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(54) HEATING PLANT WITH RADIATING STRIPS

(57) The present heating plant with radiating tubes is constituted by a burner which, by burning a mixture of fuel and comburent air, generates high-temperature combustion products, hereinbelow also indicated with the term fumes, which are made to circulate by means of a fan inside a closed loop formed by radiating tubes capable of heating rooms via irradiation. The plant is constituted by a system for drawing and expelling part of the burnt gases, placed downstream of the combustion chamber and provided with a suitable aspirator and with condensation heat recuperators.

EP 3 121 521 A1

Description

Field of application

[0001] The present invention regards a heating plant with radiating strips, according to the preamble of the main independent claim.

[0002] The present plant is advantageously intended to be employed in an industrial or commercial context for heating, in particular, large-size building premises both for a total heating and for heating partial areas of the building premises.

State of the art

[0003] As is known, different heat plants with radiating strips have existed for years on the market. Such plants are to be arranged slightly below the ceiling of the building premises to be heated, so as to irradiate heat via irradiation towards the things and people below, preferably with heat radiations in the infrared field.

[0004] Such plants of known type conventionally comprise closed loop radiating ducts, termed "radiating strips" in the jargon of the field, which are connected to a burner, in which a comburent mixture composed of air and gas is made to burn.

[0005] Such mixture produces a flow of high-temperature combustion products which is introduced into the closed loop of the radiating ducts.

[0006] The aforesaid loop of the plant is intercepted by a fan advantageously placed close to and upstream of the burner in a manner so as to subject the entire radiating loop to a reduced pressure susceptible also of maintaining the safety of the plant.

[0007] The flow of burnt gases produced by the burner is mixed in the closed loop with a flow of combustion products already introduced and in circulation, heating the latter, so as to form a heating carrier fluid that is made to circulate under reduced pressure by the action of the fan.

[0008] More in detail, the burners employed in such plants are conventionally provided with a combustion chamber, in which the comburent mixture, formed by air and gas, bums at a combustion head, generating a fume carrier fluid that is made to circulate within the radiating tubes together with the previously-produced circulation fumes. The cooler recirculation fumes are mixed with the hotter fumes produced by the burner and together they are made to circulate by the fan, which maintains the entire loop under reduced pressure conditions.

[0009] Therefore, the fan circulates in the loop a carrier fluid flow formed partly by the very hot new burnt gases produced by the burner and partly by the cooler recirculation burnt gases which have already partly exchanged their heat with the radiating tubes during the circulation thereof.

[0010] For the equilibrium of the masses involved, a part of the circulation fumes is expelled into the environment outside the building premises by means of a suitable expulsion duct (stack) usually placed upstream of the burner, immediately downstream of the fan.

[0011] For example, it is known from patent WO 2011036645 to provide such heat plants with radiating strips with heat recovery devices placed to intercept the stack in order to expel, as in normal boilers, the fumes at lower temperatures, recovering part of the latent heat of condensation.

[0012] The plant thus configured is particularly safe given that the burner is usually placed outside of the building premises to be heated and the radiating tubes are, as stated, under reduced pressure so as to prevent any possibility of dispersion of the fumes into the environment to be heated.

[0013] During its circulation in the closed loop, the carrier fluid is also mixed with air coming from the outside environment, which enters through the mechanical joints between the components that form the loop (bends, nipples, dilators, etc.).

[0014] Such infiltration of secondary air involves an increase of the oxygen content in the circulation carrier fluid, with consequent decrease of the performance of combustion measured on the fumes expelled at the stack, the latter positioned at the end of the radiating loop, more precisely between the fan and the burner.

[0015] The patent GB 2109104 describes a further example of heating plant with radiating strips of known type, which comprises a closed loop intercepted by a burner, and a stack connected to a terminal section of the closed loop. The plant is also provided with a probe for measuring the quantity of exhaust fumes expelled through the stack.

[0016] Also the latter solution of known type does not allow optimizing the combustion performance measured on the fumes expelled at the stack.

Presentation of the invention

[0017] In such context, therefore, the main object of the present invention is to overcome the drawbacks of the above-described prior art, with a heating plant with radiating strips that is capable of improving the combustion performance measured on the fumes expelled at the stack.

[0018] Further object of the present invention is to present a heating plant with radiating strips, which is entirely safe in operation.

Brief description of the drawings

[0019] The technical characteristics of the finding, according to the proposed task and objects, are clearly seen in the contents of the below-reported claims and the advantages thereof are more evident in the detailed description of several embodiments, according to the finding, illustrated as a non-limiting example in the enclosed drawing tables, in which:

- fig. 1 illustrates a diagram of the heating plant with radiating strips, object of the present invention;
- fig. 2 is a first embodiment variant of the plant of figure 1 in which it was provided to apply an air/air heat exchanger on a provided fume expulsion duct;
- fig. 3 is a second embodiment variant of the plant of figure 1 in which it was provided to apply an air-water heat exchanger on the fume expulsion duct;
- fig. 4 is a third embodiment variant of the plant of figure 1 in which it was provided to apply fans in proximity to the fume expulsion duct;
- fig. 5 is a fourth embodiment variant of the plant of figure 1 in which it was provided to apply fans in proximity to the radiating loop within which the hot carrier fluid circulates.

