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(54) **ROTARY SCREW COMPRESSOR WITH SEAL MEANS**

ROTIERENDER SCHRAUBENVERDICHTER UND DICHTUNG

COMPRESSEUR ROTATIF A VIS ET A MOYENS D'ETANCHEITE

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(56) References cited:
DE-A- 3 503 039
US-A- 3 913 346
US-A- 4 669 279

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Description

The present invention relates to a rotary screw compressor of the kind specified in the preamble of claim 1.

US-A 3 913 346 discloses a refrigeration compressor of the twin-screw type, in which the drive motor is internally cooled by liquid refrigerant of delivery pressure supplied from the condenser, and the liquid and evaporated gas is then drained to a closed working chamber in the compressor working space. The loss in compressor efficiency which is entailed with that system can be avoided by providing a pump for raising the pressure of the liquid before entering the motor space, so that the liquid-gas-mixture leaving the motor can be drained directly to the delivery line of the compressor. US-A 4 669 279 discloses such a system in connection with a centrifugal compressor.

In a hermetic oil-injected screw compressor having an oil separator mounted directly or close to its high pressure end section and the drive motor mounted at the low pressure end section of the compressor casing, the above described system for cooling the motor arises the problem of sealing between the motor space having a pressure above delivery pressure and the low pressure end of the compressor working space having inlet pressure.

A mechanical seal being able to withstand this pressure difference is expensive and would require oil cooling to an extent that it appreciably would decrease the compressor efficiency. And with a simple lip seal it would not be possible to achieve sufficient sealing.

The object of the present invention is to attain a compressor with a seal between the low pressure end of the compressor working space and a high pressure cavity at the other side of the low pressure end wall, which seal should be effective as well as economical in operation.

According to the invention this has been attained in that a compressor of the kind in question has the features specified in the characterizing portion of claim 1.

By supplying a barrier liquid, of a pressure slightly lower than the pressure in the cavity, to the intermediate chamber, the pressure difference between the intermediate chamber and the cavity will be low enough to be sealed by a lip seal. That type of seal requires comparatively moderate cooling so that the supplied barrier liquid will be sufficient to take up the heat therefrom. On the other axial end of the intermediate chamber, where the pressure difference is larger, no cooling is necessary since the seal is of the non-contacting type. The seal gap is small, and the amount of liquid leaking therethrough can be accepted. The solution according to the invention thus results in a very efficient and low cost seal arrangement with a high reliability.

Advantageous embodiments of the invention is specified in the dependent claims.

The invention will be further explained through the following detailed description of a preferred embodiment thereof and with reference to the accompanying drawings.

Fig. 1 is a schematic illustration of a refrigeration system with a compressor according to the invention.

Fig. 2 is a section through the seal means in the low pressure end section of the compressor in fig. 1.

The refrigeration system in fig. 1 has a hermetic compressor-motor unit with a twin-screw rotary compressor 1, the low pressure end of which is connected to an electric motor 2. At the high pressure end of the compressor an oil separator 3 is provided for separating oil from the working fluid, which oil has been injected into the compressor working space for sealing, cooling and lubricating purposes. The refrigeration system is of conventional type including a condenser 4, an expansion valve 6 and an evaporator 5 connected by pipes, 8, 9, 10 to form a closed refrigeration circuit. Liquid refrigerant is supplied from the condenser 4 through a pipe 11 to the motor 2 for cooling the motor windings 18. In the pipe 11 a pump 7 is provided for raising the pressure to a level about 1 to 2 bars above delivery pressure. When cooling the motor windings 18 the liquid refrigerant will partly be evaporated, and the gas-liquid mixture is drained to the discharge line of the compressor. In the illustrated embodiment the gas-liquid mixture is drained to the oil separator 3 where the remaining liquid is evaporated for cooling the oil.

One of the rotors 13 of the compressor is directly driven by the motor 2 through a shaft 14 extending through the low pressure end section 15 of the compressor. In the low pressure end section 15 there are provided roller bearings 16 and a seal arrangement 17 for sealing between the low pressure end of the compressor, where the pressure is about evaporating or suction pressure and the motor space where the pressure is 1 to 2 bars above condensing or delivery pressure.

The seal arrangement is illustrated in fig. 2 in an enlarged section. The shaft 14, including a shaft sleeve 21, is extending through the low pressure end section 15 of the compressor and is at its left end connected to the motor 2 and at its right end to one of the compressor rotors 13. The seal arrangement 17 is on its left side exposed to a cavity communicating with the motor space and thus having a pressure above delivery pressure and on its right side to a cavity communicating with the low pressure end of the compressor working space and thus having a pressure corresponding to the compressor inlet pressure.

Adjacent to the high pressure cavity a lip seal 20 is provided and adjacent to the low pressure cavity there is a non-contacting seal 24. An intermediate chamber 22 is formed between these two seals 20, 24, to which chamber oil of about delivery pressure is supplied through a nozzle 23, connected by a supply channel 28 to a source of oil under pressure, normally the oil separator of the compressor.

Since the pressure difference between the intermediate chamber 22 and the cavity communicating with the

motor space will be about 1 bar a simple lip seal 20 is enough for the sealing. Due to the moderate contact force exerted by such a seal the friction losses will be fairly low, and the generated heat can be taken up by the oil supplied to the intermediate chamber 22.

At the other end of the seal arrangement 17 the sealing is accomplished by a non-contacting seal 24, allowing the supplied oil to leak from the intermediate chamber 22 through the seal gap 27 to the compressor working space. Although the non-contacting seal can be of any kind, e.g. a labyrinth seal, the preferred embodiment shown in the figure employs a so called floating seal of the type disclosed in US-A 5 009 583. Through that kind of seal the seal gap 27 can be as small as desired, since the seal body 24 is radially movable while being axially kept in a fixed position by the supports 25, 26 on either side. The seal body 24 is squeezed between these supports 25, 26 with a force large enough to prevent rotation but low enough to allow the seal body 24 to move radially. The seal body 24 thus is self-centering around the sleeve 21 ofthe shaft 14.

The blocking oil leaking from the intermediate chamber 22 to the compressor working space passes the roller bearings 16 supporting the shaft and is used to lubricate these. The seal gap 27 therefore must be dimensioned so that the leakage is sufficient for that lubrication requirement.

Claims

1. Rotary screw compressor having at least one screw rotor (13) operating in a working space, a part of the walls limiting said working space being formed by a low pressure end section (15), said rotor (13) having a drive shaft (14) extending through said low pressure end section (15) into a cavity containing a fluid of a pressure exceeding the delivery pressure of the compressor, said low pressure end section (15) having seal means (17) surrounding said drive shaft (14) for establishing a seal between said working space and said cavity, characterized in that said seal means (17) include

   - lip seal means (20) adjacent to said cavity,
   - non-contacting seal means (24) adjacent to said working space,
   - an intermediate chamber (22) between said lip seal means (20) and said non-contacting seal means (24) and
   - barrier liquid supply means (23) for supplying a barrier liquid to said intermediate chamber (22), said barrier liquid having a pressure slightly lower than the pressure of the fluid in said cavity.

2. Compressor according to claim 1, wherein said non-contacting seal means (24) is formed by a non-rotating seal body (24) surrounding said drive shaft (14, 21) with a small gap (27).

3. Compressor according to claim 2, wherein said seal body (24) is radially movable.

4. Compressor according to any of claims 1 to 3, wherein said barrier liquid is oil and has a pressure substantially corresponding to the delivery pressure of the compressor.

5. Compressor according to claim 4, having oil separating means (3) in the delivery line of the compressor, said oil separating means (3) communicating with said barrier liquid supply means (23).

6. Compressor according to claim 4, wherein said drive shaft (14) is driven by a motor (2), said cavity communicates with the motor space and said fluid is the working medium of the compressor.

