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(54) Air-conditioning plant for building where a closed-cycle industrial washing machine is installed.

(57) Air-conditioning plant for buildings where a closed-cycle industrial washing machine is installed, which comprises a rotating drum (1) and a drying air circulation circuit (2) with a condenser (3) of the solvent entrained by the drying air coming out from said rotating drum, and a heater (4) of the drying air before putting it back into said drum. A refrigeration group (5) with a circulation circuit of a heat transfer fluid through the drying air heater and the solvent condenser is provided. The air-conditioning plant comprises at least one air-conditioning/fan unit (12) and the refrigeration group of the washing machine also serves the air-conditioning unit (12).

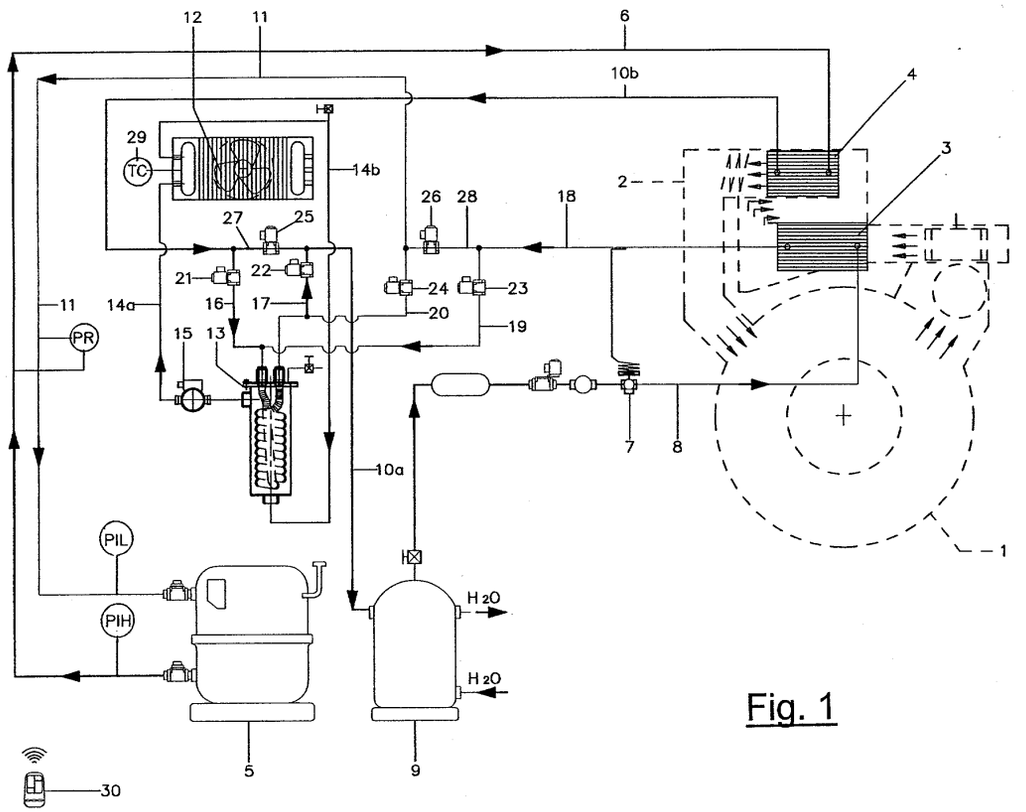

Fig. 1

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Description

[0001] The present invention relates generally to the field of air-conditioning and in particular refers to an air-conditioning plant for buildings in which a closed-cycle industrial washing machine is installed.

[0002] Closed-cycle industrial washing machines are well-known. They are used in various fields starting from that of dry-cleaning of clothing and linen, to the washing of metals, of soles of shoes and of pieces being worked or worked pieces in general. In their most general configuration these machines comprise a washing unit consisting, for example, of a rotating drum, a unit for solvent recovery and preheating the air circulating in closed-cycle in the drum and a refrigeration group that provides both the calories for heating the air and the frigories for condensing the solvent carried by the air coming out from the washing unit.

[0003] Conventional air conditioners are normally made up of a conditioning/fan unit inside the building, operated by a thermostat and possibly by a remote control, a refrigeration group arranged outside of the building to be conditioned, as well as the hydraulic and electrical connections between the two units.

[0004] The installation of the air-conditioning plant very often involves problems connected to the necessary authorisation for assembly of the refrigeration group on external walls and/or connected to making holes through said walls for the passage of the electrical and hydraulic connections. In some cases, when, for example, the air-conditioning plant must be installed in buildings located in historical centres or in buildings of historical interest, obtaining such authorisation can be really complex and expensive.

[0005] Another problem frequently encountered in the installation of air-conditioning plants is the need for extra electrical power installed for the refrigeration group.

[0006] The object of the present invention is to provide an air-conditioning plant for buildings where a closed-cycle industrial washing machine is installed that allows the aforementioned problems to be avoided.

[0007] This object is accomplished with the air-conditioning plant according to the present invention the main characteristic of which consists of the fact that its operation exploits the refrigeration group of the industrial washing machine.

[0008] According to a characteristic of the invention, indeed, the heat transfer fluid of the refrigeration group of the washing machine is also made to flow in the air-conditioning plant, directly into the air-conditioning unit or indirectly through heat exchange means.

[0009] The characteristics as well as the advantages of the air-conditioning plant for buildings where a closed-cycle industrial washing machine is installed according to the present invention shall become clearer from the following description of embodiments thereof, given as an example and not for limiting purposes, with reference to the attached drawings in which:

- figure 1 shows the scheme of a first embodiment of the air-conditioning plant according to the present invention;
- figure 2 shows the scheme of a second embodiment of the air-conditioning plant according to the present invention;
- figure 3 shows the scheme of a third embodiment of the air-conditioning plant according to the present invention;
- figure 4 shows a fourth embodiment of the air-conditioning plant according to the present invention.

[0010] With reference to figure 1, there has been schematically indicated at 1 a drum of a dry cleaning machine and and at 2 a closed circuit for the recirculation of drying air comprising a condenser of the solvent 3, arranged on the air stream coming out from the drum 1 and a heater of the air 4 or heat pump arranged downstream of the condenser 3 to heat the drying air before it is injected back into the drum 1.

[0011] The drying air heater 4 is a heat exchanger that uses as heat transfer fluid a hot compressed gas (for example freon) fed through a delivery duct 6. The solvent condenser 3 uses as refrigeration fluid the same gas cooled and expanded through an expansion valve 7 arranged on a cold gas feeding duct 8 coming out from a water condenser 9 fed with the heat transfer fluid coming out from the air heater 4 through a duct 10a.

[0012] The heat transfer fluid coming out from the solvent condenser 3 is recirculated to the compressor 5 through an intake duct 11.

[0013] An air-conditioning/fan unit, indicated at 12, is provided with a heat exchanger 13 through which a heat exchange fluid that feeds the air-conditioning/fan unit 12 passes. The circulation of the heat exchange fluid takes place in a closed circuit 14a, 14b by the action of a pump 15 arranged at the outlet of the exchanger 13.

[0014] The air-conditioning/fan unit 12 can act both as a heating unit and as a refrigeration unit of the building in which it is installed. To this end a hot fluid or a cold fluid, respectively, can be made to circulate in the heat exchanger 13. The compressed gas coming out from the water heater fed to the heat exchanger 13 through the ducts 10b and 16 is used as heating fluid. The cooled gas coming out from the heat exchanger 13 is sent to the water condenser 9 through the ducts 17 and 10a. As an alternative to the water condenser 9 an air exchanger with a fan can be used. The expanded gas coming out from the solvent condenser 3 and fed to the exchanger 13 through the ducts 18 and 19 is used as cooling fluid. The gas coming out from the exchanger 13 is conveyed to the intake duct 11 through the duct 20.

