said forms; allowing said mixture to harden; and machining the hardened mixture to the desired outer piston diameter.

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