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(54) Improvements in diffusion pumps

(57) A combination including a diffusion pump 1 and a reservoir 20 of high volumetric capacity positioned remotely from the pump. The reservoir 20 contains a working fluid and is connected to the diffusion pump 1 via a valve 28 and pipework.

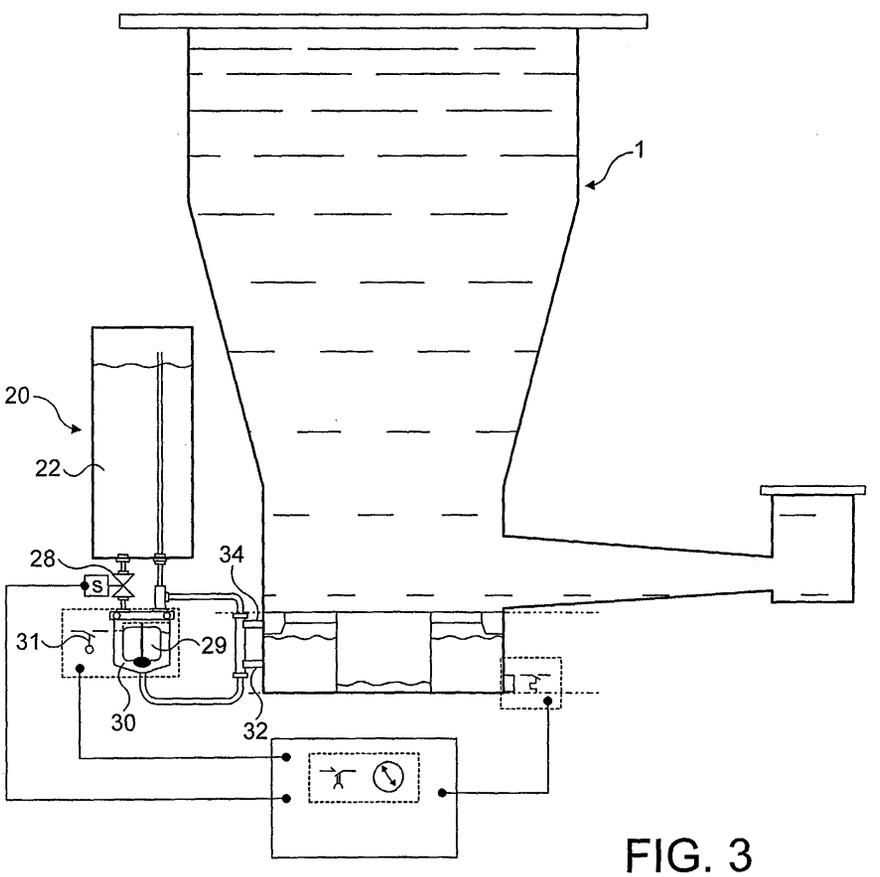

FIG. 3

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Description

[0001] The present invention relates to vacuum pumps of the type known as diffusion pumps.

[0002] Diffusion pumps are well known and widely used for the attainment of high and ultra high vacua. When used with modern working fluids and accessories, they can produce pressures approaching 10^{-10} mbar. The pumps are generally incapable of exhausting directly to the atmosphere and require the use of a backing pump, commonly an oil sealed rotary vane vacuum pump, in conjunction with the diffusion pump itself.

[0003] Diffusion pumps generally comprise a substantially cylindrical outer body which is cooled by, for example coils helically wound around the outside of the body through which cooling water can be circulated or alternatively by air cooled fins attached to the outside of the body.

[0004] Within the outer body is positioned a hollow "chimney" sitting at, or close to, the base of the outer body and which tapers (continuously or, more usually, in stages) upwardly from the base. The chimney is generally contained within the outer body and is positioned substantially concentrically therein.

[0005] Across the top of the chimney but not in contact therewith is a top cap having a generally circular portion of somewhat larger diameter than the top of the chimney and positioned symmetrically with regard to the chimney and having a downwardly projected annular side portion whose lower edge is somewhat beneath the upper edge of the chimney. The top cap is therefore substantially an inverted "cup shaped" component positioned about the top of the chimney with a circular or annular passageway therebetween. The top cap and the adjacent portion of the chimney defining the annular passageway is known as a "jet stage".

[0006] A heat source is provided in the base of the outer body, preferably in the form of an electric heater, and, prior to use of the pump, a working fluid is placed in the base of the body to a height above the lower edge of the chimney positioned within the body. The fluid is usually a low vapour pressure oil although some versions of diffusion pumps use mercury.

[0007] A pump inlet is positioned in the outer body above the top cap and an outlet in the side of the body towards the base of the chimney but above the oil level. The outlet is normally connected to a backing pump as previously described.

[0008] In use of pumps of this type, the backing (rotary) pump is turned on and left running continuously, a pressure of at least 0.1 mbar being required on the exhaust side of the diffusion pump. The cooling system (water or air) for the outer body is turned on and the oil can now be heated by the heater for, for example fifteen to twenty minutes, when it begins to boil. Hot vapour rises up the chimney and forms (aided by the taper) a relatively high oil pressure within the chimney. The vapour is then urged through the passageway between the chimney and the top cap, the jet stage, to an area of much lower pressure and creates an annular vapour jet. This jet is designed to move at a high velocity (sometimes supersonic) and impinges on the inside surface of the cooled outer body where the vapour condenses and condensed oil flows down the inside wall of the outer body and returns to the oil reservoir (boiler) at the base of the body.

[0009] With the diffusion pump turned on, gas molecules arriving at the inlet of the diffusion pump are likely to collide with the much heavier oil vapour molecules and be provided with a velocity component which will direct the gas molecules towards the outlet of the diffusion pump where they will be subsequently removed from the diffusion pump via the backing pump. A pressure difference is thereby established across the continuously flowing vapour jet.

[0010] Conventionally, as previously explained, the working fluid is held within the body of the diffusion pump and is consumed due to vapour losses. Provided that pump cooling is adequate the rate of these losses is determined by the mass flow through the pump. Generally, the working fluid needs replenishing from time to time.

[0011] It is an aim of the present invention to connect a reservoir of high volumetric capacity to the diffusion pump, the reservoir being positioned remotely from the pump body to minimise the thermal requirements of the pump that would result from having to keep a large volume of working fluid at boiling point continuously. With the reservoir connected to the pump, the pump can operate for longer periods at full throughput without oil maintenance, for example for a year or more.

[0012] According to the present invention, a novel combination comprises a diffusion pump, a reservoir containing a working fluid spaced from the diffusion pump and pipework means for allowing the flow of the working fluid from the reservoir towards the diffusion pump.

[0013] Preferably, the reservoir includes a tank for containing the working fluid, the tank being provided with a transparent window for viewing the level of the working fluid within the tank.

[0014] In one embodiment, a valve, for example a solenoid valve is provided which is movable between a first closed position to prevent the flow of working fluid out from the reservoir to a second open position.

[0015] The movement of the valve between said first and second positions may be controlled by a level monitoring sensor which includes a vertically mounted float and a reed switch and is connected to the diffusion pump via said pipework means.

[0016] An embodiment of the invention will now be described, by way of example, reference being made to the Figures of the accompanying diagrammatic drawings in which:

Figure 1 is a cross section through a known diffusion pump;

Figure 2 is a perspective view of a high capacity oil reservoir ready for connection to a diffusion pump according to the present invention; and

Figure 3 is a diagrammatic sketch showing the high capacity reservoir of Figure 2 operatively connected to a diffusion pump.

[0017] Referring first to Figure 1, a known diffusion pump 1 comprises a hollow outer body 2 of generally circular cross section, a major portion of which is provided with cooling coils 4 for the circulation of cooling fluid, for example water. The body 2 includes a base 6 and vapour chimney 8 is positioned within the outer body 2 and extends upwardly from the base 6. A working fluid 7 is located in the base of the chimney 8 and, as shown, an electric heater 10 is located immediately below the base 6.

