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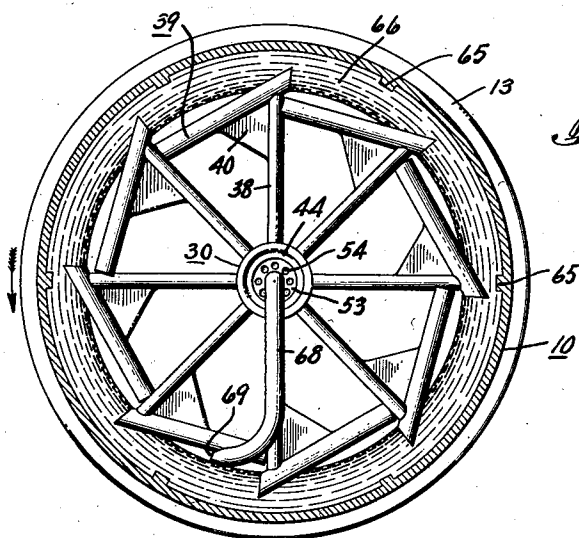
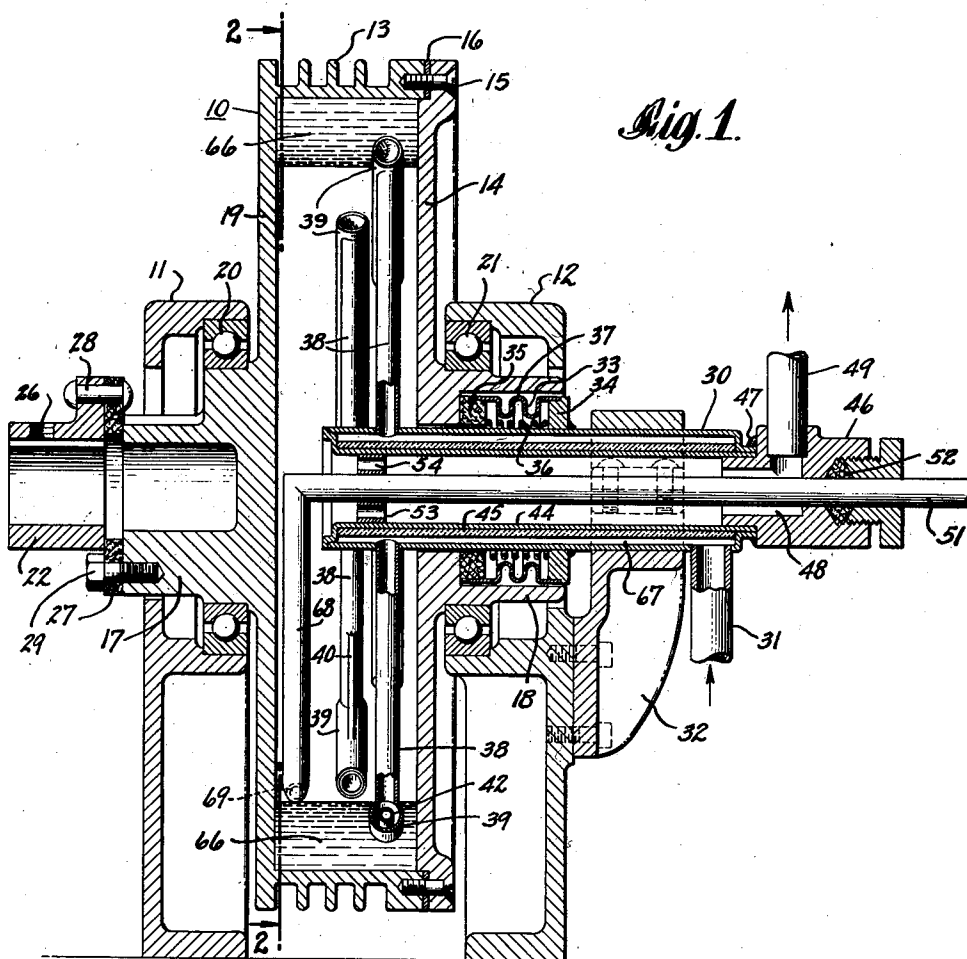
B. C. BOECKELER

