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FLUID PRESSURE APPARATUS

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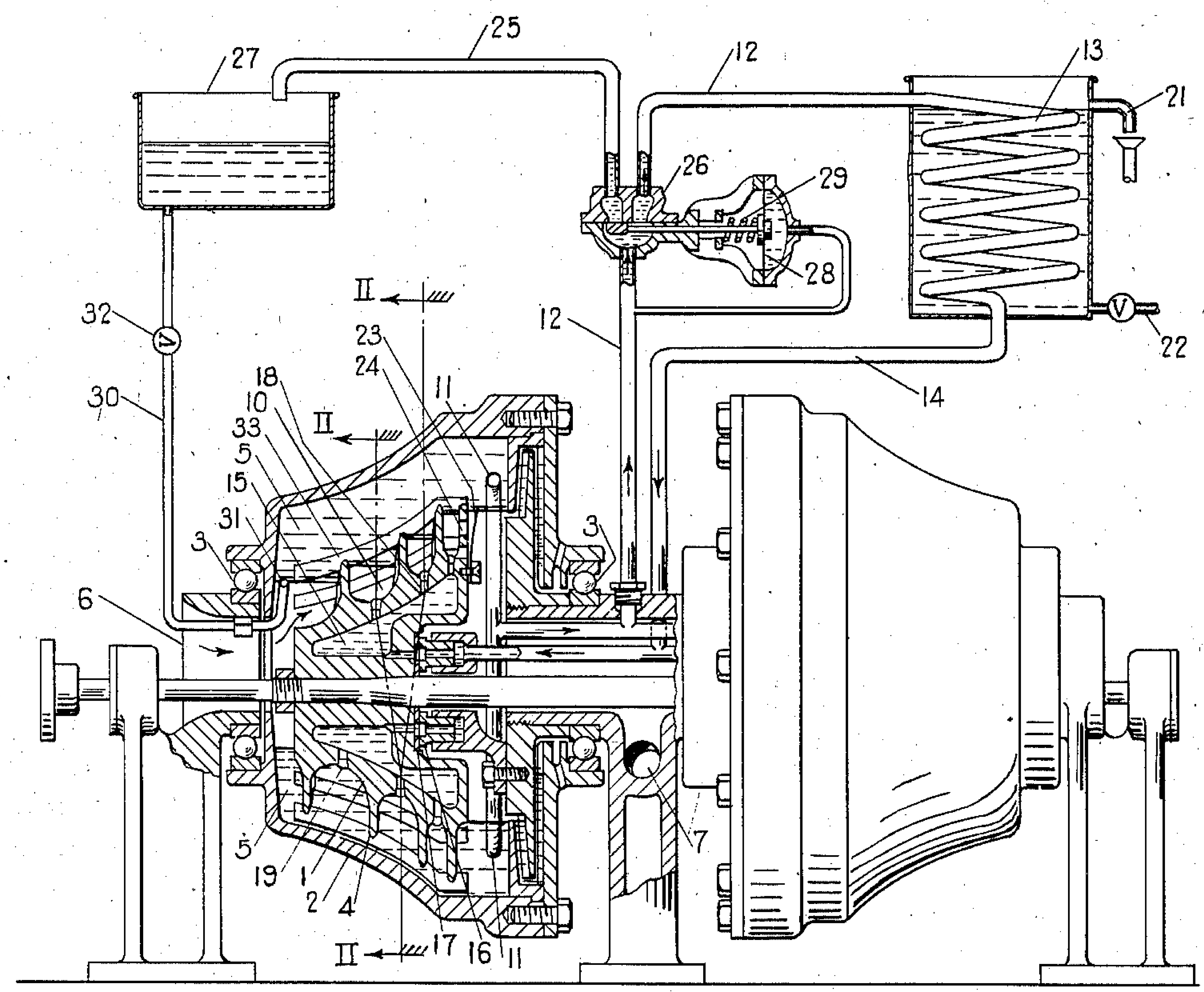

