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(54) HOT WATER SYSTEM FOR DISTRIBUTION TO A PLURALITY OF URBAN UTILITIES

(57) Water distribution system (100) comprising a thermal power plant (3) which produces hot water (A2) at a temperature (T2) by heating the water (A1) supplied by an urban waterworks; said system comprises a plurality of utilities (U) suitable for receiving the hot water (A2) coming from the thermal power plant (3), a water distribution network (7) connecting said thermal power plant (3) to said plurality of utilities (U); wherein each utility comprises an internal water system (8) comprising a cooling tank (80) arranged to be supplied with the hot water (A2) coming from the water distribution network (7) and deliver cold water (A3) at a temperature (T3) that is lower than the temperature (T2) of the hot water (A2) and dispensing terminals (81) supplied both with the cold water (A3) coming from the cooling tank and with the hot water (A2) coming from the water distribution network (7).

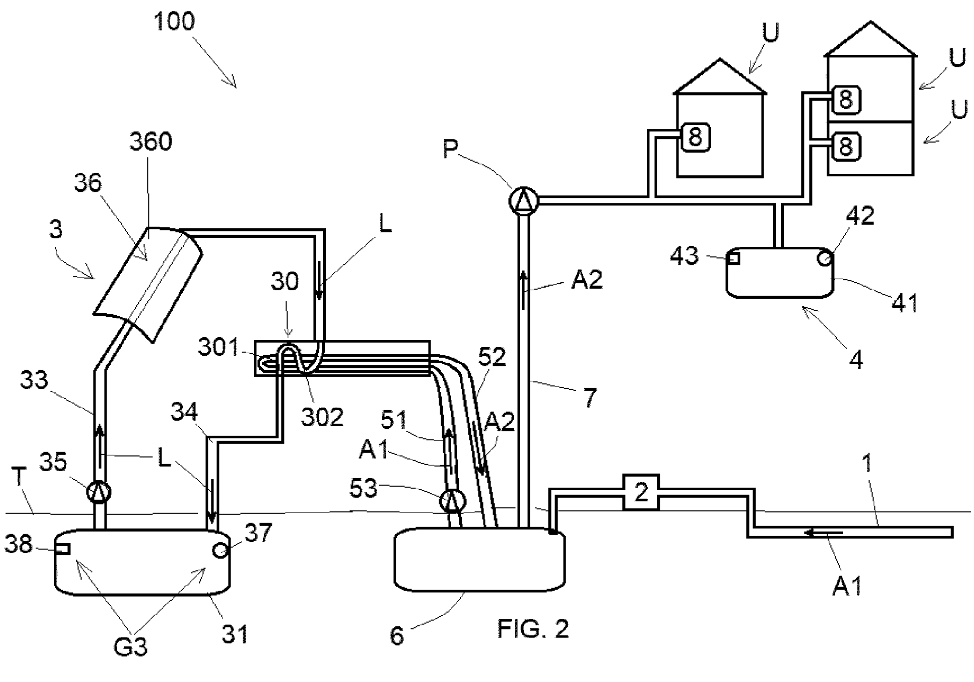

FIG. 2

EP 4 467 883 A1

Description

[0001] The present patent application for industrial invention relates to a hot water system for distribution to a plurality of utilities.

[0002] In particular, the relevant field is that of the water networks used to supply water to households/companies/facilities in urban centers that can be generically defined utilities.

[0003] Such utilities require water to be heated for sanitation or heating purposes or for the use of household appliances or machinery.

[0004] As it is well known, currently, the most popular solution used to heat water provides for using a single water supply network that distributes cold water to the utilities that are provided with heating equipment, preferably combustion boilers, solar panels or the like. As it is well known, the use of combustion boilers involves environmental pollution problems due to the fumes dispersed into the atmosphere.

[0005] Additionally, water heating systems are known, which provide for using district thermal power plants suitable for supplying the utilities with a heat transfer fluid that feeds suitable heat exchangers installed at the utilities and suitable for producing hot water for the heating and the sanitation of each utility. Such systems are commonly referred to as "district heating systems" and specifically comprise:

- a centralized heating system or thermal power plant in which a heat transfer fluid, usually water, is heated using suitable heat sources;
- a closed-loop distribution network through which the heat transfer fluid is sent to the utilities and is then recycled toward the thermal power plant to undergo a new cyclic heating process.

[0006] In practice, a water network for the distribution of hot water and of cold water is provided at each utility, in which the cold water comes directly from an urban waterworks, whereas the hot water comes from the heat exchangers in which the water coming from the urban waterworks is heated by means of the heat transferred by the heat transfer fluid coming from the thermal power plant.

[0007] Thus, two urban water networks are present in the district heating systems:

- a first water network supplied with cold water from the urban waterworks;
- a second network supplied with the hot heat transfer fluid coming from the district thermal power plant.

[0008] Obviously, the simultaneous presence of the two networks entails high costs both in terms of construction and maintenance.