[0015] Interception means, for example a group of electrovalves arranged on inlet and outlet ducts of the heat exchanger on the heating/cooling fluid side, allow the feeding of said fluid to the exchanger 13 to be controlled so as to make it operate as a heater or a cooler according to requirements. In particular, electrovalves

21 and 22 are provided on inlet 16 and outlet 17 ducts of the compressed gas from the exchanger 13 and electrovalves 23 and 24 on the inlet 19 and outlet 20 duct of the expanded gas from the exchanger 13. Electrovalves 25 and 26 are also provided on bypass ducts 27 and 28 of the exchanger 13 on the side of the compressed gas and on the side of the expanded gas, respectively.

[0016] Wishing to make the air-conditioning/fan unit 12 work as a heating unit, the electrovalves 21, 22 and 26 shall be in open condition whereas the electrovalves 23, 24 and 25 shall be in closed position. Wishing to make the air-conditioning/fan unit 12 work to cool down the building, the electrovalves 23, 24 and 25 shall be in open position, whereas the electrovalves 21, 22 and 26 shall be in closed position. Finally, wishing to make the air-conditioning/fan unit 12 work just to fan the building, the electrovalves 25 and 26 shall be in open position, whereas the valves 21, 22 and 23, 24 shall remain closed, actually shutting off the exchanger 13.

[0017] The air-conditioning/fan unit 12 shall be equipped with a thermostat 29 and can be controlled remotely through a remote control 30.

[0018] The embodiment of the air-conditioning plant illustrated in figure 2, in which identical components are given the same reference numeral, id provided with two distinct heat exchangers, indicated with 13a and with 13b, associated with the air-conditioning/fan unit 12 and respectively acting as a heater 13a and as a cooler 13b of the heat exchange fluid circulating on the air-conditioning/fan unit 12 through the circuit 14a, 14b and the pump 15.

[0019] The exchanger 13a, acting as a heater, is fed with the compressed gas coming from the drying air heater 4 through the duct 10b, the outlet gas being conveyed to the water condenser 9 through the duct 10a. The exchanger 13b, acting as a cooler, is fed with the expanded gas coming out from the solvent condenser 3 through the duct 18 and conveyed in the intake of the compressor 5 through the duct 11. The two exchangers 13a and 13b are arranged in parallel for their alternative operation and on their respective inlet ducts 16 and 19 and outlet ducts 17 and 20 respective interception electrovalves 21, 23 and 22, 24 are provided. Wishing to make the air-conditioning/fan unit 12 work as a heating unit of the building, the electrovalves 21 and 22 shall be in open condition, whereas the electrovalves 23 and 24 shall be in closed condition. The opposite occurs when the air-conditioning/fan unit 12 is used for cooling the building. On the other hand, in the case of use for just fanning the building the electrovalves 21, 22 and 23, 24 shall all be in closed condition.

[0020] In the embodiment of figure 3, in which identical components are indicated with the same reference numeral, for example, a single heat exchanger 13 is provided working as a cooler of the heat exchange fluid of the air-conditioning/fan unit circulating in the circuit 14a, 14b. In this case, the current of compressed gas coming out from the water condenser 9 is divided into two fractions, one of which is sent to the solvent condenser 3 through the expansion valve 7 installed on the duct 8, and the other one to the exchanger 13 through a further dedicated expansion valve 31 mounted on a feeding duct 32 of the exchanger 13. The expanded gas coming out from the exchanger 13 is conveyed through the duct 33 into the intake duct 11 to the compressor 5 together with the expanded gas coming from the solvent condenser 3 through the duct 18.

[0021] In this case the operation of the refrigeration circuit branch of the heat exchanger 13 works separately from the rest of the refrigeration group, with an optimal yield of the two branches.

[0022] Clearly, moreover, with a suitable by-pass system of the same type as that used for the embodiment illustrated in figure 1, it is also possible to prepare the plant for the heating operating mode.

[0023] In the embodiment of the air-conditioning plant according to figure 4, in which the same reference numerals have been given to identical components, the air-conditioning/refrigeration unit 12 is crossed directly by the heat transfer fluid of the refrigeration plant of the washing machine without intermediate heat exchange fluid.

