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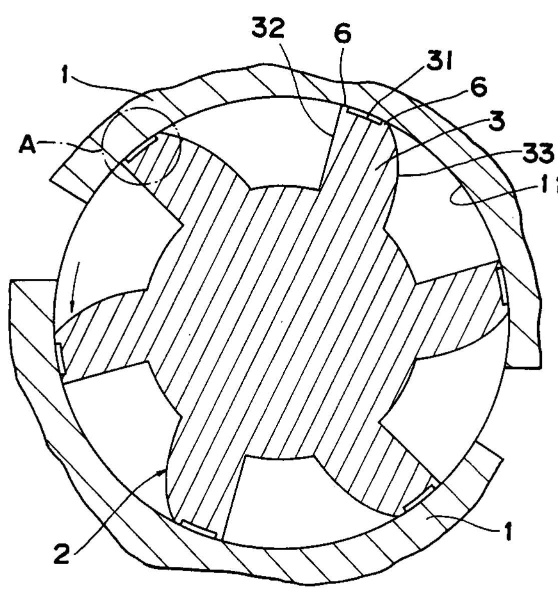
(54) **Single-screw compressor rotor construction.**

(57) A single-screw compressor has a rotor (2) with screw vanes (3) which is rotatably incorporated in a casing (1). The screw vane (3) has a confronting surface (31) which has a width in a rotating direction of the rotor (2) and which faces an inner peripheral wall (11) of the casing (1). A rib (6) narrower than the width of the confronting surface (31) is formed at one end in a widthwise direction of the confronting surface (31), extending along the spiral of the screw vane (3). Accordingly, a gap between the screw vane (3) and the inner peripheral wall of the casing (1) is made small, improving sealing properties. A rib-side lateral surface (32, 33) of the screw vane (3) is effectively utilized as a heat radiation surface, so that heat generated through contact between the rib (6) and the inner peripheral wall (11) of the casing (1) is radiated easily, thereby restricting the temperature rise of the screw vane (3) as well as the thermal expansion in the radial direction thereof.

*Fig.1*




EP 0 517 250 A1

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention generally relates to a screw compressor and more particularly, to a single-screw compressor having a rotor with a screw vane incorporated within a casing in a rotatable fashion, wherein the screw vane has a confronting surface which faces the inner peripheral wall of the casing and which has a width in the rotating direction of the rotor.

### 2. Description of the Prior Art

In a conventional rotary compressor of the type referred to above, as disclosed, for example, in Japanese Patent Laid-open Publication Tokkaisho 60-17284 (17284/1985) and as shown in Fig. 4, a rotor 2 with spiral screw vanes 3 is incorporated within a casing (not shown) in a rotatable manner via a driving shaft 21. The screw vanes 3 are meshed with a gate rotor 4 at either side of the rotor 2, thereby compressing the fluid within the casing 1. Meanwhile, the screw vanes 3 each have a surface 31 confronting to the inner peripheral wall of the casing. The confronting surface 31 has a width in the rotating direction of the rotor 2. When a lubricating oil is supplied into the casing 1, it forms an oil membrane in a gap between the confronting surface 31 and the inner peripheral wall of the casing 1, thus sealing the gap at the compressing time.

However, since the gap is sealed only by the oil membrane in the prior art, if the gap between the confronting surface 31 and the inner peripheral wall of the casing 1 is wide, it cannot be avoided that the fluid leaks from the higher pressure side to the lower pressure side during compression.

In a twin-screw compressor proposed in Japanese Patent Publication Tokkohei 2-32480 (32480/1990) discloses that in order to prevent the fluid from leaking, a rib is formed on a confronting surface of a screw vane of a female rotor to mesh with a male rotor. The rib is positioned in a central portion of the width of the confronting surface.

A solution to the problem of the fluid leakage in the single-screw compressor is to provide such a rib as disclosed in Japanese Patent Publication Tokkohei 2-32480 to the confronting surface 31. The rib will reduce the gap between the confronting surface 31 and the inner peripheral wall of the casing 1 thereby to improve the sealing efficiency.