[0009] GB2076524A discloses a district heating system, in which a single main distribution pipe, which receives hot water from a thermal power plant, has branches that distribute the hot water to different buildings in such a way that the water can flow through radiators and/or heating coils of the buildings.

[0010] It is the purpose of the present invention to devise a new water distribution system that provides the utilities with water for heating and with water for sanitary services without the need to directly connect the urban waterworks to each utility.

[0011] Otherwise said, the purpose of the present invention is to devise a new system for the distribution of hot water to the utilities, eliminating the need to install boilers or equivalent equipment at each utility to heat the cold water coming from the urban waterworks.

[0012] A further purpose of the present invention is to devise a hot-water distribution system that uses non-polluting heat sources.

[0013] Another purpose of the present invention is to devise an innovative hot-water distribution system that can be implemented using the existing urban water networks for the distribution of cold water to individual utilities.

[0014] These purposes are achieved in accordance with the invention with the features listed in the attached independent claim 1.

[0015] Advantageous embodiments appear from the dependent claims.

[0016] The system according to the invention is defined by claim 1.

[0017] For explanatory clarity, the description of the system according to the invention is continued with reference to the appended drawings, which are for illustrative and non-limiting purposes only, wherein:

Fig. 1 is a block diagram schematically showing the water distribution system according to the invention, which comprises a district thermal power plant, the water distribution network, and the individual utilities;
Fig. 2 diagrammatically shows the water distribution system according to the invention in a first embodiment;
Fig. 3 diagrammatically shows the water distribution system according to the invention in a second embodiment; and
Fig. 4 is a block diagram of the water system installed in each individual utility.

[0018] With reference to Figs. 1-4, a system according to the invention, which is comprehensively denoted with reference numeral (100), is described.

[0019] With reference to Figs. 1, 2 and 3, the water distribution system (100) according to the invention comprises a supply conduit (1) for the passage of water (A1) coming from an urban waterworks.

[0020] By way of example, said supply conduit (1) is an integral part of a water system that connects different neighborhoods or residential areas.

[0021] The water distribution system (100) also comprises a purification and filtration unit (2) connected to the supply conduit (1) and suitable for purifying and filtering the water (A1) coming from the supply conduit (1). The temperature (T1) of the water (A1) coming from the urban waterworks usually depends on the outdoor environmental conditions.

[0022] In particular, the purification/filtration unit (2) is provided with means configured for filtering and purifying the water (A1), eliminating the scale that is deposited inside the supply conduit (1) with the passing of time.

[0023] The water distribution system (100) comprises a thermal power plant (3) configured to produce hot water (A2) at a first temperature (T2) by heating the water (A1) supplied from the waterworks. Specifically, the thermal power plant (3) receives the water (A1) coming from the purification and filtration unit (2) that is arranged upstream of the thermal power plant (3).

[0024] Preferably, the temperature (T2) of the hot water (A2) is comprised between 96°C and 99°C and is higher than the temperature (T1) of the water (A1) coming from the waterworks.

[0025] The water distribution system (100) also comprises a plurality of utilities (U) arranged to receive the hot water (A2) produced by and coming from the thermal power plant (3). Therefore, hot water (A2) is constantly received in the utilities (U). It should be noted that in the present patent application, the term "utilities" indicates any building or facility for residential, industrial or similar use.

[0026] A water distribution network (7) connects said thermal power plant (3) to said plurality of utilities (U). Said water distribution network (7) may coincide with the distribution water network that is used in the prior art to conventionally supply the cold water from the urban waterworks to the individual utilities (U). Otherwise said, the water distribution network (7) may coincide with the pre-existing water network of the urban area.

[0027] The water distribution network (7) comprises pipes and a pumping system (P) configured to pump the hot water (A2) from the thermal power plant (3) to the utilities (U).

[0028] Now with reference to Fig. 4, each utility (U) comprises an internal water system (8) provided with dispensing terminals (81). By way of example, said dispensing terminals (81) comprise a sink faucet, a shower faucet, an inlet pipe of a household appliance (e.g., a washing machine or a dishwasher), and any other water terminal from which water is intended to flow. The dispensing terminals may also comprise mixers or valves to regulate the temperature of the water coming out of such dispensing terminals (81).

[0029] The internal water system (8) comprises a cooling tank (80) that is arranged to be supplied with the hot water (A2) coming from the water distribution network (7). The cooling tank (80) is also arranged to deliver cold water (A3) at a second temperature (T3) that is lower than the first temperature (T2) of hot water (A2).

[0030] The internal water system (8) also comprises two separate water distribution networks (83, 84) to distribute the water to the dispensing terminals (81). In particular, a hot-water distribution network (84) that is directly supplied with the hot water (A2) coming from the water distribution network (7), and a cold-water distribution network (83) that is supplied with the cold water (A3) delivered from the cooling tank (80) can be distinguished.

[0031] In view of the above, the dispensing terminal (81) receives cold water (A3) (passing through the cold-water distribution network (83)) and hot water (A2) (passing through the hot-water distribution network (84)). At this point a user can adjust the temperature of the water coming out of the dispensing terminal (81) by simply operating the mixer or the valve of the dispensing terminal (81).

[0032] Preferably, the cooling of the water inside the cooling tank (80) occurs by heat transfer from the inside to the outside the cooling tank (80). Otherwise said, the hot water (A2) introduced in the cooling tank (80) is gradually cooled until it reaches a thermal equilibrium with the outdoor environment in which the cooling tank (80) is installed, and is converted into cold water (A3).

[0033] Optionally, cooling means (not shown in the appended figures) may be provided inside the cooling tank (80) and configured to cool the water inside the cooling tank (80) so as to accelerate the water cooling process.

[0034] Furthermore, a temperature sensor (88) may be provided inside the cooling tank (80) and configured to detect the temperature of the water stored inside the cooling tank (80). A valve (89) may be provided between the cooling tank (80) and the cold-water distribution network (83) and interfaced with said temperature sensor (88) in such a way to be alternately disposed in:

- a closed position to prevent the water from flowing from the cooling tank (80) to the cold-water distribution network (83); and
- an opening position to let the water flow from the cooling tank (80) to the cold-water distribution network (83).

[0035] The valve (89) is arranged in open position when the temperature sensor (88) detects that the cooled water inside the cooling tank (80) has a temperature lower than a preset temperature. Conversely, the valve (89) is arranged in closed position when the temperature sensor (88) detects that the cooled water inside the cooling tank (80) has a temperature higher than a preset temperature.

[0036] In this way, the cold-water distribution network (83) will be always filled with cold water (A3), that is to say, with water having a temperature (T3) lower than a preset temperature.

[0037] Optionally, the internal water system (8) of each utility (U) may comprise a heating system (82) of the indoor environment of the utility (U) comprising heat exchangers (820) (such as radiators or coils).

[0038] The heating system (82) is arranged upstream of the water distribution networks (83, 84) and the heat exchangers (820) are arranged for the passage of the hot water (A2) coming from the water distribution network (7). Then, the hot water (A2) delivered from said heat exchangers (820) is supplied into the hot-water distribution network (84) and in the cooling tank (80). Otherwise said, the hot water (A2) introduced into the internal water system (8) will first pass through the heat exchangers (820) of the heating system (82) and will then flow toward the hot-water distribution network (84) and toward the cooling tank (80). Obviously, the hot water (A2) coming from the heating system (82) will have a lower temperature than the hot water (A2) entering the heating system (82) because part of the heat will be transferred to the outdoor environment via the heat exchangers (820).

[0039] It should be noted that if the cooling tank (80) and the hot-water distribution network (84) are full, the water can be discharged to sewers by means of special drains not shown in the appended figures.

[0040] Furthermore, the heating system (82) comprises a valve assembly (V) configured to prevent or allow the passage of hot water (A2) inside the heat exchangers (820) of the heating system (82). Otherwise said, the valve assembly (V) allows the hot water (A2) (coming from the water distribution system (7)) to by-pass or not the heat exchangers (820).

[0041] Now with reference to Figs. 2 and 3, said thermal power plant (3) uses renewable sources to heat the water. In particular, the thermal power plant (3) is powered by solar energy.

[0042] Referring to Figs. 2 and 3, the thermal power plant (3) comprises a heat exchanger (30) of "water-heat transfer fluid" type. The heat exchanger (30) comprises first pipes (301) for the passage of water (A1, A2) and second pipes (302) for the passage of a heat transfer fluid (L). The heat transfer fluid (L) is preferably a diathermic oil. The first pipes (301) and the second pipes (302) are in thermal communication with each other so that a heat exchange occurs between the heat transfer fluid (L) flowing through the second pipes (302) and the water (A1, A2) flowing through the first pipes (301). The water (A1, A2) acquires the heat from the heat transfer fluid (L) so that the water (A1) (coming from the urban waterworks) becomes hot water (A2).

[0043] The thermal power plant (3) also comprises a heat transfer fluid tank (31) in which the heat transfer fluid (L) is stored.

[0044] Delivery pipes (33) and return pipes (34) are provided to hydraulically connect the heat transfer fluid tank (31) with the second pipes (302) of the heat exchanger (30). A pump (35) is configured to draw the heat transfer fluid (L) from the heat transfer fluid tank (31), let the heat transfer fluid (L) flow inside the delivery pipes (33), then inside the second pipes (302), and finally inside the return pipes (34) so that the heat transfer fluid (L) flows back inside the heat transfer fluid tank (31).

[0045] Means (36) are arranged at the delivery pipes (33) to transfer the heat to the heat transfer fluid (L) passing through the delivery pipes (33).

[0046] Said means (36) preferably comprise an optical solar concentration system (360) configured to concentrate the sunlight in one or more focal points on the delivery pipes (33) so that the heat transfer fluid (L) absorbs solar energy and is heated.