[0024] In this case, wishing to make the air-conditioning/fan unit 12 work as a heating unit of the building, it shall be fed with the compressed gas coming out from the drying air heater 4 through the ducts 10b, 16 and 34a and the heat transfer fluid coming out through the duct 34b is conveyed to the water condenser 9 through the ducts 17 and 10a. Wishing to make the air-conditioning/fan unit 12 work to cool the building it shall be fed with the expanded gas coming from the solvent condenser 3 through the ducts 18, 19 and 34b and the gas coming out from the unit 12 through the duct 34b shall be conveyed to the compressor 5 through the duct 20 and the intake duct 11. A system of interception valves is provided in an analogous way to the embodiment illustrated in figure 1 to control the flow of the heat transfer fluid entering and leaving the air-conditioning/fan unit 12 in the two operating modes outlined above. The management of the actuation of the electrovalves in the two operating conditions, as well as for the function of just fanning, shall not be described in detail as being obvious on the basis of that which has been described previously.

[0025] It should be noted that in the embodiments of the air-conditioning plant according to the invention, it has always been foreseen that the plant can act both for heating and for cooling a building, but it is clear that, as shown in the embodiment according to figure 3, it can be equipped to carry out just one of these functions by respectively removing the components not required.

[0026] Variations and/or modifications may be brought to the air-conditioning plant for buildings where a closed-cycle industrial washing machine is installed, according to the present invention, without departing from the scope of the invention as set forth in the at-

tached claims.

Claims

1. Air-conditioning plant for buildings where a closed-cycle industrial washing machine is installed, the machine comprising a rotating drum and a circulation circuit of drying air with a condenser of the solvent entrained by the drying air coming out from said rotating drum, and a heater of the drying air before putting it back into said drum, a refrigeration group with a circulation circuit of a heat transfer fluid through said drying air heater and said solvent condenser, said air-conditioning plant comprising at least one air-conditioning/fan unit and being **characterised in that** the refrigeration group of said washing machine also serves said air-conditioning unit.

2. Air-conditioning plant according to claim 1, wherein said heat transfer fluid acts as a heat exchange fluid also for said air-conditioning/fan unit, acting as a heating fluid and/or as a cooling fluid.

3. Air-conditioning plant according to claim 1 or 2, wherein said air-conditioning/fan unit is provided with heat exchange means and a heat exchange fluid circulates between said unit and said heat exchange means, which are suitable for being fed with said heat transfer fluid coming out from said air heater, in such a case working as heating means, or else with the heat transfer fluid coming out from said solvent condenser, in such a case working as cooling means.

4. Air-conditioning plant according to claim 3, wherein said heat exchange means comprise two heat exchangers arranged in parallel and operatable alternatively as heating means and as cooling means, respectively, of said heat exchange fluid circulating in said air-conditioning/fan unit, the heat exchanger operating as a heating means being fed by the heat transfer fluid coming out from said drying air heater, the heat exchanger operating as a cooling means being fed by said heat transfer fluid coming out from said solvent condenser.

5. Air-conditioning plant according to claim 3, wherein said heat exchange means comprise a heat exchanger fed alternatively by said heat transfer fluid coming out from said drying air heater, or by said heat transfer fluid coming out from said solvent condenser.

6. Air-conditioning plant according to claim 1 or 2, wherein said heat transfer fluid coming out from said drying air heater or, alternatively, said heat transfer fluid coming out from said solvent condenser directly circulates in said air-conditioning/fan unit.

7. Air-conditioning plant according to claim 1, wherein said air-conditioning/fan unit is provided with heat exchange means and a heat exchange fluid circulates between said unit and said heat exchange means, which are suitable for being fed with a fraction of said heat transfer fluid expanded in a dedicated expansion valve, whereby said heat exchange means work only as cooling means of said heat exchange fluid.

8. Air-conditioning plant according to any one of the previous claims, wherein intercepting means are provided between said air-conditioning/fan unit and the circuit of said heat transfer fluid to control the selective supply, to said plant, of said heat transfer fluid coming out from said drying air heater and said heat transfer fluid coming out from said solvent condenser.

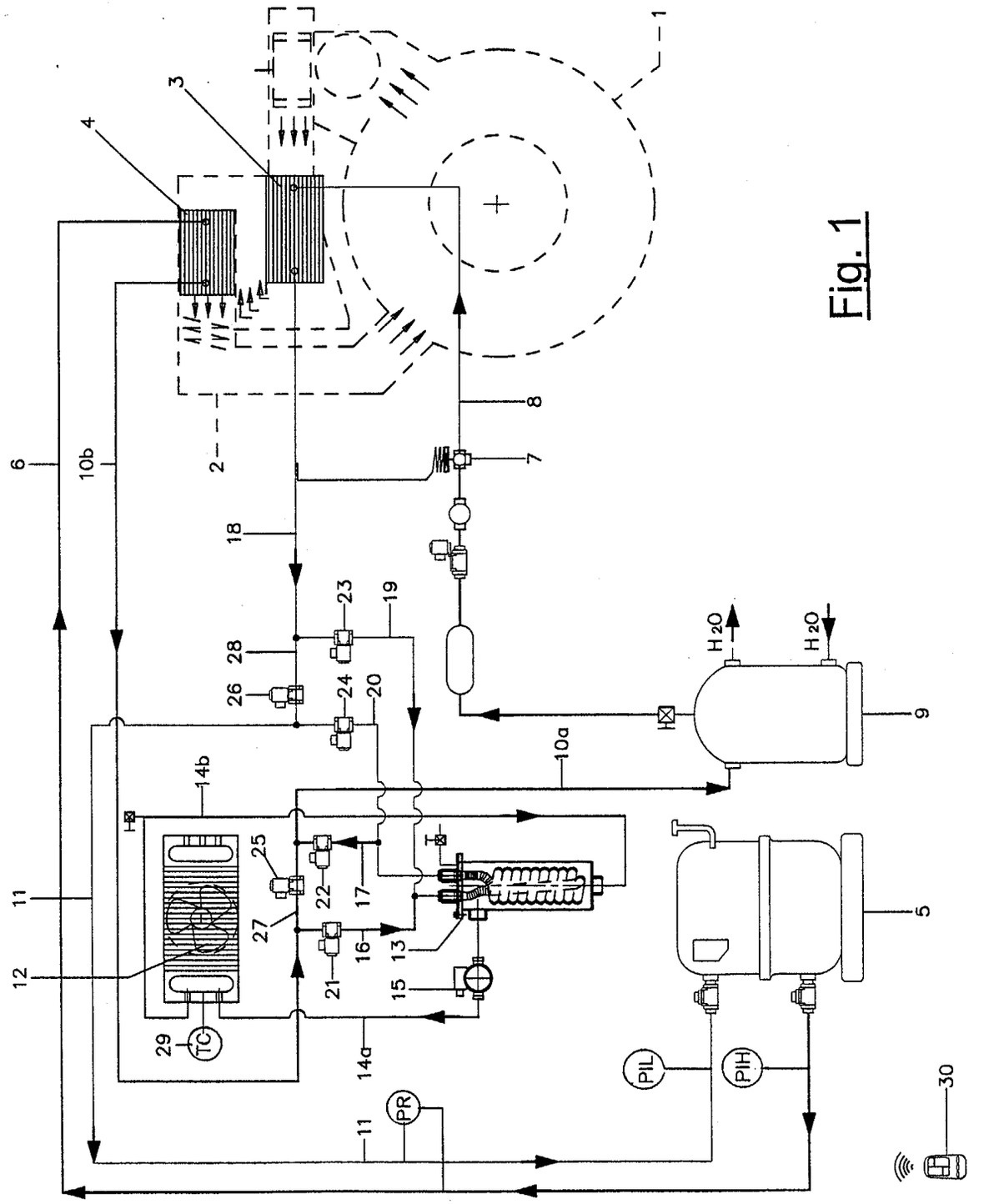
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Fig. 1

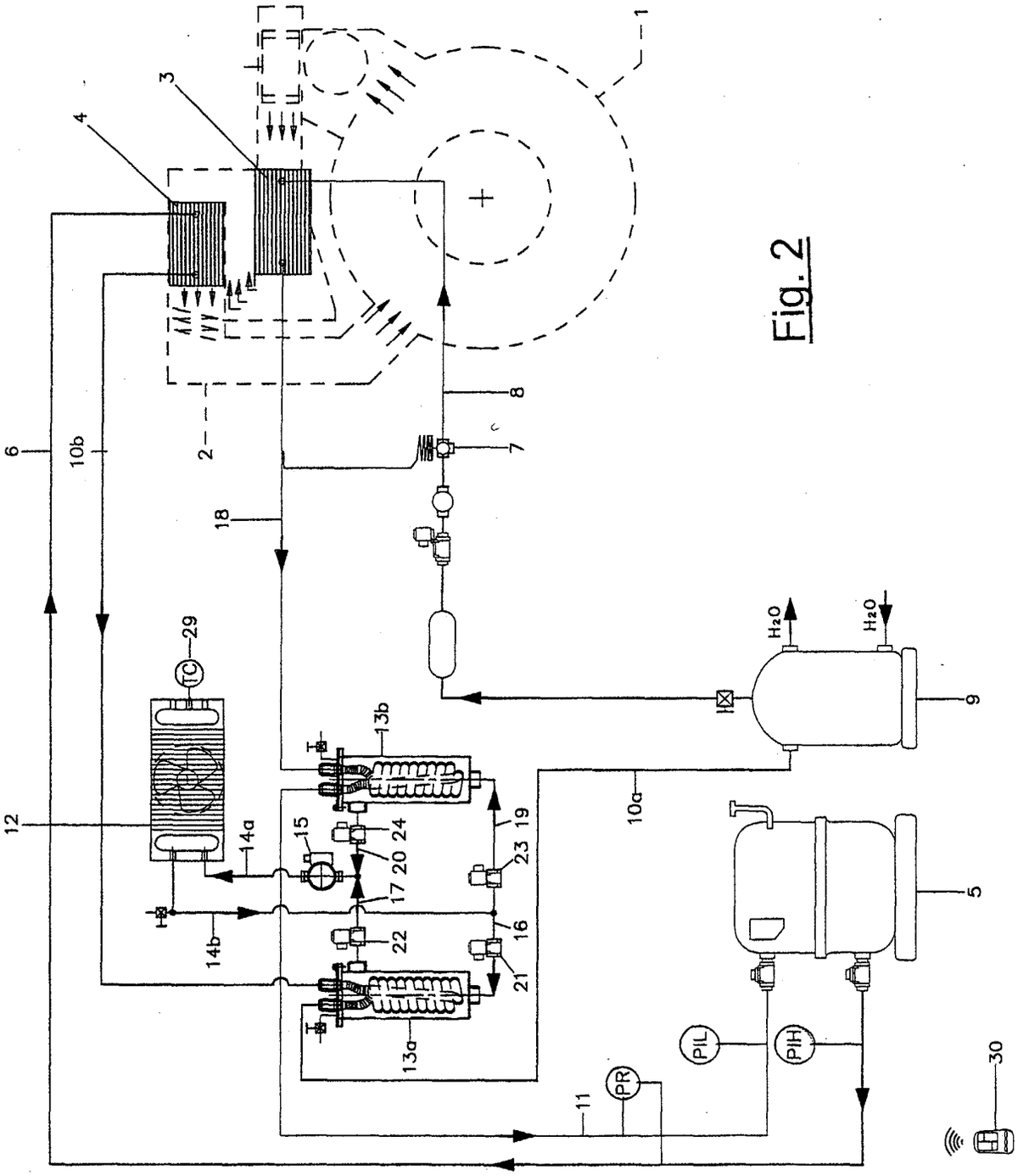
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Fig. 2

