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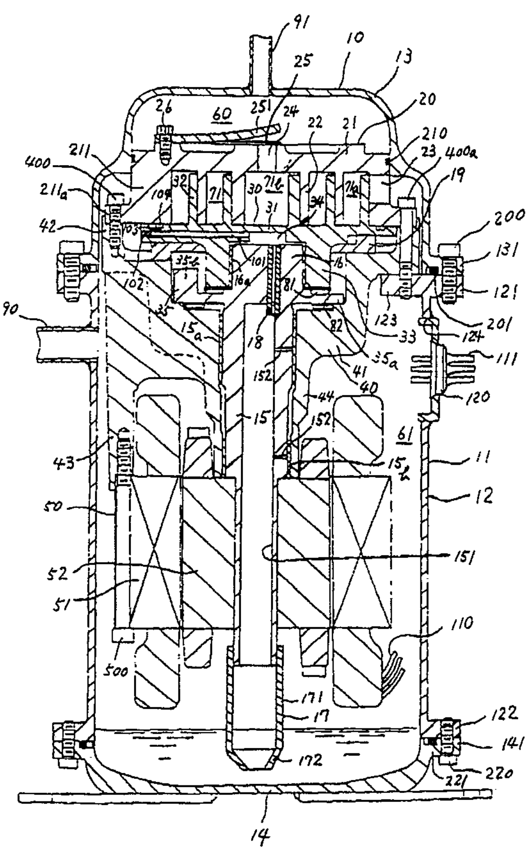
(54) Lubrication for scroll compressor.

(57) This invention discloses a lubricating mechanism of a hermetically sealed scroll type compressor. The compressor includes a hermetically sealed housing and a motor driven drive shaft supported by a plurality of plain bearings in an inner block member. The drive shaft (15) is provided with pin member (16) at its upper end. The axis of pin member is radially shifted from the axis of the drive shaft. Pin member (16) operatively connected to an orbiting scroll which orbits within a fixed scroll. A rotation preventing device prevents rotation of the orbiting scroll. The drive shaft includes an axial bore (151) extending from a lower end thereof to a lower end of the pin member. A centrifugal pump (17) is provided at a lower end of the axial bore, and immersed in the lubricating oil sump at an inner bottom of the housing. A throttling device (18) such as an orifice tube penetrates through the pin member. The lubricating oil at the inner bottom of the housing is supplied to the frictional surfaces of the slidable members of the compressor by virtue of operation of the centrifugal pump (17) via the axial bore (151) and the orifice tube (18). Thereby, the frictional surfaces can receive a sufficient, but not, excessive amount of the lubricating oil in any rotational speed of the drive shaft so that the frictional surfaces are effectively lubricated.



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This invention relates to a hermetically sealed scroll type refrigerant compressor, and more particularly to a lubricating mechanism thereof.

Japanese Patent Application Publication No. 60-73,083 discloses a hermetically sealed scroll type refrigerant compressor which is designed such that the longitudinal axis of a drive shaft is generally perpendicular to a horizontal plane when the compressor is installed. Therefore, in general, the compressor can be called a vertically installed type scroll refrigerant compressor. The compressor includes a hermetically sealed housing in which a compression mechanism having a fixed and orbiting scrolls, a driving mechanism having a motor and a motor driven drive shaft, and a rotation preventing device for preventing rotation of the orbiting scroll during orbital motion are contained. The fixed scroll includes a circular end plate which divides a cavity which is defined by the housing into a suction and discharge chamber sections. The suction chamber section contains the driving mechanism, the rotation preventing mechanism and a spiral element of the fixed and orbiting scrolls.

The drive shaft includes an axial conduit of which the axis is radially shifted from the axis of the drive shaft. The drive shaft is provided with a centrifugal pump at its lower end. The centrifugal pump is immersed in a reservoir of lubricating oil which accumulates at the inner bottom portion of the housing.

