W. HUNT.

EXHAUSTER OR COMPRESSOR FOR GASES, ALSO APPLICABLE AS AN EJECTOR CONDENSER.

APPLICATION FILED OCT. 28, 1911.

1,040,981. Patented Oct. 8, 1912.

4 SHEETS—SHEET 1.

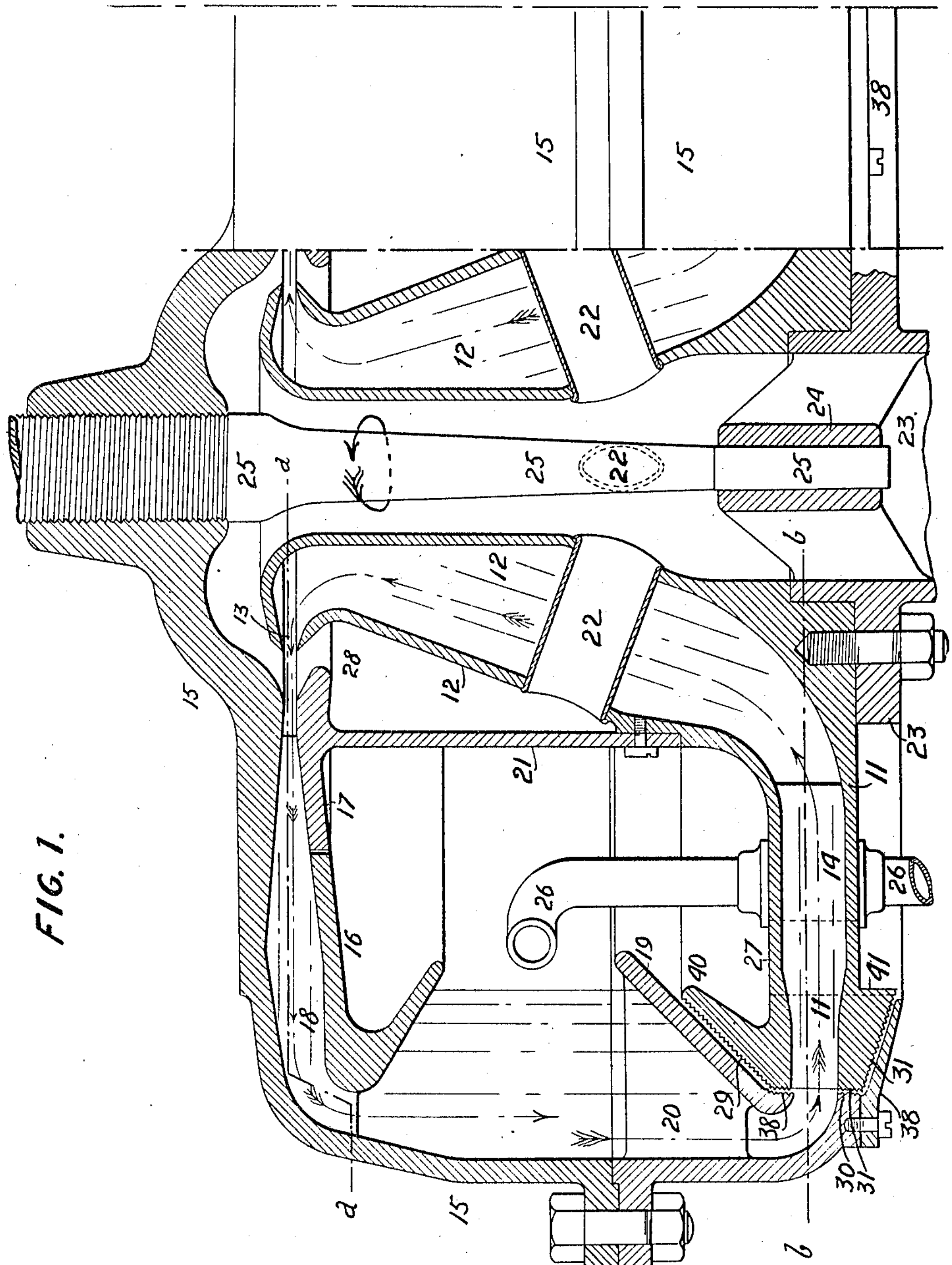

FIG. 1.

