Nov. 3, 1936. C. M. ASHLEY 2,059,839

MULTIPURPOSE HEAT TRANSFER UNIT

Filed Nov. 15, 1933 2 Sheets-Sheet 1

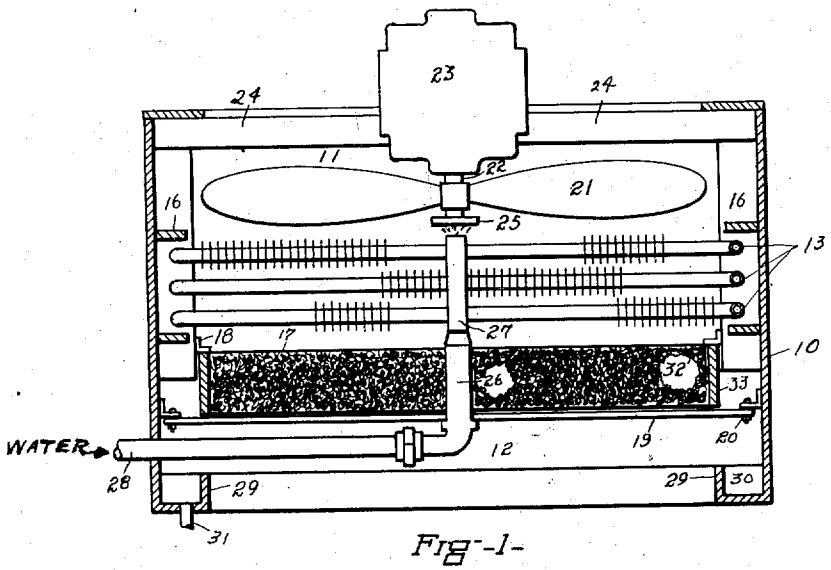


FIG.-1-

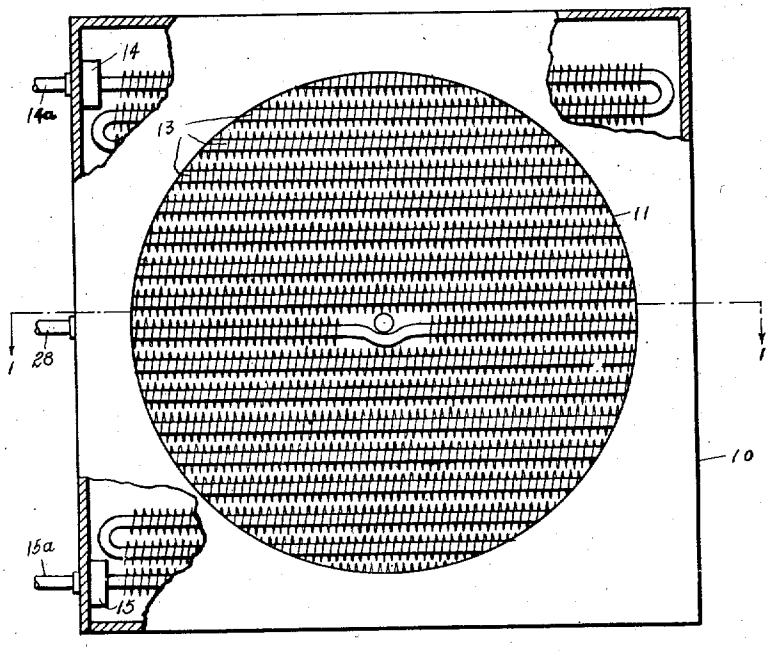


FIG.-2-

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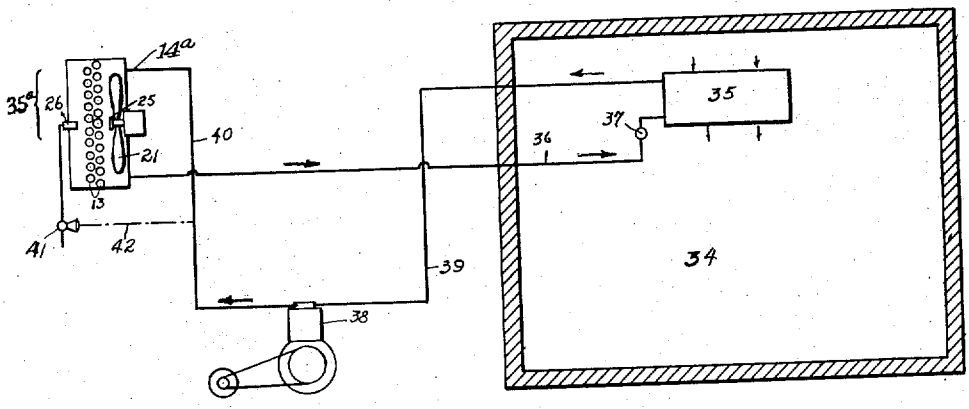


