

- [54] **ABSORPTION REFRIGERATION SYSTEM**  
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 [73] Assignee: **Carrier Corporation**, Syracuse, N.Y.  
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### Related U.S. Application Data

- [62] Division of Ser. No. 20,777, March 18, 1970, Pat. No. 3,608,332.

- [52] U.S. Cl. .... **62/141**  
 [51] Int. Cl. .... **F25b 15/06**  
 [58] Field of Search .... 62/141, 476; 415/88, 415/89

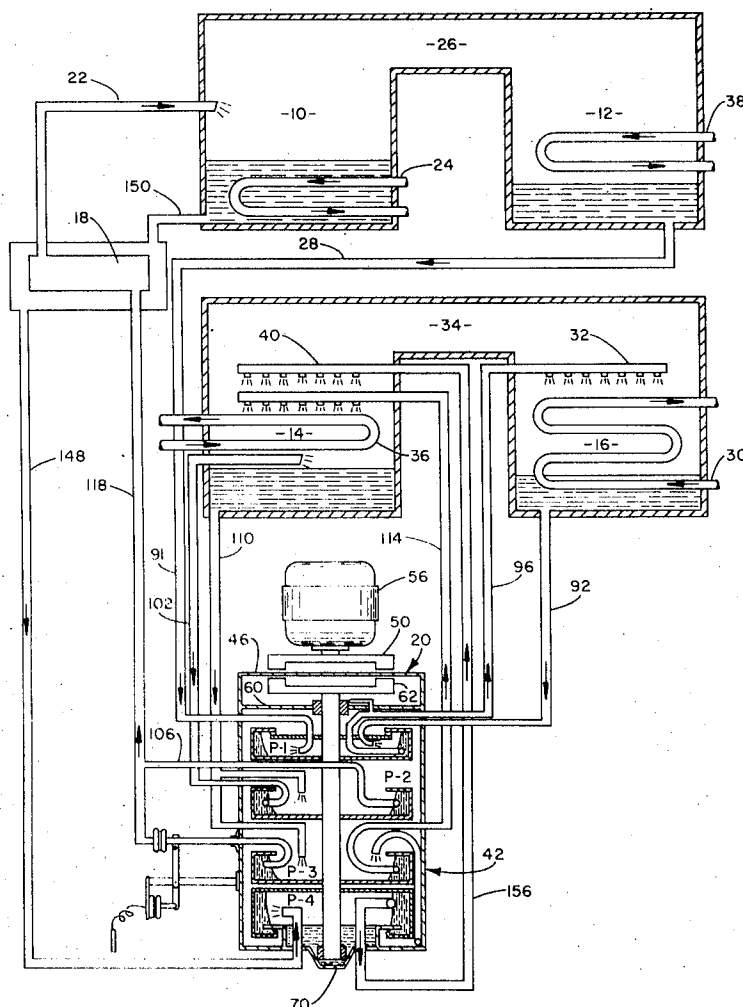
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### [57] ABSTRACT

An absorption refrigeration system wherein there is provided in communication with the evaporator, absorber, generator and condenser fluid handling apparatus in the form of a hermetic housing mounting therein a rotatively driven shaft member journaled at opposite ends in bearing means and supporting a plurality of scoop pumps for effecting, among other functions, circulation of refrigerant and absorbent solution through the system, purging, and machine capacity control.

