Title: COMPRESSOR TERMINAL PLATE

Abstract: A compressor (20) has a housing (22) having first (52) and second (48) members. A motor (24) within the housing (22) is coupled to one or more working elements (26, 28) to drive the one or more working elements (26, 28) to compress a fluid. A number of electrical terminals (104) are each mounted in an associated aperture (132) in the second housing member (48) and electrically connected to the motor (24).
BACKGROUND OF THE INVENTION

[0001] The invention relates to compressors. More particularly, the invention relates to hermetic refrigerant compressors.

[0002] Screw-type compressors are commonly used in air conditioning and refrigeration applications. In such a compressor, intermeshed male and female lobed rotors or screws are rotated about their axes to pump the working fluid (refrigerant) from a low pressure inlet end to a high pressure outlet end. During rotation, sequential lobes of the male rotor serve as pistons driving refrigerant downstream and compressing it within the space between an adjacent pair of female rotor lobes and the housing. Likewise sequential lobes of the female rotor produce compression of refrigerant within a space between an adjacent pair of male rotor lobes and the housing. The interlobe spaces of the male and female rotors in which compression occurs form compression pockets (alternatively described as male and female portions of a common compression pocket joined at a mesh zone). In one implementation, the male rotor is coaxial with an electric driving motor and is supported by bearings on inlet and outlet sides of its lobed working portion. There may be multiple female rotors engaged to a given male rotor or vice versa.

[0003] When one of the interlobe spaces is exposed to an inlet port, the refrigerant enters the space essentially at suction pressure. As the rotors continue to rotate, at some point during the rotation the space is no longer in communication with the inlet port and the flow of refrigerant to the space is cut off. After the inlet port is closed, the refrigerant is compressed as the rotors continue to rotate. At some point during the rotation, each space intersects the associated outlet port and the closed compression process terminates.
[0004] Many such compressors are hermetic compressors wherein
the motor is located within the compressor housing and may be
exposed to a flow of refrigerant. Hermetic compressors present
difficulties regarding their wiring. Routing of conductors
through the housing while maintaining hermeticity and
convenience of use while controlling manufacturing costs
present difficulty. One exemplary configuration involves
mounting electrical power terminals on a machined terminal
plate. The terminal plate is, in turn, mounted over an opening
in the compressor housing and sealed thereto.

SUMMARY OF THE INVENTION

[0005] According to one aspect of the invention, a compressor
has a housing having first and second members. A motor within
the housing is coupled to one or more working elements to
drive the one or more working elements to compress a fluid. A
number of electrical terminals are each mounted in an
associated aperture in the second housing member and
electrically coupled to the motor.

[0006] In various implementations, the compressor may be a
hermetic screw compressor. The first housing member may be a
motor case having a compressor inlet port. The second housing
member may be a rotor case.

[0007] The details of one or more embodiments of the invention
are set forth in the accompanying drawings and the description
below. Other features, objects, and advantages of the
invention will be apparent from the description and drawings,
and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a longitudinal sectional view of a
compressor.

[0009] FIG. 2 is a view of a rotor case of the compressor of
FIG. 1 carrying a motor and an electrical terminal array.
[0010] FIG. 3 is a top view of the case of FIG. 2, partially cutaway along line 3-3 of FIG. 2.
[0011] FIG. 5 is an enlarged view of the cutaway portion of FIG. 3.

[0012] Like reference numbers and designations in the various drawings indicate like elements.
DETAILED DESCRIPTION

[0013] FIG. 1 shows a compressor 20 having a housing assembly 22 containing a motor 24 driving rotors 26 and 28 having respective central longitudinal axes 500 and 502. In the exemplary embodiment, the rotor 26 has a male lobed body or working portion 30 extending between a first end 31 and a second end 32. The working portion 30 is enmeshed with a female lobed body or working portion 34 of the female rotor 28. The working portion 34 has a first end 35 and a second end 36. Each rotor includes shaft portions (e.g., stubs 39, 40, 41, and 42 unitarily formed with the associated working portion) extending from the first and second ends of the associated working portion. Each of these shaft stubs is mounted to the housing by one or more bearing assemblies 44 for rotation about the associated rotor axis.