2,260,600

PUMP

Filed Feb. 19, 1938

2 Sheets-Sheet 1



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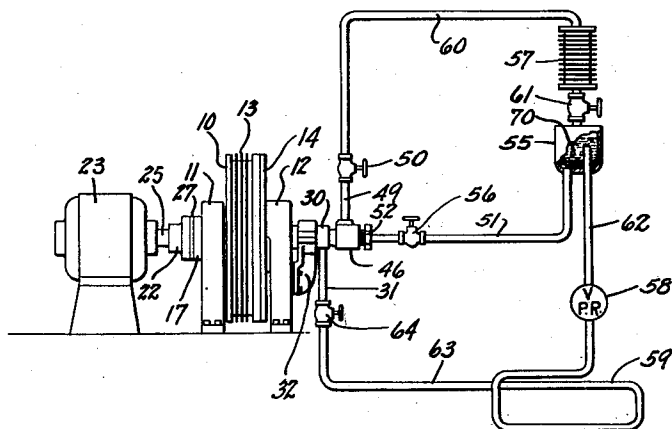
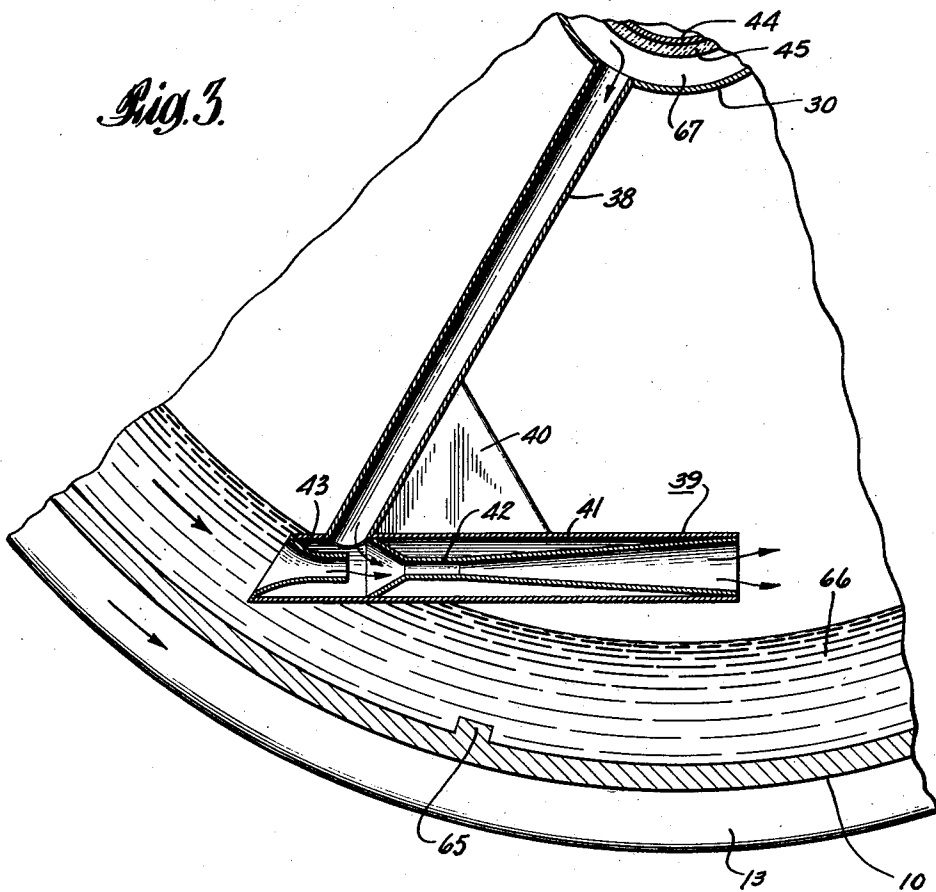
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2 Sheets-Sheet 2



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PUMP

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15 Claims. (Cl. 230—75)

My invention relates to improvements in pumps.

An object of my invention is to provide a novel and useful pump for compressing, circulating, or evacuating fluids, more particularly, gaseous or vaporous fluids, which is adapted to be compactly constructed for installation in a small space, is simple in construction and may be manufactured at a low cost.

Another object of my invention is to provide a pump which is adapted to be operated with equal efficiency in any position of installation.

Another object of my invention is to provide a pump which, when in operation, will provide a high heat transfer co-efficient between it and the surrounding atmosphere to the end that a gaseous or vaporous fluid being compressed therein may be cooled and condensed within the pump.

Another object of my invention is to provide a pump for compressing and condensing a gaseous or vaporous fluid comprising components of different densities and for separating the components from each other.

Other new and useful objects of my invention will appear from the following description, the accompanying drawings and the appended claims.

In the accompanying drawings which form part of the instant specification and are to be read in conjunction therewith and in which like numbers refer to like parts throughout the several views:

Fig. 1 is a view in elevation with parts in section of a preferred embodiment of my invention,

Fig. 2 is a view in elevation with parts in section taken along the line 2—2 of Fig. 1,

Fig. 3 is an enlarged view in elevation with parts in section of a detail of Fig. 1, and

Fig. 4 is a diagrammatic view of a refrigeration system embodying my invention.