However, if the rib is formed in the central part in the widthwise direction of the confronting surface 31 as in the twin-screw compressor mentioned above, although the gap between the inner peripheral wall and the confronting surface can be made small, the following problem is disadvantageously brought about. That is, although the gap may be rendered minimum 100 micron or so by the rib, the rib is easy to come into contact with the peripheral wall of the casing due to the temperature difference of the screw rotor with the casing at the transient operating condition. If the rib is brought into contact with the inner peripheral wall of the casing, the resultant heat is transmitted to the screw vanes 3, elongating the diameter of the rotor 2 through thermal expansion. In consequence, the contact load is further increased, and the heat is generated much more. The rotor 2 may be seized with the casing 1 in the worst case.

Checking the mechanism in which the seizing takes place, the inventors of the present invention have found the reason for the seizing in the fact that the rib is formed in the central part in the widthwise direction of the confronting surface 31. Upon contact of the rib with the inner peripheral wall of the casing and generation of heat, the heat is transmitted to the confronting surface 31 and further to the center of the screw vane 3 which is eventually expanded in the radial direction to increase the diameter of the rotor 2.

## SUMMARY OF THE INVENTION

The object of the present invention is accordingly to provide a single-screw compressor, wherein the gap between a screw vane and the inner peripheral wall of a casing is reduced to improve the sealing properties, while the seizing between the screw vane and casing is prevented.

In order to accomplish the aforementioned object, the present invention provides a single-screw compressor having a rotor with a screw vane rotatably incorporated in a casing, the screw vane being provided with a confronting surface which has a width in a rotating direction of the rotor and which faces an inner peripheral wall of the casing, characterized by a rib formed at least at one end in a widthwise direction of the confronting surface of the screw vane and extending along a spiral of the screw vane, the rib being smaller in width than the confronting surface.

The inventors have made the present invention paying attention to that, if a lateral surface of each screw vane is adapted to be effectively utilized as a radiation surface of the heat, the confronting surface becomes less heated and the screw vanes are thermally expanded in the widthwise direction rather than in the radial direction.

It is preferable that the rib is formed at both ends in the widthwise direction of the confronting surface of the screw vane.

Because of the rib formed in the confronting surface of the screw vane, the gap between the rib and inner peripheral wall of the casing is rendered smaller than that between the confronting surface and casing, and the sealing efficiency is accordingly improved.

As the rib is formed at the end part in the widthwise direction of the confronting surface, the heat generated through contact of the rib with the inner peripheral wall of the casing can be transmitted to the lateral surface of the screw vane owing to the adjacency of the rib to the lateral surface of the screw vane, that is, the lateral surface of the screw vane works as a radiation surface.

Therefore, in comparison with the case where the rib is formed in the central part in the widthwise direction of the confronting surface, the radiation area is increased and moreover, less heat is transmitted toward the center of the vane. Even when the thermal expansion of the screw vane is brought about, it is mainly in the widthwise direction, not in the radial direction.

The temperature rise of the screw vane is restricted by the above enlargement of the radiation area. In addition, the thermal expansion of the screw vane, if any, takes place mainly in the widthwise direction, not in the radial direction. That is, the thermal expansion of the screw vane in the radial direction is extremely reduced. Accordingly, the seizing between the rotor and casing are effectively prevented from occurring through thermal expansion, while the sealing properties are enhanced.

Moreover, in the case where the rib is formed at both end parts in the widthwise direction of the confronting surface of the screw vane, the fluid running in a direction reverse to the rotating direction of the screw vane is once narrowed by the front rib in the rotating direction of the screw vane and then expanded, and subsequently narrowed again by the rear rib. Therefore, the circulation resistance of the fluid is increased thereby to further improve the sealing properties.

## BRIEF DESCRIPTION OF THE DRAWINGS

This and other objects and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying drawings throughout which like parts are designated by like reference numerals, and in which:

Fig. 1 is an enlarged cross sectional view of an essential part of a single-screw compressor according to the present invention;

Fig. 2 is a detailed cross sectional view of a portion A in Fig. 1;

Fig. 3 is a cross sectional view of a screw compressor to which the present invention is applied; and

Fig. 4 is a perspective view of a rotor of a conventional screw compressor.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Now, one preferred embodiment of the present invention will be discussed hereinbelow with reference to the accompanying drawings.

In a screw compressor illustrated in Fig. 3, a rotor 2 provided with screw vanes 3 is rotatably supported adjacent to the inner peripheral wall 11 of a casing 1 within the casing 1. At the same time, a gate rotor 4 to be meshed with the screw vanes 3 is installed at either side of the rotor 2. As the screw vanes 3 and gate rotors 4 are meshed with each other, a fluid in the compressor is compressed. Each screw vane 3 has a confronting surface 31 on its ridge, namely, at an radial end of the vane 3. The confronting surface 31 has a width in the rotating direction of the rotor 2 and is opposed to the inner peripheral wall 11 of the casing 1. An oil membrane of a lubricating oil supplied into the casing 1 is formed in a gap between the confronting surface 31 and the inner peripheral wall 11 of the casing 1 so that the sealing when the fluid is compressed is secured. Slide grooves 51 in each of which a capacity-controlling slide valve 5 is slidably mounted are formed in symmetry in the radial direction of the rotor 2 in the inner peripheral wall 11 of the casing 1. By controlling the sliding position of the slide valve 5, the compressing capacity is controlled and the lubricating oil is fed into the casing 1. An intermediate suction gas refrigerant is supplied through an intermediate suction path 52.

In Figs. 1 and 2, a pair of ribs 6 smaller in width than the confronting surface 31 are formed along the spiral ridge of each screw vane 3 and at opposite ends in the widthwise direction of the confronting surface 31, more specifically, at the front and rear ends in the rotating direction indicated by an arrow of the screw vane 3. In other words, as is clear from the enlarged view of Fig. 2, the ribs 6, for example, each 100μm high are integrally formed at the front and rear ends of the confronting surface 31. A gap S1 between a radially outer end of the rib 6 and the inner peripheral wall 11 of the casing 1 is set, e.g., to be about 100μm, while a gap S2 between the confronting surface 31 and the inner peripheral wall 11 is set to be 200μm.

In the above-described structure, because the gap S1 between the rib 6 and the inner peripheral wall 11 of the casing 1 is made as small as approximately 100μm, as described above, when the rotor 2 and gate rotors 4 are rotated with the lubricating oil fed into the casing 1 and the fluid is compressed within the casing 1, the sealing properties are improved accordingly.

Further, since the ribs 6 are formed at the end parts in the widthwise direction of the confronting surface 31 and moreover adjacent to the lateral surfaces 32, 33 of the screw vane, when the ribs 6 are brought into contact with the inner peripheral wall 11 of the casing thereby to generate heat, the heat is transmitted to the corresponding lateral surfaces 32, 33 of the screw vane and eventually radiated from the lateral surfaces.

Accordingly, as compared with the prior art wherein the rib 6 is formed in the central part in the widthwise direction of the confronting surface 31, the heat radiation area becomes larger and the central part of the screw vane 3 is less heated since the heat is radiated from the lateral surfaces 32, 33 of the screw vane. Even when the screw vane 3 is thermally expanded, it is made mainly in the widthwise direction.

In this manner, the radial expansion of the screw vane 3 due to heat caused by the contact of the rib 6 with the inner peripheral wall 11 is restricted and the rotor 2 is prevented from being seized with the casing 1.

As obvious from the above, the present invention is effective to prevent seizing between the casing 1 and rotor 2 which results from the thermal expansion of the screw vane, while improving the sealing properties.

In addition, since the ribs 6 are formed at both ends in the widthwise direction of the confronting surface 31, the fluid flowing from its higher pressure side to its lower pressure side in a direction, shown by a dotted line in Fig. 2, reverse to the rotating direction of the screw vane 3 is once narrowed by the front rib, then expanded and further narrowed by the rear rib 6. The circulation resistance is thus increased to improve the sealing properties much more.

Although the ribs 6 are formed at both ends in the rotating direction of the screw vane in the foregoing embodiment, it may be possible to provide the rib at only one of the front and rear ends of the screw vane.

In the above description of the embodiment, the ribs 6 are formed into one body with the screw vane 3. However, the ribs 6 may be formed separately and fixed to the confronting surface 31.

Although the present invention has been fully described in connection with the preferred embodiment thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. Such changes and modifications are to be understood as included within the scope of the present invention as defined by the appended claims unless they depart therefrom.

## Claims

1. A single-screw compressor having a rotor with a screw vane rotatably incorporated in a casing, the screw vane being provided with a confronting surface which has a width in a rotating direction of the rotor and which faces an inner peripheral wall of the casing, comprising:

   a rib formed at least at one end in a widthwise direction of the confronting surface of the screw vane and extending along a spiral of the screw vane, the rib being smaller in width than the confronting surface.

2. The single-screw compressor according to claim 1, wherein the rib is formed at both ends in the widthwise direction of the confronting surface of the screw vane.

3. A rotor for a screw compressor to be rotatably incorporated in a casing, comprising:

   a screw vane provided with a confronting surface which has a width in a rotating direction of the rotor and which faces an inner peripheral wall of the casing; and

   a rib formed at least at one end in a widthwise direction of the confronting surface of the screw vane and extending along a spiral of the screw vane, the rib being smaller in width than the confronting surface.

*Fig.1*

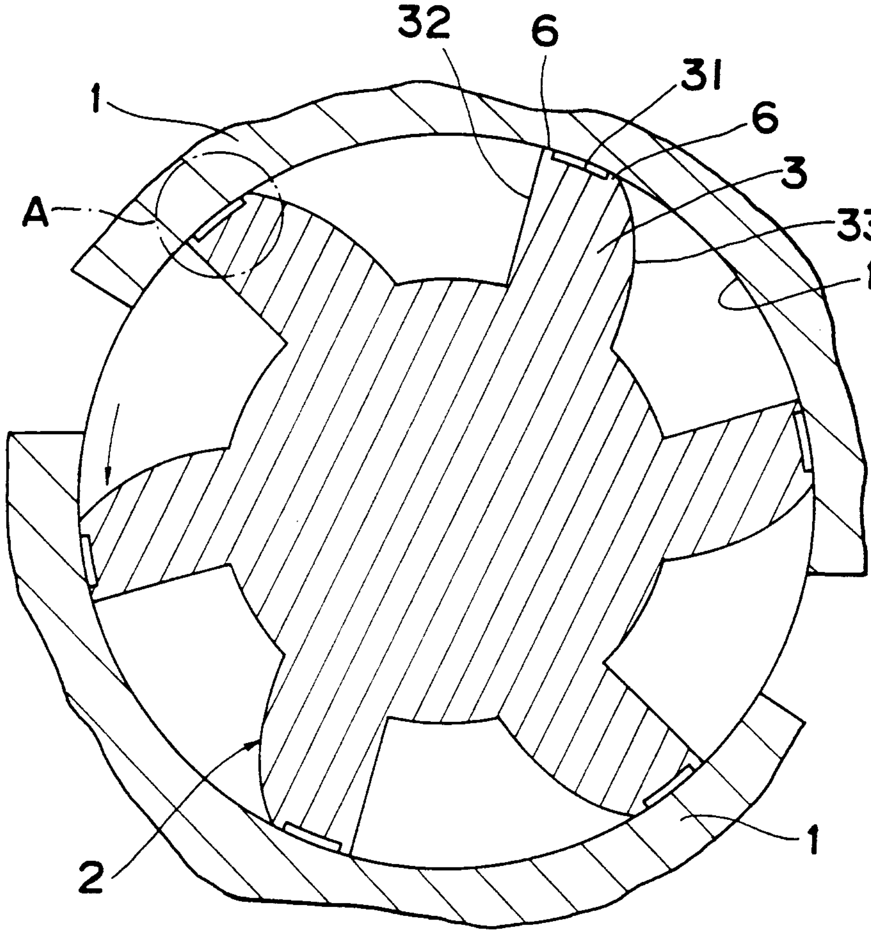


*Fig. 2*

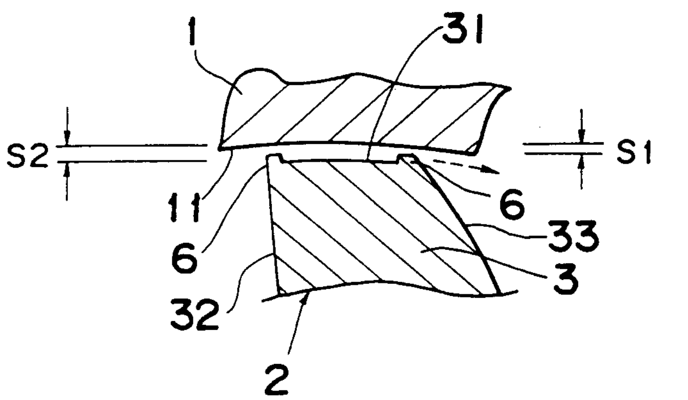



*Fig. 3*

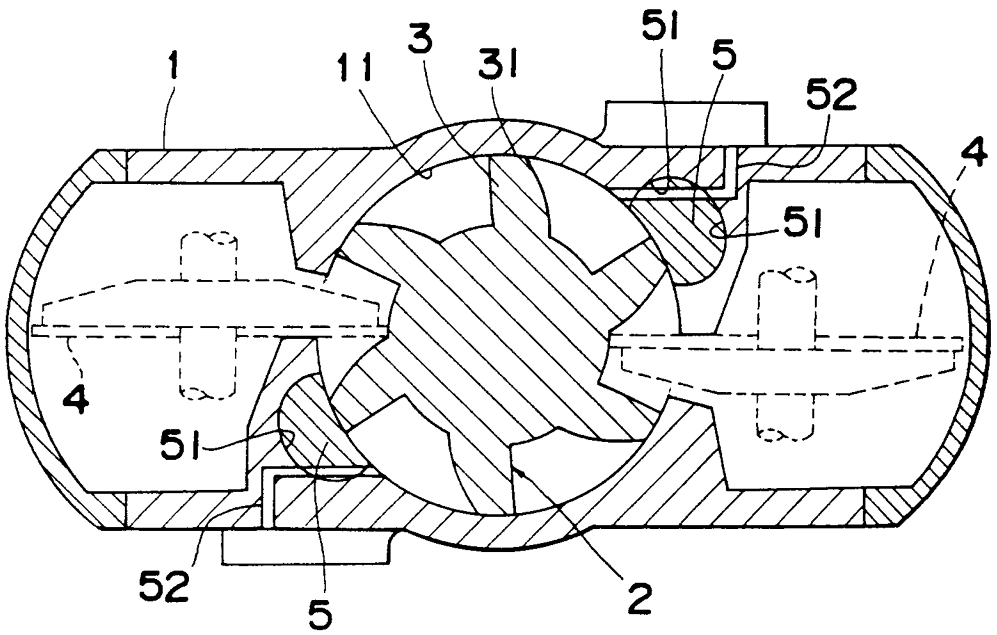
