G. C. McFARLANE.

ROTARY COMPRESSOR AND VACUUM PUMP.

APPLICATION FILED FEB. 8, 1917.

1,278,700.

Patented Sept. 10, 1918.

3 SHEETS—SHEET 1.

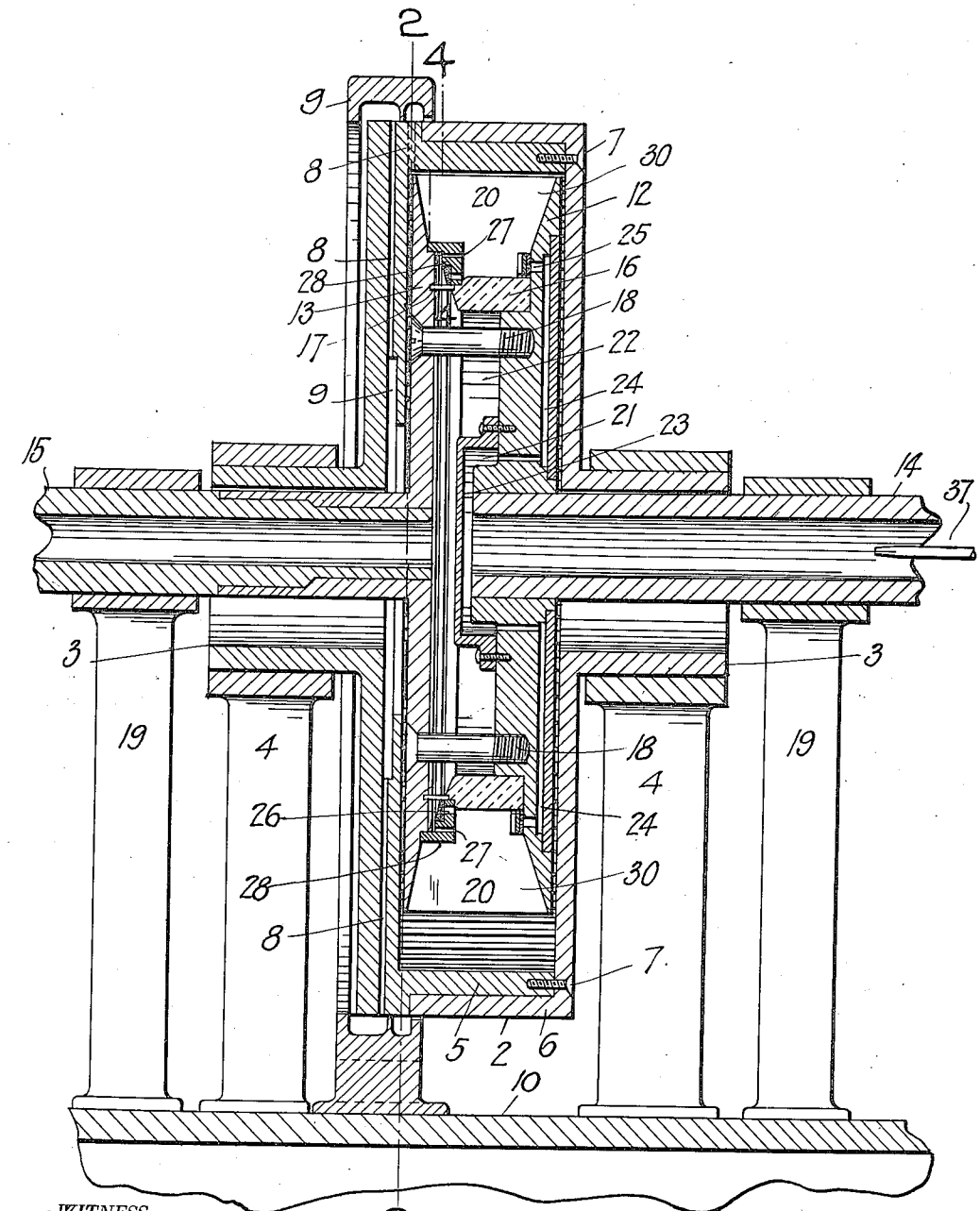