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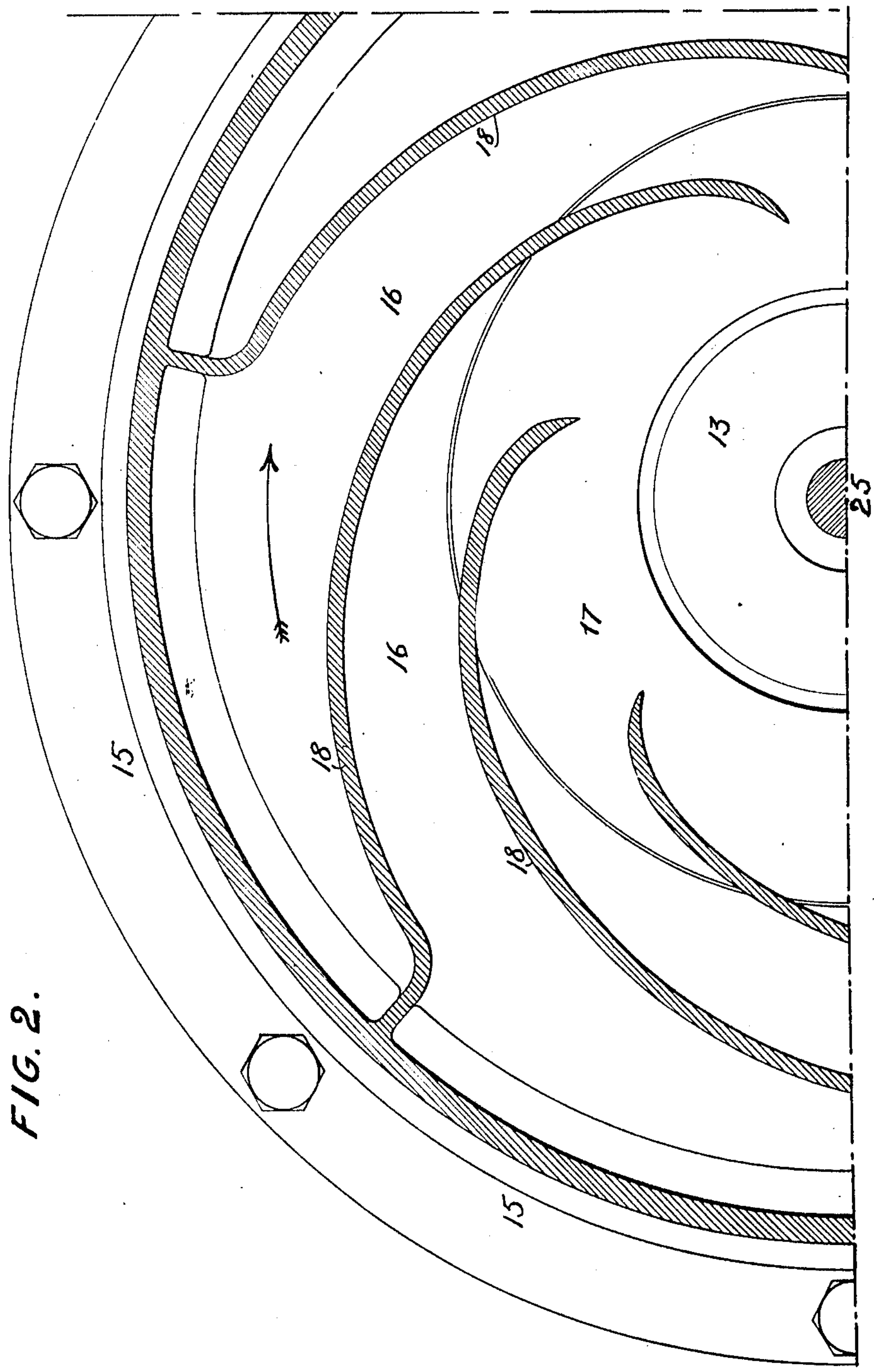

FIG. 2.

