



(86) Date de dépôt PCT/PCT Filing Date: 2003/02/28
(87) Date publication PCT/PCT Publication Date: 2003/09/04
(45) Date de délivrance/Issue Date: 2007/08/07
(85) Entrée phase nationale/National Entry: 2004/08/16
(86) N° demande PCT/PCT Application No.: US 2003/006501
(87) N° publication PCT/PCT Publication No.: 2003/072150
(30) Priorité/Priority: 2002/02/28 (US60/361,129)

(51) Cl.Int./Int.Cl. *A61L 2/20* (2006.01),
A61L 2/26 (2006.01), *B01D 53/04* (2006.01),
B01D 53/26 (2006.01)

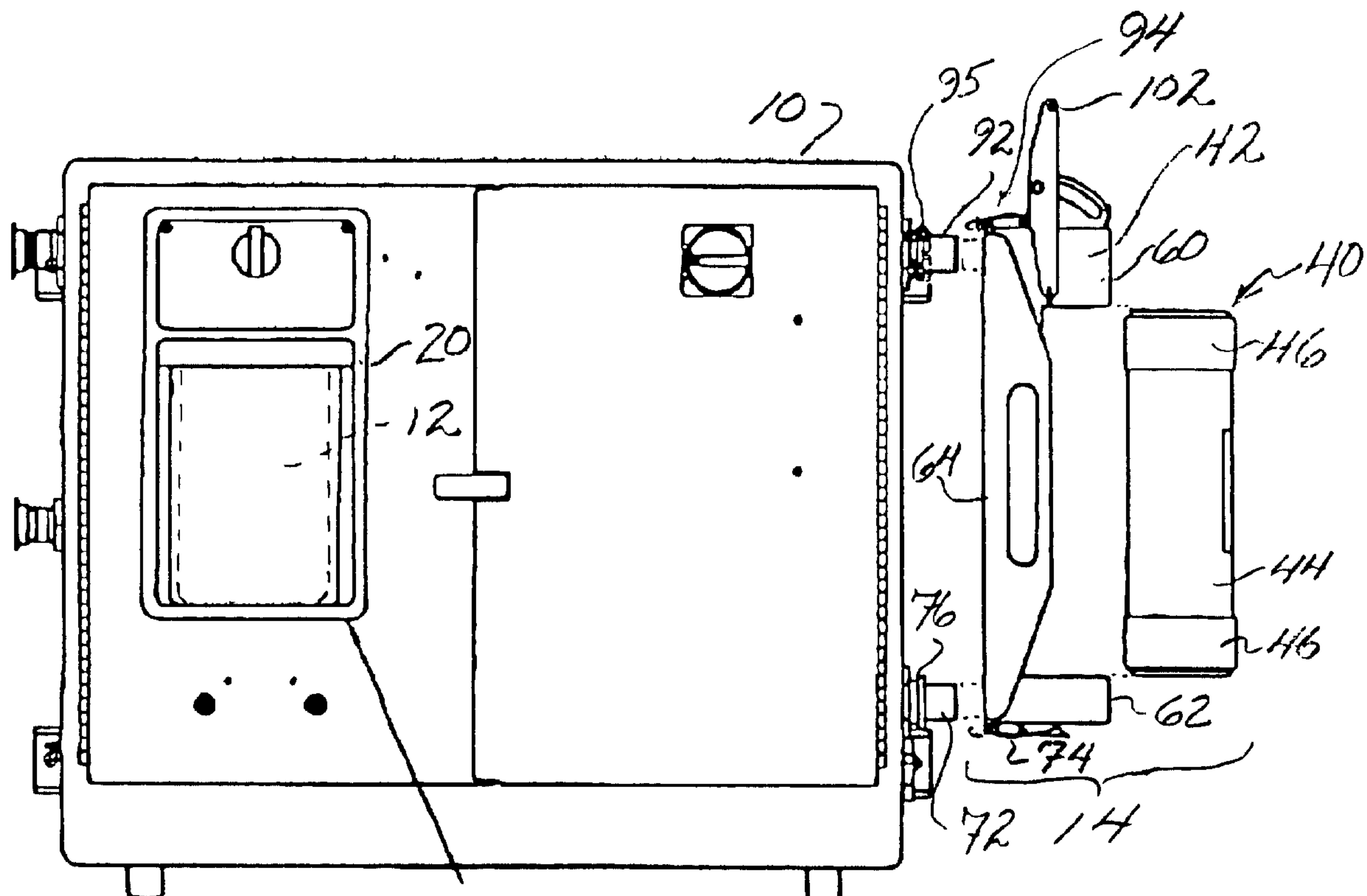
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(54) Titre : SYSTÈME DE VAPEURS DE PEROXYDE D'HYDROGENE A CARTOUCHE DESHYDRATANTE
REMPPLACABLE

(54) Title: HYDROGEN PEROXIDE VAPOR SYSTEM WITH REPLACEABLE DESICCANT CARTRIDGE



(57) Abrégé/Abstract:

A hydrogen peroxide vapor generation unit (10) receives hydrogen peroxide and water solution at an interface (20) and interconnects with an air dryer (14) by nipples (72, 92). In one embodiment, the dryer includes a clamping assembly (42) which is latched (74, 94) with the nipples and which receives a disposable desiccant cartridge (40). In an alternate embodiment, a reusable desiccant cartridge (40') is connected directly to the nipples (72, 92). When the desiccant cartridge (40, 40') is saturated, it is removed and placed in a regenerator unit (120). A regenerated cartridge is installed in its place.



(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
4 September 2003 (04.09.2003)

PCT

(10) International Publication Number
WO 03/072150 A1

(51) International Patent Classification⁷: **A61L 2/20**,
B01D 53/26, 53/04

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(21) International Application Number: PCT/US03/06501

(22) International Filing Date: 28 February 2003 (28.02.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/361,129 28 February 2002 (28.02.2002) US

