

May 17, 1938.

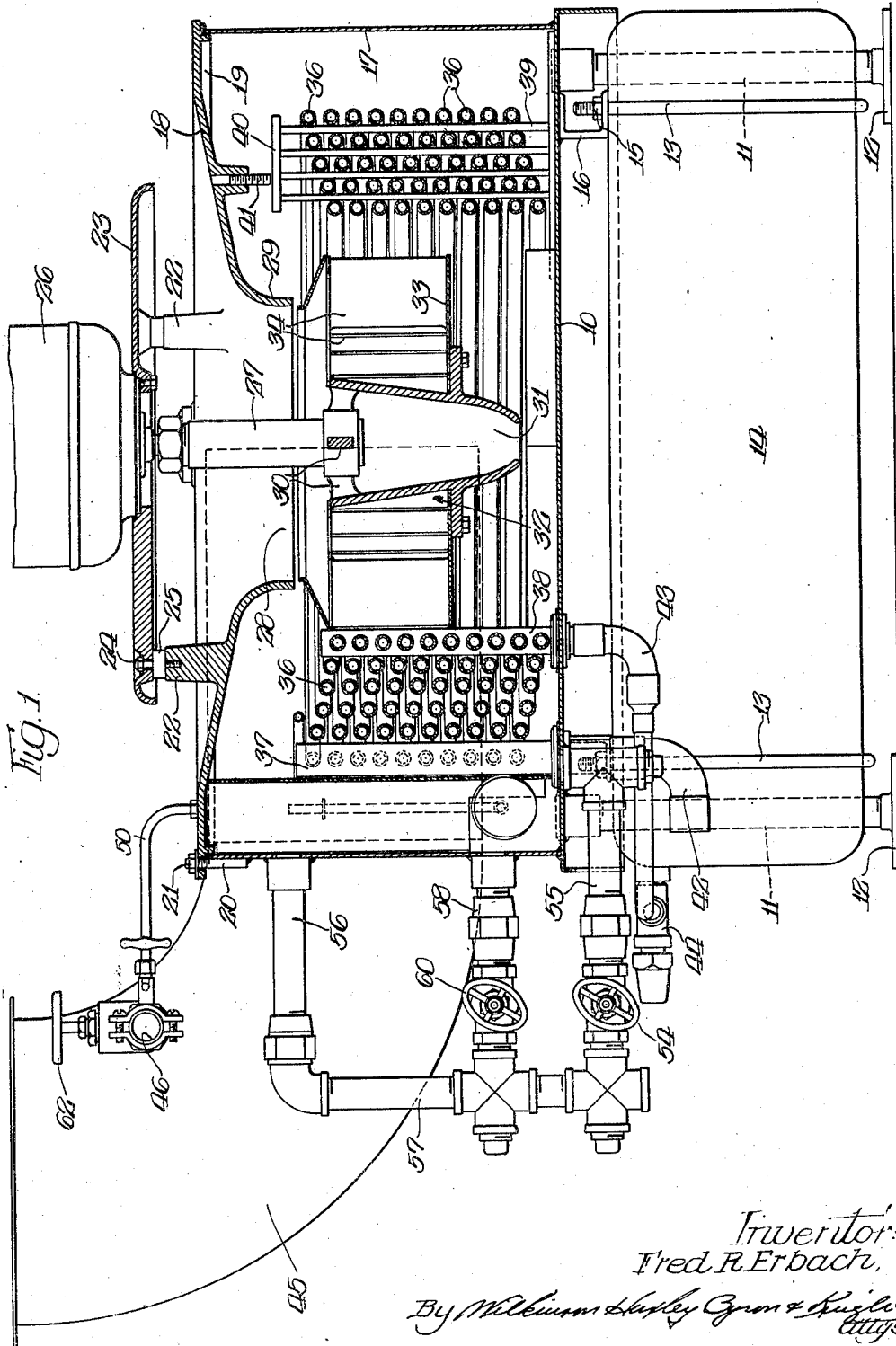
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EVAPORATIVE CONDENSER

