

RECIPROCATING COMPRESSOR FRAME

BACKGROUND

[0001] The present invention relates generally to reciprocating compressors. More particularly, the present invention relates to horizontally-opposed reciprocating compressors. Still more particularly, the present invention relates to the structural frame that supports the crankshaft of a horizontally opposed reciprocating compressor.

[0002] Reciprocating compressors are positive-displacement pumps that pressurize a fluid by moving, or stroking, a piston axially within a cylinder. In horizontally-opposed reciprocating compressors, the pistons are connected, via cross heads and connecting rods, to a crankshaft that is rotated by an external power source. The pistons are positioned horizontally and arranged in pairs opposed at different planes across the crankshaft. In conventional applications, the crankshaft is supported within a frame that supports the reciprocating loads, coupled moments, and torque on the crankshaft.

[0003] Most standard frames have a generally rectangular cross-section with vertical walls cantilevered from a heavy base. In order to minimize flexion and distortion of the vertical walls, the walls are generally very thick and interconnected at their tops by a plurality of high-strength tie bars. These tie bars must be made to very tight tolerances as any variations in length can have a major impact on the assembly of the tie bars. Further, as the capacity, speed, and pressure of a compressor increases, the size and weight of the frame also increases in order to manage the increased reciprocating loads, coupled moments, and torque.

[0004] Thus, there remains a need to develop methods and apparatus for supporting reciprocating machinery, which overcome some of the foregoing difficulties while providing more advantageous overall results.

SUMMARY OF THE PREFERRED EMBODIMENTS

[0005] The embodiments of the present invention are directed toward methods and apparatus for a reciprocating compressor barrel frame comprising a continuous curved wall having an inner surface and an outer surface. A housing is formed by the inner surface of the curved wall. A pair cross head shoe supports extend from the outer surface of said curved wall in opposite directions perpendicular to said housing. A plurality of bearing support members are disposed within the housing and supported by the curved wall. The bearing support members are arranged so as to support a crankshaft disposed within the housing. A base flange is connected to the curved wall and is operable to attach to a structure that will support the frame.

[0006] In certain embodiments, a reciprocating compressor comprises a crankshaft and a plurality of cross heads coupled to the crankshaft via connecting rods. The compressor also comprises a frame comprising a continuously curved wall that encloses the crankshaft that is rotatably mounted within the frame. A plurality of cross head shoe supports extend from and are formed integral to the curved wall of the frame. Each cross head is supported by cross head shoes that are removably connected to the cross head shoe supports. A plurality of bearing support members are disposed within the housing and are supported by the curved wall. A plurality of bearings are disposed between the crankshaft and the plurality of bearing support members. A lubricant sump is disposed within the housing and arranged so as to lubricate the crankshaft.

[0007] Thus, the present invention comprises a combination of features and advantages that enable it to overcome various problems of prior devices. The various characteristics described above, as well as other features, will be readily apparent to those skilled in the art upon reading the following detailed description of the preferred embodiments of the invention, and by referring to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] For a more detailed description of the preferred embodiment of the present invention, reference will now be made to the accompanying drawings, wherein:

[0009] Figure 1 is a view of a reciprocating compressor including a frame constructed in accordance with embodiments of the invention;

[0010] Figure 2 is a partial sectional end view of a reciprocating compressor including a frame constructed in accordance with embodiments of the invention;

[0011] Figure 3 is an partial sectional isometric view of a frame constructed in accordance with embodiments of the invention;

[0012] Figure 4 is an end view of the frame of Figure 3; and

[0013] Figure 5 is a sectional end view of a cross head disposed in a frame constructed in accordance with embodiments of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Referring now to Figures 1 and 2, reciprocating compressor 10 comprises frame 14, crankshaft 16, connecting rods 18, cross heads 20, pistons 22, cylinders 24, and valve assemblies 26. A power supply is coupled to one end of crankshaft 16 and provides the power to rotate the crankshaft. Crankshaft 16 is supported within frame 14. Connecting rods 18 couple cross heads 20 and pistons 22 to crankshaft 16. Pistons 22 move linearly within cylinders 24. Valve assemblies 26 control flow into and out of cylinders 24.

[0015] As crankshaft 16 is rotated by a power supply, connecting rods 18 and cross heads 20 transform the rotational motion of the crankshaft into linear movement of pistons 22 within cylinders 22. As pistons 22 stroke forward within cylinders 24, the pressure within the cylinder increases until discharge valves in valve assembly 26 open to allow pressurized fluids to exit the cylinder. As pistons 22 stroke backward, the pressure within the cylinders 24 decreases and an inlet valve in valve assembly 26 opens to allow fluid to fill the cylinder.

Crankshaft 16 is arranged such that while one piston strokes forward the piston on the opposite side of the crankshaft strokes backward. While this arrangement helps maintain balance, the coupled moments, which are formed by the variation of plane of action of the pistons' operation, are transferred by the crank shaft 16 and are supported by the frame of compressor 10.

