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(54) **Heating system for flowing substances**

(57) A heating system is disclosed for flowing substances in a liquid or gaseous state; such system comprises at least one heating sheath made of flexible and electrically insulating material, comprising inside it an

electrically resisting material forming at least one electrically closed circuit adapted to inductively heat the flowing substance due to Joule effect; and electric supply means of the electrically closed circuit.

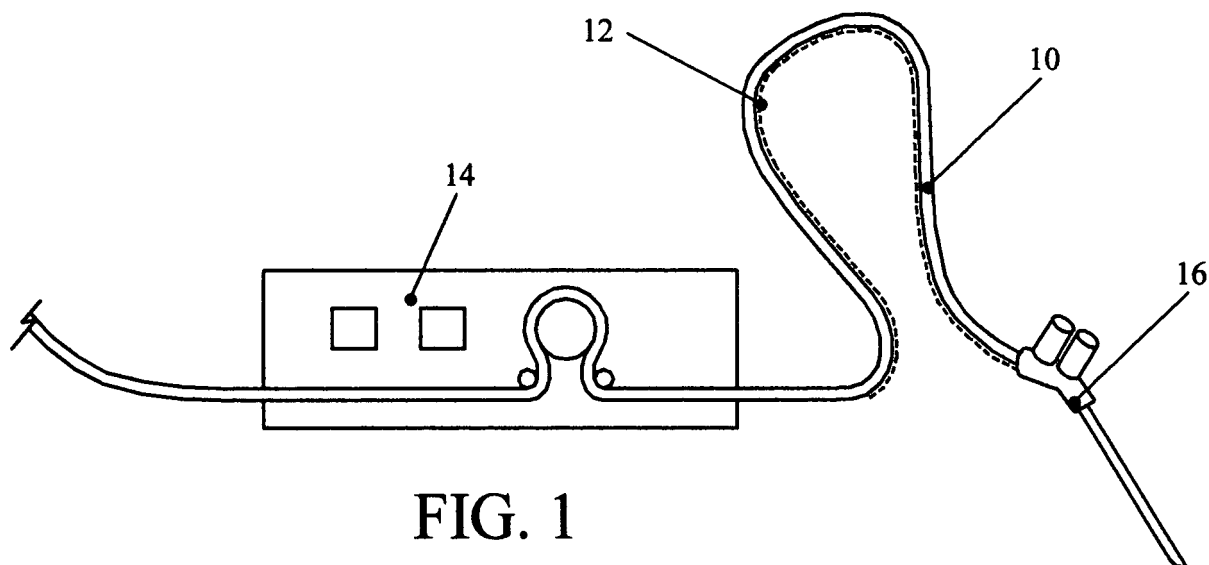


FIG. 1

Description

[0001] The present invention refers to a heating system for flowing substances, in a liquid or gaseous state, particularly for medical/sanitary use.

[0002] As known from literature, the use of cold fluids, namely fluids at a temperature much lower than the average human temperature, for infusions into patients for medical purposes is extremely problematic. On the other hand, many of such fluids, in order to be able to be stored, must necessarily be refrigerated.

[0003] In particular, blood, plasma and products derived therefrom are generally refrigerated at about 1-6 °C. Consequently, the infusion of such fluids in a patient at a lower temperature than the body one could create serious problems, such as hypothermia or heart disorders.

[0004] Obviously, also the infusion of other cold physiologic fluids, such as, for example, venous and gastric solutions or soups, can generate serious problems for patients.

[0005] Another problem which the use of physiologically cold flowing substances has is the one occurring when such substances are rinsing liquids necessary in surgical interventions, for example in endoscopy interventions. Under such situations, in fact, the seepage of a physiologically cold rinsing liquid (in this case at a temperature which is substantially equal to the ambient one, which, in a surgical room, is around 20°C) inside the intervention cavity would generate its condensation, particularly on lenses of the visor used by medical personnel, consequently preventing the intervention from going on correctly, unless probes are afterwards extracted and lenses are cleaned.

[0006] In order to solve such problems, the prior art proposes different solutions which allow heating, more or less efficiently, the flowing substances before they are infused into a patient.

