



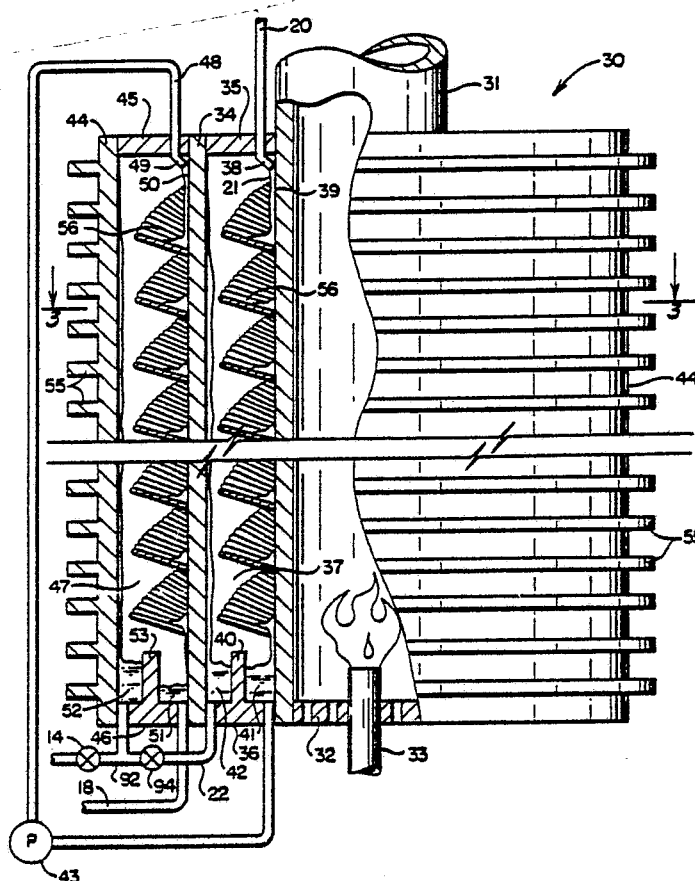
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(54) Title: POWER UNIT FOR ABSORPTION HEAT EXCHANGE SYSTEM

(57) Abstract

A power unit (30) combining a generator (11) and a condenser (12) for an absorption heat exchange system (10) including apparatus comprising a plurality of coaxially substantially vertical chambers (37), (47) in which desorption and condensation take place simultaneously in opposite walls of the chamber. Means such as a pump (43) and a conduit (48) may be provided to convey the refrigerant solution pair from one chamber (37) to the next (47).



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## POWER UNIT FOR ABSORPTION HEAT EXCHANGE SYSTEM

## 1 TECHNICAL FIELD

2 This invention relates to a power unit combining a  
3 generator and a condenser for an absorption heat exchange  
4 system. More particularly, it is an apparatus for use  
5 with either an absorption heat pump system or an  
6 absorption refrigeration system.

7 The apparatus comprises a plurality of coaxially  
8 positioned pipes surrounding a vertically oriented central  
9 pipe. Each pipe is sufficiently larger, progressively from  
10 the center axis, to form annular chambers that are  
11 contiguous one to the next surrounding the center pipe.  
12 The chambers are closed at the upper and lower ends by  
13 members that are connected to the central pipe and the  
14 plurality of surrounding pipes. A source of heat is  
15 placed to provide heat into the interior of the center  
16 pipe. A means is provided to bring a cooling fluid into  
17 contact with the outer surface of the pipe of largest  
18 diameter. Also a means is provided for discharging a  
19 refrigerant-absorbant solution upon the inner walls of the  
20 annular chambers to desorb the refrigerant from the  
21 absorbant on the inner walls of the chambers and to  
22 condense refrigerant on the outer walls of the chambers.  
23 The refrigerant-absorbant solution and the refrigerant are  
24 separately collected at the bottom of the chambers for  
25 circulation to appropriate components of an absorption

1 heat exchange system.

#### BACKGROUND ART

5 In absorption refrigeration systems, which operate primarily through heat exchange between various concentrations of chemical solutions, the rate of heat transfer and the effectiveness of heat transfer are very important. Configurational changes in the apparatus through which the refrigeration chemicals are transferred have an important bearing on the rate and effectiveness of heat transfer in the system.

10 Traditionally, in an absorption refrigeration system the generator comprises a reservoir in which the refrigerant solution pair is subjected to heat, either by the passage of heat through tubes or by the application of heat to the bottom and sides of the reservoir container. U. S. Patent 3,495,420 - Loweth et al., shows a typical unit for an absorption system.

15 Also, as shown in the above patent, a condenser of reservoir-like configuration is in adjacent spaced position. Refrigerant vaporizes in the generator chamber and is transferred over to the condenser chamber. In this conventional system the heat applied at the generator is wasted to a great extent or ineffectively applied to a large portion of the solution in the reservoir. In the same fashion the cooling applied at the condenser is not effectively used.

#### DISCLOSURE OF INVENTION

20 In the description of this invention, it is important that a clear distinction be made between solutions entering and leaving the power unit. Therefore, adopted herein is the notation of the standard setting body on absorption systems in the U. S., the ASHRAE Technical Committee (8.3) on Absorption Machines. Their notation is given in the following quote from the ASHRAE 1979



1       Equipment Handbook, Chapter 14:  
      "To avoid confusion of terminology in the  
      absorption field, ASHRAE Technical Committee"  
5       8.3 recommends the following standardized  
      terms for the absorbent-refrigerant solution.  
      **Weak absorbent** is that solution which has  
      picked up refrigerant in the absorber and is  
      then weak in its affinity for refrigerant.  
      **Strong absorbent** is that solution which  
10       has had refrigerant driven from it in the  
      generator and, therefore, has a strong  
      affinity for refrigerant."

      In co-pending application, Serial No. 177,695, filed  
      August 31, 1980, assigned to Battelle Development  
15       Corporation, a subsidiary of Battelle Memorial Institute  
      the assignee of this patent application, improvements have  
      been disclosed that are directed to the configurational  
      attributes of heat exchangers in absorption systems. The  
      disclosures therein, and in any continuation or  
20       continuations-in-part thereof, are made a part of this  
      specification by reference.

      The invention herein is a further improvement in the  
      heat exchange units of absorption systems. In this  
      invention the generator(s) and condenser(s) are combined  
25       in a single-or multiple-stage unit which is termed herein  
      a "power unit". This power unit is so termed in reference  
      to the fact that it combines the two types of components  
      of the refrigeration system which are on the high pressure  
      side of the system where the high temperature (driving)  
30       energy is applied. The other portions of the system,  
      including the evaporator and the absorber, operate at a  
      relatively lower pressure.

1           It is an object of this invention to provide a  
configuration of apparatus and structure such that the  
generator and condenser are combined, with operative  
portions of one forming other operative portions of the  
5           other, and with one integrated with the other so that the  
heat transfer of one is integrated with the heat transfer  
of the other. Another object is to provide a plurality of  
stages in a power unit to provide an optimum heat transfer  
efficiency with a minimum of space and cost, through  
10           simplicity of the arrangement and construction.

Other features and objects of the invention will be  
apparent from the following drawings and description, as  
well as the appended claims.



## 1 BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a schematic view of a typical prior art conventional absorption refrigeration system in which the invention is practiced.

5 Figure 2 is a partial sectional elevation view of the apparatus of this invention.

Figure 3 is a sectional plan view taken in the plane 3-3 of Figure 2.

## BEST MODE FOR CARRYING OUT THE INVENTION

10 Referring to Figure 1, a conventional absorption refrigeration/heating system 10 is shown schematically including a generator 11, condenser 12, evaporator 13, expansion valve 14, absorber 15, pump 16, and recuperator 17. The power unit of this invention carries out and  
15 combines the functions of the generator 11 and condenser 12 of the conventional system 10. The dash lines encompass that portion of the system 10 that is combined in the power unit 30.

20 The operation of conventional absorption heating/cooling systems is well known and requires little further explanation. In a typical system, water is a refrigerant dissolved in a lithium bromide-water solution, often called the "solution pair". Water is absorbed in the lithium bromide solution to varying degrees throughout  
25 the system and the heat of absorption is added or extracted to produce heating and cooling effects.

The solution pair enters the generator through the  
30 conduit 20 where it is subjected to heat. The applied heat builds up the pressure and desorbs refrigerant water in the form of vapor which is conveyed through line 23 to the condenser 12. There, external ambient cooling condenses the water vapor to liquid, which is conveyed through the line 22 and through the expansion valve 14,

1 where heat is absorbed in the evaporator 13. In a  
refrigeration system the heat absorbed in the evaporator  
13 is from the cooling load. The low pressure vapor  
passes through line 24 to the absorber 15 where ambient  
5 cooling allows the lithium bromide solution to absorb the  
water vapor. The solution pair is then conveyed to the  
recuperator 17 by the pump 16. The recuperator is a  
counterflow heat exchanger where heat from the absorbent  
lithium bromide coming from the generator 11 through line  
10 18 heats the solution pair on its way to the absorber 15  
through line 19.

