



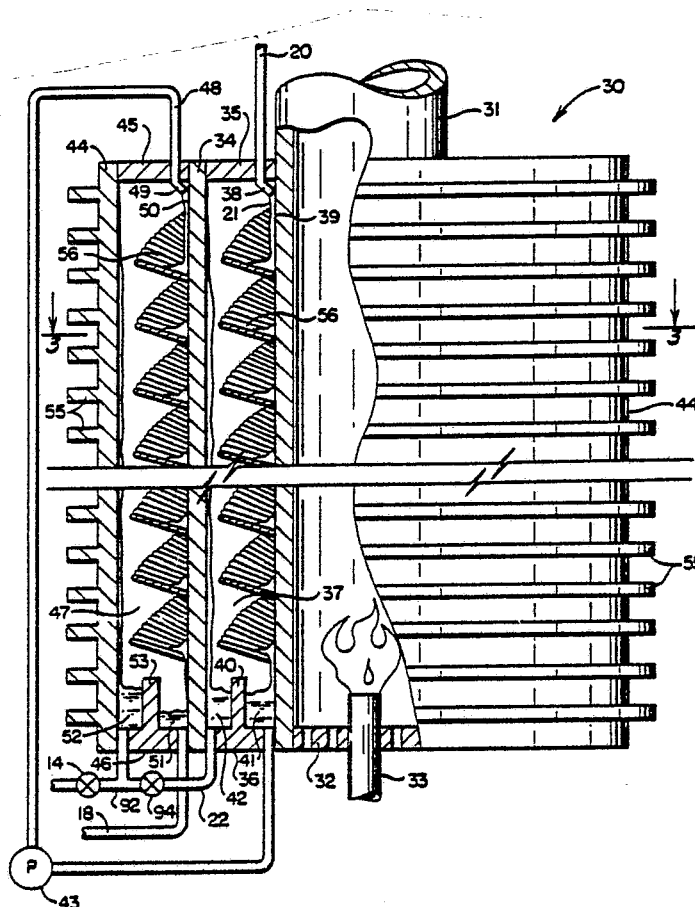
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<p>(51) International Patent Classification³ : F25B 15/00</p>	<p>A1</p>	<p>(11) International Publication Number: WO 84/ 00413 (43) International Publication Date: 2 February 1984 (02.02.84)</p>
<p>(21) International Application Number: PCT/US83/01056 (22) International Filing Date: 8 July 1983 (08.07.83) (31) Priority Application Number: 397,620 (32) Priority Date: 12 July 1982 (12.07.82) (33) Priority Country: US (71) Applicant: BATTELLE MEMORIAL INSTITUTE [US/US]; 505 King Avenue, Columbus, OH 43201 (US). (72) Inventor: WILKINSON, William, H. ; 3089 Oakridge Road, Columbus, OH 43221 (US). (74) Agent: DUNSON, Philip, M.; 505 King Avenue, Columbus, OH 43201 (US). (81) Designated States: AT, DE, GB, JP, SE.</p>		<p>Published <i>With international search report.</i></p>

(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).



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	LI	Liechtenstein
AU	Australia	LK	Sri Lanka
BE	Belgium	LU	Luxembourg
BR	Brazil	MC	Monaco
CF	Central African Republic	MG	Madagascar
CG	Congo	MR	Mauritania
CH	Switzerland	MW	Malawi
CM	Cameroon	NL	Netherlands
DE	Germany, Federal Republic of	NO	Norway
DK	Denmark	RO	Romania
FI	Finland	SE	Sweden
FR	France	SN	Senegal
GA	Gabon	SU	Soviet Union
GB	United Kingdom	TD	Chad
HU	Hungary	TG	Togo
JP	Japan	US	United States of America
KP	Democratic People's Republic of Korea		

1

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.