Fig. 4

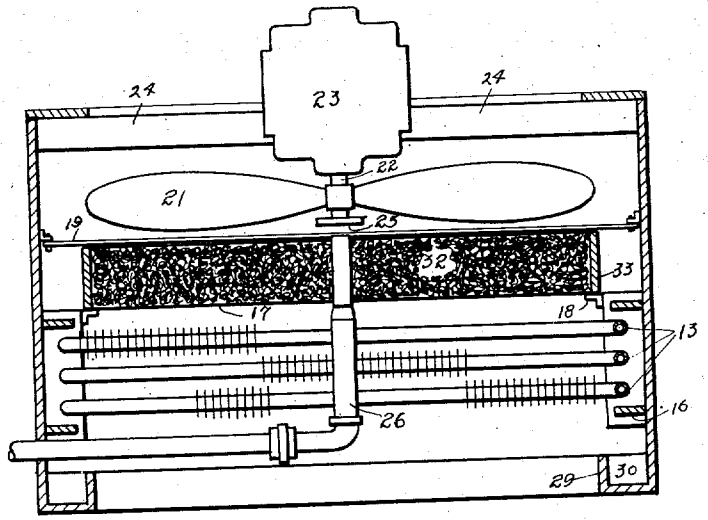


Fig. 3

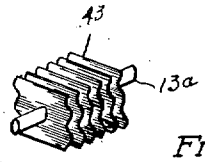


Fig. 5

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UNITED STATES PATENT OFFICE

2,059,839

MULTIPURPOSE HEAT TRANSFER UNIT

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Application November 15, 1933, Serial No. 698,142

14 Claims. (Cl. 257—70)

This invention relates to improved heat transfer devices and more particularly to devices for producing high degrees of moisture saturation in air passing therethrough.

The principal object of the invention is to provide a single unitary device which may be used for any one of a number of purposes.

Another object of the invention is to provide a device which will saturate to high degrees air at a relatively low temperature.

Still another object of the invention is to provide a complete refrigerating device including a compressor, a condenser and an evaporator, in which said condenser and said evaporator are substantially identical units.

Still another object of the invention is to provide a unitary structure which may be used as an evaporative condenser for condensing refrigerant vapors.

In connection with the foregoing object, it is another object of this invention to provide a water economizer adapted to vary the amount of water supplied to the surface of said condenser in response to changes in pressure, or in certain cases to changes in the temperature, of refrigerant vapors in said condenser.

Still another object of the invention is to provide a heat transfer device and means for uniformly wetting the surfaces of said device for the purpose of increasing the quantity of heat transferred and for simultaneously humidifying air passing through the device.

A feature of the invention resides in the provision of a small unitary structure including a large amount of heat transfer surface, a fan and a spray for wetting the heat transfer surface.

Another feature of the invention resides in the novel spray producing device comprising a rotating target and a nozzle for directing a metered quantity of water against said rotating target.

Still another feature of the invention resides in the use of an air filter made of material such as matted bronze, steel, or other metal turnings, held in position by suitable frames, for removing dirt, dust and entrained free moisture from air passing through the filter.

A further feature resides in the use of an air filter which, in addition to cleaning air, is adapted to collect free moisture and to present this moisture in intimate contact with air passing through the filter for the purpose of increasing the humidity of the air.

Still another feature of the invention resides in the novel construction of the unit whereby the aforementioned filter may be easily and simply removed for the purpose of cleaning for replacement and in certain cases for completely omitting the filter.

Another feature of the invention resides in the utilization of means, for example, corrugated plate fins, on the heat transfer tubes for distributing water evenly over the entire transfer surface.

Other objects and features will be more apparent from the following description and accompanying drawings, in which:

Fig. 1 is an elevational view of one form of the unit, the section being taken on the line 1—1 of Fig. 2;

Fig. 2 is a plan view of the unit of Fig. 1, the fan and its driving motor being omitted for the purpose of clarity;

Fig. 3 is a sectional elevation of another form of the invention in which the various cooperating parts shown in Fig. 1 are rearranged;

Fig. 4 is a diagrammatic view of an air conditioning system illustrating the use of two of applicant's units in a complete refrigerating device, one as an evaporative condenser and the other as a refrigerant evaporator; and

Fig. 5 is an isometric view of a fragment of a heat interchange tube provided with corrugated plate fins.

With reference to the drawings, similar designations denoting similar parts, Fig. 1 shows one form of the invention as embodied in a casing 10, preferably constructed of sheet metal, and generally rectilinear in configuration. The casing is open at its opposite ends to provide an air inlet 11, and an air discharge 12. Mounted within the casing 10, and approximately midway between its ends, is a heat transfer unit, which in practice, may be of any desired type. As shown in Figs. 1 and 2, however, the unit comprises three parallel rows of finned heat transfer tubes 13. Each row of tubes 13 is, in fact, a single continuous tube bent at opposite sides of the casing in such a manner as to cover substantially the entire free area of the casing. The three tubes are joined at one of their ends to air inlet header 14, to which a fluid may be supplied through inlet connection 14a, and at their other ends to a discharge header 15, from which the fluid may be removed by way of discharge connection 15a. Baffles 16, at opposite sides of the casing 10, cover the bent end portions of the tubes 13, and thus confine air passing through casing 10 to the heat transmitting portions of the unit. A filter 17, of the general type in which

a mass of metal turnings 32 is matted and confined within a frame 33, is mounted in the casing, and is held in position against angles 18 by one or more removable rods 19. When desired, the filter may be removed either for cleaning, for replacement, or for total omission, by unfastening the bolts 20 which hold rods 19 in place, and, thereafter, slipping the filter 17 out through discharge opening 12.

A fan 21 is adapted to rotate in a plane parallel to, and properly spaced from the rows of tubes 13. The fan is mounted upon, and supported by shaft 22 of motor 23, which, in turn, is supported on cross bars 24, of casing 10. A target 25, which, in practice, may be a small metal disc, a piece of carborundum, or any other hard substance, is fastened to, and rotates with, the end of shaft 22. A small water pipe 26 pierces the filter 17 at its center point, and terminates in a nozzle 27 directly opposite target 25. As can best be seen from Fig. 1, the target 25, the pipe 26, and nozzle 27 all lie on a common center line. Thus, in operation, water supplied to nozzle 27, from any suitable source through pipe 28, forms a tiny stream which strikes against target 25.

The lower end of casing 10 is turned upwardly, as at 29, to form a trough, or catch basin, 30, from which a drain pipe 31 leads to any desired point of wastage. Trough 30 catches water dripping from the ends of the cooling coils.

The filter 17, hereinbefore referred to, preferably comprises a mass of matted bronze, brass, or other metal turnings, suitably bound and confined within a frame 33. As is apparent, such a device provides a tremendous surface on which water may collect and be held in contact with a stream of air passing therethrough. Such a device may hereinafter be referred to as a "collecting surface". When the air does not require filtering, applicant may substitute layers of relatively coarse screen to serve as a collecting surface.

In order better to illustrate the invention, its operation will be considered in connection with a refrigerating system including, as essential elements, a cooler, a compressor and a condenser. In such a system, heat is absorbed by the evaporation of a refrigerant in the cooler, is then pumped to a higher temperature in the compressor, and is finally dissipated by the condensation of refrigerant vapors in the condenser. While both evaporators and condensers are substantially similar in function, i. e., both are heat transfer devices, it has heretofore been considered necessary to utilize two entirely distinct units for these two similar purposes. Applicant has invented a unit (hereinbefore described) which may be used, alternatively, for either purpose.

Considering first the use of applicant's unit as an evaporator (Figs. 1 and 4), numeral 34 represents an enclosure and numeral 35 the unit of Fig. 1, which is to be used for cooling the enclosure. A suitable refrigerant liquid is supplied to the heat transfer tubes 13 through pipe 36 and inlet connection 14a under the control of an expansion valve 37, and refrigerant vapor is removed, as, for example, by compressor 38 through discharge connection 15a and pipe 39. Fan 21 forces air from the enclosure through the unit, whereupon the heat of the air is absorbed by the evaporation of refrigerant within tubes 13, and, as a result, the temperature of the air is reduced to any desired degree. As a further result, water vapor is condensed from the air, thereby wetting the surfaces of tubes 13, and hence, increasing the amount of heat transferred. Excess moisture falls upon filter 17, and tends to collect in the interstices between the metal turnings 32. Therefore, when the cooled air passes through filter 17, not only is dust, dirt and entrained free moisture removed, but contact between the air and moisture collected on the filter insures almost complete saturation of the air. Hence, any air discharged from the unit has a relative humidity of almost one hundred per cent, a result particularly difficult of attainment with any type of surface cooler.

