July 25, 1933. W. W. PAGET 1,919,252

AIR COMPRESSOR

Filed Oct. 15, 1931 2 Sheets-Sheet 1

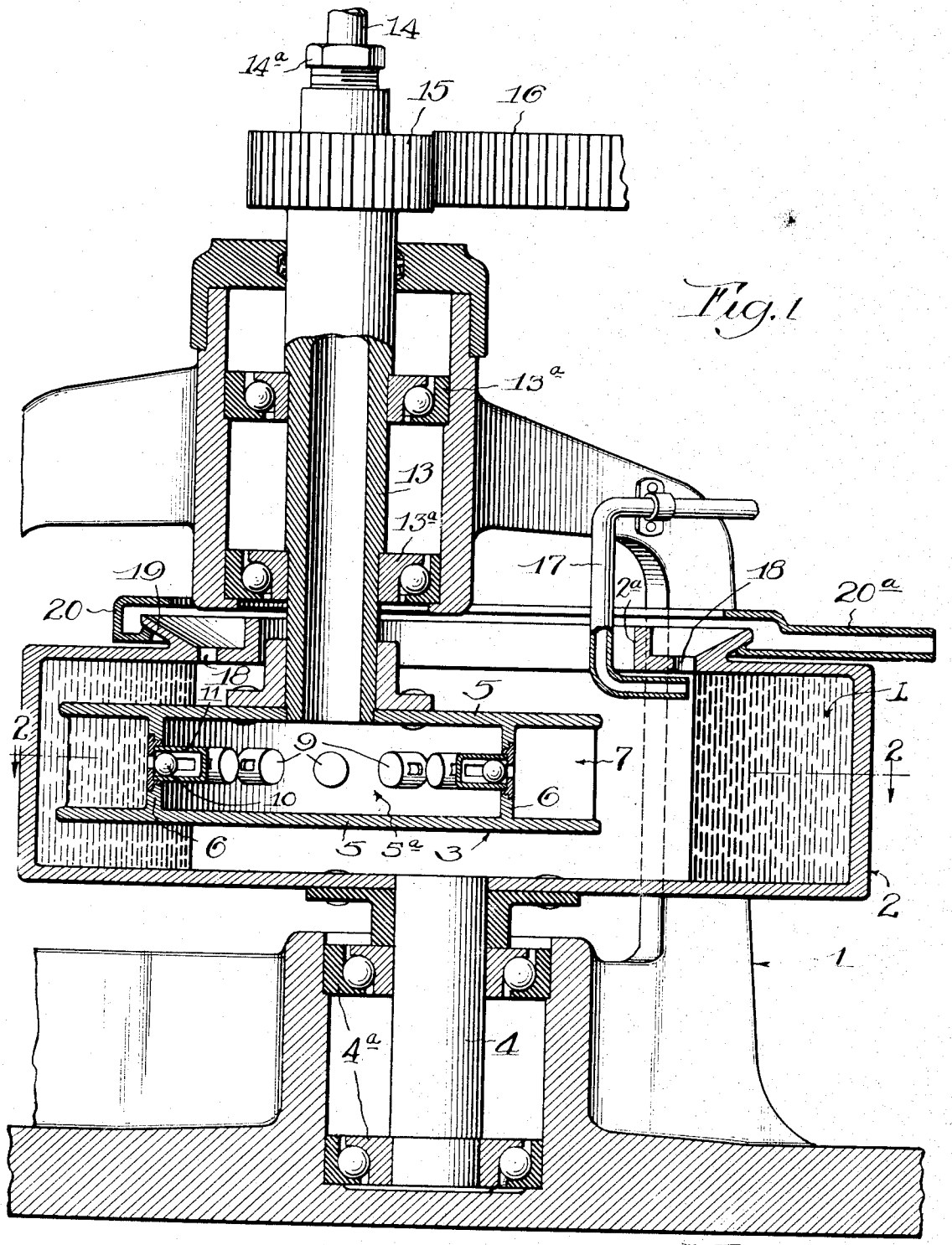


Fig. 1

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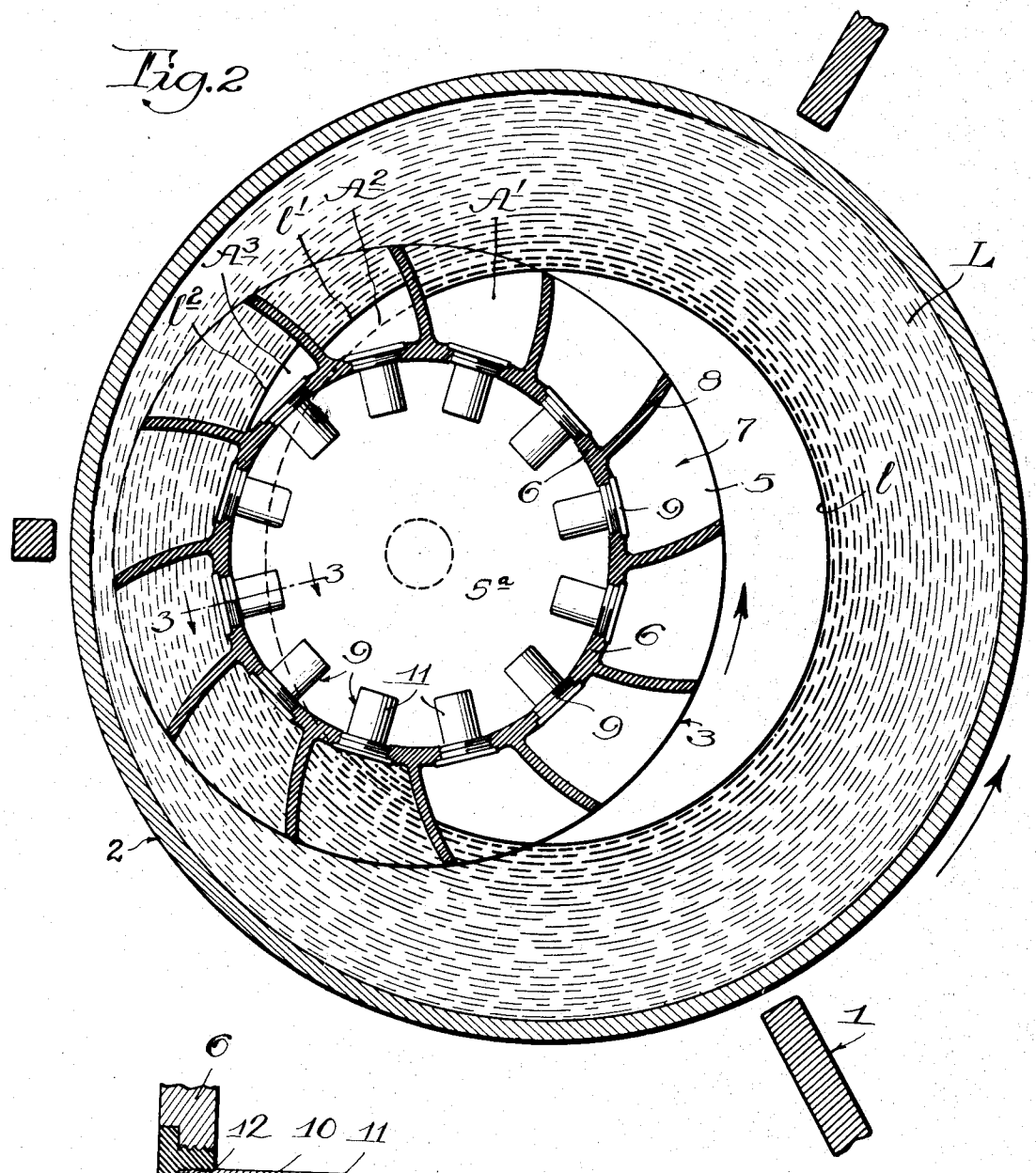
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Fig. 2



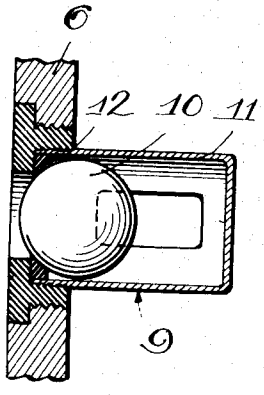


Fig. 3

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UNITED STATES PATENT OFFICE

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AIR COMPRESSOR

Application filed October 15, 1931. Serial No. 568,928.

This invention relates to improvements in air compressors, and more particularly to compressors of the type which utilize a liquid as the compressive medium.

The object of the invention is to provide a novel and practical type of air compressor, calculated to operate at a high degree of efficiency and with a minimum of wear on the moving parts.

The principle involved in the operation of the improved compressor together with its mechanical construction and design is disclosed in the accompanying drawings, in which

Figure 1 is a general view in vertical section through the compressor;

Figure 2 is a view in horizontal section through the drum and rotor as taken on line 2—2 of Figure 1, and

Figure 3 is an enlarged detail of the valve construction as taken on line 3—3 of Figure 2.