7. Compressor according to claim 6 having pump means (7) for supplying said fluid to said motor space and withdrawal means (12) for draining said fluid form said motor space to the delivery line of the compressor.

8. Compressor according to claim 4, wherein said drive shaft (14) is journalled in roller bearings (16) between said working space and said seal means (17) and having means (27) for supplying said oil to said bearings (16).

Patentansprüche

1. Rotationsschraubenverdichter mit wenigstens einem in einem Arbeitsraum arbeitenden Schraubenrotor (13), bei welchem ein Teil der Wände, die den Arbeitsraum begrenzen, von einem Niederdruck-Endbereich (15) gebildet ist, der Rotor (13) eine sich durch den Niederdruck-Endbereich (15) hindurch in eine eine Flüssigkeit mit einem den Ausgangsdruck des Verdichters übersteigenden Druck enthaltende Ausnehmung erstreckende Antriebswelle (14) besitzt und der Niederdruck-Endabschnitt (15) Dichtmittel (17) aufweist, welche die Antriebswelle (14) zur Bildung einer Dichtung zwischen dem Arbeitsraum und der Ausnehmung umgeben, **dadurch gekennzeichnet**, daß die Dichtmittel (17) eine Lippendichtung (20) nahe der Ausnehmung, eine berührungsfreie Abdichtung (24) nahe des Arbeitsraumes, eine Zwischenkammer (22) zwischen der Lippendichtung (20) und der berührungsfreien Dichtung (24) und Zufuhrmittel (23) zum Zuführen einer Sperrflüssigkeit in die Zwischenkammer (22) umfassen, wobei die Sperrflüssigkeit einen Druck besitzt, der geringfügig niedri-

ger als der Druck der Flüssigkeit in der Ausnehmung ist.

2. Verdichter nach Anspruch 1, **dadurch gekennzeichnet**, daß die berührungsfreie Dichtung (24) aus einem nicht rotierenden Dichtkörper (24) gebildet ist, der die Antriebswelle (14, 21) mit einem kleinen Spalt (27) umgibt.

3. Verdichter nach Anspruch 2, **dadurch gekennzeichnet**, daß der Dichtkörper (24) radial beweglich ist.

4. Verdichter nach einem der Ansprüche 1 - 3, **dadurch gekennzeichnet**, daß die Sperrflüssigkeit Öl ist und einen Druck besitzt, der im wesentlichen dem Förderdruck des Verdichters entspricht.

5. Verdichter nach Anspruch 4, **dadurch gekennzeichnet**, daß er in seiner Förderleitung ölabtrennende Mittel (3) besitzt, die mit den Zufuhrmitteln (23) für die Sperrflüssigkeit in Verbindung stehen.

6. Verdichter nach Anspruch 4, **dadurch gekennzeichnet**, daß die Antriebswelle (14) von einem Motor angetrieben ist, wobei die Ausnehmung mit dem Motorraum in Verbindung steht und die Flüssigkeit das Arbeitsmedium des Verdichters ist.

7. Verdichter nach Anspruch 6, **dadurch gekennzeichnet**, daß er Pumpmittel (7) zum Zuführen der Flüssigkeit zu dem Motorraum und Auslaßmittel (12) zum Abziehen der Flüssigkeit aus dem Motorraum zur Förderleitung des Verdichters besitzt.

8. Verdichter nach Anspruch 4, **dadurch gekennzeichnet**, daß die Antriebswelle (14) in Wälzlagern (16) zwischen dem Arbeitsraum und den Dichtmitteln (17) gelagert ist und Mittel (27) zum Zuführen des Öls zu den Lagern (16) besitzt.