[0014] In the exemplary embodiment, the motor is an electric motor having a rotor and a stator. One of the shaft stubs of one of the rotors 26 and 28 may be coupled to the motor's rotor so as to permit the motor to drive that rotor about its axis. When so driven in an operative first direction about the axis, the rotor drives the other rotor in an opposite second direction. The exemplary housing assembly 22 includes a rotor housing 48 having an upstream/inlet end face 49 approximately midway along the motor length and a downstream/discharge end face 50 essentially coplanar with the rotor body ends 32 and 36. Many other configurations are possible.

[0015] The exemplary housing assembly 22 further comprises a motor/inlet housing 52 having a compressor inlet/suction port 53 at an upstream end and having a downstream face 54 mounted to the rotor housing downstream face (e.g., by bolts through both housing pieces). The assembly 22 further includes an outlet/discharge housing 56 having an upstream face 57 mounted to the rotor housing downstream face and having an outlet/discharge port 58. The exemplary rotor housing,
motor/inlet housing, and outlet housing 56 may each be formed as castings subject to further finish machining.

[0016] Surfaces of the housing assembly 22 combine with the enmeshed rotor bodies 30 and 34 to define inlet and outlet ports to compression pockets compressing and driving a refrigerant flow 504 from a suction (inlet) plenum 60 to a discharge (outlet) plenum 62 (located below the cut plane and thus schematically indicated). A series of pairs of male and female compression pockets are formed by the housing assembly 22, male rotor body 30 and female rotor body 34. Each compression pocket is bounded by external surfaces of enmeshed rotors, by portions of cylindrical surfaces of male and female rotor bore surfaces in the rotor case and continuations thereof along a slide valve, and portions of face 57.

[0017] The exemplary compressor is a hermetic compressor wherein the motor 24 is sealed within the housing 22 and exposed to the refrigerant passing through the compressor. The motor 24 is coaxial with the rotor 26 along the axis 500 and has a stator 100 and a rotor 102. The rotor 102 is secured to an end portion of the shaft stub 39 to transmit rotation to the rotor 26. To supply power to the motor, electrical conductors must pass through the housing. These may include a number of terminals 104 mounted in the housing. Exemplary terminals have exterior pin-like contacts 106 having axes 510. Exemplary terminals 104 have interior contacts 108 (e.g., screw fittings). For each terminal, a wire 110 extends from a first end at the contact 108 to a second end at the motor. For an exemplary three-phase motor, there are three pairs of such terminals (FIG. 2). FIG. 2 shows the terminals in an exemplary arrangement as a parallel linear array with outboard portions extending from a flat face (outer surface portion) 120 of an integral terminal plate 122 of the rotor case 48.

[0018] FIG. 3 shows further details of the terminal mounting. Each terminal is sealed by an elastomeric O-ring 130
compressed within a bore 132 in the plate 122. Along the housing interior surface 134 there is a counterbore 136. An interior insulator 140 has a main portion 141 (FIG. 5) accommodated in the counterbore 136. An exterior insulator 142 has a main body 143 atop the face 120. The insulators 140 and 142 have respective insertion portions 144 and 145 within the bore 133 and having distal end faces sandwiching and compressively engaging the O-ring 130. Compression is maintained by a nut 146 threaded to the pin 106 and bearing against the insulator body 143. A head 147 of the pin may be faceted and captured by a head 148 of the insulator 140 and may receive the screw contact 108.

[0019] In the exemplary embodiment, the face 120 and plate 122 fall along a local shoulder 150 (FIG. 3) between a flange 152 and a local recessed area 154. The flange 152 acts as a mounting flange along the surface 49 and receives bolts 154 (FIG. 1) securing the motor case 52 to the rotor case 48. Along the terminal plate 122, the shoulder is off-longitudinal by an angle o. Thus, the axis 510 is off-longitudinal by o's complement. Exemplary o is 45°, more broadly 30-60°. This angling facilitates a number of advantages. It permits ease in forming the rotor housing by casting. The rotor housing precursor may be cast (e.g., of iron or aluminum) and subject to further machining. The machining may include machining of the rotor bores 160 and 162 and the slide valve bore 164. The machining may include forming various mounting holes and fluid communication passageways. The machining may include machining of the face 120 for precise planarity. The machining may include machining the bores 132 through the face 120 of the terminal plate 122.

