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(54) Rotary sliding-vane air compressor

(57) 1. A rotary sliding-vane compressor comprising:

- a longitudinally extended cylindrical stator (3) having an internal cylindrical surface defining a compression chamber (7); a longitudinally extended cylindrical rotor (9) eccentrically inserted in said stator (3), said rotor (9) having a series of radial grooves (11) which extend longitudinally to the rotor (9); and a series of longitudinally extended radial vanes (13), each vane (13) having an apex and a base of the vane (13) and being radially slidable in one corresponding groove (11) of the rotor (9) between a radially retracted position and a radially extended position; at the radially extended position each vane (13) coming into contact with the internal cylindrical surface of the stator (3) along a longitudinal contact generatrix (23) separating two compression zones (19m, 19v) of said compression chamber (7) with different pressure, the compression zone (19m) with lower pressure being in fluid communication with a space (27) between the base (25) of the vane (13) and the groove (11) wherein the vane (13) slides; characterised in that the apex of each vane (13) provides a nose (30) projecting into the compression zone with higher pressure (19v).

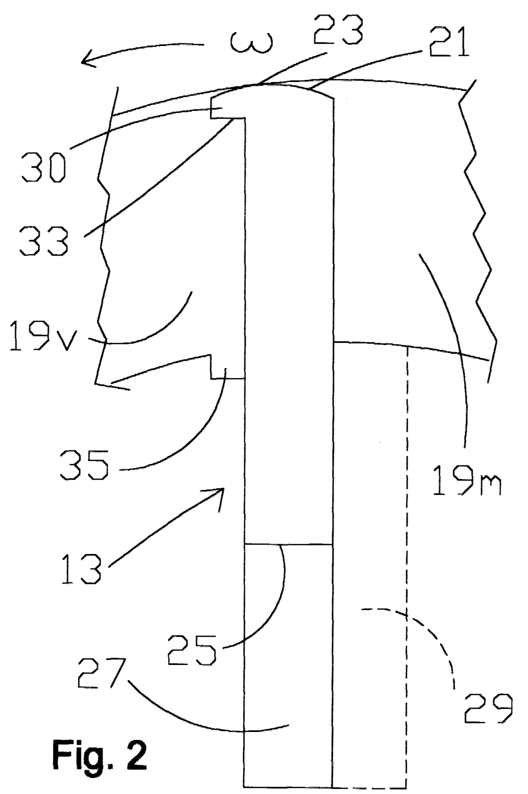

Fig. 2

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Description

[0001] The present invention relates to a rotary sliding-vane air compressor, of the type comprising an eccentric rotor in whose radial grooves vanes slide between a retracted position and an extended position wherein the vanes are in contact with the internal cylindrical surface of the stator which contains the rotor, and in particular relates to a new and different configuration of the vanes and of the rotor of the compressor.

[0002] As known, the efficiency of rotary sliding-vane air compressors currently available commercially, understood as the ratio between the power absorbed overall by the compressor and the capacity supplied at working pressure, is influenced by the speed of rotation, working pressures and absolute dimensions of the aforementioned mechanical parts of the compressor.

[0003] We shall consider, for the sake of simplicity, in the more extensive discussion on the dynamics of the vanes, radial equilibrium alone and, among the various forces acting, only centrifugal force and those caused by the pressures inside the compressor: in relation to the dimensions and working pressures, for a low rotation speed, and below around 1000 rpm, the centrifugal force whereto the vanes are subjected is not sufficient for completely overcoming the pressure differential at the opposite ends of the vanes and can generate instability of the vanes, which in turn causes an increase in internal leaks, i.e. losses of air from space to space and increase in absorbed power due to re-compression, and at times the noise of the compressor, whereas for a higher rotation speed at a typical value of each configuration (dimensional and working parameters), the increase in the centrifugal force to which the vanes are subjected causes an increase in the power absorbed due to the losses through friction between the vanes and the internal cylindrical surface of the stator.

[0004] The object of the present invention is that of providing a rotary sliding-vane air compressor which is efficient in a wider speed range.

[0005] Another object of the present invention is that of providing a rotary sliding-vane air compressor which eliminates or limits to a minimum the phenomena of instability which occur at lower working speeds, in such a way as to improve the efficiency of the compressor particularly for the low working speeds of the same.

