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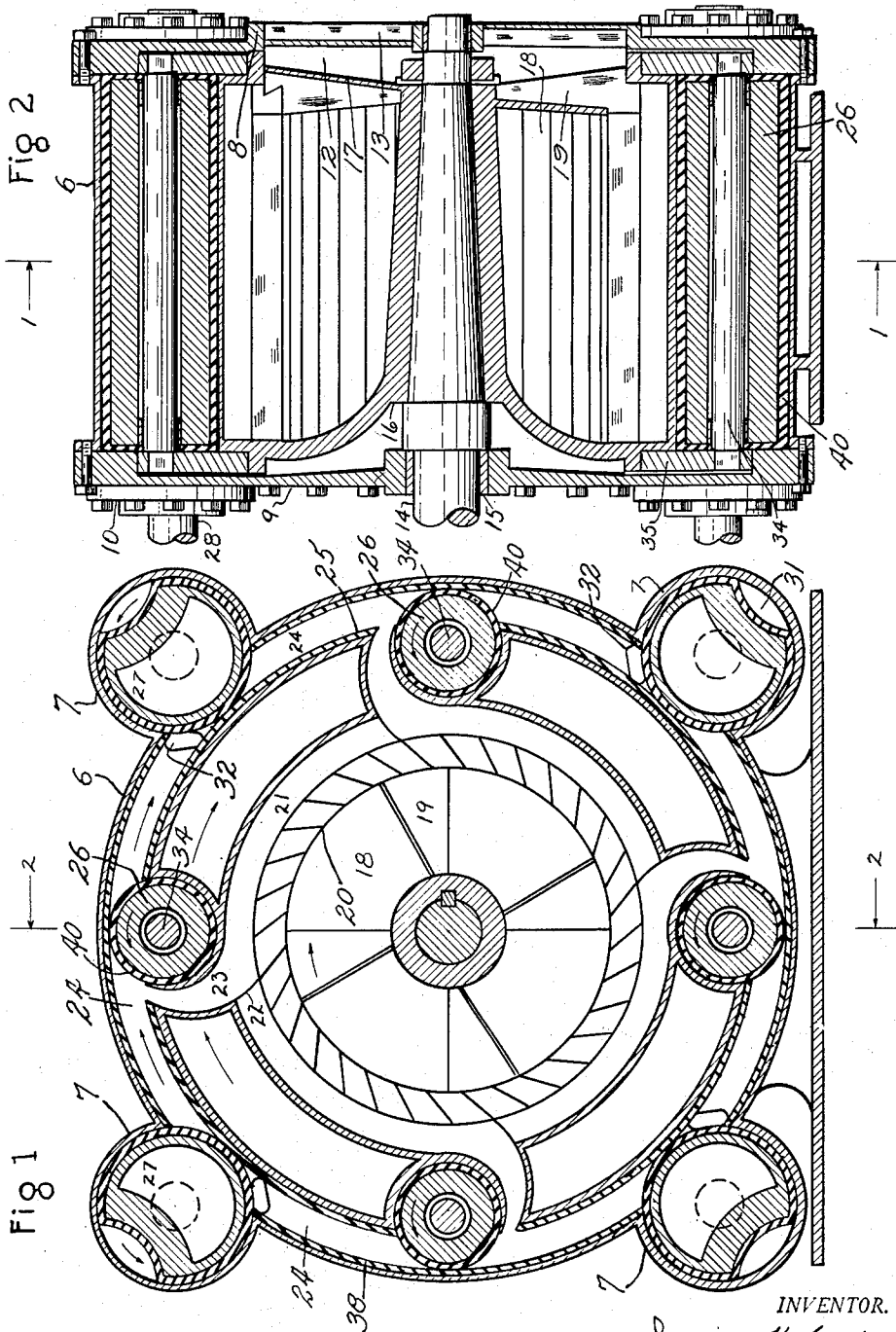
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2,776,086

FLUID COMPRESSOR OR PUMP

Filed March 18, 1952

2 Sheets-Sheet 1



INVENTOR.