Detailed description of a preferred embodiment

[0020] With reference to the enclosed drawings, reference number 1 overall indicates a heating plant with radiating strips in accordance with a preferred embodiment of the present invention.

[0021] This is intended to be mainly employed in ambient climate-control by means of irradiation, in an industrial and commercial context.

[0022] The heating plant 1, object of the present invention, comprises a closed loop 5 of radiating ducts, which are usually extended hung below a covering/roofing over the entire area that one wishes to heat via irradiation. The aforesaid radiating ducts, known with the term radiating strips, are obtained with metal tubes with high thermal transmission and are extended with a length that, in accordance with requirements, can usually vary from several dozen meters up to even 100-150 meters.

[0023] The aforesaid closed loop 5 conveys, at its interior, a carrier fluid 9' of very hot combustion products, which heat the tubes of the closed loop, irradiating heat into the outside environment to be heated.

[0024] For such purpose, such closed loop 5 is intercepted by a burner 2 which can advantageously also be placed outside the environment 19 of the building premises to be heated.

[0025] The burner 2 comprises, in a *per se* conventional manner, a combustion chamber 8, in which the combustion of a mixture formed by at least one air flow A and by at least one gas flow G occurs.

[0026] The combustion of such mixture determines the production of high-temperature combustion products which are introduced into the carrier fluid 9' in order to heat it. The closed loop 5 is also intercepted by at least one fan 6 placed upstream of the burner 2, in order to make the reduced-pressure carrier fluid 9' circulate within the closed loop 5 from the burner 2 to the same fan 6.

[0027] The closed loop 5 is provided with a suctioned section 5 ", which is extended starting from the combustion chamber 8 of the burner 2, and with a terminal section 5', which is advantageously extended as a continuation of the suctioned section 5".

[0028] More in detail, the fan 6 is associated with the terminal section 5' of the closed loop 5 of smaller length than the remaining suctioned section 5" in order to make the reduced-pressure carrier fluid 9' circulate along most of the loop. More in detail the fan 6 is placed close to the burner 2.

[0029] The heating plant 1, in accordance with the present invention, also comprises a fume expulsion duct 11 which is connected to the closed loop 5 in order to expel, into the outside environment, a part 10 of the carrier fluid 9.

[0030] In accordance with the idea underlying the present invention, the fume expulsion duct 11 is connected to the closed loop 5 in a connection position, indicated with 23 in the figures, which delimits with the combustion chamber 8 an initial section 5'" of the suctioned section 5".

[0031] Such fume expulsion duct 11 is also intercepted by an aspirator 3 and by means for detecting the composition of the fumes 13.

[0032] The aspirator 3 assists the draft of the combustion chamber 8, facilitating the formation of a longer flame with an improved combustion and simultaneously forces outward the part 10 of the carrier fluid 9 that must be substituted and that - not having traversed most of the closed loop 5 - is indicative of the quality of the combustion, since it has not been contaminated by infiltrations of outside air.

[0033] In this manner the means for detecting the composition of the fumes 13 are particularly indicative of the quality of the combustion that took place in the chamber 8.

[0034] The carrier fluid 9' that circulates in the closed loop 5 is therefore in part restored by hot fumes emitted by the combustion chamber 8 and in part reduced by the removal of the part 10 of the carrier fluid 9 which is extracted (close to the same burner) from the fume expulsion duct 11. The portion 9' of carrier fluid 9 that carries out the complete circulation of the closed loop 5 is pushed by the fan 6 to a lower temperature in the combustion chamber 8, having transferred its heat to the radiating tubes of the closed loop and also having been at least in part mixed with the air suctioned from the environment through the joints present in the loop itself.

[0035] Advantageously, the heating plant provides that the initial section 5'" of the suctioned section 5 " is extended for less than a quarter of the suctioned section 5" of the closed loop 5 since the connection of the fume expulsion duct 11 to the closed loop 5 is preferably placed close to the burner 2 (e.g. at a distance variable between 50 cm and 5 meters).

[0036] In accordance with the embodiment illustrated in figure 2, the fume expulsion duct 11 is intercepted by a condensation heat exchanger 15 of air/air type 16. The latter is traversed by a flow of ambient air 21 and is thus susceptible of drawing heat from the fumes 10 drawn by the aspirator 3 from the carrier fluid 9 which flows in the

initial section 5"' of the suctioned section 5" of the closed loop 5 in order to transfer such heat directly into the environment.

[0037] In accordance with the embodiment illustrated in figure 3, the fume expulsion duct 11 is instead differently intercepted by a condensation heat exchanger 15 of air/water type 17. The latter is then traversed by a water flow 20 susceptible of drawing heat from the fumes 10 drawn by the aspirator 3 from the carrier fluid 9 that flows in the initial section 5"' of the suctioned section 5" of the closed loop 5, and of transferring such heat to the water flow, e.g. for sanitary use or preferably as second carrier flow adapted to heat settings with further hot water / air exchangers such as fan coil units, radiators or the like.

[0038] The abovementioned means for detecting the composition of the fumes 13 are situated at the interception of the fume expulsion duct 11 downstream of the fume aspirator 3 and advantageously comprise a well for carrying out the fume combustion analysis.

[0039] In particular, the means for detecting the composition of the fumes 13 comprise a combustion analyzer, e.g. with infrared sensor, or a lambda probe, preferably connected to the aforesaid well in order to intercept the part 10 of carrier fluid 9 extracted by means of the fume expulsion duct 11.

[0040] Advantageously, the heating plant 1 comprises control means 7 operatively connected to the burner 2 and arranged for controlling the air A/gas G ratio of the comburent mixture present inside the combustion chamber 8 of the burner 2.

[0041] Preferably, the control means 7 comprise first supply means 7' operatively connected to the burner 2 and adapted to feed the combustion chamber 8 of the burner 2 with the aforesaid air flow A.

[0042] In particular, the first supply means 7' comprise a first feed duct connected to the burner 2 and intended to be connected to an air source (e.g. the outside environment), and a first control valve, e.g. of shutter type, placed to intercept the aforesaid first feed duct and drivable to regulate the air flow A that traverses such first feed duct.

[0043] Advantageously, the control means 7 comprise second supply means 7" operatively connected to the burner 2 and adapted to feed the combustion chamber 8 of the burner 2 with the aforesaid gas flow G.

[0044] In particular, the second supply means 7" comprise a second feed duct connected to the burner 2 and intended to be connected to a gas source (such as a gas distribution network), and a second control valve (e.g. a solenoid valve) placed to intercept the aforesaid second feed duct and drivable to regulate the gas flow G that traverses such second feed duct. In addition, the heating plant comprises a control unit (not illustrated in the enclosed figures) operatively connected to the means for detecting the composition of the fumes 13 in order to receive measurements indicative of the composition of the fumes, and operatively connected to the control means 7 in order to drive, as a function of the measurements received by the means for detecting the composition of the fumes 13, such control means 7 to regulate the air A/gas G ratio in the comburent mixture inside the combustion chamber 8 of the burner 2.

[0045] Preferably, the control unit comprises a control unit, for example provided with at least one circuit board.

[0046] Advantageously, the control unit is operatively connected to the first supply means 7' in order to drive, as a function of the measurements received by the means for detecting the composition of the fumes 13, the first supply means 7' to regulate the air flow A supplied to the combustion chamber 8 of the burner 2.

[0047] In this manner, advantageously, the control unit of the heating plant 1 according to the present finding is able to control the air/gas ratio inside the combustion chamber 8 in order to optimize the efficiency of the plant 1 and/or ensure the appropriate safety conditions tied to the exhaust emissions.

[0048] For example, the presence of measurements relative to a concentration of O_2 in the fumes (detected by the detection means 13) greater than a specific threshold can be indicative of a combustion that occurs in excess air, with a consequent loss of efficiency. In such operative condition, the control unit drives the first supply means 7' to reduce the air flow A to the combustion chamber 8 in order to ensure an efficient combustion of the gas G conveyed to the combustion chamber 8 itself.

[0049] Advantageously, the control unit is operatively connected to the second supply means 7" in order to drive the latter to regulate the gas flow G supplied to the combustion chamber 8 of the burner 2, in particular as a function of the desired delivery power.

[0050] In accordance with the embodiment illustrated in figure 4, at the connection position 23 of the fume expulsion duct 11, one or more first fans 18 are advantageously arranged that are adapted to send a flow of ambient air 19 (i.e. drawn from the same environment of the building premises where the plant 1 is housed) towards the fume expulsion duct 11 in order to heat and destratify the same ambient air.

[0051] The plant, in accordance with the embodiment of figure 5, can also comprise one or more second fans 18' susceptible of sending a flow of ambient air 19 towards the suctioned section 5" of the closed loop 5 downstream of the initial section 5"'.

[0052] The connection 23 of the fume expulsion duct 11 to the loop 5 is situated downstream of the combustion chamber 8, in a manner such that the composition of the carrier fluid 10 drawn for expulsion is not affected by the oxygen percentage of the ambient air which, being infiltrated through the joints along the entire reduced-pressure loop 5", is mixed with the carrier fluid 9' circulating in the radiating ducts.

[0053] In fact, such oxygen percentage present in the recirculation carrier fluid 9' contributes to the completion of the combustion in chamber 8 and hence is not subsequently present in the fumes 10 that are drawn immedi-

ately downstream of the combustion chamber 8 itself by means of suitable fume duct 11 intercepted by an aspirator 3.

[0054] In said drawing and expulsion duct 11, a condensation heat recuperator 15 can be positioned, constituted by an air/air type exchanger 16, or preferably by an air/water type exchanger 17.

[0055] The positioning of first fans 18 in proximity to the duct 11 for drawing part of the burnt gases to be expelled and, preferably, of the second fans 18' in proximity to the radiating loop 5", has the function of destratifying the surrounding ambient air, more precisely drawing hotter ambient air 19 into the top zone of the room and directing it towards the bottom part of the same, improving the heat comfort of the people present and also reducing the overall energy consumptions.

[0056] The presence of the condensation heat recuperator 15 on the fume drawing and expulsion duct 11 allows lowering the temperature of the fumes 10 to be expelled. All this allows, in addition to having a greater combustion performance, being able to increase the carrier fluid recirculation flow 9' within the radiating loop 5" with the advantage of an increased temperature uniformity over the entire length of the radiating loop 5". From a greater carrier fluid flow 9' there derives a greater average temperature thereof, the latter condition acceptable since it does not affect the temperature value of the burnt gases 10 exiting the expulsion duct 11, for the calculation of the combustion performance.

Claims

1. Heating plant with radiating strips, which comprises:

- a burner (2) provided with a combustion chamber (8) susceptible of generating high-temperature combustion products through the combustion of a comburent mixture comprising at least one air flow (A) and at least one gas flow (G);
- a closed loop (5) of radiating tubes, which conveys a carrier fluid (9) and is connected to said burner (2) in order to receive at its interior said high-temperature combustion products susceptible of heating said carrier fluid (9);
- at least one fan (6) associated with a terminal section (5') of said closed loop (5) of smaller length than the remaining suctioned section (5 ") of said closed loop (5) in order to make said reduced-pressure carrier fluid (9) circulate along the latter suctioned section (5");
- a fume expulsion duct (11) connected to said closed loop in order to extract a part (10) of said carrier fluid (9);

characterized in that said fume expulsion duct (11) is connected to said closed loop (5) in a connection position (23) that delimits, with said combustion chamber (8), an initial section (5"') of said suctioned section (5 "), and is intercepted by an aspirator (3) and by means for detecting the composition of the fumes (13).

2. Heating plant with radiating strips, according to claim 1, **characterized in that** said initial section (5"') of said suctioned section (5") is extended for less than a quarter of the suctioned section (5") of said closed loop (5).

3. Heating plant with radiating strips, according to claim 1, **characterized in that** said fume expulsion duct (11) is intercepted by a condensation heat exchanger (15) of air/air type (16), traversed by a flow of ambient air (21), said heat exchanger (16) being susceptible of drawing heat from the fumes drawn by said aspirator (3) from said carrier fluid in the initial section (5"') of said suctioned section (5 "), and of transferring such heat directly to the environment.

4. Heating plant with radiating strips, according to claim 1, **characterized in that** said fume expulsion duct (11) is intercepted by a condensation heat exchanger (15) of air/water type (17), traversed by a water flow (20), said heat exchanger (17) being susceptible of drawing heat from the fumes drawn by said aspirator (3) from said carrier fluid in the initial section (5"') of said suctioned section (5 "), and of transferring such heat to said water flow.

5. Heating plant with radiating strips, according to any one of the preceding claims, **characterized in that** said means for detecting the composition of the fumes (13) are situated at the interception of said fume expulsion duct (11) downstream of the fume aspirator (3).

6. Heating plant with radiating strips, according to claim 1, **characterized in that** at said fume expulsion duct (11), one or more first fans (18) are arranged that are susceptible of sending an ambient air flow (19) towards said fume expulsion duct (11) in order to heat and destratify the same ambient air.

7. Heating plant with radiating strips, according to claim 1, **characterized in that** it comprises one or more second fans (18') susceptible of sending an ambient air flow (19) towards the suctioned section (5") of said closed loop (5) downstream of said initial section (5"').

8. Heating plant with radiating strips, according to any one of the preceding claims, **characterized in that** it comprises:

- control means (7) operatively connected to said burner (2) and arranged for controlling the air

(A)/gas (G) ratio of said comburent mixture inside the combustion chamber (8) of said burner (2);

- a control unit operatively connected to said means for detecting the composition of the fumes (13) in order to receive measurements indicative of the composition of said fumes, and operatively connected to said control means (7) in order to drive, as a function of said measurements, said control means (7) to regulate the air (A)/gas (G) ratio of said comburent mixture inside the combustion chamber (8) of said burner (2).

9. Heating plant with radiating strips, according to claim 8, **characterized in that** said control means (7) comprise first supply means (7') operatively connected to said burner (2) and adapted to feed the combustion chamber (8) of said burner (2) with said at least one air flow (A);
said control unit being operatively connected to said first supply means (7') in order to drive said first supply means (7') to regulate said air flow (A).

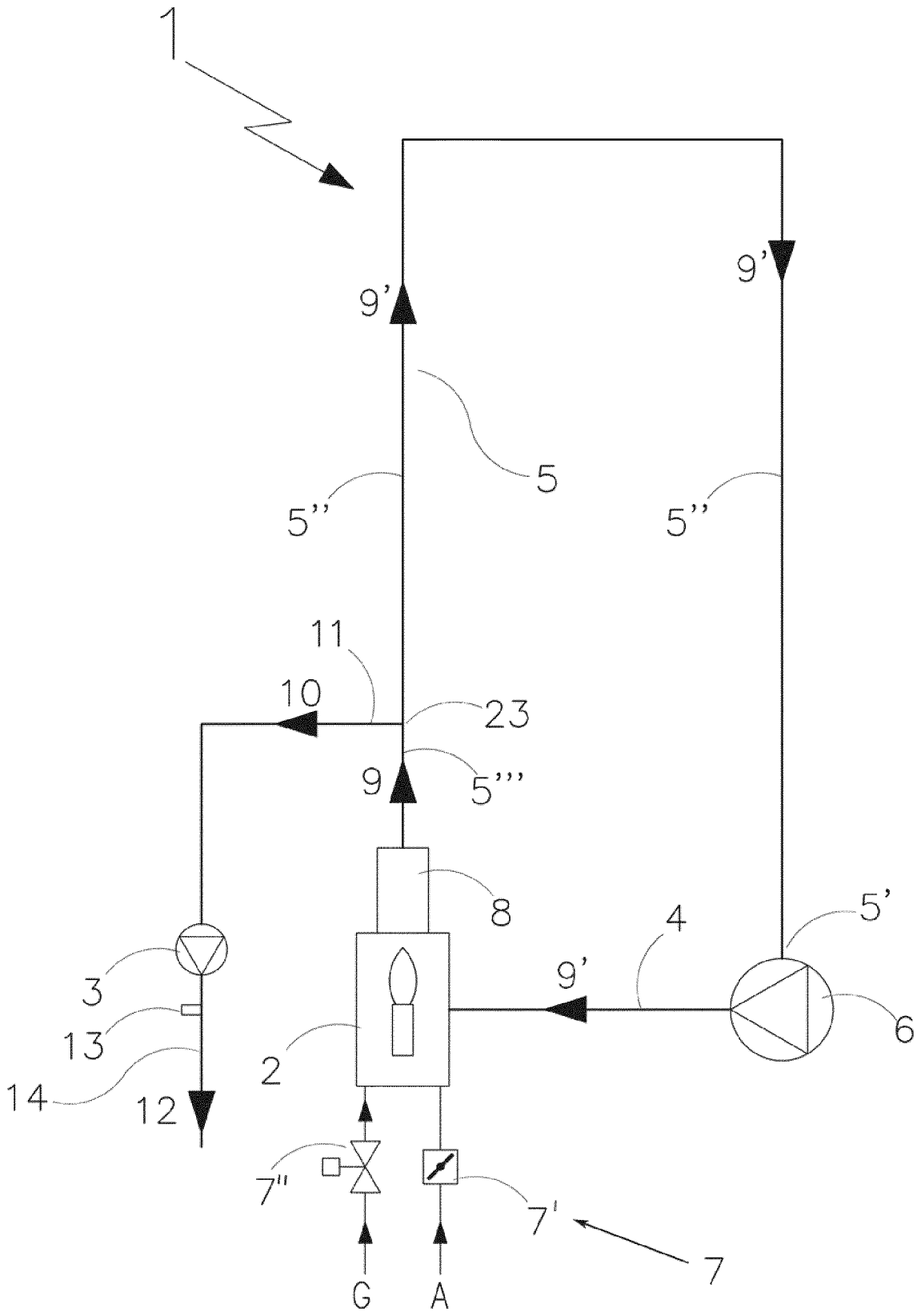

Fig. 1

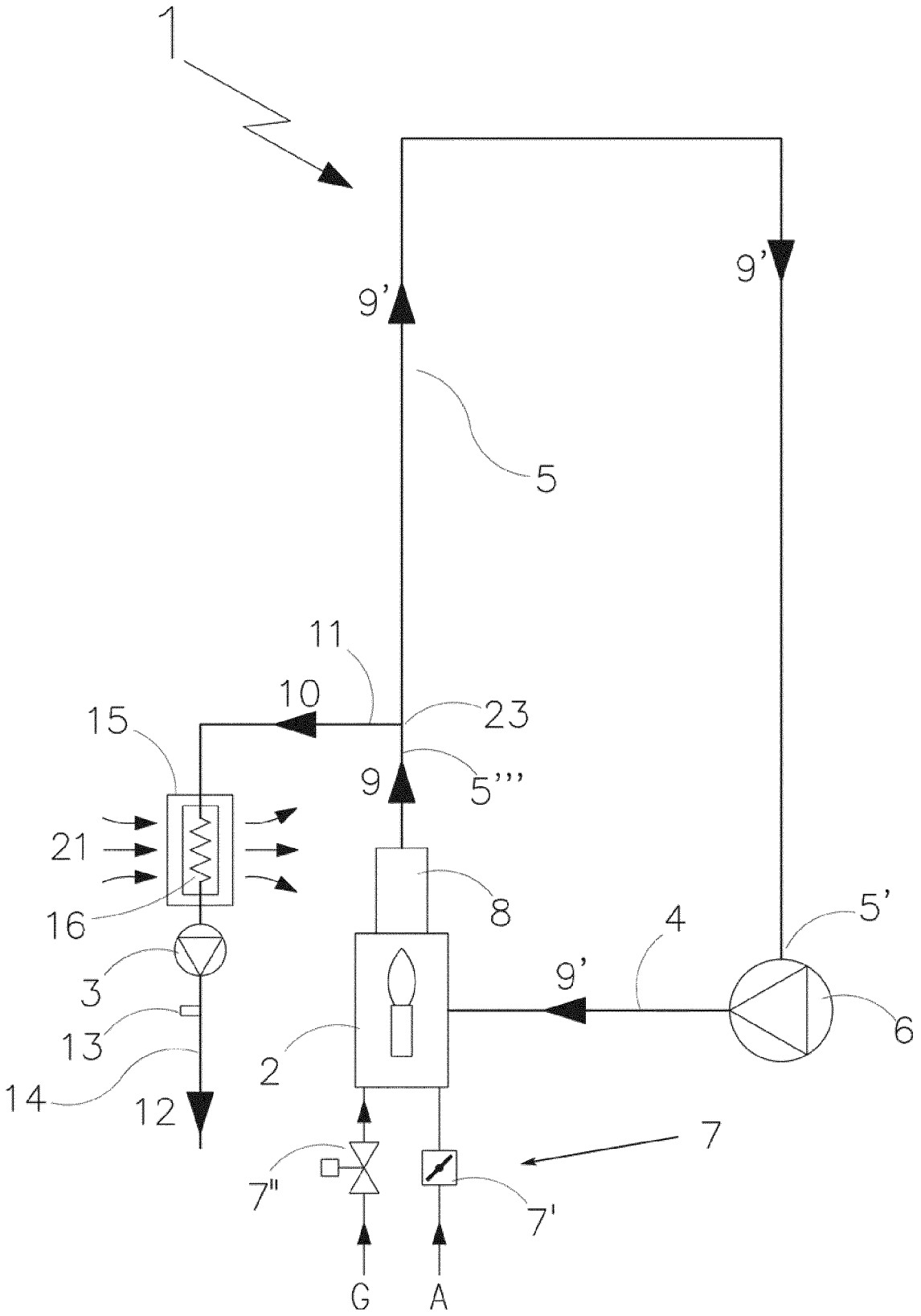

Fig. 2

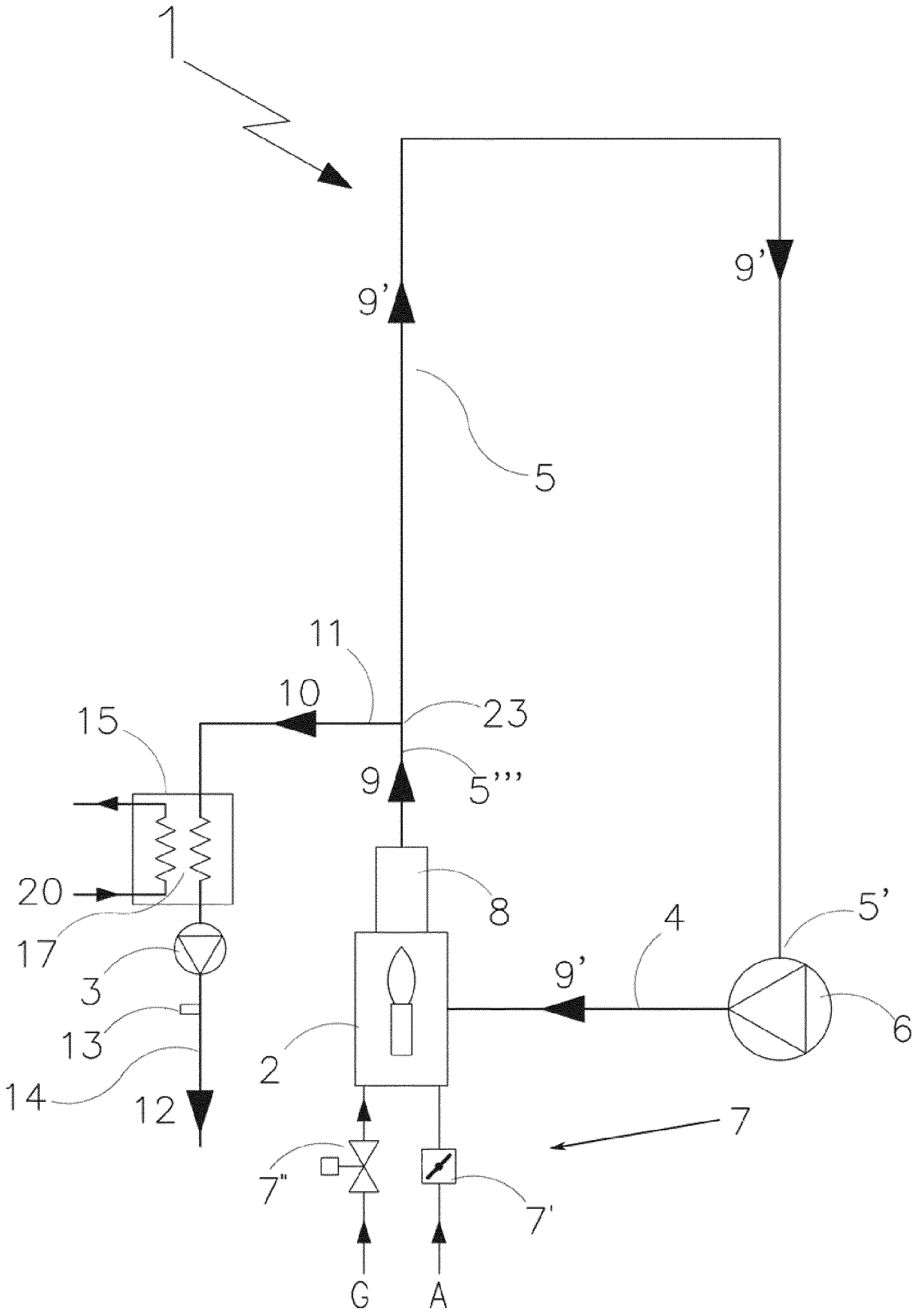

Fig. 3

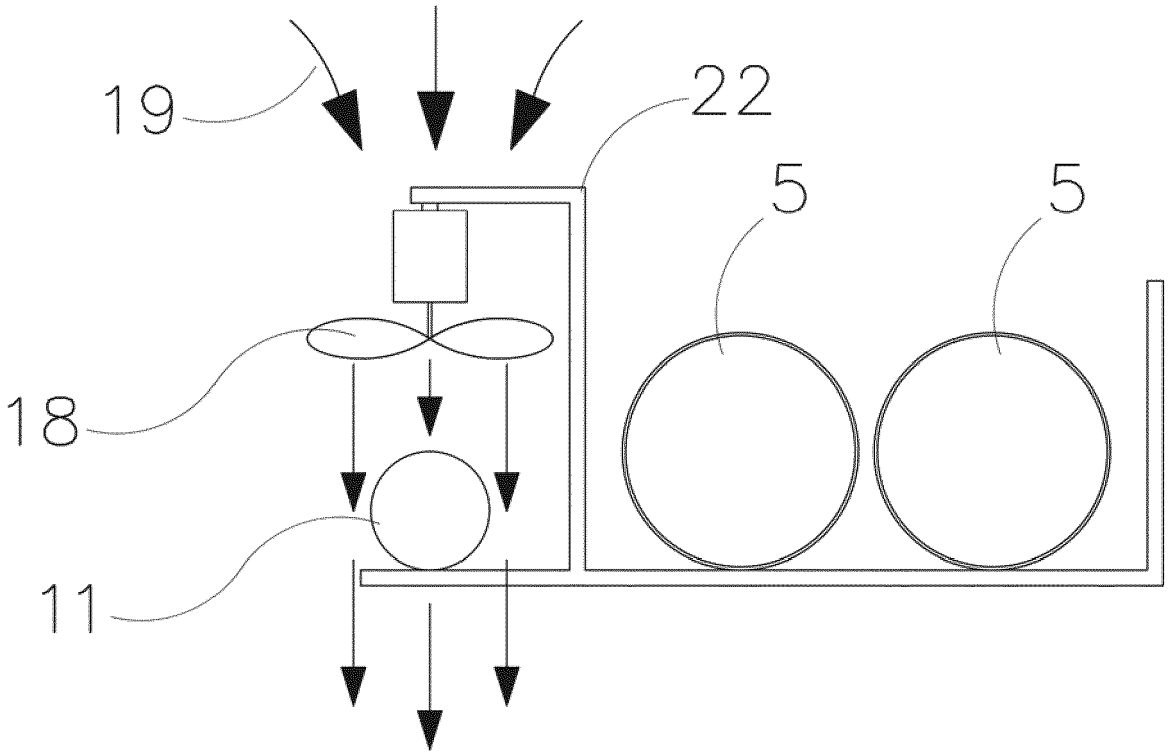

Fig. 4

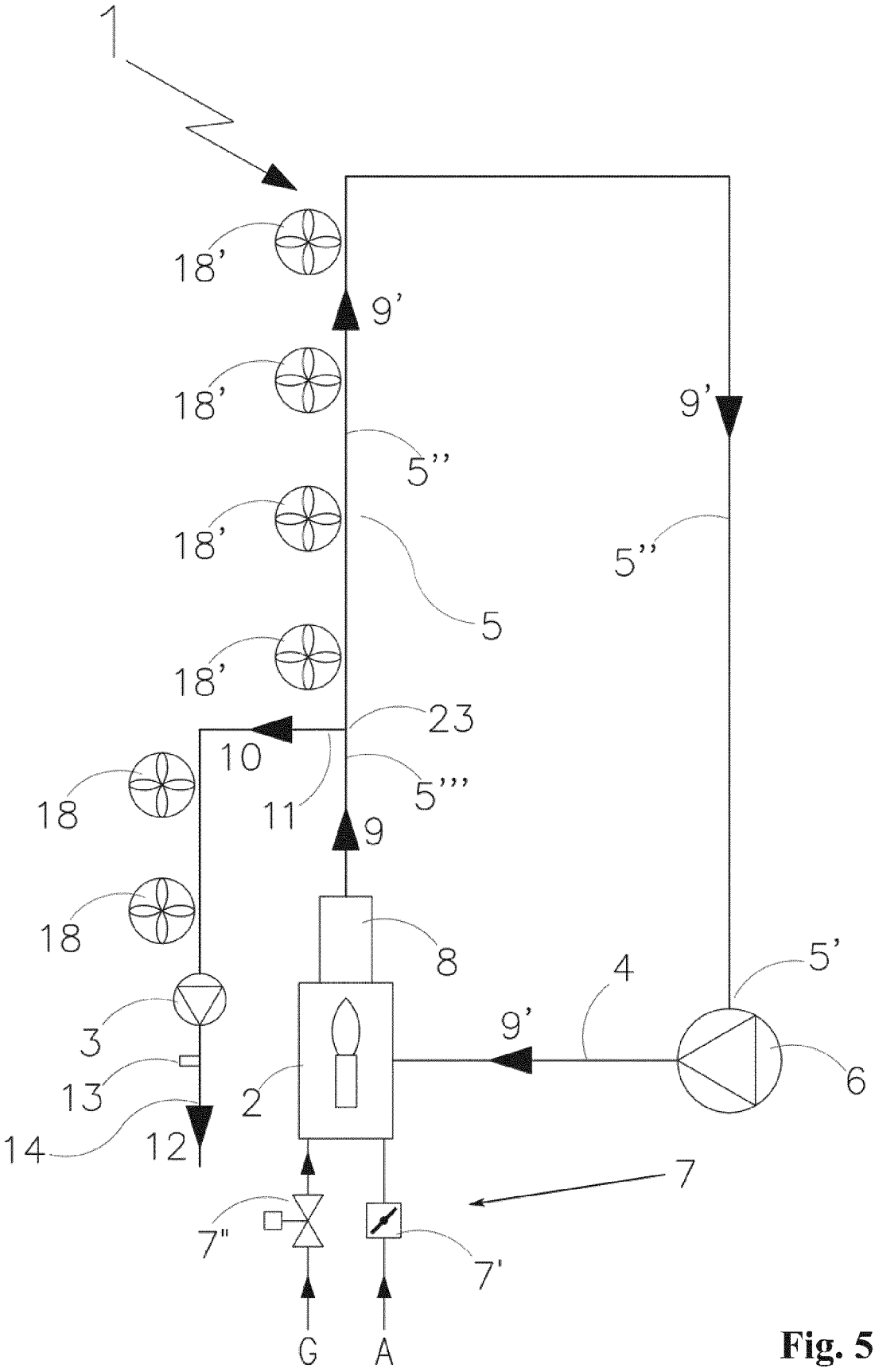

Fig. 5

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Application Number
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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	20 October 2016	Riesen, Jörg

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X : particularly relevant if taken alone
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