[0020] However, for the terminals, the machining includes machining of the counterbores 136 (FIG. 4) with a tool inserted through the open upstream/suction side end (either before or after machining the face 49 thereon). The machining
may also include machining a flat plateau surface 168 surrounding the group of bores 132 and counterbores 136 (e.g., before machining at least the counterbores). The angling helps provide clearance for the tools doing the internal machining. As viewed in FIG. 4, clearance is relative to a portion of the mounting flange to the left and upper and lower wall segments of a stator bore to the right, both extending to the face 49. The stator bore retains a downstream portion of the stator to ensure coaxiality with the rotor 26. The counterboring provides a counterbore base surface at a precise and consistent separation T from the face 120. This permits precise positioning of the terminals. This also avoids sealing problems associated with mounting the terminals in a plate separate from the casting and which must be sealed thereto by additional means. The angling may provide additional use benefits. For example, as shown in FIG. 3, a major portion of the exposed pin lies inboard of the projection 520 of the perimeter 170 of the flange 152. This may help reduce chances of damage to the pins.

The precision of the thickness T may provide additional assembly ease benefits. A precise amount of compression of the O-ring 130 is required to provide an effective seal. Typically this precision could be obtained by precise torquing. However, with a precise thickness T and precise lengths of the insulator insertion portions 144 and 145 less torque precision is needed. These dimensions may be chosen to provide the desired degree of O-ring compression when the underside (shoulder) of the insulator body 143 is flat against the face 120 and the underside of the body 141 is bottomed against the base of the counterbore. This eases assembly and reduces risk of damage to the O-ring from overtorquing.

An additional assembly benefit may come from radial enlargement and faceting of the heads 148. The spacing between bores and the size of the heads 148 is chosen so that each
head 148 interfits with the next so that more than a slight rotation of the head 148 brings it into interference with the adjacent head(s) 148 to prevent more than limited rotation. The antirotation engagement of the pin head 147 to the insulator head 148 thus holds the pin against more than this limited rotation. Thus, to tighten the nuts 146 no separate tool is necessarily required to hold the head of the pin.

[0023] One or more embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, in a reengineering, details of the existing compressor configuration may particularly influence or dictate details of the implementation. Accordingly, other embodiments are within the scope of the following claims.
CLAIMS

What is claimed is:

1. A compressor apparatus (20) comprising:
   a housing (22) having first (53) and second (58) ports along a flow path (504), the housing being an assembly of at least:
   a first housing member (52) having first and second ends; and
   a second housing member (48), having first and second ends, the second housing member first end being secured to the first housing member second end;
   one or more working elements (26; 28) cooperating with the housing to define a compression path between suction (60) and discharge (62) locations along the flow path;
   a motor (24) within the housing and coupled to the one or more working elements to drive the one or more working elements; and
   a plurality of electrical terminals (104), each mounted in an associated aperture (132, 136) in the second housing member and electrically coupled to the motor.

2. The apparatus (20) of claim 1 wherein:
   the first port (53) is an inlet port in the first housing member (52); and
   the motor (24) is at least partially within the first housing member (52).

3. The apparatus (20) of claim 2 wherein:
   a third housing member (56) has a first end secured to the second housing member second end;
   the second port (58) is an outlet port in the third housing member (56); and
the motor (24) is mostly within the first housing member (52).

4. The apparatus (20) of claim 1 wherein:
there are at least six terminals (104) oriented in a single direction (510).

5. The apparatus (20) of claim 4 wherein:
said single direction (510) is 30-60° off normal to an axial direction (500) of the motor (24).

6. The apparatus (20) of claim 5 wherein:
the second housing member (48) is a casting and the apertures (132, 136) are in said casting.

