Sept. 8, 1942. F. P. FORMAN 2,295,462

AIR COOLING SYSTEM

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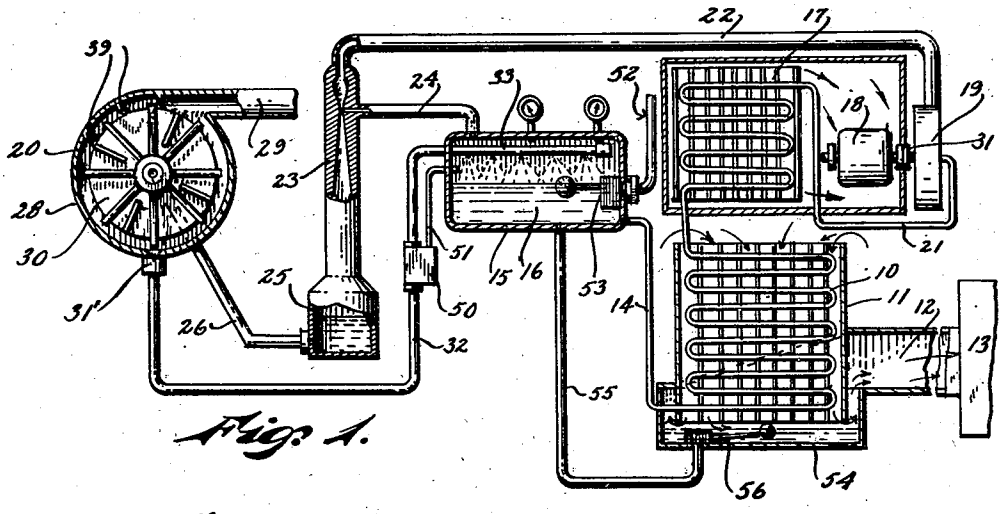
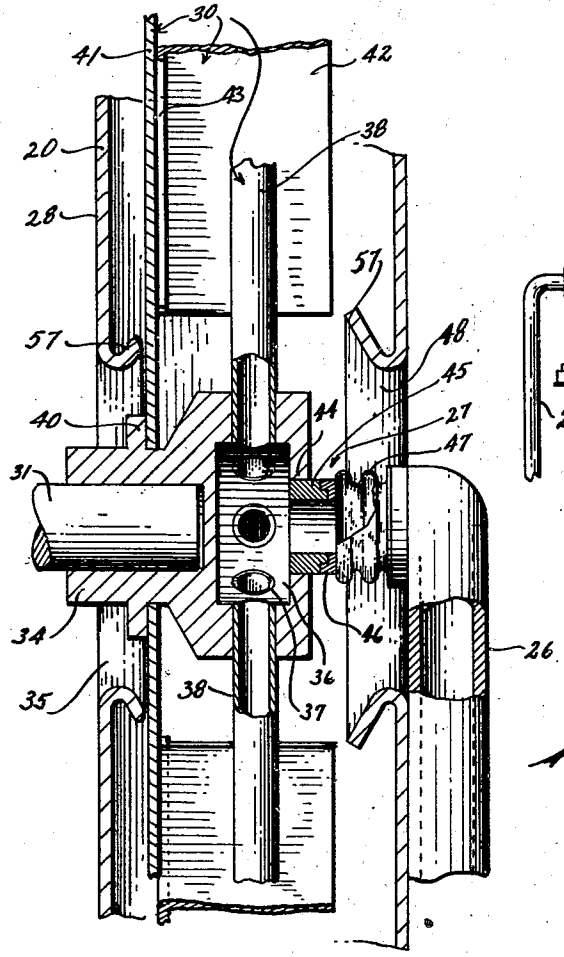


Fig. 1.



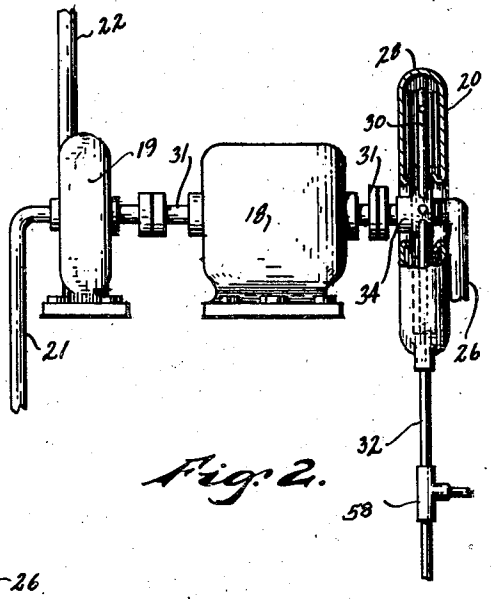


Fig. 2.