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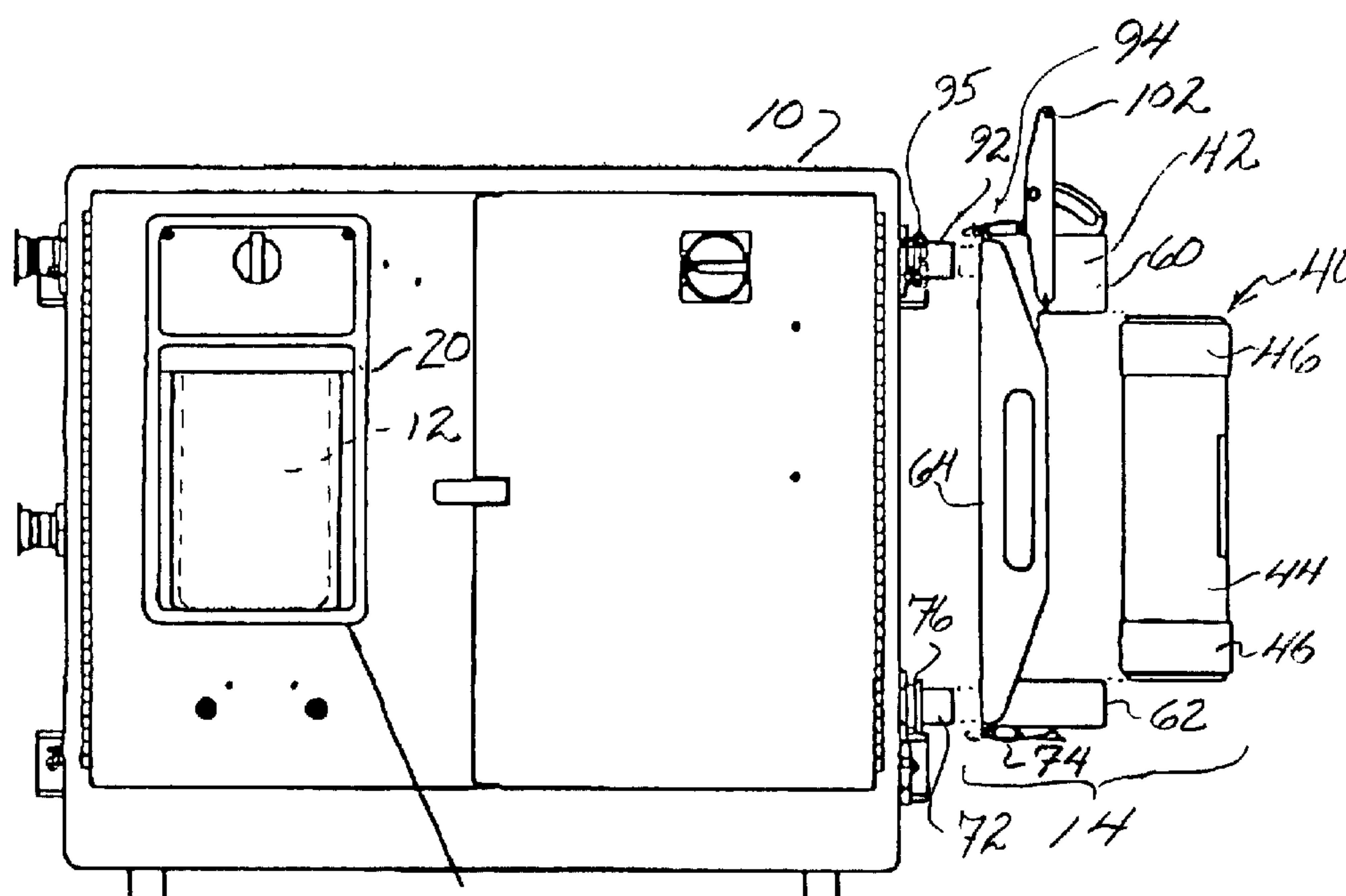
(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

[Continued on next page]

(54) Title: HYDROGEN PEROXIDE VAPOR SYSTEM WITH REPLACEABLE DESICCANT CARTRIDGE



(57) Abstract: A hydrogen peroxide vapor generation unit (10) receives hydrogen peroxide and water solution at an interface (20) and interconnects with an air dryer (14) by nipples (72, 92). In one embodiment, the dryer includes a clamping assembly (42) which is latched (74, 94) with the nipples and which receives a disposable desiccant cartridge (40). In an alternate embodiment, a reusable desiccant cartridge (40') is connected directly to the nipples (72, 92). When the desiccant cartridge (40, 40') is saturated, it is removed and placed in a regenerator unit (120). A regenerated cartridge is installed in its place.

WO 03/072150 A1

WO 03/072150 A1



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- 1 -

**HYDROGEN PEROXIDE VAPOR SYSTEM WITH REPLACEABLE
DESICCANT CARTRIDGE**

Background of the Invention

The present invention relates to the peroxy vapor treatment arts, more particularly to hydrogen peroxide vapor sterilization and disinfection. The invention finds particular application in conjunction with hydrogen peroxide vapor sterilization systems in which peroxide vapor is entrained in dry air which has been dried with a desiccant and will be described with particular reference thereto. It is to be appreciated that the present invention may be used with other peroxy vapors in conjunction with disinfection, sanitation, and other treatment processes.

Heretofore, a solution of hydrogen peroxide and water have been vaporized and entrained in dry air. The vapor and air are pumped into a sterilization or other treatment chamber. The hydrogen peroxide reacts with microbial and other decontaminants in an oxidizing reaction which deactivates them and converts the vapor molecule from peroxide to water. To maintain a preselected concentration of hydrogen peroxide in the chamber, air and vapor from the chamber are recirculated to the vaporizer. Hydrogen peroxide vapor in the withdrawn air is decomposed catalytically or by heat to water vapor. The water vapor is then removed from the air, leaving dry air to be recirculated to the vaporizer.

One technique for drying the air was by condensation. However, condensation requires relatively expensive compressors

May.17. 2004 9:50AM Fay Sharpe

No.1420 P. 12/18

- 2 -

and refrigeration units. Moreover, such condensation units typically fail to dry the air to a consistent level of humidity.

Consistent and lower level of humidity have been achieved by passing the air and water vapor through a desiccant.

5 Although desiccants dry the air consistently to a low humidity, it typically takes longer to regenerate a desiccant than to saturate it. One way to meet these demands was through the use of a desiccant wheel. The air and water vapor were passed through a first portion or section of a desiccant wheel until
10 that section became substantially saturated. The wheel was then indexed, bringing a new desiccant portion or section into the air and water vapor flow path. The saturated portion of the desiccant was subject to a regeneration process over the next several indexed positions of the wheel. Such onboard systems
15 for regenerating desiccant were not only expensive and mechanically complex, but also added significant weight and bulk to portable hydrogen peroxide generation systems.

US-A-5,173,258 discloses a system for peroxy vapor generation including an air dryer which is regenerated between
20 cycles.

US-A-3,338,032 is directed to a desiccant cartridge which is threadedly received in a flow valve at one end and which has knockouts adjacent an opposite end.

US-A-4,828,589 discloses a filter unit with a
25 replaceable cartridge filled with a hygroscopic desiccant granular material. A tubular casing has an interior chamber which is accessible through an openable and closable end port. A drying cartridge is selectively admitted into the interior chamber through the end port.

30 The present invention provides a new and improved desiccant drying system which overcomes the above-referenced problems.

Summary of the Invention

35 In accordance with one aspect of the present invention, a peroxy vapor system includes a liquid peroxy interface for receiving a source of liquid peroxy solutions, a

SUBSTITUTE PAGE 05/2004

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May.17. 2004 9:50AM Fay Sharpe

No.1420 P. 13/18

- 2a -

vapor generation unit for vaporizing the liquid peroxy solution and entraining the vapor in dry air for delivery to a point of use, and a desiccant dryer connected with the vapor generation system for drying air of vapor prior to entraining the generated vapor in the dried air. A pair of nipples interconnects the dryer with the vapor generation unit. The dryer further includes a desiccant chamber connected between end pieces, each end piece including a bore that receives one of the nipples in a fluid tight relationship and at least one latch for latching the end pieces to the nipples.

In accordance with another aspect of the invention, a disposable desiccant cartridge is supplied for the system.

SUBSTITUTE PAGE 05/2004

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- 3 -

The disposable desiccant cartridge includes a tubular chamber with end closures at each end and is dimensioned to be received between the end pieces and engage a clamping assembly on the end pieces. A desiccant material is received in the tubular chambers. An inlet aperture is defined in one end closure of the tubular member and an outlet aperture is defined in an opposite end closure. Annular seals surround the apertures of the end closures. A screen element at each end aperture restrains the desiccant material within the tubular element. Removable vapor barrier seals close the end apertures to prevent humidity from entering the desiccant cartridge before the vapor seals are removed.

In accordance with another aspect of the present invention, a method of using the above-described system is provided. A source of liquid peroxy solution is connected with an interface for the vaporizer. The liquid peroxy solution is vaporized and the vapor is entrained in dry air. The entrained vapor in air is supplied to a point of use. Air and vapor from the point of use are returned through a replaceable desiccant dryer. When or before the replaceable desiccant dryer becomes saturated, it is replaced.

One advantage of the present invention resides in its simplicity and low cost.

Another advantage of the present invention resides in the assurance of adequate desiccant drying capacity.

Another advantage of the present invention resides in the assurance of dry air with a predictable low humidity level.

Still further advantages of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.

Brief Description of the Drawings

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of

- 3a -

illustrating a preferred embodiment and are not to be construed as limiting the invention.

FIGURE 1 is a diagrammatic illustration of a hydrogen peroxide vapor decontamination system in accordance with the present invention;

FIGURE 2 is a side-view of the peroxy vapor generation system;

FIGURE 3 is an end-view of the system of FIGURE 2;

FIGURE 4 is a top view of the vaporizer unit and disposable dryer cartridge embodiment of FIGURES 2 and 3;

FIGURE 5 is an enlarged view of the desiccant cartridge of FIGURES 2-4;

FIGURE 6 is an enlarged sectional view of an end portion of the cartridge of FIGURE 5;

FIGURE 7 is a side-sectional view of the desiccant cartridge receiving assembly of FIGURES 2-4;

FIGURE 8 is a front view of an upper portion of the assembly of FIGURE 7;

- 4 -

FIGURE 9 is a top view of the assembly of FIGURE 7;
FIGURE 10 is an side view of the vaporizer system of
FIGURE 2 with an alternate, reusable dryer;

FIGURE 11 is an end view of the alternate embodiment
5 of FIGURE 10;

FIGURE 12 is a top view of the vaporizer unit and
reusable dryer cartridge embodiment of FIGURES 10 and 11 with
front access panel doors partially open;

FIGURE 13 is a side sectional view of the reusable
10 dryer cartridge of FIGURES 10-12; and

FIGURE 14 is a diagrammatic illustration of a
regenerator unit for the cartridge of FIGURES 10-13.

Detailed Description of the Preferred Embodiments

With reference to FIGURES 1, 2, 3, and 4, a vapor
15 generation unit **10** vaporizes a peroxy solution from a solution
source **12** and entrains the vapor in dry air which has been dried
by a dryer **14**. The dry air and vapor are conveyed to a
treatment chamber, such as an isolator **16**.

In the preferred embodiment, the peroxy solution
20 source is a container or cartridge of hydrogen peroxide in water
solution which is received in a cartridge interface **20**. Once
in the cartridge interface, the cartridge is interconnected with
a dip tube assembly for withdrawing the solution. Although a
solution of hydrogen peroxide in water vapor is preferred, other
25 solutions are contemplated, such as peracetic acid and water,
other peroxy compounds and water, peroxy compounds in alcohol
and water, and the like. In a preferred embodiment, the
hydrogen peroxide and water solution is 35-50% hydrogen
peroxide.

30 The vaporizer system includes an injection pump **22**
which injects metered amounts of the peroxy solution into a
vaporizer **24**. The vaporizer, in a preferred embodiment, is a
heated surface, such as a heated plate or the interior surface
of a bore onto which the peroxy solution is sprayed or injected
35 forming peroxy and water vapor. Dry air from the dryer **14** is
preheated in a preheater **26** and supplied to the vaporizer to

- 5 -

entrain the hydrogen peroxide or other peroxy vapor and water vapor. The vapor entrained in the air is supplied to the treatment chamber **16**.

In the treatment chamber, hydrogen peroxide vapor
5 interacts with microbes and other contaminants in an oxidation reaction, deactivating the microbial material and leaving water vapor suspended in the air. Thus, with time, the concentration of hydrogen peroxide in the treatment chamber drops. To maintain the concentration of hydrogen peroxide vapor, a portion
10 of the vapor and air is withdrawn and fed through a destroyer **28**, such as copper pellets. The copper pellets catalytically degrade the remaining peroxide vapor into water vapor and oxygen. A blower **30**, which provides the motive force to move the air and vapor, pumps the air and water vapor to the dryer
15 **14**. Desiccant in the dryer absorbs the water vapor such that air of accurately predictable low humidity is discharged to the preheater **26**. In this manner, air of known humidity is supplied to the vaporizer, permitting the vaporizer to optimize the concentration of peroxide vapor without condensation. It will
20 be noted that if a significant amount of unexpected water vapor were returned to the vaporizer, the additional vapor content of the saturated air could push the total vapor content of one or both of the peroxide and the water vapor beyond the condensation point.

25 In a preferred embodiment, the dryer **14** includes a disposable desiccant cartridge **40** which is clamped into a clamping assembly **42**.

With reference to FIGURES 5 and 6, the desiccant cartridge includes a cylindrical tube **44** which is closed at
30 either end with end caps **46** to form a cartridge of preselected length. Apertures **48** are defined centrally in each end cap to allow for the passage of gas into and out of the cartridge. The apertures are covered on the inside by disks **50** of screening material to retain a desiccant **52**. A water vapor impermeable
35 end seal **54** is adhesively adhered over an exterior of each opening to prevent the desiccant within the cartridge from absorbing water vapor before it is mounted in the clamping

- 6 -

assembly **42**. The aperture in each end is surrounded by a resilient gasket **56**, such as a closed cell foam of a material which is inert to hydrogen peroxide or other circulated gases.

With reference again to FIGURES 2 and 3, and further
5 reference to FIGURES 7, 8, and 9, the clamping assembly **42** includes a pair of end elements **60**, **62** and pair of tie angles **64** which maintain the end pieces **60**, **62** in a preselected, fixed spaced relationship. The lower end element **62** includes an inlet connection port or bore **70** for interconnection with an outlet
10 nipple **72** of the vapor generator assembly **10**. A latch assembly **74** engages a lip **76** around the outlet nipple to maintain the clamping assembly **42** attached to the vapor generator. The inlet port includes an L-shaped passage terminating in an outlet port **78** adjacent an inlet to the cartridge. The lower assembly has
15 a smooth sealing face **80** surrounding the outlet port **78** to provide an air-tight seal with the lower gasket **56**. The lower assembly includes an upstanding, semi-circular guide portion **82** which receives and positions a lower end of the cartridge centered on the outlet port **78**.

20 The upper element **60** includes an outlet port **90** which is dimensioned to be received in a fluid-tight relationship with a nipple **92** of an inlet port for dry gas on the vaporizer unit **10**. A latch assembly **94** locks the upper element to the nipple assembly lip **95**. The upper element **60** includes an L-shaped
25 passage terminating in an inlet port **96**. The inlet port **96** is surrounded by a piston **98** of larger diameter than the gasket **56** of the desiccant cartridge. The piston defines a smooth, polished sealing face **100** which forms a sealing relationship with the desiccant cartridge gasket. The piston **98** is retracted
30 by pulling a handle **102** toward the user, away from the vaporizing unit **10**. Springs **104** bias the piston toward engagement with the gasket of the desiccant cartridge. When a desiccant cartridge is to be inserted, the handle **102** is pushed away from the user, retracting the piston. This loosens the
35 seal between the piston and the gasket of the used desiccant cartridge which is removed. The adhesive seals **54** of the new

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May.17. 2004 9:51AM Fay Sharpe

No.1420 P. 14/18

- 7 -

desiccant cartridge are removed and the desiccant cartridge is inserted into the latching unit 72 until its rear surfaces engage the alignment surface 84 of the lower element 62 and a matching alignment surface 106 of the upper element 60. The handle 102 is returned to the angled position allowing the springs 104 to bias the sealing face 100 of the piston 98 into a fluid-tight seal with the upper gasket of the desiccant cartridge. An O-ring 108 between the piston 98 and the upper element 60 prevents vapor from passing between the piston and the upper end element.

