



**EUROPEAN PATENT APPLICATION**

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54 An apparatus for cleaning, rinsing and drying workpieces.

(57) The apparatus comprises: a reservoir (13) containing a vaporizable cleaning fluid, a processing vessel (2) having a sealed cover (3), a distillation column (20) for distillation of the cleaning fluid under a vacuum; a vacuum generating means (9) for providing a vacuum in the vessel (2) and the column (20), and connection means (40) for connecting the column (20) and the vessel (2). Application to apparatus operating in sequential cycles: cleaning, rinsing and drying without pollution e.g. escape of va-

pors in the environment. When low pressure has been attained into vessel (2), communication between vessel and column (20) is established via valves (41,32) and rapid transfer of vapor between (20) and (2) takes place, enhancing rinsing and drying of the parts. Opening the vent (42), atmospheric pressure is reestablished and vapors are transferred via vacuum pump (10) and conduit (12) to reservoir for recirculation.

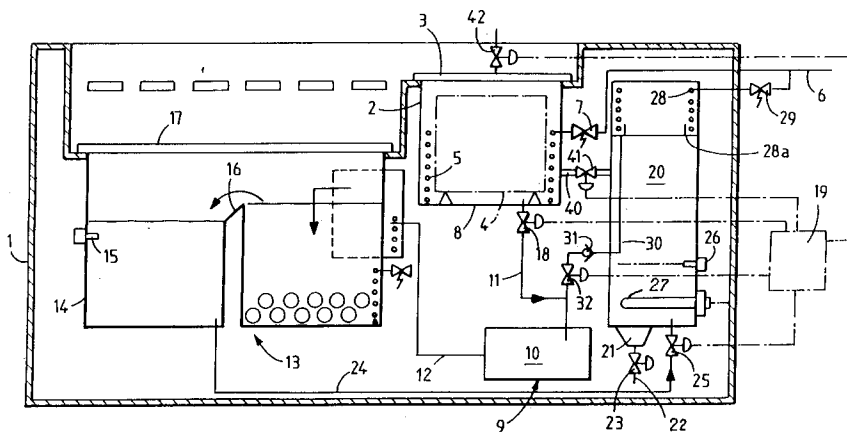


FIG. 1

The present invention relates to the industrial cleaning and in particular to apparatus adapted to clean workpieces and other industrial parts by successive dipping, spraying, and rinsing steps using a generally liquid cleaning fluid which may be inflammable or not.

More particularly, the invention relates to industrial apparatus for cleaning mechanical, electronic or optical parts and is directed more particularly but not exclusively to apparatus of a type operating in sequential cycles in contrast to apparatus of a continuous operation type.

In apparatus of the above type it has become known to dip the parts to be cleaned, by means of an appropriate basket, in a dipping vessel containing the cleaning liquid. Such a dipping operation may include a high pressure spraying step as well as a cleaning step by application of ultrasonic waves of for example about 40 KHz.

For performing such a method it has also become known to include a rinsing step and then a drying step to be performed in an enclosure adapted to retain any evaporations which may develop in order to minimize or eliminate any discharge thereof into the ambient air.

While such apparatus may be considered to achieve the desired object, they nevertheless require relatively long sequential phases, in particular for the rinsing and drying operation which results, among others, in substantial energy consumption for vaporizing the cleaning liquid and ensuring appropriate drying of the parts to be cleaned.

The present invention overcomes the above drawbacks by providing a unique apparatus for cleaning, rinsing, and drying, which apparatus includes a distillation column for distillation of the cleaning fluid under vacuum and a vessel connected to suction means and adapted to be connected to the column by connection means such that in the sealed volume which it delimits a vapour atmosphere under a relative vacuum may develop, which allows for rapid rinsing and drying without any pollution of the environment.

The proposal of the present invention is adapted to be used in existing machines or can be used to realize a new apparatus in the rinsing and drying vessel, which allows, if desired, to provide operations such as spraying and even dipping prior to the cleaning steps.

The invention and additional features of the invention are defined in the claims.

Various embodiments of the present invention will be explained in more detail with reference to the accompanying drawings wherein:

Fig. 1 is a schematic view of the first example of an apparatus in accordance with the invention;

Fig. 2 is a schematic view, corresponding to

Fig. 1, of a second embodiment;

Fig. 3 is a schematic view, corresponding to Fig. 1, of a third embodiment.

