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(54) WARM WATER SUPPLY SYSTEM

(57) The present invention relates to a warm water supply system, comprising:
- a cold water supply;
- a hot water appliance having a cold water input connected to the cold water supply, and a hot water output;
- a tap connected to the hot water output; and
- a flow restrictor arranged in a hot water supply circuit upstream of the tap.

More in detail, the invention relates to the feature, that the flow restrictor is arranged upstream of a heater in the hot water appliance.

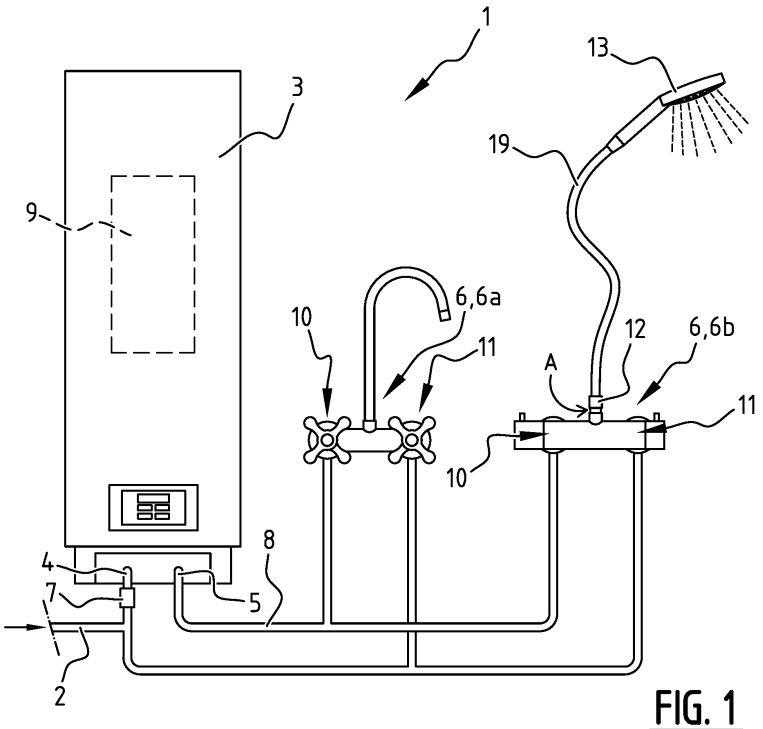

FIG. 1

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Description

[0001] The present invention relates to a warm water supply system.

[0002] Some buildings are equipped with a hot water appliance with a tankless (or instantaneous) water heater that is configured to heat water directly and only upon demand, without the use of a storage tank. Thus, cold water is heated while it flows through the water heater. Water is only heated on demand, and there are no limits on the amount of water and time.

[0003] Other buildings are equipped with a hot water appliance of the conventional geyser type or a storage tank. However, due to increasing demands on sustainability and safety, the geyser type water heaters are nowadays often replaced by a storage water heater that comprises an insulated storage tank that holds a quantity of heated water. For domestic use, a typical volume of the storage tank is e.g. 30 to 150 liter. When the water temperature in the storage tank drops below a preset temperature level, the heater is activated to bring the water temperature back up. As energy is consumed for heating the water in the storage tank, increased sustainability is obtained if the volume of the storage tank is reduced. On the other hand, heating cold water in the storage tank takes considerable time. Therefore, it is important to balance a desired output level of heated water with a required volume of the storage tank. During hot water use, e.g. when a user takes a shower, hot water is taken from the storage tank. Simultaneously, a new supply of cold water may be heated, but the rate thereof is generally not sufficient to keep up with the demand of hot water. Consequently, the storage tank will gradually run out of hot water. Using a sufficient volume of the storage tank allows a user to use water for a specific time, e.g. take a shower for fifteen minutes. Especially when multiple users take a shower successively, the last one may undesirably end up with a refreshing cold water shower.

[0004] In addition to user comfort expressed in available hot water supply, which is directly linked to e.g. showering time, another aspect of user comfort is the user perceived flow rate of hot water. During showering, people tend to favor a high flow rate, and sizes of showers are ever increasing. Especially so-called rain showers put high demands on water usage.

[0005] Thus, there is a need for an improved warm water supply system that is optimized to meet the conflicting demands of sustainability and user comfort.

[0006] In this respect, DE 10 2006 034 275 is acknowledged here to disclose a hot water appliance, having a jet pump operating according to the Venturi principle and a safety valve on an air inlet. The prior art jet pump is integrated into the hot water appliance and introduces air into a flow of water heated by a heater in the hot water appliance, as the heated water is output from the hot water appliance. The introduction of air, in particular at room temperature, contributes to reducing water throughput there through and consequently consumption of heated water is reduced, while maintaining the user perceived sense of user comfort in terms of a full flow rate of heated water while for example showering, whereas the heated water consumption is reduced nonetheless.

[0007] Additionally, reference is made here to WO 2004/088051, which discloses a warm water supply system including a hot water appliance with a hot water output pipe and a diverter valve assembly in the hot water output pipe leading to a tap. From the diverter valve assembly, water in the hot water output pipe, that has been previously heated and output from the hot water appliance but since then has cooled down in the hot water output pipe, is returned to a cold water supply pipe to be reheated, with new cold water, by the hot water appliance. At the connection from the diverter valve assembly to the cold water supply, a Venturi device is provided to mix the previously heated but cooled down water into cold water from the cold water supply. The Venturi device of WO 2004/088051 is entirely intended to effectively and properly mix the cooled down water from the diverter valve assembly, having a residual temperature that may be higher than the temperature of the cold water supply, with a fresh supply of cold water, to be heated together by the hot water appliance, and consequently has no influence on a flow rate of water passing there through.

[0008] The disclosure of DE 10 2006 034 275, which is considered to constitute the closest prior art relative to which at least features in the characterizing portion of the appended independent claim are novel and impart the presence of an inventive step for the present invention or disclosure as a whole, exhibits a number of disadvantages. For example, the jet pump operating according to the Venturi principle exhibits a considerable pressure drop across it, causing intense turbulence. Notwithstanding this turbulence, a considerable calcium deposition is generated. The Venturi effect causes considerable turbulence in the previously heated water, but the calcium deposition was unexplainably aggravated nonetheless, endangering proper function of the jet pump after only a short while in operation. These issues of DE 10 2004 034 275 have baffled skilled persons for years; the disclosure of DE 10 2006 034 275 precedes the present disclosure by more than 10 years. Furthermore, the sought effect of reducing heated water consumption has turned out to be far less than hoped and/or expected.

[0009] An object of the present invention is to provide a warm water supply system, that is improved relative to the closest prior art and wherein at least one of the above stated problems of the acknowledged prior art and/or disadvantages of any other prior art publications is obviated or at least reduced.

[0010] Said object and/or other benefits or inventive effects are achieved with the warm water supply system according to claim 1 of the present invention, comprising:

- a cold water supply;
- a hot water appliance having a cold water input con-

nected to the cold water supply, a heater for heating supplied cold water, and a hot water output;
- a tap connected to the hot water output; and
- an air injector arranged downstream of the heater of the in the hot water appliance.

[0011] In addition, a flow restrictor is arranged upstream of the heater of the hot water appliance. This is to say that the flow restrictor may be arranged in the cold water supply to the hot water appliance.

[0012] The flow restrictor restricts the flow of hot water to and through the heater of the hot water appliance, and may be mixed with cold water from the cold water supply in a mixing tap. Positioning of the flow restrictor upstream of the the heater allows reduction of the flow of cold water to and hot water from the hot water appliance, while the reduction in flow rate of heated water allows more effective injection of warm air, which is for example at room temperature, to secure the user comfort in terms of the user perceived flow rate of the hot water user. In a mixing tap, a desired water temperature may be set. The flow restrictor thus reduces intake of cold water into the hot water appliance and therefore the amount of hot water used per unit of time, and results in an increased sustainability. The present disclosure therefore prescribes provision of multiple elements / components: the flow restrictor before the heater and the air injector behind the heater, relative to the flow direction of water through the system, which runs contrary to the skilled person's natural inclinations in the field of water heating, in which minimization of numbers of components is a high goal. The flow restrictor also is capable of reducing a pressure drop.

[0013] Preferred embodiments are the subject of the dependent claims.

[0014] In more detail, the flow restrictor may be configured to reduce water flow therethrough without introducing air into the flow of cold water to the heater of the hot water appliance. Injected air could expand much more than water when heated by the heater of the hot water appliance to cause damage to the hot water appliance, which also prevents the skilled person from contemplating a change of the configuration according to DE 10 2006 034 275 to arrange the air injector known therefrom on an input or supply side into the heater of the hot water appliance, instead of the prior disclosed position of the air injector after the heater in the flow direction. This configuration according to the present disclosure therefore allows a reduction in the flow rate of heated water to be controlled from the side of the cold water supply to the hot water appliance, while the air injector compensates for any user perceived reduction in comfort in terms of the perceived flow rate of the hot or heated water, emanating from the tap.

[0015] In the following description preferred embodiments of the present invention are further elucidated with reference to the drawing, in which:

Figure 1 is a schematic view of a warm water supply system according to the invention;
Figure 2 is a perspective view of a flow restrictor according to the invention;
Figure 3 is a perspective view of an air injector according to the invention;
Figure 4 is a cross sectional view of the air injector of Figure 3; and
Figure 5 is a graph showing the water temperature plotted against the time for multiple situations.

[0016] The warm water supply system 1 as shown in Figure 1 comprises a cold water supply 2, a hot water appliance 3 having a cold water input 4 connected to the cold water supply 2, and a hot water output 5, a tap 6 connected to the hot water output 5, and a flow restrictor 7 arranged in a hot water supply circuit upstream of the tap 6. The hot water supply circuit comprises the cold water supply 2, the hot water appliance 3 that heats the cold water, and a hot water connection 8 that connects the tap 6 to the hot water output 5.

[0017] The flow restrictor 7 may be arranged anywhere in the hot water supply circuit, but is preferably arranged at or near the hot water appliance 3. In this way, one flow restrictor 7 may be functional for multiple taps 6 that are arranged downstream of this flow restrictor 7. If a flow restrictor 7 would be arranged near the tap 6, this would require further taps 6 to be equipped with a dedicated flow restrictor 7.

[0018] As shown in Figure 1, the flow restrictor 7 is arranged upstream of a heater 9 in the hot water appliance 3. A flow restrictor 7 that is arranged upstream of the heater 9, is arranged in cold water, and is therefore less susceptible for calcification.

[0019] More specifically, the flow restrictor 7 may be arranged in the cold water supply 2 connected to the cold water input 4 of the hot water appliance 3.

[0020] A typical flow rate in a cold water supply 2 is about 12 L/min. If a flow restrictor 7 is arranged in the cold water supply 2 as shown in Figure 1, the flow rate that is supplied to the hot water appliance 3 is restricted to e.g. 5 L/min. Dependent on the design of the flow restrictor 7, the skilled person may select a predetermined flow rate.

[0021] If the flow rate of cold water supplied to the hot water appliance 3 is limited to 5 L/min, this will also be the flow rate of hot water leaving the hot water appliance 3 at the hot water output 5 thereof.

[0022] In Figure 1, the taps 6 are mixing taps 6a. 6b, which are connected to the hot water connection 8 with hot water at a maximum flow rate of 5 L/min, and to the cold water supply 2 with a flow rate of 12 L/min. At the tap, cold water is available at a maximum flow rate of 12 L/ min. When warm water is required, cold water is mixed with hot water. This hot water is available at a maximum flow rate of 5L/min. If both the hot water valve 10 and the cold water valve 11 of the mixing taps 6b, 6a are opened fully in a mixing state, the flow rate of the mixed water

will be approximately 7,6 L/min with a temperature of about 40 °C.

[0023] Contrary to the water tap 6a (left water tap in Figure 1), a flow rate of 7,6 L/min may be experienced as too weak when a user takes a shower (right water tap 6b in Figure 1). In order to enhance the perceived flow rate, an air injector 12 may be arranged downstream of a valve 10, 11 in the tap 6, 6b. A shower head 13 is connected to the mixing tap 6, 6b. The air injector 12 is configured to suck in surrounding air, as indicated with the arrow A.

[0024] Preferably, the air injector 12 is arranged near the water tap 6, 6b. The air injector 12 comprises one ore more than one opening 18 that allow air A to be sucked in due to the venturi effect. However, when the valves 10, 11 of the water tap 6, 6b are closed and the flow of water stops, also the venturi effect stops. The one ore more than one opening 18 now allow water in the hose 19 to flow out of the opening 18 into the shower cabin. This reduces dripping of water out of the shower head 13 after showering, and moreover reduces legionella related risks.

[0025] Figure 2 shows a perspective view of a flow restrictor 7. Figure 3 shows a perspective view of an air injector 12, of which a cross-sectional view is shown in Figure 4.

[0026] Figure 5 shows a diagram, wherein the water temperature in degrees Celsius (°C) (y-axis) is plotted against the time in minutes of a storage tank 80 liter. Each line 14, 15, 16, 17 is set to match in perceived flow rate at the shower head 13. The cold water supply 2 had a flow rate of 12 L/min.

[0027] Line 14 shows how the temperature of the mixed water drops over time in a conventional situation, i.e. without a flow restrictor 7 or air injector 12.

[0028] If only a flow restrictor 7 is used to limit the flow rate to 5 L/min (in line with the description of Figure 1 above), a user gains approximately 5 minutes in time at a specific water temperature (see e.g. at 25 °C). This situation is indicated with line 15 in Figure 5.

[0029] If only an air injector 12 is used, additional air is supplied to the flow of mixed water. Consequently, the perceived flow rate is higher than the actual flow rate. If the perceived flow rate is set to match the situation of line 14, the actual flow rate of the water can be set to a lower level. Consequently, a user gains approximately 8 minutes in time at a specific water temperature (see e.g. at 25 °C) if only an air injector 12 is used.

[0030] If a flow restrictor 7 and an air injector 12 are applied in combination, a user gains approximately 11 minutes in time at a specific water temperature (see e.g. at 25 °C). The flow restrictor 7 reduces the flow of hot water which increases the time span a user may enjoy a comfortable hot shower, whereas the air injector 12 further increases this time span by mixing air into the flow of mixed water. Using a flow restrictor, a mixed flow of e.g. 7,6 L/min with a temperature of 40 °C is obtained. However, using the air injector 12, the additional air results in a perceived flow by a user of the shower in the range of 10-15 L/min.

[0031] The present invention is particularly suitable for hot water appliances 3 that comprise a storage water heater, because they have a limited hot water capacity. However, the skilled person will understand that a flow restrictor 7 and/or an air injector 12 may also be applied with other types of hot water appliances 3.

[0032] The flow restrictor and air injector as described are preferably applied in combination, but may also be applied independently of each other.

[0033] The above described embodiment is intended only to illustrate the invention and not to limit in any way the scope of the invention. Accordingly, it should be understood that where features mentioned in the appended claims are followed by reference signs, such signs are included solely for the purpose of enhancing the intelligibility of the claims and are in no way limiting on the scope of the claims. The scope of the invention is defined solely by the following claims.

Claims

1. Warm water supply system, comprising:

   - a cold water supply;
   - a hot water appliance having a cold water input connected to the cold water supply, a heater for heating supplied cold water, and a hot water output;
   - a tap connected to the hot water output; and
   - an air injector arranged downstream of the heater of the in the hot water appliance,
   CHARACTERISED BY THAT
   - a flow restrictor arranged upstream of the heater of the hot water appliance.

2. Warm water supply system according to any of the foregoing claims, wherein the flow restrictor is arranged in the cold water supply connected to the cold water input of the hot water appliance.

3. Warm water supply system according to claim 1 or 2, wherein the flow restrictor is configured to reduce water flow therethrough without introducing air into the flow of cold water to the heater of the hot water appliance.

4. Warm water supply system according to claim 3, wherein the air injector is configured to suck in surrounding air.

5. Warm water supply system according to any of the foregoing claims, wherein the tap is a mixing tap that is also connected to the cold water supply.

6. Warm water supply system according to any of the

foregoing claims, wherein a shower head is connected to the tap.

7. Warm water supply system according to any of the foregoing claims, wherein the hot water appliance comprises a storage water heater.

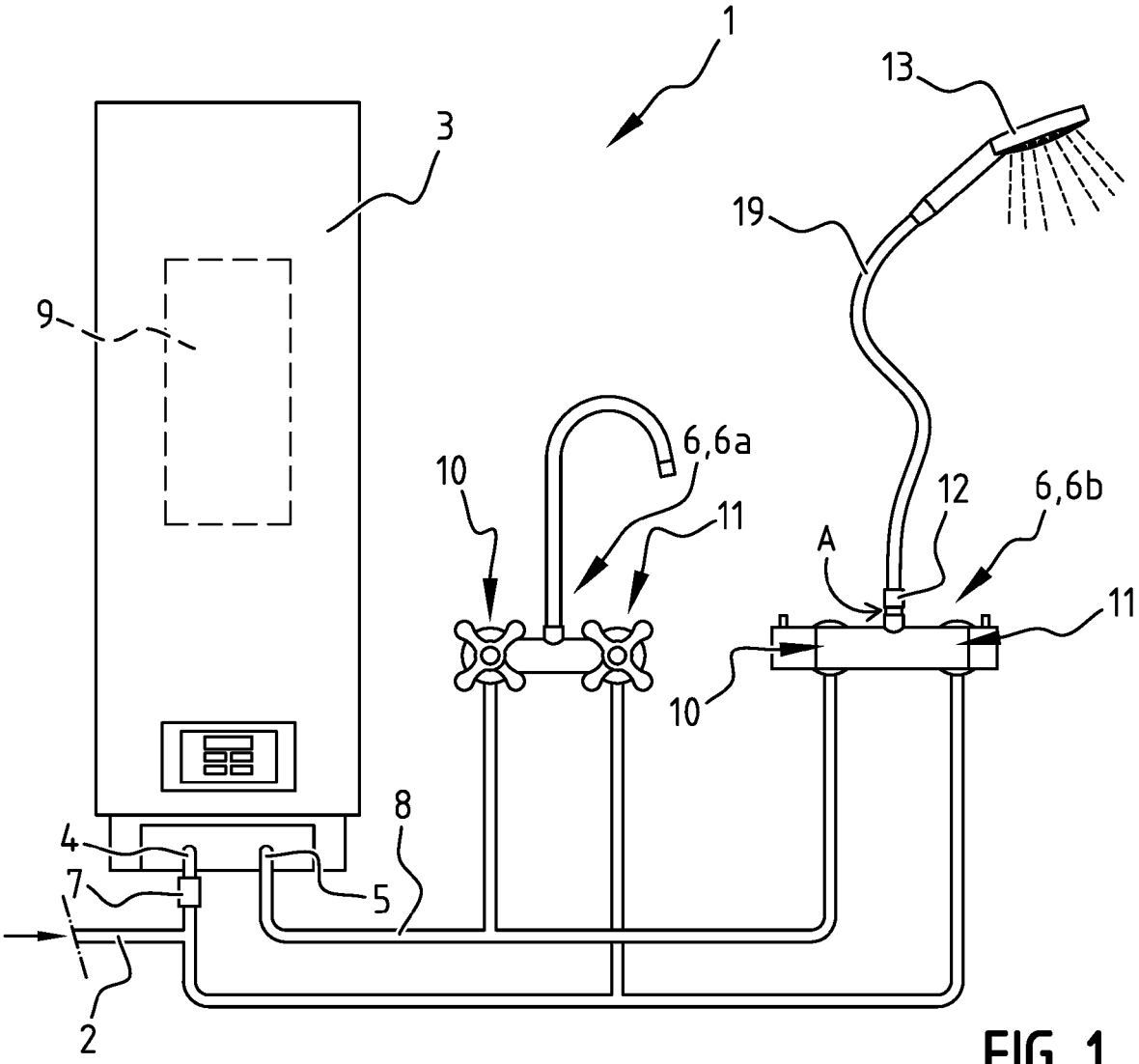

FIG. 1

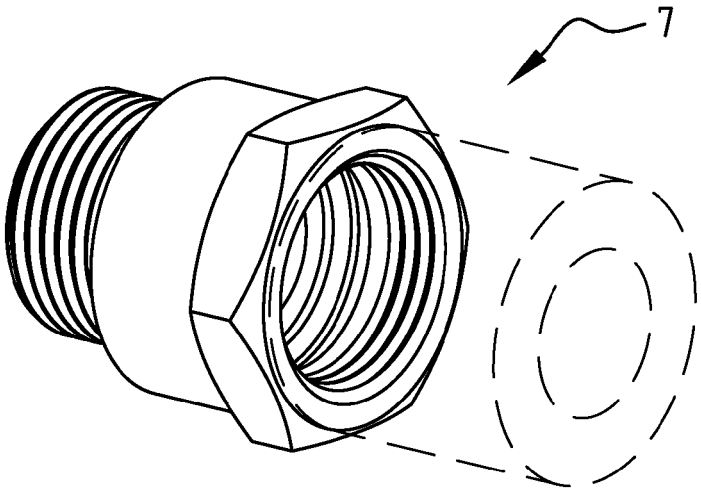

FIG. 2

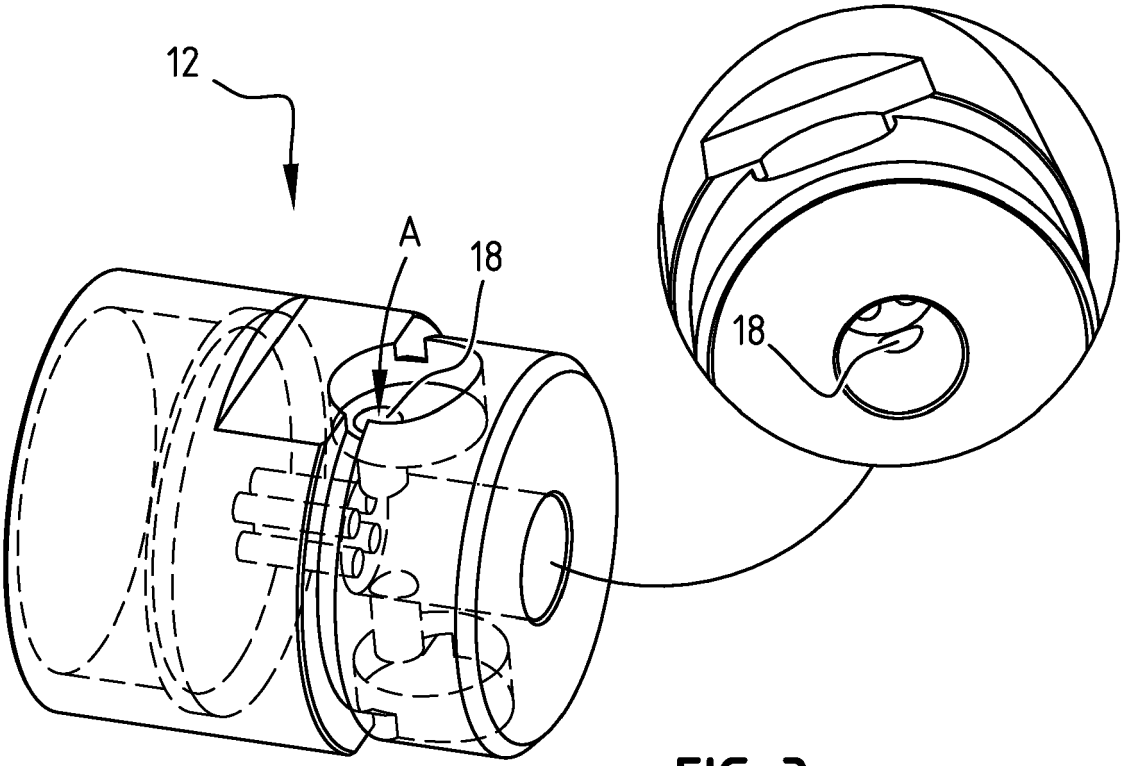

FIG. 3

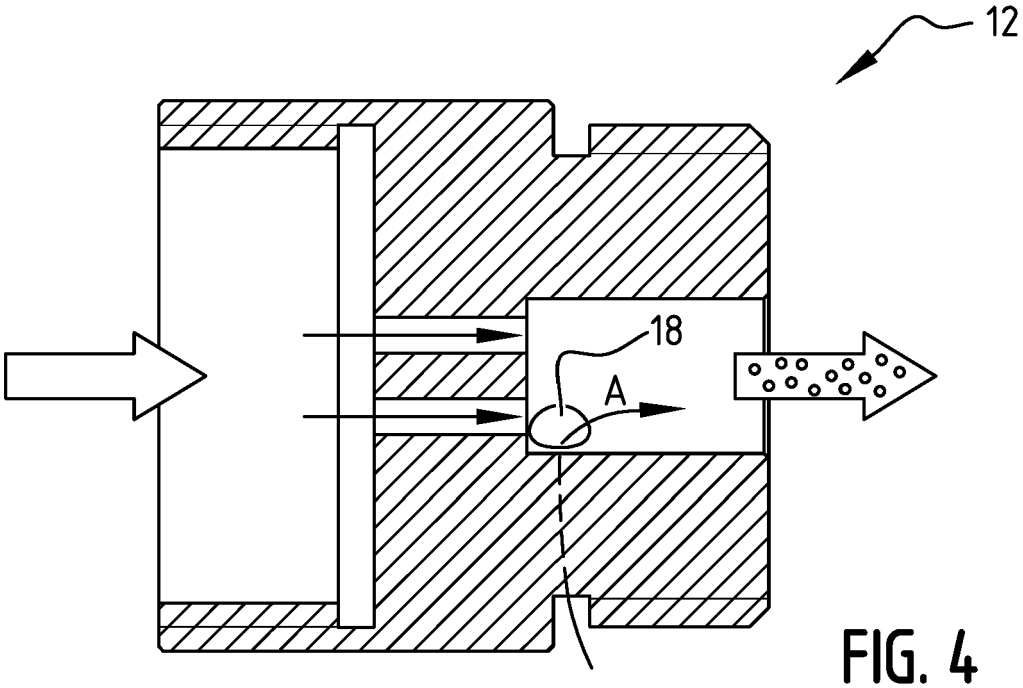

FIG. 4

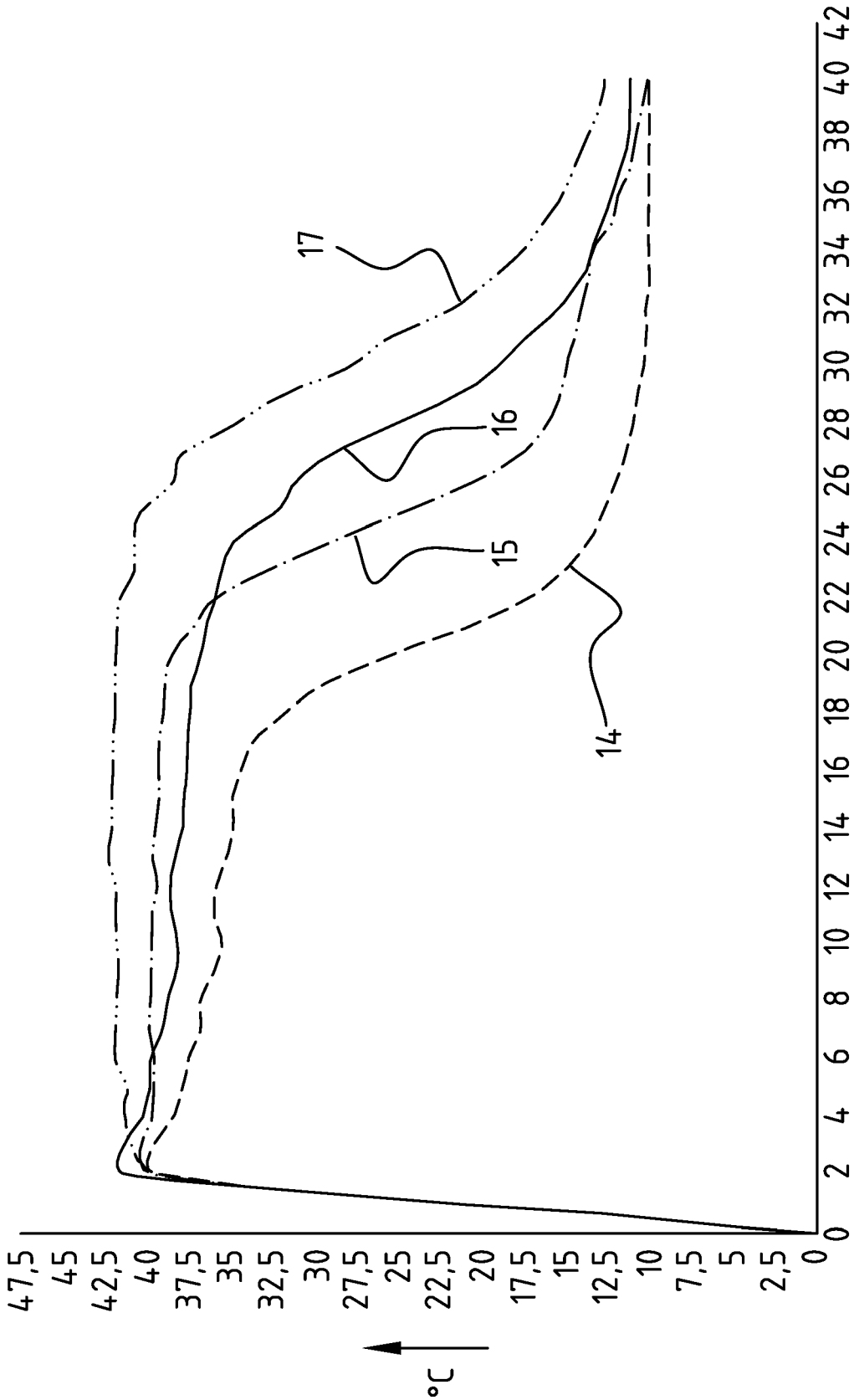
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FIG. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 19 17 3313

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F24D
E03C
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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	9 September 2019	Riesen, Jörg

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