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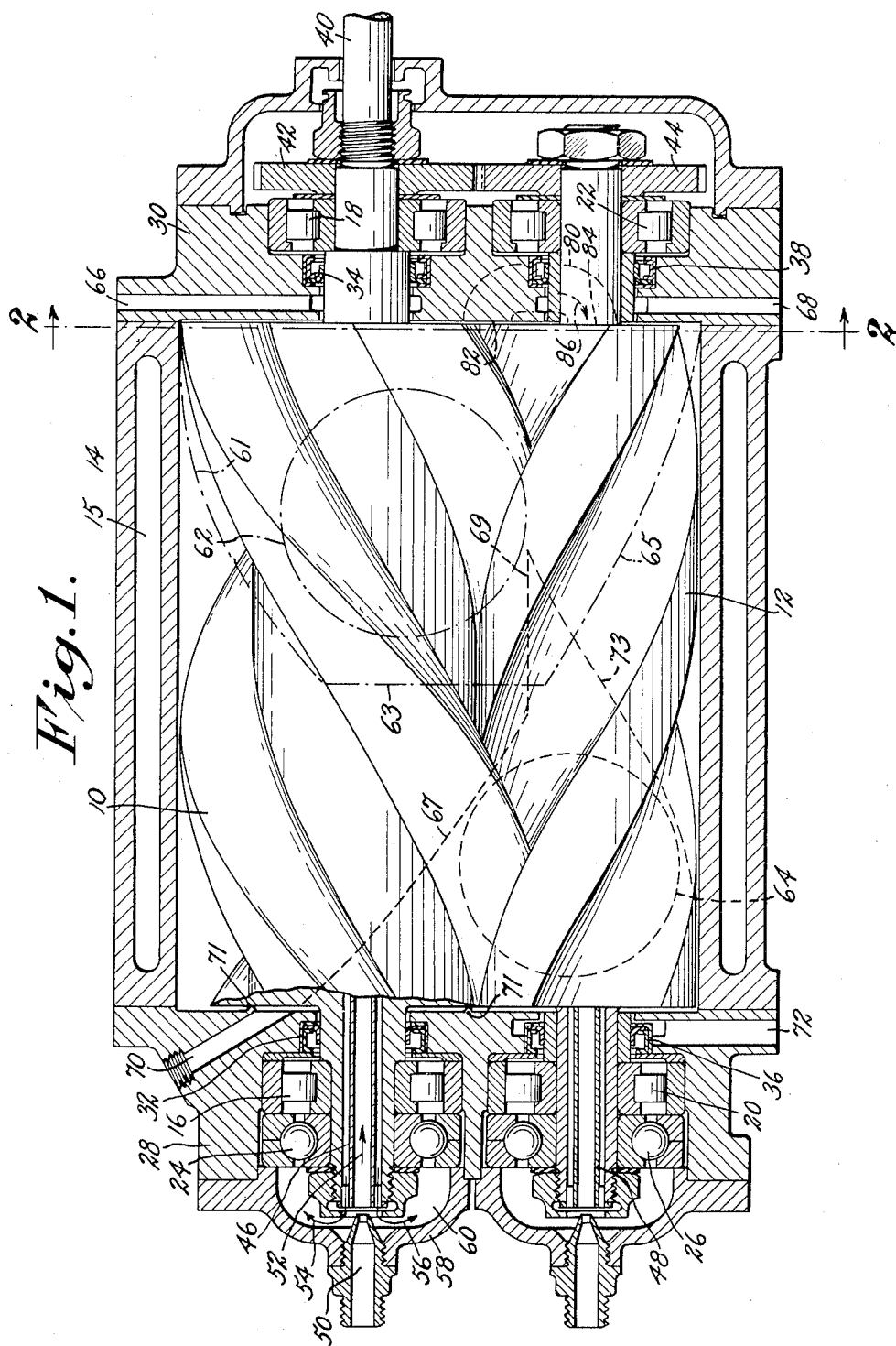
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ROTARY COMPRESSOR

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ROTARY COMPRESSOR

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The present invention relates to compressors of the rotary screw type in which two or more cooperating rotors mounted within a suitable casing operate to provide compression spaces, the volume of which varies upon rotation of the rotors to effect compression of the working fluid within the compressor.