Filed Dec. 4, 1936

3 Sheets-Sheet 1



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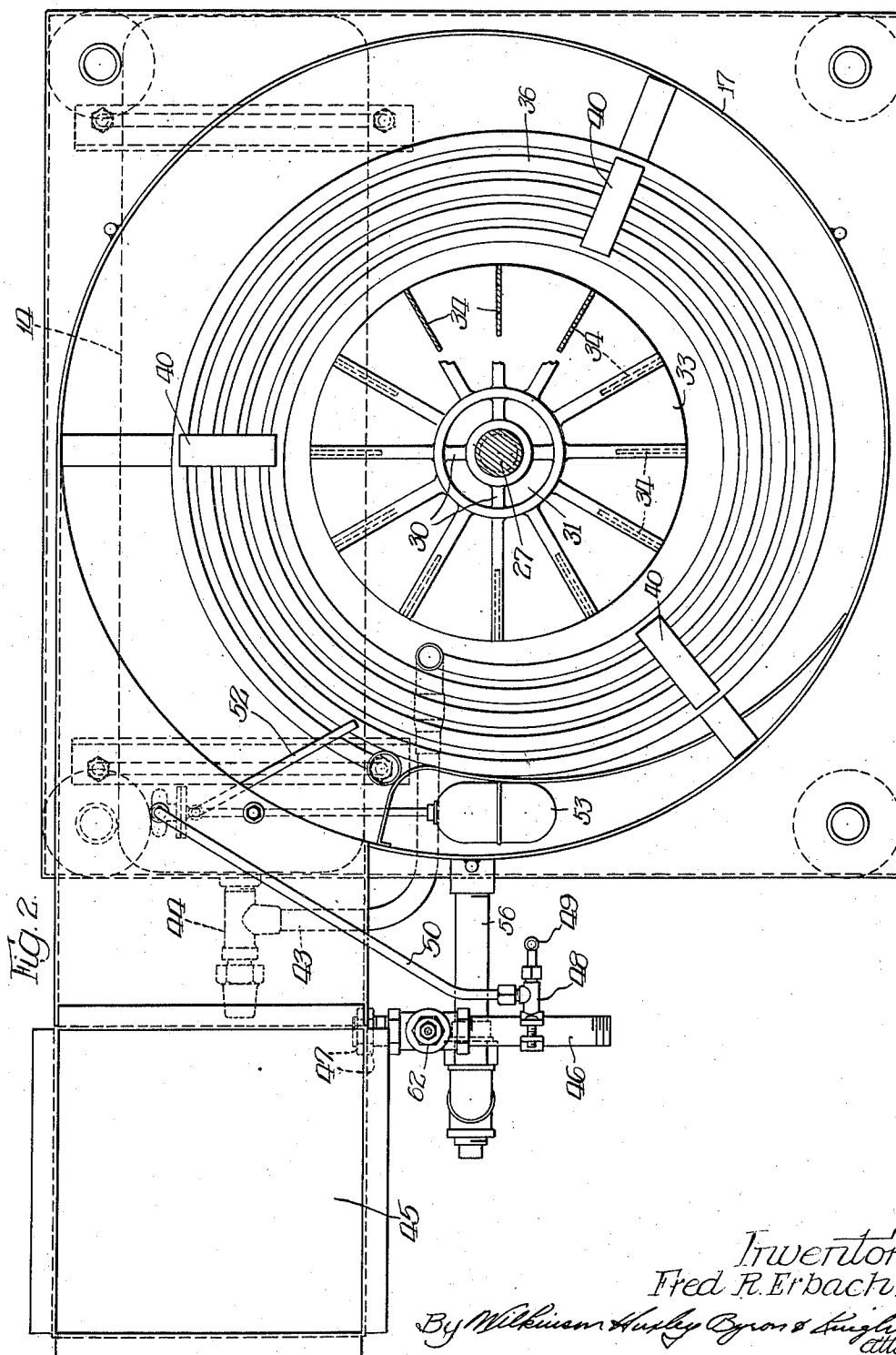
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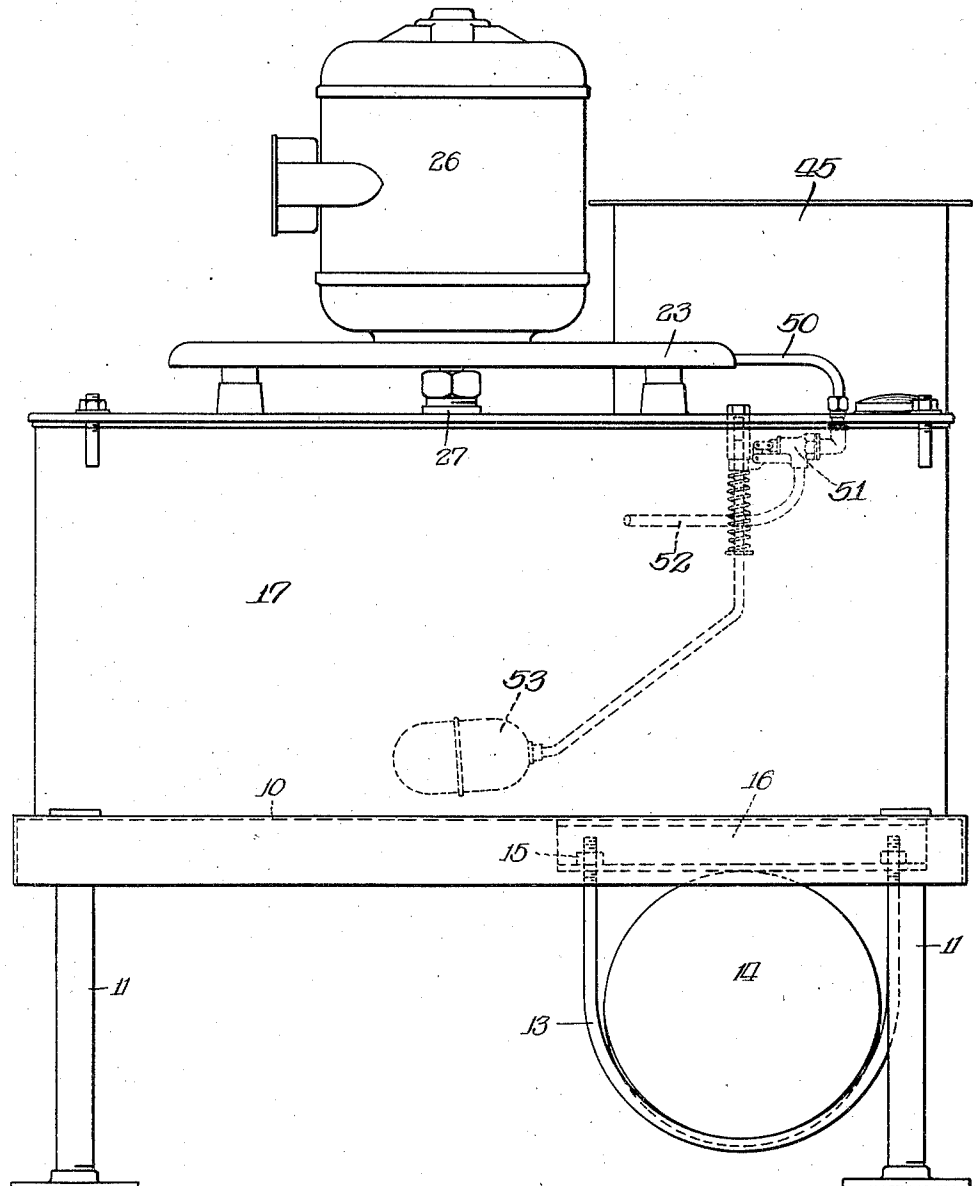
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3 Sheets-Sheet 3