FIG. 1

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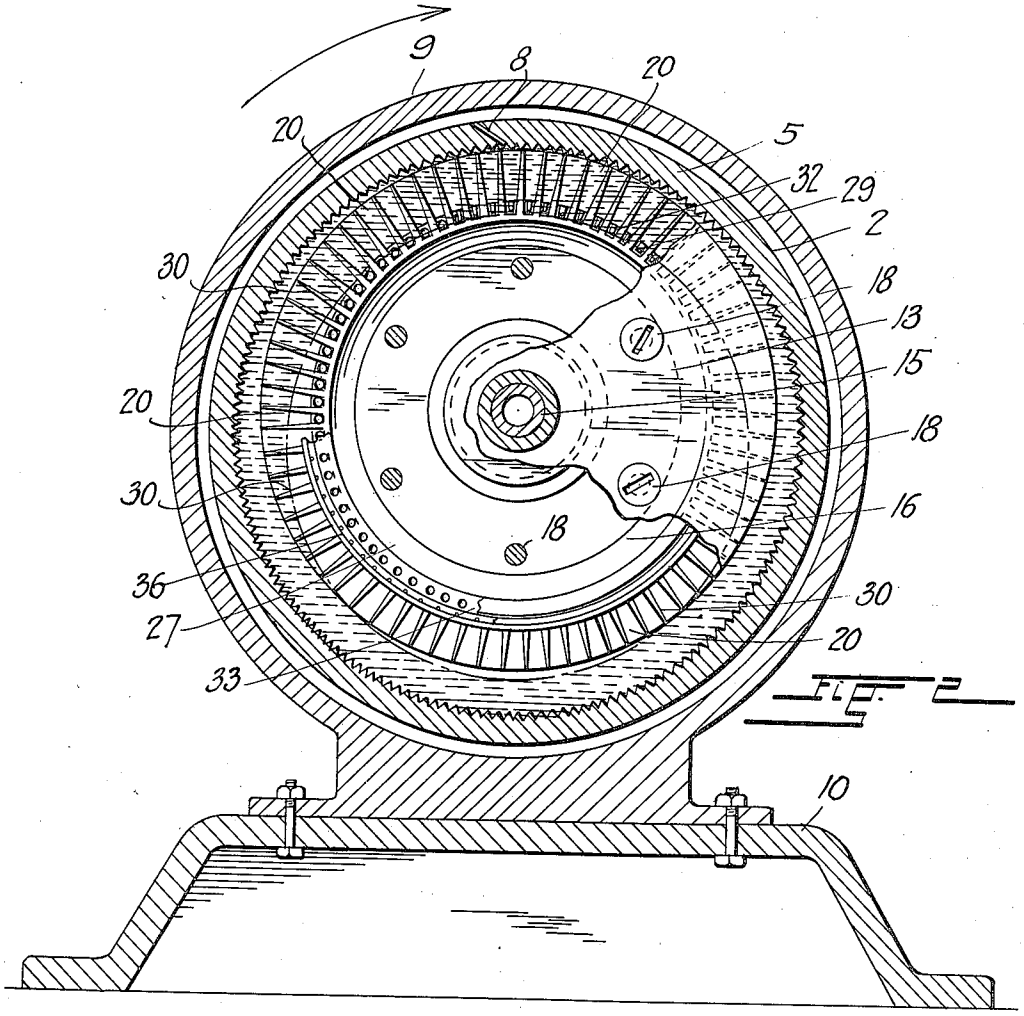


FIG. 2.

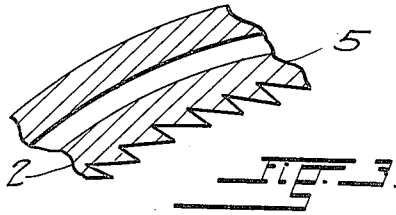


FIG. 3.

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3 SHEETS—SHEET 3.

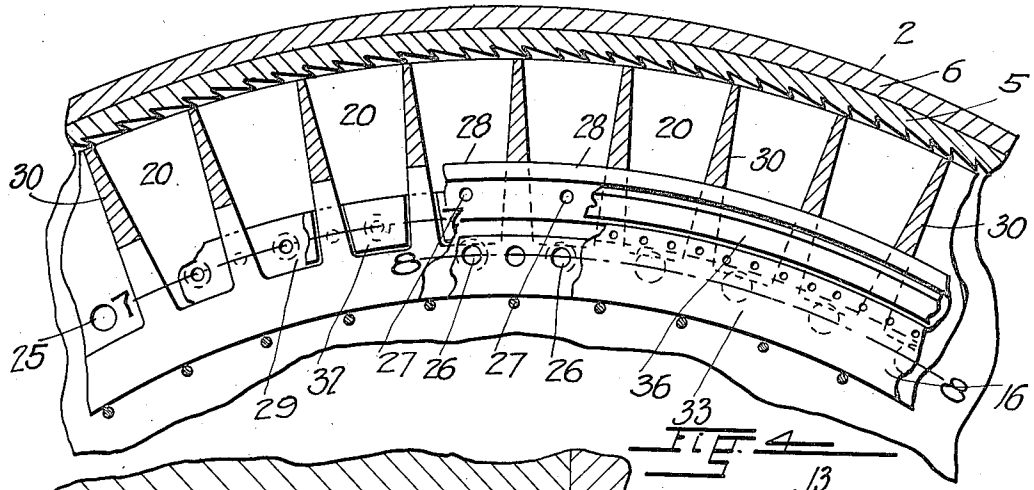


Fig. 4

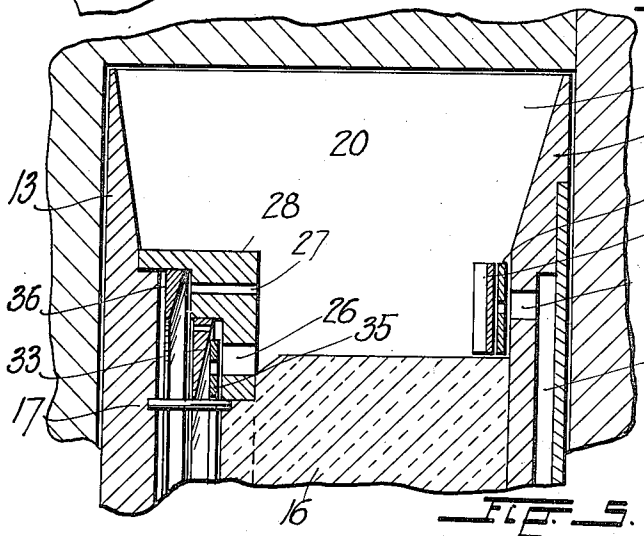


Fig. 5.

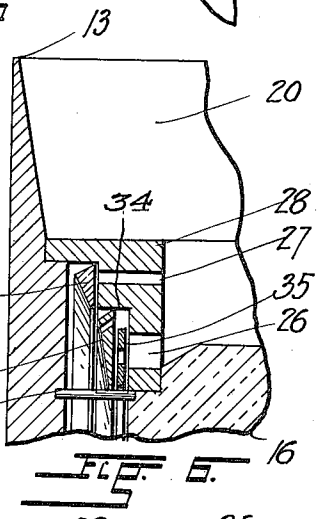


Fig. 6.

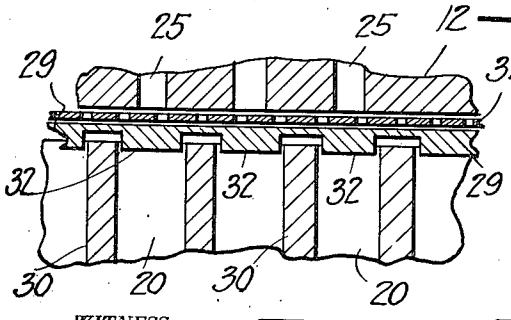


Fig. 7.

