HEAT TRANSFER DEVICE

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ABSTRACT

An improved heat transfer device particularly suited for use as an evaporator plate in a diffusion cloud chamber. The device is characterized by a pair of mutually spaced heat transfer plates, each being of a planar configuration, having a pair of opposed surfaces defining therebetween a heat pipe chamber. Within the heat pipe chamber, in contiguous relation with the pair of opposed surfaces, there is disposed a pair of heat pipe wicks supported in a mutually spaced relationship by a foraminous spacer of a planar configuration. A wick including a foraminous layer is contiguously related to the external surfaces of the heat transfer plates for uniformly wetting these surfaces.

3 Claims, 6 Drawing Figures
HEAT TRANSFER DEVICE

ORIGIN OF THE INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 U.S.C. 2457).

BACKGROUND OF THE INVENTION

The invention relates to heat transfer devices and more particularly to a heat transfer device particularly suited for use as an evaporator plate in a diffusion cloud chamber.

Studies of cloud condensation nuclei require that precisely controlled supersaturated environments, between 109 percent and 103 percent relative humidity, be maintained when employing diffusion cloud chambers. Unfortunately, diffusion chambers used to provide such an environment are characterized by two stringent requirements. The first being that thermally active surfaces must be precisely and uniformly controlled to a tolerance of ±0.1°C or better. The second requirement being that the thermally active surfaces be uniformly wetted.

In order to achieve the necessary thermal control, present systems are characterized by high flow fluids or extended area thermoelectric control systems. As can be appreciated, such systems are bulky, slow in response time, and generally inefficient in power usage. Moreover, the usual approach of using multiple heat pipes with metal to metal heat transfer regions does not adequately provide the necessary temperature uniformity over the extended surfaces.

In order to achieve uniformly wetted surfaces, it is currently common practice to deposit filter paper on these surfaces and employ the paper as a wick. However, it has been found that, in practice, it is very difficult to assure that uniform wetting will be experienced under all operating conditions.

Therefore, there currently exists a need for a practical heat transfer device which can readily be employed as an evaporator plate in a diffusion cloud chamber in order to overcome the aforementioned difficulties and disadvantages.

It is, therefore, a general purpose of the instant invention to provide an improved internally supported heat transfer device which includes thermally active surfaces particularly adapted to be reliably and uniformly wetted under substantially all operating conditions while the temperatures thereof are precisely and uniformly controlled to facilitate the maintenance of temperature uniformity over the external surfaces of this device.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the instant invention to provide an improved heat transfer device which can be employed to overcome the aforementioned difficulties and disadvantages.

It is another object to provide an improved heat transfer device particularly suited for use as an evaporator plate for a diffusion cloud chamber.

It is another object to provide an improved heat transfer device including a pair of heat pipe wicks, each being of a planar configuration, separated by a contiguously related spacer formed of a porous material.

It is another object to provide, for use in a diffusion cloud chamber, an improved heat transfer device having an external surface including an external layer of a porous material, whereby a uniform wetting of the surface is facilitated.

It is another object to provide, for use in a diffusion cloud chamber, an improved internally supported heat transfer device which includes a pair of mutually spaced heat transfer plates, each being of a planar configuration, having a pair of opposed first surfaces defining therebetween a heat pipe chamber, a pair of mutually spaced heat pipe wicks disposed within the chamber and a porous spacer of a planar configuration interposed between the wicks in contiguous supporting engagement therewith and a porous sheet contiguously related to the external surface of the heat transfer device for facilitating a uniform wetting thereof.

These and other objects and advantages are achieved through the use of an internally supported heat transfer device including a pair of heat pipe wicks, each of which includes a pair of superimposed layers of metallic screen comprising a wick, a porous spacer interposed between the wicks for maintaining the wicks in mutually spaced relation, a pair of mutually spaced heat transfer plates defining therebetween a heat pipe chamber for receiving said spacer and said pair of wicks, and an external surface including a porous layer contiguously related to the external surfaces of the heat transfer plates for facilitating a uniform wetting thereof.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic view of a diffusion cloud chamber within which there is disposed a pair of heat transfer devices, which embody the principles of the instant invention, each being connected with a heat sink through a tubular heat pipe.