**1 Claim, 5 Drawing Figures**



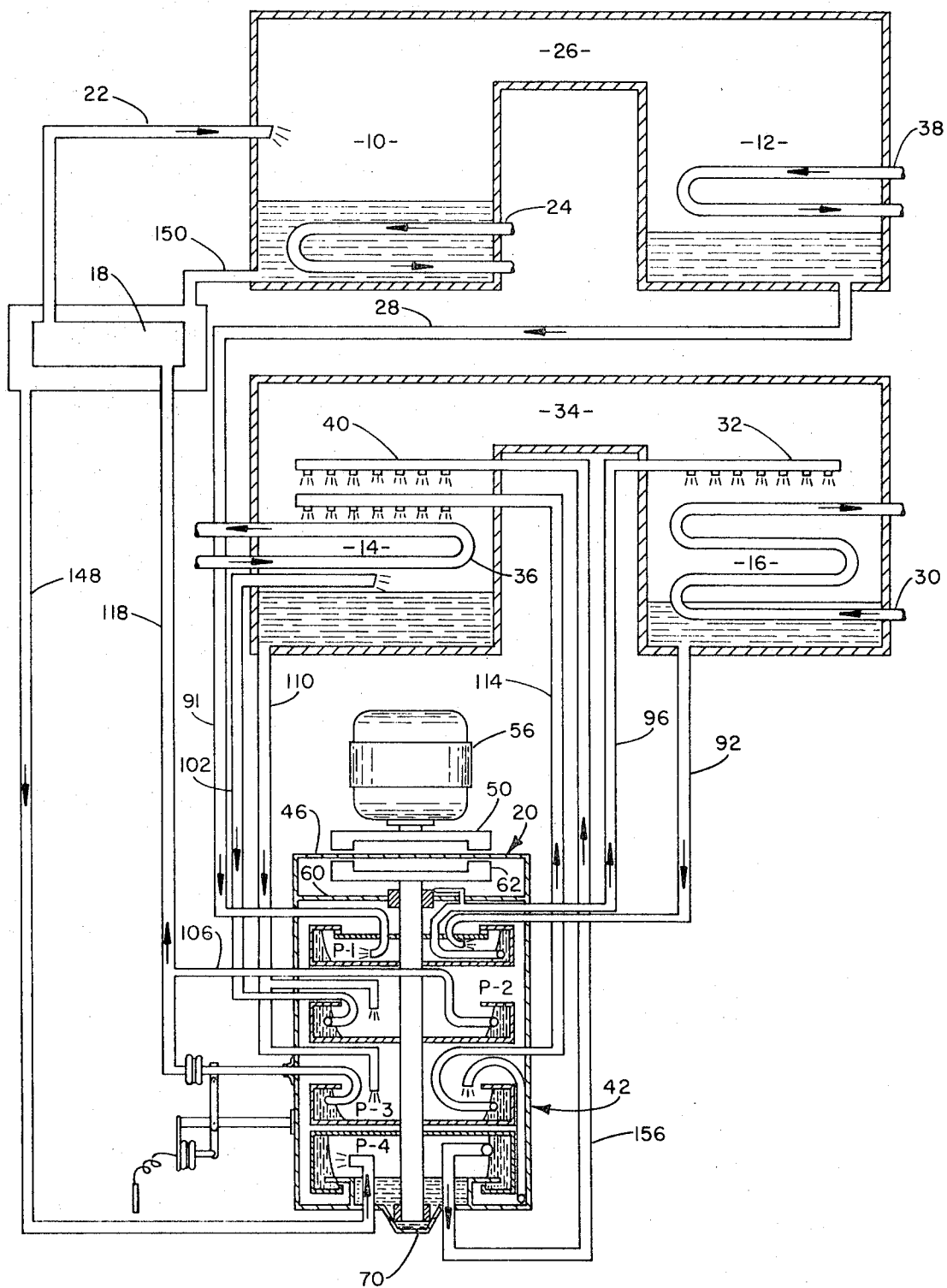


FIG. 1

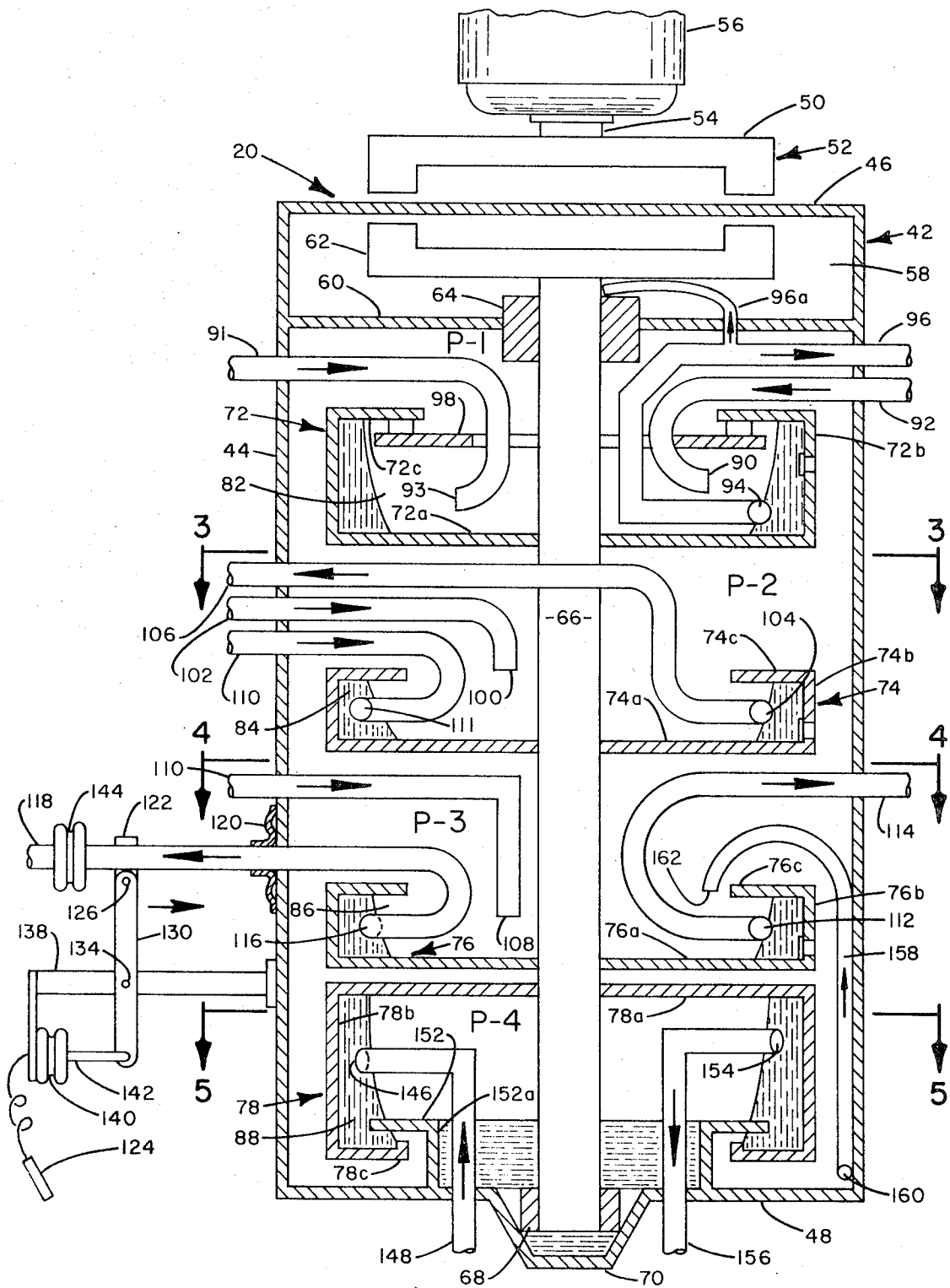