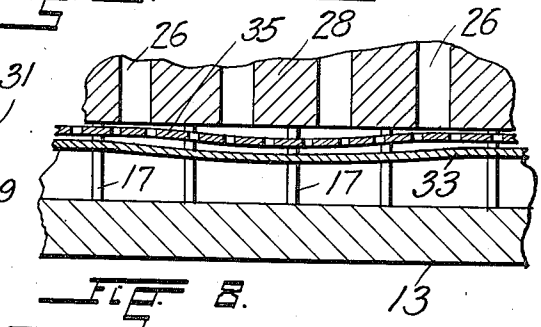


Fig. 8.

WITNESS:

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UNITED STATES PATENT OFFICE.

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ROTARY COMPRESSOR AND VACUUM-PUMP.

1,278,700. Specification of Letters Patent. Patented Sept. 10, 1918.

Application filed February 8, 1917. Serial No. 147,433.

To all whom it may concern:

Be it known that I, GEORGE C. McFARLANE, a citizen of the United States, residing at Denver, in the county of Denver and State of Colorado, have invented certain new and useful Improvements in Rotary Compressors and Vacuum-Pumps, of which the following is a specification.

This invention relates to rotary machines for the compression or exhaust of air and other gases, and its principal object is to provide in a machine of the type shown and described in my United States Letters-Patent No. 1,177,959, dated April 4, 1916, and in my application for patent, Serial No. 116,029 filed August 21, 1916, certain new and useful improvements which increase its efficiency, simplify its construction and reduce loss of energy by retrograde motion of the water used in its operation.

The essential elements of the present invention are like those of the construction disclosed in the above-referred to patent and application for patent, a rotor which is eccentrically mounted within a rotary casing and which has a number of peripheral buckets in valve-controlled connection with chambers or ducts formed interiorly of the rotor, through which the elastic fluid passes when it is displaced in the operation of the machine.

A body of water constantly replenished while the machine is in operation congregates upon the inner circumferential surface of the casing in ring-like form and converts the rotary movement of the rotor into a similar movement of the casing at a reduced rate of speed.

The rotor is tangential with the interior surface of the casing at the apex thereof and its eccentricity is proportioned so that during part of its revolution, its peripheral buckets move free from the water ring on the circumferential surface of the casing.

Air is admitted to the buckets as they emerge from the water and this air is subsequently entrapped and compressed by the buckets entering the water ring at a determinate point in the movement of the rotor.

The compressed air is forced into the interior of the rotor through valve-controlled openings and the rotor is connected with either a reservoir for the storage of air under pressure, or with a container from which air is exhausted to produce a partial vacuum.

The principal factor in attaining the above-mentioned objects of the present invention is a rotor provided with as large a number of peripheral buckets as it is possible to produce without impairing the efficiency of the element in the operation of the machine.

The buckets are preferably formed by cutting the periphery of a solid bronze ring into equidistant thin and sharp teeth by a method similar to that employed in the production of cut gears.

The depth of the teeth exceeds their circumferential pitch and the narrow spaces between them constitute the buckets in which the air is compressed as hereinbefore explained, during rotation of the rotor of which the ring is a part.

The narrowness of the buckets and their close proximity to each other make it impractical to provide separate valves for controlling the passage of air and water through the ports which connect them with the air-inlet and air-outlet of the rotor and my invention therefore includes the provision of ring-shaped valves which cover corresponding ports of the entire series of buckets and open the same by forming a catenary when subjected to pressure.

Another important object of the present invention is to increase the efficiency of the machine by resisting the back-flow of the water ring formed upon the inner circumferential surface of the casing in which the rotor is eccentrically mounted.

This object is accomplished by serrating the surface of the casing whereby to provide a series of baffles which have a retardative effect upon the water ring which is formed upon the surface in the operation of the machine.

