

April 25, 1933.

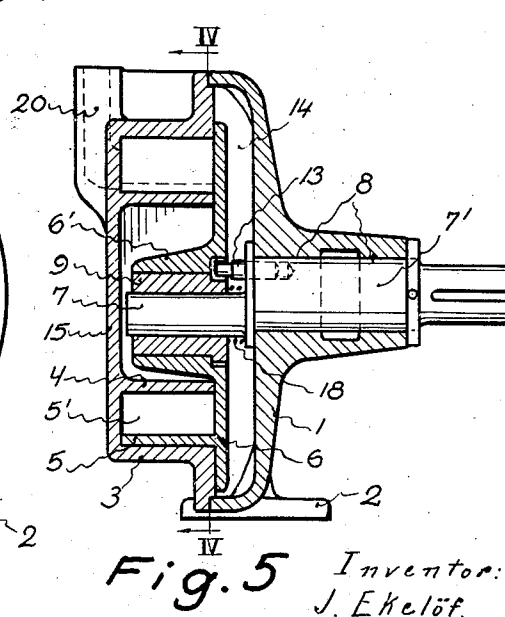
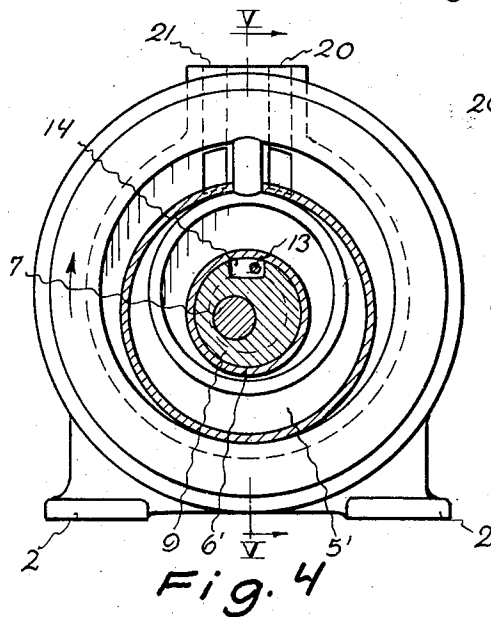
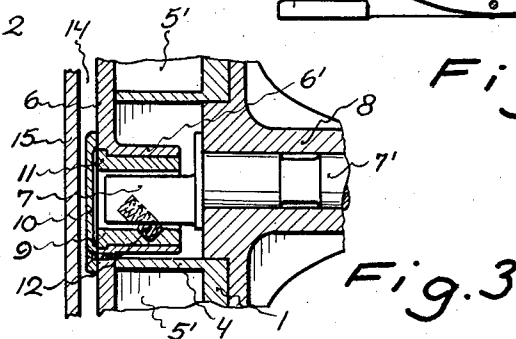
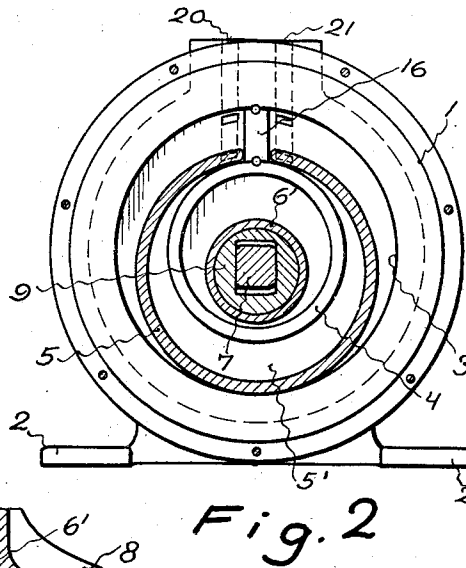
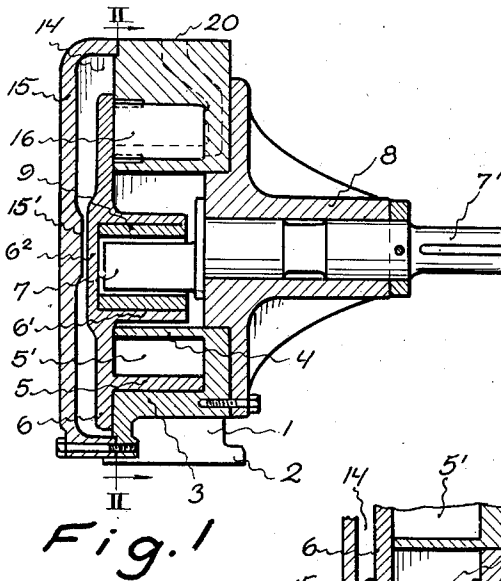
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1,906,142