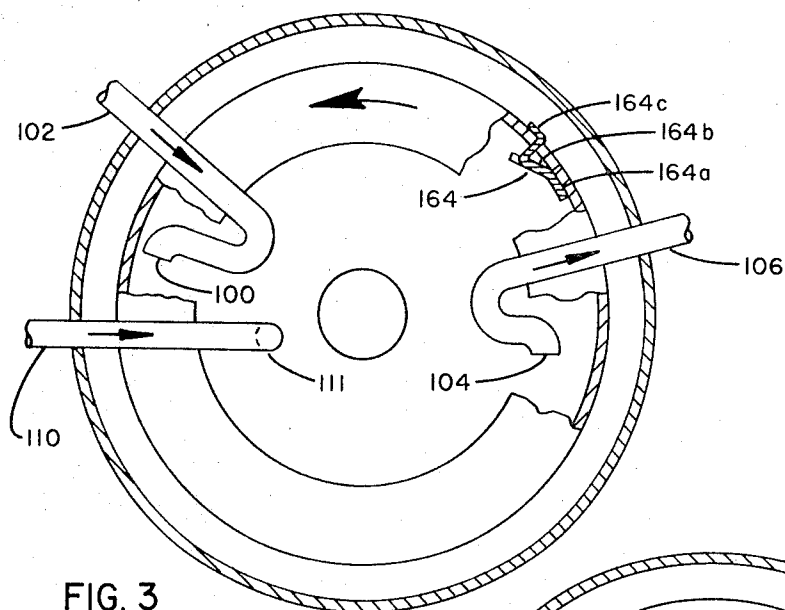
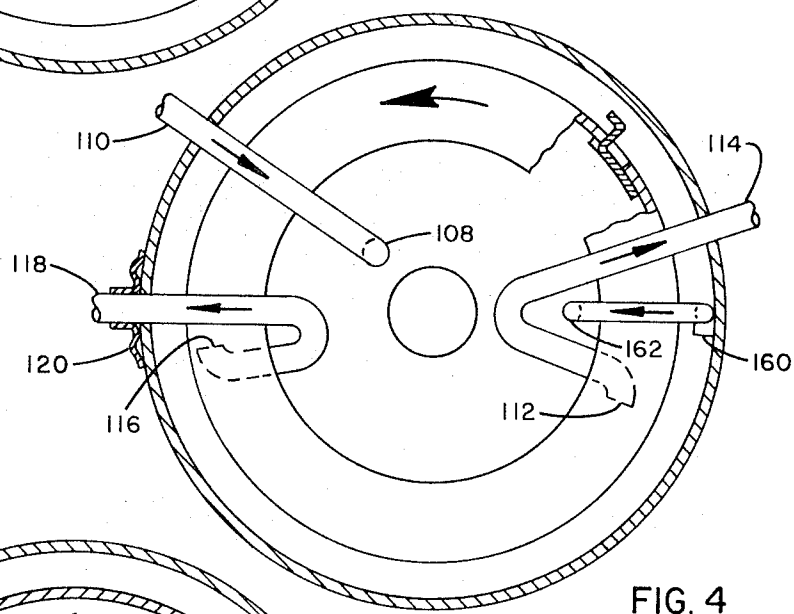
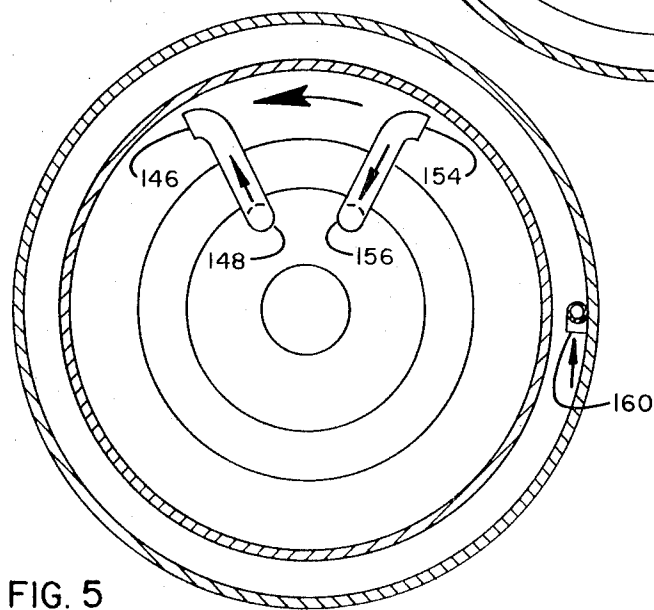


FIG. 2



## ABSORPTION REFRIGERATION SYSTEM

### CROSS-REFERENCE TO RELATED APPLICATION

This application is a division of application Ser. No. 20,777, filed Mar. 18, 1970, now U.S. Pat. No. 3,608,332 entitled "ABSORPTION REFRIGERATION SYSTEM."

### BACKGROUND OF THE INVENTION

It is common to employ centrifugal pumps to circulate refrigerant and absorbent solution in an absorption refrigeration system. Centrifugal pumps require that a positive head exist on the pump inlet in order to force the liquid into the impeller eye, to prevent flashing and vapor binding in the pump. This available head at the pump intake is referred to as "net positive suction head" or "NPSH". The requirement for NPSH in centrifugal pumps necessarily adds complexity and height to the absorption machine.

It has been proposed to transfer absorbent solution to the absorber in an absorption refrigeration machine by using a scoop pump, taking the form of a closed chamber within which is rotatably mounted a peripherally flanged disc for centrifugally impelling liquid directed into the chamber through an inlet conduit, the liquid being picked up by a scoop or eduction tube. Scoop pumps have among their advantages simplicity of construction, negligible NPSH requirements and normally will not cavitate even through only a relatively small quantity of fluid is fed to them. Further, they are essentially free of the flashing and vapor binding problem which characterizes centrifugal pumps. Such prior proposals have merely substituted a conventional scoop pump for another type of conventional pump for pumping absorbent solution without fully achieving or utilizing the advantages of the scoop pump. Furthermore, the prior proposals have been unsatisfactory in absorption refrigeration systems of the lithium-bromide type which operate under high vacuum because they contained seals exposed to atmosphere which could leak air into the machine and cause capacity and corrosion problems. Also, replacement of prior scoop pump motors required opening the machine to atmosphere, after which elaborate purging of air from the machine was required.

Accordingly, it is a principal feature of this invention to design an improved fluid handling apparatus, especially designed for an absorption refrigeration system, which provides features, advantages and improvements over, and overcomes the disadvantages of, prior scoop pump proposals.

### SUMMARY OF THE INVENTION

In accordance with this invention, there is provided an absorption refrigeration machine, which may be either of the air-cooled or water-cooled type, and which embodies fluid handling apparatus taking the form of a hermetic housing supporting interiorly a shaft member which may be journaled at opposite ends in solution lubricated bearing means. The shaft member is rotatively driven by an exteriorly mounted motor through a high torque magnetic coupling. Affixed to the rotatable shaft are a plurality of scoop pumps, each preferably taking the form of a pan or trough into which leads one or more fluid inlet conduits and one or more scoops or eduction conduits. The pans or annular collection containers define with the housing a plurality of

chambers for flash cooling refrigerant, purging, and circulating refrigerant and solution through the system. In a preferred arrangement the shaft member is vertically disposed, the lower bearing is constantly submerged in solution for lubrication thereof, and the upper bearing is lubricated with refrigerant.

### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic flow diagram, partially in cross-section, of an absorption refrigeration system embodying an exemplary form of fluid handling apparatus;

FIG. 2 is a side elevational view of the fluid handling apparatus of FIG. 1 somewhat enlarged to more fully illustrate certain details thereof;

FIG. 3 is a sectional view taken substantially along the line 3 — 3 of FIG. 2 showing a purge pump arrangement;

FIG. 4 is a sectional view taken substantially along the line 4 — 4 of FIG. 2 illustrating a scoop pump for transfer of relatively weak absorbent solution; and

FIG. 5 is a sectional view taken substantially along the line 5 — 5 of FIG. 2 showing a scoop pump for handling relatively strong absorbent solution.

### DESCRIPTION OF THE PREFERRED EMBODIMENT

In accordance with a preferred embodiment of this invention, there is provided an absorption refrigeration system which utilizes water as a refrigerant and an aqueous solution of lithium bromide as an absorbent. A suitable compound, such as octyl alcohol (2-ethyl-n-hexanol), may be added to the solution for heat transfer promotion, and suitable corrosion inhibitors may also be used. "Strong solution" as referred to herein is a concentrated solution of lithium bromide, which is strong in absorbing power, and "weak solution" is a dilute solution of lithium bromide which is weak in absorbing power.

Referring to FIG. 1, there is shown an absorption refrigeration system comprising a generator 10, a refrigerant condenser 12, an absorber 14, an evaporator 16, a solution heat exchanger 18 and fluid handling apparatus 20, connected to provide refrigeration. Weak absorbent solution is directed from heat exchanger 18 through conduit means 22 to generator 10 where the solution is heated by steam supplied to pipe 24. The absorbent solution is thereby concentrated by vaporizing refrigerant which passes to condenser 12 through passage 26. Other types of generators employing a combustible gas may be utilized instead of the arrangement schematically shown.

Water vapor boiled off from the weak solution in the generator 10 is condensed in the condenser 12 and passed to fluid handling apparatus 20 and then passed to evaporator 16. A heat transfer medium flows through heat exchanger 30 located in the evaporator and is cooled by heat exchange with evaporating refrigerant. A spray header 32 is disposed in the evaporator to wet the surface of the coil 30 with the liquid refrigerant.

Absorbent solution in absorber 14 absorbs water vapor which passes through passage 34 from evaporator 16. Heat exchangers 36 and 38 connected to a source of cooling medium such as water are located in the absorber 14 and condenser 12, respectively, to remove waste heat from the refrigeration cycle. Also located in the absorber 14 is spray header 40 which wets

the surface of heat exchanger 36 with strong absorbent solution.

Referring now also to the other views of the drawings, fluid handling apparatus 20 preferably comprises a substantially cylindrical hermetic housing 42 which includes a main body portion 44 closed at opposite ends with top and bottom walls 46 and 48, respectively. While the housing 42 is shown in a vertical position, the fluid handling functions of this invention can be performed with the housing disposed in a horizontal position.

Supported upon top wall 46 of housing 42 is coupling member 50 of magnetic drive means 52, the member 50 having attached thereto a stub shaft 54 connected to motor means 56. The exterior location of the motor 56 permits it to be of the conventional air-cooled type, in contrast to more costly solution or refrigerant-cooled models. The magnetic drive means 52 may be equipped with permanent magnets or electrically energized magnets, which can be located on a relatively large diameter and thereby provide a substantially greater torque transmission.

Located interiorly of the housing 42 in compartment 58 defined by partition 60 and the housing body portion and top wall thereon is matching coupling member 62 of magnetic drive means 52. Since the member 62 is not submerged in either refrigerant or solution, friction losses, even with a fairly large diameter, are quite low. Connected to the lower surface of the magnetic coupling member 62 and journaled at its upper end in sleeve bearing 64 is main shaft member 66 received at its opposite end in a bearing 68 seated in embossment 70 in the housing bottom wall 48. The bearings 64 and 68 are desirably formed of a suitable graphite material. Absorbent solution surrounds the lower bearing to lubricate it. Upper bearing 64 is lubricated by refrigerant from passage 96a.

Secured to the rotatable main shaft member 66 interiorly of the housing 42 are a plurality of scoop pumps generally designated by the legends P-1, P-2, P-3 and P-4, four being shown, although the number of pumps provided can obviously be varied depending upon the particular fluid handling functions to be performed. Each pump includes a rotatable collection trough or pan 72, 74, 76 and 78 of essentially identical configuration and formed with a relatively flat wall portion 72a, 74a, 76a, and 78a integral with an annular flange portion 72b, 74b, 76b, and 78b from which extends a radially inwardly directed lip portion 72c, 74c, 76c, and 78c. It may be seen that the troughs 72, 74 and 76 open upwardly, while the lowermost pan 78 is inverted and thus opens downwardly. The trough 72 defines what may be termed an evaporator circulation and flash cooling chamber 82, the trough 74 a purge chamber 84, the trough 76 an absorber circulation chamber 86, and the trough or pan 78 a generator circulation chamber 88.

The pump P-1 has an inlet nozzle 90 connected to conduit 92 leading from the evaporator 16 and an eduction scoop 94 connected to conduit means 96 leading to spray header 32 within the evaporator. It can be seen from FIG. 1 that also communicating with the pan 72 is a conduit 91 having an inlet nozzle 93. The conduit 91 communicates at its opposite end with the condenser 12 and transfers into the chamber 82 liquid refrigerant at a temperature of approximately 115°F wherein it flash cools, its temperature being reduced

thereby to about 45°F and is recirculated at this temperature through the evaporator 16 by means of scoop pump P-1 and conduits 92 and 96 forming a part thereof. The flash vapors released are absorbed by weak solution in chamber 86. In this manner, the weak or spent solution is more fully utilized and the machine efficiency is markedly increased. If desired, there may be employed in the evaporator circulation chamber 82 as a part of the pump P-1, an eliminator 98 taking the form of a flat metal disc attached to the lip portion 72c of the trough or pan 72 and provided for the purpose of centrifuging out any droplets which are liberated when flash cooling of the refrigerant occurs in the chamber 82.

The pump P-2 has an inlet nozzle 111 for passing weak solution from passage 110 into chamber 84 and another inlet nozzle 100 connected to conduit 102 leading from the absorber 14 for the purpose of passing relatively noncondensable gases from the absorber to chamber 84. As appears in FIG. 3, the purge nozzle 100 is pointed in the direction of liquid rotation to create a low pressure zone whereby the noncondensable gases are drawn into the rotating solution in purge chamber 74. The noncondensables, by reason of their relatively low density, tend to adhere to the inner surface of the rotating liquid wherefrom they are skimmed or removed together with weak solution by eduction passage or scoop 104 connected to conduit means 106 leading to the generator. The intimate mixing of the mixture of noncondensables and condensables strips out the water vapor which condenses into the weak solution so that substantially only noncondensables are pumped to the generator.

As is shown in FIGS. 2 and 4, the pump P-3 includes an inlet nozzle 108 communicating with a conduit 110 leading from the absorber 14 to drain therefrom by gravity weak solution, which is centrifugally impelled outwardly by the rotating pan 76. A portion of the solution is returned to the absorber by pick-up or eduction scoop 112 connected to conduit means 114. In this manner, a constant liquid level is maintained in the pan 76. The pump P-3, in accordance with this invention, also embodied an adjustable eduction scoop to vary the volume of solution circulated to the generator, thereby providing a main capacity control for the machine. This scoop is identified by the numeral 116 and connects with conduit means 118 leading to solution heat exchanger 18 which is in communication with the generator 10 by conduit 22.

Means for adjusting the position of eduction scoop 116 may take many forms and an exemplary arrangement is the linkage of FIG. 2. Conduit 118 may be supported for slidable movement in collar member 120 secured to the main body portion 44 of hermetic housing 42, the conduit having secured thereto a collar 122 pinned as at 126 to link arm 130 and pinned as at 134 to bracket means 138 attached to the housing main body portion 44. A bellows 140 is connected at 142 to the link arm 130 and is mounted on its base by fixed structure, while a second bellows 144 is attached to conduit 118. The bellows 140 is connected to a temperature sensing bulb 124 located on leaving chilled water coil 30 to sense the refrigeration demand imposed on the system. For example, and assuming that the control point is set for 45°F, if the leaving chilled water drops below this setting, the bellows 140 will contract, causing pick-up scoop 116 to be withdrawn, thereby reduc-

ing machine capacity by reducing solution flow to the generator. Conversely, a rise in leaving chilled water temperature will cause the scoop 116 to be inserted further into the rotating pool of liquid to increase solution flow to generator 10. Bellows 140 will move inwardly or outwardly and accordingly the depth of penetration of the scoop 116 in the centrifuging liquid is varied to control the amount of weak solution fed to the generator as a function of refrigeration demand.

The pump P-4, in addition to the inverted trough or pan 78, includes inlet nozzle 146 connected to conduit means 148 leading from solution heat exchanger 18 which is connected to the generator 10 by a line 150. In this manner strong solution flows through the conduit 148 and is discharged into the generator circulation chamber 88 to be centrifugally impelled by trough 78 wherefrom it is withdrawn by eduction scoop 154 and directed by conduit means 156 to spray header 40 in the absorber 14. It can be seen from FIG. 5 that the conduits 148 and 156 have their outer portions relatively close to one another and their orifices 146 and 154 pointed in opposite directions. By locating the inlet nozzle 146 directly behind the eduction orifice 154 in the wake thereof, a sufficiently long circumferential distance is provided within which the scoop pump can reach design velocity and be at its maximum pumping efficiency. Annular flange 152 overlies rotating annular flange 78c secured to pan 78 in spaced relation therefrom. Consequently, a liquid seal is formed between flanges 152 and 78c which balances any pressure difference between pumps P-1, P-2, P-3, which are at the same pressure, and P-4 with a radial column of liquid during rotation of pan 78.

Extending vertically in communication with the generator circulation chamber 88 and absorber circulation chamber 86 is what may be termed a clean-up scoop 158 having an eduction opening 160 adjacent the bottom wall 48 of the hermetic housing 42 and terminating in a discharge orifice 162 directed into the absorber circulation pan 76. The clean-up scoop 158 is connected to the side of housing 44 and is stationary. This scoop is effective to direct into the trough 76 any solution which collects in the bottom of the housing 42 outwardly of the stationary seal means 152, and which is rotated by movement of pan 78, thereby reducing drag on the scoop pumps upon start-up, or during operation as a result of splashing. Scoop 158 may rotate with pan 78 if it is relocated adjacent the center of pans 78, 76 and discharges radially outwardly from the center of the pans.

It is desirable upon machine shutdown that refrigerant and solution intermix in the fluid handling apparatus 20 to prevent solution solidification or salt crystallization. For this purpose, the annular side walls of the troughs 72, 74 and 76 mount valves therein which open when rotation of the troughs is terminated to permit drainage of refrigerant and solution to the bottom of the housing. Exemplary door or valve means are shown in FIGS. 3 and 4, the door in the former view being shown in an open position as during liquid drainage. Each door 164 may comprise a tab portion 164a attached to the inner surface of trough side wall 74b and integral with a relatively flexible flapper portion 164b to the back side of which is attached a hook or stop 164c. As is shown in FIG. 3, the hook limits the extent of radial movement of the flapper in its open position. Rotation of the pans and resulting centrifugal

forces together with the weight of the impelled fluid forces the flapper to the closed position of FIG. 4, and when pan rotation is stopped, the flexible character of the door causes it to open and liquid drains freely therethrough. Naturally, each door is located as close as possible to the pan bottom, except the top one 94. This is to insure a supply of liquid refrigerant for the top sleeve bearing 64, if this means of bearing lubrication is selected.

The operation of the absorption refrigeration system of this invention is as follows. Assuming rotation of the shaft member 66 through action of the motor 56 and magnetic drive means 52, each of the pans 72, 74, 76 and 78 of pump units P-1, P-2, P-3 units P-P-4 are thereby caused to rotate with the door or valve means 164 herein in closed position. Liquid refrigerant received from evaporator 16 through conduit 92 and that passed directly to evaporator circulation chamber 82 from the condenser 12, is centrifugally impelled by the pan 72; and since the chamber 82 constitutes a low pressure zone, the liquid refrigerant is flash cooled and returned to the evaporator by scoop pump 94 through conduit 96. The eliminator 98 centrifuges out any droplets liberated during the flashing process, and any vapors released are absorbed principally by weak solution in the absorber circulation chamber 86.

Simultaneously, noncondensables are induced into purge chamber 84 through purge line 102 into weak solution in pan 84, are picked up or skimmed by scoop 104 for transfer to the high pressure generator through pipe 106 along with weak solution passing through passage 111. At the same time, rotation of absorber circulation pan 76 causes additional relatively weak solution to be pumped through conduit 110 from absorber 14 and out discharge orifice 108 into chamber 86 from which it is picked up by scoops 112 and 116, a portion of the relatively weak solution being returned to the absorber through conduit 114 and another portion being directed to solution heat exchanger 18 and from there to generator 10 through conduit 22, the weak solution on entry into the generator having the refrigerant boiled therefrom. By adjustment of the depth of penetration of the scoop 116 in the rotating mass of liquid in the absorber circulation chamber 86, the volume of relatively weak solution sent to the generator 10 through the heat exchanger 18 is controlled in accordance with machine capacity demands.

Simultaneously with the pumping actions described, strong absorbent solution from generator 10 is pumped through conduit 150 and heat exchanger 18 and discharged from orifice 146 of conduit 148 into generator circulation chamber 88 from which the major portion of the rotating bath of liquid is pumped by scoop 154 and through conduit 156 to spray header 40 and absorber 14. Any stray solution in the chamber 88 is picked up by rotating scoop 158 and transferred to chamber 86 next thereabove.

In this manner, by provision of the fluid handling apparatus 20 of this invention there is accomplished with a single unit refrigerant and absorbent solution circulation, purging and machine capacity control. When the scoop pans are not rotating, refrigerant and solution drain through the open pan doors 164 to intermix and thereby prevent solution solidification.

While a preferred embodiment has been described for purposes of illustration, this invention may be oth-

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erwise embodied within the scope of the following claims.

I claim:

1. An absorption refrigeration system comprising a generator for concentrating absorbent solution by vaporizing refrigerant therefrom to form strong absorbent solution; a condenser connected for condensing refrigerant vapor formed in said generator; an evaporator for evaporating the refrigerant liquid therein; an absorber connected to the evaporator for absorbing refrigerant vapor formed therein; and a hermetically sealed scoop pump connected to said absorber and to said generator for circulating absorbent solution through the system, said scoop pump including a rotatable pan and at least

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one inlet conduit leading thereto and at least one eduction conduit leading therefrom, means connected to one of said conduits for adjusting the position of the inlet opening thereof relative to the rotating body of solution in said pan so as to control the volume of relatively weak solution passing from the absorber to the generator, thereby controlling the capacity of the absorption refrigeration system; and a second eduction conduit leading from said pan, the position of said second eduction conduit being fixed relative to the pan and being connected with said absorber for recirculating absorbent back to said absorber irrespective of the position of the adjustable eduction conduit.

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