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(19)

(54) IMPROVEMENTS IN AND RELATING TO APPARATUS FOR PURIFYING A LIQUID

(71) We, CHRISTOPHER STEVENS AND JOHN BORU STEVENS, both British Subjects c/o Thermo Technic Limited, Mochdre Industrial Estate, Newtown, Powys, Wales, formerly of Spirella Building, Cambridge Road, Harlow, Essex, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to apparatus for purifying a liquid.

It is known to use evaporation and distillation techniques to obtain recovery of chemicals in chemical processes. In some cases it is possible to utilise the heat pump principle whereby a liquid to be purified is evaporated by a heat emitter of apparatus operating in accordance with the principle and the vapour thereby given off is condensed by a heat absorber of the apparatus. However, a disadvantage of such apparatus is that it is difficult to provide adjustment of the apparatus in order to take account of the necessity rapidly to heat the liquid initally when the apparatus for purifying the liquid is to be brought into operation and effectively to bring about a steady state condition immediately an initial warm up period.

According to the present invention there is provided apparatus for purifying liquid in a container said apparatus comprising: a heat transfer medium circulating system having a condenser for supplying heat from the heat transfer medium to the liquid to vaporise the liquid, an evaporator for absorbing heat in the heat transfer medium from the vapour to condense the vapour, means for reducing pressure of the heat transfer medium circulating therethrough, a heat exchanger for exchanging heat between the heat transfer medium and another medium, and control means for controlling direction of flow of the heat transfer medium so that before being delivered to the evaporator the heat transfer medium is controlled to flow selectively through the pressure reducing means in advance of the heat exchanger, or through the heat exchanger in advance of the pressure reducing means, to control evaporation of the liquid.

Preferably the control means is adapted to direct heat transfer medium sequentially through the heat exchanger, the condenser, the pressure reducing means and the evaporator during an inoperative period of the apparatus; through the condenser, the pressure reducing means, the heat exchanger and the evaporator during an inital warm up period of the apparatus; and through the condenser, the heat exchanger, the pressure reducing means and the evaporator when evaporation of liquid in the container is in a steady state.

The control means may comprise slide valve means. The heat transfer medium circulating system may include a compressor and the heat exchanger may be provided with means for agitating said another medium said agitating means being operable in response to temperature sensed in an upper portion of the compressor. The agitating means may comprise a fan and second control means for controlling the fan, the second control means being operable in response to temperature sensed in an upper portion of said compressor.

Following is a description, by way of example only and with reference to the accompanying drawings, of one method of carrying the invention into effect.

In the drawings:—

Figure 1 is a diagrammatic representation, of apparatus in accordance with the present invention, the apparatus being in a stand-by condition.

Figure 2 is a diagrammatic representation of the apparatus when in an initial warm up period and

Figure 3 is a diagrammatic representation of the apparatus when in an operational condition.

Referring to Figure 1 of the drawings, there is shown a tank 10 having an upper portion 11 and lower portion 12. The lower portion 12 has two compartments 14, 15 separated by a weir 13.

The upper portion 11 of the tank 10 contains a drip tray 16 which extends above the compartments 14 and 15. One end of the tray 16 is connected to the compartment 14 by means of a conduit 17. The upper portion of the tank 10 also has located therein above the drip tray 16 an evaporator coil 18. The compartment 15 has located in the lower portion thereof a main condenser coil 19.

An outlet of the evaporator coil 18 is connected to an inlet of a compressor 20. An outlet of the compressor 20 is connected to an inlet port 22 of a slide valve 21 having ports 23, 24 and 25. The port 23 has connected thereto one end of the condenser coil 19 and the other end of the condenser coil 19 is connected to port 27 of a slide valve 26 having ports 28, 29 and 30. The port 28 of the slide valve 26 is connected to the port 24 of the slide valve 21 via a capillary coil 31. The port 29 of the slide valve 26 is connected to the inlet of the evaporator coil 18. The port 30 of the slide valve 26 is connected to the port 25 of the slide valve 21 via a heat exchanger comprising a coil 32. The coil 32 is contained within a housing 33 in which there is mounted an electrically operated fan 34.

The fan 34 is controlled by an electric circuit 35 which includes a thermistor 36 located in an upper portion of the compressor 20.