FIG. 2 is a fragmented plan view of a heat transfer device which embodies the principles of the instant invention.

FIG. 3 is a partially sectioned, fragmented, plan view of one corner of the heat transfer device illustrated in FIG. 1 depicting one manner in which the heat transfer device is connected with a tubular heat pipe.

FIG. 4 is a sectioned view taken generally along line 4—4 of FIG. 2.

FIG. 5 is an exploded, partially sectioned view of the device shown in FIG. 2.

FIG. 6 is a cross-sectional view taken generally along line 6—6 of FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings wherein like reference characters designate like or corresponding parts throughout the several views, there is shown in FIG. 1 a diffusion cloud chamber, not designated, within which there is disposed a pair of improved heat transfer devices, generally designated 10 and 12, which embody the principles of the instant invention.

It is to be understood, of course, that diffusion cloud chambers, their purposes, and their operations are well known and understood. Therefore, a detailed description of the diffusion cloud chamber illustrated in FIG. 1 is omitted in the interest of brevity. However, it is to be
understood that through a use of the cloud chamber, cloud nuclei are rendered visible as a consequence of
the formation thereon of liquid droplets, as they are
called to pass through the cloud chamber.

As shown in the drawings, the devices 10 and 12,
which embody the principles of the instant invention,
serve as evaporator plates which are spaced apart a
suitable distance while a flow of particle-free air is
established about the surfaces of the devices 10 and 12
from a delivery conduit 14 extended into the cloud
chamber. A stream of air bearing cloud nuclei to be
counted is introduced into the chamber via a conduit
16 and directed to flow along a linear path extended
through a zone, not designated, of supersaturation
located between the devices 10 and 12. As a practical
matter, the zone is located at equidistances from the
devices 10 and 12. The vapor within this region con-
denses on the nuclei as they are passed through the
chamber. An optical counter 18 is connected with the
cloud and serves to count the nuclei, all in a manner
well understood by those familiar with diffusion cloud
chambers. As a practical matter, the plates 10 and 12
are employed for maintaining a suitable temperature
gradient through the aforementioned zone of super-
saturation.

In practice, a pair of heat sinks 20 is provided and
connected with the heat transfer devices 10 and 12 via
a pair of tubular heat pipes, designated 22, of well
known design. The particular configuration of the heat
sinks 20, of course, is varied as is desired. For example,
a group of thermoelectric units including a fan and thin
fins can be connected with the heat pipes 22 to thus
establish a suitable heat rejection system for terrestrial
application. In a zero-gravity cloud physics laboratory
a loosely controlled fluid cooled heat sink may be
employed to provide the necessary heat rejection.

Turning now to FIG. 2, it is to be understood that
each of the heat transfer devices, designated 10 and 12,
is of a common design, and is fabricated in a similar
manner, and functions in a similar manner to achieve
similar results. Therefore, it is believed that a detailed
description of the heat transfer device, designated 10,
is deemed sufficient to provide a complete under-
standing of the instant invention.

As best shown in FIG. 2 the heat transfer device 10 is
of a planar configuration. However, it is to be under-
stood that, where so desired, the heat transfer device
10 is provided with a toroidal or similar cross-sectional
configuration.

Referring now, for a moment, to FIGS. 2 and 5, the
heat transfer device 10 includes a spacer, generally
designated 24, formed of a foraminous material, such
as, for example, double crimped copper screen formed
from 0.063 diameter wire. Disposed in contiguous en-
gagement with the spacer 24, at each of its opposite
sides, there is a heat pipe wick 26, also of a planar
configuration. As a practical matter, each of the wicks
26 comprises a double layer of number 100 mesh cop-
per screen and functions in a manner well understood
by those familiar with the operation of heat pipes.

