

June 16, 1964

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3,137,145

REFRIGERATION SYSTEM AND EVAPORATIVE COOLING UNITS

Filed Oct. 19, 1962

2 Sheets-Sheet 1

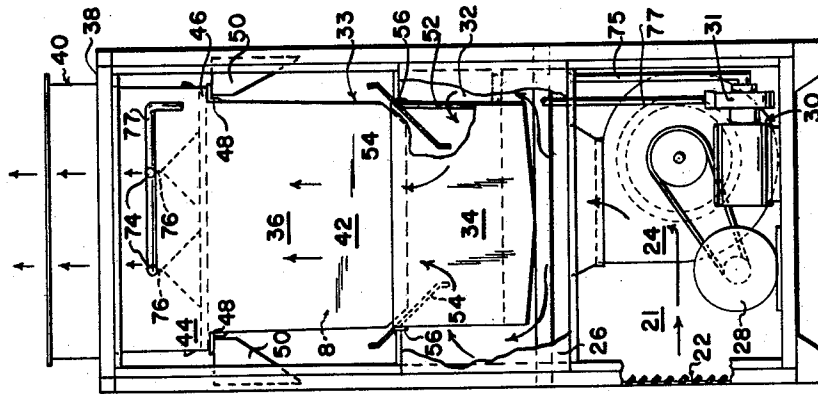


Fig. 2

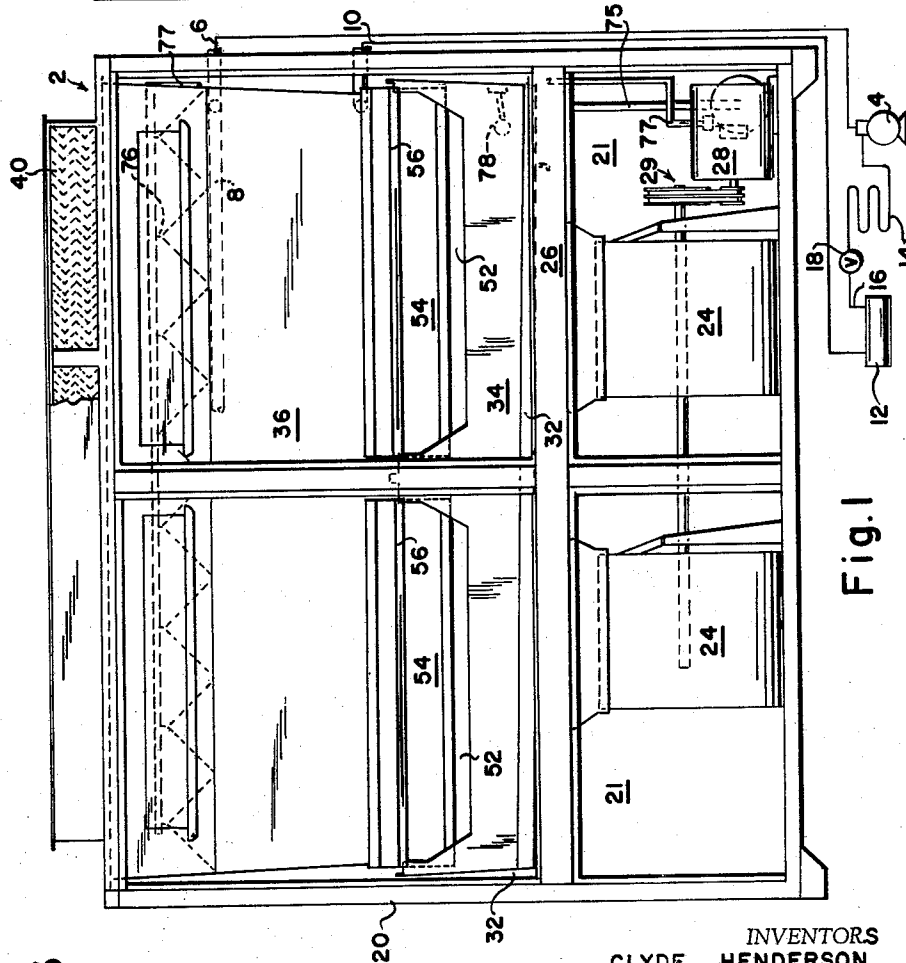
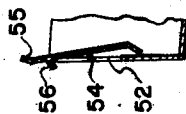


Fig. 1

Fig. 3



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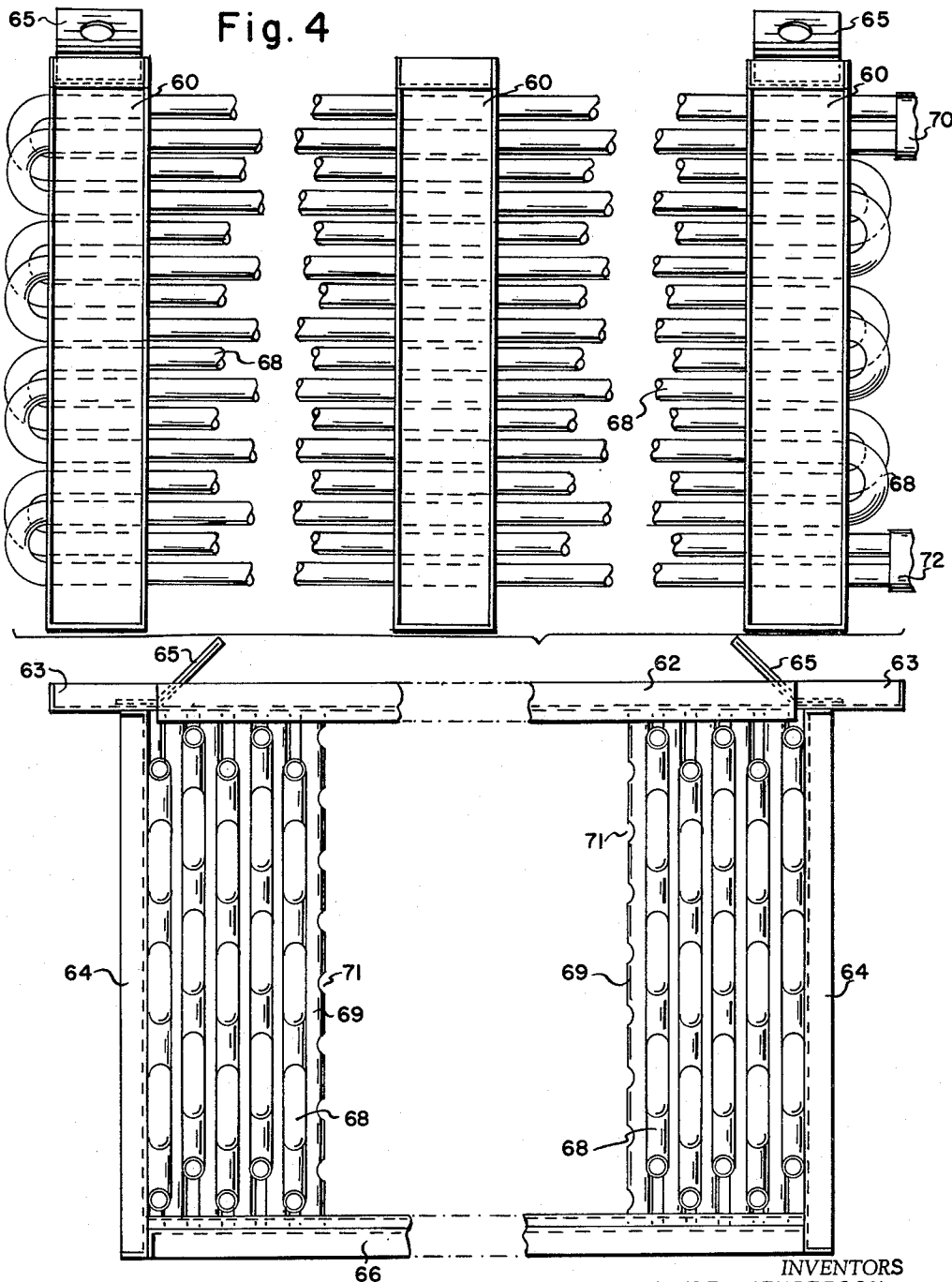
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1

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REFRIGERATION SYSTEM AND EVAPORATING COOLING UNITS

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Filed Oct. 19, 1962, Ser. No. 231,783

14 Claims. (Cl. 62-183)

This invention relates to refrigeration systems and the like, and more particular to constructions such as evaporative condensers wherein water is evaporated in a stream of air to cool refrigerant gas or a liquid in coils or tubes.

An objective of this invention is to provide improved operation of the refrigeration systems of the type wherein refrigerant gas is cooled and condensed by the cooling effects resulting from evaporating water in a stream of air. A further object is to provide improved water evaporating and cooling constructions. A still further object is to provide improved evaporative cooling units. Another object is to provide improved water and air handling mechanism in apparatus of the above character. A further object is to provide for the above with structures wherein the water is contained within a restricted flow path and does not contact surfaces which rust or corrode. A still further object is to provide for the above with relatively simple and sturdy constructions which are inexpensive to manufacture and maintain, and which are efficient, dependable and free of objectionable noise and vibration, and wherein the various parts are accessible for service. These and other objects will be in part obvious and in part pointed out below.

In the drawings:

FIGURE 1 is a front elevation of one embodiment of the invention with the front panels removed;

FIGURE 2 is a side elevation from the right-hand side of FIGURE 1, with the side panel removed and parts broken away;

FIGURE 3 is a sectional view showing the rest position of one of the air dampers;

FIGURE 4 is an enlarged side elevation of the condenser coil assembly; and

FIGURE 5 is a view from the right-hand side of FIGURE 4, with parts broken away.

Referring to FIGURE 1 of the drawings, an evaporative condenser 2 includes a condenser coil 8 and is part of a refrigeration system which includes a compressor 4 which delivers compressed hot refrigerant gas through a line 6 to the condenser coil 8, a liquid refrigerant line 10 which extends from the condenser coil to a receiver 12 and an evaporator 14 which receives liquid refrigerant from the receiver through a line 16 having an expansion valve 18 therein. The system also includes standard control and auxiliary equipment (not shown).

Evaporative condenser 2 has an upright rectangular casing 20 formed by a frame construction and an outer wall of sheet metal. During operation, air is drawn through grills 22 into a bottom chamber 21 in the lower portion of the casing, and is directed upwardly by a pair of fans 24 through rectangular openings in a horizontal partition 26. Partition 26 divides chamber 21 from the chamber 32. Fans 24 are positioned within chamber 21 together with a driving motor 28 which drives the fans through a reduction pulley and shaft assembly 29. A motor-pump assembly 30 is mounted adjacent fan motor 28 and includes a pump 31 which circulates water in manner discussed below.

The space or chamber 32 above partition 26 is sealed except at the inlet and outlet openings, and during operation it is maintained at an elevated air pressure. Mounted within chamber 32 is an inner casing or shell 33 which is

2

molded polyester reinforced with fiberglass. Shell 33 is formed by a sump tank 34 positioned centrally and longitudinally directly above the air outlet openings from fans 24, and a condenser envelope 36 in the form of a rectangular casing in which the condenser coil 8 is mounted and the bottom edge of which is snugly received in the top of the sump tank. Mounted upon the top wall 38 of casing 20 is an eliminator assembly 40 through which the air is discharged from the open top of the condenser envelope 36.

Condenser envelope 36 has vertical side walls and slightly tapered end walls, and the lower portion 42 (FIGURE 2) is slightly narrower than the upper portion 44 so as to form ledges 46 along the side of the envelope. The envelope is supported by these ledges 46 which rest upon a pair of angle irons 48 which in turn are supported by brackets 50 forming part of the frame construction. Sump tank 34 is also rigidly supported by the frame construction so that the shell 33 is securely mounted, and at the top the condenser envelope is completely closed except for the outlet provided by the eliminator assembly 40.

Each of the two side walls of sump tank 34 is cut away to provide two rectangular openings 52 through which air passes from chamber 32 to the sump tank and thence upwardly through the inner shell 33. Each of these four openings 52 is provided with an automatically operable damper 54 which is adapted to swing between the open position of FIGURE 2, wherein air flows through the opening, and the closed position of FIGURE 3, wherein the opening is covered. Each of the dampers 54 overhangs the ends of its opening 52, and at each end there is an angular tab 56 which extends outside of the tank wall. Hence, the damper rests upon the upper edge of the sump tank and may rock or swing between the open position of FIGURE 2 and the closed position of FIGURE 3. An upper portion 55 of the damper provides some counter-weight effect and it also projects above the puncture between the top of the sump tank and the bottom of the condenser envelope. Hence, the dampers act as water deflectors so as to collect any moisture falling or seeping downwardly along the envelope wall and in the vicinity of the openings 52.

Positioned above coil 8 are two spray pipes 74 which extend longitudinally of the coil and are provided with spaced spray nozzles 76. Water is drawn from sump tank 34 by pump 31 through a pipe 75 and is delivered through a pipe 77 to pipes 74, and it is discharged from the nozzles and passes downwardly, thoroughly wetting the outer surfaces of the coil. Some of the water is evaporated in the counter-current stream of air and the remainder collects in the sump tank and is recirculated. A predetermined water level is maintained in the sump tank by a water inlet control assembly 78 which is connected to a water supply.

Referring now to FIGURES 4 and 5, coil 8 has three rigid rectangular frames 60 spaced respectively at the ends and center of the coil. Each frame 60 has a bottom channel 66, and side channels 64 and a top channel 62 which is longer than channel 66 so that its end extensions 63 project beyond the side walls of the coil. Referring to FIGURE 2, these channel extensions 63 project above and rest upon ledges 46 so that the coil is supported through the wall of the condenser envelope directly by angle bars 48 and brackets 50. Four lifting brackets 65 (FIGURES 4 and 5) are provided for lifting the coil.

Coil 8 is formed by a number of individual coils 68 each of which is a single tube bent into a flat coil which is positioned vertically and generally parallel to the longitudinal side of the coil. Coils 68 are staggered and are held in spaced relationship by vertical spacer tubes 69, each of which has its ends nested in slots in the

3

top and bottom channels 62 and 66. Tubes 69 are provided with horizontal dimples or notches 71, each of which receives a horizontal run of a coil 68, and the sides of the coils mate with these notches so that each coil is clamped in a fixed position by the adjacent sets of tubes 69. The notches 71 on the opposite side of each tube are staggered so as to provide the staggered coil relationship.

The end of each coil 68 at the top of the condenser coil (see FIGURE 4) is connected to a gas inlet header 70 which receives the compressed refrigerant gas through line 6, and the end of each coil 68 at the bottom is connected to a header 72 where the condensed liquid refrigerant collects from which it flows through line 10 to receiver 12.

During operation, fans 24 draw air through grills 22 into chamber 21, and direct two streams of air upwardly into chamber 32. These streams of air are rectangular in general cross-section and are directed toward the slightly rounded bottom wall of the sump tank. The sump tank acts as an air distribution baffle and divides the streams of air and they project upwardly along the tank side walls. The elevated air pressure condition within chamber 32 causes dampers 54 to move to the fully open position, and the air flows through openings 52 and is deflected downwardly by the baffles. There is also a tendency for air to pass through the slot above the baffle and beneath and adjacent bottom edge of the condenser envelope. The air movements act with the baffle to insure that water will not pass out of shell 33 into chamber 32. All of the water is directed downwardly into the sump tank where it is collected and recirculated. The upwardly flowing stream of air produces evaporation of water and resultant cooling. Free water is removed from the air as it is discharged through the eliminator assembly 40. When fans 24 are not operating, dampers 54 move by gravity to the closed position of FIGURE 3 wherein they deflect water from the side walls of the shell to the sump tank.

An important feature of the illustrative embodiment of the invention is the molded fiberglass construction of shell 33. Specifically, sump tank 32, condenser envelope 34, and baffles 54 are molded of fiberglass reinforced polyester which is resistant to acid attack. Access panels are provided on casing 20 to the various components and the condenser envelope is provided with removeable panels for access to the sprayers. However, when these panels are in position casing 20 and shell 33 are sealed. Nevertheless, if there is an opening in the wall of casing 20, the elevated air pressure condition tends to cause leakage of air outwardly from chamber 32, and similarly, inwardly through any openings in shell 33. The reinforced fiberglass construction of shell 33 insures minimum noise during operation.

The illustrative embodiment of the present invention is a refrigeration system incorporating an evaporative condenser, and it will be appreciated that such a refrigeration system will operate with improved efficiency and dependability. However, many aspects of the present invention are applicable to other constructions, combinations and uses. For example, the provision of an elevated air pressure chamber between an outside sealed casing and an inner casing or shell insures that the circulating water will not spill or leak from the space intended for it. Also, the elevated air pressure chamber combines with the fiberglass inner shell and the other structure to dampen and reduce vibration and noise. An important feature in this regard is the "blow-through" fan or blower arrangement. This arrangement also permits the positioning of the motors and the components which they operate at the base of the casing for ready access and so that noise and vibration difficulties are at the minimum.

The automatically operating dampers are held open by the flowing air and they constitute means to insure the

4

elevated air pressure condition during operating. Under some circumstances, these automatic dampers may be replaced by dampers which are opened and closed by means which is actuated at the time that the blowers and pumps are started. Also, the blowers may be provided with controls to vary the air output in accordance with the needs.

As many possible embodiments may be made of the mechanical features of the above invention and as the art herein described might be varied in various parts, all without departing from the scope of the invention, it is to be understood that all matter hereinbefore set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In apparatus of the character described, the combination of, a casing construction having an air inlet at the bottom and an air outlet at the top, blower means positioned within said casing and adapted to draw air in through said inlet and to direct the air at an elevated pressure toward said outlet, an inner shell of fiber glass reinforced plastic positioned within said casing and providing a water circulating zone within which water passes by gravity in counter-current relationship with respect to air flowing toward said outlet, said inner shell comprising a sump tank and an upper shell and having walls spaced from said casing and including damper means which is closed automatically when there is no air circulation for controlling the entry of air to said inner shell and maintaining an elevated air pressure condition around said inner shell, and coil means positioned within said water circulating zone and adapted to pass fluid in heat exchange relationship with the air and water within said zone.

2. In apparatus of the character described, the combination of, a casing construction having an air inlet at the bottom and an air outlet at the top, blower means positioned within said casing and adapted to draw air in through said inlet and to direct the air at an elevated pressure toward said outlet, an inner shell positioned within said casing and providing a water circulating zone within which water passes by gravity in counter-current relationship with respect to air flowing toward said outlet, said inner shell having walls spaced from said casing and including means controlling the entry of air to said inner shell and maintaining an elevated air pressure condition around said inner shell, coil means positioned within said water circulating zone and adapted to pass fluid in heat exchange relationship with the air and water within said zone, said inner shell comprising a sump tank and an envelope for said coil and having air inlet openings at the top of said sump tank, and damper means closing said opening when there is no air circulation.

3. Apparatus as described in claim 2 wherein said damper means comprises a plurality of dampers which are urged toward the closed position by the action of gravity and which are opened by the action of air during operation.

4. Apparatus as described in claim 3 wherein each of said dampers comprises a sheet-like damper which swings around a pivot at the upper edge of its opening with one portion projecting below said pivot into the top of said sump tank and another portion projecting above said pivot outside of said sump tank.

5. In apparatus of the character described, the combination of, a casing construction having an air inlet at the bottom and an air outlet at the top, blower means positioned within said casing and adapted to draw air in through said inlet and to direct the air at an elevated pressure toward said outlet, an inner shell positioned within said casing and providing a water circulating zone within which water passes by gravity in counter-current relationship with respect to air flowing toward said outlet, said inner shell being formed of non-metallic mate-

5

rial and having ledges by which the shell is supported from said casing and having walls spaced from said casing and including means controlling the entry of air to said inner shell and maintaining an elevated air pressure condition around said inner shell, and coil means positioned within said water circulating zone and adapted to pass fluid in heat exchange relationship with the air and water within said zone, said coil comprising a plurality of tubes rigidly mounted together and supported upon said ledges within said shell.

6. Apparatus as described in claim 5 wherein said coil includes a plurality of rectangular frames and spacer means rigidly clamping said tubes.

7. Apparatus as described in claim 6 wherein each of said tubes is bent into a substantially flat coil which is positioned vertically, and wherein said spacer means comprises a plurality of tubes each of which has horizontal notches for receiving the adjacent coil tubes.

8. Apparatus as described in claim 7 wherein said outer casing has air inlet louvers in a side wall and an air outlet in its top wall, partition means positioned beneath said sump tank, and wherein said blower means is positioned beneath said partition.

9. Apparatus as described in claim 8 which includes sprayer means positioned above said coil, and a water circulating pump positioned beneath said partition and connected to withdraw water from said sump tank and to deliver the water to said sprayer means.

10. Apparatus as described in claim 9 which includes an eliminator positioned within said outlet.

11. In apparatus of the character described, the combination of, a casing construction having an air inlet at the bottom and an air outlet at the top, blower means positioned within said casing and adapted to draw air in through said inlet and to direct the air at an elevated pressure toward said outlet, an inner shell positioned within said casing and providing a water circulating zone within which water passes by gravity in counter-current relationship with respect to air flowing toward said outlet, said inner shell having walls spaced from said casing and including means controlling the entry of air to said inner shell and maintaining an elevated air pressure condition

6

around said inner shell, coil means positioned within said water circulating zone and adapted to pass fluid in heat exchange relationship with the air and water within said zone, a partition dividing said outer casing into an air inlet chamber and an upper chamber surrounding said inner shell, said blower means being positioned within said air inlet chamber and having a centrally positioned air discharge opening through said partition and toward the bottom of said inner shell.

12. Apparatus as described in claim 11 wherein said inner shell includes a sump tank having a bottom wall which acts as an air deflector for distributing the air from said blower means.

13. Apparatus as described in claim 12 wherein said inner shell is formed of fiberglass reinforced plastic.

14. In apparatus of the character described, the combination of, a casing construction having side walls and an air inlet and an air outlet, blower means adapted to pass air through said inlet into said casing and thence out through said outlet, an inner shell positioned within said casing, side and bottom walls spaced inwardly from the walls of said casing to provide a closed air spaced within said casing around said shell, said shell providing a water sump tank at its bottom and a water circulating zone within which water passes by gravity in counter-current relationship with respect to air flowing toward said outlet, said inner shell having an opening in a side wall above said sump tank and controlling the entry of air to said inner shell and maintaining an elevated air pressure condition around said inner shell, coil means positioned within said water circulating zone and adapted to pass fluid in heat exchange relationship with the air and water within said zone, and means to supply water to the top of said water circulating zone onto said coil means.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,137,145

June 16, 1964

Clyde Henderson et al.

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 1, line 16, strike out "the", first occurrence;
column 2, line 39, for "puncture" read -- juncture --;
column 6, line 22, for "spaced" read -- space --.

Signed and sealed this 10th day of November 1964.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents