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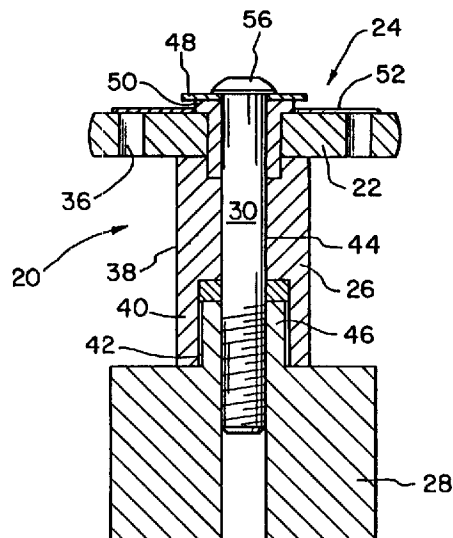
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(54) **PISTON EN DEUX PIÈCES**

(54) **TWO-PIECE PISTON**



(57) Compresseur muni d'un piston en deux pièces consistant en une tête et en une tige de piston indépendantes. La tête de piston est constituée d'un matériau de faible porosité, tel que l'acier, pour minimiser les fuites de gaz de compression du piston, la tige du piston étant composée d'un matériau léger, comme l'aluminium, pour minimiser la force nécessaire au déplacement du piston à l'intérieur du cylindre et améliorer l'efficacité du compresseur. Un ensemble de soupape d'aspiration est installé sur la tête du piston. Celle-ci, la tige et la soupape d'aspiration sont rattachées à la chape du compresseur.

(57) A compressor having a two-piece piston formed from a separate piston head and piston stem. The piston head is made from a material having low porosity, such as steel, to minimize leakage of the compressing gas across the piston and the piston stem is manufactured from a lightweight material, such as aluminum, to minimize the force required to move the piston within the cylinder and thereby improve the efficiency of the compressor. A suction valve assembly is mounted on the piston head and the piston head, stem, and suction valve assembly are then connected to the yoke of the compressor.

ABSTRACT OF THE DISCLOSURE

5 A compressor having a two-piece piston formed from a separate piston head and piston stem. The piston head is made from a material having low porosity, such as steel, to minimize leakage of the compressing gas across the piston and the piston stem is manufactured from a lightweight material, such as aluminum, to minimize the force required to move the piston within the cylinder and thereby improve the efficiency of the compressor. A suction valve assembly is mounted on the piston head and the piston head, stem, and suction valve assembly are then connected to the yoke of the compressor.

Emanuel Duane Fry

TWO-PIECE PISTONBACKGROUND OF THE INVENTION

1. Field of the invention.

The present invention relates to refrigeration compressors, and more particularly relates to piston assemblies used in refrigeration compressors.

2. Description of the related art.

5 With a refrigeration compressor, it is advantageous to have a piston which minimizes manufacturing cost and leakage of gas across the piston while maximizing the energy efficiency of the compressor. The piston should be relatively light so that less force is required to move the piston within the cylinder and therefore make a more efficient compressor. The piston should also have as low a porosity as
10 possible to minimize leakage of the suction gas across the piston.

An example of a refrigeration compressor is disclosed in U.S. Patent No. 5,080,565 assigned to the assignee of the present invention, the disclosure of which is expressly incorporated by reference herein. Refrigeration compressors such as this have piston assemblies, both the piston head and piston stem, which are
15 monolithic. Therefore, the materials available as options to manufacture the piston must have both relatively good weight and porosity characteristics. The problem with this constraint is that materials with a low weight usually have a relatively high porosity and conversely materials with a low porosity usually have a relatively high weight.

20 Although some piston assemblies have employed multiple elements, such as U.S. Patent No. 4,669,364, these piston assemblies have done so without utilizing materials of different weight and porosity for the various elements of the piston assembly.

25 Even U.S. Patent No. 4,995,284, which uses a combination of ceramic and metal to manufacture a piston assembly, does not address the conflicting demands of weight efficiency and low porosity, but rather is concerned with reduced friction and thermal expansion.