Fig. 3.

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AIR COOLING SYSTEM

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6 Claims. (Cl. 62—152)

The invention relates to refrigeration, and particularly to cooling of living rooms and buildings generally, for the purpose of maintaining temperatures lower than external atmospheric temperatures to increase the comfort of human beings or for other uses.

The invention aims to utilize to these ends the well known properties of water in evaporting and absorbing heat, and the expedient which has been known for increasing the rate of evaporation by evacuation of gas and vapor from a chamber within which the water is exposed.

A special aim of the invention is to embody a system in which the desirable effects may be accomplished economically and by practical apparatus adapted for commercial embodiment in air conditioning units or set up in rooms of a building without requiring special air duct construction necessarily.

An important object of the invention is to utilize a novel arrangement for circulating water and exhausting the evaporator chamber with a single pump, and to produce novel means for disposing of water vapor and introducing water to the evaporator.

A highly important aim of the invention is to present a system adapted for commercial embodiment with a minimum requirement for special manufactures, but enabling production of the necessary unit by utilization of standard mechanical apparatus and simple tank, case, and duct fabrication conforming to familiar shop and trade practices.

Additional objects, advantages and features of invention reside in the construction, arrangement and combination of parts involved in the embodiment of the invention, as will appear from the following description and accompanying drawing, in which

Figure 1 is a partly structural and partly diagrammatic view of the complete system.

Figure 2 is a detail of the motor unit.

Figure 3 is an enlarged fragmentary sectional view of the centrifugal dissipator and fore pump.

There is illustrated a system which may be embodied in various forms and may utilize various constructions of motor, pumps, cooling coils, tanks, ejector, valves and the like, necessary thereto, but for purely exemplary purposes indicating particular structures in some parts where thought necessary to illustrate the function intended. Variations of the arrangements and structure of the system may be made in many ways without departing from the spirit of the invention as set forth in the appended claims.

The system includes a cooling coil 10, set up in a flue structure 11, having an upper inlet for air to be cooled and a lower outlet 12 which may lead to any usual air circulating means, which may be thermally operative, or may include any usual motors and fans 13 for moving the air.

This coil receives cooling water through a pipe 14, leading from the bottom of an evaporator 15, which is a tank in which a proper body 16 of water is maintained for the purposes of the system, and in which a vacuous condition is maintained so that a part of the water is evaporated; heat being thereby absorbed from the remainder of the water, which is collected in the lower part of the evaporator. The water passing the coil 10 is next carried through a coil 17 where it absorbs heat from a motor 18 driving a centrifugal or other circulating pump 19 and a centrifugal dissipator pump 20. The pump 19 draws the water from the coil 17 through pipe 21, and propels it through pipe 22 to a pump 23 of the Venturi ejector type, where the water serves as the power medium for operating this pump in accordance with the well known principles of such devices. The suction pipe 24 of the ejector leads from the top of the tank 15, and the water being forced through the ejector by the pump exhausts the tank 15 of air and vapor, to a degree suitable for the purposes described.

The ejector is provided with a well 25 receiving the water from the Venturi passage, and from the well the water is removed by pipe 26 leading therefrom to the axial inlet 27 of the centrifugal pump 20 termed the dissipator, since in removing the vapor from the evaporator, this is the principal element for dissipating heat absorbed by the system.

The pump 20 consists of a suitable circular casing 28 having a tangential vapor exhaust port and conduit 29, and a rotor 30 mounted concentrically therein on a driving shaft 31, which is one end of the shaft of the motor 18 in the present instance. The rotor also serves as the water intake, as will be described. The casing has a water discharge port 31' at the bottom, from which a pipe 32 leads to the top of the evaporator 15, communicating with a perforated sprinkler or spray pipe 33 extending across the top of the tank.

The rotor 30 comprises a hub 34 fixed on the shaft 31, and extended into the casing 28 through a suitable opening 35, which may be restricted in any usual way further than shown if desired, so as to limit ingress of air thereat. The hub is enlarged suitably within the casing and formed

with a central chamber 36 from which a multiplicity of radial openings 37 are formed, in each of which there is fitted a radial rectilinear pipe 38 stopping short of the peripheral wall of the casing 28 a distance sufficient to clear a series of baffles 39 formed on the inner side of the casing 28 before the port 29, these baffles being shaped and positioned so as to prevent egress of water as much as practicable, but permit escape of air and vapor.

The rotor hub has a flange 40 just within the opening 35, to which flange a planiform circular disc 41 is secured in any suitable way, the periphery of which stops short of the baffles 39. On this disc a series of vanes 42 are fixed, at present these consisting of planiform rectangular plates set perpendicular to the plane of the disc and alternated with the pipes 38. Each plate is formed with a base flange 43 set against the face of the disc and secured thereto in any approved manner.

At the outer side the hub is formed with an axial port 44 in which is fitted a bearing ring 45, having an exteriorly rabbeted outer end, to which is revolubly fitted an interiorly rabbeted ring bearing 46, secured to the end of a Sylphon bellows 47 mounted on the terminal of the pipe 26 in such manner as to press the ring 46 to a seat on the hearing 45, and so form a continuous conduit with the pipe to the pipes 38. It is an advantage of the construction of the dissipator pump element that it will automatically accommodate itself to a small or large flow of water from the ejector, as will be obvious. Around the outlet of the pipe 26 and bellows 47 a large opening 48 is formed through the adjacent wall of the casing 28, through which a certain amount of air is drawn and forced outward centrifugally by the vanes 42, so that a constant current is kept passing rapidly through the casing and out through the port 29. This aids in drawing out the vapor which may be entrained with the water, and also in maintaining a vacuous condition with certainty in case the water becomes low in the well 25, by a measure of ejector action operative in conjunction with the pipes 38, as well as clearing the vapor from the casing 28. The port 29 may be extended as a conduit to any suitable point of discharge externally of the space being refrigerated or cooled, or may be otherwise utilized. Clearing the vapor from the casing 28 minimizes the return of vapor to the evaporator 15 entrained with water. Also in case the vacuuous condition in the evaporator should cause water to be drawn thereinto more rapidly than delivered from the pipes 38 a similar condition would exist. However, the latter condition is safeguarded against by introducing into the pipe 32, a pressure responsive valve device 50, having a control pipe 51 connected with the interior of the tank 15 above the liquid 16. This valve may be constructed to operate so as to close partly when an excessive low pressure is developed in the evaporator, and so restrict the flow of water from the dissipator pump. Accumulation of water in the latter will retard it and the motor 18 with the pump 19, so that the ejector will not then produce so high a pressure. Increase of pressure excessively will permit wider opening of the valve 50 again, greater clearance of water from the fore pump, and pick-up in speed of the circulatory and dissipatory systems. A water supply pipe 52 leads to the tank 16, where a float valve 53 is provided operative to admit additional water when the level of the water in the tank falls below a desired minimum. The pipe 52 may be extended from a suitable source of supply, not shown. By this means any depletion of the supply by evaporation and loss through the port 29 of the dissipator will be replenished.

It is expected that the system will operate to maintain a pressure of approximately 0.178 pound per square inch absolute, so that the external atmospheric pressure will be capable of causing water to flow rapidly from the dissipator through pipe 32 and produce an efficient spray and atomization of water at the jets of the pipe 33.

A pan 54 is provided under the coil 10 to receive any water which may collect on and drip from the coil by condensation from the atmospheric air passing through the flue 11 and around the coil. From the bottom of this tank a drain pipe 55 is extended to the tank 15 into which it opens, so that the vacuous condition in the evaporator will draw the collected water from the pan. A float valve 56 is provided at the inlet of the pipe 55 in the pan, operative to open by rising of the float to a predetermined moderate high level, so that water will then be drawn from the pan. This will insure retention of sufficient water in the pan to seal the inlet of the pipe 55. Utilization of the water condensed on the cooling coil 10 is of course advantageous in that it will be cooler than city service water in summer when apparatus of this kind will be most used.

Water being supplied to the tank 15 as required, operation of the motor 18 will cause the pump 19 to draw water through the two coils from the tank 15 and propel it through the ejector pump from whence it may drain to the intake of the dissipator pump 20. Here, passing through the hub into the pipes 38, it is thrown into the casing 28 and collected in the lower part of the latter, from whence it is drawn through pipe 32 to chamber 15, principally by suction in the chamber. Here it is sprayed into the rarified atmosphere within the tank 15 produced by the ejector, facilitating evaporation, and the cooled water collecting in the lower part of the tank 15. The vapor drawn off by the ejector will be separated from the water in the casing 28 and discharge through the port 29 by the rush of air inward through the opening 48 of the fore pump, swept outward by the vanes 42. The air contacting the coil 10 will fall by reason of its greater density after cooling, and may pass out from the bottom of the flue 11 surrounding the coil, thus drawing fresh air in at the top, and this movement may be facilitated by fans or other circulating means at 13 if desired. The current for operation of the motor 18 is the only energy required to be supplied to the system.

It will be appreciated that the system shown and described comprises virtually a continuous closed conduit in which the water circulates, this conduit comprising the chamber 15, pipe 14, coils 10 and 17, pump 19, pipe 22, ejector 23, pipe 26, casing 28 and pipe 32.

The casing 28 also serves in the lower part as a receiver of water, the pressure over which is determined by the effect of the vanes 42, which establish a partial vacuum thereover. The dissipator pump including the pipes 38 and vanes may be said to constitute a means to separate gas from liquid, and the pump 19 may be broadly termed a liquid propulsion means. The pan 54 is essentially a collector of the water of condensation precipitated on the coil 10, and may take various other forms.

The valve 50 may be said to be a throttle device, since it does not close in normal operation.

The edges of the casing 28 around the openings 35 and 48 are formed with inturned and returned flanges 57, by which water running down the sides of the casing is prevented from escaping at these openings.

If desired an overflow valve 58 may be provided on the pipe 32 between the valve 50 and the dissipator pump to vent any excess water when the valve 50 is throttled, so that water will not accumulate objectionably in the lower part of the casing 28, which constitutes a reservoir. This valve will contribute to a continuous flushing of the system. With this arrangement, in case of development of an excessively high vacuum in the chamber 15, the back pressure operative then on the pump 20, ejector, and pump 19, will effect a compensation, as will be understood.

It will be appreciated that the principal evaporation of water in the chamber 15 will occur in the sprays from the pipe 33, and that this will vaporize only a small part of the body of spray, the evaporated water immediately absorbing heat from the remainder of the spray, as well as from the walls of the chamber 15 and surface of the liquid body 16 in the lower part of the chamber. This body is thus capable of absorbing heat from the atmosphere when circulated through the coil 10. The heat absorbed in the chamber 15, and the water vapor, are then simply rejected into the external atmosphere by discharge from the exhaust 29 of the dissipator pump, the water from pump 19 being too warm to condense the vapor entrained in the ejector.

The amount of water wasted by such a system is comparatively small, and owing to the cheapness of water is an insignificant item of expense. For cooling a small house a unit adapted to carry about five gallons on the chamber 15, is believed adequate, and with such a unit it is believed that a supply of three gallons per hour will be sufficient for both evaporation and flushing. An operating pressure from the pump 19 of 50 pounds per square inch will be adequate to develop the vacuum of 0.178 lb. and develop a temperature of 50° F. in the coil 10, in summer in the temperate zone. Much will depend, of course on the effectiveness of the construction of the pumps.

I claim:

1. A refrigeration system comprising a conduit forming a closed circuit for the flow of a liquid including an evaporator chamber, means to supply liquid thereto, a cooling coil in the conduit for receiving a liquid from the lower part of the evaporator chamber, a liquid propulsion means forming part of the circuit receiving a liquid from the coil and having a discharge conduit including an ejector device forming a part of the first named conduit, the ejector device having a suction port connected to the upper part of said evaporator chamber, a discharge port connected with the upper part of the evaporator chamber, and means included between the ejector discharge port and evaporator chamber to separate gas from liquid returned to the evaporator chamber from the ejector.

2. The structure of claim 1 in which the liquid propulsion means is a liquid pump, said means to separate gas from liquid being a pump device having a gas discharge port opening from said conduit.

3. The structure of claim 1 in which the liquid propulsion means is a liquid pump, said means to separate gas from liquid being a pump device having a gas discharge port opening from said conduit and evaporator chamber, and a pressure responsive valve in the conduit between said evaporator chamber and the pump device, responsive to pressure in the evaporator chamber, arranged to throttle fluid passing through the conduit in response to low pressure, and to relieve the conduit of such restriction in response to increased pressure.

4. The structure of claim 1, in which the said liquid propulsion means consists of a rotary pump device including an operating shaft, and said means to separate gas from liquid consists of a rotary liquid pump having a liquid receiving chamber in receiving relation thereto and having an atmospheric port, said rotary liquid pump including also means to exhaust gas from said evaporator.

5. The system of claim 1, in which the liquid referred to is water, a collector beneath said coil, a duct from the collector to the said evaporator chamber, and a float valve in the collector operative to open at a predetermined high level to permit water to be forced to the chamber by atmospheric pressure.

6. The system of claim 1, in which a motor is included to operate said liquid propulsion means, and said coil includes a terminal part constructed, arranged and adapted to absorb heat from the motor.

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