[0018] As shown, the chimney is formed with a single jet stage 12.

[0019] The diffusion pump 1 also includes an outlet 14 for connection to a backing vacuum pump and an inlet 16 for connection to a chamber to be evaeuated. As shown, the jet stage 12 is located adjacent the inlet 16.

[0020] In use, when the inlet 16 is attached to the chamber to be evacuated, the backing pump is turned on to reduce the pressure within the diffusion pump 1 and a coolant is passed through the coils 4.

[0021] Heating of the working fluid 7 by means of the heater 10 causes boiled vapour to rise up the chimney 8 in the manner described earlier and to emerge through the jet stage 12 and thereafter to fall downwardly in the general direction of the base 6 along the inner surface of the outer body 2.

[0022] According to the present invention, the diffusion pump 1 is connected to a high capacity reservoir.

[0023] Referring now to Figures 2 and 3, the high capacity reservoir 20 comprises a tank 22 for working fluid connected to a support arm 24. As shown, at its upper end there is a transparent window in the form of a glass disc 26 for viewing the level of working fluid in the tank 22. At its lower end there is provided a normally closed valve 28 for example a solenoid valve. The actuation of the valve 28 is controlled by a level monitoring sensor, in this case a pot assembly 30 which contains a vertically mounted float 29 and a reed switch 31. The pot assembly 30 is connected to the working fluid fill and drain ports of the diffusion pump body 2 via connections 32, 34.

[0024] In use, when the float 29 drops to a predetermined level as a result of the working fluid level dropping within the diffusion pump body 2, the reed switch 31 is actuated and energises the solenoid valve 28. This allows working fluid to pass from the tank 22, through the solenoid valve 28 and the pot assembly 30 towards the diffusion pump 1 via connections 32, 34.

[0025] To avoid the reed switch 31 fluttering about its switching point, as its hysteresis is limited and the working fluid level oscillates slightly, there is an electronic timer circuit that delays re-closure of the solenoid valve 28. This ensures that an adequate volume of working fluid is fed into the body 2 with minimum valve actuations.

[0026] The tank 22 is sealed under vacuum so that the fresh working fluid entering the diffusion pump is fully degassed before entering the body 2.

[0027] In the design of this system generally, the monitoring pot assembly 30 senses the fluid level when the pump 1 is fully operational. When the pump is operational a head of fluid is maintained on the outside of the pump as a consequence of the pressure difference across the boiler stage. This tends to cause an increase in the height of the fluid level outside the jet stage 12. This pressure difference is the driving force that generates the vapour jets. This head takes a certain period of time to become established when the pump is started from cold. In the warm up condition the fluid level can be low and could cause emptying of the tank 22. However, this has been overcome by the inclusion of a thermal snap switch that causes the monitoring circuit to lag until the operational temperature of the pump base 6 has been reached.

Claims

1. In combination, a diffusion pump (1), a reservoir (20) containing a working fluid spaced from the diffusion pump and pipework means (32, 34) for allowing the flow of the working fluid from the reservoir towards the diffusion pump.

2. The combination as claimed in Claim 1, in which the reservoir (20) includes a tank (22) for containing the working fluid, the tank (22) being provided with a transparent window (26) for viewing the level of the working fluid within the tank.

3. The combination as claimed in Claim 2, in which a valve (28) is provided, said valve (28) being movable between a first closed position preventing the flow of the working fluid out from the tank (22) to a second open position which allows working fluid to flow out from the tank (22) towards the diffusion pump.

4. The combination as claimed in Claim 3, in which movement of the valve (28) between said first and said second position is controlled by a level monitoring sensor (30).

5. The combination as claimed in Claim 3 or Claim 4, in which the valve (28) is a solenoid valve and the level monitoring sensor (30) includes a vertically mounted float (29) and a reed switch (31), the level monitoring sensor being connected via said pipe-

work means to ports on the diffusion pump (1).

6. The combination as claimed in Claim 5 in which an electronic timer circuit is provided to delay movement of the valve (28) from its second open position to its first closed position.