[0007] Currently, the most used system for heating blood, plasma or other medical fluids is the hot water bath. Such system provides for the use of a tank containing hot water kept at a constant temperature approximately included between 36 and 40°C, in which bags are immersed containing the physiologic substance to be infused or in which at least one dispensing piping of this substance passes. A variation to such system is the one providing for the use of counter-current flows, in which two concentric pipes form a heat exchanger, blood or plasma to be heated passing through the internal pipe, while the fluid heated by the tank (usually water) is pumped along the opposite direction through the external pipe. These systems, as well as many other functionally similar ones, however have a whole set of problems, related to the actual heating capabilities against the need of having high flow-rates of the substances to be infused and to guarantee the necessary sterility to these substances.

[0008] In order to solve such problems, the prior art has developed a whole series of new solutions, such as

those disclosed in US 5,319,170, US 4,471,191, and US 6,118,111, substantially based on heating devices using electric windings, typically realised like the secondary winding of a transformer, which, once supplied with current, are heated, transferring heat by induction to the substances to be heated. Such systems, though trying to solve the prior art problems being present when they were filed, provide other problems, generally dealing with their electromagnetic emissions, their complex realisation, and their operating efficiency, the most evident of which being that such systems only guarantee the local substance heating: in fact, when the substance goes out, heated, from the heating device, it is sent to the patient through a distribution duct through which, unavoidably, it dissipates the absorbed heat: it is wholly evident that the longer the distribution duct length, the greater the amount of dissipated heat before the substance reaches the patient. In order to solve such inconvenience, it is possible to provide for the overheating of the substance to be infused to the patient: such solution however has an impact with the fact that many substances, such as for example blood or plasma, do not support excessive heating temperatures, which would damage erythrocytes and platelets. It is therefore necessary that the known heating devices are always very near to the patient in order to guarantee a minimum heat dissipation during the substance transit along the distribution ducts: such constraint, however, is opposed to the very often restricted space existing in hospital structures around the patient, above all during a surgical intervention, or the need of having to integrate the heating device in more complex medical machinery which, due to obvious dimensional problems, often cannot objectively be arranged next to the patient.

[0009] The prior art further does not propose a heating system which can be easily wound around a bag for containing the substance when this latter one is placed in order to be able to proceed with its infusion into the patient.

[0010] Therefore, object of the present invention is solving the above prior art problems, providing a heating system for flowing substances, in a liquid or gaseous state, particularly for medical/sanitary use, comprising at least one heating sheath which guarantees heating of the substances along at least one part of a distribution duct to the patient, thereby allowing to arrange the means for supplying the substances itself, such as for example pumps, tanks or bags, also at a remote distance from the patient without impairing its heating.

[0011] Moreover, another object of the present invention is providing a heating system comprising at least one heating sheath which allows a progressive heating of a substance flowing inside a distribution duct to the patient.

[0012] A further object of the present invention is providing a heating system comprising a heating bag for bags or ampullas containing a flowing substance during infusion from a patient realised with the heating sheath.

[0013] The above and other objects and advantages

of the invention, as will appear from the following description, are reached by a heating system for flowing substances as disclosed in claim 1. Preferred embodiments and non trivial variations of the present invention are the subject matter of the dependent claims.

[0014] The present invention will be better described by some preferred embodiments thereof, provided as a nonlimiting example, with reference to the enclosed drawings, in which:

- FIG. 1 shows a side view of a distribution duct equipped with a heating sheath of the heating system according to the present invention applied to any medical machinery according to the known prior art;
- FIG. 2a shows a side view of another embodiment of the distribution duct equipped with the heating sheath according to the present invention;
- FIG. 2b shows a side view of a different liquid heating system (still another embodiment of the distribution duct equipped with the heating sheath) according to the present invention;
- FIG. 3a shows a side view of an embodiment of a heating bag of the heating system according to the present invention; and
- FIG. 3b shows a side view of another embodiment of the heating bag of the heating system according to the present invention.

[0015] With reference to the Figures, it is possible to note some embodiments of the heating system for flowing substances, in a liquid or gaseous state, according to the present invention. In particular, such flowing substances can be those used in the medical and sanitary field, adapted to be infused in a patient, such as, for example, blood, plasma, physiologic substances, venous and gastric soups, or substances helping surgical interventions. It is clear that its uses can be several other ones, such as, for example, in the veterinary field.

[0016] The heating system according to the present invention comprises at least one heating sheath in a flexible and electrically insulating material, such as, for example, plastics, rubber or adequate fabric, comprising inside it an electrically resisting material forming at least one electrically closed circuit, preferably made as a 12 V filament. The heating system according to the present invention further comprises electrical supply means to which the electrically closed circuit is connected, adapted to supply with current the electrically resisting material which inductively heats the fluid substance due to Joule effect. In the preferred embodiment, the electric supply means provide 12V direct current, both for use practicality reasons, and to guarantee a minimum electromagnetic safety level within hospital environments. In such a way, the heating system according to the present invention can be easily supplied independently through electric supply means realised as a simple and scarcely encumbrant battery, avoiding a connection to the electric network supply, and allowing an extremely practical use,

also under situations in which the network supply should not be present or be difficult to reach (such as for example in field hospitals or ambulances).

[0017] In a simplified version of the present invention, it is possible to provide for the realisation of different types of heating sheaths, each one of which is equipped with a different electrically resisting material, in such a way as to realise an extremely various range of obtainable temperatures, depending on the various fluid substances to be heated.

[0018] Alternatively, the heating system according to the present invention can comprise electric supply control means which, by interacting with the electric supply means, manage and allow automatically or manually changing the amount of current supplied to the electrically closed circuit, allowing to adjust the amount of heat transmitted to the flowing substance and, consequently, its temperature. The control means can obviously be equipped with all those known devices, such as for example displays for displaying the set and obtained temperature and known service commands, which allow an easy use by a user. The control means can further comprise at least one temperature sensor for the flowing substance, which, by detecting its temperature, allows the comparison with a set temperature and manages reaching and keeping such temperature by operating on electric supply means.

[0019] In general, the minimum acceptable infusion temperature of the flowing substance will depend on the patient condition, on the infusion length, on the volume of substance which must be administered to the patient, and in some cases on the volume of patient blood before the infusion. In the majority of cases, the infusion temperature will anyway be at least near the patient body temperature.

[0020] The filament 12 can obviously be arranged inside the heating sheath in an extremely wide variety of ways: the filament 12 can for example be arranged straight or so that it is arranged as a spiral.

[0021] With particular reference to FIG. 1, the heating sheath according to the present invention can be wound around a known distribution duct 10, along at least one portion of its length, adapted to distribute a flowing substance to a patient, both through infusion and through surgical use. In such case, the heating sheath can be equipped with securing means, such as for example Velcro(R) bands, buttons, poussoirs or specific adhesives, to allow their securing around the distribution duct 10. Alternatively, the heating sheath can already have a tubular shape, so that it allows inserting inside it the distribution duct 10. In such case, it can be provided to equip the heating sheath with inserts made of elastic material which allow adapting its sizes to a variable number of distribution duct 10 diameters. In FIG. 1, the distribution duct 10, equipped at one end thereof with a known insertion probe 16, is applied as an example to a supply and heating device 14 for a rinsing fluid for endoscopic interventions, but it is clearly evident that the same dis-

tribution duct 10 can be used in wholly different applications, depending on the used flowing substance, such as, for example, for infusions of blood, plasma or other physiologic solutions.

[0022] In a possible variation thereof, the heating sheath of the heating system according to the present invention can be shaped as a heating distribution duct: in such embodiment, therefore, the filament 12 is substantially immersed inside the peripheral wall of the duct itself. It is clear that, in such case, along the heating distribution duct, only one circuit can be realised, which is electrically closed along the whole or part of its length, or many electrically closed circuits can be provided, which are controlled independently by the control means.