ROTARY PUMP OR COMPRESSOR

Filed Dec. 5, 1931

2 Sheets-Sheet 1



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ROTARY PUMP OR COMPRESSOR

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2 Sheets-Sheet 2

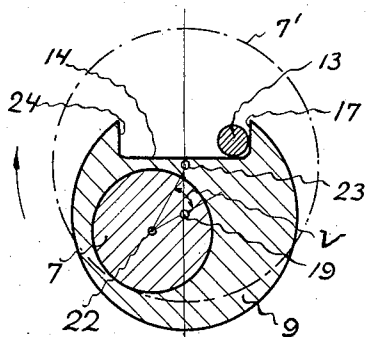


Fig. 6

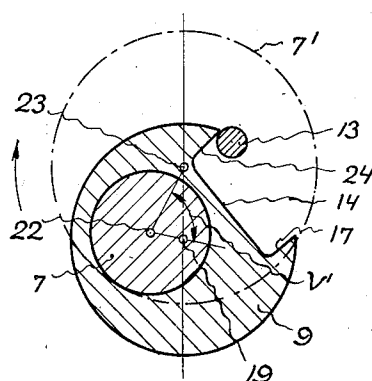


Fig. 7

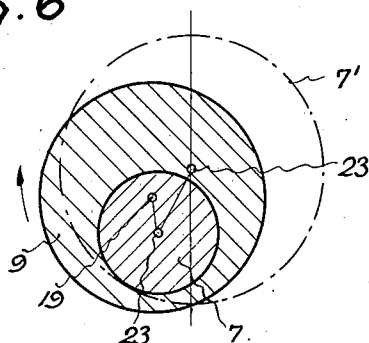


Fig. 8

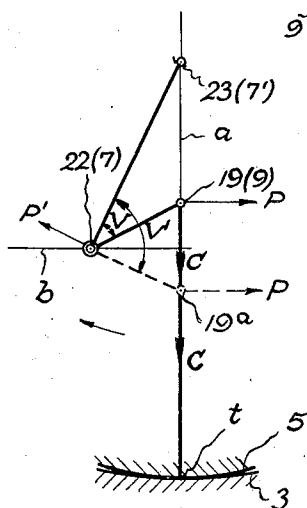


Fig. 9

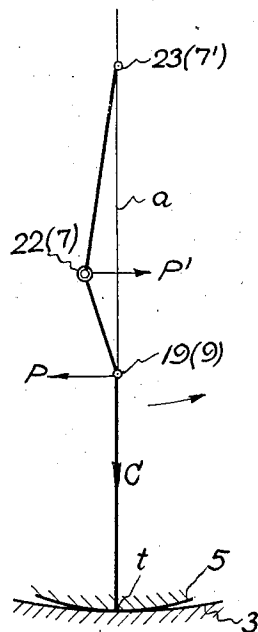


Fig. 10

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UNITED STATES PATENT OFFICE

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ROTARY PUMP OR COMPRESSOR

Application filed December 5, 1931, Serial No. 579,245, and in Sweden April 2, 1930.

This invention refers to improvements in rotary pumps or compressors of the type provided with an annular and eccentrically movable piston adapted to act within an annular cylinder provided with a radial transverse wall, one end wall of said cylinder being fixedly mounted, the other consisting of a cover disc connected with the aforesaid annular piston. The said cover disc is slidingly mounted in contact with the end faces of the cylinder walls, and it is automatically kept in a tightening contact with said faces, while the piston is also automatically kept in a tightening contact with the cylindrical faces of the annular cylinder and with the fixed end wall of the same, so that crescent-shaped working chambers are formed due to the eccentrical position of the piston within the cylinder.

In machines of this kind, the annular piston is guided in such a manner that the same will get a radial reciprocating movement at the radial transverse wall, such movement, together with the eccentric movement of the piston, being combined into a circumferentially variable sliding and rolling motion against the cylinder walls, the sliding movement being smallest (or none) at the transverse wall and greatest at a point diametrically opposite thereto.