The side valves 21 and 26 are controlled by an electrical control circuit 37.

The compartment 14 is provided with a tap (not shown) in a lower portion thereof for draining condensate collected in the compartment 14. The compartment 15 receives liquid to be purified.

When in a stand-by condition the pistons of the slide valves 21 and 26 are located as shown in Figure 1 so that heat transfer medium is circulated sequentially from the compressor 20 through the heat exchanger coil 32, the main condenser coil 19, the capilliary coil 31, the evaporator coil 18 and back to the compressor 20.

The heat transfer medium gains heat when compressed by the compressor 20 but the heat gained dissipates in the heat exchanger coil 32, the heat transfer medium thereby condensing in the heat exchanger coil 32. Since the heat is dissipated in the heat exchanger coil 32, there is no heat transfer between the main condenser coil 19 and liquid in the compartment 15.

In order to bring the apparatus quickly into operation, it is necessary rapidly to heat liquid in the compartment 15. This is achieved by operating the control circuit 37 to effect movement of the pistons of the slide valves 21, 26 to the position shown in Figure 2. In consequence, the heat transfer medium is circulated from the compressor 20, through the main condenser coil 19, the capillary coil 31, the heat exchanger coil 32, the evaporator coil 18 and back to the compressor 20. Heat gained during compression of the heat transfer medium is given up to the liquid in the compartment 15, thereby raising the temperature of the liquid in the compartment 15 such that the liquid soon commences evaporating, The heat transfer medium condenses in the main condenser coil 19. The condensed heat transfer medium expands to a lower pressure in the capilliary coil 31. Subsequently, on passing through the heat exchanger coil 32, the heat transfer medium gains heat from the ambient surroundings and gains further heat when passing through the evaporator coil 18 causing evaporation of the heat transfer medium before returning to the compressor 20. The heat gained in the evaporator coil 18 is received from vapour given off from the liquid in the compartment 15 which vapour, having lost its heat, condenses and the condensate collects in the tray 16.

When the rate of evaporation of the liquid in the compartment 15 is steady, the control circuit 37 is operated to effect movement of the pistons of the slide valves 21, 26 to the position shown in Figure 3. In consequence, the heat transfer medium is circulated from the compressor 20 through the main condenser coil 19, the heat exchanger coil 32, the capillary coil 31 and the evaporator coil 18 and back to the compressor 20.

In this manner, heat gained during compression of the heat transfer medium still is transferred to the liquid in the compartment 15 and the heat transfer medium condenses in the main condenser coil 19. The warm condensed heat transfer medium dissipates heat on passing through the heat exchanger coil 32 before being expanded to a lower pressure by the capilliary coil 31 and returned to the evaporator coil 18. The heat transfer medium on passing through the evaporator coil 18 is heated by the vapour driven off from the liquid in the compartment 15 whereby the heat transfer medium changes to the vapourous state and thereby absorbs heat from the vapour in the upper portion 11 of the tank 10 causing the vapour to condense.

The condensate is collected in the drip tray 16 and is fed to the compartment 14 through the conduit 17. As the compartment 14 fills with condensate, the condensate can be drawn off by means of the tap in compartment 14.

WHAT WE CLAIM IS:—

1. Apparatus for purifying liquid in a container said apparatus comprising: a heat transfer medium circulating system having a condenser for supplying heat from the heat transfer medium to the liquid to vapourise the liquid, an evaporator for absorbing heat in the transfer medium from the vapour to condense the vapour, means for reducing pressure of the heat transfer medium circulating therethrough, a heat exchanger for exchanging heat between the heat transfer medium and another medium, and control means for controlling direction of flow of the heat transfer medium so that before being delivered to the evaporator the heat transfer medium is controlled to flow selectively through the pressure reducing means in advance of the heat exchanger, or through the heat exchanger in advance of the pressure reducing means, to control evaporation of the liquid.

2. Apparatus as claimed in Claim 1 wherein the control means is adapted to direct heat transfer medium sequentially through the heat exchanger, the condenser, the pressure reducing means and the evaporator during an inoperative period of the apparatus; through the condenser, the pressure reducing means, the exchanger and the evaporator during an initial warm up period of the apparatus; and through the condenser, the heat exchanger, the pressure reducing means and the evaporator when evaporation of liquid in the container is in a steady state.