Still a further object of the invention is to provide means for blowing a jet or spray of cooling water into each bucket for the purpose of reducing the temperature of compression.

The above and other objects all of which will fully appear in the course of the following description, I attain by an arrangement of mechanical devices which in their

preferred form have been shown in the accompanying drawings in which

Figure 1 is a vertical axial section of my improved machine,

Fig. 2, a section taken along the line 2—2, Fig. 1.

Fig. 3, a detailed sectional view of the serrations on the inner circumferential surface of the case,

Fig. 4, an enlarged fragmentary section along the line 4—4, Fig. 1,

Fig. 5, a radial section through one of the buckets of the rotor drawn to an enlarged scale,

Fig. 6, a fragmentary section similar to that of Fig. 5, showing the valve which controls the discharge openings of the buckets, in the closed position,

Fig. 7, a section of the valve covering the intake ports of the buckets, along the line 7—7, Fig. 4, and

Fig. 8, a section through the discharge valve of the buckets taken along the line 8—8, Fig. 4.

Referring to the drawings by numerical reference characters which in the several views designate corresponding parts of the mechanism, 2 designates a cylindrical casing which by means of hollow trunnions 3 is rotatably supported in bearings 4.

The casing is composed of two annular parts 5 and 6 fitted one within the other and held together by expansion and by means of a number of screws 7.

The inner surface of the casing thus constructed is transversely milled to provide the serrations which oppose retrograde movement of the water ring as hereinabove explained, the serrations having their maximum efficiency if made in ratchet form as shown in Fig. 3.

The casing has in one of its end walls, two or more radial ducts 8 which terminate in a central opening 9 connected with the interior of the casing, for the discharge of the excess of water constantly supplied while the machine is in operation.

The ducts open in the periphery of the casing to deliver the water into an annular concavity of a splash ring which is rigidly mounted upon the base 10 which supports the bearings of the machine, in spaced relation to the casing.

The rotor which is eccentrically mounted within the casing, is composed of two heads 12 and 13 secured upon the ends of axially alined hollow shaft-sections 14 and 15, a ring 16 which in conjunction with a series of distance-pins 17 spaces the heads at their peripheries, and bolts 18 which secure the parts together.

The rotor is by means of the shaft-sections rotatably supported in bearings 19 mounted on the base exteriorly of the bearings which support the hollow trunnions of the casing.

The shaft sections which extend loosely through the trunnions 3 serve in the operation of the machine to conduct the air to and from the chambers formed in the rotor by the space between its heads, and they are by means of flexible joints connected with a suitable receiver for the storage of air under pressure, or with a container from which air is exhausted, as the case may be.

Inasmuch as the connections of the shaft with the receiver or container are not part of the present invention and have been fully described in the patent and application for patent hereinbefore referred to, they have not been shown in the drawings of the present application.

The ring 16 of the rotor is peripherally grooved to provide the multiplicity of buckets 20 the construction of which has been described hereinabove.

The hollow interior of the rotor, bounded by the inner circumferential surface of its ring and the two separated heads, is divided into two chambers 21 and 22 by a cap 23 placed over the end of one of the hollow shaft-sections and secured to the corresponding head of the rotor.

The chamber 21 which hereinafter will be referred to as the admission chamber of the machine, is by means of a plurality of ducts 24 extending partially transversely and partially radially through the head to which the cap is secured, connected with the intake ports 25 of the series of buckets in the periphery of the rotor, through which the air is admitted in the operation of the machine.

The other chamber, 22, which in the operation serves as a compression or discharge chamber, connects with the discharge ports 26 of the buckets which are disposed opposite to the inlet ports, and it also connects with the buckets by means of small vent-holes 27 through which the cooling water enters the same.

For convenience in manufacture, the discharge ports and vent holes may be formed in a ring 28 made separate from the other parts of the rotor and fitted between the same as best shown in Figs. 1, 5 and 6 of the drawings.

The intake ports of the buckets are covered by an annular valve 29 which extends through recesses in the partitions 30 by which the buckets are divided.