[0047] By way of example, said optical solar concentration system (360) comprises parabolic mirrors or linear mirrors with Fresnel reflectors or circular parabolic reflectors and the like.

[0048] Advantageously, the thermal power plant (3) comprises a heat transfer fluid temperature conditioning unit (G3) configured to maintain the heat transfer fluid (L) at a preset operating temperature.

[0049] The heat transfer fluid temperature conditioning unit (G3) comprises:

- a sensor (37) suitable for detecting the temperature of the heat transfer fluid (L) contained in the heat transfer fluid tank (31); and
- an electric heating element (38) interfaced to the sensor (37) and suitable for being activated or deactivated according to the temperature detected by the sensor (37).

[0050] In particular, said heat transfer fluid temperature conditioning unit (G3) allows to constantly maintain the heat transfer fluid (L) at the operating temperature during a prolonged absence of the sunlight and during night hours.

[0051] Preferably, the heat transfer fluid tank (31) is buried, i.e., placed under the ground (T) in such a way to limit the heat loss.

[0052] A water storage tank (6) is provided in adjacent position to the heat transfer fluid tank (31) and is hydraulically connected to the purification and filtration unit (2), to the water distribution network (7) and to the thermal power plant (3).

[0053] According to a first embodiment of the invention, which is shown in Fig. 2, said water storage tank (6) is connected to the first pipes (301) of the heat exchanger (30) by means of a first pipe (51) and of a second pipe (52) that define a closed water recirculation circuit between the heat exchanger (30) and the water storage tank (6).

[0054] The water storage tank (6) comprises a pump (53) configured to draw the water from the water storage tank (6) and pump it inside the first pipes (301) of the heat exchanger (30) so that the water is heated and is then reintroduced into the water storage tank (6). The water distribution network (7) is directly connected to the water storage tank (6), and the pumping system (P) of the water distribution network (7) draws the water directly from the water storage tank (6).

[0055] In view of the above, the water storage tank (6) will always contain hot water (A2), preferably at a temperature (T2) comprised between 96°C and 99°C.

[0056] According to a second embodiment, which is shown in Fig. 3, said water storage tank (6) is connected to the first pipes (301) of the heat exchanger (30) by the means of a single pipe (50). The water distribution network (7) is directly connected to the first pipes (301) of the heat exchanger (30), and the pumping system (P) is configured to draw the water from the water storage tank (6), letting it pass through the first pipes (301) of the heat exchanger (30) (so that the water is heated) and then into the water distribution network (7).

[0057] Still with reference to Figs. 2 and 3, a plurality of auxiliary heating units (4) may be provided along the water distribution network (7).

[0058] For illustrative purposes, said auxiliary heating units (4) comprise:

- a reservoir (41) in which hot water (A2) is suitable for being stored;
- a sensor (42) suitable for detecting the temperature of the hot water (A2) contained inside the reservoir (41); and
- an electric heating element (43) interfaced to the temperature sensor (42) and suitable for being activated or deactivated according to the temperature detected by the temperature sensor (42).

[0059] The function of the auxiliary heating unit or units (4) is to constantly maintain the hot water (A2) circulating in the water distribution system (7) at a temperature comprised between 96°C and 99°C.

[0060] The sensor (42) and the electric heating element (43) of the auxiliary heating unit (4) may be powered by the electric current generated by photovoltaic panels that are already installed or may be installed on the buildings of the utilities (U).

[0061] Following the above description, the advantages of the present invention now become apparent.

[0062] In fact, because of the provision of the thermal power plant (3) powered by renewable sources, the internal water systems (8) of the utilities (U) are all supplied by a single water distribution network (7) that provides hot water (A2), and therefore the conventional boilers that discharge polluting gases into the environment can be eliminated.

[0063] Moreover, it is worth pointing out that the water distribution system (100) according to the present invention can be easily adapted to the existing water supply networks with boilers without having to revolutionize the structural arrangement of the networks that are currently present in neighborhoods, municipalities and cities. In fact, in order to adapt the current systems with boilers to the new water distribution system (100) according to the invention, it is only necessary to:

- install the thermal power plant (3) downstream of the utilities (U); and
- modify the internal water systems (8) of the utilities (U) in such a way as to replace the boilers with the cooling tanks (80).

[0064] In such a case, therefore, the pre-existing urban water distribution network that until now is used to supply cold water to the utilities (U) can be used as water distribution network (7).

[0065] Finally, it should be noted that although all the appended figures show a thermal power plant (3) that uses optical solar concentration systems, according to alternative embodiments of the invention, the thermal power plant (3) may comprise biomass plants or other plants that use renewable energy to heat the water.

[0066] Numerous modifications may be made to the present embodiment of the invention, within the reach of a person skilled in the art, and still within the scope of the invention as expressed by the appended claims.

Claims

1. Water distribution system (100) comprising:

- a thermal power plant (3) configured in such a way to produce hot water (A2) at a first temperature (T2) by heating the water (A1) supplied by an urban waterworks;
- a plurality of utilities (U) arranged to receive the hot water (A2) produced by and coming from said thermal power plant (3);
- a water distribution network (7) connecting said thermal power plant (3) to said plurality of utilities (U);

wherein each one of said plurality of utilities (U) comprises an internal water system (8) comprising:

  - a cooling tank (80) arranged to be supplied with the hot water (A2) coming from the water distribution network (7) and deliver cold water (A3) at a second temperature (T3) that is lower than the first temperature (T2) of the hot water (A2);
  - dispensing terminals (81) from which water is suitable for flowing out;
  - a hot-water distribution network (84) arranged to be supplied directly with the hot water (A2) coming from the water distribution network (7) and distribute the hot water (A2) to the dispensing terminals (81);
  - a cold-water distribution network (83) arranged to be supplied with the cold water (A3) coming from the cooling tank (80) and distribute the cold water (A3) to the dispensing terminals (81);

characterized by the fact that said thermal power plant (3) comprises:

  - a heat exchanger (30) comprising first pipes (301) for the passage of water and

second pipes (302) for the passage of a heat transfer fluid (L); wherein the first pipes (301) and the second pipes (302) are in thermal communication with each other so that a heat exchange takes place between the heat transfer fluid (L) flowing through the second pipes (302) and the water flowing through the first pipes (301);
- a heat transfer fluid tank (31) in which the heat transfer fluid (L) is stored;
- delivery pipes (33) and return pipes (34) which hydraulically connect the heat transfer fluid tank (31) with the second pipes (302) of the heat exchanger (30);
- a pump (35) configured in such a way to draw the heat transfer fluid (L) from the heat transfer fluid tank (31), let the heat transfer fluid flow through the delivery pipes (33), then through the second pipes (302), and finally through the return pipes (34) so that the heat transfer fluid (L) flows back into the heat transfer fluid tank (31);
- means (36) suitable for transferring heat to the heat transfer fluid (L) flowing through the delivery pipes (33); and
- a heat transfer fluid temperature conditioning unit (G3) configured to maintain the heat transfer fluid (L) at a preset operating temperature;

wherein said heat transfer fluid temperature conditioning unit (G3) comprises:

- a sensor (37) suitable for detecting the temperature of the heat transfer fluid (L) stored in the heat transfer fluid tank (31); and
- an electric heating element (38) interfaced with the sensor (37) and suitable for being activated or deactivated according to the temperature detected by the sensor (37).

2. The system (100) according to claim 1, wherein said means (36) comprise an optical solar concentration system (360) configured to concentrate the sunlight in a focal point on the delivery pipes (33) so that the heat transfer fluid (L) absorbs solar energy and is heated.

3. The system (100) according to claim 1 or 2, wherein each utility (U) further comprises a heating system (82) comprising heat exchangers (820) arranged to be crossed by the hot water (A2) coming from the water distribution network (7); wherein the system is configured in such a way that the hot water (A2) delivered by said heat exchangers (820) is introduced in the hot-water distribution network (84) and in said cooling tank (80).

4. The system (100) according to any one of the preceding claims, wherein said water distribution network (7) coincides with the pre-existing water network used to conventionally send the water from the urban waterworks to the utilities.

5. The system (100) according to any one of the preceding claims, comprising a purification and filtration unit (2) disposed upstream of the thermal power plant (3) and configured to purify and filter the water coming from the waterworks.

6. The system (100) according to any one of the preceding claims, wherein said thermal power plant (3) utilizes renewable sources to heat the water.

7. The system (100) according to any one of the preceding claims, comprising a water storage tank (6) connected to the water distribution network (7) and to the thermal power plant (3).

8. The system (100) according to any one of the preceding claims, comprising auxiliary heating units (4) arranged along the water distribution network (7) and configured to constantly maintain the hot water (A2) circulating in the water distribution network (7) at a preset temperature.

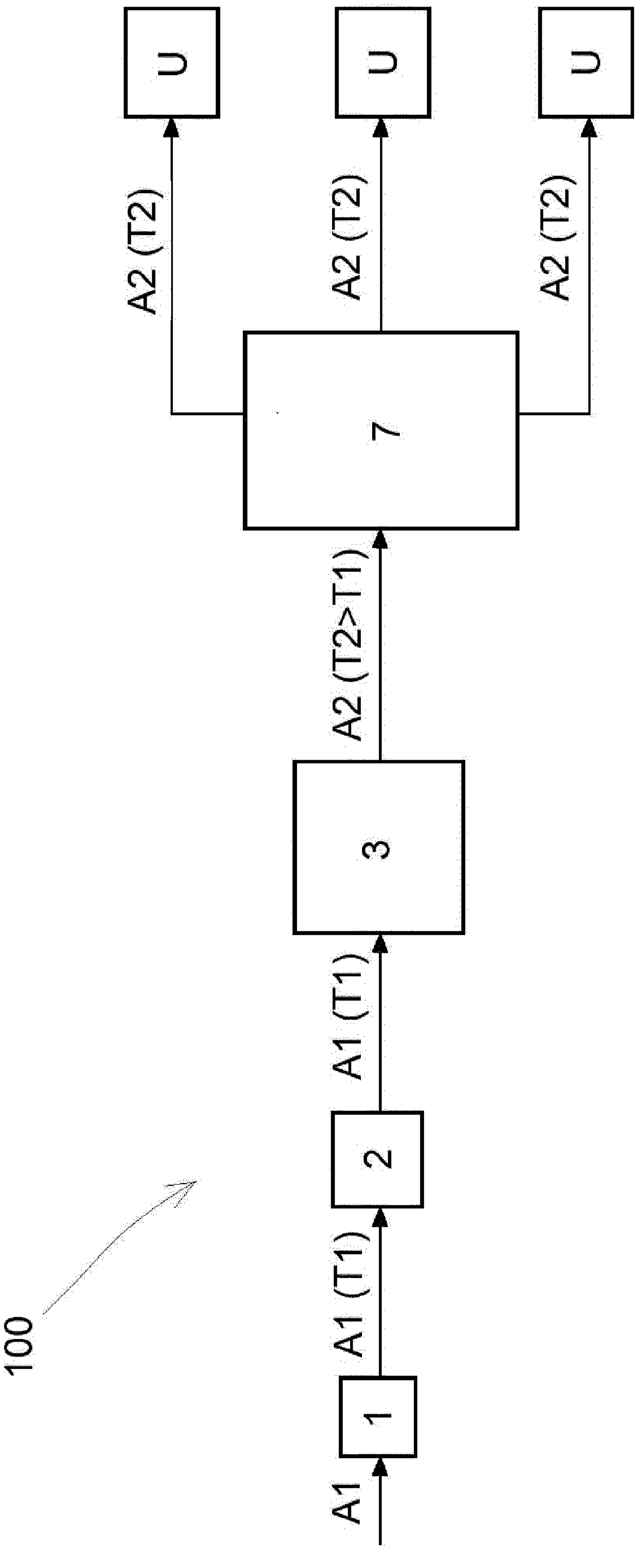

FIG. 1

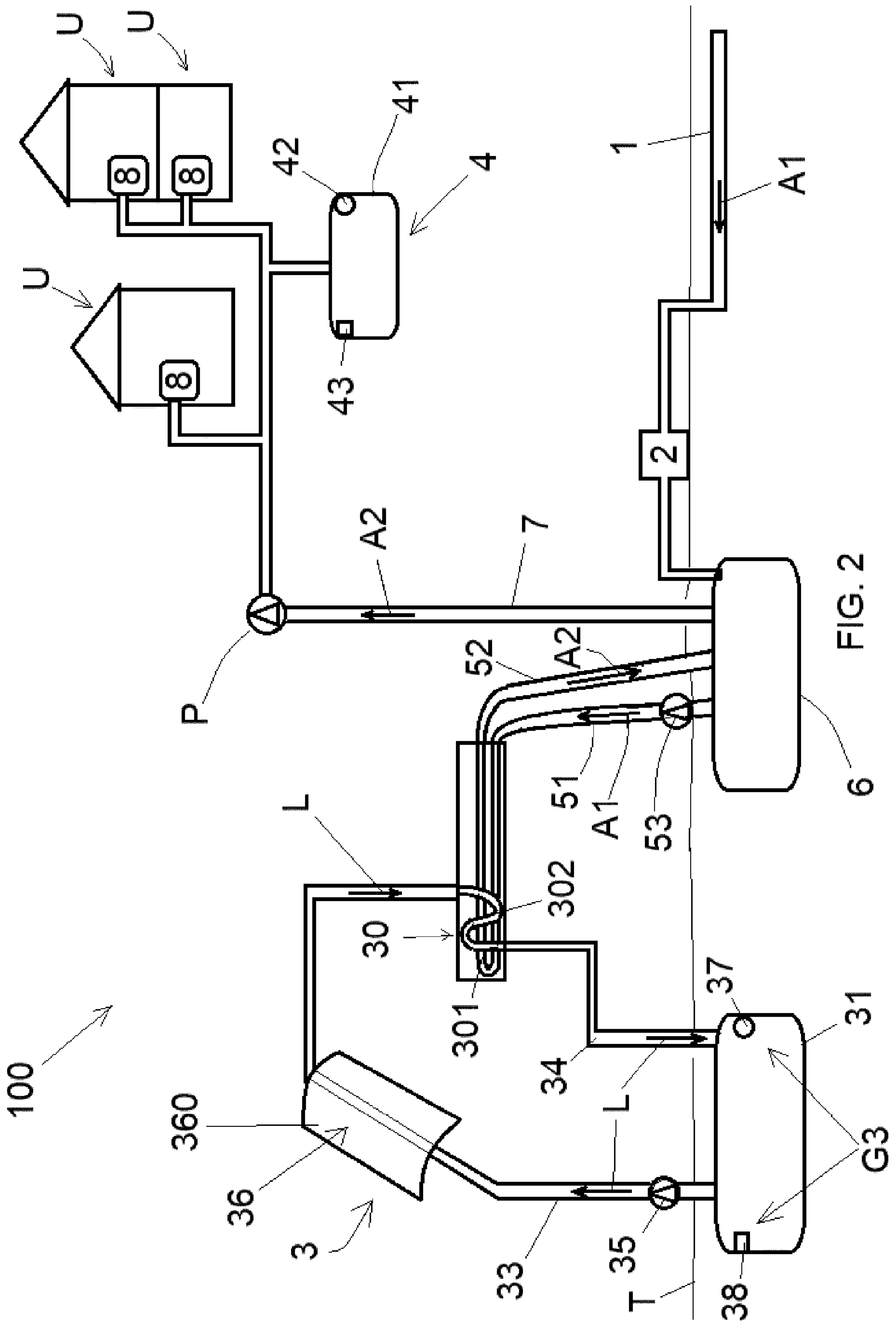
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FIG. 2

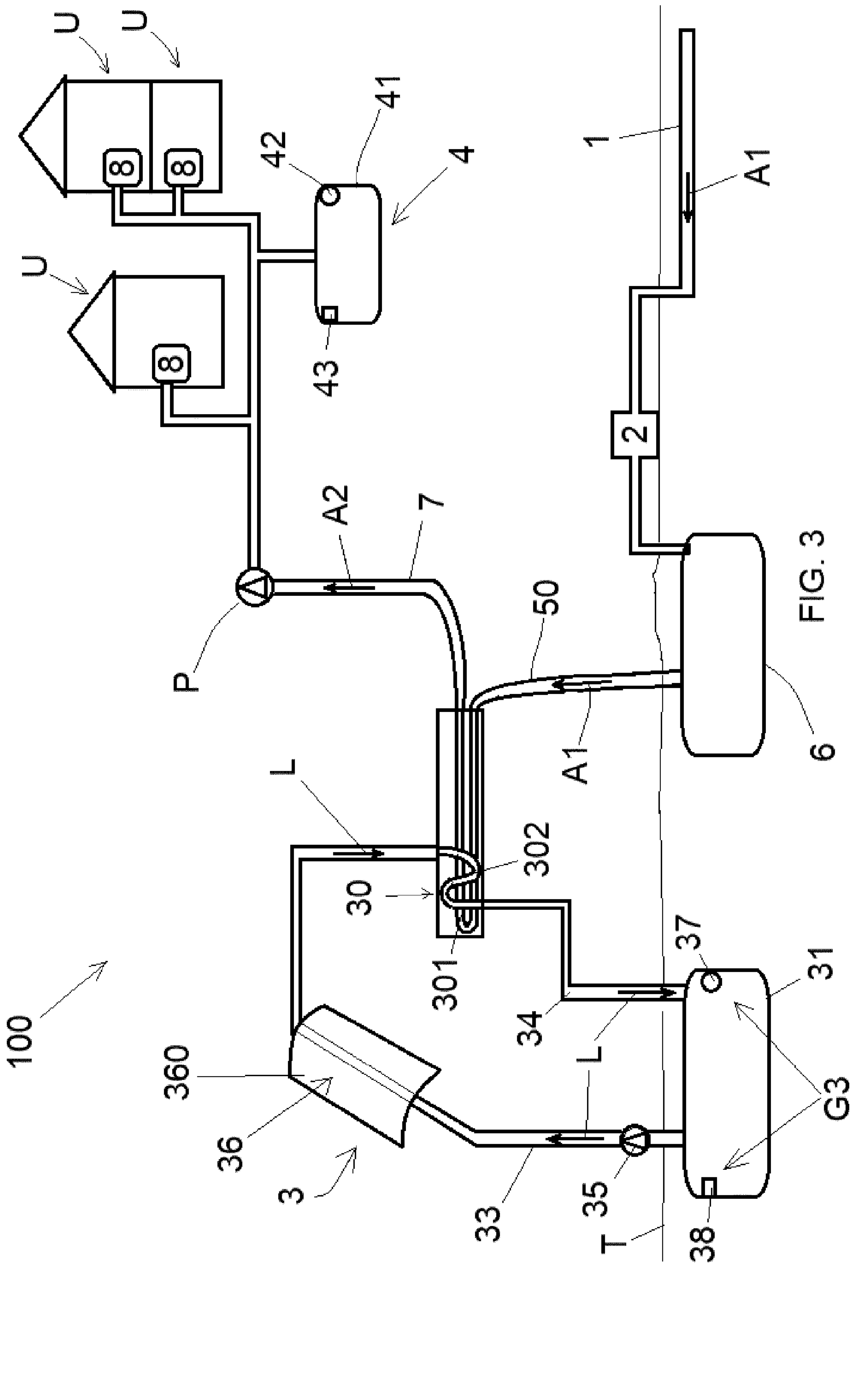
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FIG. 3

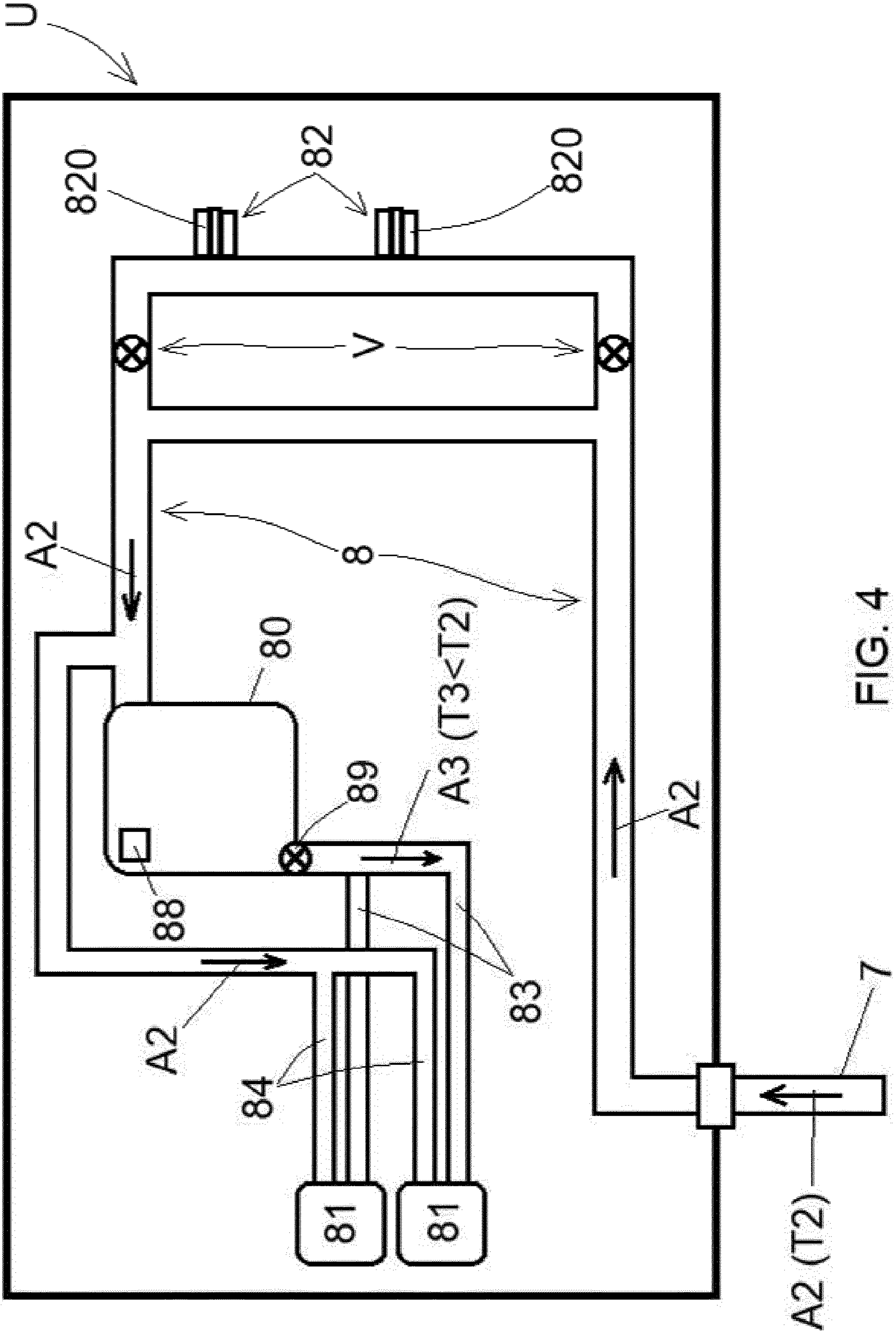

FIG. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 24 17 4474

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	GB 2 076 524 A (BELL GEORGE MALCOLM) 2 December 1981 (1981-12-02) * page 1; claim 1; figure 2 *	1-8	INV. F24D10/00 F24H15/223 F24H15/31 ADD. F24D11/00 F24D17/00
A	DE 25 18 161 B1 (SULZER AG) 28 October 1976 (1976-10-28) * column 3, line 40 - column 4, line 3; figure 1 *	1-8	
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A	BE 826 612 A (HENRY BAILLOT, PIERRE BAILLOT [BE]) 30 June 1975 (1975-06-30) * the whole document *	1-8	

TECHNICAL FIELDS SEARCHED (IPC)
F24D
F24H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	16 September 2024	Schwaiger, Bernd

1

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 17 4474

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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16-09-2024

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