In compressors of this type, compression spaces on each of two cooperating rotors are brought into communication with each other and thereafter the two spaces work together as a common compression space until further rotation of the rotors brings one or the other or both of these spaces into communication with an outlet port in the casing.

We have discovered that the action of the rotors in previously proposed forms of screw type compressors is such that reduction in volume of any given compression space in one rotor commences prior to reduction in volume of the compressor space in the cooperating rotor with which the first space is brought into communication.

The result of this is that two compression spaces are brought into communication with a certain amount of compression having already taken place in one, whereas it has not taken place in the other. Consequently, when communication between the two spaces occurs, equalization of pressure between the two spaces takes place and the pressure of the working fluid which has already been partially compressed is reduced. This reduction in the pressure of the working medium which has already been partially compressed results in an increase in entropy with a corresponding loss of work.

Accordingly, the present invention has for a major object the provision of improved compressor apparatus of the kind described in which this partial compression in one compression space prior to its communication with another compression space in which compression has not commenced is avoided and in which the compression occurring in any two compression spaces which come into communication with each other is substantially the same.

The more detailed nature of the invention and the manner in which the above stated and other and more detailed objects of the invention may be advantageously accomplished will appear more fully in the ensuing portion of this specification in which suitable embodiments of apparatus for carrying the invention into effect are described.

In the accompanying drawings forming a part of this specification:—

Fig. 1 is an axial longitudinal section of a

screw compressor of the kind under consideration, to which the invention is applied;

Fig. 2 is a section taken on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary section like Fig. 2 showing a different embodiment of the invention;

Fig. 4 is a section like Fig. 2 showing a further embodiment of the invention; and

Fig. 5 is an elevation showing a casing end plate for use with the form of the invention illustrated in Fig. 4.

The compressor illustrated in Figs. 1 and 2 comprises two rotors 10 and 12 around which is located the casing part 14. It will be understood that insofar as the present invention is concerned, the number of rotors employed is not limited to two. The casing part 14 is advantageously provided with a jacket space 15 for water or other cooling fluid.

Rotors 10 and 12 are preferably made integral with the shaft parts and are advantageously mounted in roller bearings 16 and 18, and 20 and 22, respectively, which bearings carry the radial load. Also, ball bearings 24 and 26 are advantageously provided to take up end thrust. The bearings are carried by casing parts 28 and 30 which are suitably secured to the ends of the casing part 14 and which provide the end walls for the casing. In the form of apparatus shown, the end walls limit the axial extent of the compression spaces. Packings 32, 34, 36, and 38 are provided around the shaft parts between the end walls and the bearings.

The compressor is driven from the shaft 40 connected to the rotor 10 and drive is transmitted to the rotor 12 by means of gears 42 and 44 mounted respectively on the shafts of the rotors 10 and 12.

Preferably the rotors are mounted so that a slight clearance is maintained between the rotors and the casing and also between the intermeshing surfaces of the rotors, the clearance between the latter surfaces being maintained by the gear drive through gears 42 and 44.

The rotors as well as the casing may advantageously be cooled and for this purpose may be constructed as shown with hollow shafts provided with concentrically spaced inner pipes 46 and 48 respectively. Cooling fluid for cooling rotor 10 is introduced through the nozzle 50 to the interior of the pipe 46, flowing longitudinally of the rotor in the direction of the arrow 52 inside the pipe and returning through the space between the pipe and the bore of the shaft in the direction indicated by arrows 54 and 56. The nozzle 50 is mounted in a suitable cover plate 58 which forms

a space 60 to which the cooling fluid is discharged and from which it flows through a suitable outlet opening, not shown. Cooling of the rotor 12 is effected in the same manner.

5 The inlet to the compressor for the fluid to be compressed, or working fluid, is indicated at 62 and the outlet for compressed fluid at 64. In Fig. 1 where the inlet and outlet are diagrammatically indicated in broken lines, the inlet is located in front of the plane of the drawing while the outlet is on the opposite side. The inlet port, that is the intersection between the inlet passage and the curved part of the casing, is diagrammatically indicated at 61, 63, 65, 66 being understood that the inlet port is located in front of the plane of the drawing. The outlet port is limited by the edges 67, 68, and 73 located behind the plane of the drawing.

The casing part 30 at the suction end of the compressor is provided with radially extending bores 69 and 70 extending from the shaft bores to the exterior of the casing and serving to prevent the creation of a suction effect to the left of the packings 34 and 38 which might cause 25 lubricant from the bearings 18 and 22 to be drawn into the compressor.