SUMMARY OF THE INVENTION

The present invention is a piston assembly which satisfies these needs by providing a lightweight, inexpensive, and low-porosity piston. The piston assembly is comprised of two elements, a lightweight stem and a piston head having low porosity. The piston head is made from a material having low porosity because the piston head directly contacts the suction gas and therefore should be made from a material which will minimize the amount of gas which is able to pass through the piston. Since the piston stem does not directly contact the suction gas, it need not be made from low porosity material, but should be strong enough to support the weight and force of the piston head while still being relatively light to improve the efficiency of the compressor.

The piston stem is manufactured out of lightweight material, such as aluminum, to satisfy these requirements. Aluminum provides the necessary strength to support the piston head and reduces the overall weight of the piston in order to improve the efficiency of the compressor.

The piston head is manufactured from a material having low porosity, such as steel, to minimize the amount of gas leakage across the piston. Manufacturing the piston head from a material such as steel also allows the piston head to be formed by a process such as blanking, or powdered metal forming, to provide part detail such as suction port configuration. Also, by using a material such as steel, the piston head can be ground or machined for close tolerance of the piston head outer diameter to that of the cylinder bore in order to eliminate the need for a piston ring.

In addition to the piston stem and piston head, the present invention, in one form thereof, also includes a suction valve assembly comprised of a suction valve, a spacer, a stop washer, and a threaded rod or screw. The suction valve, spacer, and stop washer are assembled and then the rod or screw is inserted through the suction valve assembly, into the piston head, through the piston stem, and secured to the yoke of the compressor.

One advantage of the present invention is that leakage of gas across the piston is minimized by using a material having low porosity to manufacture the piston head.

Another advantage of the present invention is that the overall efficiency of the compressor is improved due to the piston stem being manufactured from a lightweight material.

The present invention, in one form, is a compressor comprising a cylinder block having a cylinder bore, a piston, and a drive mechanism. The piston reciprocates within the cylinder bore and includes a piston head and a separate piston stem. The piston head is made from a less porous material than the piston stem while the piston stem is made from a material lighter than the piston head. The drive mechanism is connected to the piston for reciprocating the piston within the cylinder bore.

The present invention, in another form, is a method for manufacturing a piston for mounting to the drive mechanism of a compressor having a cylinder. A piston head made of less porous material than the piston stem is provided, as well as a piston stem made of lighter material than the piston head. The piston head is then ground or machined so that the outer diameter of the piston head closely corresponds to the diameter of the cylinder and the piston stem and piston head are then attached to the drive mechanism.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1A is a sectional view of the piston head, piston stem, and suction valve assembly secured to the yoke of a refrigeration compressor;

Fig. 1B is a plan view of the two piece piston assembly shown in Fig. 1A;

Fig. 1C is a sectional view of the embodiment shown in Fig 1A, taken along line 1C-1C of Fig. 1B;

Fig. 2A is a plan view of the piston head of Fig. 1A;

Fig. 2B is a sectional view of the piston head of Fig. 2A;

Fig. 3 is plan view of the suction leaf valve; and

Fig. 4 is a cutaway sectional view of a refrigeration compressor having the piston assembly shown in Fig 1A.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates one embodiment of the invention and such exemplification is not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

The embodiment disclosed below is not intended to be exhaustive or limit the invention to the precise form disclosed in the following detailed description.

Referring now to Fig. 1A, the present invention is generally depicted as piston assembly 20. As part of piston assembly 20, piston head 22, suction valve assembly 24, and piston stem 26, are all secured to compressor yoke 28 by connecting bolt 30.

As best depicted in Fig. 2a, cylindrical piston head 22 is designed to correspond to the cylindrical shape of a typical compressor cylinder 66. In one embodiment, piston head outer diameter 32 is precision ground for such a close fit to corresponding compressor cylinder 66 that the need for a separate piston ring is eliminated. In other words, piston head outer diameter 32 effectively seals the compression chamber of a compressor. However, other embodiments can incorporate a separate and distinct piston ring. Central bore 34 is in the center of piston head 22 to allow passage of connecting bolt 30 and as shown in Fig. 2a, a plurality of suction passages 36 are formed through the body of piston head 22. In operation, suction passages 36 allow for passage of suction gas into the compression chamber of the compressor. Central bore 34 and suction passages 36 can be formed in piston head 22 either by a blanking process or through powdered metal forming. The blanking process involves the use of a punch or stamping press in which a coil of feedstock, in the exemplary embodiment being steel, which is fed through the

punch or stamping press. The press includes a dye in the shape of the aperture to be formed in the stock being fed through the press and a bed on which the stock is disposed. Once the stock is in the appropriate position, the press will come together with sufficient force such that the dies will penetrate the stock and thereby make the appropriately sized and shaped opening. During powdered metal forming on the other hand, metal, in the form of powder, is placed within a mold having the shape of the desired part. By blending different powder alloys, the metallurgical composition of the part can be tailored accordingly. Once the powder is placed in the mold, a hydraulic or mechanical press will press down on the powder within the mold until the powdered metal assumes the shape of the desired part. For the part to attain its necessary strength, the powdered metal must be put through a furnace and heated.