[0023] The filament 12 can be further composed of a plurality of segments having mutually different diameters and/or electric and resistive characteristics, in such a way as to realise a certain temperature distribution inside the distribution duct 10 of the heating distribution duct: in this way, it is possible to provide for the progressive heating of the flowing substance during its transit.

[0024] With reference to FIG. 2a, 2b, a further variation of the heating system according to the present invention can provide that the distribution duct 10 equipped with the heating sheath or the heating distribution duct according to the present invention can be directly inserted inside a bag or an ampule 22 containing the flowing substance to be withdrawn: in this way, the filament 12, in addition to heating the flowing substance in transit, directly pre-heats, inside the bag or ampule 22, as regards the immersed portion of the filament 12, the substance itself.

[0025] With reference instead to FIG. 3a and 3b, the heating sheath according to the present invention is shaped as a heating bag 20 adapted to be arranged around a bag or an ampule 22 containing the flowing substance during its infusion to a patient. Such bag 20 can be made of various materials, from gel to polythene, with specific and different thicknesses. Merely as an example, in FIG. 3a it can be noted that the filament 12 can be arranged inside the heating sheath in a spiral way, while in the embodiment in FIG. 3b, the filament 12 is circularly arranged around the bag or ampule 22.

[0026] Once the electrically closed circuit is then supplied with current by the electric supply means, possibly managed by the control means, it is heated due to Joule effect owing to its electric resistance, transferring heat by induction to the flowing substance inside the distribution duct 10, the heating distribution duct or the bag or ampule 22. The heating system according to the present invention thereby allows arranging the means for supplying the substance, such as for example pumps, tanks or bags, also at a relevant distance from the patient without impairing its heating.

Claims

1. Heating system for flowing substances in a liquid or gaseous state, **characterised in that** it comprises:
 - at least one heating sheath made of flexible and electrically insulating material, comprising inside it an electrically resisting material forming at least one electrically closed circuit adapted to inductively heat said flowing substance due to Joule effect;
 - electric supply means for said electrically closed circuit.
2. Heating system according to claim 1, **characterised in that** said electrically resisting material is shaped as at least one filament (12).
3. Heating system according to claim 1, **characterised in that** said flowing substances are blood, plasma, physiologic solutions, venous and gastric soups for infusion, or for helping in surgical interventions.
4. Heating system according to claim 1, **characterised in that** said electric supply means supply 12V direct current to said electrically closed circuit.
5. Heating system according to claim 1, **characterised in that** it comprises electric supply control means adapted to interact with said electric supply means for automatically or manually managing and changing an amount of current supplied to said electrically closed circuit.
6. Heating system according to claim 5, **characterised in that** said control means comprise at least one temperature sensor of said flowing substance.
7. Heating system according to claim 1, **characterised in that** said heating sheath is wound around a distribution duct (10) of said flowing substance.
8. Heating system according to claim 1, **characterised in that** said heating sheath is equipped with securing means such as Velcro(R) bands, buttons, poussoirs or specific adhesives.
9. Heating system according to claim 7, **characterised in that** said heating sheath has a tubular shape or not in order to allow inserting therein said distribution duct (10).
10. Heating system according to claim 9, **characterised in that** said heating sheath is equipped with inserts made of elastic material.
11. Heating system according to claim 9, **characterised in that** said heating sheath is shaped as a heating

distribution duct.

12. Heating system according to claim 2, **characterised in that** said filament (12) is composed of a plurality of segments having mutually different diameters and/or electric and/or resistive characteristics. 5

13. Heating system according to claim 1, **characterised in that** said heating sheath is shaped as a bag (20) which keeps the previously provided temperature also with other heating systems, said bag (20) being adapted to be arranged around a bag or an ampule (22) containing said flowing substance during its infusion. 10