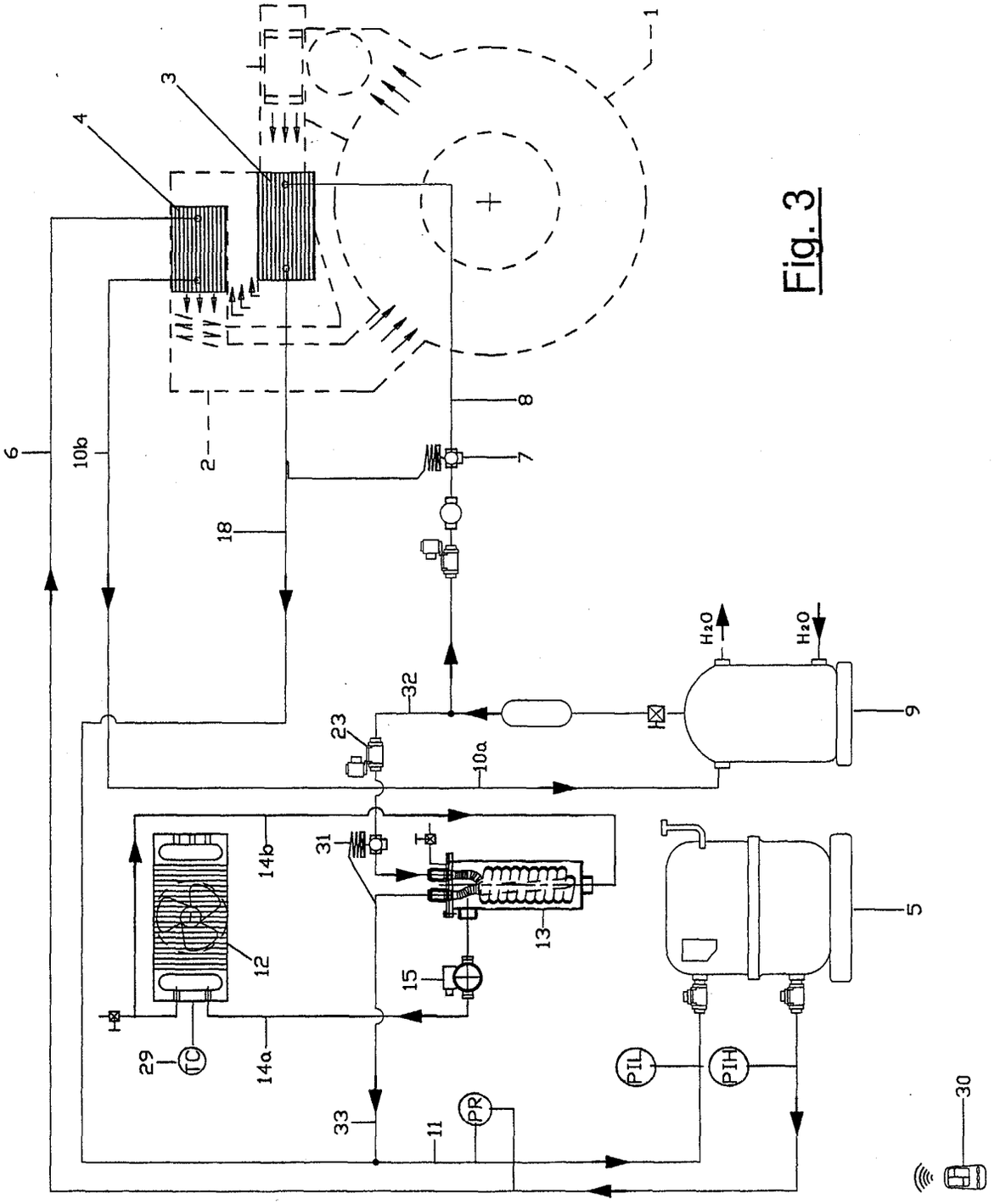
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Fig. 3

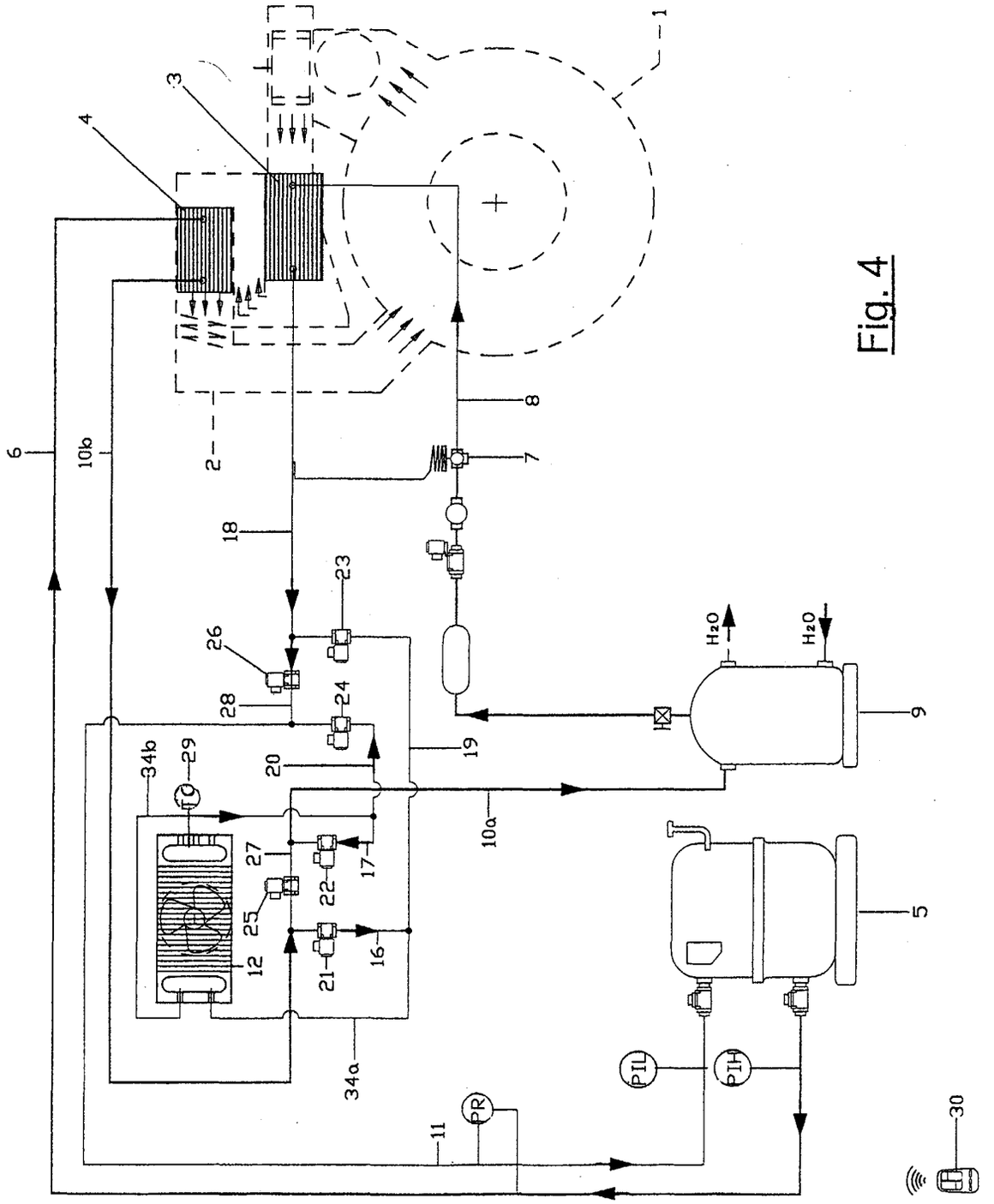
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Fig. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 42 5393

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.7)
A	US 3 064 358 A (GIUFFRE ANTHONY A) 20 November 1962 (1962-11-20) * column 3, line 62 - column 4, line 16; figure 5 * -----	1	D06F43/08 F24F5/00
A	US 5 937 663 A (CHEN SIH-LI ET AL) 17 August 1999 (1999-08-17) * abstract; figures * -----	1-8	
A	US 5 467 539 A (HAHN HORST) 21 November 1995 (1995-11-21) * column 2, line 34 - line 51; figure * -----	1	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

D06F
F24F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	9 November 2004	Courrier, G

CATEGORY OF CITED DOCUMENTS

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09-11-2004

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82