In the heating cycle the cooling applied at the  
absorber 15 and/or the condenser 12 is the heating load.

Referring to Figure 2, the fire-tube absorption power  
15 unit of this invention comprises a vertically oriented  
"combustion chamber" center columnar pipe member 31 having  
at its lower end a base plate 32 with a coaxial aperture  
through which a source of heat 33, typically a pulse  
combustor, protrudes. Coaxially surrounding the center  
20 columnar pipe member 31 is a second columnar pipe member  
34 connected to the outer surface of the center columnar  
pipe member 31 by an upper end outwardly extending,  
radially positioned, closure plate 35 and similar lower  
end closure plate 36, thereby creating a first annular  
25 desorber chamber 37.

The various parts comprising this invention are  
substantially coaxially arranged, and parts termed "inner"  
are closer in proximity to the central axis.

The washer-like upper end closure plate 35 has an  
30 aperture for the passage of a refrigerant-absorbant  
solution 21 through conduit 20 from the recuperator 17. A  
bend 38 or other means in the end of conduit 20 causes the  
refrigerant-absorbant 21 to be dispersed onto the outer  
surface 39 of the center columnar pipe member 31. The



1 lower end closure plate 36 is provided with a partition 40  
which separates the bottom of annular chamber 37 into an  
inner reservoir 41 and an outer reservoir 42.

5 A third columnar pipe member 44, is attached  
substantially coaxially surrounding the second columnar  
pipe member 34, by another upper end outwardly extending,  
radially positioned closure plate 45 and similar lower end  
closure plate 46, creating a second annular desorber  
chamber 47. The upper end closure plate 45 has an  
10 aperture through which passes a conduit 48 that connects  
chamber 47 with the inner reservoir 41 of chamber 37.  
Chamber pressure differences, in some cases enhanced by a  
pump 43, raise the partially strengthened  
refrigerant-absorbant solution in conduit 48. A bend 49  
15 or other means in the upper end of conduit 48 inside  
chamber 47 causes the partially strengthened  
refrigerant-absorbant solution from inner reservoir 41 to  
be dispersed onto the outer surface 50 of the second pipe  
member 34.

20 The lower end closure plate 46 of chamber 47 is  
likewise divided into an inner annular reservoir 51 and  
outer annular reservoir 52 by a partition 53. The conduit  
18 connects inner reservoir 51 with the recuperator 17.  
Outer reservoir 42 of chamber 37 and outer reservoir 52 of  
25 chamber 47 are interconnected by pressure let down means  
94 and conduit 22, and then are connected to expansion  
valve 14 by the conduit 92.

30 The outside surface of the third columnar pipe member  
44 may be provided with a plurality of radial surface  
extending members such as fins 55.

Attached to the surface 39 of the central columnar  
pipe member 31 within chamber 37 are generally radially  
positioned, outwardly and upwardly projecting, surface  
extending members that may have slits essentially forming

1 spines 56. Likewise, within chamber 47 on the surface 50  
of the second columnar pipe member are generally radially  
positioned outwardly and upwardly projecting surface  
extending members or spines 56.

5 In the preferred embodiment shown, these surface  
extending members 56 are attached near the top of chambers  
37 and 47 and are wrapped spirally around the central and  
second columnar pipe members, respectively, in helical  
progression down to close proximity of the partitions 40,  
10 53. In another construction the fins could be shaved from  
the pipe wall itself.

In a typical practice of this invention, the flame of  
a pulse combustor burns in the interior of or below the  
central pipe member 31, heating the pipe to a high  
15 temperature. When refrigerant/absorbant solution 21 from  
the recuperator 17 is introduced through conduit 20 into  
chamber 37 and onto surface 39, the water component of the  
solution 21 is desorbed and separates, becoming a vapor  
which then condenses on the lower temperature surface of  
20 the second pipe member 34. The surface extending members  
56 serve to expand the heated surface area promoting  
exceptionally effective vaporization of the  
water-refrigerant from a thin film condition.

The solution 21 becomes weaker in refrigerant as it  
25 progresses downward along the surface 39 and the spines 56  
until it collects in the reservoir 41. The strengthened  
solution is pumped through the conduit 48, through the  
inlet 49, onto the surface 50 where it flows downward and  
over additional spines 56. Desorption takes place and  
30 water vapor is driven off leaving the now further  
strengthened collection of solution in the reservoir 51.  
The now strong solution of water and lithium bromide is  
conveyed through conduit 18, through the recuperator 17,  
and line 19, to the absorber 15.