In machines of the type referred to, it is previously known to provide for the tightening contact in axial direction between the cover disc combined with the piston and the free end faces of the cylinder walls by means of a fluid pressure created at the outer side of the cover disc and either emanating from the pressure of the working fluid within the machine, or from the atmospheric pressure, when the machine is run as a vacuum pump. According to the invention these principles for obtaining the said tightening are also adhered to.

In previously known machines of this type, different mechanical means have been adhered to in order to provide for the tightening contact in radial direction between the annular piston and the cylindrical wall faces of the annular cylinder, such mechanical means being adapted from the rotating driv-

ing shaft of the machine to convert a portion of the driving torque into a component of force acting upon the piston in radial direction and pressing the same mechanically towards the cylinder walls in said direction. These tightening principles are not employed according to the invention.

In machines of the type in question there appears a circumstance which hitherto has been left entirely without consideration, viz. the centrifugal force, and this force is increased in proportion to the speed of rotation of the machine. As the working capacity of the machine, or the output of the same per unit of time, is also directly proportional to the speed of rotation, it follows that machines having the same working capacity may be built considerably smaller in case they are given an increased speed of rotation in proportion to the reduction in size. Naturally both technical and economical advantages are involved herein, especially as the machines are often driven by means of electric motors, and the relatively small electric motors ordinarily used for the purpose are built for considerable speeds, from reasons well known but independent of the present invention. Therefore it is desirable that the pumps or compressors according to the invention can be built for the same speeds, so that they may be directly coupled to the motors without the use of intermediate transmission means.

With regard to the known machines, this is an impossibility, however, and this fact is primarily dependent on the circumstance that a radial component of force of the driving torque has hitherto been utilized for obtaining the tightening contact of the piston within the cylinder in radial direction, as hinted at above. The said component of force will add to the centrifugal force, which at the high speed of rotation in question assumes considerable values, and the result is that the machine will run hot and cannot be used for such high speeds.

Furthermore, the said inconveniences are increased due to the fact that the radial contact faces of the piston and cylinder, which originally are cylindrical in shape, will be

deformed due to the irregular sliding movement hinted at above, and they will be worn oval so that the centre of the piston, which initially moves in a circular path, will deviate from such path of movement when the machine has been in use for some time. Hereby the piston is also displaced a little in axial direction due to the wear.

Hence, it will be evident, and by practical tests it has also been confirmed, that the connection between the piston and the driving shaft for the same, which shaft is mounted in a machine body supporting the cylinder, must be of such a kind that the piston is free to move and to adapt itself for a reliable tightening both in axial and radial direction, and besides it must be permitted to perform the movements of deviation from the original path due to the wear, as otherwise the tightening contact between the working faces needed for the function of the machine cannot be maintained, or else the contact pressure would be so great that it results in a non-permissible wear and hot running of the machine. In both cases the efficiency of the machine is very much reduced.

In order to eliminate the inconveniences referred to above, the invention is based on the employment of a combination of certain arrangements consisting therein,

(1) that the piston structure, within certain limits, is freely movable in axial direction and kept in contact with the end faces of the cylinder by means of a fluid pressure acting on the outer side of the cover disc, such pressure being greater than the pressure at hand within the cylinder, and

(2) that the piston is freely mounted in radial direction on its driving and supporting member connected with the driving shaft, in such a manner that the same is kept in tightening contact with the cylinder walls in radial direction due to the centrifugal force only. In connection herewith, and especially in machines adapted to be driven at very great speeds, it may be important, in order to prevent the machine from running hot, to mount the piston in such a manner that the influence of the centrifugal force on the contact pressure between the contacting surfaces is relieved in a certain degree. A means for converting a portion of the driving torque emanating from the driving shaft into a component of force acting on the piston in radial direction is entirely superfluous according to the invention.

In the combination referred to above, the invention has also for its object to provide for the simplest possible connection means between the piston and the driving member for the same, this connection means being of such a kind that it will automatically compensate for the deviation from the original circular path of movement required due to the wear. The said connection means is constructed in such a manner that the piston is

freely displaceable in axial direction and mounted on a crank member connected with the driving shaft, on which crank member the piston is also freely displaceable in, or approximately in, a plane through the centre line of the piston and the driving shaft and through one of the lines of contact between the piston and the cylinder walls.

