Oct. 9, 1962 J. B. MARSDEN 3,057,543

AXIAL FLOW COMPRESSOR

Filed Feb. 5, 1960 2 Sheets-Sheet 1

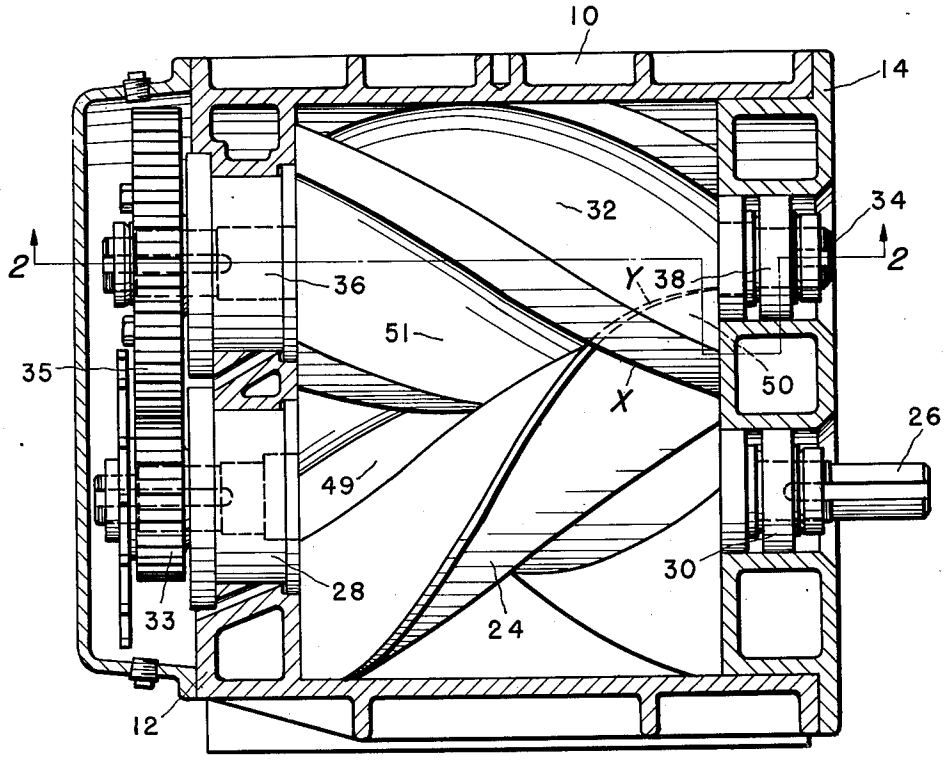


FIG. 1

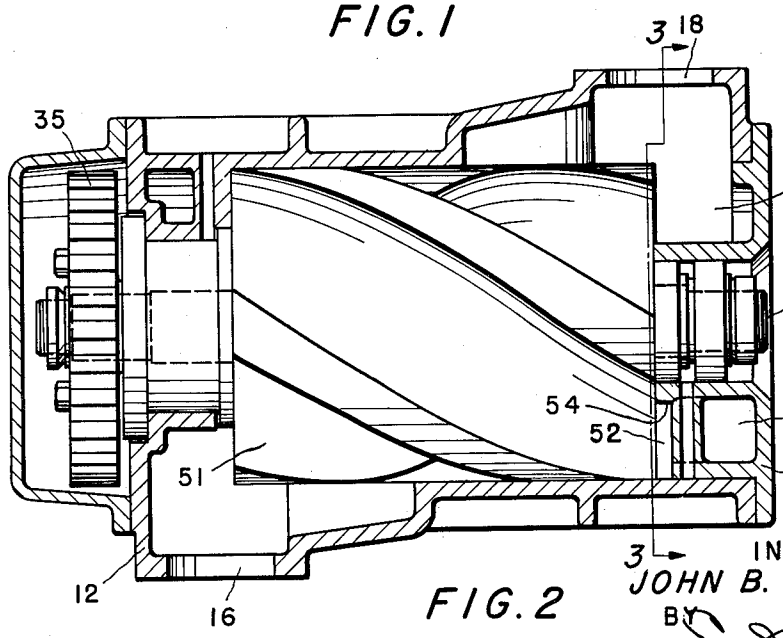


FIG. 2

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AXIAL FLOW COMPRESSOR

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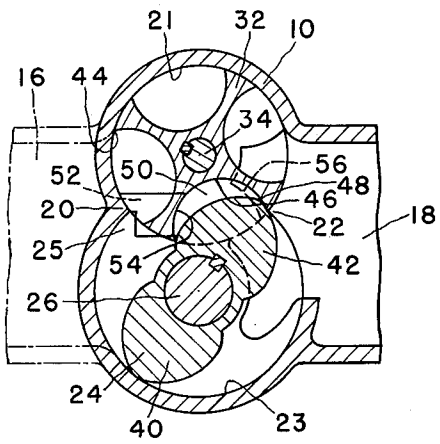


FIG. 3

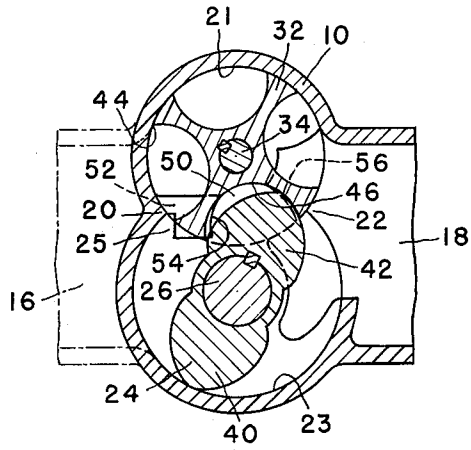


FIG. 4

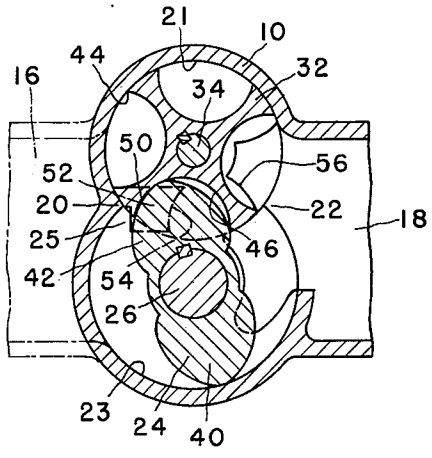


FIG. 5

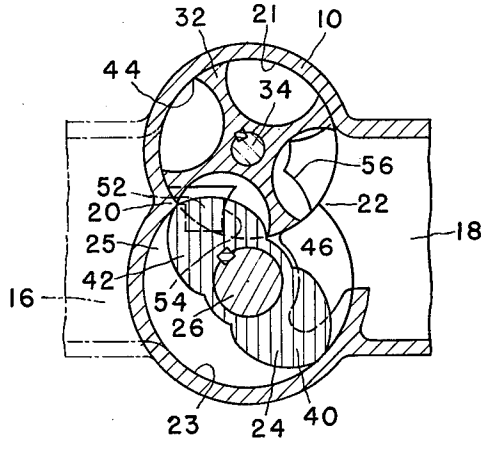


FIG. 6

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AXIAL FLOW COMPRESSOR

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Filed Feb. 5, 1960, Ser. No. 6,987
3 Claims. (Cl. 230—143)

The present invention relates generally to axial compressors, pumps, blowers and the like, and more particularly to that type wherein rotary members engage in screw and thread relationship and the pumped or compressed fluid follows an axial spiral path therebetween.

Such members, which are the core of such machines generally operate on a pair of parallel longitudinal shafts, vertically co-planar, within a fully enclosed casing except for the usual inlet and outlet ports, such as shown in Patent #2,287,716 issued to Whitfield on June 23, 1942.