1           During the desorption processes that are taking place  
in chambers 37 and 47, as just previously described,  
condensation simultaneously takes place on the inner walls  
of the second pipe 34 and of the third pipe 44 since these  
5 walls are cooler than the opposite walls and spines where  
desorption is taking place. The source of cooling effect  
is the outer wall of the third pipe 44 with the surface  
extending fins 55. Ambient air, or in some circumstances  
a liquid coolant (such as water) in a jacket (not shown),  
10 is passed adjacent to and in contact with the fins 55 and  
the wall, extracting heat progressively outwardly from the  
center of the power unit 30.

As condensation takes place, the water flows down the  
outer walls of chambers 37 and 47 and collects in the  
15 outer reservoirs 42 and 52, respectively, from whence it  
is carried via the conduits 22 and 92 to the expansion  
valve 14.

#### INDUSTRIAL APPLICABILITY

In a typical illustrative power unit which could be  
20 constructed and operated in an absorption heat exchange  
system to provide three-quarter ton refrigeration  
capacity, features would be as follows:

Center pipe - 3/4" Schedule 40 (.675"OD - .493  
ID)  
25 Second pipe - 1 1/4" Schedule 40  
(1.66"OD - 1.38"ID)  
Third Pipe - 2 1/2" Tube/14 gauge  
(2.5"OD - 2.334" ID)  
Length of Pipes between enclosure members - 5.5'  
30 (1.7M).

Into this power unit 30 a lithium bromide/water weak  
solution pair having a concentration of 58 1/2% lithium  
bromide is introduced to the outer surface 39 of the  
center pipe 31 at a temperature of about 312°F. This weak

1 solution flowing down over the surface extending members  
56 exits from the chamber 37 through the reservoir 41 at  
the bottom, partially strengthened to a concentration of  
60 1/2% lithium bromide at a temperature of about 332°F.  
5 Water condensate gathers on the inner wall of the second  
pipe 34 and exits from the chamber 37 through the  
reservoir 42 at the bottom via the conduit 22 at a  
temperature of about 226°F. The partially strengthened  
lithium bromide solution is carried via the conduit 48 to  
10 the outer wall 50 of the second pipe 34 at a temperature  
of about 194°F (the concentration remaining at 60 1/2%  
lithium bromide) after passing through the recuperator 17.  
After coursing down over the surface extending members 56,  
the strong solution exits from the chamber 47 through the  
15 reservoir 51 via the conduit 18 at the bottom at a  
temperature of about 202°F and a concentration of 62.1%  
lithium bromide. At this point, it is a strong solution  
fully desorbed. Condensate collects on the inner wall of  
the third pipe 44 at a temperature of about 110°F and  
20 exits from the chamber 47 through the reservoir 52 at the  
bottom via the conduit 92. Cooling water is circulated  
around the outside of the third pipe 44 including the  
cooling fins 55 at a temperature of about 85°F.

The concentration of the solution leaving the chamber  
25 47 has increased from 58 1/2% lithium bromide to 62.1%  
lithium bromide in the two-stage unit shown in Figures 2  
and 3. This is considered exceptionally good in an  
absorption unit of this size and capacity.

It will be seen that the enclosed coaxial  
30 configuration of the power unit of this invention is  
especially efficient and effective in the conservation of  
space and energy. The heat is generated in a confined  
space where its only possible progression is outward into  
the structure where it is used to advantage (other than

1 the exhaust through the top which is a loss in all  
combustion systems). Conversely the maximum areas for  
cooling effect is obtained through the encirclement of the  
unit of the outer pipe 44 and the fins 55.

5 The apparatus of this invention is shown with the  
central axis of the various primary pipes, chambers, and  
chamber walls in the vertical position. It is believed  
that the apparatus and system will operate most  
effectively in this substantially vertical position.  
10 However, it is to be understood that the system may  
operate in varying lesser degrees of proficiency as the  
central axis is inclined to the vertical. At some  
position of inclination, disparity between desorption and  
condensation on the lower side, and the desorption and  
15 condensation on the upper side will so reduce these  
effects as to reduce operative effectiveness of the  
apparatus. Determination of such inclination would be a  
matter of routine experimentation by those skilled in the  
art, and it is intended that this invention shall  
20 encompass and apply to apparatus systems that are inclined  
to the vertical to the degree that is acceptable to the  
user.

The configuration using columnar pipes and annular  
chambers is simple in construction and easily manufactured  
25 from commonly available and manufactured materials such as  
steel pipe with welded joints. The spiral spinned surface  
extenders 56 are particularly effective in utilization of  
the space in the annular chambers 37 and 47.