Equally good results are obtained when cold water, or brine, is circulated through tubes 13 in place of the refrigerant hereinbefore mentioned.

Fig. 3 illustrates a modification of the invention when in use as an evaporative condenser (designated unit 35a in Fig. 4) at a point outside of enclosure 34. Hot refrigerant vapor from compressor 38 is supplied to the heat transfer tubes 13 through pipe 40 and inlet connection 14a, while condensed refrigerant is supplied to unit 35 through pipe 36. Air drawn over the surfaces of the tubes by fan 21 could, if desired, be utilized alone to cause condensation. However, much better and more economical results are secured by wetting tubes 13 and thus causing the evaporation of water to absorb the heat of condensation given up by the refrigerant. For lack of a better term, applicant has chosen to call such an apparatus, i. e., a wetted surface condenser over which air is blown, an "evaporative condenser". Whenever the term occurs in this specification and claims, it is to be read in accordance with this definition. To this end, water is supplied to nozzle 27 which directs a tiny stream against the rotating target 25 located on the end of the fan shaft. The stream of water, upon striking the target, is broken into a fine mist, which mist is distributed over the tubes by the blast of air from fan 21. Further, the rotation of the target tends to spread the water by centrifugal action, thus giving a better and more even distribution over the entire heat transfer surface.

In this particular application, the filter is frequently not required. As was previously explained, it may easily be removed by the loosening of bolts 20, and removal of rods 19. Where the air used for condensing purposes is particularly dirty, which dirt would tend to collect on tubes 13, thus reducing their heat transfer coefficient, a filter may be provided. As shown in Fig. 3, the filter and heat transfer unit are so arranged that water directed against the target 25 is first distributed over the filter. Air passing through the filter is not only cleaned, but is likewise humidified, and by evaporative cooling, its temperature is very materially reduced. Further, the force of the blast of air tends to drive any unused moisture through the filter and against the surface of tubes 13, thus wetting them to increase their heat transfer capacity.

In connection with the operation of the device as an evaporative condenser, it is quite apparent that the temperature of air used for condensing purposes is as variable as the whim of nature. On certain days, for example, the air is cold and dry; on others, hot and moist; and on still others, it may be cold and moist; or hot and dry. Therefore, the amount of water which can profitably be used is a function of the air temperature and humidity. In order to economize on the amount of water used, applicant provides a valve 41 (of the general type in which the degree of opening of

the valve is determined by the pressure existing on its operating diaphragm) whose operating diaphragm is subjected, through pipe 42, to the pressure existing in the condenser. Thus, if the day is hot, the pressure in the condenser will tend to rise. This pressure is reflected on the operating diaphragm, thus causing an increased opening of valve 41 to admit more water. On the other hand, if the air temperature is relatively cool, the pressure in the condenser will decrease. Valve 41 will close to decrease the amount of water supplied. If desired, of course, valve 41 can be made to operate responsive to the temperature existing in the condenser.

The device illustrated in Fig. 3 is suitable for efficient use as an evaporator. The air passing through the wetted filter is preliminarily cooled, by evaporative cooling. The sensible heat of the air is reduced, and less refrigeration is required in the cooling coils. The air passing through the coils is dehumidified and cooled to a desired low temperature.

The operation of the device as a combined heater and humidifier is in many respects similar to its operation as an evaporative condenser. Thus, steam fed to the tubes 13 (of the unit of Fig. 1) is condensed and gives up its heat to air forced over tubes 13 by fan 21. The water mist created by the target spray promotes increased heat transfer, humidifies the air, and collecting on the filter, assists both in cleaning and in humidifying. The amount of humidification accomplished may be controlled by valve 41 operating responsive to any type of well known humidostat.

In connection with the particular type of heat transfer surface used, excellent results are obtained with almost any type of extended surface. Therefore, for economy, the so-called spirally wound finned tube is preferable. However, in those cases in which maximum water distribution over the entire surface is desired, applicant has devised a corrugated plate fin 43, mounted on a heat transfer tube 13a, as is shown in Fig. 5. In operation, the corrugations tend to reverse the direction of air flowing thereover, and consequently, to force the water mist over the entire heat transfer surface.