Fig. I

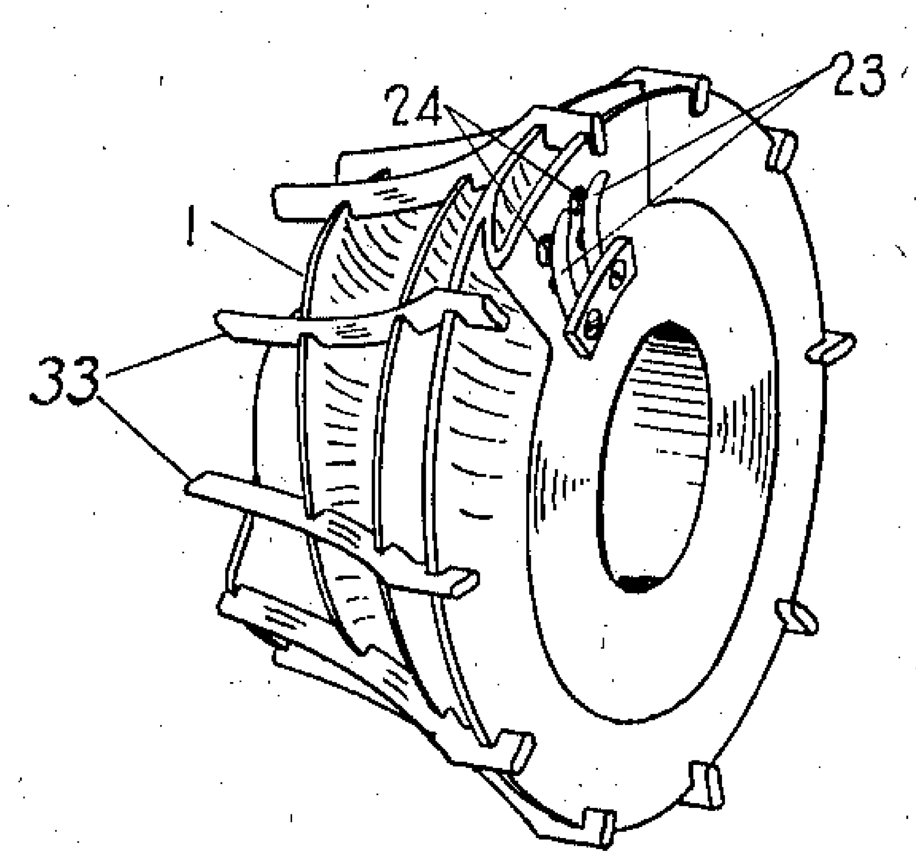

Fig. III

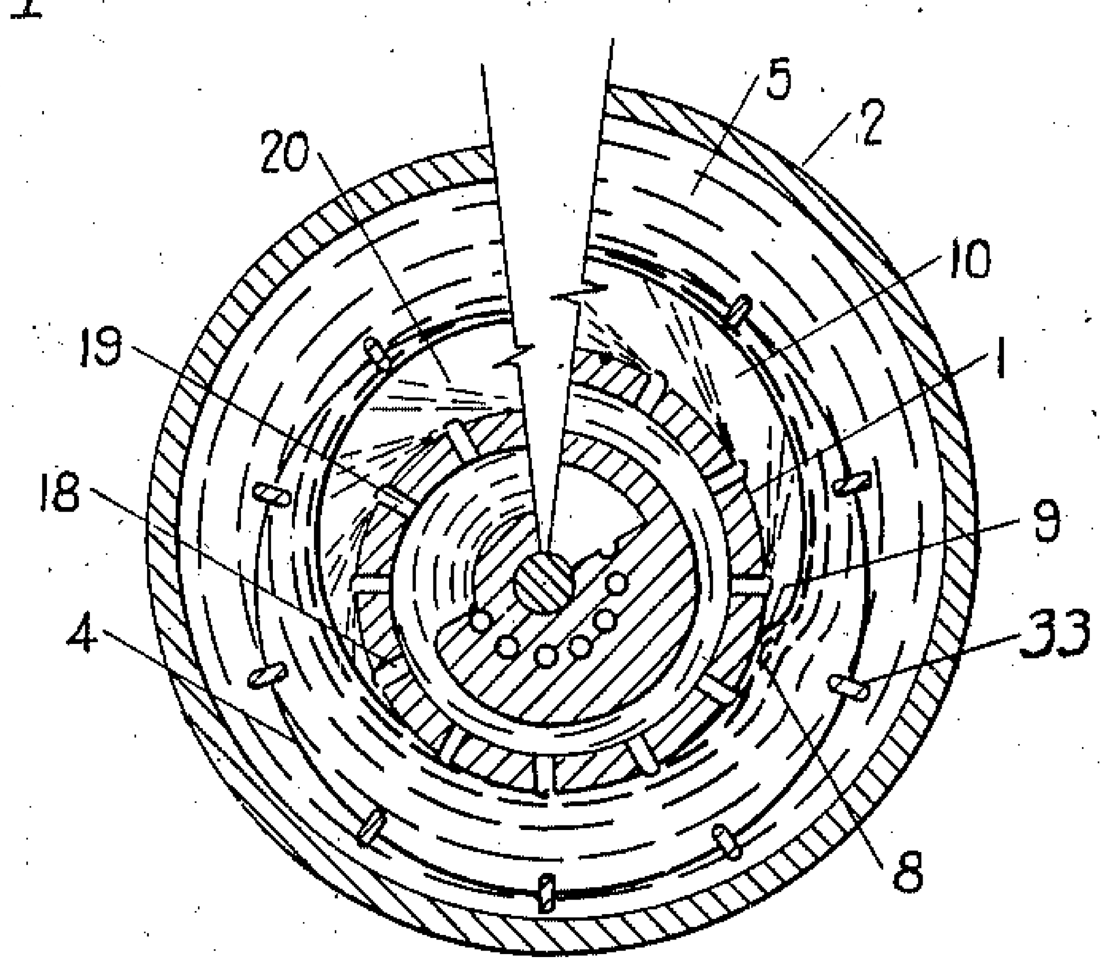

Fig. II

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FLUID PRESSURE APPARATUS

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3 Claims. (Cl. 230—79)

This invention relates to improved fluid pressure apparatus and, more particularly to improvements in apparatus of the type containing a rotor, enclosing case and sealing fluid adaptable for creating compression or suction.

Various proposals have been previously made of compressors, motors and the like in which compression or suction has been effected by movement of a rotor, having a helical or spiral blade, in a body of liquid, or by movement of the body of liquid on or between the helical or spiral blades of the rotor.

There have been various disadvantages in the practical application of such previous proposals, however, including such difficulties as those of: obtaining an economical and sufficient overall volumetric efficiency; overheating of the apparatus due to friction and heat of compression; obtaining uniform suction or pressure, due to back discharges through the liquid entrained in the helical passages; maintaining the desired and correct level of sealing fluid, and the like.

It is an object of the present invention to overcome these and other disadvantages and to provide a new and improved apparatus adaptable for gaseous or liquid compression or suction.

Other objects and advantages of my invention will be apparent by reference to the following specification in which the preferred details and embodiments are described.

The apparatus of my invention comprises an improved form of rotary compressor or suction pump in which the rotor is in the form of a conical screw, forming a helical passage or passages with a portion of each of its spirals submerged in a body of liquid, and eccentric within an enclosing case containing a liquid. The rotor of my invention, being eccentric within the case and having agitating or driving means around its outer face, carries liquid within the case around with it as the rotor revolves. At the same time, each convolution of the rotor being only partly submerged in the liquid, there is formed a pocket of air or other gas which is thus forced from one end of the rotor to the other. Inasmuch as the rotor is in the form of a conical screw, and inasmuch as the helical convolutions are reduced in width as they approach the outlet end, the capacity of the passages become less and less and the consequent pressure greater and greater toward the outlet end of the rotor.

According to one of the features of my invention, this general type of apparatus is improved and made more efficient by constructing the helical threads of the rotor in a V or U shape, i. e. with a rounded bottom to the helical groove. I have found that by use of such construction the sealing fluid is displaced in such a way that a more effective seal is obtained and therefore the volumetric efficiency is increased.