30 Because of the unique coaxial configuration with the  
surface extender, the vapor transport distance between  
evaporation surfaces on the extenders and the condensation  
surface on the outer walls of the chambers is uniformly  
very short. This increases the thermal efficiency of  
apparatus of this type.

1           Because of the configuration, exceptionally high heat  
input typically can be provided in the form of pulse  
combustors 33. By this means surprisingly high  
temperatures may be generated at the center of the power  
5           unit which can be effectively handled by the cooling  
periphery.

          Also because of the configuration and its heat  
transfer effectiveness, problems of hot spots are avoided  
or minimized. In devices of this kind, it is not uncommon  
10          for boiling to take place in the desorption process when  
high heat transfer rates are attempted. When boiling  
takes place with lithium bromide, and other typical  
solutions, agitation and temperature differences occur  
across the heat exchange surface. These "hot spots"  
15          curtail the overall effectiveness as well as producing  
highly corrosive atmospheres which are detrimental to the  
materials from which the heat exchangers are made. Also  
the hot spots can lead to solution crystallization which  
blocks the passages and stops the operation of the device.

20          In the apparatus of this invention hot spots are  
avoided since the point of highest heat is approached  
progressively by the solution pair as it progresses down  
the spined wall of the inner surfaces of the chambers.

          It will be seen that the apparatus of this invention  
25          combines generators and condensers of a multi-stage  
absorption refrigeration system into one "power unit" in  
which each heat transfer wall serves as a very effective  
component of the other.

30          A typical preferred embodiment of the invention shown  
and described herein is a two-stage unit. Using the  
concepts of this invention, additional stages can be  
coaxially added between the inner pipe 31 and the outer  
pipe 44. Each additional stage provides an opportunity to  
further increase the effectiveness of the system by

1 increasing the separation between the solution and the  
refrigerant in the high pressure side of the system.

5 Although a preferred embodiment of the invention has  
been herein described, it will be understood that various  
changes and modifications in the illustrated and described  
structure can be effected without departing from the basic  
principles that underly the invention. Changes and  
modifications of this type are therefore deemed to be  
circumscribed by the spirit and scope of the invention,  
10 except as the same may be necessarily modified by the  
appended claims or reasonable equivalents thereof.



## CLAIMS

- 1           1.    A power unit for an absorption heat exchange  
2           system comprising a plurality of substantially coaxially  
3           positioned pipes of progressively larger diameters and of  
4           sizes that provide a space between the inner and outer  
5           walls of the adjacent pipes and including:  
6           a.    a hollow vertically oriented central  
7                    pipe;  
8           b.    an upper and a lower closure member  
9                    extending outwardly from the center  
10           pipe and connected to the outer pipes  
11           to form substantially annular  
12           chambers, contiguous one to the  
13           next, surrounding the center pipe;  
14           c.    means to provide heat in the central  
15                    pipe;  
16           d.    means for providing a cooling fluid to  
17                    contact the outer surface of the  
18           largest diameter pipe;  
19           e.    means for discharging a refrigerant-  
20                    absorbant solution upon the inner  
21           walls of the substantially annular  
22           chambers to desorb refrigerant from  
23           solution with the absorbant and to  
24           condense the refrigerant on the



- 25                                   outer walls of the chambers;  
26           f.   means for collecting the refrigerant and  
27                                   solution separately in the  
28                                   substantially annular chambers;  
29           g.   means for conveying the separately  
30                                   collected solution from one chamber  
31                                   to the next contiguous progressively  
32                                   larger chamber and away from the  
33                                   largest chamber; and  
34           h.   means for conveying the separately  
35                                   collected refrigerant from the  
36                                   chambers.

1           2.   A power unit according to Claim 1 in wherein the  
2           closure members are flanges substantially radially  
3           positioned with respect to the longitudinal axis of the  
4           unit.

1           3.   A power unit according to Claim 1 wherein the  
2           pipes are circular in cross-sectional shape.

1           4.   A power unit according to Claim 1 wherein the  
2           inner pipes have generally radially positioned outwardly  
3           and upwardly projecting surface extending members at  
4           spaced intervals between the end closure members along the  
5           outer surface.

1           5.   A power unit according to Claim 4 wherein the  
2           surface extending members have slits, essentially forming  
3           spines.

1           6.   A power unit according to Claim 5 wherein the  
2           surface extending members are positioned and attached to  
3           the outer surface of the pipes in a spiral or helical  
4           progression between the end closure members.

1           7.   A power unit according to Claim 4 wherein the  
2           effect of the cooling fluid is enhanced by the provision  
3           of surface extending members on the outer side of the

4 outside pipe.