A wearing ring 31 likewise extending through the recesses of the partitions, is placed between the annular valve and the faces of the buckets in which the ports 25 are formed, to prevent uneven wear by relative movement of the parts, and this ring is provided with a number of perforations to prevent the formation of a cushion between the valve and the faces of the buckets when after having been opened by air pressure, it reassumes its normal closing position.

The annular valve has upon its outer surface a series of equidistant ribs 32 which fit between the partitions 30 and prevent leakage of air between the buckets.

Both the annular valve and the wearing ring are sufficiently elastic to permit of their bending away from the intake ports in the form of a catenary, by pressure of air admitted to the ports from the admission chamber 21.

The discharge ports of the buckets are covered by an annular valve 33 which is disposed within the compression chamber of the rotor to open by an excess of air pressure in the buckets.

The valve 33 is of wedge-shaped section and when free from stress occupies a position in which one of its sides rests against an annular shoulder 34 on the ring 28 of the rotor and its inner side is spaced from the face of the ring in which the discharge openings 26 are formed, as shown in Fig. 5 of the drawings.

By virtue of this construction, the valve will open by centrifugal force without any excess of pressure of air in the buckets over that of the compressed air contained in the compression chamber, and it closes only when the pressure in the chamber exceeds that of the bodies of air in the buckets.

A wearing ring 35 is placed between the annular valve 33 and the face of the rotor in which the openings 26 are formed, not only to prevent uneven wear of the valve by relative movement of the parts, but also to close the buckets outside the discharge zone which were opened by the contraflexion curves at the ends of the catenary in which the annular valve separates from its seat on the rotor by pressure of air in the buckets of the same, a condition which has been illustrated in Fig. 8 of the drawings.

Both the annular valve and the wearing ring are provided with perforations which prevent cushioning when the valve moves to its closing position, permit the escape of water which during compression enters the buckets through the vent holes 27, and also facilitate the discharge of air from the buckets when the respective portion of the valve opens the discharge ports of the same.

The vent-holes through which cooling water is admitted to the buckets during compression are covered by a valve 36 which in form and operation is identical to that which controls the passage of air through the discharge ports and which like the other valve is placed within the compression chamber.

The operation of my improved machine is similar to that of the machine disclosed in the patent and application for patent hereinbefore referred to.

The rotor is rotated at a high velocity by connecting one of its shaft sections with a conveniently located motive agent, and water is introduced into the shaft section connecting with the admission chamber, through a pipe 37.

The water following the rotary motion of the rotor congregates at the inner circumferential surface of the casing in ring-like form and by its frictional contact with both the rotor and the casing, converts the rotary motion of the one into a corresponding movement of the other at a reduced rate of speed, it being observed that as hereinabove explained, the serrations in the circumferential surface of the casing, prevent loss of energy by back-flow or retrograde motion of the water-ring.

The eccentricity of the rotor which is tangential with the interior surface of the casing at the apex thereof is such that at the opposite lower part of the casing the rotor runs free from the annular body of water which in Fig. 2 of the drawings has been designated by horizontal hatching.

Premising that the parts rotate in the direction of the arrow in Fig. 2, the buckets at the descending side of the rotor in emerging from the water-ring discharge their liquid contents with the result that a partial vacuum is formed which causes the portions of the annular valve and wearing ring which covered the respective intake ports to bend away from the surface in which said ports open and thereby permit air of atmospheric pressure to enter the buckets from the admission chamber.

When the buckets subsequently dip into the water-ring at the ascending side of the rotor, the air with which they are filled is entrapped and slowly compressed into the bottom portions of the buckets by the water pressure until its expansive force is substantially equal to or slightly in excess of the air pressure in the compression chamber of the rotor, when by the movement of the respective portion of the valve 33 which was torsioned by the air-pressure in the rotor, away from the face of the ring in which the discharge ports are formed, as hereinabove explained, said ports are opened to discharge the bodies of compressed air from the buckets into the compression chamber which by means of the hollow shaft section with which it communicates, is connected with a suitable receiver.

It will be seen that the discharge valve is stressed when in its closed position and opens naturally when relieved of pressure, by forming a catenary over the discharge ports of the buckets in which the air is compressed to the required degree, without stretching beyond its elastic limits.

The open portion of the discharge valve remains in this condition until all the air is expelled from the buckets when by air pressure in the compression chamber it is returned to its closing position.

The water expelled from the buckets with the air is constantly forced into the spaces between the rotor and the heads of the casing and the surplus is discharged from the machine through the ducts 8 into the splash ring.

The sheets of water between the rotor and the casing prevent their coming in frictional contact during rotation and also prevent the escape of air from the machine.

Water accumulating in the compression chamber into which it was admitted with the air discharged from the buckets, is during compression forcibly injected into the bodies of air contained in the buckets and thus reduces the heat of compression, owing to the provision of the ring 36, which is of triangular cross section and which in its unstressed position, loosely covers the water-openings 27.

The action of the compressed air inside the compression chamber is sufficient to hold the triangular ring tightly against the orifices of the openings except when the pressure of the air in the buckets is nearly equal to the pressure in the compression chamber at which time the section of the ring over these buckets tends by the stress of its metal to assume the position shown in Fig. 5, allowing water to be forced into the buckets through the openings 27.

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

1. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, and ports connecting said buckets with said air-inlet and said air-outlet, and elastic, annular valves controlling the flow of fluid through said ports.

2. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, and ports connecting said buckets with said air-inlet and said air-outlet, elastic, annular valves controlling the flow of fluid through said ports, and wearing-rings loosely disposed between said valves and their seats.

3. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, and ports connecting said buckets with said air-inlet and said air-outlet, elastic, annular valves controlling the flow of fluid through said ports, and perforated wearing-rings loosely disposed between said valves and their seats.

4. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, valve-controlled ports connecting said buckets with said air-outlet, and ports connecting the buckets with the air-inlet, and an annular elastic valve covering the last-mentioned ports within the buckets.

5. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, valve-controlled ports connecting said buckets with said air-outlet, and ports connecting the buckets with the air-inlet, and an annular elastic valve covering the last-mentioned ports within the buckets, and having ribs to prevent its rotary displacement, by engaging the partitions between the buckets.

6. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, valve-controlled ports connecting said buckets with said air-inlet, and ports connecting the buckets with the air-outlet, and an annular elastic valve adapted to cover the last-mentioned ports when stressed by fluid-pressure and to uncover the same when unstressed.

7. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which e[illegible] said liquid mass during its rotary n[illegible]

ment, valve-controlled ports connecting said buckets with said air-inlet, and ports connecting the buckets with the air-outlet, and a perforated annular elastic valve adapted to cover the last-mentioned ports when stressed by fluid-pressure and to uncover the same when unstressed.

8. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, valve-controlled ports connecting said buckets with said air-inlet, and ports connecting the buckets with the air-outlet, an annular elastic valve adapted to cover the last-mentioned ports when stressed by fluid-pressure and to uncover the same when unstressed, and a wearing ring loosely disposed between said annular valve and its seat.

9. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, valve-controlled ports connecting said buckets with said air-inlet, and ports connecting the buckets with the air-outlet, an annular elastic valve adapted to cover the last-mentioned ports when stressed by fluid-pressure and to uncover the same when unstressed, and a perforated wearing ring loosely disposed between said annular valve and its seat.

10. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having an air-inlet, an air-outlet, a multiplicity of peripheral buckets which enter said liquid mass during its rotary movement, valve-controlled ports connecting said buckets with said air-inlet, and ports connecting the buckets with the air-outlet, and an annular elastic valve of wedge-shaped section adapted to cover the last-mentioned ports when stressed by fluid-pressure and to uncover the same when unstressed.

11. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having peripherally a multiplicity of buckets which enter said liquid mass during its rotary movement, interiorly an admission-chamber and a discharge-chamber, ports connecting said buckets with said admission chamber, an annular elastic valve covering said ports within said buckets, ports connecting the buckets with the discharge-chamber, and an annular elastic valve adapted to cover the last-mentioned ports within the discharge chamber.

12. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having peripherally a multiplicity of buckets which enter said liquid mass during its rotary movement, interiorly an admission-chamber and a discharge chamber, valve-controlled ports connecting said buckets with said chambers, and valve-controlled holes connecting said discharge chamber with said buckets for the injection of cooling water thereinto.

13. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having peripherally a multiplicity of buckets which enter said liquid mass during its rotary movement, interiorly an admission-chamber and a discharge-chamber, valve-controlled ports connecting said buckets with said chambers, holes connecting said discharge chamber with said buckets for the injection of cooling-water thereinto, and an annular elastic valve covering said holes within the discharge-chamber.

14. In a machine of the character described, the combination of a rotary container, a hollow rotor eccentrically mounted therein, hollow shaft-sections for the support of the rotor, in connection with its hollow, a cap covering the orifice of one of said shaft-sections to divide the hollow of the rotor into an admission chamber and a discharge-chamber, and a mass of liquid maintained by motion of the rotor, against the inner circumferential surface of the container, said rotor having a multiplicity of peripheral buckets which enter the liquid mass during its rotation, and valve-controlled ports which connect the buckets with said admission and discharge chambers.

15. In a machine of the character described, the combination of a rotor composed of opposite heads and a ring spacing the same at their peripheries, said ring having a multiplicity of peripheral buckets in connection with the space between said heads.

16. In a machine of the character de-

scribed, the combination of a rotary container, and a rotor eccentrically mounted therein and having an air-inlet, an air outlet, a multiplicity of peripheral buckets, and valve-controlled ports in connection with said air inlet and said air-outlet, said container being composed of two annular members fitted one within the other.

17. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor against the inner circumferential surface of the container, said rotor having a multiplicity of thin, outwardly tapering teeth which are spaced to form a multiplicity of peripheral buckets, an air-inlet, an air-outlet, and valve-controlled ports connecting said buckets with said air-inlet and said air-outlet, there being a minute clearing space between the circumference of the rotor and the inner circumference of the container at the point of nearest approach, and the inner circumferential surface of the container being serrated to provide a multiplicity of minute teeth substantially parallel with the teeth of the rotor, there being a minute clearing space between the circumference of the tips of the rotor teeth and the tips of the serrations of the container at the point of nearest approach.

18. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor against the inner circumferential surface of the container, said rotor having peripheral buckets, an air-inlet, an air-outlet, and valve-controlled ports connecting said buckets with said air-inlet and said air-outlet, and the inner surface of the container being serrated to provide a multiplicity of minute teeth, there being a minute clearing space between the circumference of the rotor and the serrated surface of the container at the point of nearest approach.

19. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor against the inner circumferential surface of the container, said rotor having peripheral buckets, an air-inlet, an air-outlet, and valve-controlled ports connecting said buckets with said air inlet and said air-outlet, and the inner surface of the container being serrated to provide a multiplicity of minute ratchet-shaped teeth, there being a minute clearing space between the circumference of the rotor and the serrated surface of the container at the point of nearest approach.

20. In a machine of the character described, the combination of a rotary container, a rotor eccentrically mounted therein, and a mass of liquid maintained by motion of the rotor against the inner circumferential surface of the container, said rotor having peripheral buckets, an air-inlet, an air-outlet, and valve-controlled ports connecting said buckets with said air-inlet and said air-outlet, and the inner surface of the container being serrated to provide a multiplicity of minute ratchet-shaped teeth the front faces of which pitch forward in the direction of the rotation of the container, there being a minute clearing-space between the circumference of the rotor and the serrated surface of the container at the point of nearest approach.

In testimony whereof I have affixed my signature in presence of two witnesses.

GEORGE C. McFARLANE.

Witnesses:

F. H. Cuno,

Lela L. Rhoades.