In one preferred embodiment, the desiccant cartridge is sized in accordance with the anticipated hydrogen peroxide consumption. In one embodiment, the dryer is sized to accommodate the moisture from one cycle of the largest enclosure under worst case conditions. In this embodiment, the desiccant cartridge is replaced at the beginning of each cycle. In another embodiment, the desiccant cartridge is sized to absorb all of the water vapor that is generated by the contents of the hydrogen peroxide cartridge. In this embodiment, the desiccant cartridge is replaced each time the hydrogen peroxide cartridge is replaced. In another embodiment, the desiccant cartridge is sized to be able to hold the water generated by a plurality of the hydrogen peroxide cartridges. As yet another alternative, the desiccant cartridge includes an indicator which provides a visual indication that the cartridge is nearing saturation and should be replaced. As yet another alternative, the vaporization unit 10 includes a moisture sensor which senses the humidity of the air entering the preheater. When the humidity starts to rise, the vaporization unit provides a visual or audio signal indicating that the desiccant cartridge 40 is due for replacement.

As another alternative, the alignment surfaces 82, 106 have projections that are received in corresponding recess in the cartridge 40 to ensure accurate alignment. In another alternative, mating surface 80 of the lower element 62 and the lower end cap have mating projections and recesses outside of the perimeter of the gasket 56 to assure alignment. When the

SUBSTITUTE PAGE 05/2004

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- 8 -

handle **102** is pushed to retract the piston, a pawl holds the piston **98** retracted. A projection or element on the upper end cap interacts with the pawl directly or through a connecting linkage to release the piston only when the top of the cartridge is properly received to release the piston. As another option, cutters can be provided on the lower element **62** and the piston **98** to open the end seals **54** when the cartridge is properly aligned.

With reference to FIGURES 10-13, in another embodiment, a dryer cartridge **40'** is attached directly to the nipples **72, 92** of the vaporizer unit **10**. This embodiment includes a first or top element **60'** and a second or lower end element **62'** which are interconnected by a desiccant cylinder **44'**. The upper end element includes a bore **90'** with a gasket configured to receive the uppermost nipple **92** in a fluid-tight relationship; and the lower end element defines a lower well **70'** and a gasket **56'** configured to receive the lower nipple **72** in a fluid tight seal. A lower latch **74'** engages the latching surface of the lower nipple **72** and an upper latch **94'** engages the latch surface of the upper nipple **92**. Screen elements **50'** are disposed adjacent upper and lower outlets of the cartridge to contain a desiccant **52'** therebetween. A glass sight **110** enables the operator to view a lower desiccant chamber **112** that is defined between a pair of the lower screens **50'**. The color of the desiccant is an indication to the user whether or not a dryer has been regenerated. In the preferred embodiment, the desiccant turns clear soon after the dryer is put in use. The desiccant turns color (blue in this case) after regeneration.

Preferably, all components of the reusable desiccant cartridge are constructed of metal or other materials capable of withstanding repeated exposure to temperatures on the order of 150° C. Alternately, the cartridge can be a single use cartridge that is disposed after being used.

When the desiccant cartridge is saturated or cannot hold the moisture generated by the next cycle to be run, the latches **74', 94'** are released and the drying cartridge is

- 9 -

removed and replaced with a regenerated cartridge. With reference to FIGURE 14, the saturated cartridge is placed in a regeneration unit **120**. The regeneration unit includes nipples of the same size and spacing as nipples **72**, **92** in the second embodiment which are plug into the passages **70'**, **90'**. For
5 cartridges of the embodiment of FIGURE 5, the manifold **128** includes mating top and bottom connections. The regeneration unit includes a filter, preferably a HEPA filter **122** which removes airborne contaminants. A blower **124** blows the filtered
10 air through a heater **126** to a manifold **128**. The manifold is connected with one or more desiccant cartridges **40'** which are to be regenerated. The heated air, heated to about 150° C., is blown through the desiccant entraining the absorbed water, and discharged to the atmosphere. After the desiccant is fully
15 regenerated, as determined by measuring the temperature of the discharged air with a temperature switch **130**, based on time, or other factors, the circulation of heated air through the desiccant is stopped and a cooling fan **132** is started. The cooling fan cools the desiccant cartridge back to room
20 temperature while the ports of the cartridge remain closed. A lockable door **134** is released once the desiccant cartridges have cooled to a temperature that is safe to handle. The desiccant cartridges remain connected to the manifold to prevent the cooling air from entering the chambers where humidity from the
25 cooling air would be absorbed.

- 10 -

Having thus described the preferred embodiment, the invention is now claimed to be:

1. A peroxy vapor system including a liquid peroxy
5 solution interface for receiving a source of liquid peroxy
solution, a vapor generation unit for vaporizing the liquid
peroxy solution and entraining the vapor in dry air for delivery
to a point of use, and, a replaceable desiccant dryer connected
10 with the vapor generation unit for drying air of vapor prior to
entraining the generated vapor in the dried air, characterized
by:

a pair of nipples for interconnecting the dryer with
the vapor generating unit;

the dryer including:

15 a desiccant chamber connected between end pieces,
each end piece including a bore that receives one of the
nipples in a fluid tight relationship, and
at least one latch for latching the end pieces
to the nipples.

20

2. The system as set forth in claim 1 further
characterized by the desiccant dryer including a desiccant
cartridge including:

a tubular chamber having end closures at either end;
25 a desiccant material in the chamber;
an inlet aperture defined in one end closure and an
outlet aperture defined in an opposite end closure;
annular gaskets surrounding the apertures of the end
closures.

30

3. The system as set forth in claim 2 wherein the
desiccant cartridge is further characterized by:

- 11 -

a screen element at each end aperture for retaining the desiccant material within the tubular element; and

removable seals closing the end apertures to prevent humidity from entering the desiccant dryer before the seals are removed.

4. The peroxy vapor system as set forth in claim 2 further comprised by the end pieces including:

a clamping assembly which receives the desiccant cartridge.

5. The system as set forth in claim 4 further characterized by the clamping assembly including:

a piston mounted in one of the end pieces, the piston having a sealing face for engaging a cartridge gasket in a sealing relationship therewith;

a second gasket sealing face on the other end piece;

a means for retracting the piston to facilitate removal of a saturated desiccant cartridge and receipt of an unsaturated desiccant cartridge.

6. The system as set forth in claim 5 further characterized by the clamping assembly further including:

springs for biasing the piston into contact with the desiccant cartridge gasket; and,

wherein the retracting means includes a manually operable lever which is operated to move the piston against the springs retracting it.

7. The system as set forth in either one of claims 5 and 6 further characterized by:

an alignment bracket associated with each end element for aligning the desiccant cartridge gaskets with the gasket sealing faces of the clamping assembly.

- 12 -

8. The system as set forth in any one of claims 1-7 further characterized by:

the pair of nipples projecting from the vapor generation unit and each nipple having a latch engaging surface;
5 and

the latches engaging the nipple latch surface for latching the end pieces to the nipples.

9. The system as set forth in claim 1 further
10 characterized by the desiccant chamber being detachable from the end pieces, the end pieces including:

a piston mounted in one of the end elements, the piston having a sealing face for engaging one face of the desiccant chamber in a sealing relationship therewith;

15 a second sealing face on the other end element;

a mechanism for retracting the piston to facilitate removal of a saturated desiccant chamber and receipt of an unsaturated desiccant cartridge.

20 10. The system as set forth in any one of claims 1-9 further characterized by:

the desiccant chamber having a moisture absorption capacity matched to a volume of liquid in a peroxy solution cartridge that is received in the liquid peroxy solution
25 receiving interface.