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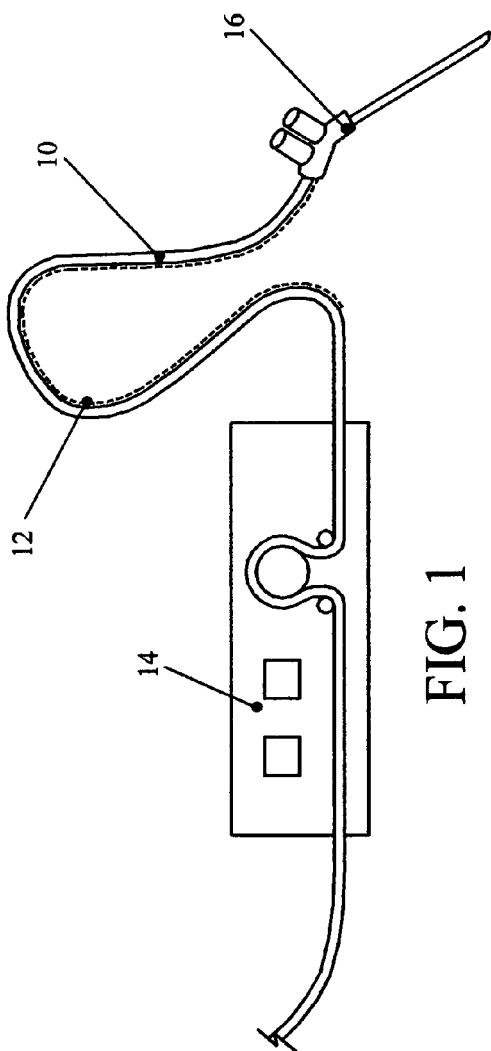


FIG. 1

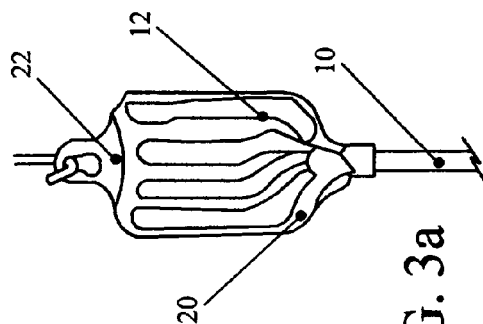


FIG. 3a

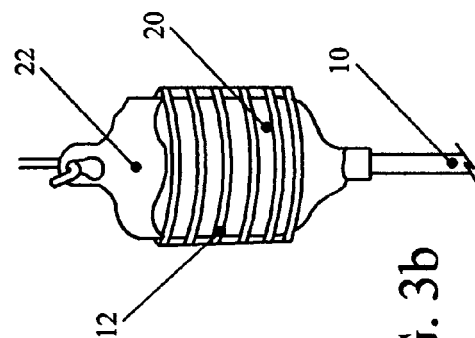


FIG. 3b

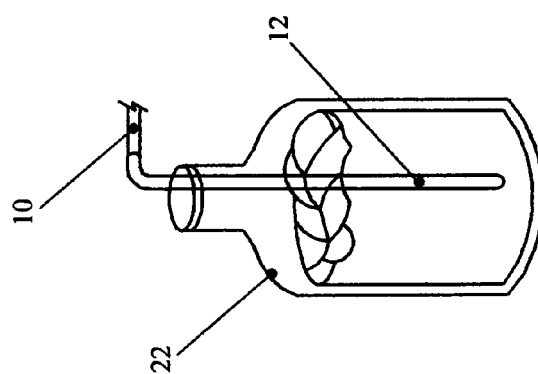


FIG. 2a

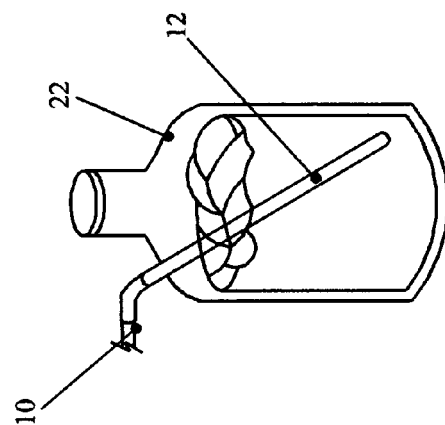


FIG. 2b



European Patent
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EUROPEAN SEARCH REPORT

Application Number
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Place of search The Hague		Date of completion of the search 16 May 2006	Examiner Van Gestel, H
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EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
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