In general, my invention consists of a pump comprising a rotatably mounted shell or member forming a vessel adapted to contain a liquid, within which are positioned one or more suction-compression devices for drawing fluid through the pump inlet and for delivering such fluid at an increased pressure into the interior of the shell from which the fluid is adapted to be discharged in a liquid or non-liquid state through the pump outlet.

More particularly, the pump or apparatus for moving a fluid medium of my invention comprises a rotatably mounted shell adapted to contain a liquid and to be rotated at a speed such that liquid when contained therein will be formed

into a rotating annulus traveling at high velocity and having a free surface; means are provided within the shell such as for example suction-compression devices, which utilize the high velocity of the liquid of the annulus for directly creating a region of reduced pressure within the shell, the said means projecting at least in part into the free surface of the annulus; suitable means are also provided for conducting the fluid to be moved to the reduced pressure region and for mixing and entraining the fluid in the reduced pressure region with the liquid of the annulus and for conducting the mixture of liquid and fluid from the reduced pressure region to a region of increased pressure.

The suction-compression devices are caused to function by relative movement between them and liquid contained in the shell, this liquid being formed, by rotation of the shell at high speed, into a rapidly spinning liquid annulus in which the suction-compression devices are immersed. Thus, there is provided within the shell a continuous stream of high velocity liquid whose movement relative to the suction-compression devices is made use of thereby through the application of the known principles of Bernoulli to create suction at the pump inlet and subsequent compression of the fluid caused to flow therethrough into the interior of the shell.

The rotation of the shell provides for a much higher heat transfer co-efficient between the shell and the surrounding atmosphere than would be the case were the shell stationary. Hence, through the provision of adequate cooling area in the form of fins or otherwise, heat may be dissipated from the shell at a rate sufficient to effect a cooling of the compressed fluid within the shell to a temperature at which such fluid will condense.

Condensate formed under these circumstances adds to the liquid of the annulus whose depth is maintained at a predetermined maximum value through a scooping operation by which the liquid is caused to flow under its own momentum preferably to an external receiver from which the liquid may flow back to the shell again should the depth of the annulus fall below the predetermined desired value.

The liquid annulus may be condensate of the fluid being compressed; or, it may be a separate liquid; or it may be formed of a separate liquid and condensate of a fluid being compressed. The fluid being compressed may consist of one or more constituents. If, for example, the fluid being compressed consists of a number of con-

stituents of differing boiling points, some of the fluid may be condensed within the shell and may be removed as a liquid from the annulus and from the shell by the scooping operation referred to while the uncondensed portion of the fluid may be discharged from the shell in an uncondensed compressed state, thus enabling a separation of constituents from each other; or all of the fluid may be condensed within the shell; or the fluid may be merely compressed within the shell and subsequently further cooled and condensed externally of the shell. It is desirable, however, that the separate compressing liquid when employed be of lower vapor pressure and greater density than condensate of the fluid being compressed. For example, I may employ water as a compressing liquid for compressing a single component fluid such as gaseous pentane which, as a liquid, is not only immiscible with the water, but is of lower density and has a higher vapor pressure. The greater density of the water will cause the water to be thrown outwardly by centrifugal force to the outer portion of the annulus. However, any liquid pentane formed, being of lesser density, will stratify with respect to the water and remain in the inner portion of the annulus from which it may be continuously removed by the scooping operation previously referred to. If desired, the separate compressing liquid may be treated so as to increase its density and/or render it immiscible with a fluid being compressed. For example, I may add potassium carbonate to water to render water as a compressing fluid immiscible with condensate of a fluid such as acetone vapors and thereby achieve a greater difference in density and vapor pressure of the respective fluids.

Referring now more particularly to the accompanying drawings, I have shown a hollow metal shell 10 of cylindrical contour mounted for rotation on the cylinder axis in standards 11 and 12.

The shell 10 has its outer circumferential periphery provided with annular cooling fins 13 and embodies a removable cover-plate 14 detachably secured to the rim of the shell as by an annular row of threaded members 15. An annular gasket 16 of suitable sealing material is clamped between the cover plate and the rim of the shell to seal the joint therebetween against the escape of fluid under pressure from within the shell.