This invention is directed more particularly to improvements in the associated components thereof such as the provision of an end clearance chamber for purposes of unloading therein the compressed fluid trapped in the end clearance pocket, which would otherwise seep through the normal clearance between the rotors and between the rotor ends and the chamber end wall, and means for directing this fluid back towards the low pressure side of the compressor which also provides for conducting any water or other liquid entrapped therein out towards the low pressure side of the compressor. In this manner the compressor is now able to handle a certain amount of liquid flow therethrough, otherwise such entrapped liquid would normally prevent escape of the trapped gases through the normal clearance between the rotors, and in extreme cases tend to distort the precise relationship between the rotors and cause physical damage to the compressor.

Devices of the herein described nature generally have two helically threaded rotors supported on and revolving about parallel axes, with the threads of the rotors continuously intermeshing to thereby define a continuous seal line for the full extent of their engagement. The casing encloses both of the members and the crests or perimetral edges of the threads of the rotary members also form seals with the inner surface of the casing. The end wall of the casing forms a seal with the end faces of the rotary members. Therefore any flow of fluid from one end of the members to the other must pass through the grooves between the threads of the rotary members. Due to the sealing thus described the threads of the members when they are rotated cooperate with each other and with the walls of the casing to form fluid pockets that advance and move from one end of the casing whereat the low pressure or intake port is located, to the other end of the casing whereat the high pressure, or discharge port is located.

In order to permit rotation of the members the threads must be complementary. Thus the threads of one member have a right hand helical twist, while the threads of the other member have a left hand helical twist.

One of the rotary members is commonly referred to as the main rotor. The complementary rotary member is usually referred to as the gate rotor.

In operation of the device, the threads in the main rotor act as a continuous series of pistons which slide axially in the same direction through the grooves of the gate rotor and produce a successive series of pockets which convey the fluid from one end of the members to the other.

When the trailing edge of the crest of the main rotor on the end of the rotor at the discharge port, crosses the intersection of the bores of the casing, a pocket is

formed bounded by the leading flank of the main rotor lobe and the trough of the gate and the end plate of the casing. As the main rotor revolves the fluid entrapped in this pocket is compressed. There being no escape for this fluid other than the normal clearance between the rotors, an undesirable condition is set up. A certain amount of extra horsepower is required to compress the entrapped fluid to a pressure necessary to force it through the normal clearance between the rotors thereby reducing the efficiency of the compressor. While the trapped pocket is formed on both ends of the compressor, the pocket on the discharge end is the only one of major importance, since the pocket on the inlet end is a low pressure pocket.

In the case of a non-compressible fluid being so entrapped, such as a liquid, or a fluid with a high liquid content, the threads of the weaker rotor, usually the gate rotor, may be deformed or actually broken.

The present invention contemplates overcoming the foregoing problem by providing a pressure relief chamber in the end wall of the casing at the high pressure side and communicating with the enclosed pocket before the pocket is completely sealed off from the discharge port. The pressure relief chamber extends across the lobes of the rotors and communicates with the low pressure side of the compressor and/or the pockets of the rotors which in turn are in communication with the intake port.

Thus at all times an escape path of sufficient size is provided to allow evacuation of the entrapped fluid to the low pressure pockets of the rotors without any undue pressure buildup.

The fluid thus evacuated is negligible in volume and does not noticeably affect the overall efficiency of the compressor. The slight loss so sustained is less than that caused by normal manufacturing tolerances.

It is therefore one of the objects of this invention to prevent the pressure buildup due to the entrapped fluid in the aforementioned end pocket of the compressor, and to do so in a novel and effective manner.

Another object of the invention is to provide means for evacuating the entrapped fluid in said end pocket over to a low pressure area of the compressor.

Still another object of the invention is to increase the ability of the compressor to pass a certain amount of liquid therethrough without damage to the rotors.

The foregoing and other objects and advantages will become more apparent by a consideration of the drawings and the detailed description that follows, but it is to be understood that the drawings are for the purposes of illustration only and do not in any way define the limits of the invention.