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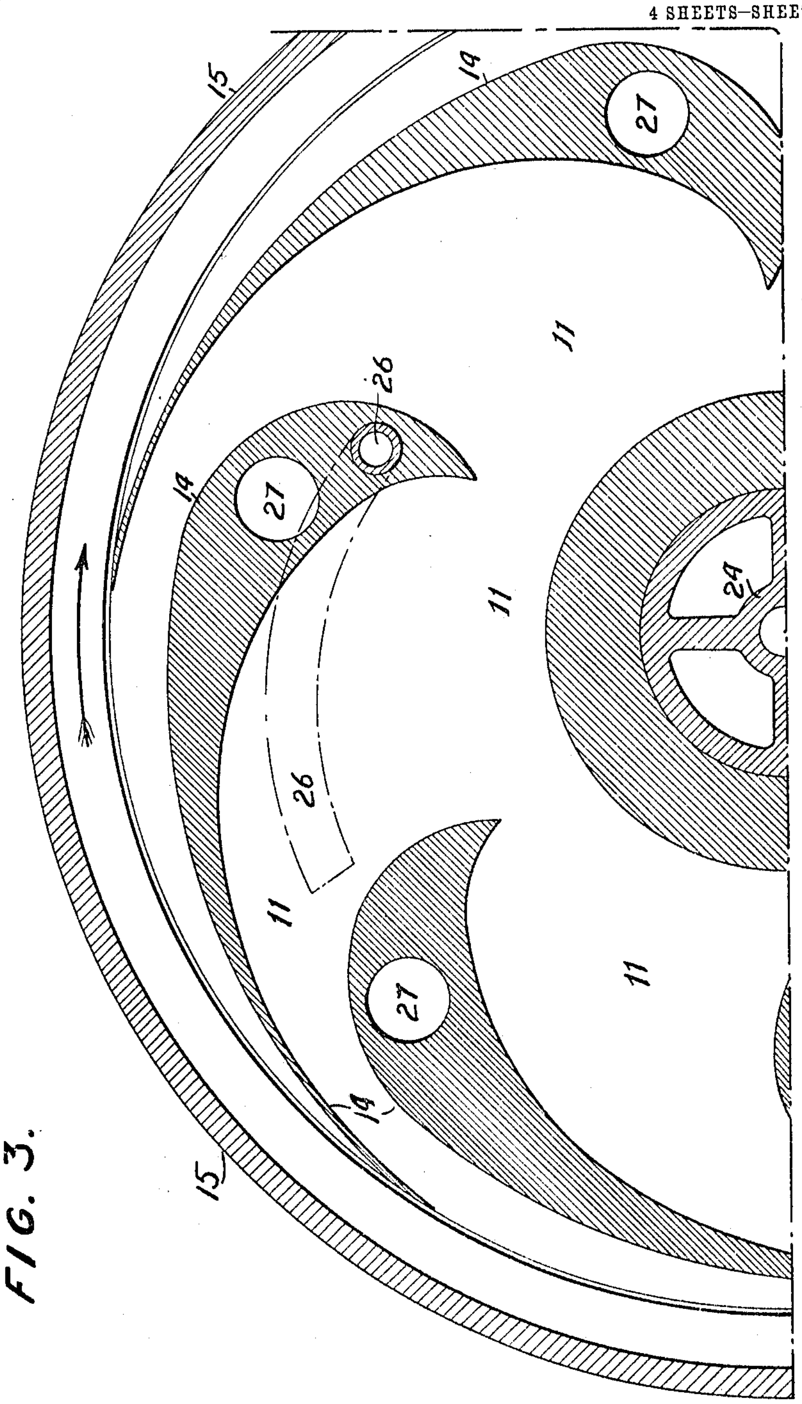

FIG. 3.

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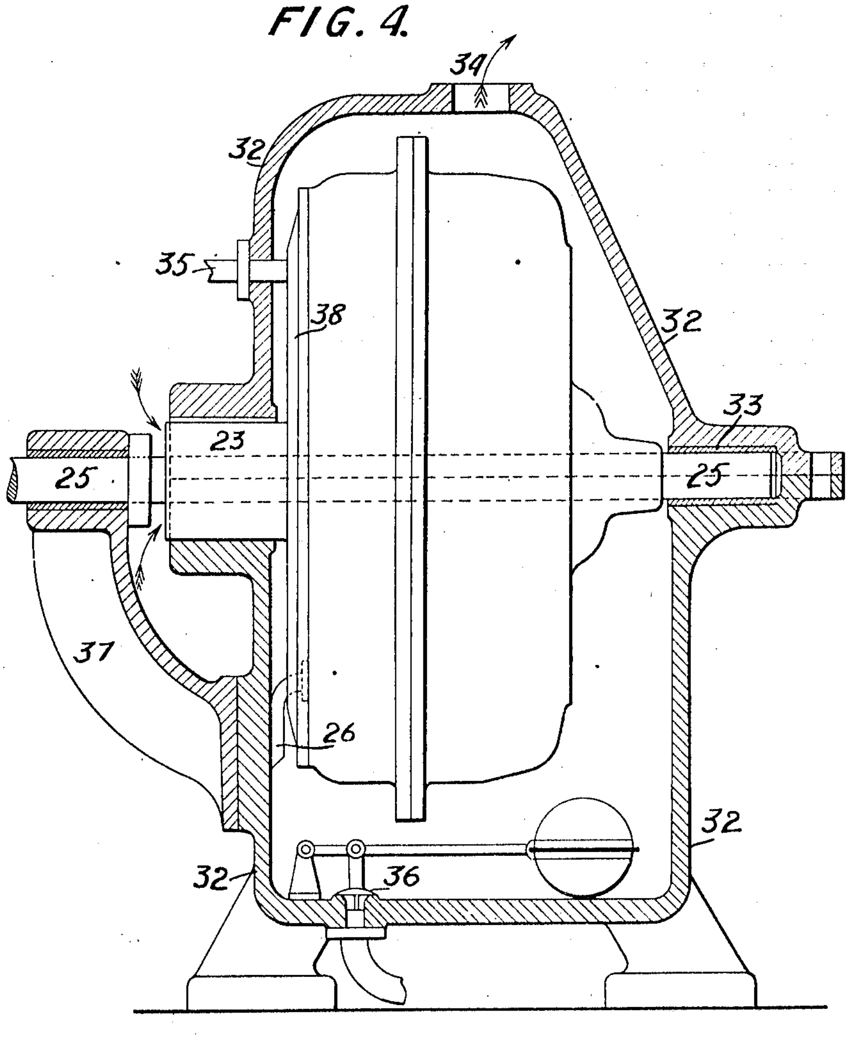
4 SHEETS—SHEET 4.

FIG. 4.



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UNITED STATES PATENT OFFICE.

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EXHAUSTER OR COMPRESSOR FOR GASES, ALSO APPLICABLE AS AN EJECTOR-CONDENSER.

1,040,981. Specification of Letters Patent. **Patented Oct. 8, 1912.**

Application filed October 28, 1911. Serial No. 657,308.

To all whom it may concern:

Be it known that I, Wilfred Hunt, a subject of the King of Great Britain and Ireland, and a resident of Hillhead, Glasgow, Scotland, have invented a certain new and useful Exhauster or Compressor for Gases, also Applicable as an Ejector-Condenser, of which the following is the specification.

The invention has for its object to provide an apparatus in which the energy in a moving body of liquid is utilized in the known manner of an ejector to produce a pressure-difference in a gas handled by it, and in which the operative liquid or a major part of it moves in a closed cycle, the greater part of its energy being thus conserved.