[0006] These objects are achieved by a rotary sliding-vane air compressor comprising:

- a longitudinally extended cylindrical stator defining internally a compression chamber and having a section for aspiration of the air to be compressed and a section for the delivery of the compressed air;
- a longitudinally extended cylindrical rotor, eccentrically inserted in the cylindrical stator and provided with a series of radial grooves which extend longitudinally to the rotor; and
- a series of longitudinally extended radial vanes, wherein: each vane slides radially in a corresponding groove of the rotor between a radially retracted position and a radially extended position; during rotation of the rotor described, the vane maintains contact with the internal cylindrical surface of the stator along a longitudinal generatrix which separates two zones of the pressure chamber with different pressure, the compression zone with lower pressure being in fluid communication with the space between the base of the vane and the groove wherein the vane slides;

characterised in that the apex part of each vane, having a rounded part of appropriate radius, provides a section with greater thickness compared to the remaining part and projects into the compression zone with higher pressure.

[0007] The pressure differential acting at the radial ends of the vane in both the compression zones defined above by the contact generatrix and which it separates in the radially extended position can thus be easily controlled by the design of the shape of the vane.

[0008] The centripetal force which this pressure differential generates and which opposes the centrifugal force, possibly causing the working limitations described previously, can be rendered negligible, and it is therefore possible to eliminate the possible instability of a compressor which operates at low speed. In the absence of a pressure differential at the radial ends of the vane, which would cause overall centripetal stress on the vane, the centrifugal force which pushes the rotating vane remains the only appreciable force on the vane and its value, proportional to the rotation speed of the compressor, is also sufficient at a low speed of rotation of the compressor for preventing detachment of the vane from the internal surface of the stator.

[0009] Moreover given that the centrifugal force also depends on the dimensions of the compressor (the greater, as the latter increase), by means of the present invention it is possible to use a more compact compressor at a low speed of rotation of the compressor without creating instability and therefore deterioration of efficiency.

[0010] Given that the vane of the present invention can control the pressure differential existing at its radial ends, the instability of the compressor can be prevented irrespective of the value of the working pressure.

[0011] In particular the instability of the compressor can be avoided for a high working pressure even if the rotation speed of the compressor is low.

[0012] Thanks to the configuration of the radial vanes of the present invention the optimal speed range for a given configuration can then be advantageously extended for a relatively low rotation speed, approximately within a range between 500 rpm and 2000 rpm.

[0013] These and other aspects will be made clearer by the following description of a preferred embodiment of the present invention, to be read by way of a nonlimiting example of the more general concept claimed.

[0014] The present description refers to the accompanying drawings, wherein:

Fig. 1 is a front view of a cross section of a rotary sliding-vane air compressor;

Fig. 2 is a front view, enlarged in detail, of a vane, and of the rotor and stator zone relating thereto.

[0015] In Fig. 1 the air compressor according to the present invention comprises a longitudinally extended external cylindrical body 1, inside whereof there is a second cylindrical body 3 which defines with the first a chamber 5, said chamber being that of the lubrication oil in that it is normally half-filled with a suitable quantity of oil for lubrication and cooling of the compressor.

[0016] The internal cylindrical body 3, said body of the stator, defines in turn a compression chamber 7 inside whereof a rotor 9, in an eccentric position, rotates at an angular speed ω.

[0017] The rotor 9 has longitudinal radial grooves 11, each of which guides the radial sliding of a corresponding vane 13 which, due to the centrifugal force acting thereon, is pushed from a retracted position to an extended position, maintaining contact with the internal cylindrical surface of the stator 3. The chamber of the lubrication oil and the stator chamber are closed at the front and back by covers which support, during rotation, the shaft of the rotor, in turn connected to the shaft of a drive motor.

[0018] The air to be compressed is fed into the compression chamber 7 through an inlet conduit 15, while the compressed air is delivered from the compression chamber 7 to the next stage of separation of the oil through a manifold 17.

[0019] Referring now to Figures 1 and 2, each vane, in its radially extended position, has an apex surface curved like an arc 21, in contact with the internal cylindrical surface of the stator 3 along a longitudinal contact generatrix 23 which separates a compression zone 19m which, with reference to the direction of rotation of the rotor 9, is placed upstream of the contact generatrix 23, from a compression zone 19v downstream of the contact generatrix 23.

[0020] As shown in Figure 2, the groove 11 for sliding of the vane 13 and the base 25 of the vane 13 define a space 27 which is in fluid communication with the compression zone 19m through a passage 29 which can be obtained from a radial conduit along the wall of the rotor 9 which defines the radial side of the groove 11 for sliding of the vane 13, turned towards the compression zone 19m.

[0021] Since the internal pressure of a compression zone 19 increases in the angular positions subsequently reached, by following the direction of rotation of the rotor 9, the compression zone 19v will have a higher pressure than the compression zone 19m.

[0022] The apex part of the vane 13 describes a nose 30 which projects towards the interior of the compression zone 19v.

[0023] The nose 30 has a radially internal contour surface 33 whereon the pressure inside the compression zone 19v acts, which in turn contrasts the pressure acting on the portion of the apex surface 21 of the vane 13 placed downstream of the contact generatrix 23 between the vane 13 and the internal cylindrical surface of the stator 3.

[0024] The top of the radial wall of the groove 11 for sliding of the vane 13 adjacent to the compression zone 19v has finally an outlet 35 wherein the nose 30 fits in the retracted position of the vane 13.

[0025] The compressor can have standard empty/loaded regulation, regulation with two speeds, modulated regulation or finally regulation with the use of a variable speed motor.

[0026] The shape of the vane, and therefore the thickness of the vane, the radius of curvature of the apex of the vane and the shape and dimensions of the nose of the vane, which prevents instability of the compressor, can be optimised according to a working speed of the compressor.

[0027] In the case of a compressor with two-speed regulation or with regulation by a variable speed motor, a compromise decision must therefore be made on the shape of the vane.

[0028] The vane of the present invention is therefore suitable for being used preferably for a compressor which functions with a predefined rotation speed, such as a modulated regulation compressor, wherein by regulating the influx the air feed vane is choked to reduce the air delivery, or a standard regulation compressor, wherein the compressor rotates idly for a predefined period of time when it has to deal with air demand changes.

[0029] The vane of the present invention could naturally be used for a sliding-vane compressor having any working gaseous fluid different from air.

Claims

1. A rotary sliding-vane compressor comprising:

- a longitudinally extended cylindrical stator (3) having an internal cylindrical surface defining a compression chamber (7);
- a longitudinally extended cylindrical rotor (9) eccentrically inserted in said stator (3), said rotor (9) having a series of radial grooves (11) which extend longitudinally to the rotor (9); and
- a series of longitudinally extended radial vanes (13), each vane (13) having an apex and a base of the vane (13) and being radially slidable in one corresponding groove (11) of the rotor (9) between a radially retracted position and a radially extended position; at the radially extend-

ed position each vane (13) coming into contact with the internal cylindrical surface of the stator (3) along a longitudinal contact generatrix (23) separating two compression zones (19m, 19v) of said compression chamber (7) with different pressure, the compression zone (19m) with lower pressure being in fluid communication with a space (27) between the base (25) of the vane (13) and the groove (11) wherein the vane (13) slides;

characterised in that the apex of each vane (13) provides a nose (30) projecting into the compression zone with higher pressure (19v).

2. A compressor according to claim 1, **characterised in that** the differential pression acting on the vane (13) in said higher pressure compression zone (19v) is controlled by the shape design of said nose (30).

3. A compressor according to any one of the previous claims, **characterised in that** the top of the radial wall of the groove (11) for sliding of the vane (13) adjacent to the compression zone with higher pressure has an outlet (35) wherein the nose (30) of the vane (13) can be fitted in the retracted position of the vane (13).

4. An air compressor according to any one of the previous claims, **characterised in that** it is of the type with modulated regulation or standard loaded/empty regulation.