Mounting of the shell 10 in the standards 11 and 12 is accomplished by means of hubs 17 and 18 coaxial with the cylinder axis and extending from the opposed ends of the shell. Thus, the hub 17 is formed integrally with the shell end 19 and the hub 18 is formed integrally with the opposed end or cover-plate 14. A rotary bearing member 20 is interposed between the hub 17 and the standard 11 and a rotary bearing 21 is interposed between the hub 18 and standard 12, although any suitable type of anti-friction bearing may be employed. The hub 17 is preferably driven through a tubular coupling member 22 by means of a suitable prime mover such as the motor 23 shown in Fig. 4 whose shaft 25 is received within the bore of the coupling member and locked thereto by means of a set screw (not shown) receivable within the threaded opening 26. The union between the coupling member 22 and the hub 17 is preferably flexible in character and is accomplished through the provision of a flexible element 27 fastened to the coupling member and

the hub by suitable fastening elements such as the rivet 28 and the threaded member 29. Obviously, the shell 10 may be operatively connected with and rotated by the prime mover in any other suitable manner as through the medium of pulleys, gearing, etc. or, if desired, the shell may be constructed to function as the rotor of an alternating current induction type motor thus providing a self-contained unit of extreme simplicity and compactness.

The hub 18 is formed as an annulus surrounding and extending outwardly from an opening in the cover-plate 14 concentric with the cylinder axis of the shell 10, through which opening there extends a metal inlet tube 30 for conducting gaseous or vaporous fluid to be compressed from a feed pipe 31 into the interior of the shell 10. The tube 30 is rigidly supported adjacent its outer end co-axially with the cylinder axis of the shell 10 by means of an arm 32 secured to the standard 12.

A pressure tight joint is effected between the cover-plate 14 and the tube 30 through the medium of a stuffing box 33. This comprises an annular member 34 suitably secured to the tube 30 as by welding, an annular packing member 35 slidably sealingly engaging the cover-plate 14, a helical spring 36 for pressing the packing member 35 against the cover-plate 14, and a bellows type annular casing member 37 sealingly engaging the annular member 34 and the sealing member 35 positioned within the annular space formed between the inner periphery of hub 18 and the outer periphery of the tube 30.

The inner end of the inlet tube 30 extends within the shell 10 and forms a fixed hub-like header from which a plurality of hollow metal distributing tubes 38 arranged in two groups extend radially from the tube 30 in spokewise fashion. The axes of the tubes in one group lie in one plane while the axes of the tubes in the other group lie in a separate plane, the planes being parallel to each other and being perpendicular to the plane containing the axis of the shell cylinder.

The groups are further arranged so that the axes of the tubes of one group are angularly displaced with respect to the axes of the corresponding tubes of the other group. Thus, the axes of all the tubes are spaced about the circumference of the tube 30 at equal distances from each other.

Each of the tubes 38 carries at its outer end a suction-compression device 39 constructed preferably of metal and maintained in fixed relationship to the tube by means of a metal gusset plate 40. The suction-compression device 39, the distributing tube 38 and the gusset plate 40 are preferably secured to each other by welding, or brazing so as to form an integral rigid structure.

Each suction-compression device 39 preferably comprises a jacket member 41 to which is fastened one end of the distributing tubes 38 through which fluid may be supplied to the interior of the suction-compression device 39. The construction is best shown in Fig. 3. Situated in the jacket or streamlining member 41, at one side of a peripheral opening therein over which the tube 38 is fastened, is a combining-delivering member 42 of the suction-compression device 39. A nozzle member 43, for accelerating the compressing liquid and for directing the liquid into member 42, is situated in the jacket member 41 at the opposite side of the opening into the tube 38. Thus, it will be observed that in the example depicted in Fig. 3, the combination of a portion of the

jacket member 41, the combining-delivering member 42 and the nozzle member 43 forms a suction-compression, velocity-pressure conversion, or energy conversion device of the Venturi type operating on the injector principle, as will be understood by those skilled in the art, to apply suction through a distributing tube 38 to the pump inlet and to discharge fluid in a compressed state to the interior of the shell. The suction-compression device 39 may obviously be constructed in many forms, the type shown being by way of example only.

The angular relationship of the axes of each suction-compression device 39 and its distributing tube 38 is advantageously one which will secure total immersion of the inlet end of the suction-compression device in the liquid of a rapidly rotating liquid annulus 66 which is formed by the rotation of the shell 10 to which such liquid has been supplied. I have shown the suction-compression device 39 so positioned that the greater portion of its outer periphery is out of the liquid of the annulus, thus minimizing the skin friction. It should be understood, however, that the suction-compression device 39 may be entirely immersed in the liquid of the annulus if desired, in which case, an air foil contour may be found desirable in order to promote a more streamline flow along the periphery of the device. I have found that for most satisfactory operation, it is desirable that the entrance opening of the nozzle member 43 be preferably located in the plane of the cylinder axis of the shell 10 and that liquid of the annulus enter the opening perpendicularly to the plane of the opening.