Fig. 3.



Inventor:
Fred R. Erbach,
By *Wilkinson Huxley Bryson & Knight*
Attorneys

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EVAPORATIVE CONDENSER

Fred E. Erbach, Beloit, Wis., assignor to General Refrigeration Corporation, Beloit, Wis., a corporation of Delaware

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4 Claims. (Cl. 257—37)

The invention relates generally to the art of refrigeration with more particular reference to improvements in apparatus for cooling condenser coils by the evaporation of moisture, thereby rapidly removing heat from the condenser coils which may have a high temperature refrigerant gas or other high temperature gas or liquid flowing therethrough.

In a refrigeration machine the hot discharge gas from the compressor must be cooled in order to condense the refrigerant and return it to the receiver as a liquid. The heat may be removed by means of air as in an air cooled condenser, by means of water flowing through a water cooled condenser in which the water temperature is raised, or by evaporation of water, in which case both air and water are used as the means for removing the heat from the condenser coils.

An object of the invention is to provide an improved evaporative condenser having increased efficiency which is attained by thoroughly mixing the air and water and properly distributing the mixture over the surface of the condenser coils where evaporation takes place.

Another object of the invention is to provide an evaporative condenser wherein the motor for operating the fan and water pump is mounted vertically above the tank, thereby eliminating packing boxes, bearings, or fittings below the water level in the tank which might leak or be the cause of serious trouble.

Another object of the invention is to provide an evaporative condenser having a pump of the simplest rotative cone design in which water enters at the bottom inlet of the cone and is deflected upwardly until it reaches the mouth of the cone, whereupon it is discharged by centrifugal force across the air streams entering the fan. By this arrangement thorough mixing of the air and moisture as it passes into the fan is secured.

Another object of the invention is to provide an improved arrangement of condenser coils wherein the high temperature gases are introduced through a header at the outside of the condenser coils, which consist of a series of flat spirals of copper tubing connected in parallel to an inside header forming the outlet for the condenser. According to the invention as the spirals progress toward the center of the coil they have a downward pitch, permitting the condensed refrigerant liquid or other liquid to drain inward toward the outlet header. The arrangement also results in accomplishing the counter-flow principle in heat exchange. The hot discharged gas is fed in at the outside of the condenser and as it pro-

gresses toward the center it is cooled. Thus the condenser liquid is cooled to the minimum inlet air temperature and the outlet discharge air temperature is raised to the maximum degree possible.

The invention is also concerned with the provision of an evaporative condenser wherein the condenser surfaces can be readily cleaned to remove the hard deposits which adhere thereto as a result of the evaporation of water. Practically all water is hard and contains minerals which may cause an encrustation over the surface of the condenser. The condenser coils of the present evaporator are mounted in a tank that can be flooded to submerge the coils in a cleaning solution of the proper chemical analysis for dissolving the particular type of mineral deposits left on the coils by the evaporating water. A special valve is provided by means of which the water level may be changed from the normal operating level to the flooded level for cleaning purposes and which may be opened for draining the tank after completion of the cleaning process.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation, as will be more fully described and particularly pointed out in the specification, drawings and claims appended hereto.

In the drawings which illustrate an embodiment of the invention and wherein like reference characters are used to designate like parts—

Figure 1 is an elevational view, parts being shown in section, of the evaporative condenser embodying the features of the invention;

Figure 2 is a top plan view of the evaporative condenser of Figure 1 with the cover plate for the tank and fan motor removed, and

Figure 3 is an end elevational view of the evaporator looking toward the left in Figure 1.

In the embodiment of the invention selected for illustration in the drawings, the operating parts of the present evaporator are supported upon a table having a top substantially rectangular in plan and which in turn is supported on any suitable foundation by means of the uprights 11 having circular foot rests 12. Suspended by means of U-shaped rods 13 from the table top 10 is a cylindrical tank 14 forming the receiver for the liquid medium after the same has been condensed by the condensing structure to be presently described. The respective ends of the rod 13 are secured by nuts 15 to the brackets 16 which are fastened as by welding to the undersurface of the top plate 10.