1 8. A power unit according to Claim 4 wherein the  
2 means for applying a cooling fluid and effect is a water  
3 jacket.

1 9. A power unit for an absorption heat exchange  
2 system of generally symmetric construction about a central  
3 axis for an absorption refrigeration system, comprising:

4 a. a centrally positioned combustion chamber  
5 member constructed with an outer  
6 wall surface and an inner wall  
7 surface, and formed to receive a  
8 fuel-fired combustor positioned  
9 to extend a flow of combustion  
10 products into a combustion chamber  
11 therein, the combustion chamber  
12 member having generally radially  
13 positioned outwardly projecting  
14 surface extending surfaces at  
15 spaced intervals, between opposite  
16 ends along the outer wall surface,  
17 in the direction of the central  
18 axis, the ends comprising radially  
19 formed closure members outwardly  
20 projecting from the outer wall  
21 surface;

22 b. a first desorber chamber member  
23 surrounding the combustion chamber  
24 member, spaced apart from the outer  
25 wall thereof and attached to the  
26 closure members, the first desorber  
27 chamber member having generally  
28 radially positioned out-wardly

- 29 projecting surface extending  
30 surfaces at spaced intervals between  
31 the opposite ends along the outer  
32 wall in the direction of the central  
33 axis, the ends comprising radially  
34 formed closure members outwardly  
35 projecting from the outer wall  
36 surface;
- 37 c. a first desorber chamber, between the  
38 combustion chamber member and the  
39 first desorber chamber member,  
40 having an inlet aperture at one  
41 end and having a partition at  
42 the opposite end, the partition  
43 being positioned generally  
44 parallel to the outer wall and  
45 perpendicular to the closure member,  
46 dividing the end of the first  
47 desorber chamber into inner and outer  
48 reservoirs, with an outlet aperture  
49 from each reservoir;
- 50 d. a second desorber chamber member surround-  
51 ing the first desorber chamber  
52 member, spaced apart from the outer  
53 wall thereof and attached to the  
54 closure members; and
- 55 e. a second desorber chamber between the  
56 first desorber chamber member and  
57 the second desorber chamber member  
58 having an inlet aperture at one end  
59 and having a partition at the  
60 opposite end, the partition being

61 positioned generally parallel to the  
62 outer wall and perpendicular to the  
63 closure member, dividing the end of  
64 the second desorber chamber into  
65 inner and outer reservoirs, with  
66 an outlet aperture from each  
67 reservoir.

1 10. A power unit according to Claim 9 wherein there  
2 is a fluid communication means between the inner reservoir  
3 of the first desorber chamber and the inlet to the second  
4 desorber chamber.

1 11. A power unit according to Claim 9 wherein the  
2 surface extending surfaces have slits, essentially forming  
3 spines.

1 12. A power unit according to Claim 11 wherein the  
2 surface extending surfaces are positioned and attached to  
3 the outer surface in a helical progression between the end  
4 closure members.