In operation, refrigerant gas flowing from an external fluid circuit flows into the suction chamber section through an inlet port which is disposed through a side wall of the housing, and is taken into a pair of outer fluid pockets which are defined by the spiral elements. The refrigerant gas is compressed inwardly toward a central fluid pocket due to orbital motion of the orbiting scroll. As the refrigerant gas moves towards the central fluid pocket, it undergoes a resultant of volume reduction and compression and is discharged into the discharge chamber section through a hole extending through the circular end plate of the fixed scroll. The compressed refrigerant gas in the discharge chamber section flows out of the compressor to the external fluid circuit through an outlet port which is disposed through an upper end of the housing. After circulating through the external fluid circuit, the refrigerant gas which exits through the outlet port returns to the compressor through the inlet port.

Furthermore, lubricating oil which accumulates at the inner bottom end portion of the housing flows upwardly through the axial conduit by virtue of operation of the centrifugal pump which operates during rotation of the drive shaft. The lubricating oil which has upwardly passed over the axial conduit flows through other conduits, and into a frictional surfaces of the slidable members of the compressor, such as the rotation preventing mechanism and the bearings rotatably supporting the drive shaft, in order to lubricate thereof.

As mentioned above, in this prior art, the lubricating oil at the inner bottom portion of the housing is supplied to the frictional surfaces of the slidable members of the compressor through the axial conduit and the other conduits by use of the centrifugal pump. However, flow rate of the lubricating oil which has passed over the axial conduit and the other conduits quadratically increases in accordance with increase in a rotational speed of the drive shaft, because that hydraulic resistance which is generated at the axial conduit and the other conduits when the lubricating oil passes therethrough is negligible.

Accordingly, when capability of the centrifugal pump is designed so as to be able to supply a sufficient amount of the lubricating oil to the frictional surfaces of the slidable members of the compressor in a low rotational speed of the drive shaft, an excessive amount of the lubricating oil is supplied to the frictional surfaces in a high rotational speed of the drive shaft. Therefore, in the high rotational speed of the drive shaft, viscous drag of the lubricating oil generated between the frictional surfaces extremely increases so that the frictional surfaces do not smoothly slide each other. In addition, when an excessive amount of the lubricating oil is supplied to the frictional surfaces between the fixed and orbiting scrolls, an excessive amount of the lubricating oil is taken into the fluid pockets of the scrolls together with the refrigerant, and exits to the fluid circuit via a compression and discharge processes of the refrigerant. Therefore, a ratio of an amount of the lubricating oil to an amount of the refrigerant in the circulation of the fluid circuit increases, thereby decreasing heat exchange-ability of an evaporator which forms a part of the fluid circuit. On the other hand, when the capability of the centrifugal pump is designed so as to be able to supply a sufficient, but not an excessive, amount of the lubricating oil to the frictional surfaces in a high rotational speed of the drive shaft, an insufficient amount of the lubricating oil is supplied to the frictional surfaces in the low rotational speed of the drive shaft. Therefore, the frictional surfaces may seize in the low rotational speed of the drive shaft due to lack of the lubricating oil.

In order to resolve these defects, Japanese Patent Application Publication No. 63-90,684 discloses a vertically installed type scroll refrigerant compressor. A construction of this compressor is substantially similar to the construction of above Japanese '083 Publication other than a lubricating oil pumping device which is disposed at the lower end of the drive shaft. The pumping device includes a centrifugal pump and a positive-displacement pump of which displacement is linearly increases in accordance with increase in a rotational speed of the drive shaft. By a combination of the centrifugal pump and the positive-displacement pump, a sufficient, but not excessive, amount of the lubricating oil is supplied to the frictional surfaces even though the drive shaft rotates in any rotational speed. Accordingly, the above-mentioned defects can be resolved.

However, in this prior art, the pumping device is assembled by a large number of the component parts, thereby causing a complicated assembling process thereof and increasing a manufacturing cost.

Accordingly, it is an object of the present invention to provide a hermetically sealed scroll type refrigerant compressor which includes a simply structured lubricating mechanism for effectively lubricating a frictional surfaces of the slidable members thereof in any rotational speed of a drive shaft.