The moving parts of the machine are supported upon a suitable frame 1 for rotation about vertical axes, the main moving parts being a relatively shallow cylindric drum 2 and a rotor 3 located within the drum with its axis offset from or eccentric with respect to the axis of said drum.

The drum has the form of a cylindric casing with a circular opening 2^a in its top wall of a diameter of approximately one-half the diameter of the drum and concentric with its axis. Depending centrally from its bottom wall is a stud shaft 4 journalled in suitably designed bearings 4^a, 4^a whereby the drum is mounted to rotate freely about its vertical axis.

The rotor 3 also has the general form of a drum consisting of a pair of circular walls 5, 5 spaced apart and an annular transverse wall 6 joining the circular walls substantially midway between their common axes and peripheries and dividing the space between the circular walls radially into a central chamber 5^a and an annular surrounding channel. This outer channel is subdivided into a plurality of outwardly opening pockets 7 by a series of blades or vanes 8 spaced apart at equal intervals about the rotor. These vanes are based upon the annular wall 6 and are curved slightly in the same direction, although disposed in a generally radial relation to the axis of the rotor. Each pocket has a valved port 9 through its bottom section of the annular wall 6 to the internal chamber 5^a at the center of the rotor. Each of the valved ports has a ball-shaped valve member 10 adapted to normally close the opening from the inside of the central chamber, being enclosed within a slotted cylindric cage 11 of a light metal construction projecting into the internal chamber, and adapted to engage a concave valve seat 12 surrounding the opening. These valved openings or ports extending circumferentially around the central chamber in equally spaced relation, provide the discharge openings for the compressed air to be delivered from the pockets.

The rotor, as already noted, is suspended within the drum, said rotor having a hollow shaft 13 extending upwardly from the center of the top wall and journalled in bearings 13^a immediately above the drum 2. Above the bearing 13 is a pinion 15 fixed to the shaft 12 and meshing with a suitable driving gear 16. Any suitable drive, however, may be employed for the rotor. Thus the rotor 3 is the driven member, while the drum 2 is mounted to idle or rotate freely on its axis.

Now, within the drum is contained a quantity of liquid L, such as water, which is preferably supplied continuously to the drum through a feed pipe 17 projecting downwardly through the top opening 2^a in the drum near its edge and thence turned radially.

It will be understood at this point that any liquid introduced into the drum would in the absence of rotative movement find its level in a horizontal plane, so that in defining the disposition of this liquid, it must be assumed that it is rotating with the drum at such a high speed that centrifugal force overcomes the force of gravity, and it becomes an annular body with its level defined by an annular surface substantially coinciding with the edge of the top opening 2^a of the drum and concentric with the axis of rotation of the drum. Moreover, the rotor being the driv-

ing member, the drum becomes a driven member and rotates only because of the friction exerted on its internal surface by the liquid, which in turn is being circulated by the rotor. Thus when starting the machine, the rotor is started and the liquid, which, with the parts stationary, contacts with the lower portions of the rotor, gradually commences to flow in a circular path under the impeller action of the rotor blades, followed by the rotation of the drum under the frictional resistance offered by its internal surface, until finally the rotor, the mass of liquid and the drum are rotating at the same speed and substantially as a unit, the liquid constituting a substantially quiescent fluid compressing medium between the rotor and the drum.

With the relationship between the moving parts and the disposition of the liquid mass when the compressor is operating at its normal speed clearly in mind, the compressor action will now be discussed with the aid of certain graphic representations on Figure 2. In the first place, it is seen that the axis of rotation of the rotor is eccentric to the axis of the drum as well as the annular surface or level of the liquid indicated by the letter l. Thus assuming that the rotor is turning in a counterclockwise direction as indicated by the arrow, a portion of its periphery including an arc somewhat less than a semi-circle, at all times falls inside of the circle indicating the liquid level l, whereas the remaining arc of the rotor periphery falls outside of or below the liquid level. Now the annular space at the central portion of the drum manifestly forms an air space into which air at atmospheric pressure enters through the top opening 2^a. Hence the air enters and fills the pockets 7 in the rotor which at the moment are inside of the circle l indicating the liquid level. Thus tracing the progress of one of these pockets filled with atmospheric air, it follows that as it travels toward the point where its periphery intersects the liquid level l, the air (indicated by the unshaded area A^1) trapped therein undergoes no compression until the trailing vane 8 of the particular pocket being considered has passed into the body of the liquid L. At this point the volume of air trapped in the pocket is subjected to the pressure of the liquid which tends to maintain its annular level and therefore to press into the pocket as the latter travels to a greater depth below the liquid level in its eccentric path of travel. Thus at the outset there are two opposing forces set up, namely, that of the pressure of the liquid compressing the air, and the air resisting or forcing back the water. However, the air being less dense than the water, it is subjected to a steadily increasing liquid pressure, although there is an accompanying resistance to compression offered by the air, with the result that there is a depression of the water level in the pocket below the normal level l to that indicated by the dotted line l^1, this first stage of compression being indicated by the smaller area A^2 in Figure 2. Similarly as the rotor carries the same pocket still deeper below the normal level l to the next stage, the pressure is proportionately increased, with the result that the air is further compressed to its maximum reduced volume A^3, which is accompanied with a further depression of the liquid level to that indicated by l^2.