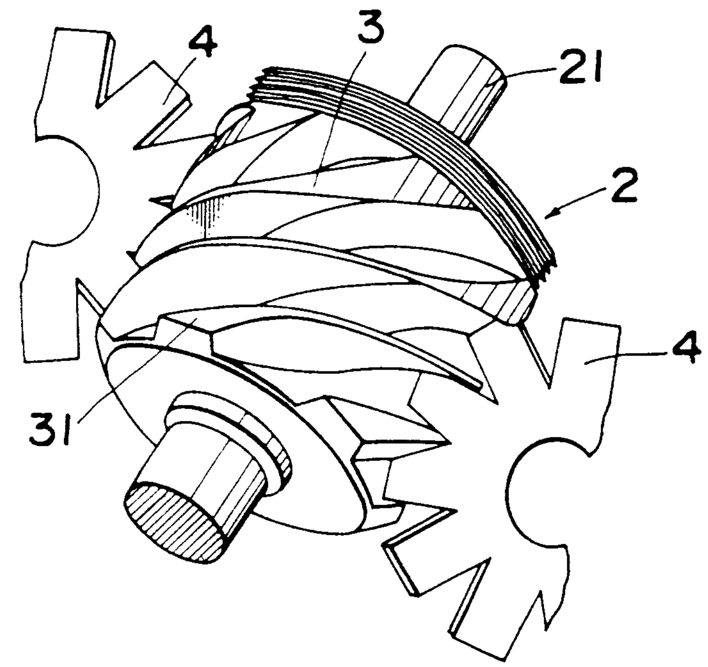


Fig.4 PRIOR ART



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# EUROPEAN SEARCH REPORT

Application Number

EP 92 10 9553

## 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 | GB-A-923 042 (ZIMMERN)<br>* page 3, line 46 - line 56; figure 1 *<br>--- | 1-3 | F04C18/30 |
| X | US-A-1 735 477 (STUART)<br>* page 2, line 99 - line 115; figures 7,19-21 *<br>--- | 1-3 | |
| A | GB-A-2 131 877 (ZIMMERN)<br>* the whole document *<br>----- | 1-3 | |
| | | | TECHNICAL FIELDS SEARCHED (Int. Cl.5 ) |
| | | | F04C<br>F01C |

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| THE HAGUE | 16 SEPTEMBER 1992 | DIMITROULAS P. |

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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