Piston head 22 is manufactured from a low-porosity material to minimize leakage of gas across the piston during compression. In the exemplary embodiment, the low-porosity material used to manufacture piston head 22 is die quality steel that can be hardened.

Piston stem 26 is comprised of a generally cylindrical body 38 with a bolt receiving bore 44 formed therein. An annular collar 40 is integral with and extends outwardly from the cylindrical body 38 and forms a yoke receiving space 42. Bolt receiving bore 44 is formed in body 38 and passes through the length of piston stem 26 to allow for insertion of connecting bolt 30. Piston stem 26 is mounted onto yoke 28 such that yoke neck 46 is inserted into yoke receiving space 42. Piston head 22 and suction valve assembly 24 are then mounted on top of piston stem 26 and the entire piston assembly 20 is then secured to yoke 28 by connecting bolt 30. In the exemplary embodiment, piston stem 26 is die cast. Die casting is a metal forming process in which molten metal, in the exemplary embodiment being aluminum, is forced under pressure into a mold having the shape of the desired part.

The material used to manufacture piston stem 26 must be a lightweight material and in the exemplary embodiment is made of aluminum. The aluminum can be die cast, or made from wrought rod which is then drilled, or from other

suitable forms of manufacture. Lightweight material is used to make piston stem 26 so that the total weight of piston assembly 20 is minimized. By minimizing the weight of piston assembly 20, the force needed to reciprocate piston assembly 20 within a cylinder of a compressor is also minimized and therefore produces a more efficient compressor.

Suction valve assembly 24 includes stop washer 48, spacer collar 50, and suction leaf valve 52 as shown in Figs. 1A, 1B, and 1C. Stop washer 48 is mounted onto connecting bolts 30 and is adjacent bolt head 56. Spacer collar 50 is also mounted around connecting bolt 30 and is adjacent stop washer 48. Finally, suction leaf valve 52 is mounted around spacer collar 50. Connecting bolt 30 passes through suction valve assembly 24 and through central bore 34 of piston head 22. As shown in Fig. 1A, spacer collar 50 penetrates piston head 22. Suction leaf valve 22 is slidable between the position shown in Fig. 1A, which is directly against piston head 22, and the position shown in Fig. 1C, which is against stop washer 48.

Suction valve assembly has both an open and a closed position. The arrangement of suction valve assembly 24 shown in Fig. 1A illustrates the position of suction leaf valve 52 during the discharge stroke of piston assembly 20. During the discharge stroke, suction passages 36 of piston head 22 are sealed by suction leaf valve 52 thereby preventing passage of the gas being compressed through piston head 22. Conversely, during the suction stroke of piston assembly 20 within a compressor, suction leaf valve 52 will slide axially along spacer collar 50 until it abuts stop washer 48 as shown in Fig. 1C. During the suction stroke, suction passages 36 of piston head 22 are open and permit the communication of suction gases from a gas intake into the compression chamber of the compressor.

The communication of gases is allowed not only around the outer perimeter 58 of suction leaf valve 22 but also through valve ports 60 of suction leaf valve 22. As shown in Fig. 3, a plurality of valve ports 60 as well as central aperture 62 are formed through the body of suction leaf valve 22. Gases are therefore able to enter the compression chamber during the suction stroke along the path shown by arrows 64 in Fig. 1C. In operation, piston assembly 20 reciprocatingly moves within

cylinder 66 of compressor 68. Compressor 68 comprises a crankcase or cylinder block 70, which defines cylinder wall 72, and discharge valve assembly 74 as shown in Fig. 4. Discharge valve assembly includes a flat annular discharge valve 76 attached to central hub portions 78 and is disposed intermediate valve seat plate 80 and cylinder head 82.

As piston assembly 20 moves in its downward or suction stroke, suction leaf valve 52 will be positioned as shown in Fig. 1C. Gases will therefore be able to enter compression chamber 84 along flow path 64 also shown in Fig. 1C. During the discharge or upward stroke of piston assembly 20, suction leaf valve 52 will be positioned as shown in Fig. 1A. Since suction leaf valve 52 is blocking passage of gases through suction passages 36, the gases within compression chamber 84 will discharge through open discharge valve 76.

While this invention has been described as having an exemplary design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

WHAT IS CLAIMED IS:

1. A compressor comprising:
a cylinder block having a cylinder bore;
a piston reciprocating within said cylinder bore, said piston including
5 a piston head and a separate piston stem, said piston head made of less porous
material than said piston stem, said piston stem made of a lighter material than said
piston head; and
a drive mechanism connected to said piston for reciprocating said
piston within said cylinder bore.
- 10 2. A compressor as recited in Claim 1, further comprising a suction
valve assembly mounted to said piston head.
3. A compressor as recited in Claim 1, wherein said piston head further
comprises a plurality of suction passages, said piston assembly further comprises a
suction valve assembly including a retaining member, a stop spatially separated
15 from said piston head, and a suction valve slidably mounted around said retaining
member adapted to seal said suction passages of said piston head.
4. A compressor as recited in Claim 1, wherein said piston head is made
of non-porous material.
5. A compressor as recited in Claim 1, wherein said piston head is made
20 of steel.
6. A compressor as recited in Claim 1, wherein said piston stem of
lightweight material is made of aluminum.
7. A compressor as recited in Claim 1 wherein said compressor is a
scotch yoke-type compressor.
- 25 8. A compressor as recited in Claim 1, wherein said piston stem further
comprises a cylindrical body having an annular collar extending therefrom, said
collar defining a space, an element of said drive mechanism being received in said
space.
9. A compressor as recited in Claim 8, wherein said drive mechanism
30 further comprises a cylindrical collar which is received in said space.

10. A compressor as recited in Claim 8 further comprising an annular retainer having a central aperture, said retainer received within said annular collar and disposed between said stem and said drive mechanism cylindrical collar.

5 11. A method for manufacturing a compressor having a cylinder bore and a drive mechanism, comprising:

providing a piston head and separate piston stem, said piston head being made of less porous material than said piston stem, said piston stem being made of lighter material than said piston head;

10 maintaining said piston head such that the diameter of said piston head closely corresponds to the diameter of the cylinder, whereby the need for a piston ring is eliminated; and

attaching said piston stem and said piston head to said drive mechanism.

15 12. A method for manufacturing a compressor as recited in Claim 11 further comprising the step of forming a plurality of suction passages and a central bore through said piston head.

13. A method for manufacturing a compressor as recited in Claim 12, further comprising the steps of:

20 mounting a suction valve assembly having a stop washer, a spacer collar, and a suction leaf valve onto said piston head;

securing said piston stem, piston head, and said suction valve assembly to said drive mechanism by extending a fastener through said valve assembly, piston head and piston stem and connecting said fastener to said drive mechanism.

25 14. A method for manufacturing a compressor as recited in Claim 13 wherein said piston head is made of steel.

15. A method for manufacturing a compressor as recited in Claim 13 wherein said piston head is made of non-porous material.

30 16. A method of manufacturing a compressor as recited in Claim 13, wherein said piston stem of lightweight material is made of aluminum.

17. A method of manufacturing a compressor as recited in Claim 13 further comprising the step of mounting an annular retainer within said stem and between said stem and said drive mechanism.

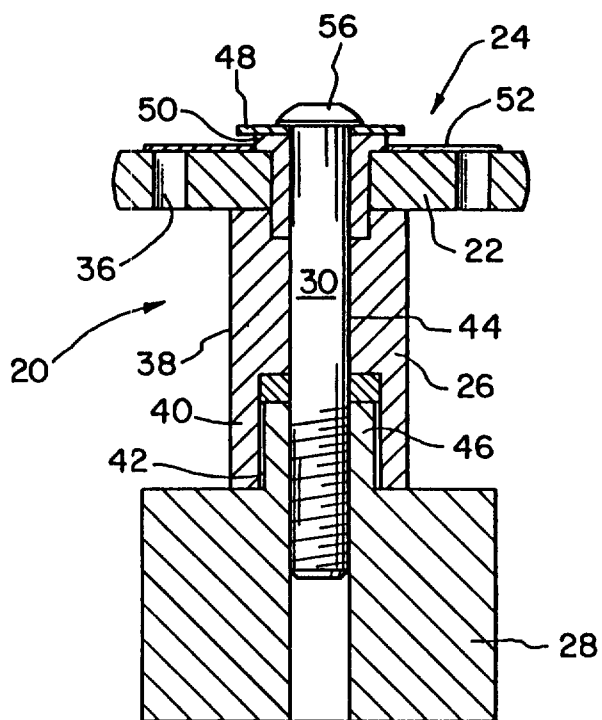


FIG. 1A

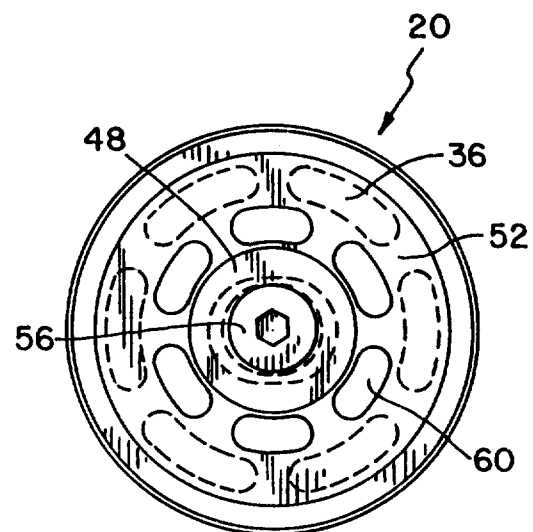


FIG. 1B

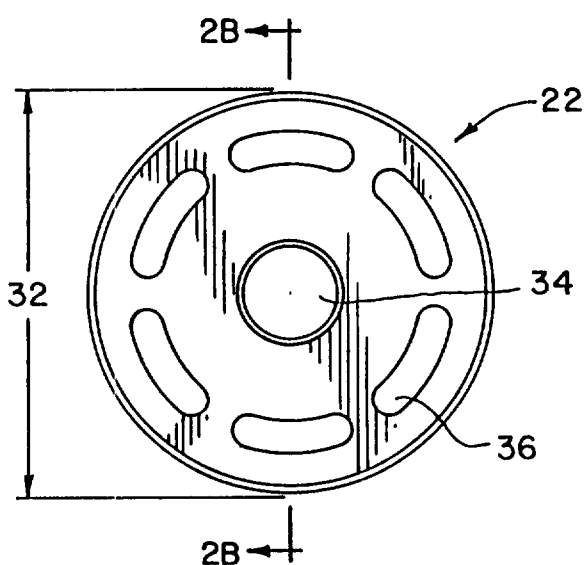


FIG. 2A

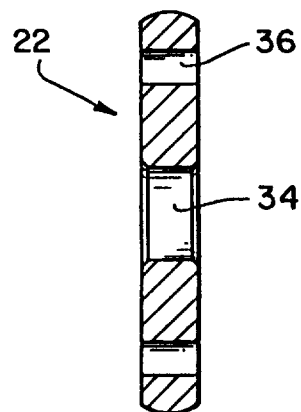


FIG. 2B

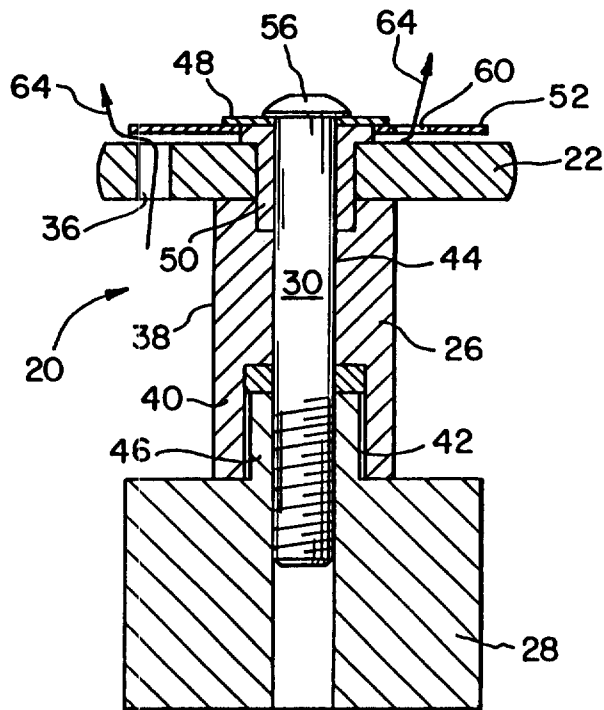


FIG. 1C

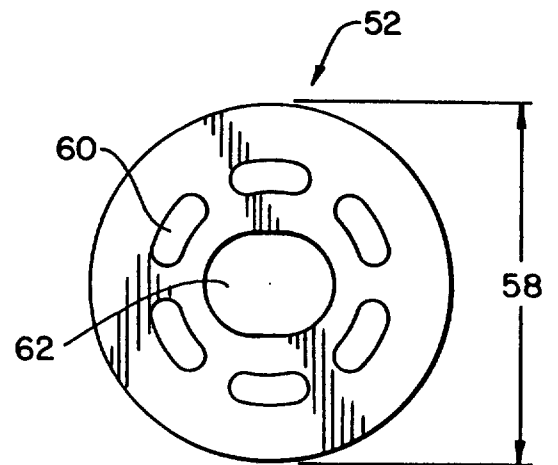


FIG. 3

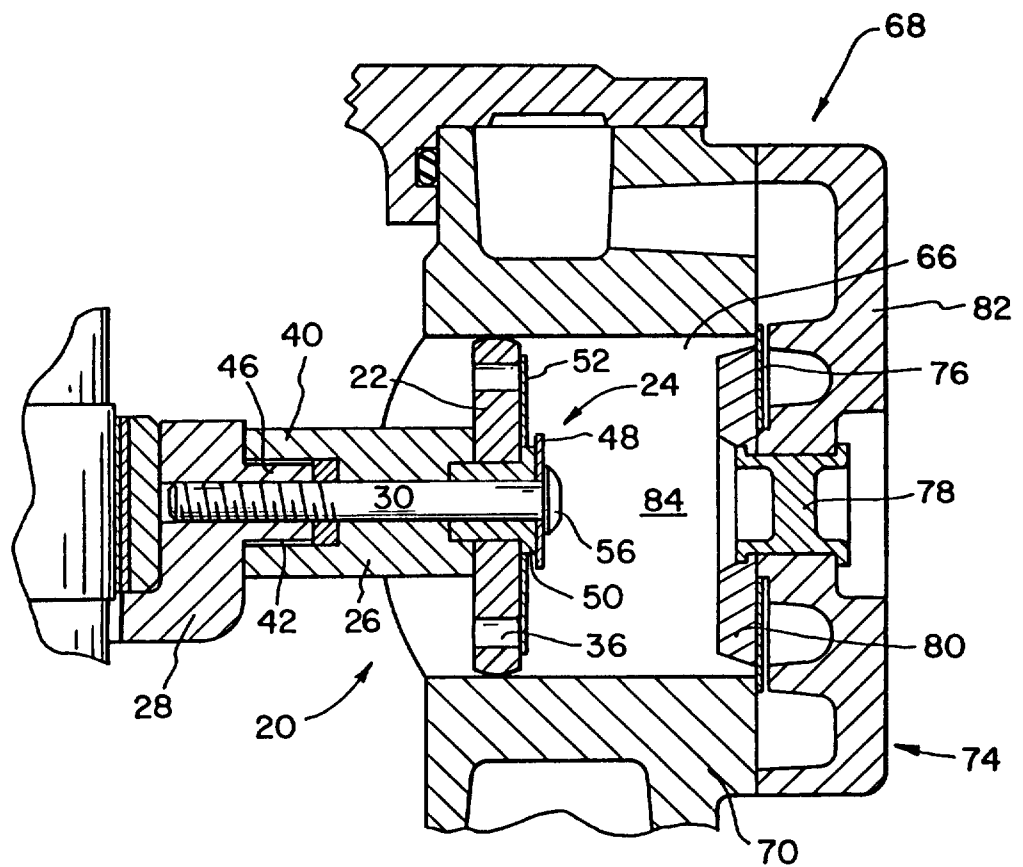


FIG. 4