I have also found that the functioning of the combining-delivering member 42 is benefited by maintaining the delivery tube portion of the member 42 within a twelve degree (12°) angle and by placing the device so that the entrance opening of the nozzle member 43 is as close as possible to the inner circumferential periphery of the shell where liquid velocity and pressure is greatest.

A tube 44 jacketed with asbestos or other suitable heat insulating material 45 is positioned coaxially within the tube 30 and is of sufficiently smaller diameter than the tube 30 to form an annular space 67 therewith through which fluid to be compressed may be conducted from the feed pipe 31 into the distributing tubes 38. The tube 44 is securely fastened and sealed at each end as by welding, brazing, or in any other suitable manner to the tube 30 and receives within its outer end a fitting 46 which is secured to the tube 30 throughout the circumference thereof so as to form a pressure tight joint by welding, brazing, or in any other suitable manner as has been indicated at 47. The tube 44 forms a passage for conducting compressed fluid from the interior of the shell 10 into a passage 48 formed in the fitting 46 from which passage the compressed fluid is conducted through a pipe 49 controlled by a manually operated valve 50 to a locus external of the pump proper.

A pipe 51 extends through a stuffing box 52 in the fitting 46 co-axially with the cylinder axis of the shell 10 and is supported within the tube 44 at the inner end thereof by means of an annular member 53 having a central opening through which the pipe 51 passes. A plurality of passageways 54 extending through the annular member 53 permit compressed gaseous or vaporous fluid within the shell 10 to flow there-

from through the tube 44 and be discharged from the pump as has previously been described.

The end section 68 of the pipe 51 forms a scoop extending in a direction opposite the direction of movement of the liquid of the annulus and is preferably arranged so as to be tangential to the inner periphery of the rotating annulus at the locus of the scoop inlet opening 69.

The entrance opening 69 of the scoop is preferably in a radial plane so that liquid of the annulus will enter the scoop at right angles to the plane of the opening. Liquid of the annulus in excess of that amount necessary to maintain the annulus at a predetermined maximum depth will be stripped from the annulus by the end section 68 and will be conducted from the shell by the pipe 51 preferably to an external separator-accumulator 55. Should the depth of the annulus become less than a predetermined desired value, liquid in the accumulator 55 may be permitted to flow back through the pipe 51 into the shell 10 to restore automatically the depth of the annulus to the desired value. A valve 56 is provided in the tube 51 to control the flow of liquid to and from the accumulator 55 and to seal the pump if desired.

In Fig. 4, I have shown the application of my invention to a refrigeration system comprising a suitable air or liquid cooled condenser 57, pressure reducing valve 58 and refrigerating coil 59. In the system there shown, a suitable refrigerant such as gaseous pentane leaving the shell 10 in a compressed state through the pipe 49 is conducted from the valve 50 by a pipe 60 into the condenser 57 wherein it is cooled to a liquefying temperature and thereby liquefied, the resultant liquid pentane flowing without reduction in pressure through a valve controlled pipe 61 into the separator-accumulator 55. The separator-accumulator 55 is preferably divided by baffles 70 into an upper and a lower section. The lower section contains water adapted to flow as needed to and from the shell 10 to maintain the depth of water forming the rotating annulus at the predetermined value. The upper section of the accumulator provides storage space for the liquid pentane which floats on the denser water. The liquid pentane flows from the separator-accumulator 55 serially through a pipe 62 whose inlet end extends into the body of liquid pentane and through the pressure reducing valve 58 in the pipe 62 into the refrigerating coil 59 wherein the evaporation at the reduced pressure effects the desired refrigeration in a known manner. The vaporized gaseous pentane flows from the cooling coil 59 serially through a pipe 63 and valve 64 into the feed pipe 31 of the pump for recompression in the shell 10.

The shell 10 is supplied with a quantity of water to be used as a compressing liquid which is formed into a rapidly spinning liquid annulus 66 by rotating the shell 10 at a high speed by means of the prime mover 23. The depth of this annulus is governed by the position of the scoop or stripping member 68 through the entrance opening of which any excess water is caused to flow under the velocity head of the spinning annulus and is conducted via the pipe 51 into the separator-accumulator 55.