Now, the valve associated with the particular pocket being considered, is held to its seat by centrifugal force during the first two stages of compression A^1 and A^2, but upon reaching the third stage A^3 the pressure to which the air is compressed overcomes the opposing centrifugal force holding the valve to its seat, and the valve opens allowing the compressed air to pass into central chamber 5^a, the valve closing immediately after the air has escaped as the normal conditions are restored.

This series of steps is performed by each pocket once during each revolution, and since there are a considerable number of pockets and the rotor is revolving on its axis at a high rate of speed, it follows that although the volume of air compressed in each pocket is relatively small, the aggregate is quite large, and comparable to the capacity of compressors of other types of the same or approximate rating.

The compressed air manifestly is discharged through the hollow rotor shaft 13 from the central chamber 5^a to a suitable storage tank or other point of use, the connection from the end of the rotating shaft to a stationary pipe 14 being preferably through a suitable joint 14^a packed with a fluid sealing medium such as mercury.

From the foregoing, it will be seen that the compression is primarily effected by the pressure exerted by a body of liquid upon small increments of air trapped at atmospheric pressure and depressed below the liquid level. The operation is made continuous by arranging the pockets in which the air is trapped, radially about a driven rotor mounted to rotate about an axis eccentric to the axis of the freely rotating drum in which the annular mass of the liquid is retained. It follows, therefore, that under the impeller action of the rotor, the mass of liquid revolves with the drum about a common axis, and at the same speed as the rotor so that the compression of the air is the result of the pressure of the liquid upon the volumes of trapped air, and not the utilization of kinetic energy of the water.

Manifestly heat is generated during the operation of the machine as it is whenever air is compressed, this being latent heat which

in this case is absorbed by the liquid, being a natural cooling medium. It is for this reason that it is preferred to continually add fresh liquid to the drum which enters through the feed pipe as heretofore described. It follows also, that it is necessary to maintain a constant liquid level in the drum, and for this purpose an overflow is provided in the form of a series of openings 18 in the top wall of the drum surrounding the edge of the top opening 2^a which is preferably flanged as shown in Figure 1. Just beyond the circle including this flanged opening is an outer concentric flange 19 inclined upwardly and outwardly at an angle of approximately 45° to the vertical. The outer edge of this flange is surrounded by a stationary collecting ring 20 having an internally facing U-shaped channel and a discharge pipe 20^a leading radially therefrom. Thus as fresh liquid is added to the drum, the level of the liquid tends to advance toward the axis of the drum, and in so doing the liquid overflows through the openings 18 and thence is thrown by centrifugal force into the collecting ring 20 for disposal. In this manner the liquid is maintained at a uniform temperature and volume within the drum.

It may be stated that water is suitable for use as the fluid compressing medium, although heavier liquids or even mercury would be equally serviceable under varying conditions. Consequently I do not wish to be limited to the use of any particular form of liquid, nor in fact to any specific details of the apparatus shown.

I claim as my invention:

1. An air compressor comprising a drum mounted to rotate freely about a vertical axis and having a closed bottom and a top inlet, a driven rotor mounted within said drum with its axis offset from but parallel to the axis thereof, and a predetermined quantity of liquid within said drum, said drum, liquid and rotor being adapted to rotate simultaneously whereby said liquid under centrifugal force becomes an annular mass having its surface substantially concentric with the axis of rotation of the drum, said rotor having a plurality of radially opening pockets about its periphery, means for admitting air to said drum and within the space surrounded by the liquid whereby the same is trapped within the pockets and carried thereby below the surface of the liquid to be compressed thereby, and means for automatically releasing the compressed air from the bottom of said pockets when the stage of maximum compression is reached.

2. An air compressor comprising a drum closed at its bottom and open at its top and mounted to rotate freely about a vertical axis, a driven rotor mounted within said drum with its axis offset from the axis thereof, and a quantity of liquid within said drum and maintained in motion with said drum by force created by the impeller action of said rotor whereby the liquid assumes the form of an annular mass having its surface concentric with the axis of rotation of the drum, said rotor having a plurality of radially opening pockets about its periphery adapted to travel in an eccentric path relative to the annular surface of the liquid whereby the air at atmosphere pressure is trapped within said pockets and carried thereby below the level of the liquid and compressed, and valved ports acting automatically to pass the compressed air from the pockets.

3. An air compressor comprising a drum mounted to rotate freely about a vertical axis, a driven rotor mounted within said drum with its axis offset from but parallel to the axis thereof, a predetermined quantity of liquid within said drum, said drum, liquid and rotor being adapted to rotate in the same direction and simultaneously whereby said liquid under centrifugal force becomes an annular mass having its surface concentric with the axis of rotation of the drum, said rotor comprising a plurality of radially opening air pockets surrounding a central chamber connected therewith by a plurality of valved ports, means for admitting air at atmospheric pressure to said drum, a discharge pipe connected with the central chamber of said rotor, and means for continuously effecting a controlled change of the liquid within said drum.

4. An air compressor comprising a drum mounted to rotate freely about a vertical axis, a driven rotor mounted within said drum with its axis offset from the axis thereof, a predetermined quantity of liquid within said drum, said drum, liquid and rotor being adapted to rotate in the same direction and simultaneously whereby said liquid under centrifugal force becomes a substantially stable mass having an annular free surface concentric with the axis of rotation of the drum, said rotor comprising a plurality of radially opening air pockets surrounding a central chamber separated therefrom by an annular wall, valved ports in said annular wall connecting said central chamber with each of said pockets, and operative by the pressure exerted by the air at a predetermined degree of compression to open and pass the air to said central chamber, means for conducting the compressed air from said chamber, and means for continuously effecting a controlled change of the liquid within said drum including liquid supply means and means for automatically discharging excess liquid from the top of said drum.

5. An air compressor comprising a drum mounted for free axial rotation on a vertical axis and having an air inlet opening adjacent its axis, a quantity of liquid contained within

said drum and subject to centrifugal force acting in the rotation thereof to assume a surface concentric with the axis of rotation of the drum, a driven rotor mounted in said drum and rotative on an axis eccentric to the axis thereof, said rotor having radially opening pockets about its periphery and a central chamber communicating with said pockets through valved openings, each of said pockets during the rotation of said rotor moving from a position above the surface of the liquid to a predetermined depth below the surface whereby the quantity of air within each pocket is compressed by the pressure of the liquid exerted thereon, and thereupon discharged through a valved opening into the central chamber of said rotor, means for conducting the compressed air from said rotor, and means for continuously effecting a controlled change of the liquid within said drum.

6. An air compressor comprising a drum mounted for free axial rotation on a vertical axis and having an air inlet opening adjacent its axis, a quantity of liquid contained within said drum and subject to centrifugal force acting in the rotation thereof to assume a surface concentric with the axis of rotation of the drum, a driven rotor mounted in said drum and rotative on an axis eccentric to the axis thereof, said rotor having radially opening pockets about its periphery and a central chamber communicating with said pockets through valved ports, each of said pockets during the rotation of said rotor moving from a position above the surface of the liquid to a predetermined depth below the surface whereby the quantity of air within each pocket is compressed by the pressure of the liquid exerted thereon, said valve ports acting automatically under the pressure of the air to open at the stage of maximum compression to permit the passage of the air into said central chamber of said rotor, and means for continuously effecting a controlled change of the liquid within said drum including liquid supply means and means for automatically discharging excess liquid from the top of said drum.

7. An air compressor comprising a container freely rotatable upon a vertical axis, a mass of liquid in said container adapted to assume a condition of substantial stability relative thereto, a driven rotor rotatable in said container about a vertical axis eccentric to the container and the surface of the liquid during normal rotation of the rotor and container, said rotor having a plurality of air pockets about its periphery adapted to trap the air at atmospheric pressure and carry it beneath the surface of the liquid to compress the air, means for releasing the compressed air from said pockets, means for controlling the quantity of liquid in said container including a vertical opening through the upper wall of the latter surrounded by a throwing flange, and a drain casing enclosing said flange.

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