A scroll type compressor with a hermetically sealed housing includes a fixed and orbiting scrolls disposed within the housing. The fixed scroll comprises a first end plate from which a first spiral element extends. The orbiting scroll comprises a second end plate from which a second spiral element extends. The first and second spiral elements interfit at an angular and radial offset to form a plurality of line contacts which define at least one pair of sealed off fluid pockets.

A drive mechanism includes a drive shaft which is rotatably supported in the housing, and a pin member which is integrated with one end of the drive shaft. The axis of the pin member is radially shifted from the axis of the drive shaft. The pin member is rotatably connected to the orbiting scroll to effect orbital motion of the orbiting scroll. A rotation preventing device, such as an Oldham coupling mechanism prevents rotation of the orbiting scroll during orbital motion whereby the volume of the fluid pockets changes to compress refrigerant fluid within the pockets. The longitudinal axis of the drive shaft is generally perpendicular to a horizontal plane, when the compressor is installed. A motor is associated with the drive shaft so as to rotate the drive shaft.

An axial bore is formed through the drive shaft. One end of the axial bore opposite to the orbiting scroll is immersed in lubricating oil which accumulates at an inner bottom portion of the housing. A throttling device, such as an orifice tube penetrates through the pin member, and links to the axial bore. A centrifugal pump which operates during rotation of the drive shaft is provided at the one end of the axial bore so as to conduct the lubricating oil at the inner bottom portion of the housing to a frictional surfaces of the slidable members of the compressor via the orifice tube.

The only drawing is a vertical section view of a vertically installed type scroll refrigerant compressor in accordance with one embodiment of the present invention.

With reference to the drawing, a vertically installed type scroll refrigerant compressor in accordance with one embodiment of the present invention is shown. Compressor 10 includes casing 11 comprising cylindrical portion 12 and a pair of shallow cup-shaped portions 13 and 14 hermetically fixed to both ends of cylindrical portion 12, fixed and orbiting scrolls 20 and 30, inner block member 40 and motor 50.

Cylindrical portion 12 includes annular flanges 121 and 122 radially outwardly projecting from an upper and lower ends thereof, respectively. Shallow cup-shaped portion 13 includes annular flange 131 radially outwardly projecting from an opening end thereof, and shallow cup-shaped portion 14 includes annular flange 141 radially outwardly projecting from an opening end thereof. Flange 131 is hermetically and releasably secured to flange 121 by a plurality of screws 200 through O-ring seal 201. Flange 141 is hermetically and releasably secured to flange 122 by a plurality of screws 220 through O-ring seal 221. Thereby, cylindrical portion 12 and the par of shallow cup-shaped portions 13 and 14 are disassembled when is required. Cylindrical portion 12 further includes a plurality of projections 123 radially inwardly projecting from the upper end thereof.

Fixed scroll 20 includes circular end plate 21 and spiral element or wrap 22 extending downwardly from the lower end surface of circular end plate 21. Circular end plate 21 is forcibly inserted into an inner peripheral wall of shallow cup-shaped portion 13. O-ring seal 210 is disposed between the outer peripheral surface of circular end plate 21 and the inner peripheral wall of shallow cup-shaped portion 13 to seal the mating surface therebetween. Thereby, the cavity defined by casing 11 is divided into first and second cavities 60 and 61 by circular end plate 21 of fixed scroll 20. Axial hole 24 is formed in circular end plate 21 at the central location to link cavity 60 and a later-mentioned central fluid pocket 71b. Axial hole 24 is covered by one way valve 25 disposed on the upper end surface of circular end plate 21. Curved plate 251 of rigid material, such as, steel is disposed on one way valve 25 so as to prevent an excessive bend of one way valve 25. Curved plate 251 and one way valve 25 are firmly secured to circular end plate 21 at their one end by screw 26. Circular end plate 21 is provided with annular wall 211 projecting downwardly from the peripheral end surface thereof. Radial hole 23 is formed in annular wall 211. Annular flange 211a radially outwardly projects from a lower end of annular wall 211. Orbiting scroll 30 includes circular end plate 31 and spiral element or wrap 32 extending upwardly from one end surface of circular end plate 31. Spiral element 22 of fixed scroll 20 and spiral element 32 of orbiting scroll 30 interfit at an angular and radial offset to form a plurality of line contacts which define at least one pair of sealed off fluid pockets 71 therebetween. Annular projection 33 projects axially from the other end surface of circular end plate 31. Shallow depression 34 is formed at the other end surface of circular end plate 31 at the central location, and is linked to radial conduit 101 which is formed in circular end plate 31. Radial conduit 101 extends to the outer peripheral surface of circular end plate 31, but the outer radial end thereof is blocked by plug 102. The outer radial portion of conduit 101 is linked through axial short path 103 to annular groove 104 formed at one end surface of circular end plate 31 at the peripheral location. Radial conduit 101, axial short path 103 and annular groove 104 conduct the lubricating oil in shallow depression 34 to the mating surfaces between annular wall 211 of fixed scroll 20 and circular end plate 31 of orbiting scroll 30.

Inner block member 40 includes central portion 41, first axial annular wall 42 upwardly projecting from central portion 41 at a peripheral location, and second axial annular wall 43 downwardly projecting from central portion 41 at the peripheral location. ·Axially annular projection 44 projects downwardly from central portion 41 at a central location. First axial annular wall 42 is secured by a plurality of screws 400 to flange 211a of annular wall 211. A plurality of elongated screws 400a secure flange 211a to a plurality of projections 123, respectively through first axial annular wall 42. Thereby, inner block member 40 and fixed scroll 20 are firmly secured to cylindrical portion 12 of casing 11.

Motor 50 includes stator 51 which is firmly secured to a lower end of second axial annular wall 43 by a plurality of screws 500. Rotor 52 of motor 50 is disposed within stator 51 and is fixed to drive shaft 15 extending therethrough. Wires 110 from stator 51 are connected with terminals 111 which are connected to an external electric source (not shown). Hermetic seal base 120 is insulated from terminals 111 and hermetically fixed to opening 124 which is formed at cylindrical portion 12

Drive shaft 15 extends through axial annular projection 44, Axial annular projection 44 extends within an opening in rotor 52. Drive shaft 15 is rotatably supported within axial annular projection 44 through upper and lower fixed plain bearings 15a and 15b disposed between the exterior surface of drive shaft 15 and the interior surface of axial annular projection 44. Drive shaft 15 extends through central portion 41 of inner block member 40. Pin member 16 is integrated with and projects axially from the upper end surface of drive shaft 15. The axis of pin member 16 is radially offset from the axis of drive shaft 15. Pin member 16 is rotatably disposed within axial annular projection 33 of orbiting scroll 30 through fixed plain bearing 16a. Drive shaft 15 includes axial bore 151 extending from an opening at the lower end surface of drive shaft 15 and terminating at the lower end portion of pin member 16. A plurality of radial bores 152 extend through drive shaft 15 at a location within annular projection 44.

Centrifugal pump 17 includes annular cylinder 171 which is firmly secured to the outer peripheral surface of the lower end portion of drive shaft 15 at its upper end by welding or by a plurality of fastening device, such as screws (not shown), and annular truncated cone 172 which is integrated with the lower end of annular cylinder 171. Annular truncated cone 172 gradually narrows downwardly. Centrifugal pump 17 is immersed in a reservoir of lubricating oil which accumulates at the inner bottom portion of casing 11.

A throttling device, such as orifice tube 18 penetrates through pin member 16 so as to link shallow depression 34 to axial hole 151.

Balance weight 35 is integrated with a lower end portion of pin member 16 and serves to average the torque of drive shaft 15 acting on pin member 16 during rotation. Balance weight 35 includes annular disk portion 35a and crescent-shaped portion 35b which is integrated with the upper surface of annular disk portion 35a. Needle thrust bearing 81 is disposed between the end surface of axial annular projection 33 and the upper end surface of annular disk portion 35a, and needle thrust bearing 82 is disposed between the lower end surface of annular disk portion 35a and an upper surface of central portion 41 of inner block member 40. Thereby, balance weight 35 is rotatably supported by bearings 81 and 82.