Revendications

1. Compresseur rotatif à vis ayant au moins un rotor à vis (13) fonctionnant dans un espace de travail, une partie des parois limitant ledit espace de travail étant formée par une section d'extrémité à basse pression (15), ledit rotor (13) ayant un arbre d'entraînement (14) traversant ladite section d'extrémité à basse pression (15) vers une cavité contenant un fluide d'une pression supérieure à la pression de refoulement du compresseur, ladite section d'extrémité à basse pression (15) comportant des moyens d'étanchéité (17), entourant ledit arbre d'entraînement (14), afin d'établir une étanchéité entre ledit espace de travail et ladite cavité, caractérisé en ce que lesdits moyens d'étanchéité 17 comprennent:
   - des moyens formant joint à lèvres (20) adjacents à ladite cavité,
   - des moyens d'étanchéité sans contact (24) adjacents audit espace de travail,
   - une chambre intermédiaire (22) entre lesdits moyens formant joint à lèvres (20) et lesdits moyens d'étanchéité sans contact (24) et
   - des moyens d'alimentation de liquide formant barrière (23) fournissant un liquide formant barrière à ladite chambre intermédiaire (22), ledit liquide formant barrière ayant une pression légèrement inférieure à la pression du fluide contenu dans ladite cavité.

2. Compresseur selon la revendication 1, dans lequel ledit moyen d'étanchéité sans contact (24) est formé par un corps d'étanchéité (24) non-rotatif, entourant ledit arbre d'entraînement (14,21) avec un petit jeu (27).

3. Compresseur selon la revendication 2, dans lequel ledit corps d'étanchéité (24) est déplaçable radialement.

4. Compresseur selon l'une quelconque des revendications 1 à 3, dans lequel ledit liquide formant barrière est de l'huile et est à une pression correspondant sensiblement à la pression de refoulement du compresseur.

5. Compresseur selon la revendication 4, ayant un moyen de séparation d'huile (3) dans la conduite d'alimentation du compresseur, ledit moyen de séparation d'huile (3) communiquant avec ledit moyen d'alimentation de liquide formant barrière (23).

6. Compresseur selon la revendication 4, dans lequel ledit arbre d'entraînement (14) est entraîné par un moteur (2), ladite cavité communique avec l'espace du moteur et ledit fluide est le milieu de travail du compresseur.

7. Compresseur selon la revendication 6, ayant des moyens de pompage (7) fournissant ledit fluide audit espace de moteur et des moyens d'extraction (12) drainant ledit fluide depuis ledit espace de moteur vers la conduite d'alimentation du compresseur.

8. Compresseur selon la revendication 4, dans lequel ledit arbre d'entraînement (14) est monté tournant dans des paliers à rouleaux (16) entre ledit espace de travail et lesdits moyens d'étanchéité (17) et présentant des moyens (27), fournissant ladite huile auxdits paliers (16).