15 Referring to Figure 2, the fire-tube absorption power
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.

30 The washer-like upper end closure plate 35 has an
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

20 In a typical illustrative power unit which could be
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.

25 The concentration of the solution leaving the chamber
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.

30 It will be seen that the enclosed coaxial
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.

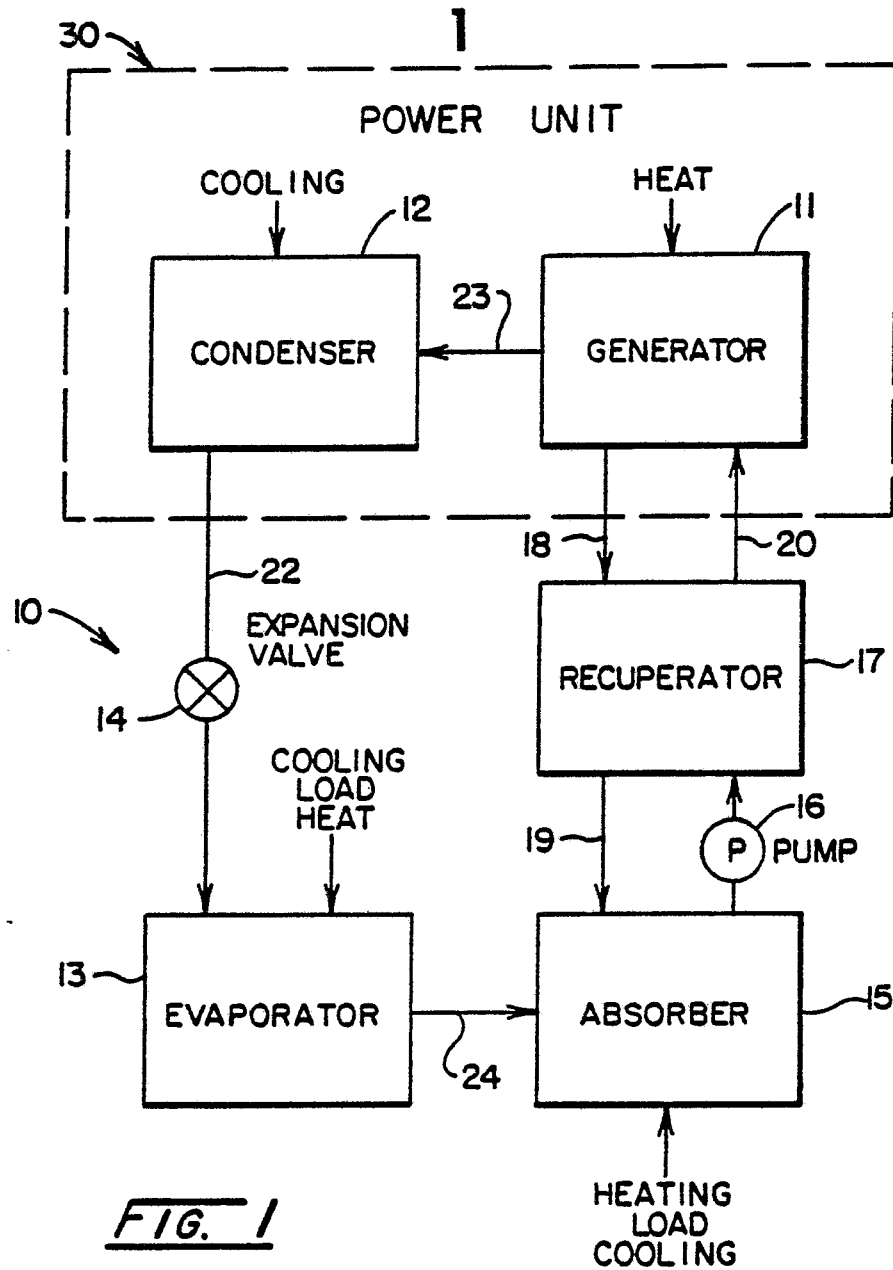


FIG. 1

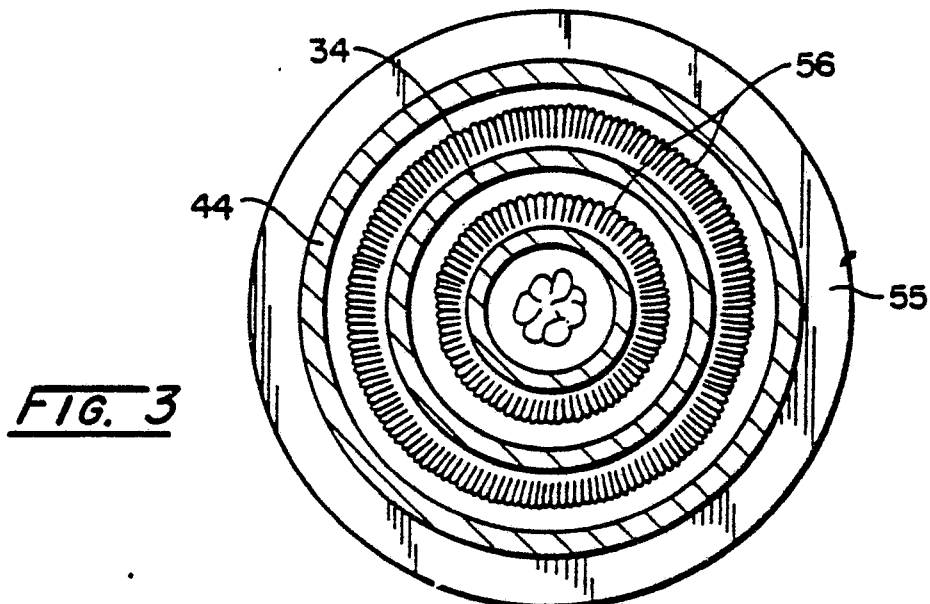


FIG. 3



2

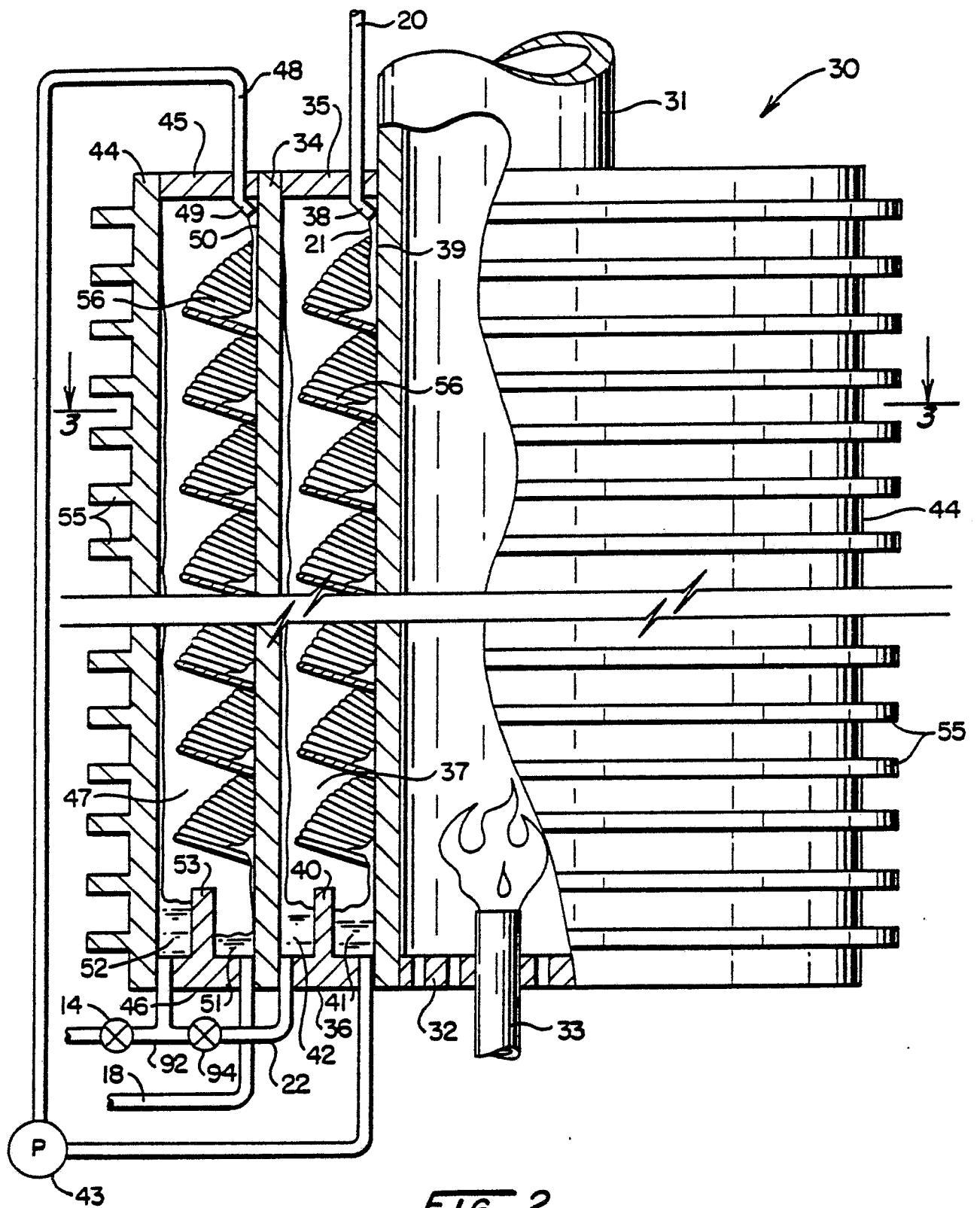
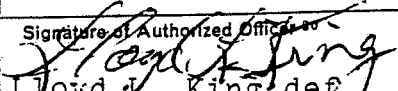


FIG. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT / US 83/ 01056

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) ³		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT. CL. ³ - F25B 15/00		
U.S. CL. - 62 / 476		
II. FIELDS SEARCHED		
Minimum Documentation Searched ⁴		
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 ⁵		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹⁸
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: ¹⁵</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>"&" document member of the same patent family</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search ²	Date of Mailing of this International Search Report ²	
06 September 1983	04 OCT 1983	
International Searching Authority ¹	Signature of Authorized Officer ¹⁰	
ISA / US	 Lloyd L. King, def	