Rotation preventing device 19, for example, an Oldham coupling mechanism is disposed between the lower peripheral surface of circular end plate 31, exterior of annular projection 33, and the upper surface of inner block member 40 to prevent rotation of orbiting scroll 30 during orbital motion. Rotation preventing device 19 and pin member 16, as well as spiral elements 22 and 32, are all contained in cavity 61.

In operation, stator 51 generates a magnetic field, causing rotation of rotor 52 to thereby rotate drive shaft 15. Rotation of drive shaft 15 is converted to orbital motion of orbiting scroll 30 by pin member 16, and rotational motion of orbiting scroll 30 is prevented by rotation preventing device 19.

Refrigerant gas is introduced into cavity 61 from the external refrigeration circuit through suction gas inlet pipe 90 and is taken into the outer of fluid pockets 71a between fixed scroll 20 and orbiting scroll 30 through hole 23. Refrigerant gas is compressed inwardly toward the central fluid pocket 71b of spiral elements 22 and 32 due to the orbital motion of orbiting scroll 30. As the refrigerant gas moves towards the central fluid pocket 71b, it undergoes a resultant of volume reduction and compression and is discharged from the central fluid pocket 71b to cavity 60 through hole 24 with bending the other end of one way valve 25. Compressed refrigerant gas in cavity 60 flows out of the compressor to the external refrigerant circuit through discharge gas outlet pipe 91.

Lubricating oil which accumulates at the inner bottom portion of casing 11 flows upwardly through axial bore 151 by virtue of operation of centrifugal pump 17 which operates during rotation of drive shaft 15. Small part of the lubricating oil which upwardly flows through axial bore 151 further flows into the gap between fixed plain bearings 15a, 15b and the exterior surface of drive shaft 15 to lubricate the contact surfaces by virtue of the centrifugal force generated by rotation of drive shaft 15 during operation of the compressor. Large part of the lubricating oil which upwardly flows through axial bore 151 further flows through orifice tube 18. The lubricating oil which has passed over orifice tube 18 is supplied to fixed plain bearings 16a, needle thrust bearings 81 and 82, and the mating surfaces between annular wall 211 of fixed scroll 20 and circular end plate 31 of orbiting scroll 30 in order to lubricate thereof.

Furthermore, flow rate of the lubricating oil which flows through axial bore 151 quadratically increases in accordance with increase in a rotational speed of drive shaft 15. When the lubricating oil which flows through axial bore 151 further flows through orifice tube 18, hydraulic friction generated at orifice tube 18 quadratically increases in accordance with increase in flow rate of the lubricating oil which flows through axial bore 151. Accordingly, increase in flow rate of the lubricating oil which has passed over orifice tube 18 is sufficiently declined due to the quadratic increase in hydraulic friction generated at orifice tube 18 even though flow rate of the lubricating oil which flows through axial bore 151 quadratically increases in accordance with increase in the rotational speed of drive shaft 15. Therefore, if the diameter and length of orifice tube 18 are appropriately designed, flow rate of the lubricating oil which has passed over orifice tube 18 varies within a narrow range of values which allow the frictional surfaces of the above-mentioned slidable members of the compressor receive a sufficient, but not excessive, amount of the lubricating oil even though drive shaft 15 rotates in any rotational speed.

Still furthermore, in the above embodiment, orifice tube 18 is used as a throttling device, however, a porous metal member or an aperture having a throttling portion can be also used as the throttling device in this invention. Such the throttling devices can be positioned at any location along axial bore 151 of drive shaft 15.

As mentioned above, in this invention, the frictional surfaces of the slidable members of the compressor can receive an appropriate amount of the lubricating oil even though the drive shaft rotates in any rotational speed, while a lubricating mechanism is structured by a simple combination of the throttling device and the centrifugal pump. Accordingly, the defects met in Japanese '684 Publication are eliminated.

This invention has been described in detail in connection with the preferred embodiments. These embodiments, however, are merely for example only and the invention is not restricted thereto. It will be understood by those skilled in the art that other variations and modifications can easily be made within the scope of this invention defined by the claims.

Claims

1. In a scroll type compressor (10) with a hermetically sealed housing, said compressor (10) comprising a fixed scroll (20) disposed within said housing, said fixed scroll (20) having a first end plate (21) from which a first spiral element (22) extends, an orbiting scroll (30) having a second end plate (31) from which a second spiral element (32) extends, said first and second spiral elements (22, 32) interfitting at an angular and radial offset to form a plurality of line contacts which define at least one pair of sealed off fluid pockets (71), a drive mechanism (15) operatively connected to said orbiting scroll (30) to effect orbital motion of said orbiting scroll (30), rotation preventing means (19) for preventing rotation of said orbiting scroll (30) during orbital motion whereby the volume of said fluid pockets (71) changes to compress refrigerant fluid within said pockets, said drive mechanism (15) including a drive shaft (15) rotatably supported within said housing, said drive shaft including a bore (151) formed therein, one end of said bore immersed in lubricating oil which accumulates at an inner bottom portion of said housing, the improvement comprising:
said bore (151) including throttling means (18) and centrifugal force generating means (17, 171, 172) which is provided at said one end of

said bore, said centrifugal force generating means operating during rotation of said drive shaft so as to conduct the lubricating oil at said inner bottom portion of said housing through said bore (18).

2. The scroll type compressor of claim 1 wherein said throttling means (18) is positioned at any location of said bore (151).

3. The scroll type compressor of claim 1 or 2 wherein said throttling means (18) includes an orifice tube.

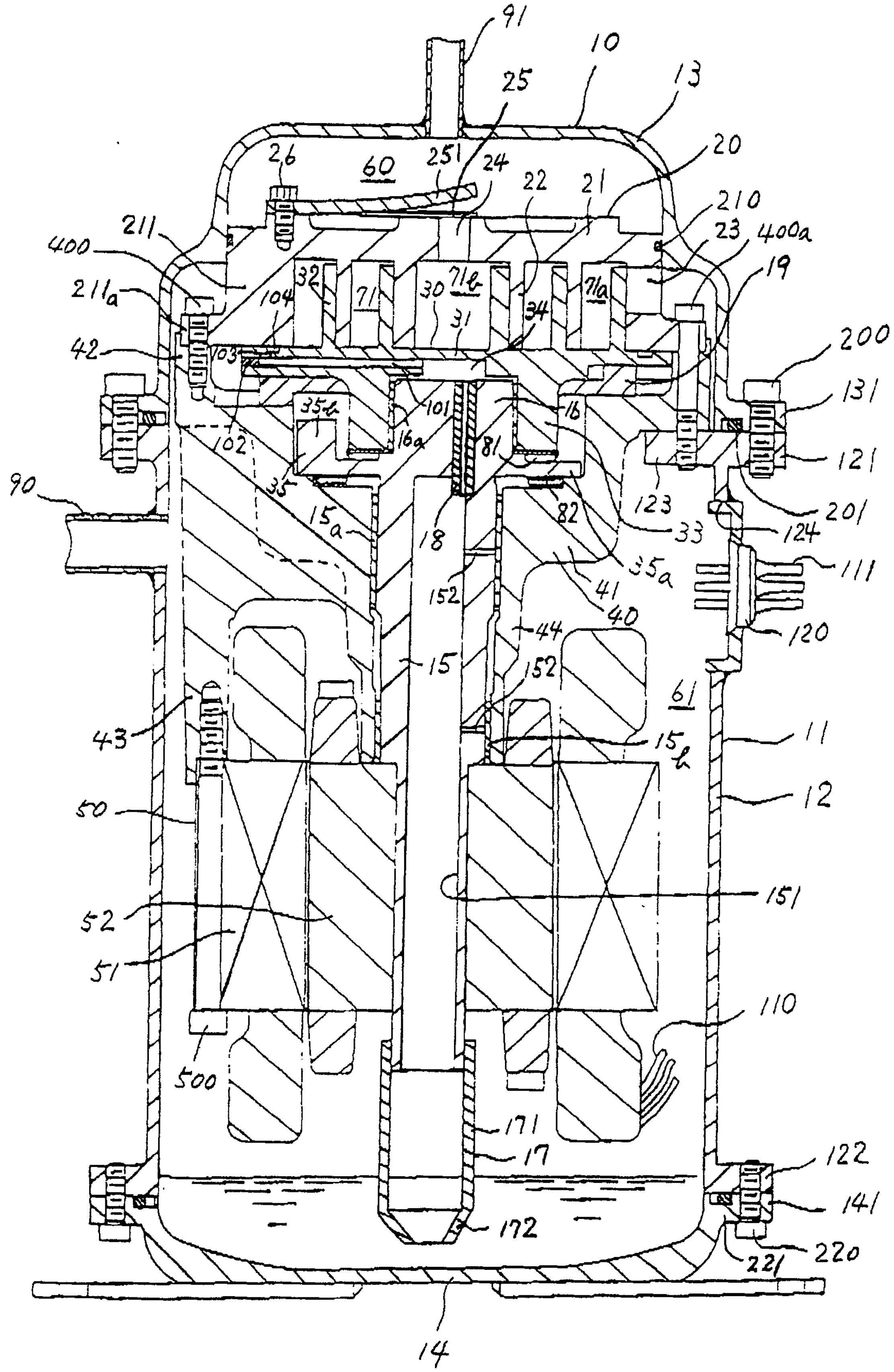
4. The scroll type compressor of one of claims 1 to 3, said driving mechanism further including a pin member (16) which axially projects from one end of said drive shaft (15), the axis of said pin member radially shifted from the axis of said drive shaft, said pin member (16) rotatably connected to said orbiting scroll (30), said bore (151) axially formed through said drive shaft (15) from said one end of said drive shaft to the other end of said drive shaft, said orifice tube (18) penetrating through said pin member (16).