In a connection means between the piston and the driving shaft of the kind referred to, the invention has finally also for its object to provide a stopping means which prevents the piston from taking a position deleterious to the efficiency of the machine while simultaneously permitting the movability and the automatic adjustment of the same within certain limits.

A number of embodiments showing the practical applicability of the invention are to be described in the following by reference to the accompanying drawings, in which

Fig. 1 shows an embodiment of the machine seen in longitudinal section.

Fig. 2 shows the machine in cross section at the line II—II in Fig. 1, and

Fig. 3, in the same manner as Fig. 1, shows a partial section of a modification of the connection means between the piston and the driving shaft.

Fig. 4 shows another embodiment of the machine seen in cross section at the line IV—IV in Fig. 5, and

Fig. 5 is a longitudinal section at the line V—V in Fig. 4.

Fig. 6 is a diagram intending to disclose the relative position of the constructional elements forming the connection means, when the machine is new and has not been subject to wear, and

Fig. 7 is a similar diagram disclosing the relative position of the elements after considerable wear.

Fig. 8 is included for the sake of comparison, and this figure is a diagram disclosing the constructional elements in an unfavourable position which would be taken in case no stopping means had been at hand.

Figs. 9 and 10 are also diagrams intended under different conditions to show the distribution of the forces acting on the crank member, the piston member and the connection means for obtaining the tightening contact between the piston and the cylinder walls.

Referring to Figs. 1 and 2, 1 is the machine body which is supported by the base plate 2 and provided with two coaxial cylinder walls 3 and 4 forming the annular cylinder chamber 5' within which the annular piston member 5 is adapted to move. As stated above, the annular piston is eccentrically movable within the cylinder 5', and it contacts at its outer face with the cylinder wall 3, the inner face contacting with the

cylinder wall 4, so that the aforesaid crescent-shaped working chambers are formed within the cylinder. The piston member is connected with a cover disc 6 positioned in tightening contact with the free end faces of the cylinder walls 3, 4, so that the cylinder is closed at its one end by means of said disc. At its opposite end the cylinder 5' is confined by means of a fixed wall which may be carried out in one piece with the cylinder walls 3 and 4.

The piston member 5 is set into movement by means of a crank pin 7 on the driving shaft 7' which is mounted and guided in axial direction in a cover member 8. The crank pin 7 is rectangular in cross section, and an exteriorly cylindrical boss 9 is mounted on said pin so as to be permitted to move a little in radial direction thereon by means of a corresponding aperture surrounding the pin with a little clearance at two opposite sides. A hub member 6' is rotatably mounted on the boss 9 and connected with the cover disc 6 and thereby also with the piston member 5 connected with the latter. Hence, at the rotation of the shaft 7' the crank pin 7 by means of the boss 9 and the hub member 6' will transmit an eccentric movement to the cover disc 6 and thereby also to the piston 5.

Since the boss 9 is radially displaceable on the crank pin 7, the piston member 5 will automatically go in contact with the cylinder walls, even if said elements have got an oval shape due to wear, and this contact will permanently be maintained. The said contact is due to the centrifugal force only created at the running of the machine.

Initially the boss 9 is preferably adjusted in such a manner on the crank pin 7 that the piston member 5 is kept weakly in touch with the cylinder walls.

The axial contact and tightening of the piston member 5 against the end walls of the cylinder are established in a manner known per se by overflow of the working fluid, or by atmospheric pressure when the machine is run as a vacuum pump, to the chamber 14 at hand at the outer side of the cover disc 6, so that a suitable pressure arises within the said chamber. The chamber 14 is closed by means of a fixed cover 15, and this cover at its centre portion being preferably provided with a projection 15' positioned, in new machines, very lightly in touch with a corresponding raised centre portion 6² of the cover disc 6. The piston 5 and the cover disc 6 connected therewith are prevented from rotation and guided in a suitable manner known per se by means of a radially extending transverse wall 16 within the cylinder 5'.

According to the modification shown in Fig. 3, the piston member in a manner known per se is acted upon by a spring 12

mounted in an inclined position between the pin 7 and the boss 9 which is provided with a flange 11 abutting, due to the spring pressure, against the hub member 6'. At its outer side the boss is enclosed by means of a cover 10.

The power of the spring 12 is adjusted to a suitable value, and it acts upon the piston member in such a manner that the piston is initially slightly pressed into contact with the cylinder walls both in axial and radial direction. The spring might also be positioned in such a manner (parallel to the axis of rotation) that it will act in axial direction only, or in a position (perpendicular to the axis of rotation) causing its action in radial direction only. It is also possible to employ more springs, one or more of which acting in radial direction, the rest acting in axial direction. The said spring, or springs, are adapted to maintain the tightening contact when the machine is at rest, or when starting the same, only, and if such spring, or springs, are at hand, the part 15' on the cover 15 becomes superfluous.

At opposite sides of the radial transverse wall 16, the cylinder 5' is provided with inlet and outlet means 20, 21 for the working fluid, in a manner known per se.

In the embodiment illustrated in Figs. 4 and 5, the same references as above are used for similar or corresponding parts of construction, and a further description of the machine in respect of said constructional parts seems superfluous. It is to be noted, however, that the machine according to this embodiment is supposed to be reversed in that the driving shaft is inserted from the opposite end thereof, but this constructional modification ought to be understandable without further explanation, and it does not in the slightest involve any difference in respect of the function of the machine.

In comparison with the embodiments shown in Figs. 1-3, the main difference is to be found in that the crank pin 7 is cylindrical, and that the boss 9 is eccentrically rotatable thereon. It is evident that in case the boss 9 is rotated on the pin 7, the centre of the boss, while performing a swinging motion around the centre of said pin, will be displaced radially in relation to the axis of the machine, just as if the whole boss had been radially displaceable on the pin (as according to Figs. 1 and 2), and naturally it is the position of the boss centre, which is determining for the position of the piston member 5 within the cylinder 5'.

Hence, it is possible also in this case to keep the piston automatically into contact with the cylinder walls independently of an oval wear, in the same manner as described above.

In this instance, the initial contact of the cover disc 6 is supposed to be obtained by

means of a spring 18 mounted on the pin 7 and abutting against the boss 9 which is both axially displaceably and eccentrically rotatably mounted on the said pin. When the machine is running, the contact pressure of the cover disc is also controlled by the working fluid due to the difference of pressure at hand on the opposite sides of said disc.

It is evident, that if the boss 9 was fully freely rotatable on the pin 7, and if an attempt was made to rotate the driving shaft 7' in a direction opposite to the normal direction of rotation (indicated by an arrow in Fig. 4) of the machine when running, the boss would turn around its pin in such a manner that the piston member would be jammed by wedge-action within the cylinder due to the leverage arising from the eccentric bearing conditions, and thereby the machine would be damaged. Naturally a fatality of this kind must not occur.

For the limitation of the rotational movement of the boss 9 around the pin 7, the machine is provided with a stopping means which for instance may consist of a pin 13 affixed to the driving shaft 7', or a suitable part of construction rigidly connected therewith, this pin being mounted so as to extend into a recess 14 suitably positioned in the boss 9. The said recess is arranged in such a manner that, when one edge 17 of the same abuts against the pin 13 (Fig. 6), the centre 19 of the boss 9 is in a position beyond the centre 22 of the pin 7 counted in the normal direction of rotation, as indicated by arrows in the drawings. Thereby a certain angle V will be formed between the lines drawn from the apex of the angle positioned in the centre 22 of the pin 7 to the two centres 19 and 23 of the boss and the driving shaft, respectively. When the centre 19 takes this position, the piston 5 will lag behind the pin 7 in the rotation, instead of being pushed forward in advance of the same in the manner indicated in Fig. 8. In case the centre 19 would be permitted to take a position in advance of the centre 22, counted in the normal direction of rotation, this position being possible in case the relative rotating movement being unlimited, the piston 5 would get a very great contact pressure against the cylinder walls caused by the pin 7, and hereby the efficiency of the machine would be considerably reduced on account of the increased frictional resistance, as hinted at in the foregoing.

The opposite edge 24 of the recess 14 is adapted, after a very advanced amount of wear, to abut against the pin 13 so as to prevent any further outward tilt of the piston 5 around the pin 7. When the wear has advanced so far (compare Fig. 7), the machine is to be provided with a new piston member having a larger wall thickness only, and then it will be in full working order again.

The coacting members, the pin 13 and the edge 24, will also serve the purpose of preventing a jamming of the piston member in the cylinder, as hinted at above, in case the machine should unintentionally, or otherwise, be rotated in a direction opposite to the normal one.