The apparatus, applicable as an exhauster or compressor or as an ejector-condenser, comprises essentially two members, one the "returner", rotatory, the other the "director", stationary, and both of annular form as a whole. Both inner and outer peripheries of these members are interconnected. Between the inner peripheries is a passage provided with an ejector device. Between the outer peripheries is an annular passage or chamber provided with devices for the discharge of the gas handled and it may be also of the operative liquid. The inner passage is stationary, the outer annular passage or chamber is rotatory. The members are provided with vanes or passages within them, the returner to direct liquid outward, the director to collect liquid circumferentially from the rotatory annular passage or chamber and direct it radially or more or less so inward. Means are provided for maintaining a determinate radial depth of liquid in the annular passage or chamber when the apparatus is rotating, and the annular area of that body of liquid and its depth axially are so proportioned to the capacity of the members that time is given for the due discharge centripetally by centrifugal pressure developed in the liquid of gas taken up by the liquid.

When the apparatus is for use as an exhauster or ejector-condenser, the annular effective width of the returner, the radial distance of its mean radius and the speed of rotation may be so jointly proportioned that the radial column of liquid contained in the annulus of the returner is barometric—that is to say, the speed of revolution is such that the centrifugal force developed in the annular column of liquid between the outer and the inner peripheries of the returner causes a centrifugal pressure at the outer periphery of two atmospheres absolute when the inner periphery is open to the atmosphere and the annulus is maintained full of liquid.

In order that the invention and the manner of performing the same may be properly understood, there are hereunto appended four sheets of explanatory drawings, Figure 1, Sheet 1, being a sectional side elevation, and Figs. 2 and 3, Sheets 2 and 3, sectional plans, respectively, on the lines *a—a* and *b—b* of Fig. 1 of an example of an exhauster made according to the invention, and Fig. 4, Sheet 4, a sectional elevation of the same apparatus adapted as a compressor.

As has been said, an apparatus made according to the invention comprises essentially two members—a rotatory returner and a fixed director. These are co-axial. The fixed director consists of a hollow disk 11 merging in a hollow annular and tubular part 12 which terminates in an annular jet nozzle 13. There are blades 14 within the disk part of the director, these blades are substantially tangential at the periphery, curving as they proceed inward so as finally to direct the inflowing water radially.

The rotatory returner consists of a drum 15 made circumferentially in halves bolted together. Fixed within the drum is an annular disk part 16 forming with a like stationary part 17 one side of an annular passage extending from the jet nozzle 13 to the outer part of the drum, the other side of which is formed by the end of the drum. Within this annular passage are blades 18. Fixed within the drum also and adjacent to the entrance to the disk part 11 of the fixed director is a conical part 19 between which part and the curved wall of the drum 15 is formed a passage leading to the space within the director. This conical part 19 is supported by webs 20 from the wall of the drum.

The stationary part 17 is formed on a cylindrical part 21 which makes tight joint with the tubular part 12 of the director. Through this tubular part of the director there extend tubes or passages 22. The fixed director is carried upon a tube 23 forming as hereinafter explained the air inlet to the apparatus. Within this tubular part and carried on webs from it is a bearing 24 for a shaft 25 upon which the rotatory returner drum 15 is mounted. This shaft extends outward and is there supported in suitable bearings (not shown) in which there is provision for end thrust. Any suitable driving means may be applied to the shaft 25.

The tube 23 carrying the fixed director is mounted in any convenient form of sufficiently rigid bracket or pedestal, while the axis of rotation of the returner may be either vertical (as shown) or horizontal.

Considering the apparatus to be rotating clockwise as indicated by the arrows in Figs. 1, 2, and 3, water or other liquid within it will take up the position indicated by broken lines. The water is maintained at any desired radial level of rotation by a pipe 26 tangentially bent so as to skim the surface of the liquid and rotatable through an angle from outside. Through the blades 14 in the director are apertures 27 serving for the introduction of water and for the discharge of air or gas as hereinafter explained.