[0016] Regardless of the efforts taken to balance crankshaft 16, there will be some unbalanced forces and compressor 10 will be subject to vibratory reciprocating loads. By supporting crankshaft 16 and all of the other moving components, frame 14 will be subjected to the reciprocating loads, coupled moments, and torque on the crankshaft and has to be able to withstand those loads without excessive distortion. In order to improve the distribution of the reciprocating loads, coupled moments, and torque as well as the distortion of the frame itself, frame 14 is a "barrel"-type frame comprising a continuous, curved wall 28 that forms a crankshaft housing 30.

[0017] Curved wall 28 surrounds crankshaft 16 such that the loads generated in a plurality of directions by the movement of the crankshaft and the reciprocating actions of the piston assemblies are transferred to the wall. Because wall 28 is continuously curved, every element of the wall is supported by adjacent elements within the wall and the curved wall is effectively self-supported against these loads in a plurality of directions. Therefore, no external tie bars are necessary to support and balance the reciprocating loads as are found in the existing art. Curved wall 28 also improves the efficiency with which the reciprocating loads, coupled moments, and torque are dissipated, thus allowing a reduction in wall thickness, and hence a reduction in the weight of frame 14 versus a conventional box-type frame.

[0018] Referring now to Figures 3 and 4, barrel-type frame 14 integrally comprises curved wall 28, housing 30, cross head shoe supports 32, base flange 34, end flanges 36, bearing supports 38, lubricant sump 40, and access openings 42. Frame 14 is shown as having two cross heads,

but multiple pairs of cross heads are possible. Frame 14 may be constructed from a single casting that is machined to include desired features. Constructing frame 14 from a single piece of material eliminates welding and other high-temperature processes that may distort the frame. Furthermore Frame 14 may be constructed with plurality of ribs formed between wall 28, base flange 34, and cross head shoe supports 32 that provide structural rigidity and potentially increase thermal transfer capability of the frame.

[0019] Base flange 34 is a flat, rectangular member that provides a base suitable for attachment to a foundation or other structure that will support the compressor. Base flange 34 may comprise a bolt pattern or other means for securing the compressor. Curved wall 28 extends from base flange 34 to form substantially cylindrical housing 30 having end flanges 36. Although curved wall 28 is illustrated as being substantially cylindrical, other curved shapes are possible and may provide advantages in certain applications.

[0020] Housing 30 provides an enclosure adapted to receive a crankshaft and comprises bearing supports 38, lubricant sump 40, and access openings 42. Bearing supports 38 provide mounting and attachment points for bearings that support the crankshaft. Lubricant sump 40 provides a reservoir of lubricant that can be used to lubricate the bearings and crankshaft. Access openings 42 provide access to the crankshaft and other components installed within the housing. When in operation, access opening 42, as well as end flanges 36 may be covered with simple hinged covers, clamped covers, or other type covers.

[0021] Frame 14 also features cross head shoe supports 32 that are constructed integral with wall 28. Integral cross head shoe support 32 provides support for each of the shoes and cross head as well as further increase the strength of wall 28. The integral feature of cross head shoe support 32 with the frame 14 also allows machining of the crank shaft bore and the cross head shoe support bore with the same machining set up. This eliminates misalignment problems between the cross head with the crank shaft as it is inherent with the conventional separate

cross head guide design. Furthermore, the integral design eliminates the extra machining and bolting arrangement which is required by the conventional attachment design..

[0022] Cross head shoe supports 32 comprise an internal cavity 44 shaped to receive cross head and cross head shoe. Cavity 44 may be fitted with a stationary cross head shoe 50, see Figure 5, that provides a precision-machined surface for guiding the cross head 52. Shoes 50 are removable and can be replaced as needed. By mounting cross head shoes 50 on shoe support 32, the surfaces of the shoe support are protected from damage and only the shoes need to be replaced in the event of surface wear. Hence, the replaceable shoes will protect frame 14 from any primary damage caused by the motion of cross head on the shoes. In certain embodiments, cross head shoe supports 32 have access openings that allow for the removal and replacement of shoes 50 without removing cross head 52.

[0023] While preferred embodiments of this invention have been shown and described, modifications thereof can be made by one skilled in the art without departing from the scope or teaching of this invention. The embodiments described herein are exemplary only and are not limiting. Many variations and modifications of the system and apparatus are possible and are within the scope of the invention. For example, the relative dimensions of various parts, the materials from which the various parts are made, and other parameters can be varied, so long as the compressor frame apparatus retain the advantages discussed herein. Accordingly, the scope of protection is not limited to the embodiments described herein, but is only limited by the claims that follow, the scope of which shall include all equivalents of the subject matter of the claims.

WHAT IS CLAIMED IS:

1. A reciprocating compressor frame comprising:
 - a one-piece frame, said one-piece frame having a barrel-shaped body formed by a curved wall; and
 - a pair of cross head shoe supports extending generally perpendicular to said barrel-shaped body from said curved wall in opposite directions;
 - wherein said curved wall is integral with said cross head shoe supports; and
 - wherein at least a portion of said curved wall extends from one of said pair of said cross head shoe supports to the other of said pair of said cross head shoe supports.
2. The reciprocating compressor frame of claim 1 further comprising a plurality of bearing support members disposed within said one-piece housing and supported by said curved wall.
3. The reciprocating compressor frame of claim 2 wherein said bearing support members are directly coupled to said curved wall and arranged so as to support a crankshaft disposed within said one-piece frame.
4. The reciprocating compressor frame of claim 1 wherein said one-piece frame further includes a base flange connected to said curved wall, wherein said base flange is operable to attach to a structure that will support the one-piece frame.
5. The reciprocating compressor frame of claim 1 further comprising a lubricant sump disposed within said one-piece frame.

6. The reciprocating compressor frame of claim 5 wherein said lubricant sump is arranged so as to lubricate a crankshaft disposed within said one-piece frame.
7. The reciprocating compressor frame of claim 28 wherein the plurality of arcuate wall portions defines a plurality of access openings in the curved wall.
8. The reciprocating compressor frame of claim 7 wherein said access openings are arranged so as to provide access to a crankshaft, connecting rods, or bearings disposed within said one-piece frame.
9. The reciprocating compressor frame of claim 7, further comprising hinged or clamped on covers that cover said access openings.
10. The reciprocating compressor frame of claim 1 further comprising stationary cross head shoes removably connected to said cross head shoe supports.
11. A reciprocating compressor comprising:
 - a crankshaft;
 - a plurality of cross heads coupled to said crankshaft via connecting rods;
 - a one-piece, barrel-shaped frame enclosing said crankshaft with said crankshaft rotatably mounted therein, said one-piece, barrel-shaped frame comprising a curved wall having a plurality of access openings through the curved wall to provide access to said crankshaft and a plurality of arcuate wall portions, wherein each of the plurality of access openings is disposed between an adjacent pair of the plurality of arcuate wall portions;

said frame further including a plurality of cross head shoe supports extending from and formed integral to the curved wall of said frame, wherein each cross head is supported by at least one cross head shoe that is removably connected to one of said plurality of cross head shoe supports;

a plurality of pistons, wherein each piston is coupled to a cross head and disposed within a cylinder coupled to a cross head shoe support; and

a valve assembly coupled to each cylinder, wherein said valve assembly comprises an inlet valve that opens in response to decreasing air pressure within said valve assembly and an outlet valve that opens in response to increasing air pressure within said valve assembly.

12. The reciprocating compressor of claim 11 further comprising:

a plurality of bearing support members disposed within said frame and supported by said curved wall; and

a plurality of bearings disposed between said crankshaft and said plurality of bearing support members.

13. The reciprocating compressor of claim 11 further comprising a lubricant sump disposed within said frame and arranged so as to lubricate said crankshaft.

14. The reciprocating compressor of claim 11 further comprising:

a plurality of covers operable to cover said access openings.

15. The reciprocating compressor of claim 14 wherein said plurality of covers are hinged or clamped to said frame.

16. An assembly comprising a reciprocating compressor, the reciprocating compressor comprising:

a one-piece reciprocating compressor frame having a generally arcuate shape with a plurality of arcuate wall portions formed in one side thereof and extending between a pair of laterally extending cross head shoe supports;

a cross head disposed in each of the cross head shoe supports;

a reciprocating compressor piston coupled to the cross head and disposed in a reciprocating compressor cylinder assembly; and

a reciprocating compressor crankshaft assembly at least partially disposed in an interior region of the one-piece frame and coupled to the piston via a supporting rod.

17. The assembly of claim 16, wherein the frame includes a plurality of apertures located between the cross head shoe supports.

18. The assembly of claims 16, further comprising a bearing support integral with the one-piece frame and having an arcuate shape.

19. The assembly of claim 16, wherein the one-piece frame comprises a continuous curved wall that at least partially encloses said crankshaft, and wherein each of the cross head shoe supports is formed integral to the curved wall.

20. The assembly of claim 16, wherein said frame is barrel-shaped.

21. The reciprocating compressor frame of claim 1, wherein the curved wall further comprises a plurality of arcuate wall portions extending between the pair of the cross head shoe supports.

22. A reciprocating-compressor assembly, comprising:

a unitary frame having an arcuate wall substantially surrounding an interior volume about the longitudinal axis of the unitary frame; and

a pair of cross head shoe supports extending generally perpendicular to the longitudinal axis of the unitary frame.

23. The reciprocating-compressor assembly of claim 22, wherein the pair of cross head shoe supports is integral with the arcuate wall.