As shown in Fig. 1, the apparatus for cleaning, rinsing and drying of industrial parts such as workpieces comprises a housing 1 containing a processing vessel 2 having an upper portion provided with a cover 3 adapted to sealingly close vessel 2. The vessel 2 is adapted to receive the parts to be cleaned, which may be disposed therein either directly or by means of a basket 4 which may be inserted or removed in any appropriate manner, in particular by means of a manipulator (not shown).

The vessel 2 includes a cooling circuit 5 such as a coil or similar means adapted to be connected to a circuit 6 for supplying a cooling fluid via a valve 7. Furthermore the processing vessel 2 is connected, via its bottom 8, to a vacuum generating circuit 9 comprising a pump 10. The pump 10 has its suction side connected by a line 11 to the bottom 8 and has its pressure side connected by a line 12 to a reservoir 13 containing a vaporizable cleaning fluid. The reservoir 13 may be a storing receptacle or, if desired and as shown in Fig. 1, a preprocessing vessel wherein the basket 4 has been initially received in order to subject the parts which it carries to a dipping and rinsing operation with or without the application of ultrasonic energy. If desired, the reservoir 13 may be part of a more complex assembly comprising a vessel 14 for a preceding dipping and agitation operation, wherein a constant level control is obtained by a detector 15 and an overflow system 16 of overflow with respect to the reservoir 13 having a higher level provided for the rinsing step.

In such an assembly the vessels 13 and 14 are included in the housing 1 and are preferably closed by a cover 17 which may be separate or common to both vessels.

The equipments and accessories adapted in such a case to the vessels 13 and 14 may be considered to be of conventional design and to be not relevant with respect to the present invention.

The line 11 is preferably controlled by a selector valve 18 which may be controlled manually or automatically via a programmable control unit such as 19.

The apparatus of the present invention further comprises within the housing 1, a distillation column 20 having a bottom provided with connection means 21 connected to a discharge line 22 via a discharge valve 23. The bottom of the column 20 is connected to a supply line 24 controlled by an isolating valve 25 and originating from the reservoir 13 and/or 14.

The distillation column 20 is of a type having a constant filling level controlled by a level detector 26. The column 20 comprises heating means 27

adapted to raise the temperature of the cleaning fluid contained, in liquid state, in the lower portion of the column.

In a manner known per se the upper portion of the column 20 is provided with a condensor 28 and a condensate collector 28a. The condensor 28 may be connected to a cooling circuit such as 6a via a valve 29.

In accordance with the invention, the column 20 is connected to a vacuum generating circuit 9, either directly or via the condensate collector 28a. Preferably, this connection is obtained by a common circuit via a line 30 provided with a check valve 31 opposing any flow in the feeding direction of the suction pump 10 towards the column 20. Preferably, the line 30 is provided with a selector valve 32 disposed between the suction pump 10 and the check valve 31.

According to a further feature of the invention, the column 20 and the vessel 2 are connected by a connection circuit 40 which is controlled by an isolating valve 41 which may be controlled either manually or automatically by the control unit 19. The control unit 19, if desired, may also control sequential operation of valves 25 and 32 as well as that of an exhaust valve 42 mounted to the cover 3 of the vessel 2.

The operation of the above described apparatus is as follows:

Prior to inserting the basket 4 into the vessel 2 the valve 7 as well as the valves 41, 18 and 23 are closed while the valves 25 and 32 are open. In such a situation operation of the suction pump 10 generates a vacuum in column 20 wherein the resistance or other heating means 27 causes the liquid to boil. The resulting vapors are condensed in the upper portion of the column where a cold condensation zone is established by the condensor 28.

At this time the vessel 2 is opened to allow to insert the basket 4, whereafter the cover 3 is closed and the valve 42 is actuated to be closed in order to isolate the vessel 2 from the environment.

Under these conditions the valve 18 can now be opened, with the valve 32 being open or closed. Actuation of the suction pump 10 generates a vacuum in the internal volume of the vessel 2 until an absolute pressure of for example 0,1 bar will be obtained.

At this time the operation cycle may be initiated by opening the valve 41 controlling the connection circuit 40 so as to allow to feed the vaporized cleaning fluid in the column 20 into the vessel 2 which is closed and under vacuum. The vapor introduced into the vessel 2 provides for a rinsing of the parts contained in the basket 4 and for a rapid drying thereof.

According to an aspect of the invention it is possible to provide different absolute pressures between the operating pressure of the distillation column and the pressure existing prior to opening of the valve 18. Accordingly, it is possible to provide in the column 20 an absolute pressure of 0,1 bar and then to isolate this column when said pressure has been attained by closing the valve 32 and simultaneously opening the valve 18. The circuit 9 now provides for a vacuum in the vessel 2, for example so as to attain an absolute pressure of 0,01 bar. When this pressure has been attained, the valve 32 as well as the valve 41 are opened, which allows to provide for a rapid transfer of vapor between the column 20 and the vessel 2 enhancing rinsing and drying of the parts to be cleaned.

The actuation of the vacuum generating circuit 9, which has to recycle the vapors and the condensate of the cleaning fluid towards the reservoir 3, may now be modified by initiating the closure of the valve 41 and the opening of the valve 42 such as to reestablish the atmospheric pressure in the vessel 2 while ensuring the discharging of the vapors of the cleaning fluid through the circuit 9.

It then will be possible to remove the cover 3 in order to withdraw the basket 4, with or without providing a preceding cooling step by means of the condensor 5 supplied by the circuit 6 via the valve 7.

It is to be understood that the constant level in the distillation column 20 may be controlled by means of the detector 26 either by a permanent loading thereof or via actuation of a supply pump including the line 24.

Following an operation cycle as described above, the control unit 15 resets all the valves to their initial states allowing to perform another operation cycle as described above.

Fig. 2 shows a modification wherein the vessel 2 is arranged to perform additionally a spraying operation by spraying the parts before they are cleaned by dipping and agitation, with the application of ultrasonic energy if desired, in an assembly which is separate and annexed or which forms part of the machine of the present invention by being comprised for example of the vessel 14.

According to this modification the vessel 2 comprises at least one spray ramp 50 which is supplied from the outlet of a pump 51 drawing the cleaning fluid in liquid form from the reservoir 13 or even directly from the vessel 14. In this case, the bottom of the vessel 2 is provided with discharge circuit 52 controlled by a closure valve 53 and feeding the liquid directly into the reservoir 13.

Prior to rinsing by vapor under a vacuum atmosphere as described above, the apparatus according to Fig. 2 allows to provide for a spraying cycle permitting a liquid rinsing of the cleaned

parts.

A further modification is shown in Fig. 3 wherein the pump 51 is used to supply the ramp or ramps 50 by a first circuit 54 provided with a valve 55. The pump 51 may supply also a second circuit 56 extending to the bottom of the vessel 2 and controlled by a valve 57. In this manner by an appropriate control of the opening and closing sequencies of the valves 55 and 57 it may be ensured to charge the vessel 2 with the cleaning fluid in liquid form heated to an appropriate temperature externally or internally of the vessel 2.

Accordingly a first dipping step may be provided prior to the liquid rinsing step via the ramp or ramps 50 whereafter the final rinsing and drying operation is performed by opening the connection circuit 40 as described with reference to Fig. 1.

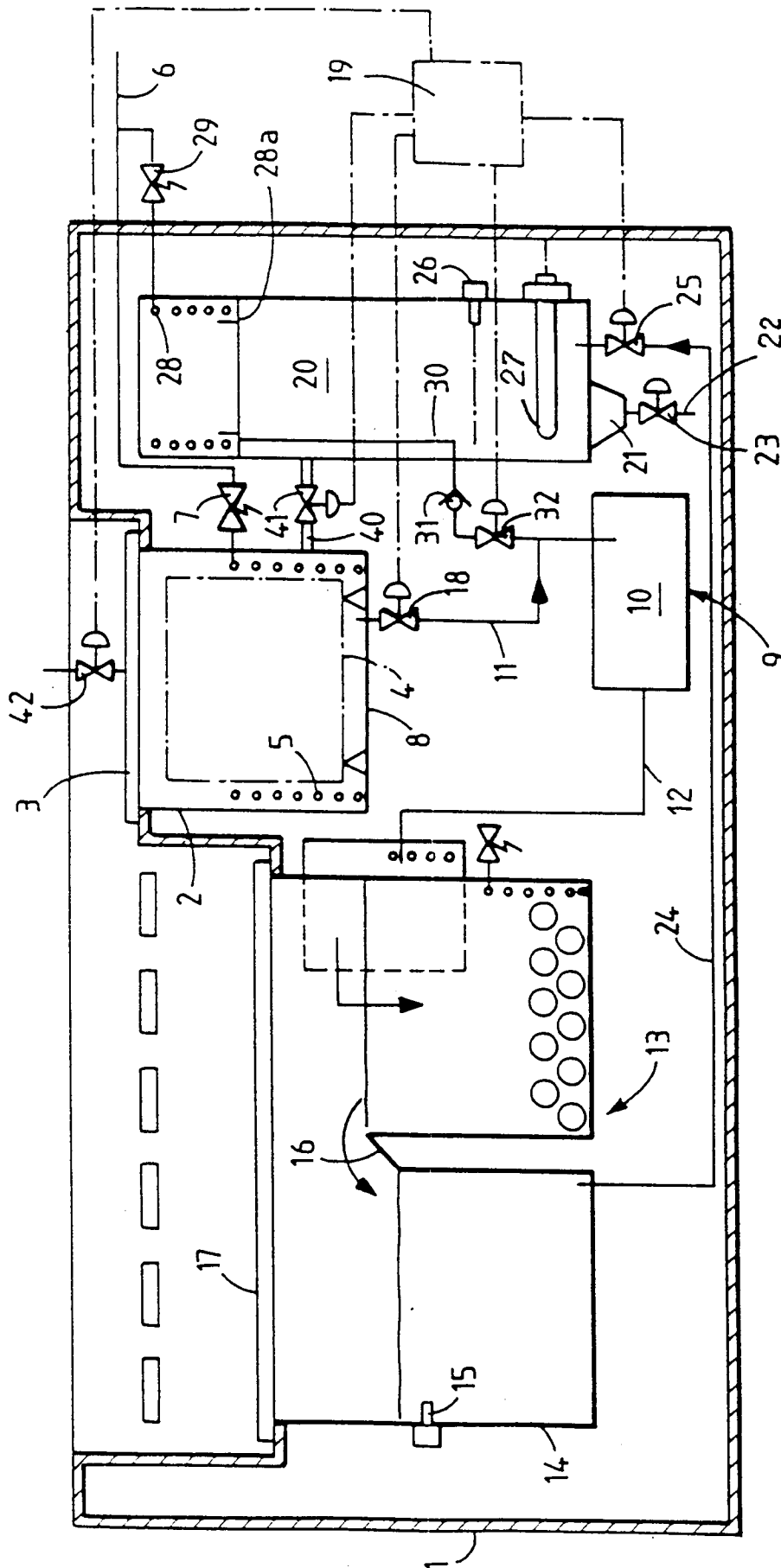
The valves 53,55 and 57 are also preferably controlled in a programmed automatic manner via the control unit 19.

In this embodiment, according to Fig. 3, it may be advantageous to provide the vessel 2 with a liquid level sensor 60 assisting the operation of the pump 51 in the phase of charging the vessel.

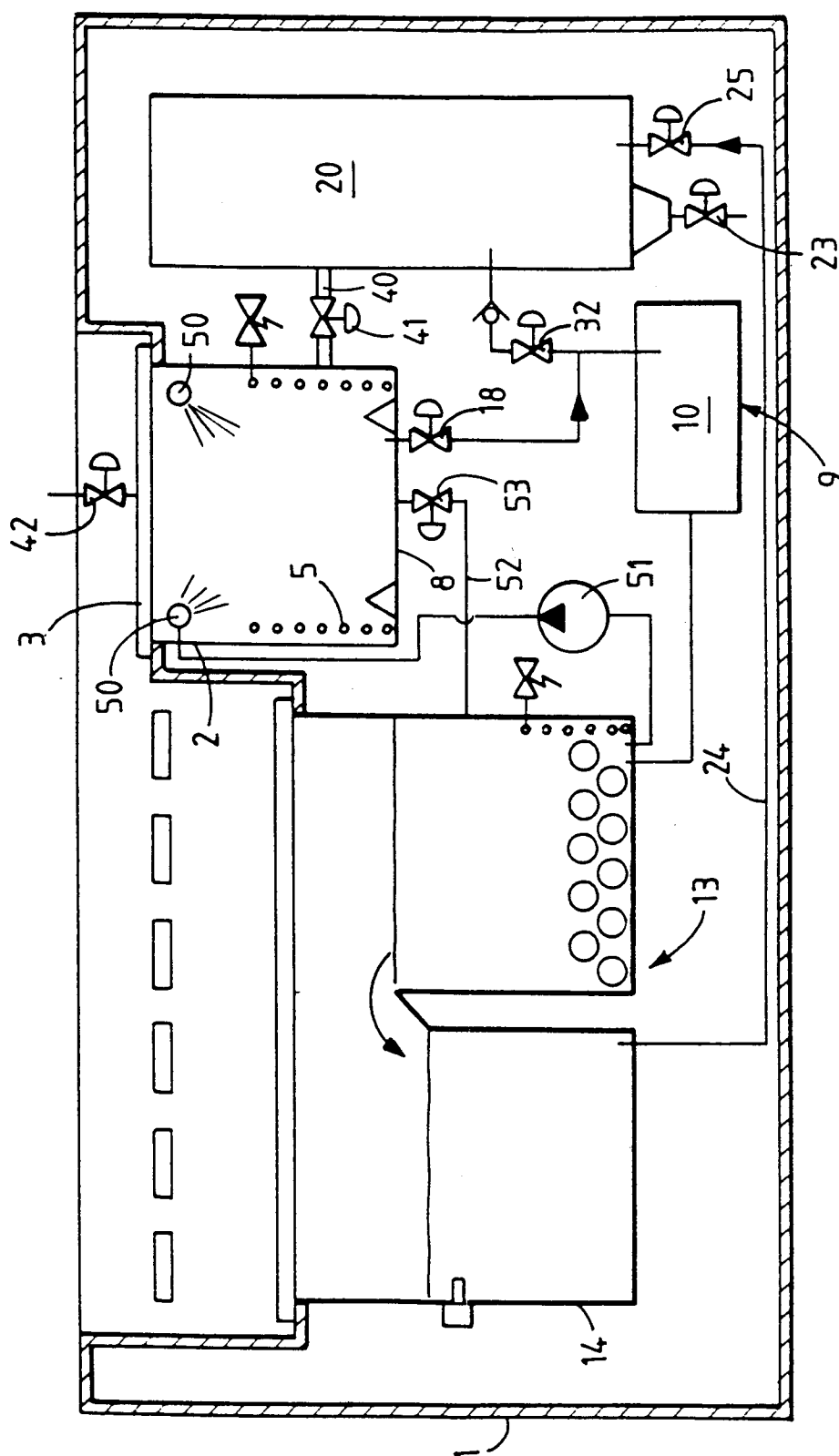
It is to be understood that the invention is not limited to the described and shown embodiments in that various modifications are possible within the scope of the claims.

## Claims

1. An apparatus for cleaning, rinsing and drying workpieces and other industrial parts, comprising:
  - a reservoir (13) containing a vaporizable cleaning fluid,
  - a processing vessel (2) having a sealed cover (3),
  - a distillation column (20) for distillation of the cleaning fluid under a vacuum;
  - a vacuum generating means (9) for providing a vacuum in the vessel (2) and the column (20), and
  - connection means (40) for connecting the column (20) and the vessel (2).
2. An apparatus in accordance with claim 1, wherein the cleaning fluid containing reservoir includes at least one dipping and spraying vessel (14) of a constant level type.
3. An apparatus in accordance with claim 1 or claim 2, wherein the vacuum generating means (9) is connected via a refeeding line to the reservoir (13) and the column (20) receives the fluid by a feeding line (24) extending from the reservoir.
4. An apparatus as set forth in claim 1 or claim 3, wherein the vacuum generating means (9) is common to the column and the vessel and includes a suction pump (10) having its suction side connected to the column and the vessel by a pair of branch lines (11,30) one of which at least includes a selector valve (18;32).
5. An apparatus as set forth in claim 1 or claim 3 or claim 4, wherein said connection means (40) and said feed line (24) each are provided with an isolating valve (41, 25).
6. An apparatus in accordance with claim 1, wherein said processing vessel (2) comprises:
  - internally at least one pressurized spray means (50) connected to the outlet of a pump (51) drawing the cleaning fluid from the reservoir (13) and
  - discharging means (52) provided with a closure valve (53) and connected to said reservoir (13).
7. An apparatus in accordance with claim 1 or claim 6, wherein said vessel (2) is connected to said pump by a pair of circuits (54,56) provided with selectively controllable control valves (55,57), one of which is connected to the spray means (50) and the other one of which is connected to the bottom (8) of the vessel which is provided with a level detector (60).
8. An apparatus in accordance with any of claims 4 to 7, wherein said selector (18,32), isolating (25,41), closure (42) and control valves are controlled as to their opening and closing sequencies by a programmable control unit (19) controlling the operation cycle of the apparatus.