In the drawings:

FIGURE 1 is a side elevation of the compressor with the near face of the housing removed,

FIGURE 2 is a section view taken along the line 2—2 of FIG. 1 in the direction of the arrows,

FIGURES 3 to 6 are sections taken along the line 3—3 of FIG. 1, showing the positions of the rotors during the interval of rotation when the entrapping pressure pocket is in communication with the pressure relief chamber.

Referring now to the drawings and more particularly to FIGS. 1 and 2, a housing 10 comprises an end plate 12 and an oppositely disposed end plate 14. The end plate 12 forms part of an inlet port 16 and the end plate 14 forms part of an outlet port 18. The housing 10 is substantially in the form of a figure 8 in end view as shown in FIGS. 3 to 6 inclusive, and is more specifically defined by two parallel bores 21 and 23 having common intersections at 20 and 22 to form a common chamber 25.

A helical main rotor 24 (FIG. 1) is rotatably mounted

on a longitudinal shaft **26** and is supported in bearings **28** and **30** respectively encased in the end plates **12** and **14**. A mating helical rotor **32** usually called the gate rotor is mounted on a second longitudinal shaft **34**, and supported in bearings **36** and **38** respectively encased in the end plates **12** and **14**.

The main rotor **24** in section is asymmetrical in form and comprises a pair of lobes **40** and **42** the flanks of which are generated by the crest edges **44** of the gate rotor **32**.

The grooves **46** of the mating gate rotor **32** are generated by the crest edges **48** of the main rotor lobes **40** and **42**.

Thus the helical main rotor **24** and the helical gate rotor **32** mesh, and when rotated, form a continuous seal line, which moves diagonally across the housing **10** from one end of the rotors to the other along the complete length thereof.

A pinion **33** mounted on the shaft **26** operatively engages a gear **35** mounted on the shaft **34** to maintain a normal running clearance between the mating elements of the main rotor **24** and the gate rotor **32**.

In the normal operation of the device fluid is drawn into the inlet port **16** by the action of the rotors, rotating in opposing directions to open the pockets **49** and **51** of the mating main rotor **24** and gate rotor **32**. The pockets **49** and **51** continue to draw in fluid until they reach their maximum displacement, at which point they are cut off from the suction port **16** and compression of the fluid begins as the rotors continue to rotate. After a predetermined amount of internal compression has occurred, the pockets of the rotors now communicate with outlet port **18**.

However, when the trailing crest edge **48** of the main rotor lobe **40** passes beyond the intersection **22** of the bores **21** and **23** a pressure pocket **50** is formed between a leading flank of one of the main rotor lobes **40**, a groove **46** of the gate rotor, and the inner surface of the end plate **14** as illustrated in FIG. 3, and as shown in longitudinal depth by the area bounded between the lines X and Y in FIG. 1.

During certain applications the fluid compressed has a relatively high liquid content and as the fluid is transported through the device a portion of liquid is entrapped in the pocket **50**. With no means for escape other than the normal running clearances between the parts defining the pocket **50**, major damage to the device would result from the continued rotation of the rotors, since the liquid is incompressible.

To avoid the foregoing consequences, a pressure relief chamber **52** is provided in the end wall of the plate **14** on the opposite side from the outlet port **18** (FIG. 2) that is in constant communication with the low pressure side of chamber **25**. The inboard boundary **54** of the chamber **52** registers with the groove **46** of the gate rotor **32** when the rotors are in the relative position shown in FIG. 3. At this point communication still exists between the pocket **50** and the outlet port **18** through a passage **56** in the end wall of the end plate **14**. As the rotors continue to rotate the flank of the groove **46** leaves the boundary edge **54** of the chamber **52** providing communication between the pressure pocket **50** and the chamber **52**. As the passage to the discharge port grows smaller (FIGS. 4 and 5) the communication with the chamber **52** increases providing a constant area of the passageway means for the escape of entrapped fluid and liquid. In this manner any substantial increase in the pressure of the entrapped fluid is prevented.

FIGS. 3 to 6 inclusive illustrate the progressive reduction of the pressure pocket **50**, beginning from when the pocket initially is formed, and the rotors **24** and **32** continue to rotate, up until its complete evacuation of fluid into the pressure relief chamber **52**.

It will be noted from these illustrations (FIGS. 3 to 6) that at each and every one of the progressive stages of the pocket **50** the pressurized fluid confined therein is provided with an escape path either to the discharge port of the compressor as shown in FIG. 3, or over to the low pressure areas of the compressor as shown in FIGS. 4, 5 and 6.

Thus, means are provided whereby the several objects of this invention are achieved in a positive and effective manner. Although only one embodiment of the invention has been illustrated and described, it will readily be apparent to those skilled in the art, that changes and modifications in the parts, and relative arrangement, may be made without departing from the spirit and scope of the invention.

I claim:

1. A compressor comprising a casing having a chamber, a pair of oppositely disposed end plates connected to said casing to close the ends of the chamber, a pair of rotors disposed in the chamber between said end plates, said chamber having an inlet at one axial end thereof on one side of a plane through the axes of rotation of both rotors and an outlet at its other axial end on the other side of said plane, said rotors having complementary helical threads meshing with each other and operating to cyclically define pressure pockets each being formed in communication with the inlet and sequentially being blocked from the inlet then communicating with the outlet, each pressure pocket enlarging in volume during communication with the inlet to draw fluid therein and reducing in volume thereafter to compress the fluid then discharge the compressed fluid through the outlet, one of said threads defining helical lobes, the other of said threads defining helical grooves for receiving the meshing lobes progressively from the inlet to the outlet end of said compressor to provide seals between succeeding pressure pockets that move axially in the compressor tending to form fluid traps when such pockets are closed to said compressor outlet after discharge, and said end plate at the outlet end of said compressor having a recess on the inlet side of said plane being in constant communication with said compressor inlet and communicating with the ends of the fluid traps when formed to relieve trapped fluid therein to said compressor inlet.

2. A compressor in accordance with claim 1 in which, each of said lobes has a leading and a trailing flank surface intersecting to provide a crest edge, each of said grooves has an arcuate surface generated by the crest edges of said lobes and terminating at a crest edge that generates the leading flank surfaces of said lobes, said crest edges of meshing lobes and grooves forming seal lines with the surfaces they generate that are spaced by a pocket of varying volume defined by the lobe and groove disposed between the seal lines, and said pockets between the crest edges forming the fluid traps when the crest edges form seal lines that extend to the outlet ends of said rotors and close the formed traps to the compressor outlet.

3. A compressor comprising a casing having a pair of intersecting parallel bores forming a chamber therein, a pair of oppositely disposed end plates connected to said casing to close the ends of said bores, a pair of rotors disposed in said bores between the end plates, said chamber having an inlet at one axial end thereof on one side of a plane through the axes of rotation of both rotors and an outlet at its other axial end on the other side of said plane, said rotors having complementary helical threads meshing with each other and operating to cyclically define pressure pockets each being formed in communication with the inlet and sequentially being blocked from the inlet then communictting with the outlet, each pressure pocket enlarging in volume during communication with the inlet to draw fluid therein and reducing in volume

thereafter to compress the fluid then discharge the compressed fluid through the outlet, one of said threads defining helical lobes, the other of said threads defining helical grooves for receiving the meshing lobes progressively from the inlet to the outlet end of said compressor to provide seals between succeeding pressure pockets that move axially in the compressor tending to form fluid traps after such pockets are closed to said compressor outlet, said end plate at the outlet end of said compressor having a pair of recesses therein each disposed on one side of said plane, said recess disposed on the outlet side of said plane being in constant communication with the compressor outlet and providing the last connection thereto from said pockets when such traps are being formed, and said recess on the inlet side of said plane being in constant communication with said compressor inlet and communicating with the ends of the fluid traps when formed to relieve trapped fluid therein to said compressor inlet.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

October 9, 1962

Patent No. 3,057,543

John B. Marsden

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 73, for "communictting" read -- communicating --; column 6, line 16, under the heading "UNITED STATES PATENTS" for "2,915,876" read -- 2,915,976 --.

Signed and sealed this 20th day of August 1963.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents