

Description

Field of application

[0001] The present invention concerns apparatus for quick production of a hot liquid according to the preamble of the main claim.

[0002] The apparatus in question is intended to be advantageously used for the quick production of a hot liquid to be used for industrial applications or for sanitary and heating purposes both in residential and industrial environments.

[0003] More in detail, the apparatus according to the invention is preferably intended to be used in cases where there can be various needs for instantaneous production of a hot liquid such as water, such as for example the need for heating water at a high pressure and high temperature for industrial applications or for needs regarding heating water at low pressure for sanitary and heating purposes.

[0004] The main industrial application of the apparatus according to the invention is related to instant production of a high pressure hot liquid for independent or single high-pressure water jet machines useable for washing in garages, slaughter houses etc

State of the art

[0005] Currently, as known, available in the market are various different apparatus for instant generation of hot water by means of a boiler with burner - usually diesel - intended to be conveyed at high pressures to one or more jet pipes for high-pressure water jet machines.

[0006] Patent EP 1398577 describes an apparatus for producing high pressure hot water for high-pressure water jet machines, which employs a boiler provided with a gas burner inserted into a combustion chamber, delimited at the upper part by a vat for preheating hot water subjected to atmospheric pressure. Derived from the abovementioned vat is a supply pipe which - by means of a pump - delivers water to a tubular exchanger which develops with a double winding in form of a cylinder, arranged inside the combustion chamber, and connected to the pipe jet to obtain a hot water jet. The fumes exhaust port is arranged adjacent to the gas burner at the same side of the boiler.

[0007] The apparatus described in this patent is not particularly versatile in that it does not allow employing hot water produced for applications different from the high-pressure water jet machines for which it had been designed.

[0008] Furthermore, the configuration of the boiler described above, is poorly practical in the choice of arranging the exhaust system on the part of the burner and it does not allow achieving high performances fully exploiting the fumes pressure produced by the gas burner.

[0009] Patent WO 98/07530 describes an apparatus for producing high pressure hot water for high-pressure

water jet machines similar to the one mentioned above and described in patent EP 1398577, in which, in order to optimise heat transfer, the exchanger is obtained by means of a pipe which is wound in a helical manner forming a cylinder whose height is comprised between 3 and 7 times the internal diameter.

[0010] Patent DE 10041154 describes an apparatus for producing high pressure hot water for high-pressure water jet machines wherein the combustion chamber is partially surrounded by a jacket for preheating water which is then conveyed by means of a pump to the tubular exchanger. Alternatively, patent DE 9310430 describes an analogous apparatus in which the external jacket of the combustion chamber is employed for preheating air.

[0011] Patent FR 2542854 regards an apparatus for producing high pressure hot water for industrial cleaning. The exchanger is made up of a wound pipe 3 with two helices, inserted in a combustion chamber having an external wall with a cavity defining a jacket for preheating water connected to a low-pressure recirculation system with an atmospheric pressure accumulation vat and to a high pressure circuit intercepted by a pump adapted to supply the tubular exchanger with high pressure preheated water.

[0012] Further known are apparatus for producing high pressure hot water for high-pressure water jet machines which employ variously shaped tubular exchangers.

[0013] The exchanger described in patent US 3,785,363 is provided with two tubular exchangers in series one of which at high pressure at direct contact with the fumes and the other at low pressure inserted in a cavity filled with water for preheating the water.

[0014] The exchanger described in patent US 3,051,146 is provided with a tubular exchanger made up of three coaxial cylindrical tubular windings which defines a path for the fumes with exit of gases cooled by the specific part of the burner.

Presentation of the invention

[0015] Thus, in this situation, the essential object of the present finding is that of overcoming the drawbacks revealed by the solutions of the known type, by providing an apparatus for quick production of a hot liquid which allows meeting the various heating needs in an efficient and versatile manner.

[0016] Another object of the present finding is that of providing an apparatus for quick production of a hot liquid capable of exploiting the fumes pressure generated by a gas burner in the exchanger performance to the maximum.

[0017] Another object of the present finding is that of providing an apparatus for quick production of a hot liquid operatively entirely safe and operatively entirely reliable.

[0018] Further object of the present finding is that of providing an apparatus for quick production of a hot liquid such apparatus being easy to install and maintain.

[0019] These and other objects, are all attained by the

apparatus for the quick production of a hot liquid in question according to the attached claims.

Brief description of the drawings

[0020] The technical characteristics of the finding, according to the abovementioned objects, are clearly observable from the content of the claims provided herein-after and the advantages of the same shall be more apparent in the subsequent detailed description, provided with reference to the attached drawings, which represent a strictly exemplifying and nonlimiting embodiment thereof, wherein:

- figure 1 shows a logical operation diagram of the apparatus for quick production of a hot liquid subject of the present invention;
- figure 2 shows a side view of the apparatus for quick production of a hot liquid subject of the present invention in longitudinal section with some parts removed to show the others more clearly;
- figure 3 is a perspective view of the apparatus for quick production of a hot liquid subject of the present invention in longitudinal section with some parts removed to show the others more clearly;
- figure 2' shows a side view of the apparatus for quick production of a hot liquid subject of the present invention in longitudinal section with some variant embodiments and some parts removed to show the others more clearly;
- figure 3' shows a perspective view of the apparatus of figure 2' in longitudinal section.

Detailed description of a preferred embodiment

[0021] According to the figures of the attached drawings, the apparatus for quick production of a hot liquid subject of the present invention was indicated in its entirety with 1.

[0022] The apparatus 1 is adapted to be mainly used for instantaneous production of hot water or any other hot liquid, at high pressure in particular for the operation of high-pressure water jet machines in independent or centralised systems, both fixed and moveable, for example for cleaning garages, slaughter houses or more generally in the food industry, or anywhere a high pressure hot liquid is instantaneously required.

[0023] However, in many cases the demand for high pressure hot water is also accompanied by a more traditional demand of hot water for sanitary purposes or for heating purposes.

[0024] In these cases, the apparatus 1 according to the present invention allows differentiating the operation selectively providing high and low pressure hot water for the specific required use.

[0025] Obviously, without departing from the scope of protection of the present patent, provided for may be other applications of the present apparatus which require

quick times for producing high pressure hot water.

[0026] The apparatus 1 is provided with a metal bearing structure 2, intended to be laid against the ground or bracketed and hanged on a wall, and comprising at least one front wall 3 bearing a burner 4 fixed and a bottom wall 5, removable, made on which is the fumes exhaust port 6.

[0027] More in detail, the apparatus 1 comprises a substantially cylindrical combustion chamber 7 with a longitudinal development axis preferably horizontal, which is held by the bearing structure 2, and it is operatively connected to the gas burner 4 which is partially extended with a torch 4' thereof for a section into the combustion chamber 7 starting from the front wall 3.

[0028] Transfer of heat from the fumes produced by the combustion, to the water in the hydraulic system described hereinafter, occurs by means of two exchangers arranged in series one of which being for low temperature generally indicated with 8 and one for high temperature generally indicated with 9 arranged coaxially inside the former 8.

[0029] The high temperature exchanger 9 is directly heated by means of radiation by the flame of the burner 4 while the low temperature exchanger 8 is touched by the fumes coming from the burner 4 and intended to be evacuated through the exhaust port 6.

[0030] The low temperature exchanger 8 is advantageously made up of several chambers arranged in series and in particular it comprises an annular cylindrical chamber 8', arranged outside the combustion chamber 7, and delimited by two coaxial cylindrical walls, one being internal 10 and the other external 11.

[0031] Operatively, the low temperature exchanger 8 is used for preheating the required water flow. Such flow generally supplies the exchanger 8 by means of a first inlet connection 12 coming from a water supply circuit (for example from the water pipeline) at a temperature generally comprised between 10 and 15°C and it exits from the exchanger through a first outlet connection 13 generally at a temperature comprised between 20 and 30°C.

[0032] The high temperature exchanger 9 indicated above is in turn obtained by means of a pipe which develops with a spiral winding coaxially inside the annular cylindrical chamber 8' of the first low temperature exchanger 8 and coaxially outside with respect to the torch 4' of the burner 4.

[0033] The tubular winding of the high temperature burner 9 laterally delimits the combustion chamber 7 given that the two ends 14, 15 are closed by other chambers of the low temperature exchanger 8 as explained in detail hereinafter.

[0034] The abovementioned high temperature exchanger 9 is supplied at the second connection 17 thereof with the preheated water coming from the low temperature exchanger 8 by means of at least one connection circuit 16, and in turn supplying by means of a second outlet connection 8 a system (or application) operating

at high pressure 19 or low pressure 20, selected depending on the operative mode provided for according to the clarifications outlined hereinafter.

[0035] According to the idea on which the present invention is based, the connection circuit 16 is provided with at least one first three-way valve 21 susceptible to communicate the first outlet connection 13 of the low temperature exchanger 8 with the second inlet connection 17 of the high temperature exchanger 9 selectively by means of a low pressure pump 22 or by means of a high pressure pump 23.

[0036] The second outlet connection 18 of the high temperature exchanger 9 is thus in turn connected by means of a second three-way valve 24 to a system or application operating at high pressure 19, such as for example a high-pressure water jet system, or at low pressure 20 for other usages of the hot fluid.

[0037] The two three-way valves 21 and 24, are controlled by a logic control unit, not illustrated in detail in the attached figures, in a constrained manner so that the low pressure pump 22 and the high pressure pump 23 convey low and high pressure hot water respectively only to the related systems 19 and 20 operating at low and high pressure.

[0038] Obviously, the abovementioned three-way valves may be replaced by equivalent hydraulic solutions such as for example by two two-way valves on the two pipes derived for supplying the two systems 19 and 20 operating at a low and high pressure without departing from the scope of protection of the present patent.

[0039] Therefore, the term "three-way valves" shall hereinafter include equivalent hydraulic solutions for selectively directing a flow towards various directions.

[0040] The previously mentioned gas burner 4 is of the modulating type with pre-mixture of air and methane gas, or lpg or biogas. For this purpose, the burner 4 is provided with a pre-mixing chamber intended to generate a stoichiometric mixture of the fuel gas flow rate and of the oxidising air flow rate, and with a rotor intended to introduce - under pressure - the mixture thus obtained into the combustion chamber 7 so that the torch 4' triggers the combustion thereof generating a flow of hot fumes under pressure.

[0041] In particular, the pressure of the hot fumes must be sufficient to overcome the counterpressure in the combustion chamber 7 due to the particular configuration of the high temperature exchanger 9 which provides for the double inversion of the direction of the fumes to allow them to exit from the opposite part with respect to the burner 4 after having transferred their heating value to the two exchangers 8 and 9.

[0042] In particular, the exit of the fumes shall occur within the range of 60-80°C allowing condensation thereof to recover latent heat and optimise the efficiency. According to a preferred embodiment of the apparatus subject of the present invention, the burner 4 has a maximum heat supply of 83 kW, at which it must overcome an internal counterpressure of the combustion circuit amount-

ing to about 460 Pa to which further 40 Pa are to be added, for a total of 500 Pa, that the burner 4 must produce at that power to overcome the head loss of a fumes exhaust port 6 having a length of 10 m and a diameter of 100 mm.

[0043] The attached diagrams 1 and 2 indicate the characteristic curves of a preferred example of a rotor for the burner 4 of the apparatus 1 subject of the present invention.

[0044] Obviously, slight value differences with respect to the reference values indicated in the aforementioned curves and known to a man skilled in the art, shall be in any case deemed within the preferred example indicated regarding the present apparatus 1.

[0045] More generally, the introduction pressure of the mixture shall be comprised between 400 and 600 Pa with a maximum thermal power comprised between 65 and 100 kW and preferably around 500 Pa with a maximum power of 83 kW.

[0046] The thermal power provided by the burner 4 is constantly modulable during the operation of the apparatus 1 to substantially maintain the temperature preset by the user constant. More clearly, the logic control unit of the apparatus selectively receives temperature signals from at least one first and at least one second temperature detection probe, one respectively associated to a system operating at high pressure and the other to a system operating at low pressure. The temperature signal detected by a probe on any of the two sides determines two different thermodynamic controls by the control unit of the burner 4. In any case, the burner is capable of accurately reproducing the thermal power required to meet the required temperature and water flow rate needs by modulating the introduced air-flow rate to which the corresponding amount of gas that is pre-mixed and introduced into the combustion chamber 7 is related in a suitably calibratable manner.

[0047] Preferably, the apparatus 1 is dimensioned for the production of a hot water flow-rate (or of any other hot liquid) variable between 3 and 350 litres per minute at a pressure comprised between 1 and 200 bars. More in particular, in case the apparatus 1 is used for producing the hot fluid at low pressure, the production of hot fluid typically under pressure comprised in the range between 1-2.5 bars (for example for use in sanitary or heating systems) shall preferably be provided for.

[0048] More in detail, according to the preferred configuration of the apparatus subject of the present invention, the high temperature exchanger 9 is formed by two coaxial tubular windings, one being internal 9' and the other external 9", spaced from each other by a first cavity 25. The two windings develop in a substantially longitudinal direction from the first end 14 of the combustion chamber 7 having the burner 4 associated mounted on the front wall 3, to the second end 15 of the combustion chamber 7 having the fumes evacuation port 6 associated.

[0049] The path of the fumes produced by the burner

4 provides for that the fumes first touch the inner face of the internal winding 9' up to the second end 15 of the combustion chamber 7 at which they are conveyed by a closure plate 26 to perform a first inversion and return longitudinally into the abovementioned first cavity 25 touching the two windings 9' and 9". During the inversion, the fumes pass through the widened turns of the pipe forming the internal winding 9' of the high temperature exchanger 9 and which is connected without interruption with the pipe forming the external winding 9".

[0050] Once they reach at the first end 14 of the combustion chamber 7 again, the fumes are conveyed by a second closure plate 27 to perform a second inversion and to be inserted into a second cavity 28 which remains defined between the external face of the second winding 9" and the internal wall 10 of the annular chamber 8' of the low temperature exchanger 8. Provided for is a sealing bulkhead 50 adapted to prevent the fumes from passing directly into the second cavity 28 towards the exit. Upon exit from the second cavity 28 the fumes are conveyed to exit from the fumes evacuation port 6 which is advantageously arranged in a coaxial and centred position with respect to the combustion chamber 7.

[0051] The low temperature exchanger 8 is made up of several chambers connected to each other forming a complete coating around the combustion chamber isolating it completely from the external environment and allowing a high heat recovery. Furthermore, the arrangement of such chambers, as explained hereinafter, serves to allow the extraction of the high temperature exchanger 9 to allow easy maintenance thereof.

[0052] More in detail, the internal and external cylindrical walls 10, 11 of the annular cylindrical chamber 8' of the low temperature exchanger are connected to at least two septa 29 used for separating the annular chamber 8' in at least two sections connected to each other at the first end 14 of the combustion chamber 7 by means of a connection chamber 8" arranged close to the burner 4 and substantially delimited by the first closure plate 27 and by the front wall 3.

[0053] The low temperature exchanger 8 further comprises a bottom chamber 8"" fixed by welding at the head of the high temperature exchanger 9 at the second end 15 of the combustion chamber 7. The abovementioned bottom chamber 8"" has a diametric overall dimension substantially equivalent to that of the second winding 9" of the high temperature exchanger 9, and it is defined between the first closure plate 26 and a further third closure plate 31 spaced from the first and made on which is the first outlet connection 13.

[0054] The low pressure pump 22 may be fixed on the third plate 31 (see figure 2) or advantageously to the support structure 2 adjacent to the annular chamber 8' (see figure 2').

[0055] As illustrated in the diagram of figure 1, the first three-way valve 21 communicates the first outlet connection 13 of the low temperature exchanger 8 to the high temperature exchanger 9 by means of the low pressure

pump 22 or by means of the high pressure pump 23 arranged downstream of the valve 21. For such purpose, the first three-way valve 21 is connected at the outlet with a branch, to the low pressure pump 22, and with the other branch to the high pressure pump 23 preferably arranged outside the apparatus and being part of a pumping group available separately.

[0056] Hydraulically, such bottom chamber 8"" receives water through a suitable connection 30 from the annular chamber 8' and it sends it to said connection circuit 16 through the first outlet connection 13. Therefore, the water enters the first section of the annular chamber 8' of the first low temperature exchanger 8 and reaches the connection chamber 8" to invert its progress in the second section of the annular chamber 8'. At this point, through the connection 30, it passes into the bottom chamber 8"" integral with the high temperature exchanger 9, from which it exits definitely preheated through the connection 13 to be selectively directed through the first three-way valve 21 to the low pressure pump 22 or to the high pressure pump 23 and hence reach the two windings in series 9' and 9" of the high temperature exchanger 9.

[0057] Lastly, exiting from the high temperature exchanger 9, the hot water is selectively conveyed through the second three-way valve 24 to a high 19 or low 20 pressure system for the desired applications, of the type already mentioned previously.

[0058] Advantageously, the hydraulic circuit of the low temperature exchanger 8 defined in the two sections of the annular chamber 8' is intercepted by an expansion vessel 40, while connected at the bottom chamber 8"" is a safety valve 41 provided in case of overpressures.

[0059] For better heat exchange efficiency, the internal winding 9' of the high temperature exchanger 9 has at least one end portion 60 (see figure 3') at the second end 15 of the combustion chamber 7, which is narrowed in particular with a conical shape to convey the hot fumes which progress longitudinally in the combustion chamber 7 towards the bottom chamber 8"" facilitating the inversion towards the connection chamber 8".

[0060] Advantageously, according to a preferred characteristic of the present invention, the high pressure exchanger 9 is slidably extractable from the second end 15 of the combustion chamber 7 upon removal of the preset removable fixing means 31, the bottom wall 5 and the connection between 30 the bottom chamber 8"" and the annular chamber 8'.

[0061] The abovementioned removable fixing means 31 are advantageously of the screw/female-screw type and they provide for that the ends of the inlet and outlet connections 17 and 18 of the pipe forming the windings 9', 9" of the high pressure exchanger 9 be threaded and projecting from through holes obtained in the front wall 3 to be engaged by counter-threaded bolts thus positioned in such manner to block the high pressure exchanger 9 inside the combustion chamber 7.

[0062] Analogously the bottom wall 5 may be easily removed by unscrewing stop screws 32 which engage it

in a removable manner against the support structure 2.

[0063] The finding thus conceived attains the preset objects.

[0064] Obviously the finding may acquire, in its practical assembly, even shapes and configurations different from the one described above without departing from the present scope of protection. Furthermore, all details may be replaced by technically equivalent elements and the shapes, dimensions and materials used may vary depending on the requirements.

Claims

1. Apparatus for quick production of a hot liquid, such apparatus comprising:

- a bearing structure intended to be laid against the ground;
- a combustion chamber supported by said bearing structure and operatively associated to a fuel burner partially extended thereinto starting from a first end;
- at least one low temperature exchanger comprising an annular chamber for holding water, delimited by two coaxial walls, one being internal and the other external, arranged outside said combustion chamber; said low temperature exchanger being adapted to preheat a liquid flow;
- at least one high temperature exchanger provided with a pipe which develops with spiral winding coaxially inside said annular chamber, and for at least partial delimitation of said combustion chamber; said high temperature exchanger being supplied with the preheated liquid flow coming from said low temperature exchanger through at least one connection circuit, and being adapted to produce liquid at the desired final temperature;

characterised in that the internal and external cylindrical walls of said low temperature exchanger are connected by at least two septa aimed at partitioning said annular chamber into at least two sections connected to each other at one end by means of a connection chamber arranged close to the burner, said low temperature exchanger comprising a bottom chamber fixed at the head to the high temperature exchanger at said second end, connected by means of a connection to said annular chamber and by means of a first outlet connection to said connection circuit for the hydraulic connection in series with the high temperature exchanger.

2. Apparatus according to claim 1, **characterised in that** said connection circuit is provided with at least one prima three-way valve susceptible to communicate said low temperature exchanger with said high

temperature exchanger selectively by means of a low pressure pump or by means of a high pressure pump.

3. Apparatus according to claim 2, **characterised in that** it comprises at least one second three-way valve susceptible to communicate the outlet of said high temperature exchanger with a system or application functioning at a high pressure or at a low pressure at the operative position of said first three-way valve.

4. Apparatus according to claim 1, **characterised in that** said gas burner is provided with:

- a pre-mixing chamber provided for generating a stoichiometric mixture of the fuel gas flow rate and of the oxidising air flow rate;
- a rotor provided for introducing - under pressure - said mixture into said combustion chamber being provided with a torch for the combustion of said mixture and for the generation of a flow of hot fumes.

5. Apparatus according to claim 4, **characterised in that** the introduction pressure of said mixture is comprised between 400 and 600 Pa with a maximum thermal power comprised between 65 and 100 kW and preferably around 500 Pa with a maximum power of 83 kW.

6. Apparatus according to claim 1, **characterised in that** said high temperature exchanger is made up of two coaxial tubular windings, one being internal and the other external, spaced from each other by a first cavity, such windings developing in substantially longitudinal direction from the first end of the combustion chamber having said burner associated to the second end of the combustion chamber having the fumes evacuation port associated thereto, **characterised in that** said fumes first touch the internal face of said internal winding, then they return longitudinally passing through the first cavity between the two windings and then they pass through a second cavity defined between the external face of said second winding and the internal wall of said low temperature exchanger up to exiting from said fumes evacuation port.

7. Apparatus according to claim 1, **characterised in that** said connection chamber is arranged close to the burner and in particular it is defined by a front wall for holding the burner and by a first plate for closing said combustion chamber.

8. Apparatus according to claim 1, **characterised in that** said high temperature exchanger is held in said combustion chamber by means of removable fixing

means, in particular a screw/female screw.

9. Apparatus according to claim 8, **characterised in that** said high pressure exchanger is provided with inlet and outlet connection ends threaded and projecting from through holes made in said front wall and **characterised in that** said removable fixing means comprise counter-threaded bolts susceptible to be engaged to the threaded ends of said connections to block said high pressure exchanger inside said combustion chamber. 5 10
10. Apparatus according to claim 8, **characterised in that** said high pressure exchanger is slidably extractable from said second end of combustion chamber upon removal of said removable fixing means as well as said bottom wall and said connection between said bottom chamber and said annular chamber. 15 20
11. Apparatus according to claim 6, **characterised in that** the internal winding of said high temperature exchanger is provided with a narrow end portion in particular conical arranged at said second end of said combustion chamber. 25
12. Apparatus according to claim 2, **characterised in that** it comprises a unit for controlling said burner connected to said three-way valves for selecting the boiler operation mode. 30
13. Apparatus according to claim 1, **characterised in that** said burner is connected to a first and to a second temperature detection probe respectively associated to said system operating at high pressure or low pressure, the detection of a temperature signal by a probe on one side or the other determining two different thermodynamic controls of the burner. 35 40 45 50 55

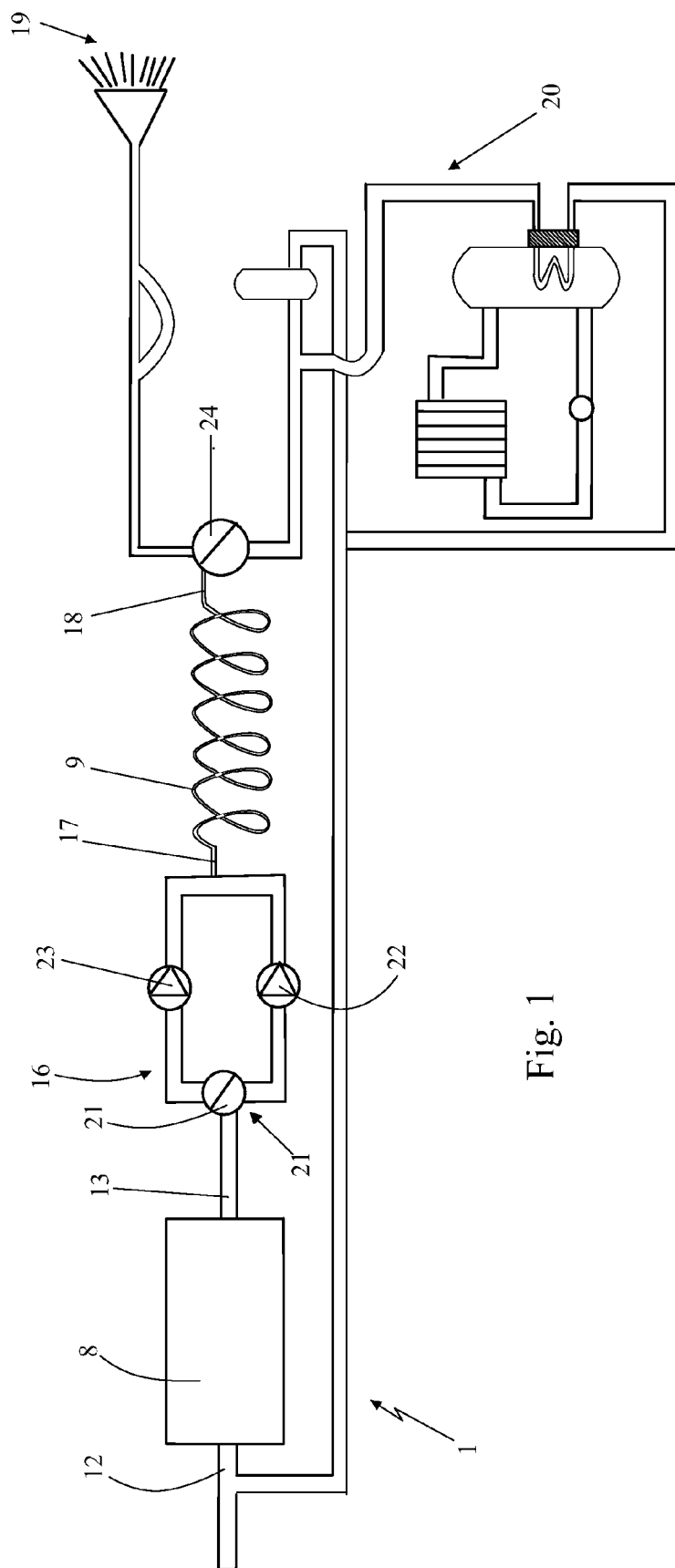


Fig. 1

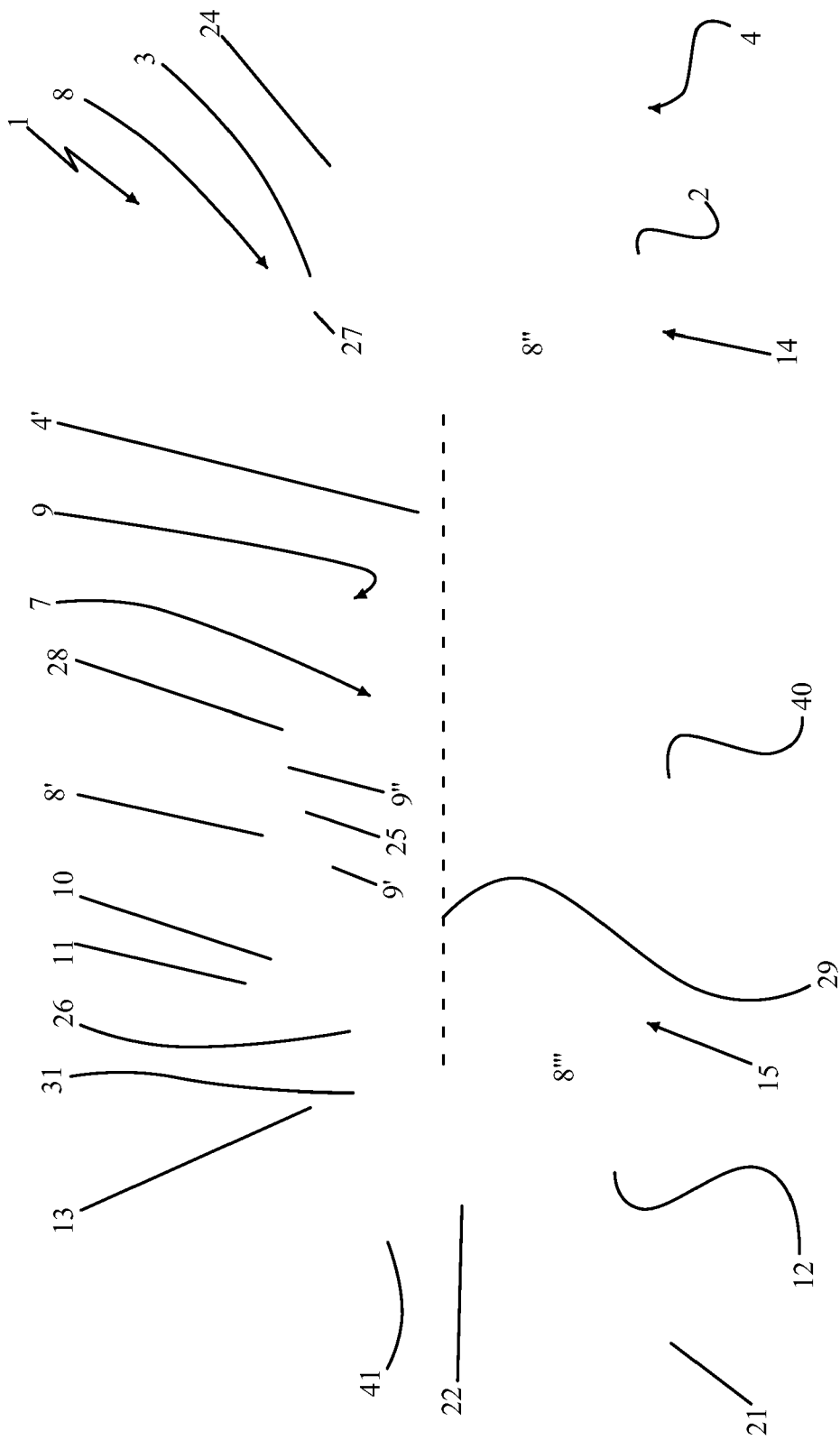


Fig. 2

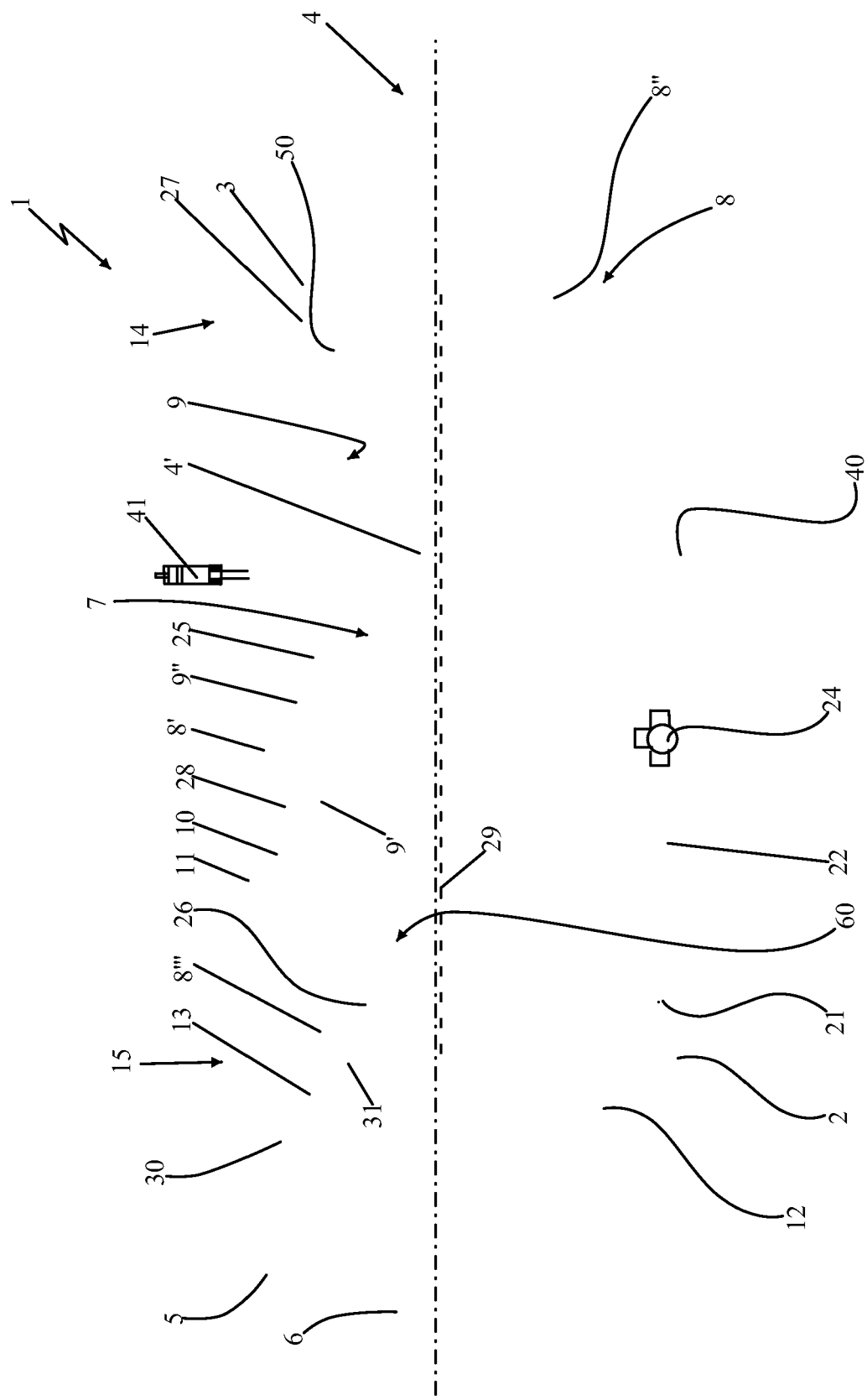


Fig. 2'

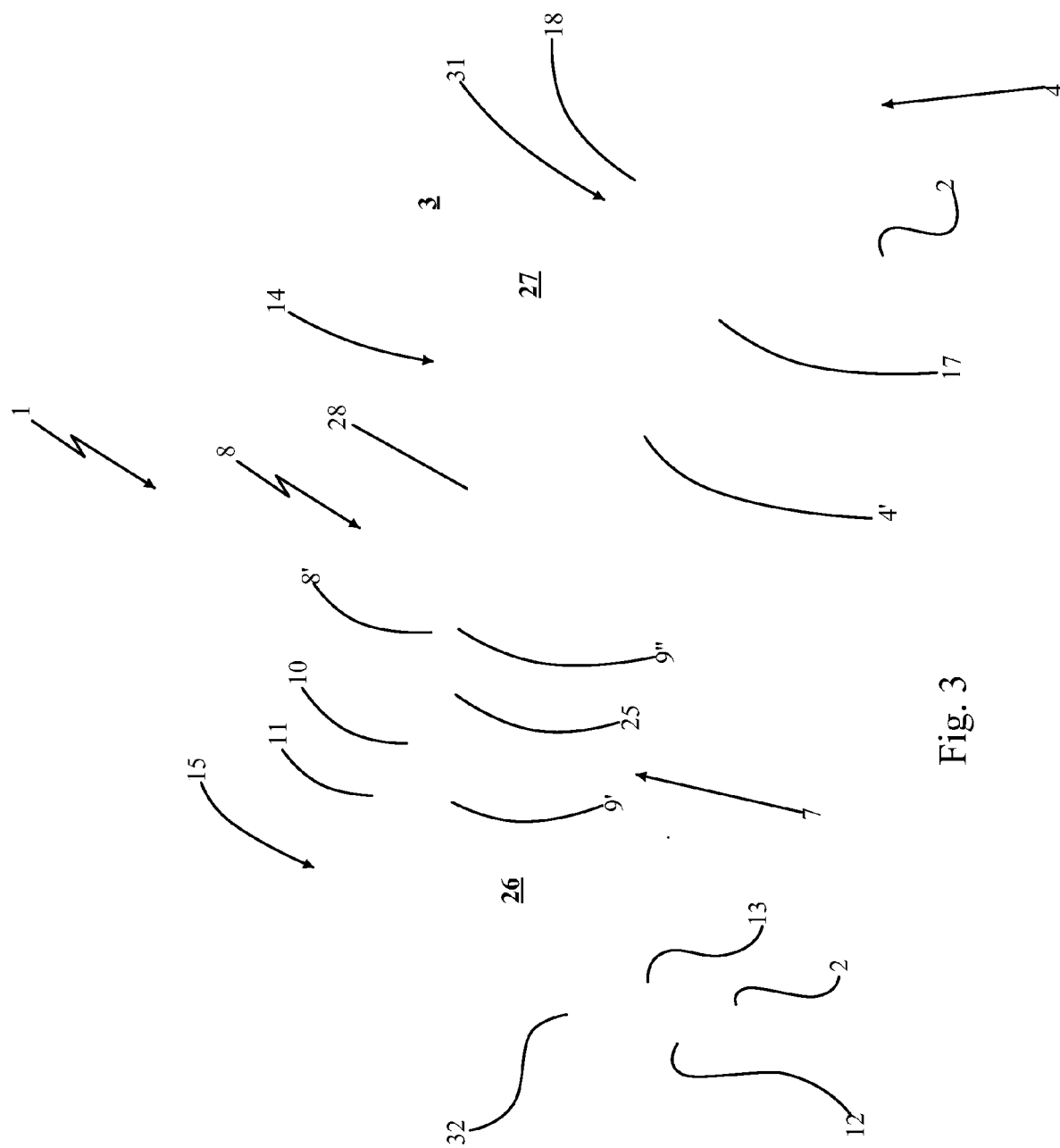


Fig. 3

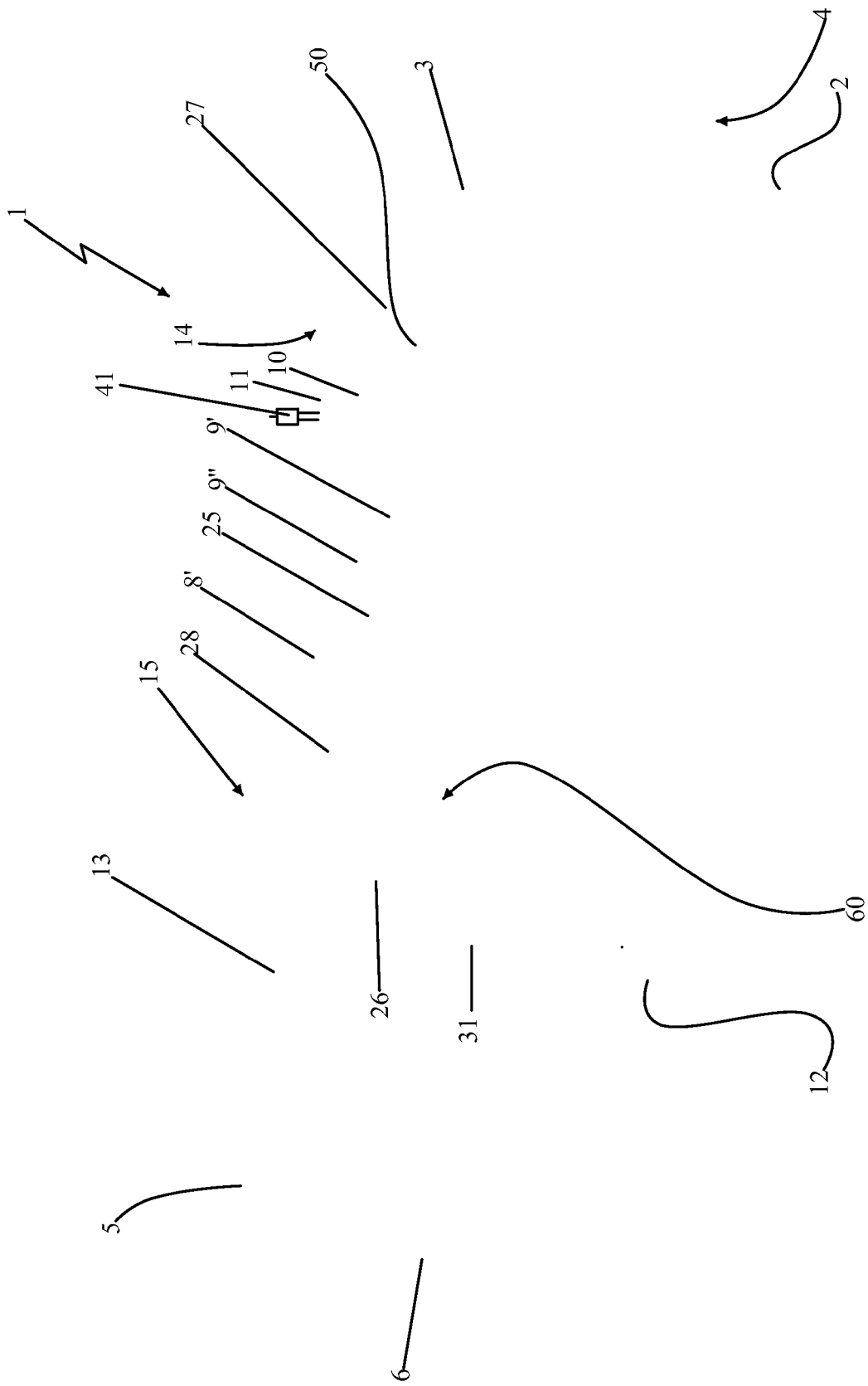


Fig. 3'

REFERENCES CITED IN THE DESCRIPTION

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