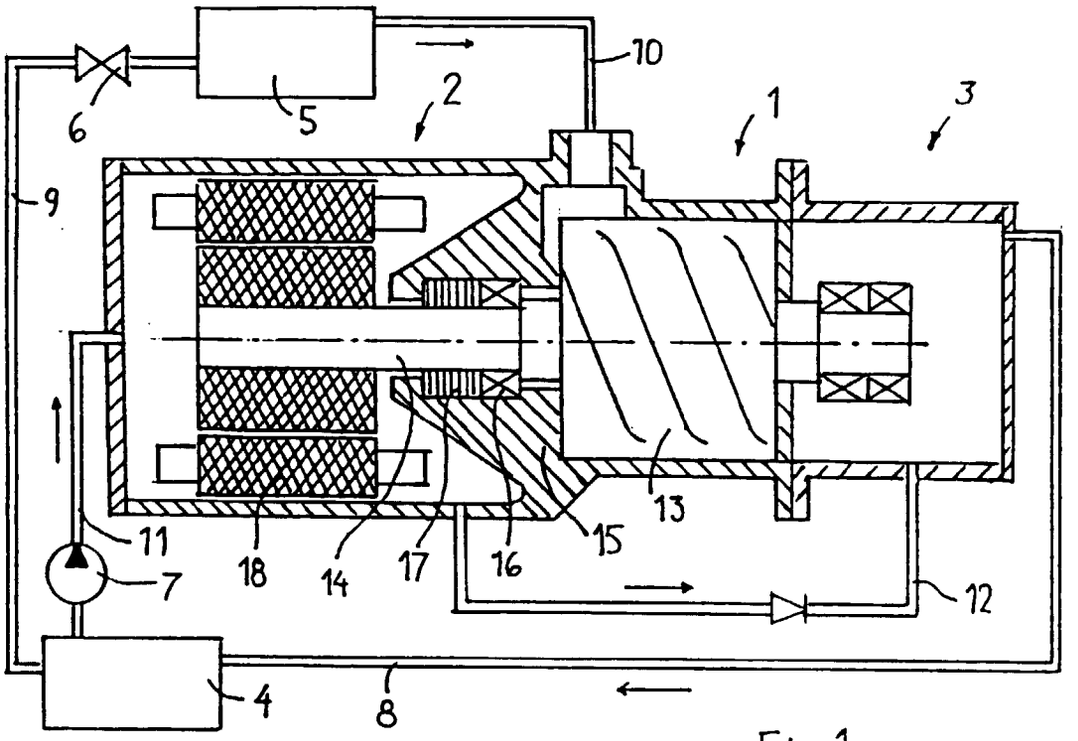

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Fig 1

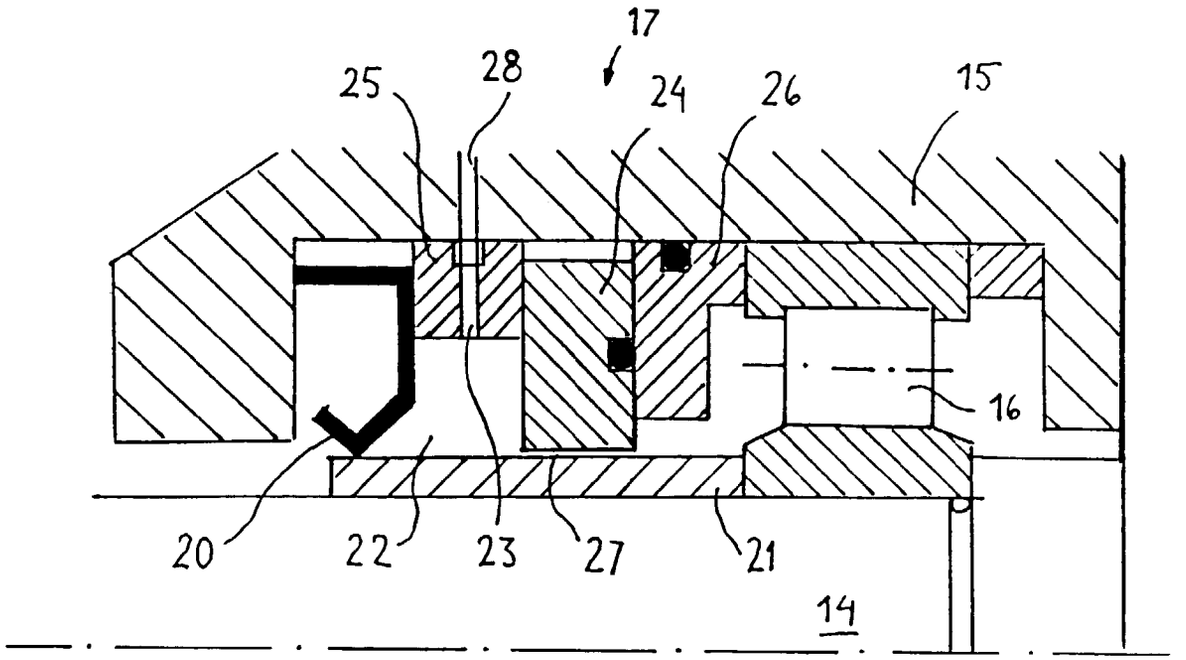

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Fig. 2