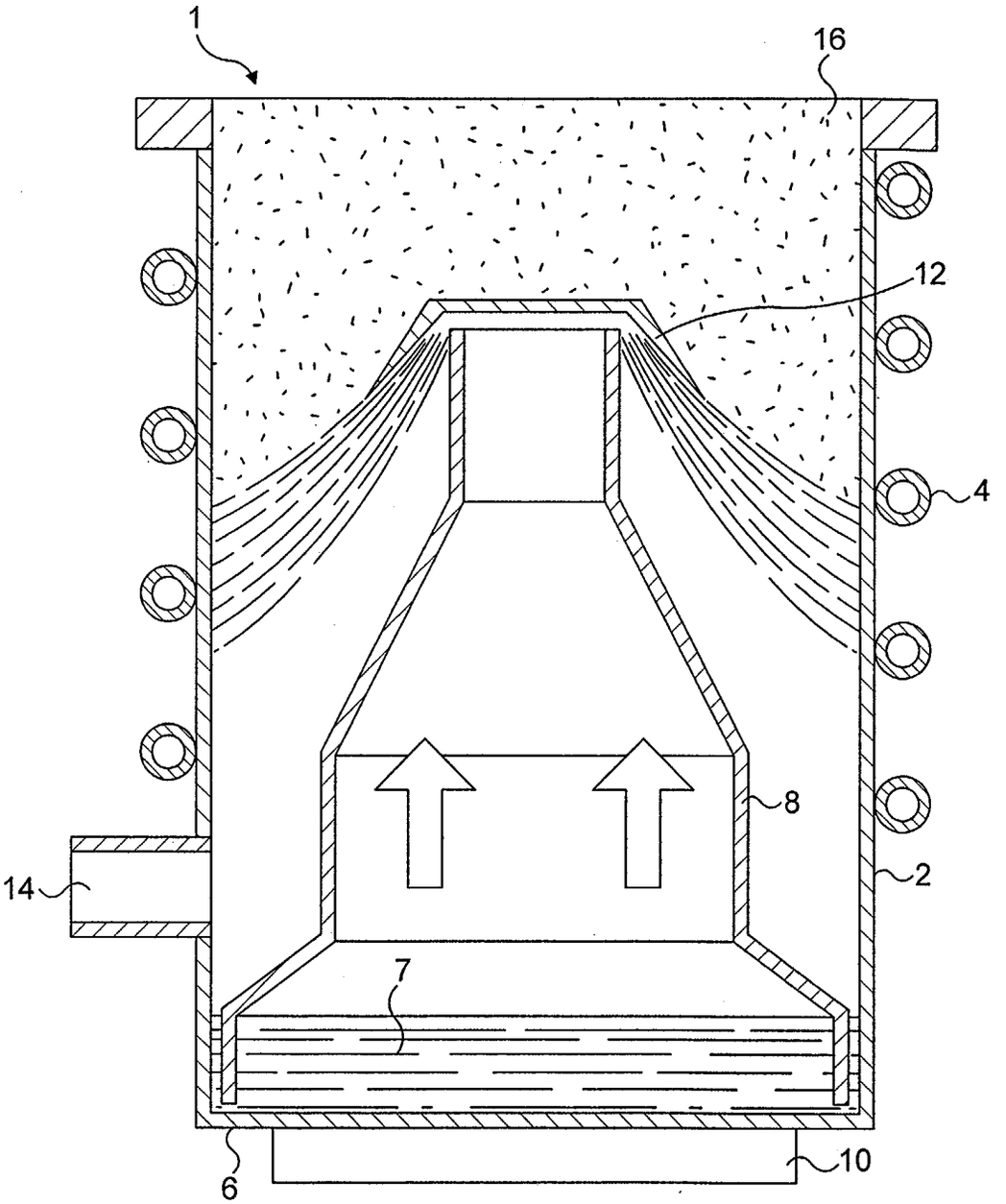

FIG. 1

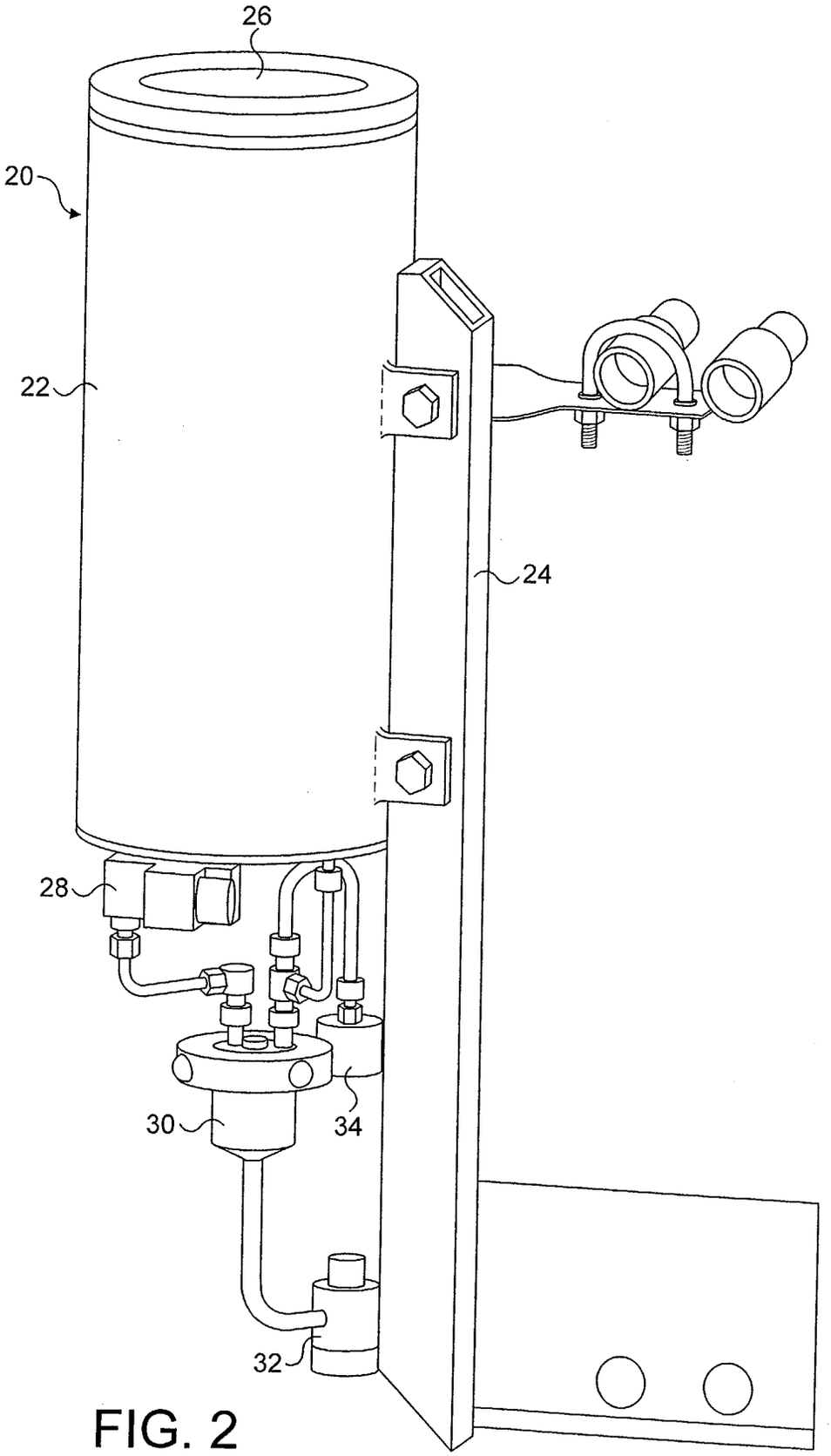

FIG. 2

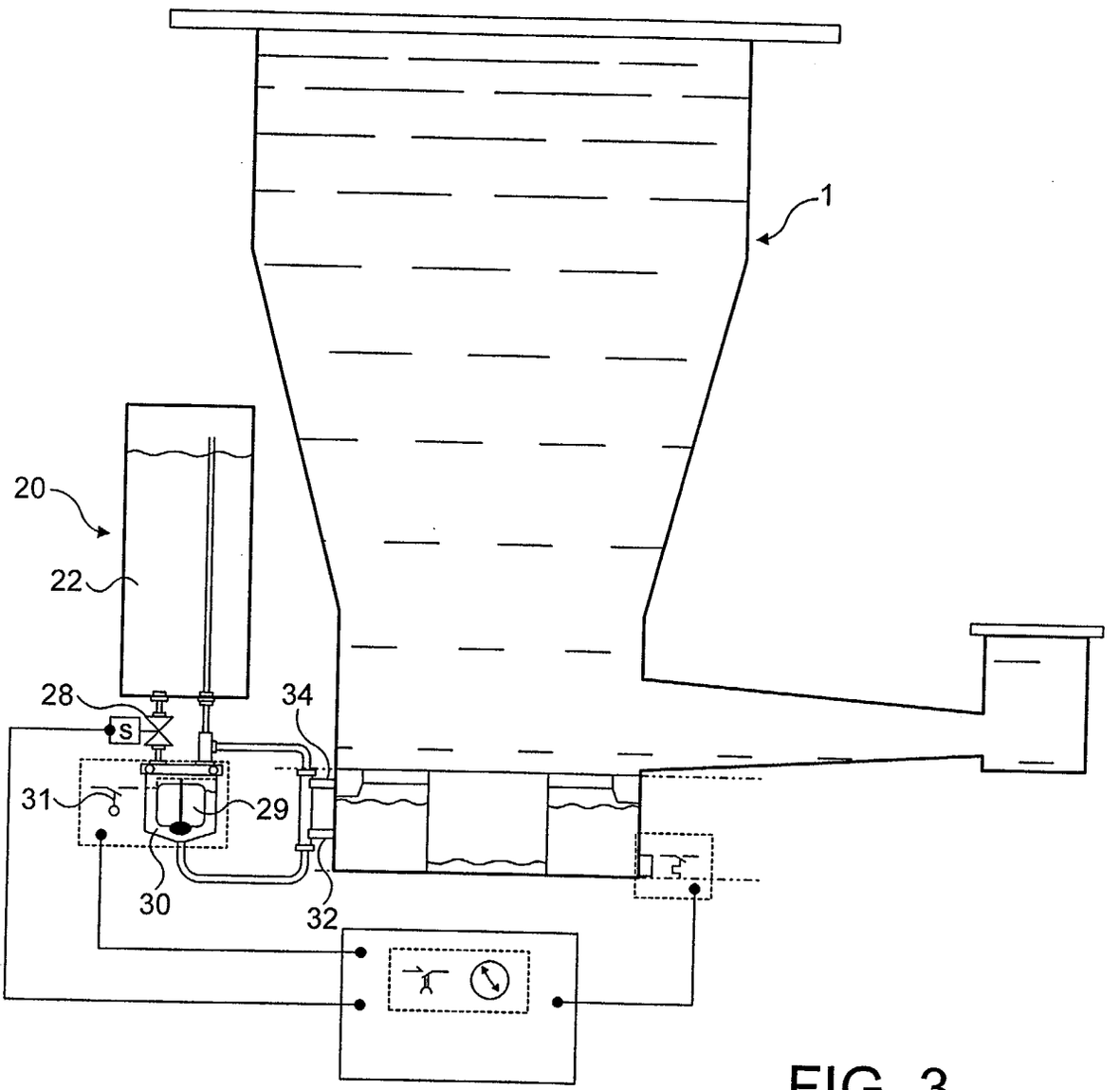

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number
EP 03 25 0705

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
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Y	* page 1, column 2, line 48 - page 1, column 2, line 57 * * page 2, column 2, line 94 - page 2, column 2, line 108 * ---	5	
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Y	* page 1, column 2, line 84 - page 2, column 2, line 112; figures * ---	5	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	29 April 2003	Pinna, S

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82