May 23, 1950 E. BOCKMEYER 2,509,031

APPARATUS FOR COOLING FLUIDS

Filed March 1, 1946 2 Sheets-Sheet 1

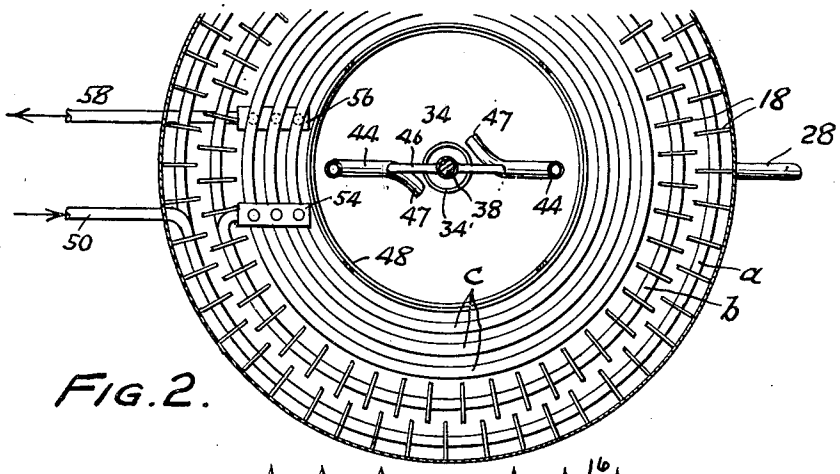


FIG. 2.

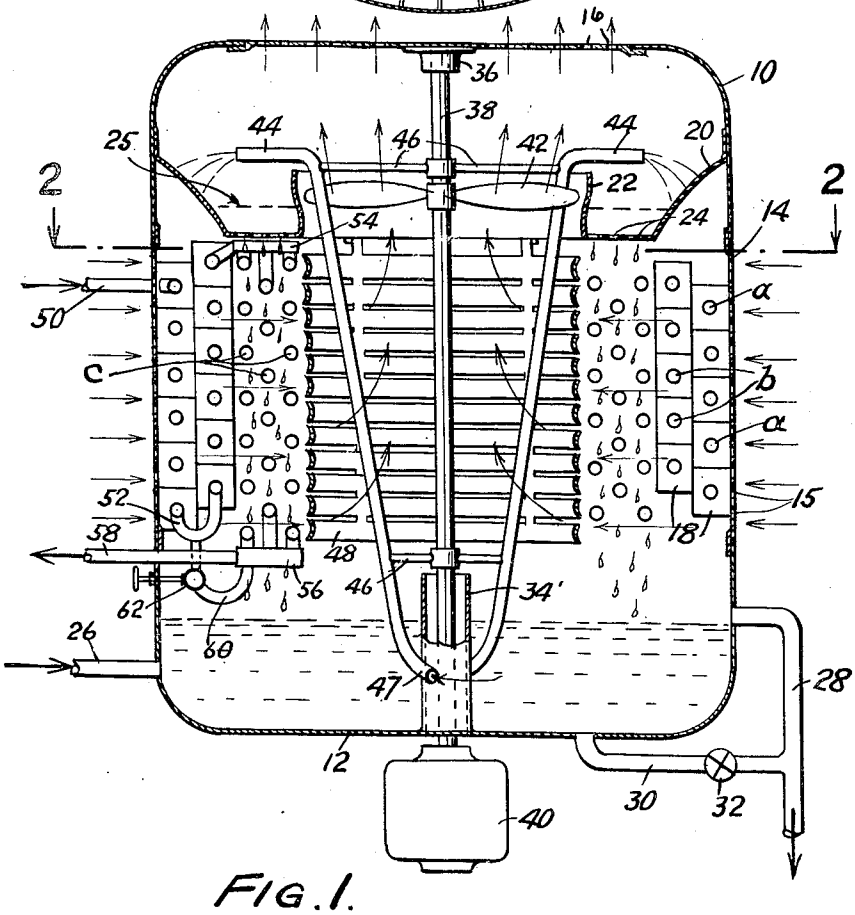


FIG. 1.

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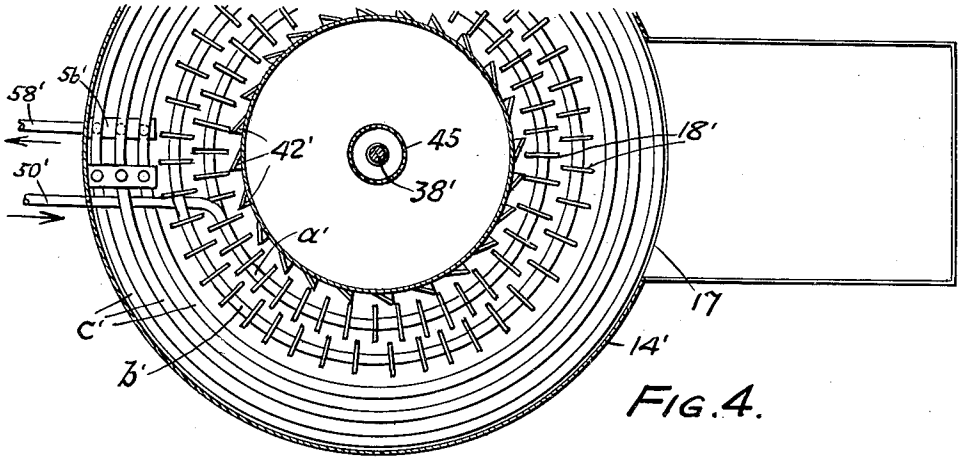


FIG. 4.

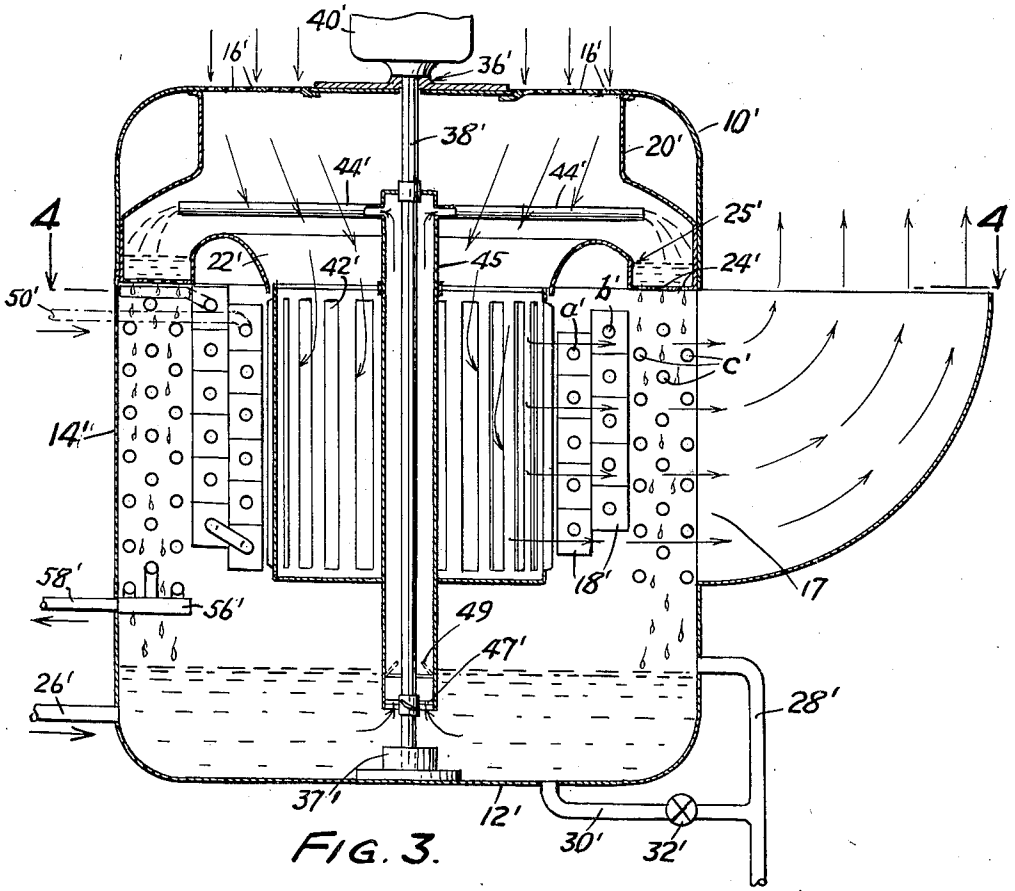


FIG. 3.

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UNITED STATES PATENT OFFICE

2,509,031

APPARATUS FOR COOLING FLUIDS

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Application March 1, 1946, Serial No. 651,084

7 Claims. (Cl. 257—37)

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This invention relates to an improvement in a method and apparatus for cooling fluids.

One of the objects of my invention is the provision of means whereby the fluid to be cooled is successively cooled by both air and vapor cooling means.

Another object of my invention is the provision of means whereby air is first passed over a set of conduits through which the hot fluid to be cooled is delivered, whereby the temperature of the air is raised, and then passing the heated air over a second set of conduits to which the fluid is delivered from the first set of conduits over which water for vaporization is passed, whereby the rate of vaporization will be increased.

Another object of my invention is the provision of means for wetting the second set of conduits over which the heated air is passed.

A still further object of my invention is the provision of means for continuously delivering water to the second set of tubes as well as the air which is passed over both sets of conduits.

Having now described, in a general way, the nature and purpose of this invention, I will now proceed for illustrative purposes to a detailed description of preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 is a vertical section through one form of apparatus for cooling fluids;

Fig. 2 is a sectional plan view on the line 2—2 of Fig. 1 of the greater portion of the apparatus;

Fig. 3 is a view similar to Fig. 1 showing another form of apparatus for cooling fluids; and

Fig. 4 is a sectional plan view on the line 4—4 of Fig. 3 of the greater portion of the apparatus.

Referring first to the construction shown in Figs. 1 and 2, the apparatus comprises a casing having an upper head 10, a lower head 12 and a cylindrical side wall 14 between the heads, which is provided with a plurality of perforations 15 through which the air passes to the apparatus while the upper head 10 is also provided with a plurality of perforations 16 through which the air passes from the apparatus.

Located within the casing are two outer coils *a* and *b* of tubes and three inner coils *c*, the tubes of coils *a* and *b* being encircled with heat transfer fins 18, and may be supported in any desired manner, the supporting means being omitted for clearness, the convolutes of adjacent coils being in staggered relation to each other.

Supported within the head 10 is an annular

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channel member having an annular flange 20 connected to the side wall of the head 10, an annular flange 22 concentric with the flange 20 and a perforated web 24, there being an annular water trough 25 formed between flanges 20 and 22 to which water is delivered as hereinafter described, and from which trough water trickles in a continuous manner over the inner coils of tubes *c*. The lower head 12 is arranged to form a water receptacle to which water is supplied through an inlet pipe 26, the flow thereto may be controlled by a valve in the pipe 26, or it may be controlled by means of a float. The level of the water is maintained by means of an overflow pipe 28 to which is connected a drain pipe 30 having a valve 32 for emptying or flushing the water receptacle.

Extending upwardly from the bottom of the lower head 12 is a tubular extension 34 which extends to a position somewhat above the water level in the head 12. Rotatably mounted in a supporting bearing (not shown) in the tubular member 34 and a bearing 36 connected to the head 10, is a shaft 38 having a motor 40 connected to the lower end thereof.

Mounted on the shaft 38 is a fan 42 for drawing air through the perforations 15 over the coils *a*, *b* and *c*, while water for keeping the tubes of coils *c* wet is delivered to the annular trough 25 in the head 10, is supplied from the water receptacle in the head 12 through a plurality of tubes 44 connected to the shaft 38 by means of rods 46 at the upper and lower portions of the tubes 44. The tubes 44 are placed diametrically opposite each other and are of the same weight and bent exactly alike so as to be in balance with each other and contain the same amount of water which enters the lower ends of the tubes which are curved in the direction of rotation of the shaft 38, as shown at 47, which act as impellers to force the water through tubes 44.

In order to break up the direct flow of air passing over the tubes of coils *a*, *b* and *c*, an annular slotted baffle 48 surrounds the water tubes 44 concentric with the axis of the shaft 38 within the coils, and forms a cylindrical flue for the air extending in a vertical direction substantially the full height of the coils.

The fluid to be cooled enters the outer annular coil of air cooled tubes *a* at 50, passes downwardly through coil *a*, passes from the lower end thereof to the lower end of the coil *b*, through a U-shaped connection 52, then upwardly through coil *b*, the upper end of the coil *b* is connected to a header 54. The three coils *c* are connected at their upper ends to the header 54 and at their lower

ends to a similar header 56 having an outlet pipe 58 connected thereto.

During the operation of condensing a gas or cooling a liquid, the fluid is passed through the successive coils *a*, *b* and *c* from inlet 50 to outlet 58, and during its passage therethrough, water is continuously fed to the trough 25 in the head 10, which wets the coils *c* by trickling over the coils while air is drawn in through perforations 15, which is heated by contact with the coils *a* and *b* and the heat transfer fins 18, partially cooling the fluid passing through coils *a* and *b*, and the fluid is finally cooled by the evaporation of the mosture from the coils *c* by the heated air passed over coils *a* and *b*, the air passing through the perforations 16 in the head 10.

When condensing gases, it is desirable to remove the condensate from coils *a* and *b* by bleeding the condensate from these coils directly to the outlet 58 by means of a trap 60 connected to the U-shaped connection 52, provided with a valve 62 therein, whereby the flow through the trap can be cut off if liquid is passed through the apparatus for cooling.

The structure shown in Figs. 3 and 4 comprises substantially the same elements shown in Figs. 1 and 2, except the means for bleeding liquid from the air cooled coils and in which the flow of air is reversed as well as the air cooled and vapor cooled coils.

In Figs. 3 and 4, the same reference characters have been applied to the same elements as in Figs. 1 and 2 with ' (prime) added.

The end of the head 10' is perforated for the inlet of the air, while the air passes out through an outlet 17 in the side wall 14' of the casing.

The flange 20' of the trough 25' is secured to the end portion of the head 10' at the outer edge of the perforated portion of the head 10' and forms an inlet for the air passing to a squirrel cage fan 42' which forms a slotted air flue within the coils substantially the full height of the coils, while the inner flange 22' forms a partition between the inlet and outlet of the fan 42', the air in its passage from the fan to outlet 17 from the casing first passes over air cooled coils *a'* and *b'* and then over the wet coils *c'*, which are kept wetted by water trickling from the trough 25'.

The water from the receptacle in head 12' is delivered to the trough 25' through a tube 45 and diametrically opposite tubes 44' extending radially therefrom.

The tube 45 is connected to a shaft 38' rotatably mounted in bearings 37' and 39' and is rotated by a motor 40' on the upper end thereof.

Connected to the lower portion of shaft 38' and to the tube 45 is an impeller 47' for forcing the water through tube 45, and if desired, several such impellers may be secured to the shaft or an Archimedean screw may be used.

In order to prevent the water in the tube 45 returning to the supply in the head 12' if the motor 40' is stopped, a check valve or valves indicated in dotted lines at 49 may be provided, which are shown above the impeller, but, if desired, the check valves may be located below the impeller.

The operation of the structure shown in Figs. 3 and 4 is the same as that shown in Figs. 1 and 2, differing only in that the air flow through the apparatus is reversed and the air cooled coils are within the evaporative coils so that the air first passes over the air cooled coils and then over the vapor cooled coils as in Figs. 1 and 2.

The advantages of my invention result from

the provision of a heat transfer device for cooling fluids by passing air over conduits to which the fluid to be cooled is delivered to reduce the temperature of the fluid, and then passing the heated air over wetted conduits to which the partially cooled fluid is delivered to further cool the fluid by the vaporization of the moisture from the last mentioned conduits.

What I desire to secure by Letters Patent is:

1. An apparatus for cooling liquids comprising a casing having a removable head, a water receiving receptacle in the lower end of the casing, an annular water trough in the head having a perforated bottom, a plurality of annular vapor cooled coils below the bottom of the trough, a plurality of air cooled coils connected to each other and to the vapor cooled coils concentric with the vapor cooled coils and in the same horizontal plane, an inlet for the liquid to be cooled to one end of the air cooled coils, an outlet for the cooled liquid from one end of the vapor cooled coils, a vertical air flue within the coils substantially the height of the coils, there being slots through the wall of the flue for the passage of air between the flue and the surrounding coils, a shaft rotatably mounted concentrically of the coils, means for rotating the shaft, tubular means for delivering water from the water receptacle to the trough when the shaft is rotated, the casing having air inlet and outlet openings, and means including a fan connected to the shaft for drawing air through the air inlet, passing it radially over the air cooled coils then over the vapor cooled coils to the air outlet through the flue at right angles to the flow of air over the coils.

2. An apparatus for cooling fluids comprising a casing having a body portion, a removable head supported thereon, a water receptacle in the lower end of the casing, an annular slotted baffle supported in the casing forming a vertical air flue, a plurality of vapor cooled coils surrounding the flue concentric therewith of substantially the same height as the flue, a plurality of air cooled coils connected in series surrounding the vapor cooled coils connected to the vapor cooled coils, there being an inlet to one end of the air cooled coils and an outlet from one end of the vapor cooled coils, a water receiving trough supported in the removable head, a shaft centrally mounted within the air flue, means for rotating the shaft, a plurality of tubes mounted on the shaft open at each end, said tubes extending upwardly and outwardly from the water receptacle to a point above the water trough for delivering water to the trough when the shaft is rotated, said trough being perforated for trickling water over the vapor tubes, a fan connected to the shaft above the slotted air flue, there being air inlet openings in the casing in the plane of the coils, and means for permitting the escape of air above the water trough, the air being drawn in through the openings in the casing radially over the coils at right angles to the flow of air, through the air flue and out through the escape above the fan.

3. An apparatus for cooling liquids comprising a casing having a removable head, a water receiving receptacle in the lower end of the casing, an annular water trough in the head having a perforated bottom, a plurality of annular vapor cooled coils below the bottom of the trough, a plurality of air cooled coils connected to each other and to the vapor cooled coils within the vapor cooled coils and in the same horizontal plane,

an inlet for the liquid to be cooled to one end of the air cooled coils, an outlet for the cooled liquid from one end of the vapor cooled coils, a shaft rotatably mounted concentrically of the tubes, means for rotating the shaft, a tube surrounding the shaft extending from the water receptacle to a point above the annular trough, radially extending outlet tubes extending from the tube surrounding the shaft over the trough, an impeller in the lower end of the shaft for forcing water through the tube surrounding the shaft to the trough, check valves in the tube surrounding the shaft for preventing the return of water to the water receptacle when the impeller is not rotated, a vertical air flue within the coils substantially the height of the coils, there being slots through the wall of the flue for the passage of air between the flue and the surrounding coils, and means including a fan connected to the shaft for causing air to pass over the air cooled coils, then over the vapor cooled coils in a radial direction and then vertically through the flue.

4. An apparatus for cooling fluids, comprising a casing, an annular air cooled coil and an annular vapor cooled coil connected thereto substantially concentric thereto, there being an inlet for the fluid to one end of one coil and an outlet from one end of the other coil, an annular trough above the vapor cooled coil, means for trickling liquid from the trough on the vapor cooled coil, means for continuously supplying liquid to said trough, a vertical air flue within the coils substantially the height of the coils, there being slots through the wall of the flue for the passage of air between the flue and the surrounding coils, and means for passing air in a radial direction over the air cooled coils, then over the vapor cooled coils and thence axially and upwardly through the vertical flue.

5. An apparatus for cooling fluids, comprising a casing, a plurality of air cooled coils connected in series and concentric to each other, a plurality of vapor cooled coils concentric to each other and to the air cooled coils, the convolutes of adjacent coils being staggered relative to each other, there being an inlet to one end of one of the air cooled coils and an outlet from one end of the vapor cooled coils for the fluid to be cooled, an annular water trough above the vapor cooled coils, means for trickling water from the trough to the vapor cooled coils, a water container in the casing, means for delivering water from said container to the trough, a vertical air flue within the coils substantially the height of the coils, there being slots through the wall of the flue for the passage of air between the flue and the surrounding coils, and means for passing air in a radial direction over the air cooled coils, then over the vapor cooled coils and thence axially and upwardly through the vertical flue.

6. An apparatus for cooling fluids, comprising a casing, a plurality of annular air cooled coils connected in series and concentric to each other,

a plurality of vapor cooled coils concentric to each other and to the air cooled coils, there being an inlet to one end of one of the air cooled coils and an outlet from one end of the vapor cooled coils for the fluid to be cooled, a water trough above the vapor cooled coils, means for trickling water from the trough to the vapor cooled coils, a water container in the casing, means rotatable about an axis substantially central of the coils for delivering water to the trough from said container, a vertical air flue within the coils substantially the height of the coils, there being slots through the wall of the flue for the passage of air between the flue and the surrounding coils, means for rotating said rotatable means, and means for passing air in a radial direction over the air cooled coils, then over the vapor cooled coils and thence axially and upwardly through the vertical flue.

7. An apparatus for cooling fluids, comprising a casing having a substantially circular horizontal cross section, a plurality of annular air cooled coils connected in series and concentric to each other and the casing, a plurality of vapor cooled coils concentric to each other and within the air cooled coils, said vapor cooled coils being connected to each other and the air cooled coils, there being an inlet to one end of one of the air cooled coils and an outlet from one end of the vapor cooled coils for the fluid to be cooled, a water trough above the vapor cooled coils, means for trickling water from the trough to the vapor cooled coils, a water container in the casing, means rotatable about an axis substantially central of the coils for delivering water from a water container to the trough, a vertical air flue within the coils substantially the height of the coils, there being slots through the wall of the flue for the passage of air between the flue and the surrounding coils, means for rotating said rotatable means, and means for passing air in a radial direction over the air cooled coils, then over the vapor cooled coils and thence axially and upwardly through the vertical flue.

ELDON BOCKMEYER.

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