A pair of heat transfer plates, designated 28 and 30,
is provided in a mutually spaced relationship and de-
fines therebetween a heat pipe chamber, designated 32.
Preferably, the plate 30 is provided with a projected
peripheral lip 34. This lip serves to establish a periph-
eral wall for the chamber 32 upon which is seated the
transfer plate 28. In practice, the lip 34 is provided with
a plurality of suitably spaced reliefs 36, each being
suitably configured to receive therein a coupling pin
38, which is extended through a coaxially aligned open-
ing 40 formed in the peripheral zone of the heat trans-
fer plate 28. The coupling pins 38 are employed for
uniting the heat transfer plates 28 and 30 to form an
integrated unit and are welded, soldered or otherwise
suitably secured to the plates. Moreover, when so de-
sired, a plurality of spacer blocks 42 are disposed
within the chamber 32 and are employed for purposes
of maintaining the heat transfer plates 28 and 30 in
parallelism.

As shown in the drawings, each of the heat pipes 22
is of a tubular configuration and includes a heat pipe
wick 44, also of a tubular configuration, mated with
both of the heat pipe wicks 26, and is disposed within a
tubular chamber 46 defined within a tubular conduit
48. Hence, it will be appreciated that each of the heat
pipes 22 provides a suitable flow path for a working
fluid, not shown, extended between one of the wicks 26
disposed within the heat pipe chamber 32 and a heat
sink 20. As a practical matter, any suitable working
fluid is employed and, where so desired, is introduced
into the heat pipe chamber 32 via the tubular heat pipe
chamber 46.

In order to facilitate a uniform wetting of the external
surface of the heat transfer devices 10, a layer of num-
ber 200 mesh copper screen 50 is deposited on the
external surface of the device 10 and secured in place
through a use of welds, solder or other suitable means.
This layer of screen functions as a wick for causing a
flow of water to be established across the surface. A
water delivery conduit 52 is, where desired, extended
into the cloud chamber for delivering water to the
surface of the heat transfer device 10. In any event, it is
to be understood that the layer of screen 50 functions
as an exterior wick for uniformly wetting the surfaces
of the plate.

OPERATION

It is believed that in view of the foregoing descrip-
tion, the operation of the device will readily be under-
stood and it will be briefly reviewed at this point.

With the diffusion cloud chamber assembled in the
manner hereinbefore described, each of the heat trans-
fer devices, designated 10 and 12, is provided to serve
as an evaporator plate. Water is delivered via the con-
duct 52, to the surfaces of the heat transfer devices
whereupon the layer of screen 50 serves to uniformly
wet the external surfaces thereof through a wicking
action. Within each of the heat transfer devices 10 and
12 the working fluid is caused to be wicked along the
internal surfaces of the heat transfer devices 10 and 12
while the heat sinks 20 perform necessary heat rejec-
tion functions in a manner well understood by those
familiar with the heat pipe art.

It will, therefore, be appreciated that through the
instant invention it is possible to achieve precise uni-
form, thermal conditions for thermally active surfaces
which are uniformly wetted in order to effectivly and
economically establish a zone of super-saturation
within the diffusion cloud chamber.

Although the invention has been herein shown and
described in what is conceived to be the most practical
and preferred embodiment, it is recognized that depart-
tures may be made therefrom within the scope of the
invention, which is not to be limited to the illustrative
details disclosed.

We claim:
1. In a diffusion cloud chamber, an improved internally supported heat transfer device comprising:
   A. means including a pair of mutually spaced heat transfer plates, each being of a planar configuration, having a pair of opposed first surfaces defining therebetween a heat pipe chamber;
   B. means defining a pair of mutually spaced heat pipe wicks disposed within said chamber and contiguous related to said pair of first surfaces;
   C. means defining a foraminous spacer of a planar configuration interposed between said wicks in contiguous supporting engagement therewith; and
   D. means externally related to said chamber for uniformly wetting a selected portion of a second surface of each heat transfer plate, opposite to the first surface thereof, comprising a foraminous sheet contiguously related thereto.
2. The device of claim 1 wherein said spacer is formed from a woven material having a relatively low mesh number and each wick of said pair of heat pipe wicks comprises a pair of superimposed layers of metallic screen having a relatively high mesh number.
3. The device of claim 1 further comprising means for connecting said improved evaporator plate to a heat sink including a tubular heat pipe having a heat pipe wick connected with each wick of said pair of heat pipe wicks.