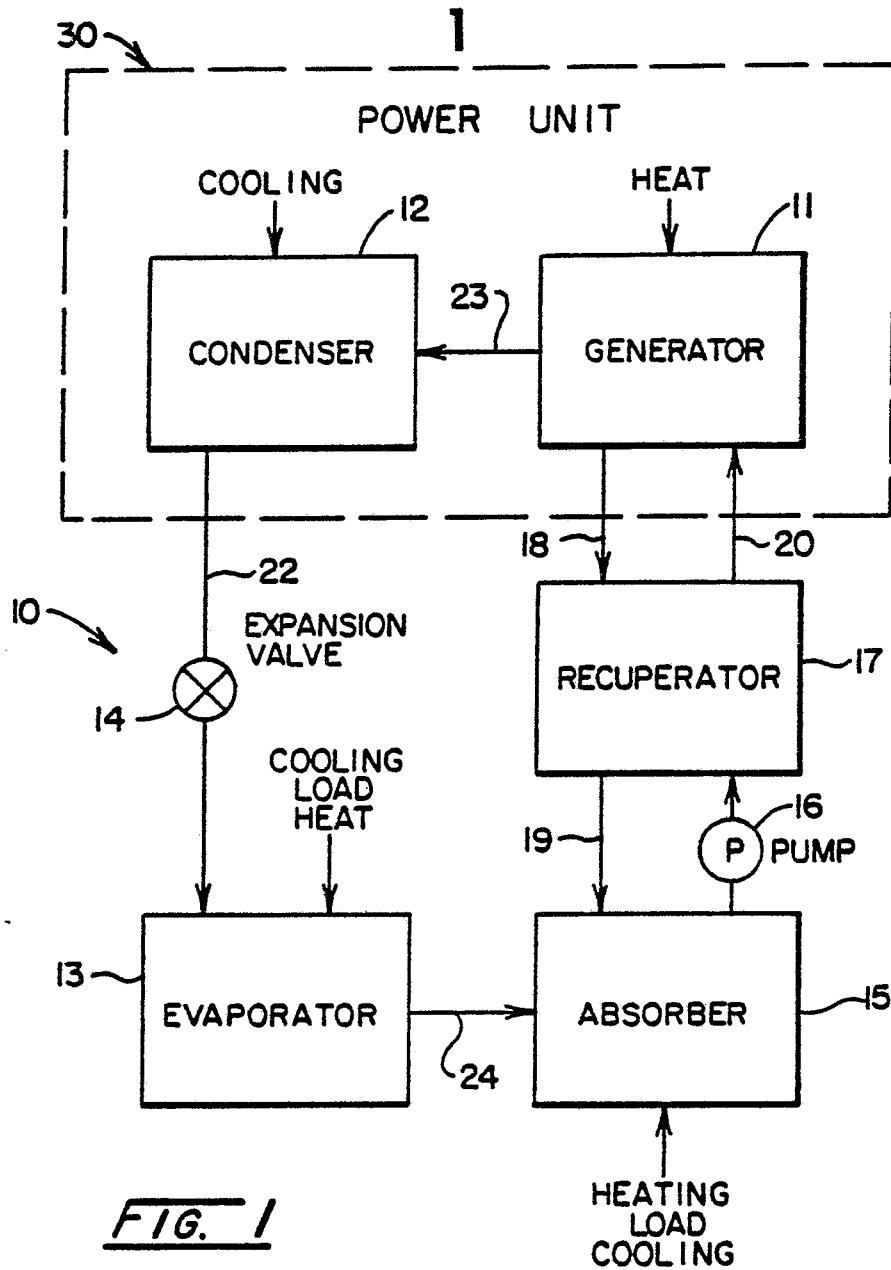


FIG. 1

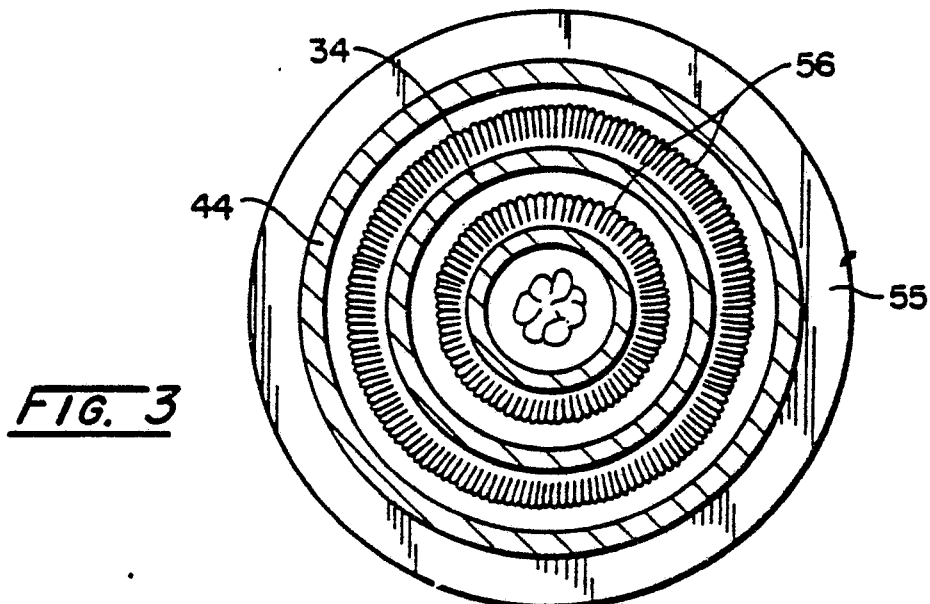


FIG. 3



2

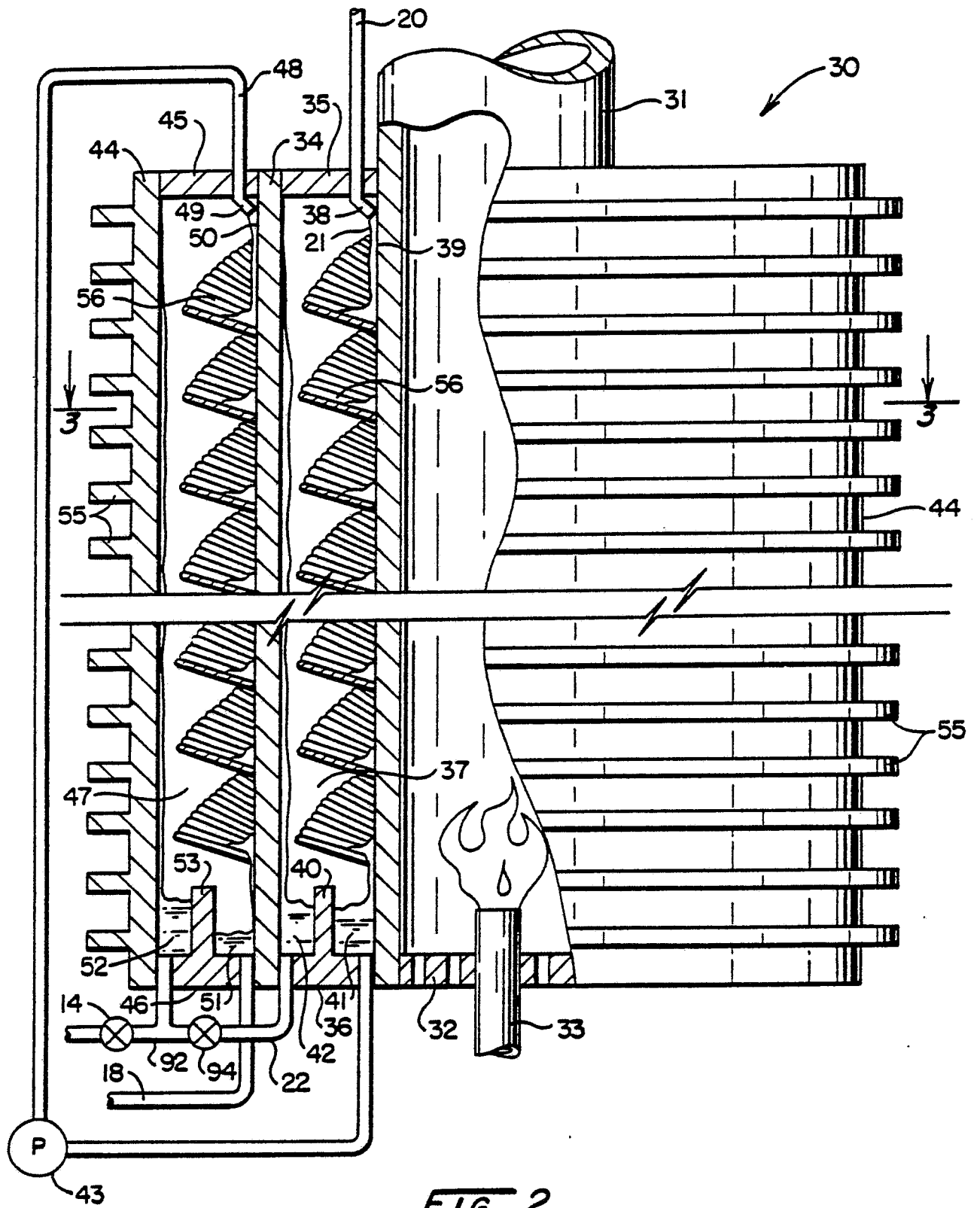
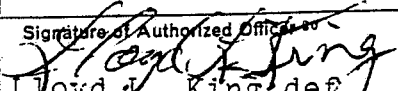


FIG. 2



# INTERNATIONAL SEARCH REPORT

International Application No PCT / US 83/ 01056

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (if several classification symbols apply, indicate all) <sup>3</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT. CL. <sup>3</sup> - F25B 15/00		
U.S. CL. - 62 / 476		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>4</sup>		
Classification System	Classification Symbols	
U.S.	62 / 476, 497	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>5</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category *	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
A	US, A 3,323,323 published 06 June 1967, Phillips	1-12
A	US, A 3,367,137 published 06 February 1968, Whitlow	1-12
A	US, A 3,608,331 published 28 September 1971, Leonard, Jr.	1-12
A	US, A 4,106,309 published 15 August 1978, Phillips	1-12
A	US, A 4,127,993 published 05 December 1978, Phillips	1-12
<p>* Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search <sup>2</sup>	Date of Mailing of this International Search Report <sup>2</sup>	
06 September 1983	04 OCT 1983	
International Searching Authority <sup>1</sup>	Signature of Authorized Officer <sup>19</sup>	
ISA / US	 Lloyd L. King, def	