**FIG. 1**



**FIG. 2**

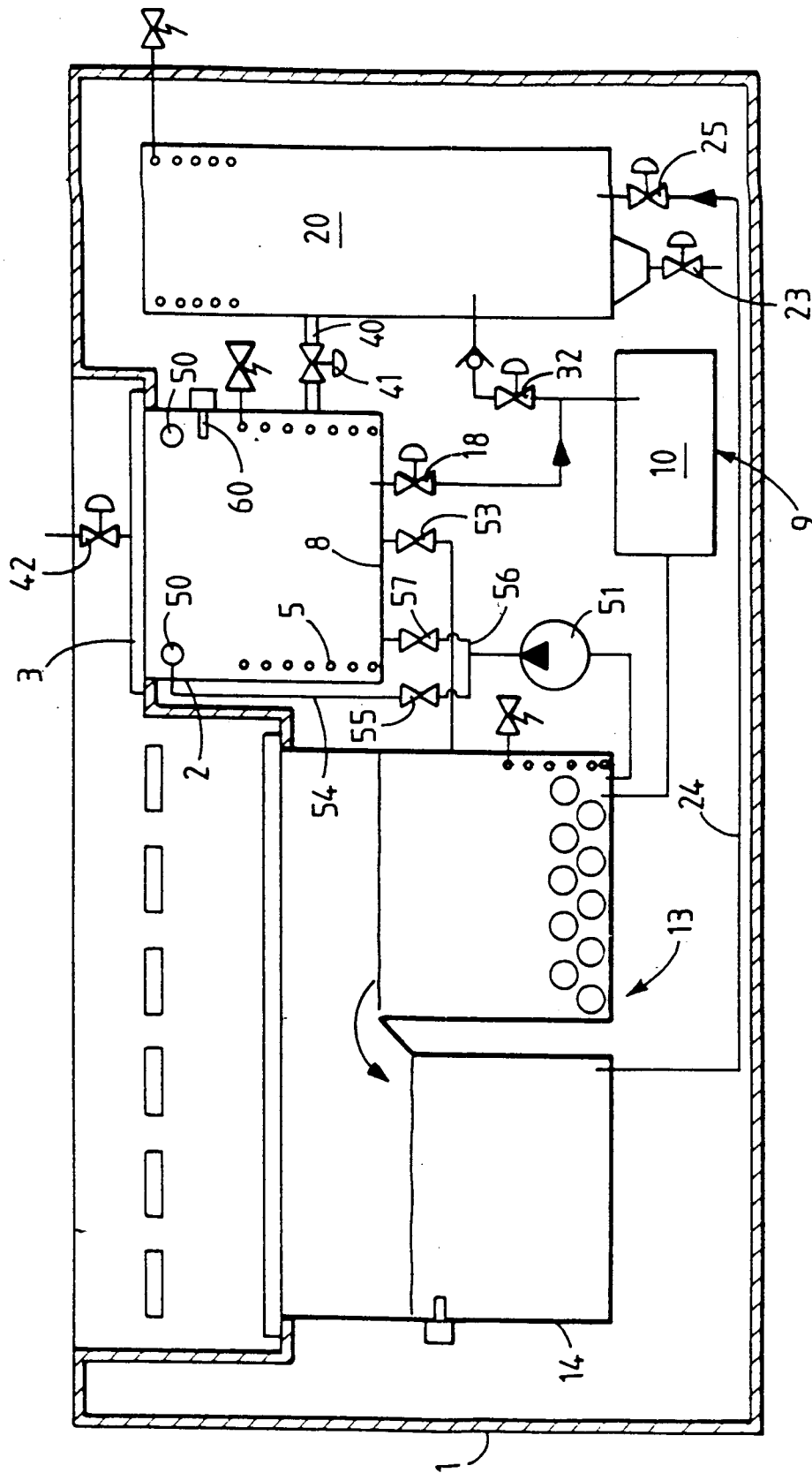


FIG. 3



European Patent  
Office

## EUROPEAN SEARCH REPORT

Application Number  
EP 94 11 2668

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	DE-U-90 13 241 (J. HÖCKH ET AL) * page 5, line 2 - page 9, line 4; claim 1 *	1-6,8	B08B3/08 C23G5/04
Y	& US-A-5 180 438 (J. HÖCKH ET AL) ---	7	
X	EP-A-0 221 028 (ECOLSIR S.R.L.) *the whole document; in particular: page 7, line 18 - page 8, line 13*	1,3	
Y		7	
A		2,4,5	
A	DE-A-38 23 322 (CARL DITTMANN GMBH & CO) * column 4, line 6 - column 56 * ---	1	
A	EP-A-0 496 899 (TOSHIBA K.K. ET AL) * page 13, line 14 - line 44 * * page 15, line 37 - page 16, line 37 * -----	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B08B C23G
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 23 November 1994	Examiner Lilimpakis, E
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ..... & : member of the same patent family, corresponding document			