The top plate 10 comprises the bottom of the tank which is formed by the cylindrical side wall 17 welded to said top plate so as to form a fluid tight connection therewith. The top member of the tank comprises a removable cover 18 having a depending flange 19 adapted to fit within the cylindrical wall 17 of the tank and thus properly positions the cover thereon. Suitably secured to the exterior of the cylindrical wall 17 of the tank are upwardly projecting pins 20 adapted to pass through openings formed in the cover and receive screws 21, thereby releasably securing the cover in place. Said cover has formed integral therewith upwardly extending lugs 22 which form supports for plate member 23, the same being releasably secured thereto by the threaded screws 24, the rubber inserts 25 being interposed therebetween in order to cushion the vibrations of the motor 26 supported by said plate member. The rotor shaft 27 of said motor extends centrally through the opening 28 in the cover 18 formed by the downwardly curved walls 29 and attached to the lower end thereof by the connecting webs 30 is a pump tube formed by the inverted cone 31. Said pump tube carries the centrifugal fan designated generally in Figure 1 by numeral 32 and which consists of a base member 33 supporting a plurality of radial plates 34.

Located within the tank 17 and positioned substantially concentric with the centrifugal fan are a plurality of condenser spirals 36 each having connection at its outer end to a supply header 37 and connecting at its inner end to an outlet header 38. Each header extends upwardly through the base 10 of the tank and is positioned with respect to the other header so as to give each spiral a downward pitch as the spiral progresses from the header 37 to the outlet header 38. As a result oil in the high temperature gas flowing through the condenser spirals and the condensed liquid will drain inward toward the outlet header. The spaced vertical rods 39 maintain the spiral coils in proper superimposed relation. Three sets of these rods are used, each set being retained in spaced relation by the top member 40 which is held against the rods by the screw 41 having threaded connection with cover 18. The header 37 is joined to a supply pipe 42 by which high temperature refrigerant gas or other high temperature gas or liquid may be delivered to said header and thus to the spiral coils connecting therewith. In a like manner the outlet header 37 connects with an outlet pipe 43 which discharges into the receiver 14, the same being connected thereto by the member 44.

The space between the cover 18 and the plate member 23 forms the air inlet for the centrifugal fan, air being drawn through said space and through the central opening 28 in said cover and being delivered thereby to said fan. The duct 45, substantially rectangular in cross section, comprises the air outlet for said tank, said duct having a tangential connection therewith, as will be clearly understood by reference to Figure 2. Water is supplied to said tank for cleaning or flushing purposes by the water pipe 46 which passes through the side wall of the duct 45 so as to discharge within said duct, said discharge end of the pipe being suitably secured to the wall by nuts 47. Joined to the water main 48 is a valved connection 49, regulated by handle 49, and which is provided with tube 50 connecting with a float operated valve 51, suitably located within said tank. The outlet 52 from said valve,

as shown in Figure 2, terminates over the spiral coils 36. The float 53 actuates valve 51 so as to maintain a constant water level within the tank during operation. For draining said tank it is only necessary to open valve 54, located in the water drain 55, connecting with the bottom 10 of the tank. According to the invention the tank can be substantially filled with water in order to submerge the condenser coils for the purpose of cleaning said coils to remove deposits and the like adhering thereto as a result of the evaporation of water by said coils. For this reason the present tank is constructed so that the air inlet and the air outlet will be above the water level in the tank during the cleaning operation. The flood level of the water is determined by the overflow connection 56 joined by pipe 57 to connection 58, having valve 60 therein. This last mentioned connection determines the normal level of the water within the tank.

During operation of the structure above described the pump tube 31 will dip into the water in the bottom of the tank since the normal water level, as determined by outlet 58, will be slightly above the lower end of said pump tube. When the motor 26 is started, causing rotation of the fan, water is caused to flow up the pump tube 31 and to be discharged radially in a fine spray from the upper end of said pump tube. Accordingly, the fine water sprays are directed across the path of the air being delivered to the fan. The pumping action of the inverted cone 31 is dependent on skin friction and the centrifugal force of the water on the interior wall of the inverted cone. The water escapes from the end of said pump tube in a substantially horizontal spray and moisture together with air is accordingly delivered to the blades of the fan. The discharge from the fan therefore comprises air having moisture uniformly distributed throughout and which is directed against the said spiral coils 36 of the condenser. Moisture in finely divided form impinges on the condenser coils 36 surrounding the fan and as said coils are at a high temperature, due to the high temperature medium such as refrigerant gas flowing there-through, evaporation readily takes place. The evaporation of the water or moisture by the coils abstracts considerable heat from the medium flowing through the coils. This dissipation of heat by the coils takes place rapidly, thus condensing the medium as the same progresses toward the outlet header. The present evaporative condenser operates at a high efficiency since the water consumption is a minimum for the quantity of heat dissipated. The method of cooling the condenser coils by the evaporation of moisture delivered to the coils uniformly by air streams passing thereover and carrying the moisture in suspension is more effective and more economical than cooling by air or by water only.