3. Apparatus as claimed in Claim 1 or Claim 2 wherein the control means comprises slide valve means.

4. Apparatus as claimed in any one of the preceding claims wherein the heat transfer medium circulating system includes a compressor and the heat exchanger is provided with means for agitating said another medium, said agitating means being operable in response to temperature sensed in an upper portion of the compressor.

5. Apparatus as claimed in Claim 4 wherein the agitating means comprises a fan and second control means for controlling the fan, the second control means being operable in response to temperature sensed in an upper portion of said compressor

6. Apparatus for purifying liquid substantially as hereinbefore described and as illustrated in the accompanying drawings.

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1573553 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

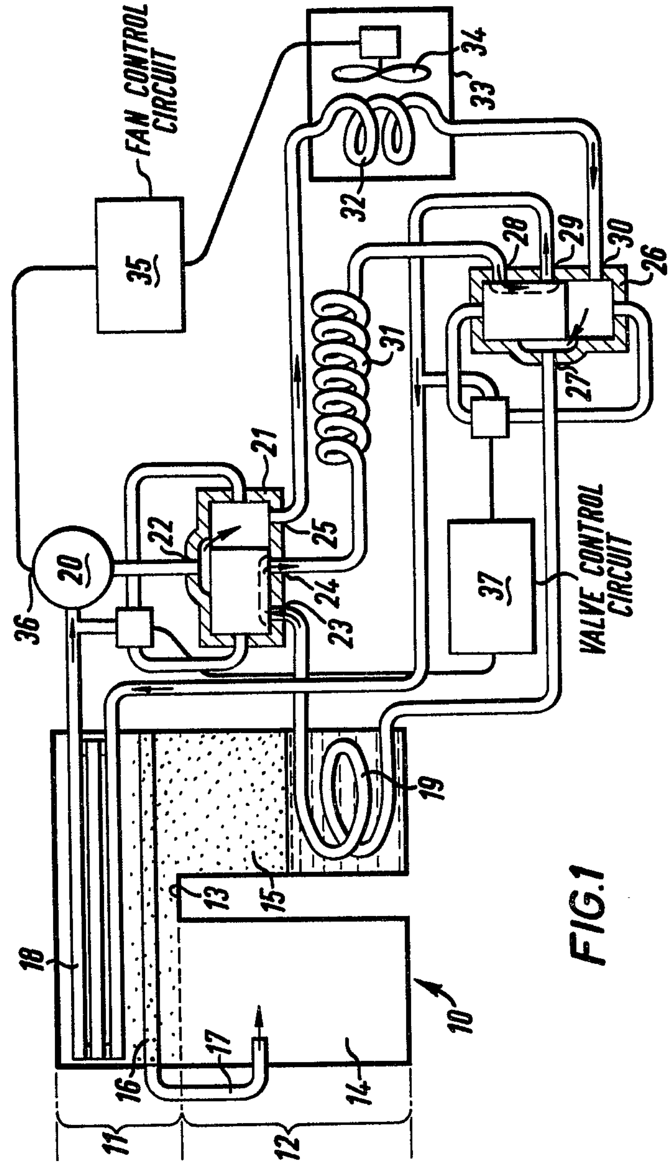

FIG.1

1573553 COMPLETE SPECIFICATION

3 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 2

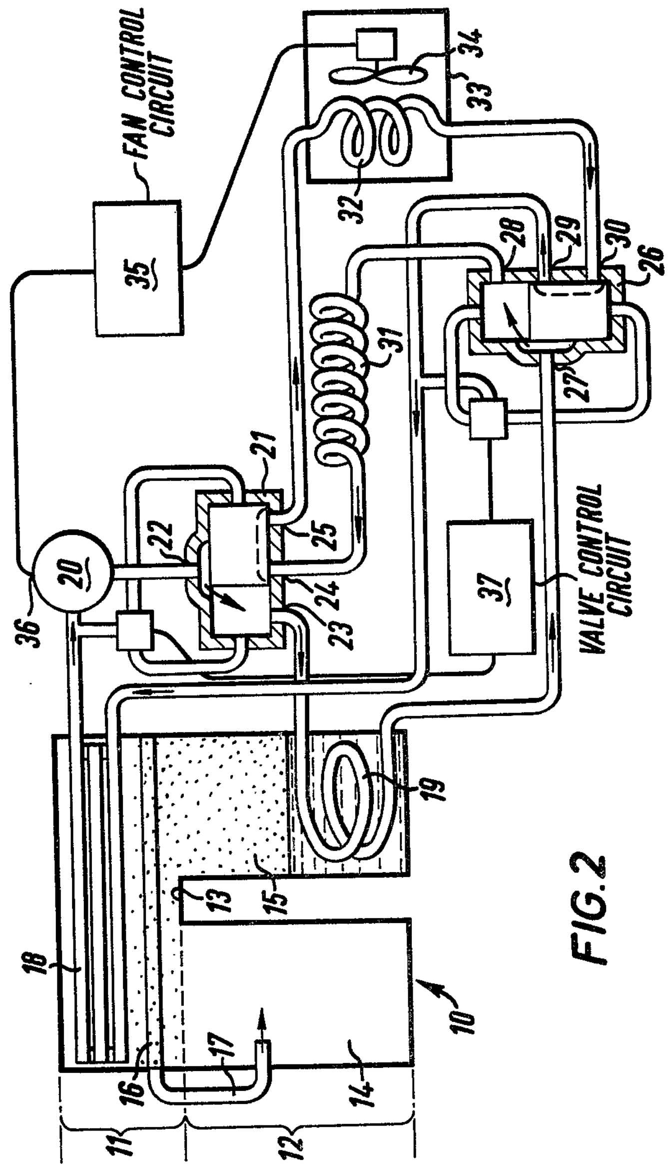

FIG.2

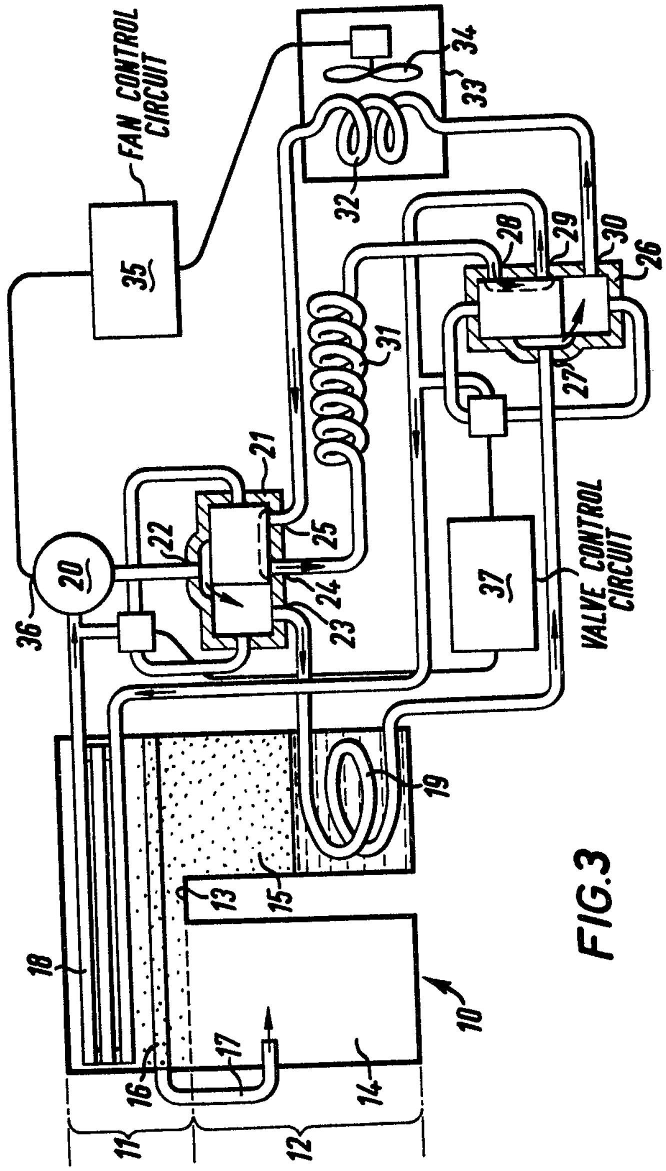
FAN CONTROL CIRCUIT
VALVE CONTROL CIRCUIT
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FIG.3