The depth of the annulus will be governed by the relative positions of the inlet opening of the orifice or jet member 43 and the inner circumferential periphery of the shell 10. Obviously, it is desirable that the inlet opening of the nozzle member 43 be below the inner circumferential

periphery of the spinning annulus and it is apparent that the closer this opening is to the inner circumferential periphery of the shell 10, the greater will be the linear velocity of the liquid entering the suction-compression device 39 and the greater the amount of energy available in the entering liquid for the desired pumping effect.

The relative movement between the water of the annulus 66 and the suction-compression devices 39 causes a flow of water at a high velocity through the nozzle members 43 and the combining-delivering members 42 as a result of which a powerful suction is communicated through the distributing tubes 38 and annular passage 67 to the feed pipe 31 to thereby cause the gaseous pentane to be drawn into the pump, compressed in the suction-compression devices 39 and discharged thereby into the interior of the shell 10 in a compressed state.

The compressed gaseous pentane flows from the interior of the shell through the tube 44 whose insulating material 45 minimizes the transfer of heat to the incoming cooler gaseous pentane in the passageway 67 and flows via the pipe 49 and pipe 60 to the condenser 57 wherein heat is removed by indirect heat exchange with a colder fluid medium so as to effect a liquefaction or condensation of the pentane at the existing pressure. The liquid pentane formed is returned to the accumulator-separator 55 and the cycle repeated.

The rotation of the shell 10 in the surrounding atmosphere effects a high rate of heat transfer from the liquid within the shell to the surrounding atmosphere. The radiation of heat from the periphery of the shell 10 is augmented by the provision of the cooling fins which increase the effective heat radiating area. The rate of radiation may be further improved by operating the shell 10 in a cool atmosphere which in itself may be in motion so as to obtain a higher velocity of relative movement between the shell 10 and the surrounding gaseous medium. Thus, I may dispense with the external condensing apparatus 57 entirely and effect a condensation of the compressed gaseous pentane within the shell 10 by reason of the high heat transfer co-efficient I am enabled to attain with my invention. In such case, the valves 50 and 61 may be closed to disconnect the condenser 57 from the pump. The liquid pentane formed within the shell will be added to the liquid of the annulus as formed and will be stripped or scooped therefrom by the scoop or stripping member 68 and discharged thereby through the pipe 51 into the separator-accumulator 55. If any water be present in the separator-accumulator 55 under these conditions, the liquid pentane will by reason of its lower density, float on the surface of the water from which it may be separated and utilized for cooling in the refrigeration system as has been previously described, or utilized for any other suitable purpose.

In order to develop the full efficiency of the apparatus, I have found it desirable to provide the inner circumferential periphery of the shell 10 with ridges or shoulders 65 extending transversely of the shell between the opposite faces of the shell. By these means I am enabled to reduce the "slippage" which normally would occur between the shell and the liquid annulus 66 and thus develop the maximum velocity of the annulus commensurate with the velocity of the rotating shell. The ridges 65 may extend inward-

ly from the shell periphery for an appreciable distance into the annulus in which case it may be desirable and necessary to provide them with slots or cutaway portions to obtain the necessary clearance with the non-rotating suction-compression devices 39.

As a specific illustration of the results to be obtained from the application of my invention, I have by using water as a compressing fluid secured a vacuum of 27 inches of mercury when using a shell of six inches diameter rotating at a speed of 2400 revolutions per minute and equipped with a single suction-compression device connected to the pump inlet.

Obviously, the shell 10 may be made of any suitable material such as steel, brass, copper, aluminum or other suitable metal, or of plastic compositions and may be formed by casting, spinning, or as an assembly of machined parts united by welding, brazing, or by such other manner as will be readily apparent to those skilled in the art.

It will be observed that I have accomplished the objects of my invention and have provided a pump for compressing, circulating, or evacuating fluids which is adapted to be compactly constructed for installation in a small space, is simple in construction, may be manufactured at a low cost, is adapted to be operated with equal efficiency in any position of installation, that provides a high heat transfer co-efficient between it and the surrounding atmosphere to the end that a gaseous or vaporous fluid being compressed therein may be cooled and condensed in the pump, and that may be employed for compressing and condensing a gaseous fluid comprising components of different densities and for separating the components from each other.

It will be observed that certain features and sub-combinations of my invention are of utility and may be employed without reference to other features and sub-combinations thereof. This is contemplated by and is within the scope of the appended claims. It is further obvious that various changes may be made in details within the scope of the appended claims without departing from the spirit of this invention. It is, therefore, to be understood that this invention is not to be limited to the specific details described.