11. The system as set forth in any one of claims 1-10 further including:

a regeneration oven for regenerating saturated dryers.
30

12. A method of using the system of any one of claims 1-11 further characterized by:

- 13 -

connecting a source of liquid peroxy solution with
an interface for a vaporizer;

vaporizing the liquid peroxy solution and entraining
the vapor in dry air;

5 supplying the entrained vapor in air to a point of
use;

returning air and vapor from the point of use through
a replaceable desiccant dryer; and

when or before the desiccant dryer becomes saturated,
10 replacing the desiccant dryer.

13. The method as set forth in claim 12 wherein the
desiccant dryer includes a cartridge and wherein the replacing
step includes:

15 disconnecting a saturated desiccant dryer cartridge
from a flow path leading to the vaporizer; and,

connecting an unsaturated desiccant dryer cartridge
in the flow path to replace the saturated cartridge.

20 14. The method as set forth claim 13 wherein the
source of peroxy liquid includes a canister containing a
preselected volume of peroxy liquid and further including:

loading a amount of desiccant in the cartridge which
is sufficient to absorb the preselected volume.

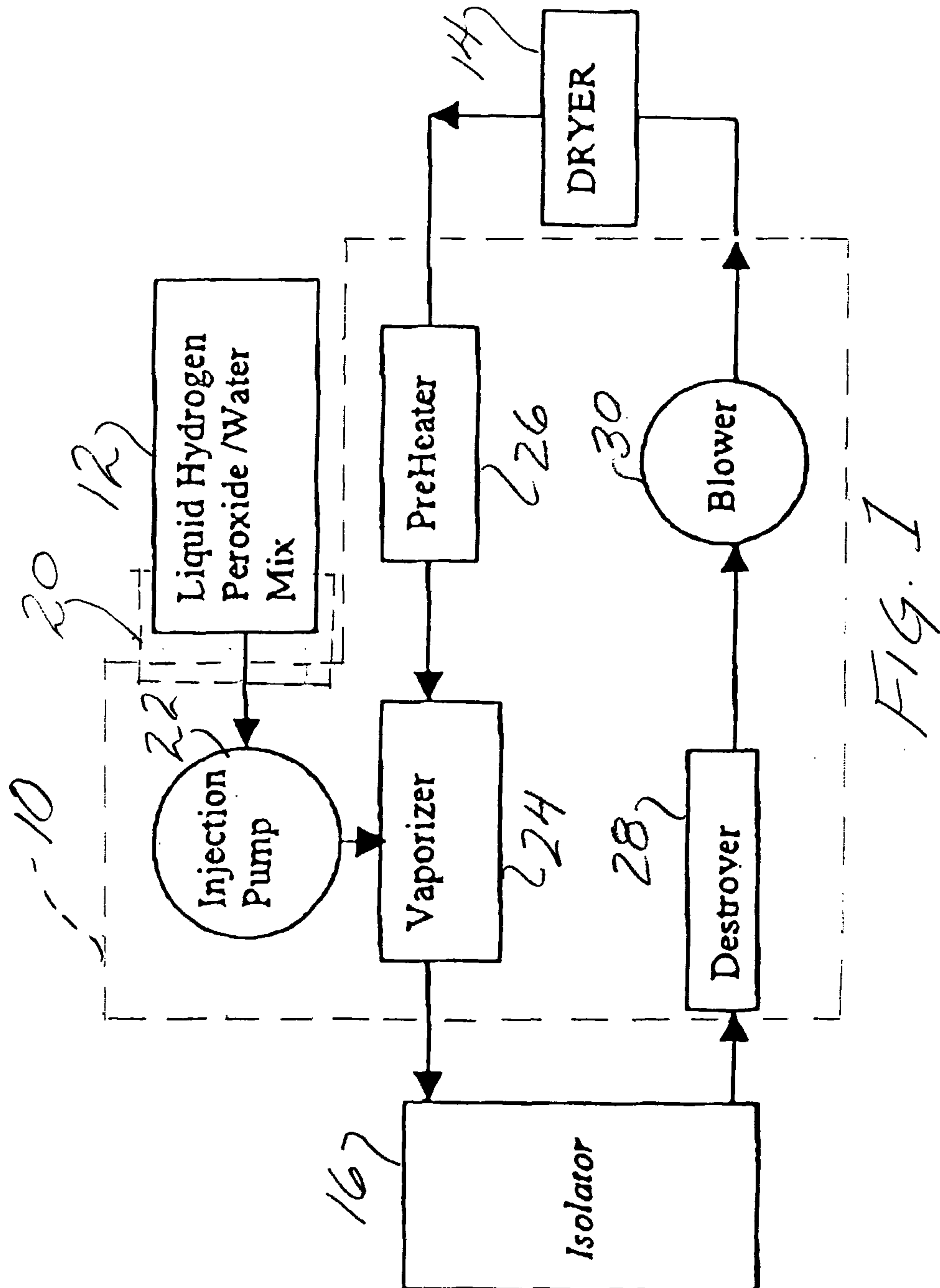
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15. The method as set forth in either one of
claims 13 and 14 further including:

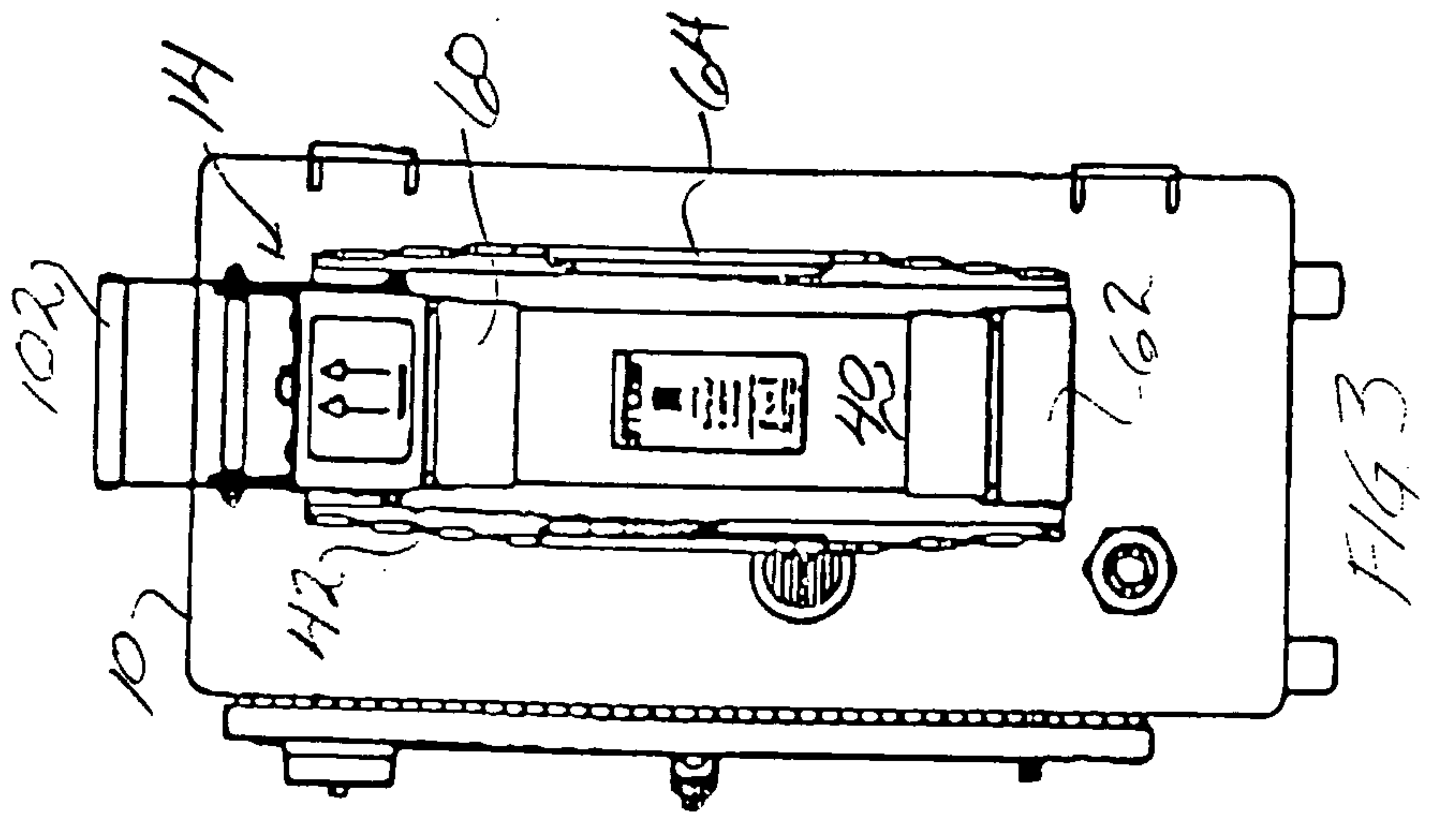
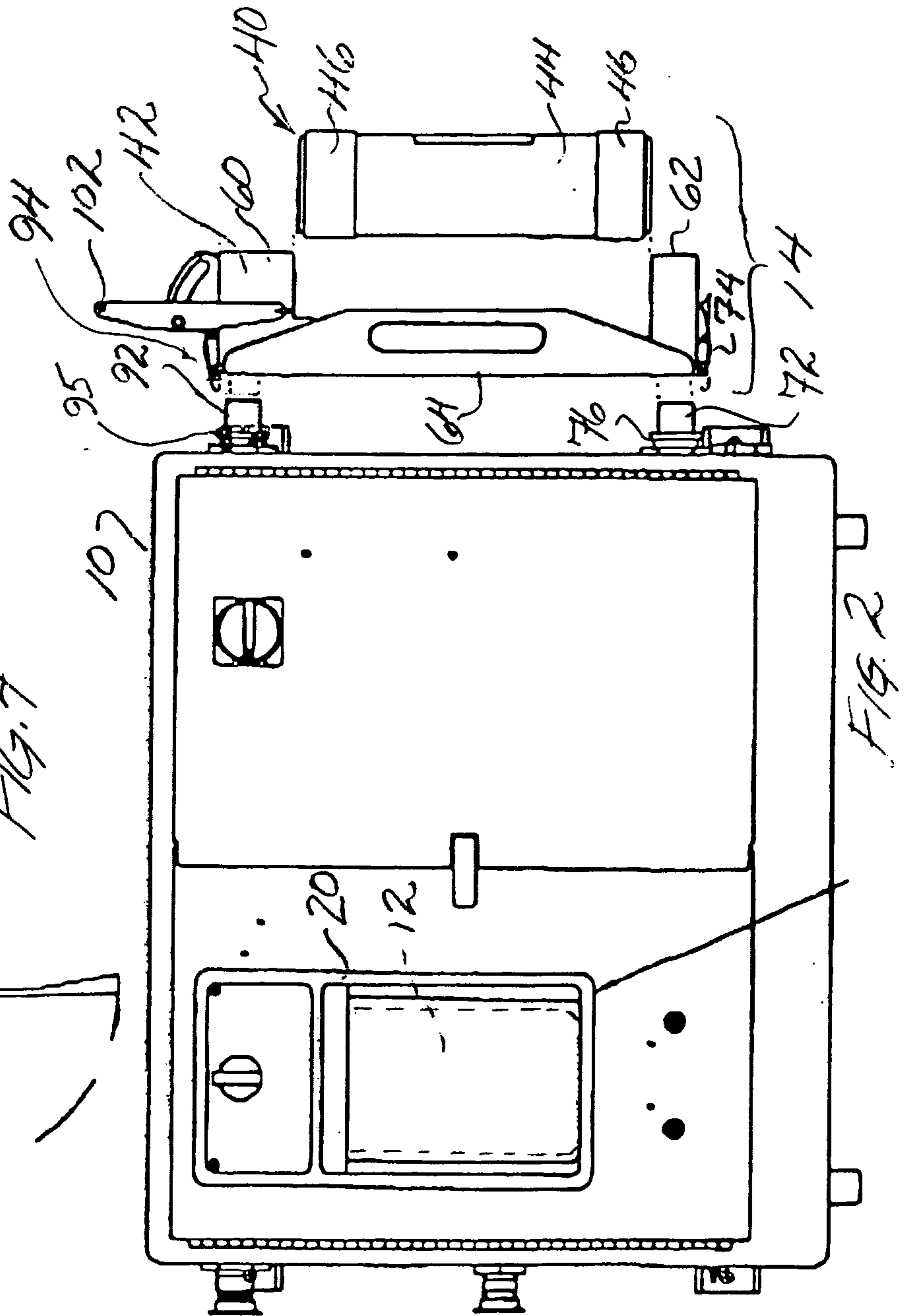
regenerating the saturated desiccant cartridge;

30 attaching temporary seals to openings into the
cartridge to prevent the regenerated desiccant from absorbing
moisture; and,

before connecting the regenerated cartridge, opening
the seals.