As a further feature of my invention, there are provided pick-up tubes, within the enclosing casing, which carry a part of the sealing liquid through a heat exchange unit for removal of the heat caused by friction, and/or compression of the gaseous fluid and thereafter return the fluid to the enclosing casing. In returning this sealing liquid to the enclosing casing, it is first introduced into the hollow rotor, from whence it passes out thru ports or nozzles provided for the purpose, thru the gaseous fluid being compressed, and returns to the main body of sealing liquid.

The ports or nozzles in the rotor are designed to break up the sealing liquid, which passes thru them, into a flat spray and to direct this spray in a direction tangent to the periphery of the rotor and opposite to the direction of rotation. The advantages of this feature are described in greater detail hereinafter.

The removal of sealing liquid for cooling and returning in this way, accomplishes four definite improvements in the overall efficiency and/or utility of the machine, i. e., it provides a means for maintaining a uniform controlled temperature within the machine; it provides a means for compressing gases while in intimate contact with a cooling medium thereby approximating isothermal compression of the gas; it provides a means of absorbing one or more components of a gaseous mixture into the sealing fluid during compression; and, since in a machine of this general type there is a relative rotating motion between the rotor and sealing liquid on the one hand and the gases being compressed on the other, and since the jet velocity of the discharge of sealing liquid from the tangential rotor ports or nozzles equals or exceeds the peripherial velocity of the rotor, there is presented to the gases being compressed a quantity or series of relatively stationary sprays which largely prevent the frictional rotation of the gases and thereby largely reduce leakage under the rotor seal and increase volumetric efficiency.

An additional feature of my invention resides in means for checking "leaking" of the gas, i. e., when the compressor has reached the height of pressure for which it is designed. I have found that there is ordinarily a tendency for the gas to be forced back against the liquid seal, from one stage or convolution to another (the high pressure to the low pressure end) and the velocity attained by the gas results in appreciable loss of pressure in the high pressure end before this action stops. According to my invention, however, a check valve or check valves are incorporated at the discharge end of the compressor so that only that gas which may be entrained in the helical passage is able to leak back, thus producing an automatic unloading and constant pressure action within the compressor.

As a further feature of this invention which, together with those features previously described, increases greatly the smoothness of operation and efficiency of the rotor, I have provided an automatic means for discharging the sealing liquid upon stopping the compressor and for maintaining the correct level of sealing liquid during operation of the compressor. These automatic features are accomplished, according to my invention, by means of a spring-loaded diaphragm-operated, two way valve which is so placed in connection with the pick-up tubes for recirculation and cooling of the sealing liquid that, during normal operation of the compressor, sealing liquid is directed through cooling coils, from the internal portions of the enclosing case, and back to the inside of said case. As the speed and/or pressure decreases, however, the diaphragm valve is operated so as to retard or stop this flow of liquid through the cooling means and the liquid is forced into a storage receiver, which is in turn so positioned as to give a head of liquid at a higher level than that of the interior of the enclosing case.

The preferred details and embodiments of this invention will be made clear by reference to the following description, when taken with the accompanying drawing in which Figure 1 is a central sectional view through one form of my improved apparatus; Figure 2 is a cross section of the rotor of Figure 1, the section being made at II as indicated in Figure 1; and Figure 3 is a diagrammatic sectional view showing the helical threads and automatic valves of my invention.

Referring to Figure 1, the machine consists of a rotor **1** revolving eccentrically within an outer casing **2** which in turn is mounted on bearings **3** and free to revolve. The rotor **1** has a continuous spiral fin or fins **4** forming a conical spiral passage or passages progressively decreasing in pitch as the rotor increases in diameter, which entrain the gaseous fluid to be compressed. The case **2** carries a sealing fluid **5**, the gaseous fluid to be compressed entering at **6** and discharging at **7**. The fins **4** which form the spiral or helical passages for entraining fluids to be compressed are thickened at the base, where they join the main body of the rotor, to form U shaped passages.

Referring to Figure II, which is a cross or transverse section thru rotor **1**, outer case **2**, and sealing fluid **5**, the normal position of the sealing liquid surface is shown at **8**, the direction of rotation being clockwise. Since in this general type of machine there is a relative plunging and receding motion between the rotor fins **4** and sealing liquid **5** and since in my design the bases of these fins **4** are thickened or broadened, there is created at the point **8** a greater than normal displacement of sealing liquid causing the liquid surface to curve inward for a short distance as indicated, **9**. This causes a region of increased sealing liquid pressure against rotor **1** near this point, assisting the sealing liquid in preventing the fluid **10** which is being compressed, from "leaking" under the rotor seal, which action produces an increase in the volumetric efficiency of the machine.

Affixed to the outer periphery of fins **4** are a series of blade **33**, with the side of greatest dimension presented to the direction of rotation. These blades impart energy to sealing fluid **5** to cause rotation of the body of fluid in the direction of rotation of rotor **1**. The resulting centrifugal force causes the sealing fluid to assume the shape of an annular ring within the outer casing **2**.

Referring to Figure 1, there are enclosed within the outer casing **2** a tube or tubes **11** in a stationary position with the open end or ends facing the direction of rotation. Due to the kinetic energy of the rotating sealing liquid **5**, which is produced by centrifugal force and impact against the open ends of the pick-up tubes **11**, the sealing liquid is forced thru passages **12** to a heat exchanger **13** and back thru passages **14** to a hollow annular space **15** within the rotor **1**. If heat exchange is not desired, the fluid from pick-up tubes **11** may be directly passed, by means not shown, to the hollow annular space **15**. A sealing ring **16** with suitable anti-friction facing **17** is provided where the liquid passes from the stationary tubes **14** to the rotor space **15**. The rotation of the liquid while within the rotor space **15** imparts additional energy which assists in forcing the liquid thru ports **18** to nozzles **19** (Figure II) from where it is sprayed thru the fluid **10** which is being compressed. Figure II illustrates the tangential sprays **20** from these nozzles **19**. By this movement of liquid the heat of compression is removed from the fluid **10** as it is formed, thereby producing isothermal compression which not only increases the overall efficiency of the machine but makes it possible to compress gaseous fluids which have a tendency to decompose upon increase of temperature. The heat is dissipated from heat exchanger **13** by circulating a cooling fluid thru tubes **21** and **22** or by any other convenient means of heat dissipation.

As shown in Figure II, nozzles **19** produce a flat spray tangential to the surface of the rotor **1** and backward with respect to the direction of rotation. In this type of machine there is a rapid rotating motion of the surfaces of the rotor **1** relative to the fluid **10** which is being compressed. The sprays **20** present a relatively stationary surface forming a series of baffles to prevent the rotation of fluid **10** which is being compressed, thereby largely preventing leakage of the fluid **10** under the rotor seal and increasing volumetric efficiency of the machine.

Again referring to Figures I and III, a check valve, or valves, **23** allow compressed gases to escape from the rotor passage thru ports **24** but prevent a backward discharge, i. e., from the high pressure end of the machine back to lower stages of compression. Since a backward discharge due to over-compression beyond that pressure for which it was designed will result in a progressive expansion of the compressed gases in a backward direction and, due to the gas velocities reached, coupled with a considerable volume of gas in the high pressure end which must be dissipated before the action stops, a considerable amount of sealing liquid may be "blown out" thru the low pressure end of the machine and in any event a considerable loss of compressed gases is effected. According to my invention, valves **23** prevent any gases blowing back except those within the rotor passages, which do not exist in sufficient volume to sustain a "blow-back" for a harmful period of time. Actually a balance of pressures is reached within the rotor passages to the extent that a more or less continuous "blow-back" occurs, the alternate compression and decompression of gases in the rotor passages taking place rapidly, (decompression only partially) resulting in only a part of the normal amount of compression, and therefore only a part of the normal power, being used, which constitutes an automatic "unloading" of the machine.

As shown in Figure I a system of piping **25** and automatic diaphragm- or other pressure-actuated valve **26** together with a storage tank **27** may be utilized according to my invention. A valve **26** is so adjusted and connected that during normal operation the flow of sealing liquid thru the tubes **12** is directed to a heat exchanger **13**. However, when power is removed from the machine and it reduced speed, there is resultant drop in static pressure of sealing liquid, and in the valve **26** a corresponding reduction in pressure on the diaphragm **28**, allowing a spring **29** to move the valve and stop the flow of sealing liquid to the heat exchanger **13**, directing it to a pipe **25** which in turn carries it to a storage tank **27**. In this way the major portion of the sealing liquid is removed from the machine when it is shut down and thus prevented from overflowing into either the intake or discharge ports, **6** or **7** respectively.

A pipe **30** acts as a drain from storage tank **27** and terminates in an open end **31** inside the machine and at the low pressure end, with the opening facing against the direction of rotation. When the machine is started and a valve **32** is opened there is a flow of sealing liquid into the case **2** which continues until the inner surface of the annular ring of sealing liquid **5** reaches the level of the tube opening **31**, at which time impact pressure of the liquid **5** against the tube opening **31** stops the flow thru tube **30**.

Should the surface of the sealing liquid **5** for any reason submerge the tube opening **31** to the extent that the resulting impact pressure becomes greater than the static head pressure from the storage tank **27** there will be a reversed flow in tube **30**, returning sealing liquid to the storage tank **27**. This provides an automatic means of maintaining a constant level of sealing liquid **5** within case **2**.

Blades **33** act upon sealing fluid **5** to produce movement of this fluid within the outer casing **2** and in the direction of rotation of rotor **1**. Centrifugal force causes the sealing fluid **5** to assume the position of an annular ring within the outer casing **2**. By maintaining this rotation of fluid **5** at a speed approaching the speed of rotor **1**, there is less disturbance of the inner surface of the ring of sealing fluid **5** and as a result better sealing is produced.

Various changes may be made in the present invention without departing therefrom or sacrificing any of the advantages thereof.

I claim:

1. An apparatus adapted for rotary compression comprising a freely revolvable hollow casing containing a body of liquid, with inlet and outlet means, a revolvable rotor within and eccentric to the axis of the casing and having the form of a conical screw, the helical convolutions on the rotor forming, between the convolutions, a U-shaped helical trough progressively decreasing in pitch as the rotor increases in diameter, at least one outlet from the hollow casing leading to a hollow annular space within the rotor, ports leading from the hollow annular space within the rotor to the U-shaped trough formed by the helical convolutions, a series of vanes affixed to the outer periphery of the rotor convolutions with their side of greatest dimension presented to the direction of rotation, and a valve governing the outlet for compressed fluid from the high pressure end of the rotor and adapted to allow forward but to prevent backward flow of compressed fluid through the rotor.

2. An apparatus adapted for rotary compression comprising a freely revolvable hollow casing, containing a body of liquid, with inlet and outlet means, a revolvable rotor within and eccentric to the axis of the casing and having the form of a conical screw, the helical convolutions on the rotor forming, between the convolutions, a U-shaped helical trough progressively decreasing in pitch as the rotor increases in diameter, at least one outlet within the hollow casing facing counter to the direction of rotation of the rotor and leading to a hollow annular space within the rotor, ports leading from the hollow annular space within the rotor to corresponding nozzles affixed to the U-shaped trough formed by the helical convolutions, a series of vanes affixed to the outer periphery of the rotor convolutions with their side of greatest dimension presented to the direction of rotation, and a valve governing the outlet for compressed fluid from the high pressure end of the rotor and adapted to allow forward but to prevent backward flow of compressed fluid through the rotor.

3. An apparatus adapted for rotary compression comprising a freely revolvable hollow casing containing a body of liquid, with inlet and outlet means, a hollow revolvable rotor within and eccentric to the axis of the casing and having the form of a conical screw with helical convolutions on the rotor forming, between the convolutions, a U-shaped helical trough progressively decreasing in pitch as the rotor increases in diameter, at least one stationary outlet within the hollow casing with an open end facing counter to the direction of rotation of the rotor, heat exchange means connected with at least one stationary outlet within the hollow casing and connected to a hollow annular space within the rotor, a series of ports leading from the hollow annular space within the rotor, a series of nozzles connected to the ports and affixed to the trough formed by the U-shaped helical convolutions and pointing in a direction counter to the direction of rotor rotation, a series of vanes affixed to the outer periphery of the rotor convolutions with their side of greatest dimension presented to the direction of rotation, and a check valve governing the outlet for compressed fluid from the high pressure end of the rotor and adapted to allow forward but to prevent backward flow of compressed fluid through the rotor.

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