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PISTON CONSTRUCTION

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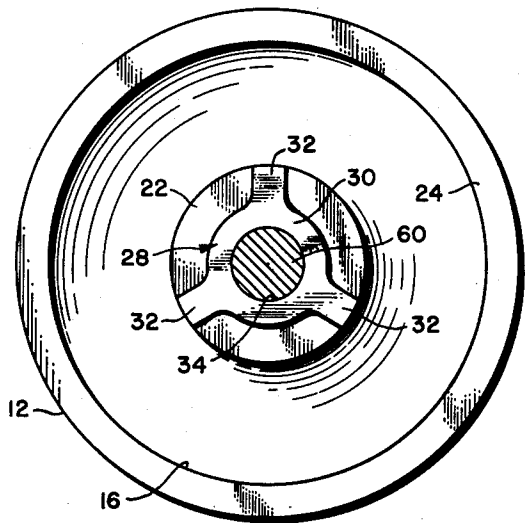


FIG. 1

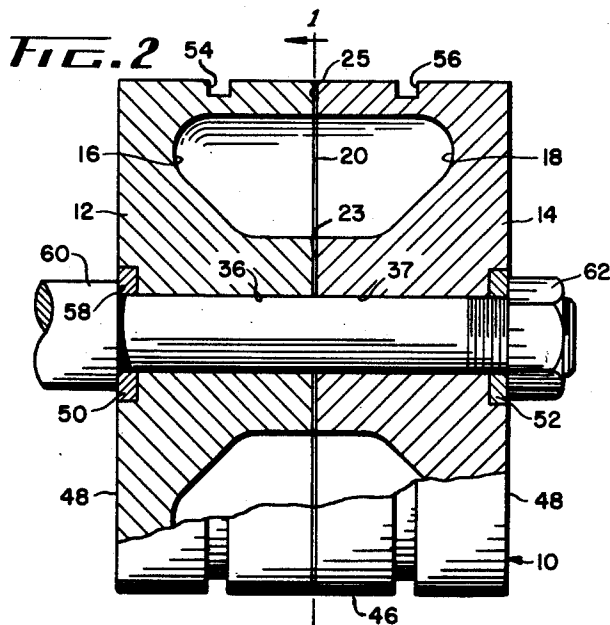


FIG. 2

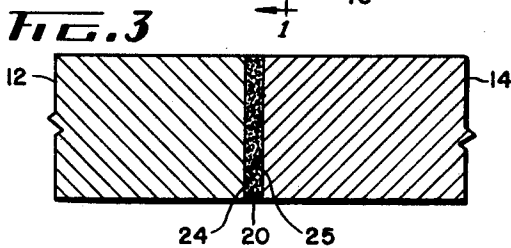


FIG. 3

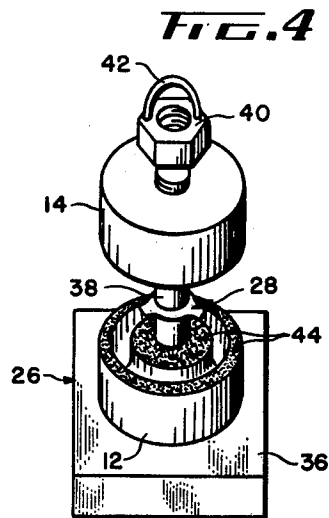


FIG. 4

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PISTON CONSTRUCTION

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The present invention relates generally to pistons of the type employed in compressors, pumps and allied apparatus, and to an improved method for constructing such pistons.

Pistons of the aforesaid type are conventionally cast as a unitary member having internal voids for the purpose of reducing the mass and inertia of the piston. In accordance with conventional foundry practice, shaped cores are supported within a mold or other matrix to provide the aforementioned internal voids; and, in the past, shifting of the cores during pouring of molten metal into the mold tends to produce undesirable variations in the thickness of wall sections of the piston body. Removal of the cores through riser openings in the cast body is a time-consuming and, therefore, costly operation. Furthermore, closure of the riser openings by means of threaded metal plugs not only increases part cost, but also weakens the metal and produces undesirable local stress concentrations which often lead to early part failure. Moreover, due to limitations on the size of the riser openings, the interior surfaces and wall sections of the piston body are not subject to efficient visual or mechanical inspection.

Therefore, a general object of the present invention is to provide an improved piston construction and method for making the same which will solve the various problems above set forth.

Another object is to provide a piston body assembled from identical halves which may be cast without internal coring, thereby eliminating problems of core positioning and removal and facilitating efficiency and economy in production and inspection.

Still another object is to provide a piston construction wherein cast piston halves of a piston body are structurally joined in mating relation by a layer of high strength adhesive material.

Yet another object is the provision of an improved method for joining cast piston halves by means of metal adhesive, whereby the assembled piston body may be machined to final form as a unitary structure.

A still further object is to provide a piston construction of the afore-described type wherein mating surfaces of the piston halves are maintained in axially spaced apart relation by a substantially noncompressible member disposed therebetween to control the thickness of the adhesive layer which structurally joins the piston halves.

Another object is to provide a spacer means as afore-described which additionally serves to limit compressive loading of the adhesive layer and thereby protects the latter from destructive squeezing when the piston is mechanically attached to a piston rod.

These and other more detailed objects and advantages will become apparent upon reading the following description and claims and upon considering in connection therewith the accompanying drawings in which:

FIG. 1 is a sectional view taken along lines 1-1 of FIG. 2 and showing a piston constructed in accordance with the present invention;

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FIG. 2 is a fragmentary sectional view of a piston body mounted upon a piston rod;

FIG. 3 is an enlarged fragmentary view showing the details of the connection between mating halves of the piston body; and,

FIG. 4 is a perspective view of various piston parts shown in spaced apart relation upon a jig suitable for carrying out the method hereinafter described.

The piston body shown in the drawings and generally indicated by numeral 10 comprises identical halves 12 and 14 which may be cast to approximately final form in iron, aluminum or other suitable material. It will be appreciated that bodies such as piston halves 12 and 14 may be cast in a relatively simple manner by means of sand molds or permanent molds without the use of internal coring to define the annular recesses 16 and 18. Such open casting of the piston halves 12 and 14 obviates many, if not all, of the problems heretofore encountered in casting single-piece piston bodies requiring careful positioning of internal cores and subsequent core removal by laborious and costly procedures.

The present invention contemplates that the piston halves 12 and 14 be structurally joined or bonded together in the assembled relation shown in FIG. 2, by means of a layer of high-strength adhesive material, indicated at numeral 20. For purposes of description, the thickness of the adhesive layer 20 is greatly exaggerated with respect to the dimensions of the parts joined thereby. While there are many commercially available high-strength structural adhesives suitable for carrying out the present invention, the layer 20 preferably comprises a thermosetting adhesive having a paste-type consistency and being particularly well adapted for joining impervious metal surfaces, such as the radially spaced inner surfaces 22 and 23 and the outer surfaces 24 and 25 of the mating piston halves 12 and 14. Additionally, it is preferable, but not necessary, that the adhesive require only contact pressure during the curing or setting operation, thereby eliminating the need for elaborate and expensive jigs and fixtures. One example of a well-known form of adhesive which meets the above-recited requirements is an epoxy resin base adhesive having a latent hardener which is activated by subjecting the adhesive to a heat curing cycle. It will be understood that the degree of heating and the length of time of heat application will depend upon such factors as the type of adhesive employed, the thickness of the adhesive layer 20, the design and size of the piston halves 12 and 14, and the mass of any jig or fixture used to secure the parts together during the curing operation. Assuming that the piston halves comprise cast aluminum bodies approximately six inches in diameter and that the halves are secured for curing upon a jig similar to that illustrated in FIG. 4, an adhesive layer of .004 inch thick would require curing at 300° F. to 400° F. for approximately sixty minutes. If a thicker adhesive layer were utilized, the required curing time would be longer in order to raise the temperature of the adhesive to its setting or hardening temperature.

An important feature of this invention is the provision of a spacer or shim, generally indicated in the drawings by numeral 28, which functions to regulate the thickness of the adhesive layer 20 and to provide a metal to metal abutment between the piston halves 12 and 14. As best shown in FIG. 1, the spacer 28 comprises a thin metal member having an annular body portion 30 provided

with radially extending arms 32. The body portion 30 has a central aperture 34 positioned in coaxial relationship with central bores 36 and 37 cast in the piston halves 12 and 14, respectively. The arms 32 may be of any selected shape and number provided only that they maintain stable coaxial alignment of the piston halves 12 and 14 and that portions of the inner surface 22 be exposed between the arms for a purpose to be described. In the illustrative embodiment, the outer ends of the three angularly spaced arms 32 register with the outer periphery of surface 22. The thickness of the spacer 28 is uniform and should be selected to correspond with the desired thickness or axial dimension of the adhesive layer 20.

The clamping jig 26 is illustrative of a very simple and inexpensive type of jig or fixture which may be employed for securing together the parts of the piston 10 and for handling the assembled piston during the curing operation. Generally, the jig 26 comprises a base 36 having an upstanding cylindrical shaft 38 extending normally and centrally therefrom and terminating in a threaded portion for receiving a threaded nut 40. The nut 40 may conveniently be provided with a bail 42 for transporting the jig from place to place.

The following is a disclosure of one method for making a piston of the type described above. First a pair of identical piston halves, such as those indicated by numerals 12 and 14 are cast or molded in approximately final form and are thereafter inspected for defects such as blow holes and thin wall sections. Next the surfaces 22, 23, 24, and 25 are the rough castings are machined to provide smooth mating surfaces; and, the central bores 36 and 37 of the castings are drilled to slidably receive the shaft 38 of jig 26. Then one piston half, in the drawings piston half 12, is positioned upon the jig 26 with its open end up and with its other end resting upon the base 36. A layer of adhesive paste 44 is then evenly applied to the entire surfaces 22 and 24 by means of a suitable implement; and, the spacer 28 is positioned upon the shaft 38 to rest upon the paste layer 44. The piston half 14 is then placed upon shaft 38 in reversely turned relation with piston half 12 so that the surface 23 will abut the upper surface of the shim 28. If it is found necessary or desirable, the surfaces 23 and 25 of the upper piston half 14 may also be spread with adhesive paste to insure a plentiful supply of adhesive between the mating piston surfaces. Finally, the nut 40 is tightened down on the upper threaded portion of the shaft 38 to bring the entire assembly under pressure sufficient to cause the adhesive paste 44 to flow into the spaces between the spacer arms 32 and to press the spacer 28 downwardly through the paste into bearing contact with the piston surface 22. Tightening of the nut 40 need be only great enough to bring the piston halves 12 and 14 into bearing contact with the spacer and to insure even distribution of the paste layer 44 between the inner piston surfaces 22 and 23 and the outer piston surfaces 24 and 25. It will be appreciated that the coaction of the spacer 28 with the abutting piston surfaces 22 and 23 will maintain the mating surfaces of the piston halves in parallelism and will assure a coaxial relationship between the outer cylindrical surfaces of the piston halves. Furthermore, the spacer is effective to provide an adhesive layer 20 of uniform axial dimension between the piston halves.

Having assembled the piston parts upon the jig 26 in the above disclosed manner, the jig is placed in an oven or an equivalent heat source to raise the temperature of the adhesive paste 44 to approximately 300° F.-400° F. After curing in the oven at the above stated temperature for approximately sixty minutes, the jig is removed from the oven by means of the bail 42 and is permitted to cool to room temperature.

With the piston 10 securely bonded together by means of adhesive layer 20, the piston halves 12 and 14 are

machined as a structural entity to their final form shown in FIG. 2. The machining steps include turning and grinding the outer cylindrical surface 46 of the piston, facing the piston ends 48, boring the center holes 36 and 37, counterboring the recesses which receive washers 50 and 52, and cutting the annular piston ring grooves 54 and 56. Preferably, the material making up the layer 20 has high resistance to shear stress; therefore, the above machining operations can be quickly and efficiently accomplished by chucking one end of the piston 10 at a time in a conventional turning lathe. It will be appreciated that machining the piston 10 as a unitary member, rather than as separate halves, greatly facilitate the production of an accurately dimensioned and symmetrical piston. Moreover, the provision of the spacer 28 as a means for coaxially aligning the cast halves prior to machining the outer cylindrical surface 46 requires removal of less material in turning down this surface, thereby providing economy in machining costs and in material costs.

The finished piston 10 is usually assembled with a piston rod 60 which penetrates the central bores 36 and 37 in close fitting relation. A recessed washer 50 abuts a shoulder 58 and a threaded nut 62 is tightened against another recessed washer 52 to clamp the piston 10 axially against the shoulder 58. While most structural adhesives, such as comprises layer 20, display high strength under tensile and shear loading, compressive loads, if sufficiently great, tend to crush or otherwise destroy the integrity of the adhesive joint. However, according to the present invention, compressive loading of the adhesive layer 20 is limited by the aforedescribed metal-to-metal abutment of the piston halves 12 and 14 against the substantially noncompressible spacer 28. Such limitation of loading and avoidance of damage to the adhesive layer 20 is particularly important where the piston is employed in liquid pumps in order that entrance of liquid into the central cavities of the piston be avoided. However, should the adhesive layer deteriorate due to aging or due to contact with corrosive agents, the spacer 28 will prevent relative tilting or cocking of the piston halves 12 and 14, thereby avoiding damage to a cooperating cylinder wall or the like.

It will be understood that the above description and accompanying drawings comprehend only a general and preferred embodiment of the invention and that various changes in construction, proportion, material and arrangement of the elements thereof and in the number and sequence of steps thereof may be made without sacrificing any of the above enumerated advantages or departing from the scope of the appended claims.

Having fully described the invention, what is claimed as new and useful is:

1. In a piston construction:

- (a) reversely turned piston halves having radially spaced mating surfaces;
- (b) substantially noncompressible spacer means disposed between and in abutting relation with said piston halves; said spacer means providing axial spaces between said surfaces;
- (c) a layer of adhesive material received in said axial spaces and structurally joining said halves; and,
- (d) said spacer means being disposed in coaxial relation with said halves and having angularly spaced arm portions extending therefrom and in part defining said axial spaces.

2. In a piston construction:

- (a) reversely turned piston halves having radially spaced mating surfaces;
- (b) substantially noncompressible spacer means disposed between and in abutting relation with said piston halves; said spacer means providing axial spaces between said surfaces;
- (c) a layer of adhesive material received in said axial spaces and structurally joining said halves;

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(d) said spacer means being disposed in coaxial relation with said halves and having angularly spaced arm portions extending therefrom and in part defining said axial spaces; and,

(e) said arm portions terminating in surfaces which register with the periphery of an inner one of said surfaces.

3. In a piston construction:

(a) reversely turned piston halves having mating surfaces;

(b) substantially noncompressible spacer means disposed between said surfaces; said spacer means axially spacing said halves;

(c) a layer of adhesive material disposed between and joining said halves; and

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(d) said layer having its axial dimension determined by the axial dimension of said spacer means.

4. The invention according to claim 3, wherein said spacer means comprises a thin member extending radially between said surfaces.

5. The invention according to claim 4, wherein said thin member includes angularly spaced portions extending radially from a central body portion.

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