The manner of action of the boss 9, and the conditions in respect of the position of the same are to be understood by the diagrams in Figs. 9 and 10.

In Fig. 9 the centre of the driving shaft 7' is shown by the little circle 23, and the centre 22 of the pin 7 is rigidly connected with the former as indicated with the full line between the said centres. The boss 9 is rotatably mounted on the centre 22, which is indicated with the circle surrounding said centre, and connected with the centre 19 of the boss by means of a full line.

At the rotation of the driving shaft in the direction indicated by the arrow, the pin 7 and the centre 22 of the same rigidly connected with said shaft will be caused to move in a circular path, and thereby the piston 5 mounted on the boss 9 when acted upon by the centrifugal force will get a tendency to be thrown radially outwards, such movement being, however, limited by the cylinder walls 3, 4 which thus will take up the contact pressure emanating from the centrifugal force, the amount of such pressure determining the tightening contact between the piston member and the cylinder walls. The direction of the centrifugal force is indicated by an arrow C extending from the centre 19. The piston 5 and the boss 9 are also subjected to a force caused by the reaction pressure of the working fluid, the direction of this force being indicated by the arrow P extending from the centre 19. The said force P tends to tilt the centre 19 around the centre 22, i. e. the force P creates a component of force acting upon the centre 19 in the same direction as the force C thus adding itself to the latter, and thereby a greater contact pressure between the piston member and the cylinder walls is established.

If the machine is working at a high pressure, the force P will become the greater, and thereby the contact pressure will also be increased. Hence, the arrangement described will cause the required contact pressure at different pressure conditions during the working to be automatically increased according to the increase of the working pressure within the machine. In order to obtain this, the common centre 19 of the piston 5 and the boss 9 must be located on a straight line α passing through the centre of rotation 23 of the machine and a point t at the line of contact between the piston 5 and the cylinder wall 3 or 4 (as shown in Fig. 9), and besides the said centre 19 must be

positioned at the same side as the centre 23 of a normal b extending from the aforesaid straight line a and passing through the centre 22 of the pin 7.

5 The same Fig. 9 indicates in dotted lines another position of the centre 19. In this position (having the reference 19^a) the reaction force P creates a component counter-acting the centrifugal force so that the contact pressure of the piston 5 against the cylinder walls 3, 4 is reduced, this being advantageous in case the contact pressure caused by the centrifugal force is greater than the amount of pressure required according to the interior differences of pressure arising due to the working of the machine. This might occur in large machines working with a small difference of pressure at the suction and pressure sides only. In such instances the centre 19 ought to be positioned on the said straight line a but at the opposite side of the normal b in relation to the centre of rotation 23.

When the centre 19 has swung a certain angle greater than the angle V' , the force P will entirely eliminate the centrifugal force, and then the contact pressure between the elements will be so very much reduced that leakage might occur between the piston 5 and the cylinder walls 3, 4, such leakage causing a reduction of the efficiency of the machine. In order to prevent this, the edge 24 is adapted to be stopped by the pin 13 after a maximal amount of wear of the piston (and the cylinder walls), so that the boss 9 cannot be rotated any further on the pin 7.

Fig. 10 shows the position of the centres 19 and 22 after a very much advanced wear of the piston 5 and the cylinder walls 3, 4, and such an amount of wear may be supposed to have been due to the absence of the abutment edges 17, 24 coacting with the pin 13. In case the machine would then be started in the direction indicated by the arrow, it will be apparent from the diagram and the direction of the forces shown therein (the centrifugal force C , the reaction of the working fluid pressure P and the driving power P') that a substantial pressure would occur in the direction of the force C , so that the elements of the machine would be jammed together and damaged.

Naturally, the scope of invention is not limited to the particulars of construction described above for the sake of explanation. On the contrary, the mechanical construction of the machine parts may be modified in a substantial degree without departing from the principles of the invention. The pin 13 might for instance be provided with abutment faces adapted to coact with lugs or the like provided on the boss 9 for the purpose of limiting the rotational movement of the latter on the crank pin 7.