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3/6

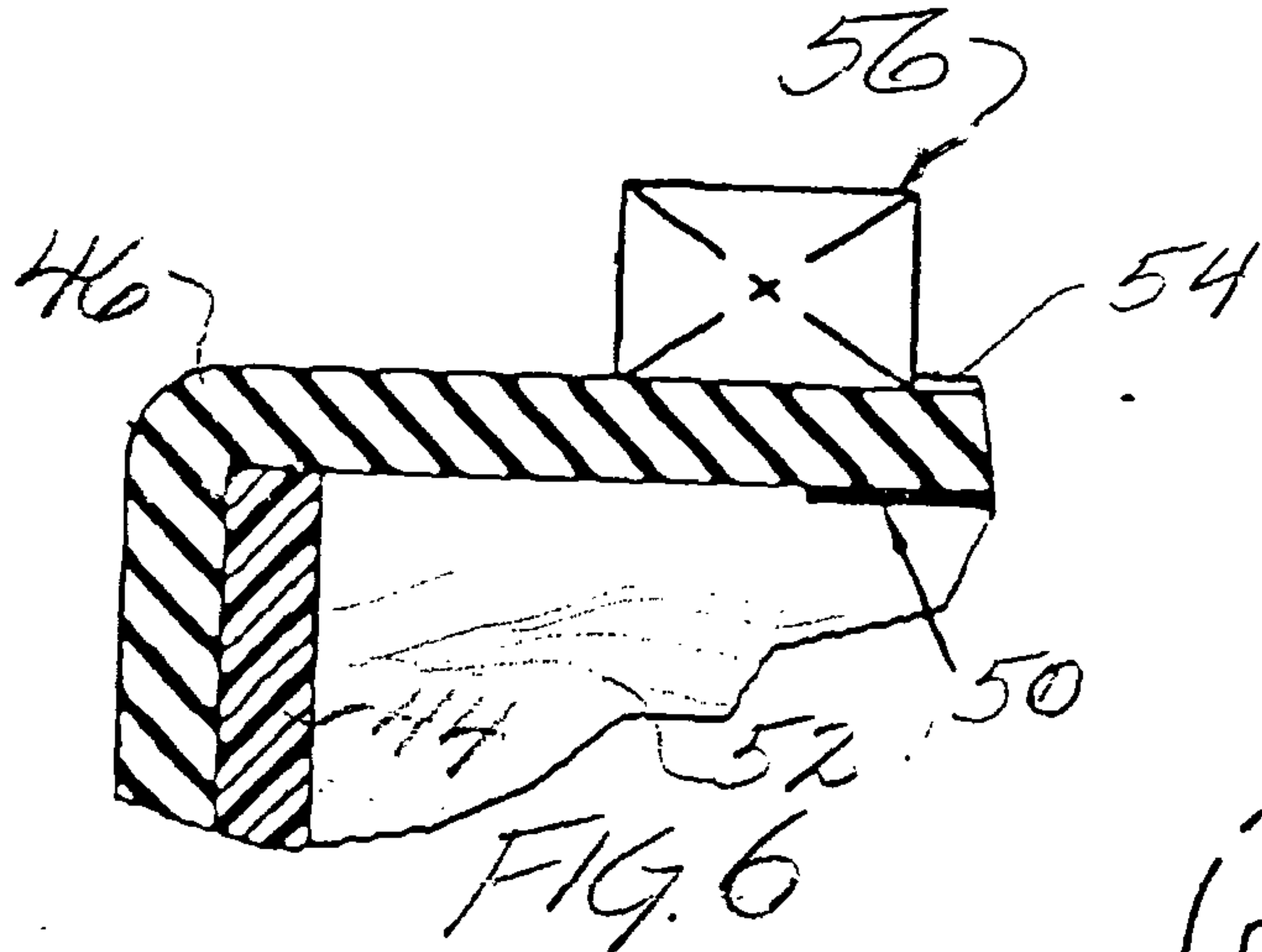
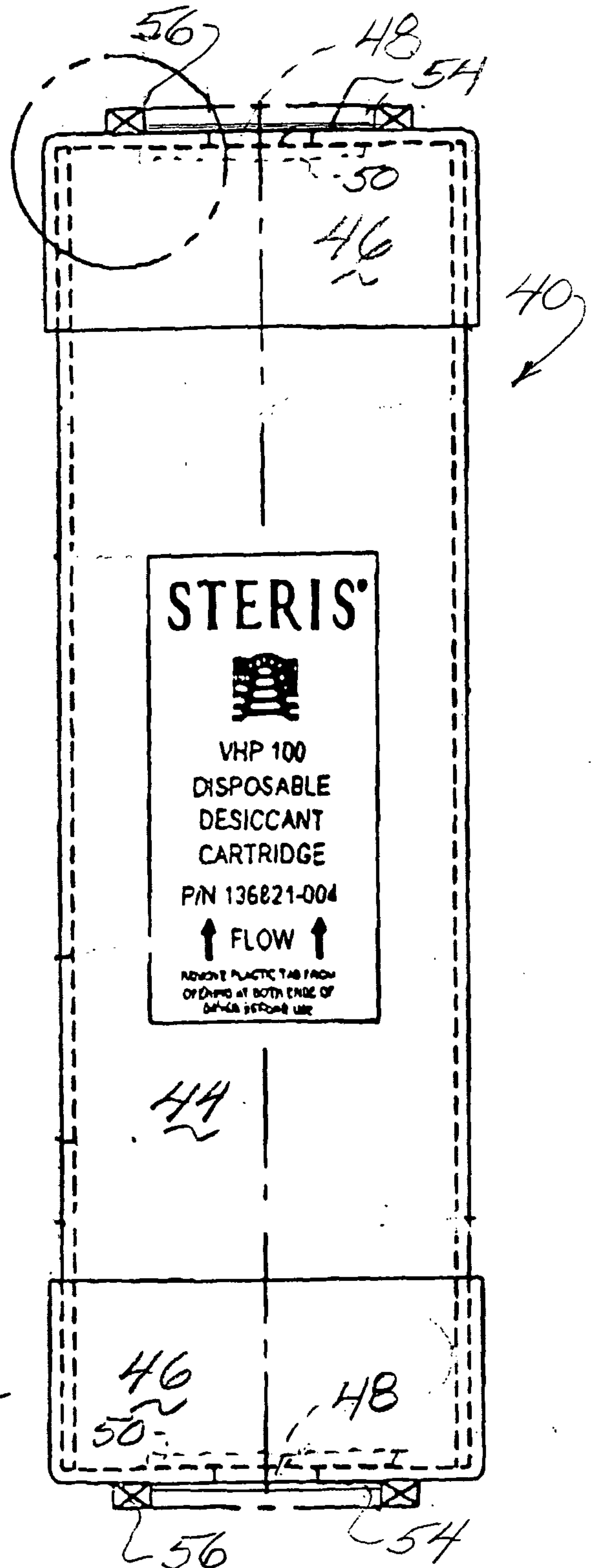