7. The apparatus (20) of claim 1 further comprising:
wiring (110) coupling the terminals (104) to the motor (24).

8. The apparatus (20) of claim 7 wherein:
each of the terminals (104) comprises an external contact (106) for engaging external wiring.

9. The apparatus (20) of claim 7 wherein:
the terminals (104) are in a linear array.

10. The apparatus (20) of claim 1 wherein
each of the terminals (104) comprises an external contact (106) for engaging external wiring; and
the external contacts are mostly inboard of a mounting flange (152) at the second housing member first end.

11. The apparatus (20) of claim 1 wherein the one or more working elements include:
a male-lobed rotor (26) having a first rotational axis (500); and

a female-lobed rotor (28) having a second rotational axis (502) and enmeshed with the male-lobed rotor.

12. The apparatus (20) of claim 11 wherein:
at least one of the rotors (26; 28) is coaxial with the motor (24); and
lobed portions (30; 34) of the rotors (26; 28) are essentially entirely within the second housing member (48).

13. The apparatus (20) of claim 1 wherein:
the motor (24) is a three-phase electric motor; and there are six such terminals (104).

14. The apparatus (20) of claim 1 wherein:
each aperture comprises a bore (132) and a counterbore (136), the counterbore on an interior surface (134) of the second housing member (48).

15. A method for manufacturing a compressor housing member comprising:
casting a precursor of the member;
machining a first mounting surface at an open end of the member; and
forming a plurality of terminal mounting apertures by:
boring a plurality of bores; and counterboring the bores at an interior of the member.

16. The method of claim 15 wherein:
the is counterboring is performed by a tool extending through the open end.
17. The method of claim 16 wherein:
the counterboring is performed after the machining.

18. The method of claim 15 wherein:
the is counterboring is off axial by an angle of 30-60°.

19. The method of claim 15 further comprising:
boring at least a pair of axial rotor bores in the
housing member; and
boring a slide valve bore in the housing member.

20. A method for manufacturing a compressor comprising:
manufacturing a housing member according to claim 19;
assembling a pair of rotors to the housing member in the
pair of rotor bores;
. assembling a slide valve to the housing member in the
slide valve bore;
coupling a motor to a first of the rotors; and
assembling a motor housing member to the open end.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : F04B 17/00; B23P 15/00, 25/00
US CL : 417/410.4, 410.1, 371; 29/888.023, 527.6

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 417/410.4, 410.1, 371; 29/888.023, 527.6

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

US-PGPUB, USPat, USOCR, EPO, JPO, Derwent, IBM_TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category *</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>US 5,246,349 A (Hartog) 21 September 1993 (21.09.1993), fig. 2, full text.</td>
<td>1-4, 7-9, and 11-14</td>
</tr>
<tr>
<td>A</td>
<td>US 5,961,293 A (Clemmons et al.) 05 October 1999 (05.10.1999), full text, drawings.</td>
<td>5, 6, and 10</td>
</tr>
<tr>
<td>A</td>
<td>US 2004/0072474 AI (Nyblin et al.) 15 April 2004 (15.04.2004), full text, fig. 1.</td>
<td>1-4, 7-9, and 11-14</td>
</tr>
<tr>
<td>A</td>
<td>US 6,494,699 B2 (Sjoholm et al.) 17 December 2002 (17.12.2002), full text, drwgs.</td>
<td>5, 6, and 10</td>
</tr>
</tbody>
</table>

* Further documents are listed in the continuation of Box C. □ See patent family annex.

Date of the actual completion of the international search 06 May 2005 (06.05.2005)

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Facsimile No. (703) 305-3230

Date of mailing of the international search report 14 JUN 2005

Authorized officer

Christopher H. Orders

Telephone No. (571) 272-3750

Form PCT/ISA/210 (second sheet) (January 2004)
<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 4,193,657 A (Stone) 18 March 1980 (18.03.1980), full text, drwgs.</td>
<td>14-16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17-20</td>
</tr>
</tbody>
</table>

Form PCT/ISA/210 (continuation of second sheet) (January 2004)