The compressor discharge gases or other gas or liquid is delivered to the condenser through the header 37 located to the outside of the condenser and therefore said medium must flow inwardly toward the center of the spiral coils. However, the direction of the air and water mixture delivered by the fan is just opposite the same flowing from the center toward the periphery of the condenser coils. This arrangement results in accomplishing the counter-flow principle in heat exchange. As a result the refrigerant gas or other medium is condensed and is cooled to the minimum inlet air temperature while the dis-

charge air temperature is raised to the maximum degree possible.

Another feature of the present condenser resides in the downward pitch of the spiral coils as they progress toward the outlet header 38. This facilitates the flow of the condensed liquid toward the outlet header.

A serious problem in a condenser of the above type is that of cleaning the evaporating surfaces which become coated with deposits left from the water evaporated. In the present structure the tank can be flooded to submerge the coils in a cleaning solution of the proper chemical analysis to dissolve the particular type of mineral deposit left on the coils by said evaporation. This flooding of the coils is made possible by locating the air inlet opening and air discharge opening above the upper level of the coils. For the cleaning operation the motor 26 is stopped and valve 60 is closed. Water from the water main 46 is then admitted to the tank by opening the valve in said main controlled by handle 62. The water will fill the tank to a level determined by the overflow connection 56. For cleaning the condenser coils whenever the hardness in the water is largely calcium bicarbonate hardness, hydrochloric acid has been found satisfactory. The proper quantity of acid is added to the water in the tank after the coils are completely submerged. During the cleaning operation the solution may be stirred occasionally or the process can be speeded up by flowing a high temperature medium through the coils in order to heat the solution. At the end of the cleaning operation the drain 54 is opened to completely drain the solution from the tank.

The invention is not to be limited to or by details of construction of the particular embodiment thereof illustrated by the drawings, as various other forms of the device will of course be apparent to those skilled in the art without departing from the spirit of the invention or the scope of the claims.

What is claimed is:

1. In an evaporative condenser, in combination, a tank providing a reservoir for water, a cylindrical fan mounted for rotation on a vertical axis and located in the upper end of said tank, means rotating with the fan for drawing

water from said reservoir and discharging the same radially from the center of said fan, means located above said fan delivering air thereto, a plurality of condenser coils encircling said fan and located in the path of said water and air mixture discharged by said fan, and an outlet for said air located above the level of said condenser coils, whereby said tank may be substantially filled with water to submerge the condenser coils in order to clean said coils.

2. In an evaporative condenser, the combination with a tank forming a reservoir for water, of a plurality of condenser coils supported within said tank, a motor operated fan positioned centrally of said coils and operating to discharge a water and air mixture over said coils, and an air supply opening and an air discharge outlet located above the level of said coils, whereby said tank may be substantially filled with water to submerge said coils in order to permit cleaning of said coils.

3. In an evaporative condenser, the combination with a tank forming a reservoir for water, of a plurality of condenser coils supported within said tank, a motor operated fan positioned centrally of said coils and operating to discharge a water and air mixture over said coils, an air supply inlet located above said fan, an air discharge outlet located above the level of said condenser coils, whereby said tank may be substantially filled with water to submerge said condenser coils for the purpose of cleaning said coils, and means for completely draining said tank.

4. In an evaporative condenser, the combination with a tank forming a reservoir for water, of a plurality of condenser coils supported within said tank, a motor operated fan positioned centrally of said coils and operating to discharge a water and an air mixture over said coils, an air supply inlet positioned above said fan, an air discharge outlet located above the level of said condenser coils, whereby said tank may be substantially filled with water for submerging said condenser coils, an overflow connection for said tank determining the level of the water when said coils are submerged, and means for completely draining said tank.

FRED R. ERBACH.