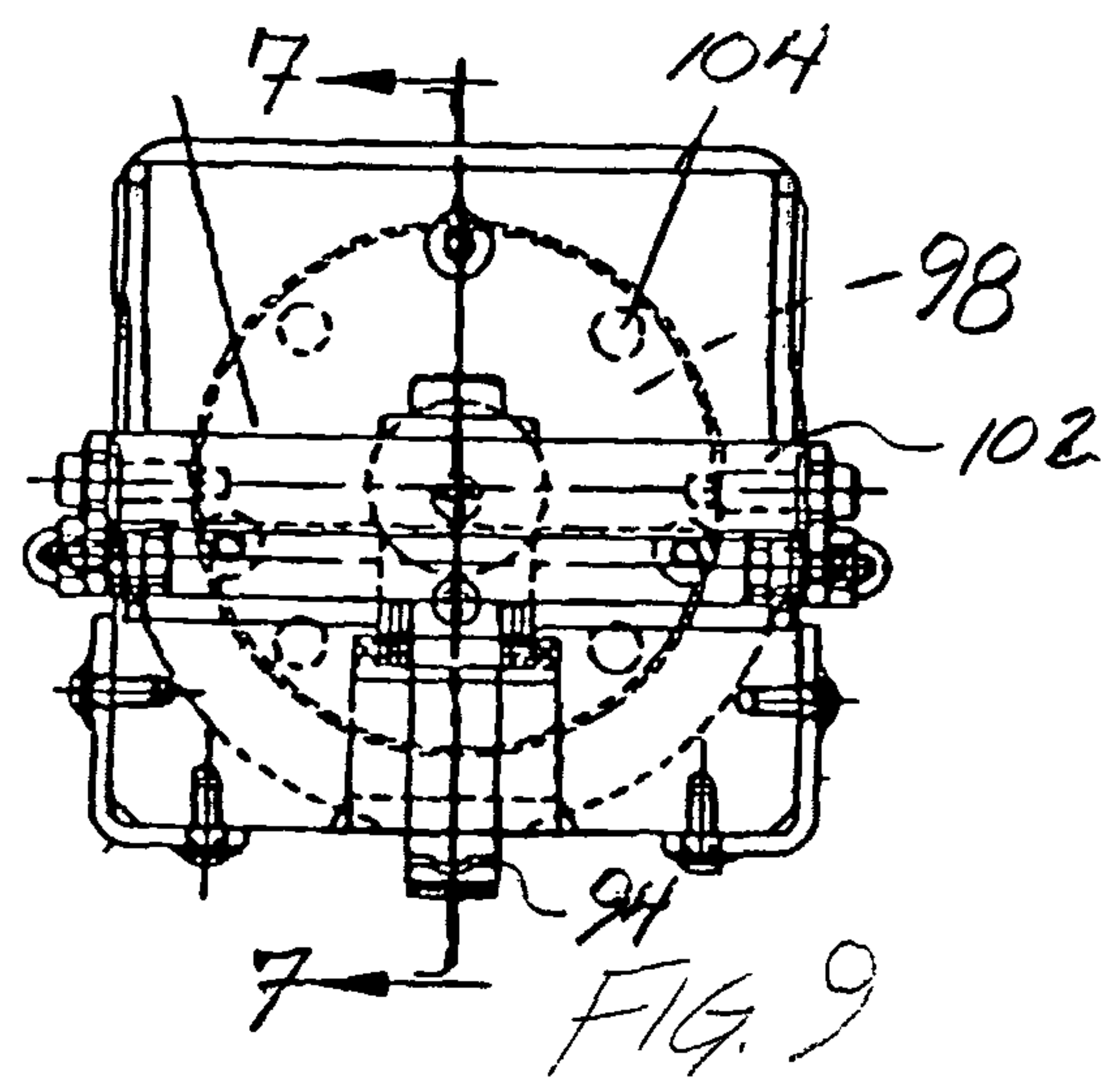
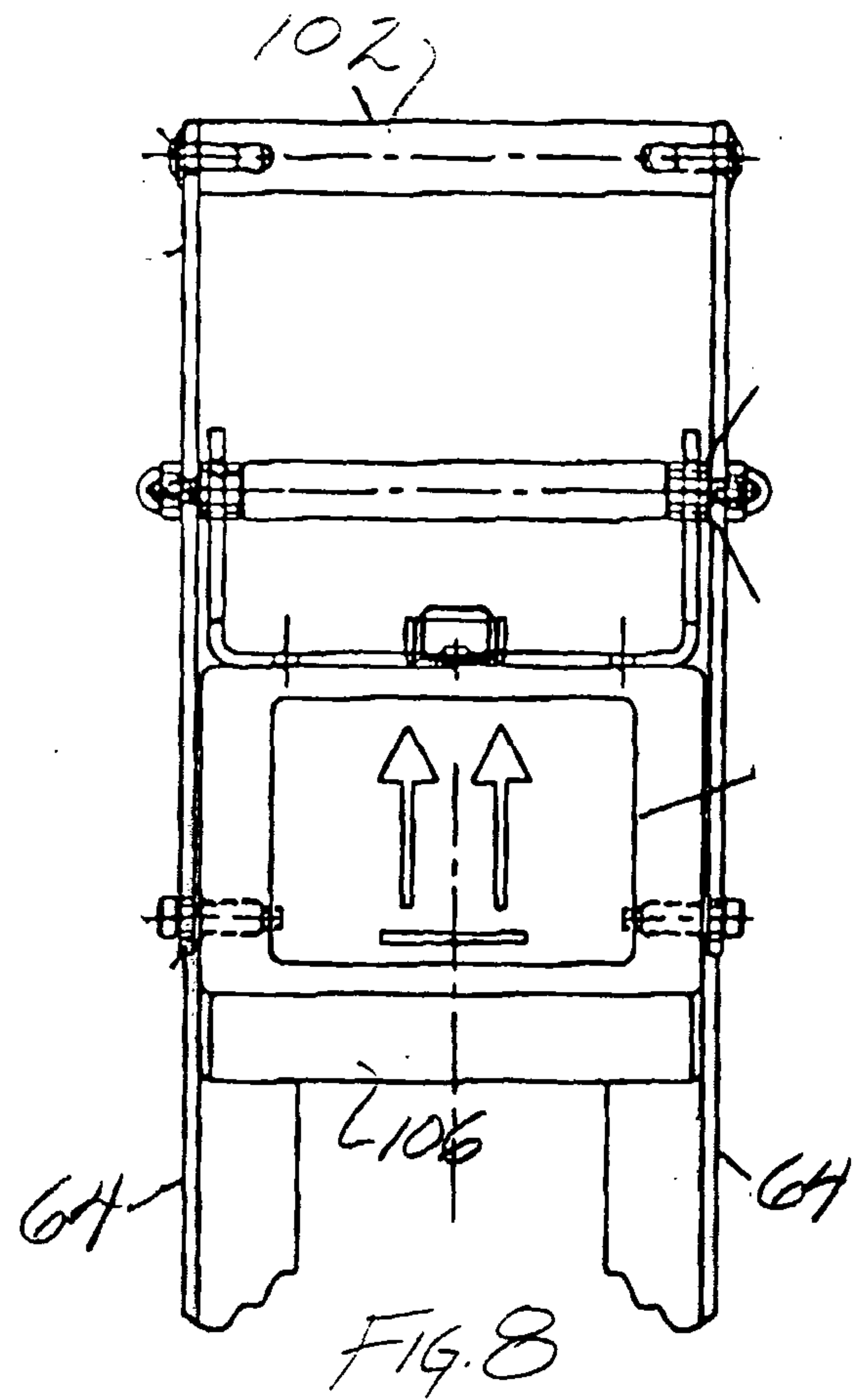
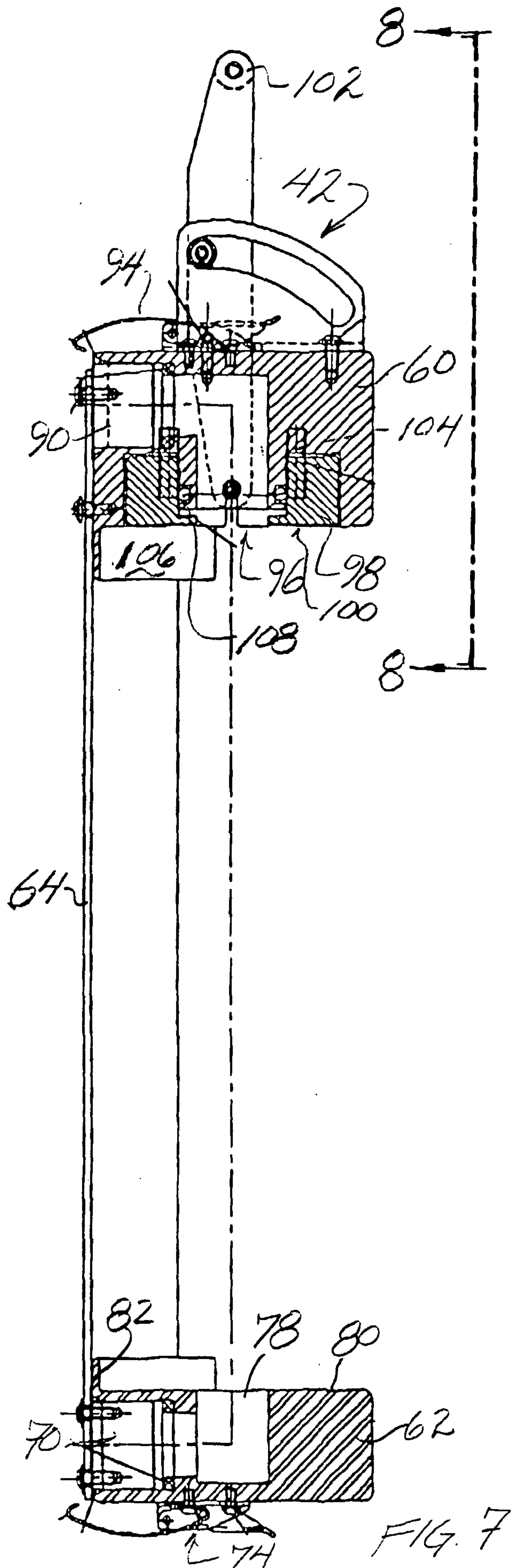


FIG. 5



4/6



5/6