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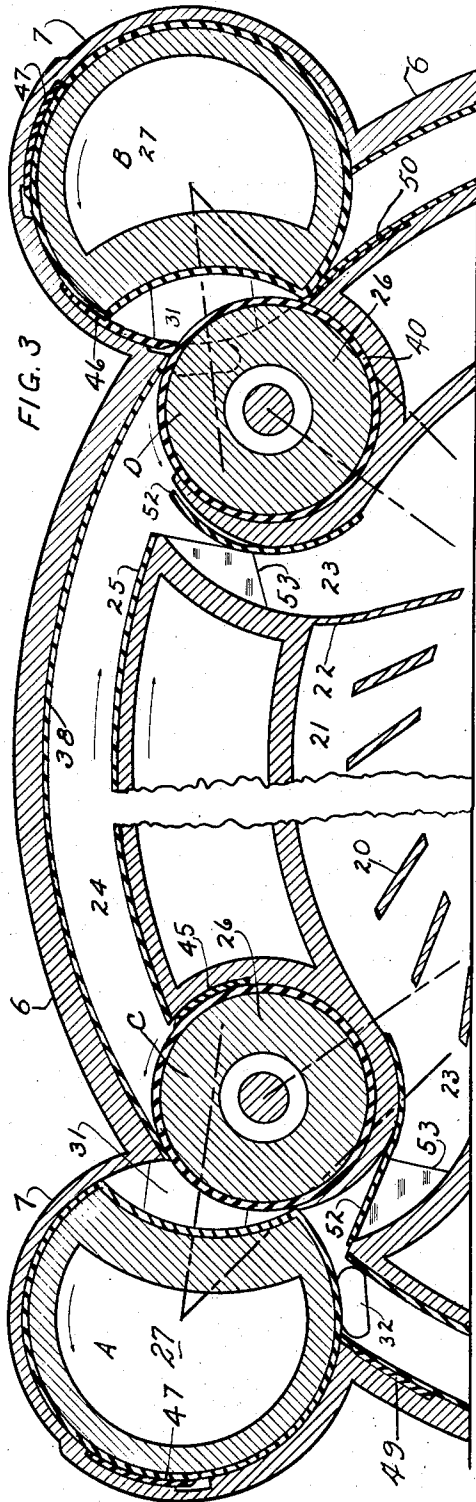
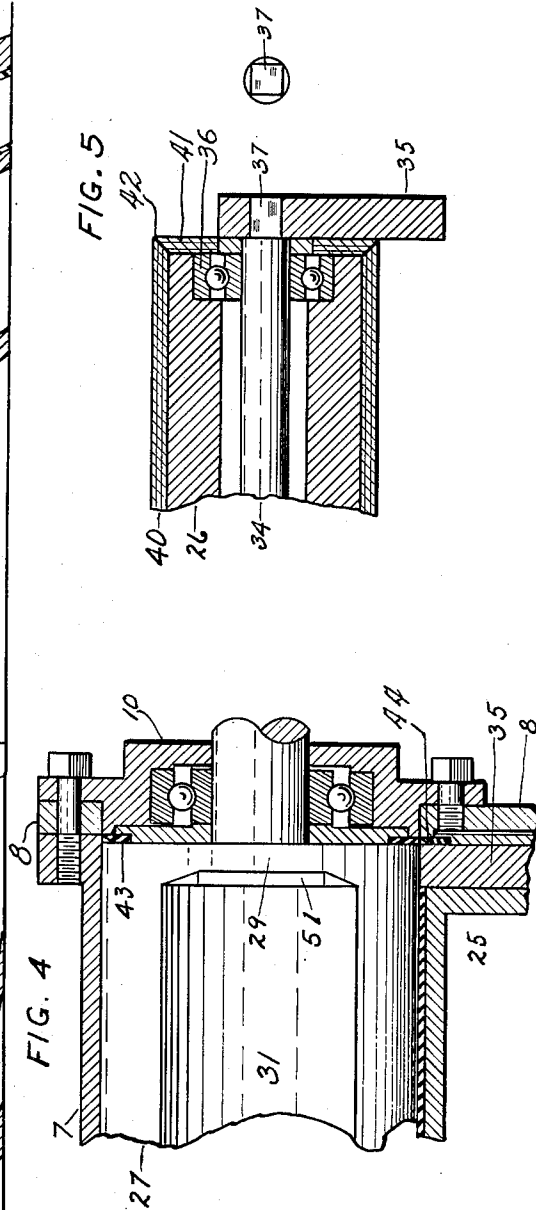
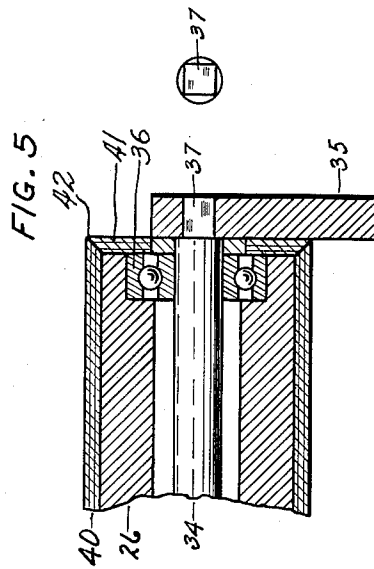
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INVENTOR.

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FLUID COMPRESSOR OR PUMP

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Application March 18, 1952, Serial No. 277,243

8 Claims. (Cl. 230—45)

This invention relates to fluid pumps or more specifically to rotary compressors and has particular reference to compressors adapted to be operated at high speeds and to compress relatively large volumes of air to substantial pressure within the compressor. Such compressors are inherently reversible so as to be operable as motors and it is within the scope of this invention to include such use. However, for sake of simplicity of description the apparatus forming the subject matter of this invention will hereinafter be described and claimed but without limitation as to motor use, as compressor apparatus.

Positive rotary compressors with good volumetric efficiency have long been the object of investigation. However, the problems of line seals, proper clearances and tolerances and noise of operation due to their designs solely specifying metals have been hard to solve. Now with the constant developments of improved plastics it may be possible that most of the old obstacles to this type of compressor can be overcome. Polyethylene plastics capable of withstanding temperature ranges of 250 degrees recently developed may be applicable for certain parts but in using the word plastic in this specification no particular plastic is referred to but the term is used loosely with the aim being that special thought be given to each adaptation in separate parts of the compressor in as much as certain parts would necessarily require a plastic of more resilience than others. In this connection rubber or rubber compounds may be covered by the use of the word plastics.

Methods of fastening all the plastic parts in their respective places are not specifically covered but it is assumed they will be cemented to the metal parts in an approved manner.

In the development of a new piece of mechanism such as herein specified it is hard to foresee definitely to what surfaces the application of plastics would attain the most efficient results, consequently it has been a constant aim in this design to be all inclusive of any adaptation of plastics for seals, valves and resilient surfaces. It is also the belief of the inventor that the most efficient compressor built from this design would not include all the plastic adaptations shown.

One of the main objects of this invention is to avoid "line seals." In the application of resilient plastic surfaces on adjacent rolling cylindrical bodies with sufficient mechanical pressure between them to form "two dimensional seals" such a result may be achieved. This may be clarified as follows:

If two steel cylinders with parallel axes are placed against each other side by side their common line of contact is merely a line. The use of line seals in this art is unsatisfactory because "blowby" and wear from dirty fluids soon pit the surfaces thereby rendering them impractical.

However if two cylinders with resilient plastic surfaces and parallel axes are forced together with sufficient pressure their common contact surface becomes an area of two dimensions. In this art such a condition when used

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to withstand increased fluid pressure may be referred to as a two dimensional seal and is practical because sufficient mechanical pressure between the bodies can be applied to prevent blowby and small particles of dirt no matter how hard may roll through this contact area without any permanent harm to the rolling parts.

Due to the scale used in this design and ratio or sizes of parts it was predetermined there would have to be 4 abutments and 4 vanes to give the highest efficiency to its piston displacement. However a change in the number of pistons and/or abutments should not be construed to be outside the scope of this invention.

Other objects of this invention are to provide a rotating or rolling vane or "piston" and fan blades on the intake side of the main rotor thereby giving a supercharging effect to the intaken air or gases.

These and other objects are attained by the devices, mechanisms and arrangements illustrated in the accompanying drawings, in which:

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

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

Fig. 3 is an enlarged section of 2 rotary abutments in their proper relation to each other in a segment of the main rotor housing but turned to positions out of proper sequence to each other, and a sector of the main rotor is left out in order to show the two vanes in their relatively untrue positions, to demonstrate certain phases of the compression cycle.

Fig. 4 is a cross-section of part of the main rotor housing where it encloses a rotary abutment.

Fig. 5 is a cross-section of part of a cylindrical vane.

Similar numerals of reference refer to similar parts throughout the several views.

Referring now, to the drawings, it will be seen that the fixed frame comprises an enveloping casting 6, of general circular section, having a series of four extensions 7 equally distributed around the circle and adapted to enclose the four abutments, hereinafter described, and closed by two end plates 8 and 9, suitably shaped to cover the central casting and bored and adapted to receive end plates 10 of abutment housings or extensions 7. The said plates 8 and 9 are secured to the enveloping casting 6 to form the containing frame.

The end plate 8, on the intake side of the machine, is provided with a series of openings 12, between louvers or blades 13, around the axis of the machine and each blade 13 is inclined to the axis so as to give the air, passing through the blades, an initial circular or spiral motion in the direction of rotation of the rotor.

The shaft 14 is mounted in suitable bearings 15 in the plates 8 and 9 and carries the hub 16 of the rotor. As seen in Fig. 2, this rotor is provided with an end plate 17 in which inlet ports 18 are formed between radially inclined fan blades 19 extending inward and adapted to draw air, or other fluid, through the inlet ports 18 and the openings 12 in the rotor housing by screw action. The outer surface of the hub 16 is curved, as shown, to direct the inflowing fluid outward towards the periphery of the rotor.

The interior of the rotor is equipped with a ring of blower blades 20. These blower blades subtend a radial angle and extend a part way to the hereinafter described rotor drum, leaving an opening or passage 21 between the drum and their sides. The blower blades 20 extend horizontally across the rotor.

Four blower blade extensions 22 are appropriately placed to close passage 21 and effectively deflect the fluid into the passages 23 provided behind each piston or vane for the centrifugally actuated fluid from the interior of the rotor to be delivered into the channel 24 wherein it is positively compressed between the next succeeding piston and the next intervening abutment.

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The space between the inner surface of the enveloping casting 6 and the outer surface of the drum section 25, or main rotor, forms a closed channel 24 in which the pistons 26 travel.

Each abutment comprises a cylindrical body 27, fitting with sufficient clearance to prevent friction, in the extensions 7 of the enveloping frame 6, and is positioned so that its external surface is substantially tangent to the drum 25 of the rotor, with either the rotor drum or the abutment or both sufficiently surfaced with a slightly resilient plastic. These two bodies to be fit with sufficient pressure between them to form a surface of two dimensions thus avoiding a line seal. The dimensions of the component parts are such that the abutments will turn 4 times as fast as the main rotor. The pitch diameters of the gears (not shown) that turn the abutments being the same as the diameter of the main rotor and the diameter of the abutments. Consequently the only friction here would be that of rolling friction.

The main gear and pinion gears to drive the abutments are not shown but would be placed on the left end (see Fig. 2) of the main shaft 14 and abutment shafts 28 and have a ratio of 4 to 1.

The outer surface of the abutment 27 has a passing slot 31. The slot being of less length than the abutment body but of sufficient clearance to allow the rotating vanes 26 to pass.

The rotating vanes 26 (Fig. 5) consist of a hollow cylindrical body mounted on suitable bearings 36 and shaft 34. Shaft 34 is held in annular rings 35 and kept from turning by square boss 37 on end of shaft 34 in square holes in rings 35. Annular rings 35 are the same diameter as and bolted to the ends of the main rotor drum 25 and are the same width as the abutment extension 29 of abutments 27. Plastic sleeve 40 covers the cylindrical surface of the vanes 26 giving them a slightly resilient surface which when properly fitted with sufficient pressure against the outer curved plastic surface 38 of annular channel 24 will give a seal of two dimensions, thus avoiding another line seal. The only friction here would be that of rolling friction and the bearings. The plastic discs 41 fastened to the ends of the vanes 26 are of a resilient nature and are so constructed as to exert a slight outward pressure at point 42. Disc 41 is not cemented to sleeve 40 but allowed to open a little at their joining surface to allow discs 41 to continue to exert a slight outward pressure even after a slight amount of wear.

This outward pressure would have the same effect in sealing the air channel as a leather sucker on an air pump and the pressure against the sides of the channel would increase with the air pressure. This feature would be important on a compressor designed to run very slowly but in compressors of average speeds would lose its importance due to the terrific speed the vanes would travel, approximately 3 times as fast as a piston in a reciprocating engine of comparable size turning at the same R. P. M. However it seems important to have plastic discs on the ends of the vanes if only to reduce noise. The vane's rotation on its axis is due mainly to the friction against the curved surface 38.

In cases of wear or improper fit between the rolling vane and outer channel surface 38 the square boss on the end of the vane shaft may be ground off the side desired as the case may be and properly fitted shims placed on the opposite side of the boss to regulate the fit.

Fig. 4 shows plastic ring 43 fastened on the ends of the abutments 27. It will be noted that ring 43 is feathered toward its greatest circumference which is formed to exert a slight outward pressure against enclosing plate 10. This pressure supplemented by the pressure of fluids against its back side should supply a practical seal in preventing said fluids from passing the ends of the abutments to blow out by the bearings. Plastic rings 44 are fastened to the annular rings 35 and turn with them and the main rotor. They are also feathered at their outer

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circumferences and seal the gap between the annular rings 35 and the main end plates 8 and 9.

Fig. 3, numbers 45, 46, 47, 49 and 50 illustrate plastic seals at the vanes and abutments. Due to the fact the rotors and abutments both turn away from the surfaces to be sealed it facilitates the application of these plastic seals. The lines being sealed run the full length of the abutments or the rotary vanes and seal the lines where the circumferences of the abutments intersect the arcs formed by the line 38 and the lines where the vanes intersect the outer circumference 25 of the rotor.

Two types are shown, 45, 46, and 47 may be called a parallel type for they are parallel to the curved surfaces of the smallest arcs, and 49 and 50 a perpendicular type, the latter two being approximately perpendicular to the surfaces of the smallest arcs being sealed.

In the cases of 45, 46 and 49 and 50, either type would suffice but in the case of 47 the parallel type is imperative. Seal 47 is an auxiliary seal to prevent blow-by at the circumference of abutments 29 when the abutment openings 31 are in such a position as to render the seals 46 or 49 ineffective. In the so named perpendicular seals 49 and 50 their back sides are cut away at the extreme contact point to allow for flexibility and clearance for wear. The pressure of the fluid against these seals supplements their natural resilience to make them effective, which is also the case in the parallel type but in the parallel type clearance on the outside of these seals must be a feature at their rear tapered ends to allow the fluids under pressure a surface to work on. Said clearances are shown greatly enlarged for illustration purposes only.

Fig. 3 illustrates the maximum working length of a compression stroke. The positions of the vanes as shown is a result of removing a sector of the main rotor and placing the two vanes closer together than is their true position of 90 degrees apart. This naturally turns the abutments 27 out of proper relation to each other. The amount of degrees of turn required by abutment B to pass vane D from its entering position as shown to a departing position as illustrated by relative positions of abutment A and vane C is 38 degrees. Assuming that abutment A is in its normal position then abutment B is turned 38 degrees behind its normal position and vane D is 9½ degrees behind its proper relative position, for as before stated the abutments rotate four times as fast as the main rotor and it takes a 38 degree turn of an abutment to pass a vane from one side to the other.

The vanes never touch the abutments, consequently the pressure of the compressed fluids is at its maximum when the vanes are approximately in a position as illustrated by abutment B and vane D. The compression ratio at this point is about 6.7 to 1. Outlet or exhaust ports 32 are apparently cut off by vane D as seen in position of vane D, however this is not the case as the edges of passages 32 are recessed on the arc side of said ports at the arc formed by the lines of the abutments. Thus the port 32 opening is not in one geometric plane but also opens into the arc of the circle that the abutments turn in.

There are 2 outlet ports 32 in each channel section or 4 through each end plate 8 and 9, making a total of 8 ports 32 in the compressor. There are no exhaust valves shown due to the limited space but for the machine to be practical there would have to be an automatic valve in each passage between ports 32 and a main discharge manifold and the closer to the main channel 24 the more efficient the compressor.

Fig. 4 shows part of an abutment 27 with its passing slot 31 drawn facing squarely out. The abutment extension as shown is thinner at the outer circumference than it is nearer the center. The extensions on each end of the abutments are cut out the same way. The purpose of this is to form a channel around the ends of the vanes to permit the fluid to escape into ports 32 when vanes 26 and abutments 27 are in position as illustrated by abutment B and vane D, Fig. 3.

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In Fig. 3, the function of automatic intake valves 52 can be best explained if we assume that abutment B and vane D are in their proper location and consequently abutment A would be rotated back 38 degrees and vane C would be back $9\frac{1}{2}$ degrees to be in the same relative positions as abutment B and vane D. As the main rotor 25 rotates to the right, abutment B rotating to the left soon breaks the seal between the outer circumferences of said bodies as the abutment opening 29 turns into channel 24, at practically the same instant the vanes 31 (see vane D) continuing into the passing slots of the abutments break the seal between their outer circumference and outer channel surface 38 and as the fluids compressed into abutment openings 31 are released into main channel 24 the direction of the fluids flowing through channels 23 is reversed and the back pressure of said fluids blows automatic valves 52 closed as shown at vane C.

Lateral segments 53 offer very little resistance to the flow of the fluids through the spacious passages 23. The intake passages 23 have a cross-section approximately $\frac{3}{4}$ as great as the main channel itself as can be seen for they extend virtually the full width of the rotor. The said segments 53 merely divide channel 23 into several smaller channels their purpose being to furnish a seat to suitably support valve 52 when it is closed. Valve 52 itself consists either of suitable rubber reinforced with fabric or a piece of suitable plastic properly fastened at one end to the interior of channel 23 in main rotor 25 lying free at the other end and normally closing channel 23 as seen at vane C, but opens as shown at vane D when the air pressure is greater from the center of the rotor than from the main channel. This furnishes a valve of great volume and little resistance and at the same time the centrifugal force from the speed of the rotor would have little effect on it due to its position approximating that of a radial line.

The purpose of these valves is to retain as much fluid in the main channel as possible; thus when the next succeeding compression stroke begins the said fluids may have a higher than atmospheric pressure.

The machine should have proper lubrication for its plastic surfaces depending on the types of plastics used. In some adaptations sufficient lubrication could be derived from the water used in air cooling processes sometimes used to increase the efficiency of compressors whereby the air could carry enough humidity to properly lubricate the plastic surfaces.

If a drier compressed air were required the plastic surfaces would no doubt have to be lubricated by oil in which case the plastics used would have to be of a type impregnable to the type of oil used.

Description of action

As the rotor is turned, the piston 26 which is receding from one of the abutments 27 causes a partial vacuum in the channel 24 and in the passages 21 and 23, thus drawing air from the intake ports 12 and 18. As the air passes the blades 13 in the end of the rotor housing it is given a swirling motion thereby, thus entering the rotor with an initial spiral motion. This rotary motion is increased by the fan blades 19 which also have a strong sucking effect on the air.

As the fluid starts to rotate and is drawn in, the centrifugal force is supplemented by the low pressure volume behind the piston 26 which is connected by the large passage 21 and 23 with the interior of the rotor. As the piston 26 passes the next abutment 27, the abutment has rotated to close the channel 24. Thus the succeeding piston 26 compresses the fluid in the said closed channel against the abutment ahead of it. Then, as the piston 26 approaches the abutment the fluid is forced by the positive compressive action of the piston, through the outlet port 32.

Having therefore described my invention, what I claim and desire to secure by Letters Patent, is:

1. In a rotary compression unit having an enclosing cir-

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cular frame; a hollow cylindrically shaped rotor mounted concentrically therein to form an annular channel and adapted to travel therein; vanes on the rotor effectively closing said channel; a plurality of rotating abutments mounted in said frame and extending into said annular channel and into engagement with said rotor, dividing said channel into intake and compression chambers, said chambers to be used alternately as intake and compression chambers; slots in said abutments adapted to mesh with each said vane as it passes said abutments; exhaust ports through the enclosing frame from the intake and compression chamber on the compression side of the abutments; an intake passage on one end wall of said frame consisting of an annular opening therethrough concentric with said rotor; intake ports in the adjacent end wall of said rotor, consisting of an annular opening therethrough concentric with said rotor and adapted to admit fresh charges into the interior of said rotor from said intake passage; said intake passage on said end wall of said frame formed by a series of radial louver blades mounted in said end wall, designed and pitched to transmit a minimum of friction to the fluid as it enters said intake passage; radial fan blades mounted in said intake ports in said adjacent end wall of said rotor and having a pitch in the opposite direction to that of the said louver blades in said end wall of said frame and cooperating with said louver blades to draw fresh charges into said rotor and to force them into passages between longitudinal blades within said rotor which assist in further compressing said fluids to force them through openings in the periphery of said rotor adjacent to the vanes on the low pressure side of said vanes into the annular channel where the fluids are further compressed between the vanes and the abutments.

2. In a rotary compression unit having an enclosing circular frame; a hollow cylindrically shaped rotor mounted concentrically therein to form an annular channel and adapted to travel therein; vanes on the rotor effectively closing said channel; a plurality of rotating abutments mounted in said frame and extending into said annular channel and into engagement with said rotor, dividing said channel into intake and compression chambers, said chambers to be used alternately as intake and compression chambers; slots in said abutments adapted to mesh with each said vane as it passes said abutments; exhaust ports through the enclosing frame from the intake and compression chamber on the compression side of the abutments; an intake passage on one end wall of said frame consisting of an annular opening therethrough concentric with said rotor; intake ports in the adjacent end wall of said rotor, consisting of an annular opening therethrough concentric with said rotor and adapted to admit fresh charges into the interior of said rotor from said intake passage; radial fan blades mounted in said intake ports in said adjacent end wall of said rotor cooperating with said intake ports to draw fresh charges into said rotor and to compress them therein; arcuate channels from the interior of the said rotor extending to rectangularly shaped longitudinal ports in the periphery of said rotor adjacent to the vanes on the low pressure side of said vanes adapted to deliver said charges into said intake and compression chambers; a flow of fluid alternating in direction through said rectangular ports in said rotor due to varying pressures in said intake and compression chambers; lateral seating segments in said arcuate channels, spaced sufficiently apart and extending from the side of the channel opposite said vane to a line from the intersecting point of the opposite side of said arcuate channel and the circumference line of the rotor drum and tangent with the inner convex surface on the side adjacent to the vane where the channel leads out of the inner side of the rotor, to substantially form a valve surface; a plastic flap at each of said ports designed to rest on said lateral seating segments and to substantially cover said segments, said flaps fastened at their, central or interior

end, at a point sufficiently beyond its tangential contact line with said convex surface when in a closed position to exert a very slight pressure when normal against said lateral seating segments and of sufficient dimension to effectively close said port when the pressure is greater on the intake and compression side of said port and to readily open when the pressure is greater on the interior or central side of said port; and automatic means to open and close said port.

3. In a rotary compression unit having an enclosing circular frame; a hollow cylindrically shaped rotor mounted concentrically therein to form an annular channel and adapted to travel therein; and vanes on the rotor; a plurality of rotating abutments mounted in said frame and extending into said annular channel and into engagement with said rotor, dividing said channel into intake and compression chambers, said chambers to be used alternately as intake and compression chambers; slots in said abutments adapted to mesh with each said vane as it passes said abutments; said vanes consisting of cylindrically shaped rolling bodies arranged to substantially close said annular channel, traveling in a rolling position with their outer surface rolling against the inner arc of the enclosing frame where it forms the outer circle of the said annular channel.

4. In a rotary compression unit having an enclosing circular frame consisting of a central body and two end plates; a hollow cylindrically shaped rotor mounted concentrically therein, to form an annular channel and rolling cylindrical vanes on the rotor arranged to travel in said annular channel the ends of said vanes laying adjacent to said frame end plates, a plurality of rotating abutments turning in frame extensions on shafts supported by bearings in separate end plates at said frame extensions; said rotating abutments extending into said annular channel and into engagement with said rotor, dividing said channel into intake and compression chambers, said chambers to be used alternately as intake and compression chambers, concave passing slots in said abutments adapted to mesh with each said vane as it passes said abutments; plastic ring members of substantial thickness and substantially fastened, one to each end of each said vane, one to each end of each said abutments, and one to each end of said hollow rotor; coaxial with and of the same diameter as each respective body and each exerting a longitudinal pressure at its greatest circumference against their respective said end plates; whereby a seal is formed between said bodies and said end plates.

5. The rotary compression unit of the class described as set forth in claim 4, in which each of the following surfaces is equipped with a substantial layer of resilient plastic; the cylindrical vanes on their entire convex surface; the entire concave surface of the enclosing frame central body where it forms the outer arcs of the annular channel; the entire convex surface of the rotor where it forms the inner surface of the annular channel; the entire convex and concave surfaces of the abutments; the relative bodies so positioned and adjusted as to employ the resilient qualities in said plastic surfaces to the extent that the contiguous parts are no longer true arcs but depressed to such a degree as to form a "contact area" as against a line which would be the contact point between two touching geometrically perfect cylinders of parallel axes if side by side; whereby a two dimensional seal is formed between each said abutment convex surface and the convex surface of the said rotor; when they are in a contacting position; whereby a two dimensional seal is formed between said cylindrical vanes and said enclosing frame central body where it forms the outer arcs of the annular channel when said bodies are in contact.

6. In a rotary compression unit having an enclosing circular frame consisting of a central body and two end plates; a hollow cylindrically shaped rotor mounted concentrically therein, to form an annular channel and rolling vanes on the rotor arranged to travel in said an-

nular channel, said rolling vanes recessed in concave pockets in the rim of said rotor, a plurality of rotating abutments turning in frame extensions on shafts supported by bearings in separate end plates at said frame extensions; said rotating abutments extending into said annular channel and dividing said annular channel into intake and compression chambers, said chambers to be used alternately as intake and compression chambers; slots in said abutments adapted to mesh with each said vane as it passes said abutments, the forward sides of said vanes and said abutments being the approaching side and the side approached respectively as the rotor turns to the right, compressed fluids in said compression chambers; a plastic flap at each vane lying parallel to the convex surface of each said vane within said concave pocket of said rotor on the forward side of said vanes and extending to a line of intersection between the circumference of said vanes and the greatest arc of the rotor, and extending the full length of the vane; a plastic flap seated within the frame extensions, parallel to the convex surface of the said abutments and extending to the line of intersection between the circumference of said abutment and the arc of the annular channel formed by said enclosing frame, on the forward side of said abutments and extending the entire length of said abutments; an auxiliary plastic flap seated well within the frame extensions a distance slightly greater than the arc subtended by the abutment passing slot, measured on the forward side of said abutment from the intersecting line formed where the circumference of said abutment intersects the arc of the annular channel formed by said central body, lying parallel to the convex surface of said abutments and extending the entire length of said abutments; a plastic flap seated within the rotor rim at the forward side and against each said rolling vane and approximately perpendicular to the convex surface of said vane and extending the entire length of said vane; a plastic flap seated within the arc of the annular channel in said frame central body on the forward side and against each said abutment and approximately perpendicular to the convex surface of said abutment and extending the entire length of said abutment; all of said plastic flaps of sufficient width and substantially fastened and shaped to respond to the pressure of the compressed fluids to effectively form seals first between the forward side of said vanes and the rim of said rotor at the line where the convex arcs of these bodies intersect and second between said frame central body at the abutments where the arcs of said frame central body and said abutments intersect on the forward side of said abutments and third at the said auxiliary seals of the abutments well within the frame extension between said frame extension and said abutments; whereby seals are formed to prevent blowby between the said rotor and the convex surface of said rolling vanes; and whereby seals are formed to prevent blowby between the convex surface of said rotary abutments and the said enclosing frame central body and between said abutments and said frame extensions.

7. In a rotary compression unit having an enclosing circular frame; a hollow cylindrically shaped rotor mounted concentrically therein to form an annular channel; vanes on the rotor arranged to travel in said annular channel; a plurality of rotating abutments mounted in said frame and extending into said annular channel and into engagement with said rotor, dividing said channel into intake and compression chambers, said chambers to be used alternately as intake and compression chambers; and slots in said abutments adapted to mesh with each said vane as it passes said abutments; said vanes consisting of cylindrically shaped rolling bodies arranged to substantially close said annular channel, each of said rolling vanes suitably mounted on a vane shaft, said shaft extending into and supported by two annular vane mounting rings coaxial with said rotor and fastened substantially to opposite ends of said rotor, the axes of said rolling vanes and said rotor being parallel to allow

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the vanes to roll in the annular channel against the concave surface of said annular channel.

8. In a rotary compression unit having an enclosing circular frame; a hollow cylindrically shaped rotor mounted concentrically therein to form an annular channel; vanes on the rotor arranged to travel in said annular channel; a plurality of rotating abutments mounted in said frame and extending into said annular channel and into engagement with said rotor, dividing said channel into intake and compression chambers, said chambers to be used alternately as intake and compression chambers; and slots in said abutments adapted to mesh with each said vane as it passes said abutments; said vanes consisting of cylindrically shaped rolling bodies arranged to substantially close said annular channel, each of said rolling vanes suitably mounted on a vane shaft, said shaft extending into and supported by two annular vane mounting rings coaxial with said rotor and fastened substantially to opposite ends of said rotor, the axes of said rolling vanes and said rotor being parallel to allow the vanes to roll in the annular channel against the concave surface of said annular channel; said vane shafts terminating

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in a square boss on each end to fit square holes in said vane mounting rings, said square holes so positioned to have one side perpendicular to and bisected by a radial line of said mounting ring, suitably arranged to grind one side or another off of said square bosses on said vane shafts and shims applied on the opposite side to provide means for adjustment for original fit or subsequent wear.

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