At the compression end of the compressor, the casing part 28 is provided with bores 70 and 72 which serve to prevent flow of compressed working fluid into the bearing chambers.

One or more tightening edges, preferably extending annularly such as indicated at 71, are advantageously employed between the high pressure ends of the rotors and the adjacent end wall, such edges being formed either on the casing part or on the end surface of the rotor.

As will be seen from Figs. 1 and 2, the rotors 10 and 12 are each of the type having three helical grooves which provide the compression spaces. 40 It will be understood, however, that the number of grooves may be varied within the scope of the invention and also that different numbers of grooves may be employed on different but co-operating rotors. These grooves may be considered as pockets in the rotors separated by the radially projecting parts of the rotors which may be considered as threads.

In the position of the rotors shown in Fig. 2, compression of the working fluid is about to commence as the rotors turn from the position shown, in the direction of the arrows 76 and 78. The working fluid which has previously entered the compressor to the suction space 74 has been confined in the space or pocket P in the rotor 10, this space being defined by the threads T and T₁, a portion of the wall of the casing part 14 and portions of the end walls formed by the end members 28 and 30. Working fluid from the suction space 74 has also been confined in the pocket R formed 60 in the rotor 12. In the position of the rotors shown, no compression has taken place in either pocket P or pocket R.

If we disregard the construction of the apparatus which embodies the present invention, and 65 which will hereinafter be described, compression of the working fluid confined in the pockets P and R would take place as follows upon further rotation of the rotors in the directions indicated. Upon such further rotation, the thread S on rotor 12 will enter into the moving pocket P and will reduce its volume, thereby causing a certain amount of compression to take place in this pocket. On the other hand, during movement of the rotor 12 from the position shown in the figure to the position in which the rear limiting

point G of the thread S reaches the point M, no change in volume of the pocket R occurs and consequently the working fluid in this pocket remains at suction pressure.

As soon as the point G passes the point M, the 5 two pockets P and R are brought into communication with each other and equalization of pressure between the bodies of fluid confined in these pockets takes place. This equalization of pressure results in a lowering of the pressure in the pocket P as compared with the pressure just prior to communication between the pockets, with consequent loss.

In the present embodiment of the apparatus, this loss is avoided by providing a pressure relief passage 80 in the casing part 30. Passage 80 terminates in two ports 82 and 84 located as shown in Fig. 2 so that these ports are uncovered respectively by the threads T and S. If full advantage is to be secured from the provision of the passage 80, the ports should be arranged so that they are uncovered not later than the instant when the thread S commences to enter the pocket P, so that no compression can be effected in the pocket P prior to the establishment of communication by means of passage 80 between this 25 pocket and pocket R. By interconnecting the pockets in this way, compression cannot occur in one of the pockets prior to the commencement of compression in the other of the pockets and there is consequently no time during the compression period when a pressure equalization takes place between two spaces which entails any appreciable drop in pressure of fluid previously compressed to a higher pressure. In the 35 arrangement shown, commencement of compression occurs substantially simultaneously in both pockets, some of the working fluid from pocket P flowing through the passage 80 to the pocket R during that portion of the compression period when the volume of pocket P is being reduced and prior to direct communication between the two pockets.

It will be evident that in order to effect the desired purpose, the passage for connecting the 45 two pockets need not be situated in the end member of the casing, although this provides an advantageous location, but may be situated in the cylindrical portion of the casing with its terminal ports located so as to be opened by the radially outer edges or surfaces of the rotor threads or teeth, as illustrated by the modification shown in Fig. 3. In this embodiment, the pockets P and R may be connected by a passage 80a provided in the cylindrical portion 14 of the casing and 55 terminating in two ports 82a and 84a.

In the embodiment illustrated in Figs. 4 and 5, pre-compression of fluid in the pocket P prior to the time of direct communication between this pocket and the pocket R is prevented by 60 forming the end portion of the casing structure so that communication between the pocket P and the suction chamber of the compressor is not cut off until direct communication between pockets P and R is established.

In this embodiment, the suction ends of the rotors are not entirely covered by the end wall of the casing part 30a at the suction end of the compressor, the latter being advantageously recessed to provide what is in effect an end plate 70 88 having the contour shown in Fig. 5, which end plate acts as a closure for the pockets P and R during that part of the compression period when these pockets extend to the suction ends of the rotors. Obviously, the end plate 88 may pro- 75

ject from an inner plane surface of the end part of the casing. Regardless of the specific form of construction of the part 30a, the ends of the rotors at the suction end of the compressor are in contact, or substantially in contact, only with an end wall surface limited by the lines *e, f, g, h, k, m, n*. With this arrangement, the pocket P remains in communication with the suction space 74 until the front edge *a* of the thread T1 reaches the position *a*₁, in which position it has just passed the edge *e* of the end wall 88.

Until edge *a* passes edge *e*, no compression takes place in the pocket P and the position of the edge *e* is arranged so that it substantially coincides with the position of the edge *a* at the instant when the point G on the thread S passes the point M. When the edge *e* is located in this manner, no compression is effected prior to the time of direct communication between pockets P and R and thereafter compression commences, with the two pockets in communication so that simultaneous and like compression takes place in both pockets.

While we prefer to connect the pocket P with the suction chamber of the compressor until the two pockets are brought into direct communication with each other, it will be evident that the passage which prevents compression in pocket P prior to compression in pocket R may lead directly to atmosphere if the compressor is being employed to compress atmospheric air or to any zone of pressure substantially equal to the inlet pressure of the fluid being compressed.

It will also be evident that the pressure relief passage providing communication between pocket P and the desired zone of low pressure need not necessarily be formed by special configuration of the end member of the casing but may be formed by special configuration of a part of the casing radially enclosing the rotor.

It will further be evident that the special configuration of the end member 30a with respect to the portions *f, g, h, and k* need not be exactly as shown in the illustrated embodiment. In Fig. 4, the position of the pocket R at the instant when the edge *a* on rotor 10 registers with the edge *e*, is indicated by the dotted line *b* and it will be evident that the end wall surface may be altered in desired manner so that pocket R is permitted to remain in communication with the suction chamber until it arrives at the position indicated by line *b*, in which position, however, the axial end of the pocket should be covered.

Certain novel features of compressor construction relating to thread structure and porting disclosed but not claimed herein are not our joint invention but constitute the sole inventions of Alf Lysholm forming the claimed subject matter of U. S. applications Serial No. 44,935, filed October 14, 1935, and Serial No. 183,664, filed January 6, 1938, as a continuation in part thereof.

From the foregoing description, it will be evident that the invention may be embodied in many different specific forms of apparatus differing from the embodiments hereinbefore described by way of example and it is further to be noted that the invention is independent of the number of rotors employed, the number of pockets provided per rotor and of the specific form or configuration of the pockets or threads defining the pockets.

We claim:

1. A compressor of the rotary screw type including a casing having an inlet and an outlet

for fluid, a first rotor and a second rotor mounted in said casing, said rotors having interengaging screw threads forming pockets therein formed and arranged together with the inner walls of said casing to provide compression spaces registering at different times with said inlet and said outlet and decreasing in volume between the time of registry with said inlet and the time of registry with said outlet, said compression spaces including a first pocket in the first rotor and a second pocket in the second rotor, said first pocket and said second pocket being disposed so as to be brought into direct communication with each other during rotation of said rotors and the volume of said first pocket being reduced before direct communication between the pockets occurs, and a pressure relief passage in communication with said first pocket for maintaining the pressures in the first and second pockets substantially equal until direct communication therebetween is established.

2. A compressor of the rotary screw type including a casing having an inlet and an outlet for fluid, a first rotor and a second rotor mounted in said casing, said rotors having interengaging screw threads forming pockets therein formed and arranged together with the inner walls of said casing to provide compression spaces registering at different times with said inlet and said outlet and decreasing in volume between the time of registry with said inlet and the time of registry with said outlet, said compression spaces including a first pocket in the first rotor and a second pocket in the second rotor, said first pocket and said second pocket being disposed so as to be brought into direct communication with each other during rotation of said rotors and the volume of said first pocket being reduced before direct communication between the pockets occurs, and a passage arranged to provide communication between said first pocket and said second pocket before direct communication between the pockets is established.