What I claim and desire to secure by Letters Patent is:—

1. In a rotary pump, or compressor, an annular cylinder confined in radial direction by two coaxial cylinder walls and at its one end by a fixed wall, an annular piston mounted eccentrically movable within said cylinder in contact with its walls, a cover disc connected with the annular piston member and adapted slidably to contact with and to close the opposite cylinder end, a radial transverse wall mounted within the cylinder and straddled by a split portion of the piston therein, inlet and outlet means positioned at opposite sides of said transverse wall, a driving shaft rotatably mounted centrally in relation to the annular cylinder, a crank means connected with the said driving shaft, a boss-shaped eccentric rotatably mounted on said crank means, a hub portion connected with the cover disc and rotatably mounted on said eccentric means for mounting the cover disc and the parts of construction connected therewith to have sliding movement in axial direction in relation to the cylinder, two circumferentially interspaced abutment means positioned on the boss, one abutment member rigidly connected with the driving shaft and extending between the aforesaid abutment means, and means for confining a fluid pressure at the outer side of the cover disc.

2. In a rotary pump, or compressor, according to claim 1 the additional features that the common centre of the boss and the piston member is located on a straight line passing the rotational centre of the machine and one of the points of contact between the piston member and the cylinder walls, and that the said common centre is adjustable at opposite sides of a normal extending from the said straight line through the centre of the crank pin.

3. In a rotary pump or compressor, an annular cylinder confined in radial direction by two coaxial cylinder walls and at its one end by a fixed wall, an annular piston member mounted eccentrically movable within said cylinder in contact with its walls, a cover disc connected with the annular piston and adapted slidably to contact with and to close the opposite cylinder end, means for mounting the combined piston aggregate slidably in axial direction due to difference in pressure acting upon the opposite sides of the cover disc, a radial transverse wall mounted in the cylinder and straddled by a split portion of the piston, inlet and outlet means positioned at opposite sides of said transverse wall, a driving shaft rotatably mounted centrally in relation to the annular cylinder, a cylindrical crank pin connected with said shaft, a cylindrical boss rotatably mounted in an eccentric position on said crank pin, such boss and a hub portion of the cover disc rotatably mounted thereon being adapted within cer-

tain limits under influence of the centrifugal force only to be freely displaced in radial direction independently of the axial displacement of the same members, and means for limitation of the turning movement of the boss around the crank pin.

4. In a rotary pump or compressor, an annular cylinder confined in radial direction by two coaxial cylinder walls and at its one end by a fixed wall, an annular piston member mounted eccentrically movable within said cylinder in contact with its walls, a cover disc connected with the annular piston member and adapted slidably to contact with and to close the opposite cylinder end, a radial transverse wall mounted in the cylinder and straddled by a split portion of the piston, inlet and outlet means positioned at opposite sides of said transverse wall, a rotatable driving means positioned centrally in relation to the annular cylinder, a crank means connected with said driving means and means for mounting the combined piston aggregate fully floatingly in relation to said crank means, such mounting means providing for a free axial sliding movement of the said aggregate due to pressure differences at opposite sides of the cover disc, and for a free displacement of said aggregate also in radial direction under influence of the centrifugal force only and independently of the axial displacement, in a plane substantially through the common axis of the driving means and the piston and one of the lines of contact between the piston member and the cylinder walls.

5. In a rotary pump, or compressor, an annular cylinder confined in radial direction by two coaxial cylinder walls and at its one end by a fixed wall, an annular piston member mounted eccentrically movable within said cylinder in contact with its walls, a cover disc connected with the annular piston member and adapted slidably to contact with and to close the opposite cylinder end, a radial transverse wall mounted in the cylinder and straddled by a split portion of the piston, inlet and outlet means positioned at opposite sides of said transverse wall, a rotatable driving means positioned centrally in relation to the annular cylinder, a crank means connected with said driving means, a closed chamber means provided at the outside of the cover disc, means for mounting the combined piston aggregate freely slidably in axial direction in relation to the cylinder end so as thereby to provide for leakage of pressure from the interior of the cylinder to the chamber means at the outside of the cover disc in order to establish a tightening pressure therein and means for mounting the piston aggregate freely slidably also in radial direction, independently of the radial sliding movement, in relation to the crank means substantially

in a plane through the common axis of the driving means and the piston member and one of the lines of contact between said piston member and the cylinder walls, in order to provide for a free action of the centrifugal force in said plane.

In testimony whereof I have signed my name to this specification.

JOHN EKELÖF.

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