5. The scroll type compressor of one of claims 1 to 4, wherein said throttling means (18) includes a porous metal member.

6. The scroll type compressor of one of claims 1 to 5, wherein said throttling means (18) includes an aperture having a throttling portion.

7. The scroll type compressor of one of claims 1 to 6, wherein the longitudinal axis of said drive shaft (15) is generally perpendicular to a horizontal plane when the compressor is installed.

Figure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EUROPEAN SEARCH REPORT

Application Number

EP 91 10 6116

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 14, no. 29 (M-922)(3972) 19 January 1990, & JP-A-1 267376 (MITSUBISHI ELECTRIC CORP.) 25 October 1989, * the whole document *	1,7	F 04 C 29/02 F 04 C 18/02
X	PATENT ABSTRACTS OF JAPAN vol. 12, no. 260 (M-720)(3107) 21 July 1988, & JP-A-63 41681 (MATSUSHITA ELECTRIC IND CO LTD) 22 February 1988, * the whole document *	1,7	
X	PATENT ABSTRACTS OF JAPAN vol. 10, no. 191 (M-495)(2247) 04 July 1986, & JP-A-61 34383 (MATSUSHITA ELECTRIC IND CO LTD) 18 February 1986, * the whole document *	1,7	
A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 87 (M-937)(4030) 19 February 1990, & JP-A-01 300080 (MATSUSHITA REFRIG CO LTD) 04 December 1989, * the whole document *	1	**TECHNICAL FIELDS SEARCHED (Int. Cl.5)**
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 223 (M-829)(3571) 24 May 1989, & JP-A-01 36994 (MATSUSHITA ELECTRIC IND CO LTD) 07 February 1989, * the whole document *	1	F 04 C F 01 C F 04 B
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The present search report has been drawn up for all claims

Place of search	Date of completion of search	Examiner
The Hague	15 July 91	DIMITROULAS P.

CATEGORY OF CITED DOCUMENTS

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