Having thus described this invention, what is claimed is:

1. A pump comprising a shell of cylindrical contour mounted for rotation on the cylinder axis of revolution, said shell being adapted to contain a liquid and to be rotated at a speed at which liquid when contained therein will be formed into a rotating liquid annulus; cooling fins on said shell; velocity-pressure conversion means located within said shell for establishing a pressure differential between the induction and eduction sides of said pump, said means being so located therein as to extend into and be traversed by said liquid annulus; conduit means extending within said shell for feeding a gaseous or vaporous fluid to said velocity-pressure conversion means; and means for stripping excess liquid from the inner periphery of said liquid annulus and for conducting such liquid to a locus external of the pump.

2. A pump for circulating, compressing or evacuating fluids comprising a rotatably mounted shell adapted to contain a liquid and to be rapidly rotated whereby said liquid may be formed into a rapidly spinning liquid annulus; and Venturi means positioned within and movable relative to said shell adapted to be acted upon by said liquid

for establishing a pressure differential between the induction and eduction sides of said pump, said means being adapted to be supplied with fluid from the induction side of said pump and being so located within said shell as to extend into and be traversed by said liquid annulus.

3. A pump for circulating, compressing or evacuating fluids comprising a rotatably mounted shell adapted to contain a liquid and to be rapidly rotated whereby said liquid may be formed into a rapidly spinning liquid annulus; and Venturi means positioned within said shell adapted to be acted upon by said liquid for causing fluid to flow into said shell and to be discharged from said shell under an increased pressure, said Venturi means being adapted to be supplied with fluid from the induction side of said pump and being so positioned in said shell as to extend into and be traversed by said liquid annulus.

4. A pump for circulating, compressing, or evacuating fluids comprising a rotatably mounted shell adapted to contain a liquid and to be rapidly rotated whereby said liquid may be formed into a rapidly spinning liquid annulus; a suction-compression device within said shell for drawing fluid through the pump inlet and for discharging the fluid under an increased pressure into said shell, said device being so positioned within said shell that its compressing liquid inlet opening will be immersed in said liquid annulus; and means for conducting liquid from or to the inner periphery of said liquid annulus.

5. A pump for circulating, compressing or evacuating gaseous or vaporous fluids comprising a rotatably mounted shell adapted to be supplied with a liquid and to be rapidly rotated whereby said liquid may be formed into a rapidly spinning liquid annulus; means extending inwardly from an inner peripheral portion of said shell for reducing slippage normally tending to occur between said rotating shell and said liquid annulus; and a suction-compression device within said shell for drawing fluid through the pump inlet and for discharging the fluid under an increased pressure into said shell, said device being so positioned within said shell that its compressing liquid inlet opening will be immersed in said liquid annulus.

6. A pump for compressing and condensing fluids of a gaseous or vaporous nature comprising a rotatably mounted shell adapted to be supplied with a compressing liquid and to be rapidly rotated whereby said liquid may be formed into a rapidly spinning liquid annulus; cooling fins extending outwardly from an outer peripheral portion of said shell; means extending inwardly from an inner peripheral portion of said shell for reducing slippage normally tending to occur between said rotating shell and said liquid annulus; and a suction compression device within said shell for drawing fluid of a gaseous or vaporous nature through the pump inlet and for discharging the fluid under an increased pressure into said shell for cooling and condensation; and means having an orifice contiguous to the inner periphery of the annulus formed for removing condensate resulting from the cooling of said compressed fluid and for conducting the removed condensate to a locus external of the pump.

7. A device for pumping fluids of a gaseous or vaporous nature comprising a rotatably mounted shell adapted to be supplied with a liquid and be rapidly rotated whereby said liquid may be formed into a rapidly spinning liquid annulus; a

suction compression device within and movable relative to said shell for drawing fluid of a gaseous or vaporous nature through the pump inlet and for discharging the fluid under an increased pressure into said shell; and means movable relative to said shell for removing liquid from said liquid annulus and for conducting said liquid to a locus external of the pump.

8. The device of claim 7 including means extending inwardly from the inner peripheral portion of said shell for reducing slippage normally tending to occur between the rotating shell and said liquid annulus.

9. A device for separating a gaseous or vaporous fluid having two or more components differing in density, into fractions respectively containing at least one of said components, comprising the combination of: a rotatably mounted member forming a hollow vessel adapted to be supplied with and to contain a liquid more dense than condensate of the heaviest component of said fluid, said member being adapted to be rotated at a speed at which liquid, when contained therein, will be formed into a rotating liquid annulus; energy conversion means located in the vessel formed by said member, said means having a transit passageway through which liquid of said annulus is adapted to flow so as to establish, along said passageway, zones respectively relatively of low and high pressure, the inlet of said passageway being so positioned as to intersect said liquid annulus and be supplied with high velocity liquid thereby; means for supplying said gaseous or vaporous fluid to said energy conversion means at a low pressure zone of said passageway; means for removing, from the inner stratum of said liquid annulus, as one of said fractions, a condensate discharged from said energy conversion means into said vessel; and means for removing, from said vessel, as another of said fractions, a gaseous or vaporous fluid discharged from said energy conversion means into said vessel in an uncondensed state.