In action, water passes through director and returner in the closed cycle indicated by the arrows, and passing from the nozzle 13 across the gap 28 of the ejector part to the throat-like part of the annular returner passage, entrains air or gas upon each side, one stream from the tubular inlet 23 up between the tubular part 12 of the director and the shaft 25 over to the top of the annular jet, and the other from the tubular inlet through the passage 22 to the space between the cylindrical part 21 and the tubular part 12 of the director and so to the under side of the jet. This entrained air then passes with the water to the annular space between the parts 16 and 19, where, under the high centrifugal force developed it is immediately separated centripetally and passes out through the air discharge apertures 27. The water then again enters the director.

Water for making up leakage and for cooling purposes is introduced by a pipe (not shown) passing through one of the apertures 27 and is packed up and discharged by the skim pipe 26. During its passage through the cycle the water undergoes only pressure-velocity changes and therefore (neglecting frictional losses) its energy is conserved—the work being only that actually done upon the air in entraining and not what is required to produce a jet of the requisite velocity.

Referring to Fig. 2, the water entering at the inner periphery of the annular returner passage with the high velocity of the entraining jet passes therethrough with a gradually dropping velocity—the spaces between the blades being of such gradually increasing area radially outward that its velocity at the outer periphery is about one-eighth of that at its inner periphery. Again, the blades 18 in this passage conform to the path of the water moving radially through the annular space with gradually dropping velocity—thus the path of that water is almost radial and centrifugal force is developed in it only sufficient to make up the energy lost in friction in the circuit and in the entrainment of the air. From the outer periphery of the annular passage the water passes with still dropping velocity to the annular space between the parts 16 and 19. There, moving comparatively slowly, it gives up its air under centrifugal force. It then passes at comparatively low velocity and in the form of a sheet to the director, and it is here to be pointed out that although its velocity relatively to the rotatory returner, and due mainly to the centrifugal head in the annular space between the parts 16, 19, is low; its velocity relatively to the fixed director (since it has the rotatory velocity of the returner) is high. So it then enters between the blades 14 (Fig. 3) of the director at high velocity to be reduced in velocity (increasing in pressure) since the area between them increases as rapidly as may be. It is again, of course, increased in velocity at the jet nozzle 13 by the reduction in area there.

It will be noticed that part of the annular passage of the returner is formed by a stationary disk 17, it is pointed out that the radial width of this disk is made such that at its outer edge the pressure during action is so nearly normal that no leakage over its edge takes place.

In order to prevent leakage between the returner and the director the director has formed on it a conical part 40 counterpart to the part 19 on the returner, and a like part 41 counterpart to an annular inwardly projecting lip 38 secured to the returner. These parts and the adjacent faces of director and returner may have helical grooves cut upon them. The direction of rotation being as shown by the arrows, there is a left-hand thread 38 on the upper returner edge, a right-hand thread 29 on the upper director edge, a right-hand thread 30 on the lower returner edge, and a left-hand thread 31 on the lower director edge. Other known means to the same end may be employed for this purpose. Further the part 19 when filled or partially filled by water forms a seal for the joint between the adjacent faces of returner and director at the inside, while at the outside a like seal is formed by water retained within an annular inwardly projecting lip 38 secured to the returner.

Instead of the skim-pipe device, the annular depth of water in the returner may be maintained by other means, such as pipes or passages communicating with the exterior of the returner drum and extending inward a distance equal to the desired depth of annulus.

When the apparatus is used as an ejector-condenser, water for condensing is constantly supplied to the drum and constantly escapes from the drum by the skim pipe or equivalent device—the energy given to that water on entry and remaining in it on discharge being of course lost.