3. A compressor of the rotary screw type including a casing having an inlet and an outlet for fluid, a first rotor and a second rotor mounted in said casing, said rotors having interengaging screw threads forming pockets therein formed and arranged together with the inner walls of said casing to provide compression spaces registering at different times with said inlet and said outlet and decreasing in volume between the time of registry with said inlet and the time of registry with said outlet, said compression spaces including a first pocket in the first rotor and a second pocket in said second rotor, said first pocket and said second pocket being disposed so as to be brought into direct communication with each other during rotation of said rotors and the volume of said first pocket being reduced before direct communication between the pockets occurs, and a passage formed in said casing and arranged to provide a connection between said first pocket and said second pocket before direct communication between the pockets is established.

4. A compressor of the rotary screw type including a casing having end walls having an inlet and an outlet for fluid, a first rotor and a second rotor mounted in said casing between said end walls, said rotors having interengaging screw threads forming pockets therein formed and arranged together with the inner walls of said casing to provide compression spaces registering at different times with said inlet and said outlet and

decreasing in volume between the time of registry with said inlet and the time of registry with said outlet, said compression spaces including a first pocket in the first rotor and a second pocket in the second rotor, said first pocket and said second pocket being disposed so as to be brought into direct communication with each other during rotation of said rotors and the volume of said first pocket being reduced before direct communication between the pockets occurs, and a passage formed in one of said end walls, said passage terminating at its ends in ports disposed to register with said first pocket and said second pocket before direct communication between the pockets is established.

5. A compressor of the rotary screw type including a casing having an inlet and an outlet for fluid, a first rotor and a second rotor mounted in said casing, said rotors having interengaging screw threads forming pockets therein formed and arranged together with the inner walls of said casing to provide compression spaces registering at different times with said inlet and said outlet and decreasing in volume between the time of registry with said inlet and the time of registry with said outlet, said compression spaces including a first pocket in the first rotor and a second pocket in the second rotor, said first pocket and said second pocket being disposed so as to be brought into direct communication with each other during rotation of said rotors and the volume of said first pocket being reduced before direct communication between the pockets occurs, and a passage arranged to provide a connection between said first pocket and said second pocket before direct communication between the pockets is established, said passage terminating at its ends in ports disposed in said casing to register with said first pocket and said second pocket and to be opened and closed by movement of parts of said rotors.

6. A compressor of the rotary screw type including a casing having an inlet and an outlet for fluid, a first rotor and a second rotor mounted in said casing, said rotors having interengaging screw threads forming pockets therein formed and arranged together with the inner walls of said casing to provide compression spaces registering at different times with said inlet and said outlet and decreasing in volume between the time of registry with said inlet and the time of registry with said outlet, said compression spaces including a first pocket in the first rotor and a second pocket in the second rotor, said first pocket and said second pocket being disposed so as to be brought into direct communication with each other during rotation of said rotors and the volume of said first pocket being reduced before

direct communication between the pockets occurs, and a pressure relief passage in communication with said first pocket for preventing appreciable compression in said first pocket until direct communication is established between said first pocket and said second pocket.

7. A compressor of the rotary screw type including a casing having an inlet and an outlet for fluid, a first rotor and a second rotor mounted in said casing, said rotors having interengaging screw threads forming pockets therein formed and arranged together with the inner walls of said casing to provide compression spaces registering at different times with said inlet and said outlet and decreasing in volume between the time of registry with said inlet and the time of registry with said outlet, said compression spaces including a first pocket in the first rotor and a second pocket in the second rotor, said first pocket and said second pocket being disposed so as to be brought into direct communication with each other during rotation of said rotors and the volume of said first pocket being reduced before direct communication between the pockets occurs, and a pressure relief passage providing communication between said first pocket and the inlet of the compressor substantially until communication between said first pocket and said second pocket is established, whereby to prevent appreciable compression in said first pocket before compression is effected in said second pocket.

8. A compressor of the rotary screw type including a casing having end walls having an inlet and an outlet for fluid, a first rotor and a second rotor mounted in said casing between said end walls, said rotors having interengaging screw threads forming pockets therein formed and arranged together with the inner walls of said casing to provide compression spaces registering at different times with said inlet and said outlet and decreasing in volume between the time of registry with said inlet and the time of registry with said outlet, said compression spaces including a first pocket in the first rotor and a second pocket in the second rotor, said first pocket and said second pocket being disposed so as to be brought into direct communication with each other during rotation of said rotors, and the volume of said first pocket being reduced before direct communication between the pockets occurs, one of said end walls having a surface formed to provide communication between said first pocket and the inlet of the compressor substantially until said first pocket and said second pocket are brought into communication.

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