10. A pump for circulating, compressing or evacuating fluids and having induction and eduction sides, said pump comprising a rotatably mounted shell adapted to contain a liquid and to be rapidly rotated whereby said liquid may be formed into a rapidly spinning liquid annulus, and means within and movable relative to said shell for converting a velocity head of said liquid into a pressure head to thereby establish a pressure differential between the induction and eduction sides of said pump, said means comprising one or more devices of the Venturi type each having its inlet immersed in the liquid annulus and its outlet above the inner periphery of the liquid annulus and connected to be supplied with fluid from the induction side of said pump.

11. An apparatus for moving a fluid medium which comprises a rotatably mounted shell adapted to contain a liquid and to be rotated at a speed such that liquid when contained therein will be formed into a rotating annulus traveling at high velocity and having a free surface, means within the shell utilizing the high velocity of the liquid of the annulus for directly creating a region of reduced pressure within the shell, said means projecting at least in part into the free surface of the annulus, means for conducting the fluid to be moved to the reduced pressure region, means for mixing or entraining the fluid in the reduced pressure region with the liquid of the annulus and means for conducting the mix-

ture of liquid and fluid from the reduced pressure region to a region of increased pressure.

12. An apparatus for moving a fluid medium which comprises a rotatably mounted shell adapted to contain a liquid and to be rotated at a speed such that liquid when contained therein will be formed into a rotating annulus traveling at high velocity and having a free surface, means for diverting a stream of liquid from said annulus, said diverting means projecting at least in part into the free surface of the annulus, means within the shell utilizing the high velocity of the diverted stream for directly creating a region of reduced pressure within the shell, means for conducting the fluid to be moved to the reduced pressure region, means for mixing or entraining the fluid in the reduced pressure region with the liquid of the annulus and means for conducting the mixture of liquid and fluid from the reduced pressure region to a region of increased pressure.

13. An apparatus for moving a fluid medium which comprises a rotatably mounted shell adapted to contain a liquid and to be rotated at a speed such that liquid when contained therein will be formed into a rotating annulus traveling at high velocity and having a free surface, a jet-type pump element within the shell, means for diverting a stream of liquid from said liquid annulus into the jet-type pump element, said diverting means projecting at least in part into the free surface of the annulus, means for conducting the fluid to be moved to the reduced pressure region of the jet-type pump element and means for conducting the mixture of liquid and fluid formed in the reduced pressure region of the jet-type pump element to a region of increased pressure.

14. An apparatus for moving a fluid medium which comprises a rotatably mounted shell adapted to contain a liquid and to be rotated at a speed such that liquid when contained therein will be formed into a rotating annulus traveling

at high velocity, means for diverting a stream of liquid from said annulus, means utilizing the high velocity of said diverted stream for directly creating a region of reduced pressure, means for conducting the fluid to the reduced pressure region, said diverting means being so constructed and arranged that the diverted liquid moves through the diverting means and into the reduced pressure region substantially in the direction of rotation of the annulus, means for mixing or entraining the fluid in the reduced pressure region with liquid of the diverted stream and means for conducting the mixture of liquid and fluid from the reduced pressure region to a region of increased pressure, said conducting means moving the said mixture of liquid and fluid substantially in the direction of rotation of the annulus, and means for discharging said liquid substantially in the direction of rotation of the annulus.

15. An apparatus for moving a fluid medium which comprises a rotatably mounted shell adapted to contain a liquid and to be rotated at a speed such that liquid when contained therein will be formed into a rotating annulus traveling at high velocity, a jet-type pump element, means for diverting a stream of liquid from said liquid annulus into the jet-type pump element, said diverting means being so constructed and arranged that the diverted liquid moves through the diverting means and into the jet-type pump element substantially in the direction of rotation of the annulus, means for conducting the fluid to be moved to the reduced pressure region of the jet-type pump element and means for conducting the mixture of liquid and fluid formed in the reduced pressure region of the jet-type pump element to a region of increased pressure, said conducting means moving the said mixture of liquid and fluid substantially in the direction of rotation of the annulus, and means for discharging said liquid substantially in the direction of rotation of the annulus.

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