United States Patent

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[54] **ROTARY SCREW MACHINE**
3 Claims, 5 Drawing Figs.

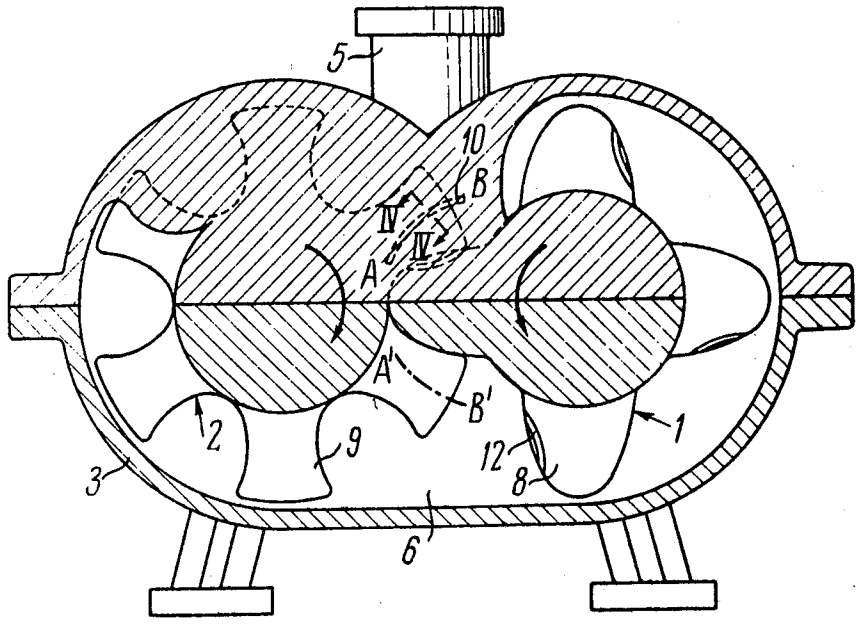
[52] **U.S. Cl.** **418/189,** 418/190, 418/201
[51] **Int. Cl.** **F01c 21/00,** F01c 1/16
[50] **Field of Search** 418/189, 190, 197, 201, 202, 203

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ABSTRACT: A rotary screw machine in which the openings for charging and discharging a gaseous working medium are located in the casing at both faces of the screws, and in which, in each portion of the casing adjacent to the like faces of the screws at a certain distance from the opening provided in this portion of the casing, a groove is provided along the line of engagement of the teeth of the screws and facing the adjacent faces of the screws. One end of this groove is located at the dedendum circle of the teeth of the female screw while the other end of the groove is located beyond the addendum circle of the teeth of this screw.



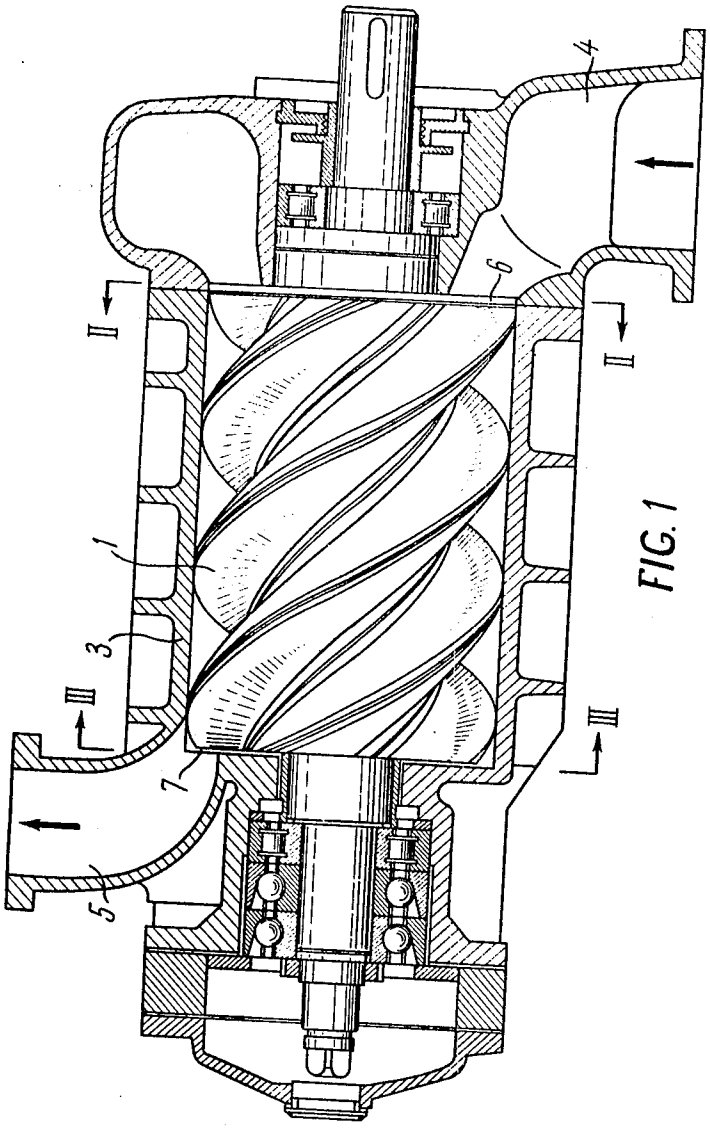


FIG. 1

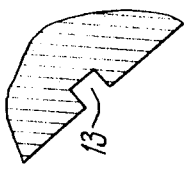


FIG. 5

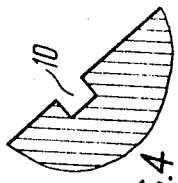


FIG. 4

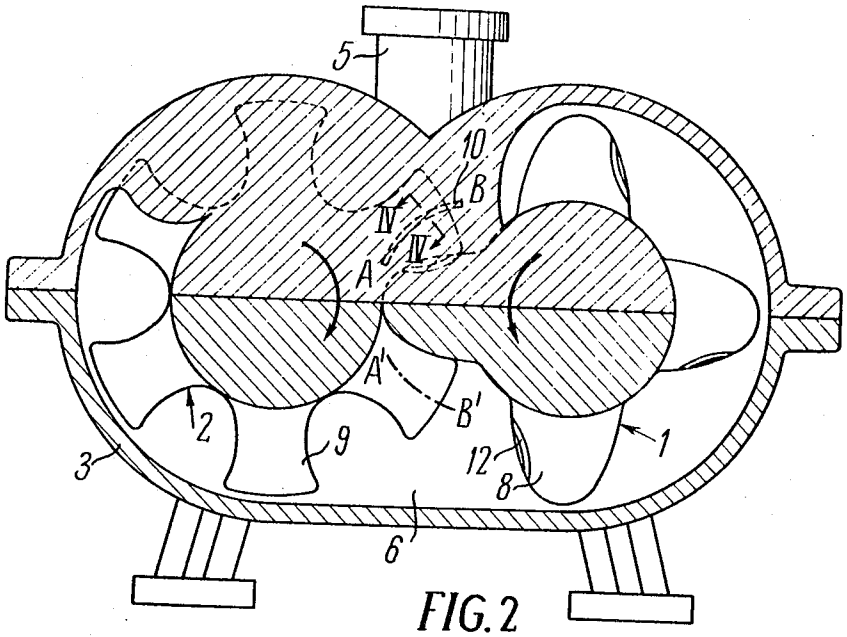


FIG. 2

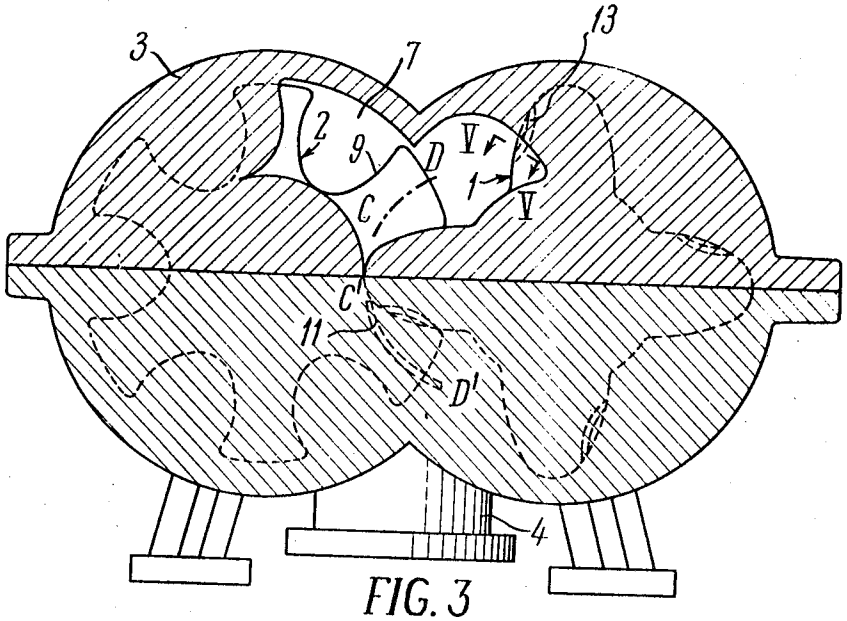


FIG. 3

ROTARY SCREW MACHINE

The present invention relates to rotary screw machines, having male and female intermeshing rotary screws. Provided between the teeth of the screws and the machine casing are chambers into which a gaseous medium is admitted. If a torque is applied to one of the screws these screws start to rotate and the machine compresses said medium functioning as a compressor.

If the gaseous medium is forced under pressure into the said chambers, the screws start to rotate and in this case the machine can be utilized as a motor.

The present invention can be most effectively used, when the profile of each tooth of the male screw follows an elliptical, cycloidal or other curve, whose shape is similar to that of said curves, while the profile of each tooth of the female screw follows a curve enveloping the curves formed by the point of the tooth profile of the male screw during the rotation thereof (such a profile is described in the USSR Inventor's Certificate No. 125860, cl.27 c 3/01, 1960).

The known rotary screw machines have two openings for charging and removal of the gaseous medium. One of these openings is usually located on the low-pressure side in the lower portion of the casing, while the other opening is located on the high-pressure side in the upper portion of the casing. During the rotation of the screws closed chambers are formed on the low-pressure side and high-pressure side of the machine.

The closed chambers on the low-pressure side of the machine are formed between the rear flank of the tooth of the male screw and the front side of the tooth of the female screw and the end wall of the casing. The beginning of their formation coincides with the initial moment of engagement of the screws. In the course of further rotation of the screws the volume of this chamber increases and reaches a maximum value in the position of complete engagement of the screws. As a result, a vacuum is formed within the closed chamber, and due to this fact a clamp or shock wave occurs at the moment of communication of the chamber with the high-pressure zone of the machine. This phenomenon causes the increases of the noise level of the rotary screw machine and also results in energy losses.

The closed chambers on the high-pressure side of the machine are formed between the front side of the tooth of the male screw, the rear flank of the tooth of the female screw and the end wall of the casing. The beginning of their formation coincides with the moment when the contacting tooth of the male screw faces the axis of rotation of the female screw. During further rotation of the screws the size of this chamber decreases and disappears when the screws disengage.

As a result, an overpressure of the working medium in the closed chamber takes place and this is accompanied by the losses of the energy consumed for the compression as well as by the claps or shock waves created during the communication of the closed chambers with the low-pressure zone of the machine, therefore, the noise level of the screw-rotor machine increases.

In order to reduce an adverse effect of the closed chambers the known rotary screw machines are provided with grooves in the faces of the male screws, one end of these grooves communicating with the lateral surface of the tooth. The other end of each groove in the course of rotation of the screws passes by the values built into the casing and communicating the closed chamber with the high-pressure zone (for example, see the U.S.A. Pat. Specification No. 2,578,196).

In the process of making the known machines of the abovementioned type and during their maintenance there are difficulties associated with placing the valves in the machine casing and with controlling the state of the valves during their maintenance. Furthermore, these valves decrease the rate of changing the pressure within the closed chambers unproportionally to the change of this rate due to the fact that their area of passage is invariable.

The main object of the invention is to provide such a rotary screw machine in which the closed chambers after their formation during the rotation of the screws constantly communicate with the zone of such a pressure whose value is close to the value of pressure within the closed chamber.

According to the invention this object is achieved by providing a groove in each portion of the casing adjoining the like faces of the teeth at some distance from the opening made in this portion of the casing, said groove being located along the line of engagement of the teeth of the screws and facing the adjacent faces of the screws. In this case one end of the groove is located at the dedendum circle of the teeth of the female screw, while the other end of the groove is located beyond the addendum circle of the teeth of this screw.

Such an embodiment of the rotary screw machine makes it possible to provide for the same effect which is obtained by means of the previously known valves. In this case, however, the design of the machine is essentially simplified, while the reliability thereof is increased.

In order to reduce the rate of changing the pressure within the formed closed chambers on the low-pressure side proportionally to the change of this rate, it is expedient to make a groove in said side of the face of each tooth of one screw, particularly, the male one, at the part of the tooth profile, located backwards as viewed in the direction of rotation of the screw, said groove communicating the middle portion of the tooth profile with a portion of this profile at the tooth root.

In order to reduce the rate of changing the pressure within the formed closed chambers on the high-pressure side proportionally to this rate it is expedient to make a groove in said side of the face of each tooth of one screw, particularly, the male one, at the part of the tooth profile located in front as viewed in the direction of rotation of the screw, said groove communicating the middle portion of the tooth profile with a portion of this profile at the tooth root.

The basic advantage of the invention consists in that the noise level of the compressor or pump is reduced approximately by 20 percent while the energy losses are correspondingly reduced.

Given below is a detailed description of an embodiment of the rotary screw compressor or pump, according to the invention, with reference to the accompanying drawings, in which:

FIG. 1 illustrates a longitudinal section of the rotary screw machine according to the invention;

FIG. 2 is a section taken along the line II—II of FIG. 1;

FIG. 3 is a section taken along the line III—III of FIG. 1;

FIG. 4 is a section taken along the line IV—IV of FIG. 2;

FIG. 5 is a section taken along the line V—V of FIG. 3.

The rotary screw machine comprises a male screw 1 (FIG. 1) and a female screw 2 (FIG. 2) mounted within the casing 3 and engaging the screw 1. Provided in the lower portion of the casing on the low-pressure side is a branch 4, while the upper portion of the casing on the high-pressure side is provided with a branch 5. The branches 4 and 5 are intended for charging and discharging a gaseous working medium and communicate with the chambers formed between the teeth of the screws and the casing 3 of the machine through the opening 6 (FIGS. 1 and 2) and opening 7 (FIGS. 1 and 3) respectively. The contact of the teeth 8 of the male screw 1 and the teeth 9 of the female screw 2 at the like faces of the screws is effected along the lines of engagement AB and A'B' (FIG. 2) and along the lines of engagement CD and C'D' &(FIG. 3) respectively. Provided in the casing 3 at each of said openings at some distance therefrom along the lines AB and C'D' of engagement are a groove 10 (FIG. 2) and a groove 11 (FIG. 3) respectively, facing the adjacent respective faces of the screws 1 and 2, as shown in FIGS. 2, 3, 4 and 5. In this case one end of each groove is located at the dedendum circle of the teeth 9 of the female screw 2, whereas the other end is located beyond the addendum circle of the teeth of this screw.

Owing to the fact that the closed chambers between the contacting teeth 8 and 9 of the screws 1 and 2 are formed along the grooves 10 and 11, these grooves provide for con-

stant communication of said closed chambers with the openings 6 and 7 respectively.

Such a design makes it possible to eliminate a rapid change of pressure within these chambers or a significant pressure drop of the working medium within these chambers and in the zones adjoining the branches 4 and 5 respectively.

Noisy exhaust of the working medium from these chambers as well as any claps or shock waves are eliminated. The energy losses of the compressor are reduced.

It is understood that the grooves 9 and 10 may even have rectilinear sections, however, these sections should be tangential to the line of engagement.

Owing to the fact that the closed chambers feature a variable volume it is expedient to increase the cross section of the passage through which they communicate with one of said zones at the moments, when the rate of changing their volume is maximum.

To solve this problem the face of each tooth 8 of the male screw 1 on the low-pressure side (at the opening 6) and at the portion of the tooth profile which is backwards as viewed in the direction of rotation of the screw 1 is provided with a groove 12 (FIGS. 1, 2, 3) communicating the middle part of the profile of the tooth 8 with a section of this profile at this tooth root. In these places the rate of changing the volume is the highest, therefore, the groove 12 will communicate the closed chamber with the low-pressure zone at the moments of the maximum rate of changing of said volume.

On the high-pressure side (at the opening 7) the above problem is solved with the help of a groove 13 made on the face of each tooth 8 of the male screw 1 on said side, the groove 13 being located at that portion of the profile which is forward as viewed in the direction of rotation of the screw 1. This groove communicates the middle part of the profile of the tooth 8 with the section of this profile at the root of the tooth 8. In order to simplify the process of manufacture of the grooves 12 and 13 it is expedient to make them arc-shaped.

It is clear that the grooves are preferably made in the male screw having convex (wide) teeth.

We claim:

1. A rotary screw machine comprising a casing having an inlet branch and an outlet branch for a gaseous working medium, male and female screws located inside said casing and being in engagement, an inlet opening provided in said casing at the first like faces of said screws, an outlet opening within said casing at the other like faces of said screws, a groove in each portion of said casing adjacent to said first like faces and to the second like faces of said screws, said groove being located along the line of engagement of the teeth of the screws at a distance from the corresponding opening and facing the adjacent faces of said screws, one end of this groove being located at the dedendum circle of the teeth of said female screw and the other end of this groove being located beyond the addendum circle of said teeth of this screw.

2. A rotary screw machine according to claim 1 in which at the low-pressure side of the face of each tooth of one of said screws at that portion of the profile of this tooth which is backward as viewed in the direction of rotation of said screw, a groove is provided connecting the middle portion of said profile of said tooth with a section of this profile at the root of said tooth.

3. A rotary screw machine according to claim 1 in which at the high-pressure side on the face of each tooth of one of said screws at that portion of the profile of said tooth which is forward as viewed in the direction of rotation of said screw, a groove is provided connecting the middle portion of said profile of said tooth with a section of this profile at the root of said tooth.