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ROTARY COMPRESSOR

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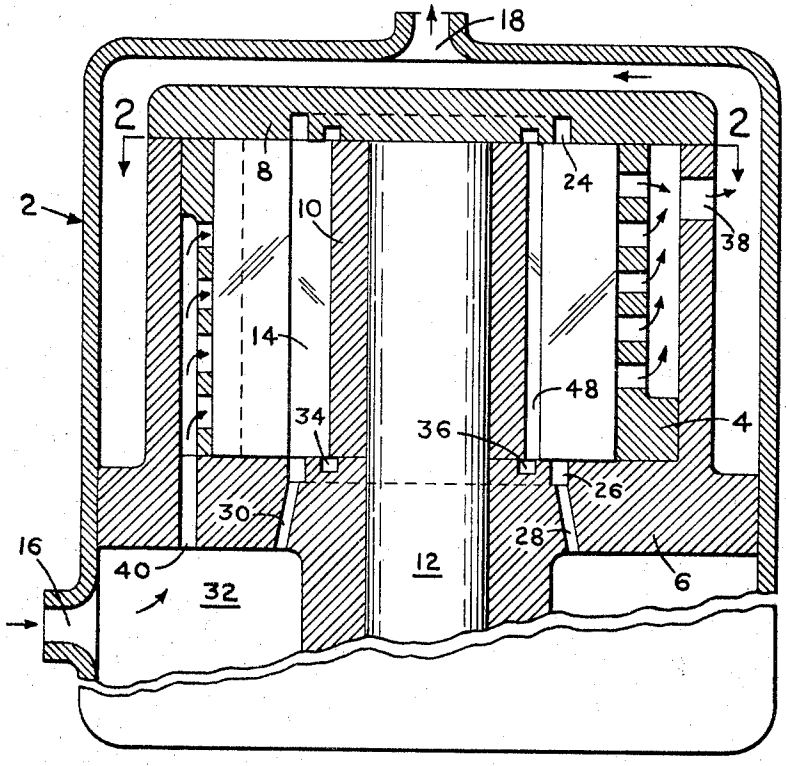


FIG. 1

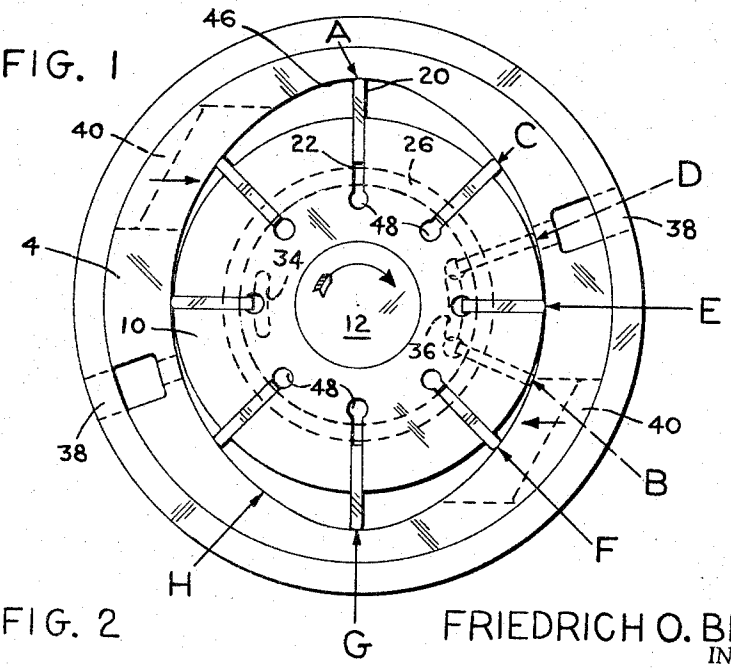


FIG. 2

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ROTARY COMPRESSOR

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ABSTRACT OF THE DISCLOSURE

A rotary, sliding vane compressor having an annular channel in each end wall connected to the compressor suction and located at a radial position intermediate the fully retracted and fully extended position of the inside end of the vanes so that the chambers behind the vanes are cut off from the annular channel at a predetermined point in the inward travel of the vanes to form gas pockets behind the vanes. The gas pockets act as springs to keep the vanes in contact with the cylinder wall during their outward acceleration. Small pressure relief chambers are located in the end walls and register with the chambers behind the vanes as the vanes approach their fully retracted position to limit the maximum pressure developed behind the vanes.

Background of the invention

This invention relates to sliding vane rotary compressors and particularly to means for maintaining contact between the vanes and the cylinder walls.

It is important that the vanes of a rotary vane compressor be kept in steady contact with the inside wall of the housing during rotation so as to secure a gas seal between the vane tips and the housing and also to prevent vane "hopping" or vibration which causes rapid wear at the vanes and uneven wear on the housing wall in the form of "washboard" ripples.

Loss of vane contact tends to occur in the area of the suction ports where the housing shape requires rapid outward acceleration of the vane in order to maintain contact with the wall. The centrifugal force tending to throw the vanes outward may not be sufficient in this area to overcome the vane inertia causing the vane to lose the necessary sealing contact with the cylinder wall.

Some of the prior rotary vane compressors provide springs behind the vanes to obtain steady contact with the housing wall, but higher production costs and the possibility of spring breakage, especially in high speed compressors, are distinct disadvantages in these designs.

Other designs have utilized compressor discharge pressure behind the vanes instead of the springs. This causes extremely high loading of the vanes when passing over the suction inlet where there is no counter pressure acting on the vanes and the compressor discharge pressure tends to blow lubricating oil away from the vane area where it is needed.

A preliminary search 230, Subclass 152 and Class 103, Subclass 136 has uncovered the following specific prior patents in this area:

Patent No.: 2,743,090, G. L. Malan, (Vibrator); 3,099,387, F. H. Beckfield, (Vacuum and Air Pumps); 2,739,539, D. B. Gardiner, (Power Transmission); 3,169,696, M. Y. Warner, (Compressor Lubrication Means); 2,522,824, T. L. Hicks, (Rotary Compressor).

None of these patents show a gas spring behind the vane for storing energy and keeping the vane in contact with the cylinder wall.

Beckfield simply connects the back side of the vane to the next compartment. Gardiner applies a constant gas pressure to the back side of the vanes while Hicks and Warner do the same with oil under pressure.

Malan uses gas pockets to cushion the impact of vanes in a vibrator as they strike the cylinder wall at full extension. The rotor does not turn on an axis but rolls along the cylinder with the vanes being driven outward by compressed air and impact with the wall is minimized by the gas pocket. There is no energy storage to keep the vane in contact with the wall.

Summary

Accordingly, it is an object of this invention to reduce the wear on the vanes, rotor and housings of a sliding vane compressor by keeping the vanes in contact with the cylinder wall throughout the cycle.

It is a further object of this invention to provide a simple, inexpensive means for maintaining the vanes of a sliding vane compressor in contact with the cylinder wall.

It is a further object of this invention to provide means for applying a controlled pressure to the back side of the vanes as they pass over the suction port so as to maintain the contact between the vane and the cylinder wall.

It is a further object of this invention to provide a system for maintaining the vanes of a sliding vane compressor against the cylinder wall with a force which will vary as a function of the operating pressure of the compressor.

These objects are achieved by forming a small, closed variable volume gas chamber behind each vane as the vane moves inward so that the gas chamber acts as a spring to keep the vane in contact with the cylinder wall.

Drawings

FIGURE 1 is a vertical longitudinal sectional view of a compressor embodying this invention.

FIGURE 2 is a cross sectional view taken through section 1—1 of FIGURE 1.

Description

Referring to the figures, there is shown a compressor generally indicated by numeral **2**. A cylinder **4**, together with a bottom plate **6** and a top plate **8**, enclose a slotted rotor **10** which is suitably supported for rotation within the cylinder and which is driven by a drive shaft **12**. Housing **14** having an inlet **16** and an outlet **18** encloses the cylinder and rotor. A motor, not shown, is adopted to drive the drive shaft in a predetermined direction. Vanes **20** are freely slidable in a radial direction within slots **22** in the rotor. The slots are somewhat longer than the vanes so that there is always clearance between the vanes and the base of the slots. The end plates **6** and **8** have circular grooves **24** and **26** formed therein for communicating with all of the rotor slots while passages **28** and **30** communicate the circular groove with the suction compartment **32**. The inside edges of the grooves **24** and **26** are located at a radial position intermediate the fully retracted and fully extended position of the inner end of the vanes. A pair of arcuate grooves **34** and **36** are located in the top and bottom plates at an angular position between the discharge and suction ports **38** and **40** respectively, and are radially positioned so that their

outer edges are radially outward of the inside base of the slots in the rotor.

Operation

The operation of rotary sliding vane compressors is well known as shown by the prior art patents mentioned above and accordingly will only be briefly discussed herein.

As the rotor rotates in a clockwise direction as seen in FIGURE 2 suction gas which is drawn into the suction compartment **32** from the inlet **16** will be drawn into the suction **40** of the dual chamber compressor shown and will fill up the cells formed between the rotor, cylinder and adjacent vanes as they move past the suction ports. The maximum volume of the cell is attained as the trailing vane passes the end of the suction port thereby cutting off additional flow to the cell. From that time until the cell passes the discharge port, the volume of the cell is continuously decreased so as to compress the gas in the cell.

The following description should be read in conjunction with FIGURE 2 in which various positions of a vane as it rotates over 180° have been indicated to show how the gas cushion, or spring, effect behind the vane is created to maintain uninterrupted contact between the vane and the housing as the rotor turns. At position A the vane **20** is in the "out" or fully extended position and it touches the cylinder wall **46**. As the vane turns with the rotor between position A and position C, it will gradually be pushed into the slot by the housing wall **46**. A resisting force composed of centrifugal force and the inertia of the vane tends to keep the vane in the "out" position as it was at point A and is sufficient to keep the vane in contact with the wall **46**. Since all the chambers **48** at the base of the slots are connected by the circular grooves **24** and **26** during this portion of the cycle, the pressure in the chamber at position C will be equal to suction pressure as are the other slot chambers similarly open to the annular grooves **24** and **26**. At point C the inside edge of the vane is passing over the inner edges of the grooves **24** and **26** and is shutting off the communication between the grooves **24** and **26** and the gas chamber formed behind the vane. Further movement of the rotor from C to D drives the vane deeper into the gas chamber compressing the gas trapped behind the vane. At position D the chamber begins to communicate with the closed arcuate chamber **36** so as to prevent excessive pressure from building up as the vane is driven further into the slot. As the vane moves from position D to position E, which is the fully retracted position, the pressure behind the vane increases only slightly due to the larger effective volume of the closed chamber.

As the vane and rotor move from position A to position D the gas pressure in the cell just forward of the vane is gradually increasing until a maximum value is reached at the discharge port **38**. This pressure tends to push back the vane and lift it from the wall **46** to create a gas bypass which reduces efficient performance of the compressor. However, the pressure in the gas chamber acting on the back side of the vane will force the vane against the wall so as to maintain the seal between the wall and the vane.

As the rotor turns through positions B and F centrifugal force alone may not be sufficient to overcome the inertia of the vane and friction in the slot so as to maintain contact between the rotor and the cylinder wall and there is a tendency for the vane to loose contact with the wall between position E and F. However, due to the pressure of the gas in the chamber, the vane will be driven out fast enough so that contact between the vane and the cylinder will not be lost between positions E and F. As the vane passes point F the chamber **48** will again be connected to the ring grooves **24** and **26** to equalize the pressure behind the vane with that of suction side of the compressor. At the same time when passing point F the vane has about gained its maximum outgoing speed. The retarding effect of the inertia of the vane becomes zero, and then reverses, so that the centrifugal force alone is now great enough to keep the vane in contact with the wall **46**.

At G the cycle is completed.

What is claimed is:

1. An improvement in rotary sliding vane compressors of the type having a cylindrical chamber, end members closing the cylindrical chamber, a rotor mounted for rotation in the chamber, the rotor having a plurality of inwardly extending longitudinal vane slots formed therein, and inlet port in the cylinder at one angular position for drawing gas in to the chamber, an outlet port in the cylinder augularly spaced from the inlet port for discharging compressed gas from the chamber, and vanes slidable in the slots thereby defining compression chambers between successive vanes, the cylinder and the rotor, each vane also defining a chamber of variable size at the inner end of each slot; the improvement comprising an annular groove in at least one end member in communication with the compressor inlet and having its inner side located at a radial position between the fully retracted and fully extended position of the inside ends of the vanes whereby the chambers defined behind the vane will be closed to form gas pockets as the vanes are pushed inward, the gas compressed in the chamber acting as a spring to maintain contact between the vanes and the cylinder wall.

2. The improvement defined in claim **1** including annular grooves in both end members.

3. The improvement defined in claim **1** including a recess in at least one end member angularly positioned between the outlet port and the inlet port and radially positioned with its outer side between the inner side of the annular groove and the inner ends of the slots so that the variable size chamber behind each vane will communicate with the recess as the slot and vane move between the outlet and the inlet ports thereby limiting the pressure build-up in the chamber behind each vane as the vane reaches its fully retracted position.

4. The improvement as defined in claim **3** including an annular groove and a recess in each end member.

5. A rotary sliding vane compressor comprising:

(a) a housing including;
  (1) a pair of parallel end closure members;
  (2) an annular stator member mounted intermediate the end closure members;
(b) a rotor member rotatably mounted within the stator member, the rotor having a plurality of radially evenly spaced longitudinal vane slots therein;
(c) vanes slidable in the rotor vane slots and forming variable volume chambers at the base of each vane slot;
(d) angularly spaced inlet and outlet ports in the housing; and
(e) an annular groove in at least one end closure member having its inner side at a radial location intermediate the fully retracted and fully extended positions of the inside ends of the vanes.

6. The compressor as defined in claim **5** including a recess in at least one end closure member located so that the variable volume chamber at the base of each slot will be opened to the recess as the vanes approach their fully retracted positions.

7. The compressor as defined in claim **5** including a recess in at least one end closure member radially located with its outer edge between the inside surface of the annular groove and the bases of the slots and angularly located so that the chamber at the base of each slot will be opened to the recess as the vanes approach their fully retracted position.

8. The compressor as defined in claim **5** wherein the annular groove is in communication with the compressor inlet port.

9. The compressor as defined in claim **6** including a re-

cess and an annular groove in each end closure member to provide a balancing effect on the rotor and vanes.

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