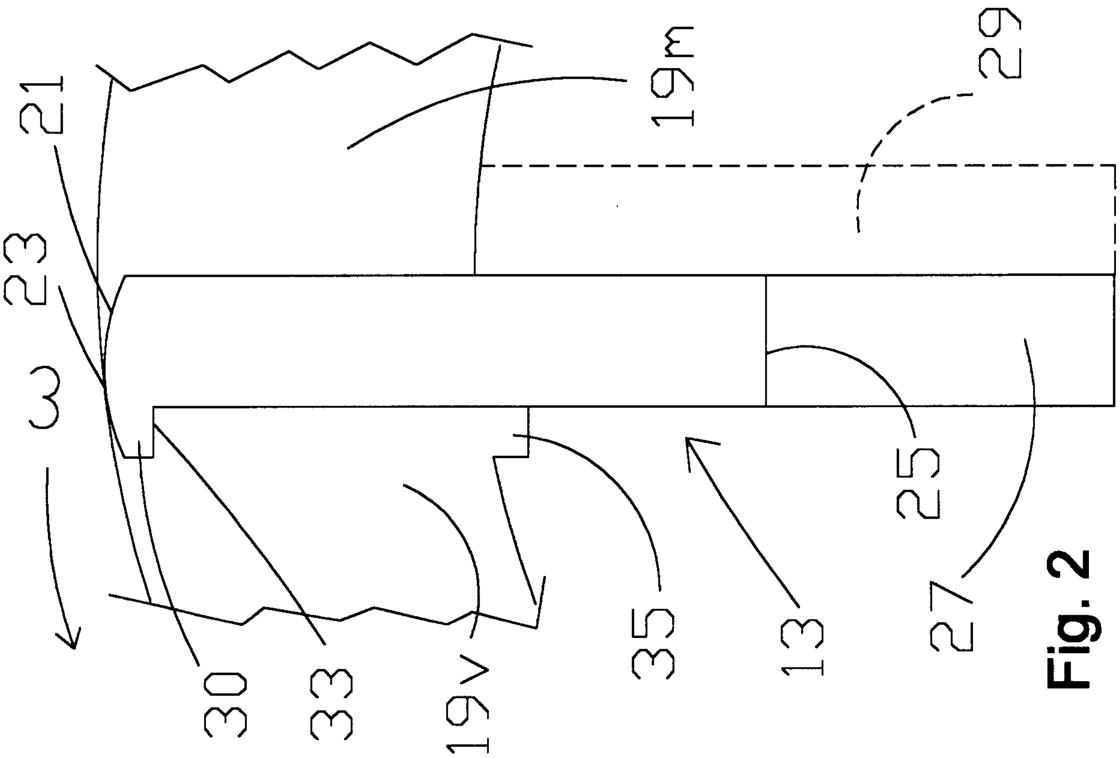

Fig. 2

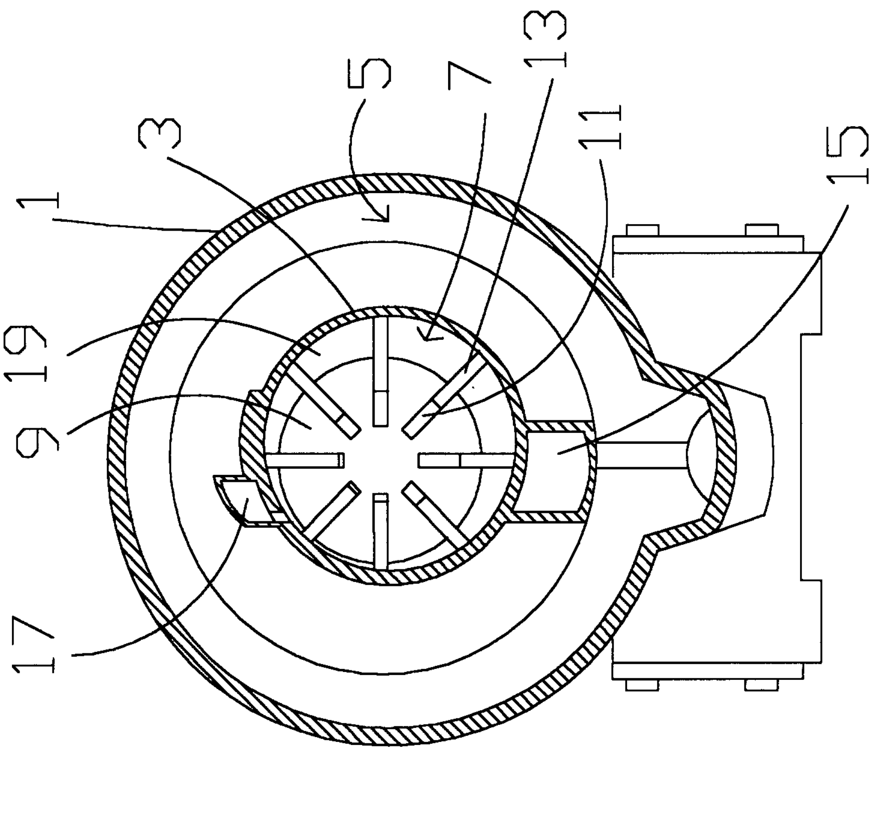

Fig. 1