Since certain changes in carrying out the above process and in the constructions set forth, which embody the invention may be made without departing from its scope, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In a heat exchange unit, a casing, a heat exchanger and a collecting surface mounted within said casing, a fan for discharging a stream of air over said heat exchanger and collecting surface, a target carried by said fan, and a nozzle for directing a stream of water against said target whereby the water will be broken into a fine mist, and the mist distributed over said heat exchanger and collecting surface by the stream of air.

2. In a heat exchange unit, a casing, a heat transfer coil and a filter mounted within said casing, a fan for discharging a stream of air through said casing, a rotating target carried by said fan, and a nozzle for directing a stream of water against said target whereby the water will be broken into a fine mist, the mist thrown from the target by centrifugal action and distributed over said coil and filter by the stream of air.

3. In a heat exchange unit, a casing, a heat transfer coil and a filter in said casing, a plurality of corrugated plate fins on said coil, a fan for directing a stream of air through said casing, a target carried by said fan, and a nozzle for directing a stream of water against said target whereby mist from the target will be distributed over said coil and filter.

4. In a heat exchange unit, a casing, a heat transfer coil and a filter in said casing, a fan for directing a stream of air through said casing, a target, means for directing a stream of water against said target, whereby said coil and said filter will be netted, and means for varying the quantity of water.

5. In an evaporative condenser, a casing, a heat transfer coil in said casing, a fan for directing a stream of air through said casing, a target, means for directing a stream of water against said target whereby the water will be broken into a mist and the mist distributed over said coil by said stream of air, means for supplying refrigerant vapor to said coil, and means for varying the quantity of water directed against said target in response to variations in said refrigerant supply means.

6. In an evaporative condenser, a casing, a heat transfer coil in said casing, means for supplying refrigerant vapors to said coil, a fan for directing a stream of air through said casing, a target carried by said fan, a nozzle for directing a stream of water against said target, and means for varying the quantity of water responsive to pressure variations in said vapor supply means.

7. In an evaporative condenser, a casing, a heat transfer coil in said casing, means for supplying vapor to said coil, a fan for directing a stream of air through said casing, a rotating target carried by said fan, a nozzle for directing a stream of water against said target whereby the water will be broken into a fine mist by impact, thrown from said target by centrifugal force, and distributed over said coil by said air stream, and means for varying said stream of water responsive to temperature changes in said vapor supply means.

8. In a heat exchange unit, a casing, a heat transfer coil and a filter in said casing, a fan for directing a stream of air through said casing, a target and means for directing a stream of water against said target, whereby said water will be distributed over said coil and said filter.

9. In a heat transfer unit, a casing, a fan for directing a stream of air through said casing, a cooling surface for condensing moisture from said air stream, and a filter composed of metallic turnings for collecting said moisture in the interstices between and on said metallic turnings.

10. An apparatus of the character described, comprising a series of coils, means for circulating refrigerant through the coils, a filter positioned adjacent the coils and arranged to receive directly from the coils moisture condensed upon the coils, whereby air circulated in contact with the coils will pass through and leave the device at a reduced temperature and in substantially saturated condition.

11. A combination of apparatus of the character described comprising a fan, heat exchanger coils, a moisture collecting device, a casing within which all said apparatus is located, and means for supplying moisture to the casing whereby said coils and said device will be wetted and air

passing through the device will have its moisture content changed.

12. A combination of the character described comprising a heat exchanger, a collecting surface, means for wetting said heat exchanger and said collecting surface, and means for passing air in heat exchange relation with said heat exchanger and through said collecting surface.

13. In a condensing unit, a condenser coil, means for supplying refrigerant vapor to said coil, means for passing air in contact with said coil, means for supplying a liquid to the outer surfaces of said coil, whereby said refrigerant vapors will be evaporatively condensed, and means for varying the quantity of liquid responsive to variations in pressure in said vapor supply means.

14. In a condensing unit, a condenser coil, means for supplying refrigerant vapor to said coil, means for passing air in contact with said coil, and means for supplying a liquid to the outer surfaces of said coil, whereby the refrigerant vapor will be condensed.

CARLYLE M. ASHLEY.

CERTIFICATE OF CORRECTION.

Patent No. 2,059,839. November 3, 1936.

CARLYLE M. ASHLEY

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction as follows: Page 2, second column, line 18, before "when" insert the comma, word and comma , which, ; line 19, before "at" insert is suitably positioned; page 3, second column, line 16, claim 4, for "netted" read wetted; and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 26th day of January, A. D. 1937.

Henry Van Arsdale

(Seal) Acting Commissioner of Patents.

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