If the apparatus be used as a compressor it is apparent that any considerable air pressure within the drum would obstruct the passage of water from returner to director, but as shown in Fig. 4 if the whole apparatus as set forth be inclosed in a casing 32 (made in halves horizontally bolted together) and that casing embrace the tubular inlet 23 and be formed with a closed-ended bearing 33 for the shaft 25, it is usable as a compressor. Air finds its way in (as shown by the arrows) as before by the tubular part 23, is discharged to the casing through the apertures in the director, and leaves the casing by the discharge aperture 34, a pipe 35 supplies water—of course under a head equal to the pressure of compression—and the skim pipe 26 discharges within the casing—the water from it being discharged from the casing by a ball-controlled valve 36. To avoid the necessity for packed bearings, the shaft 25 is prolonged through the inlet tube 23 and is supported in end and side thrust bearings in a bracket 37, the drive being applied to it at that end.

It is at once apparent that the proportions and velocities which will maintain a complete vacuum (against the atmosphere) will equally effectively compress to two atmospheres absolute—or, if anything, more—and for pressures greater than that—and those within reasonable limits are possible—it is only necessary to vary the proportions in the direction of increase of jet velocity.

When the apparatus is thus used as a compressor the annular effective width of the rotatory returner, its radial distance and its speed of rotation may be so jointly proportioned that the centrifugal pressure at the outer periphery of the rotatory returner is equal to the pressure to which it is desired to compress the gas.

Throughout the cycle the liquid only undergoes velocity-pressure transformations, consequently the energy lost is only that due to the friction of the passages and that due to the entry and discharge of liquid for condensing or cooling purposes. Therefore the efficiency is much higher than is the case in apparatus in which the liquid comes to rest after passing through an ejector or like device to be subsequently re-started.

The essential elements of the invention may obviously be embodied in many varied constructions—for example what has been termed the director may be rotated under some conditions at a speed differing from the returner, while water, mercury, or any other convenient liquid may be used as the medium of induction. Further, directing vanes may be provided in the annular rotatory chamber to direct the liquid helicoidally around that chamber.

What I claim is:—

1. An air or gas exhauster or compressor or an ejector-condenser, comprising a stationary director and an ejector device, a rotatory centrifugal returner arranged to receive an extraining liquid from the ejector, subject the same to centrifugal action and pressure to effect the separation of the entrained gases from the liquid and discharge said liquid to the stationary director, so that said liquid travels a circuit, in combination with means for maintaining the amount of the entraining liquid, an entrance for entrained air or gas and a discharge port for the separated air or gas.

2. An air or gas exhauster or compressor or an ejector condenser, comprising a rotatory returner and a stationary director co-axial and both of annular form as a whole, interconnection between both inner and outer peripheries of these members, an entraining ejector device between the members and a space in the returner where entraining liquid is subjected to centrifugal pressure, means being provided for maintaining the amount of liquid and for admitting and discharging the air or gas.

3. An air or gas exhauster or compressor or an ejector condenser comprising a rotatory returner of drum form, an annular centrifugal extracting portion at the periphery thereof, a device delivering liquid at one side thereof, an annular passage receiving liquid at the other side thereof, vanes in said passage dividing it into spaces the areas of which gradually increase from the inner to the outer periphery of said passage and which vanes are curved to the path upon the disk taken by the liquid moving radially with dropping velocity and a fixed annular director receiving liquid from the returner, a jet nozzle on the director returning the liquid to the returner and means for maintaining the amount of liquid and for admitting and discharging air or gas.

4. An air or gas exhauster or compressor or an ejector condenser comprising a coaxial director and returner, the director of hollow internally vaned annular disk form merging in the tubular with an annular ejector nozzle terminating the tubular part and the returner having a vaned annular hollow disk part into the inner periphery of which the ejector nozzle discharges and the outer periphery of which merges in a drum part open inwardly which part again merges into an annular discharge directed toward the outer periphery of the director,

a casing about the tubular part of the director and carrying a part forming part of the annular hollow disk part of the returner, a passage for the intake of air within the tubular director part, communicating passages therefrom to the space between the casing and the tubular part, means for the discharge of air after entrainment and means for supplying and maintaining the level of entraining liquid within the apparatus.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses.

WILFRED HUNT.

Witnesses:
DAVID FERGUSON,
JAMES EAGLESON.