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(71) Applicant: **Kunststofverwerkende Industrie Katan B.V.**
Weerdskampweg 15 P.O. Box 2042
NL-5202 CA 's-Hertogenbosch(NL)

(72) Inventor: **van Liempt, Johannes Michael**
Karel Doormanstraat 80
NL-5224 GL 's-Hertogenbosch(NL)

(74) Representative: **Noz, Franciscus Xaverius, Ir. et al,**
Algemeen Octrooibureau P.O. Box 645
NL-5600 AP Eindhoven(NL)

(54) **Method for applying electrodes to a piece of metallized textile material, heating device for humidifying a gas- or gas-mixing stream.**

(57) Method for applying electrodes to a piece of metallized textile material, whereby said method comprises the selective immersion of the piece of metallized textile material in an electroless bath.

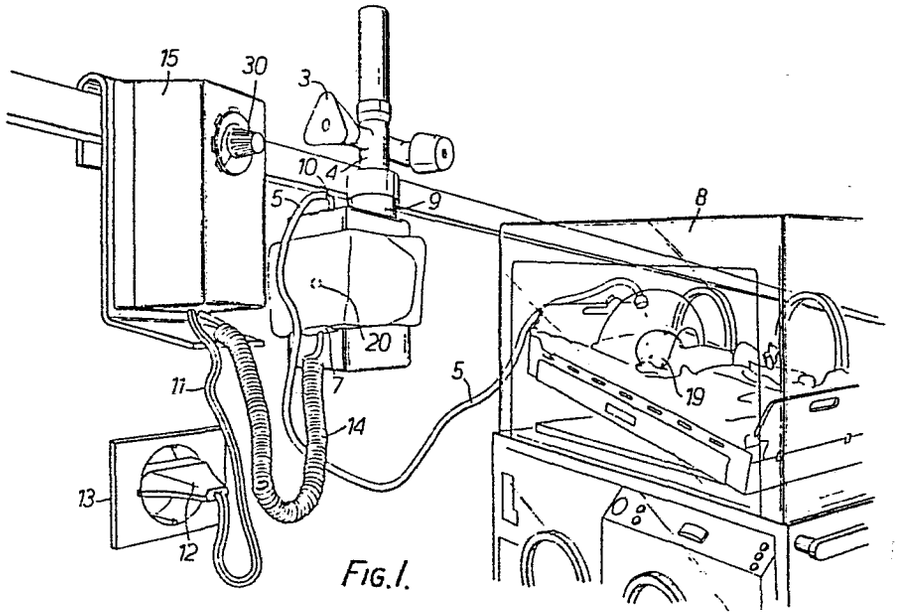

FIG. 1.

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Method for applying electrodes to a piece of metallized textile material, heating device and device for humidifying a gas- or gas-mixture stream.

The invention relates to a method for applying electrodes to a piece of metallized textile material.

A known method for applying electrodes to a piece of metallized textile material is tucking up stranded copper wire. It has appeared, however, that in this manner no impeccable contact is possible, not even if for tucking up suitable yarn material is used and the wire tension is kept as high as possible. Further the known method makes it difficult or time-consuming to provide electrodes on either side.

The purpose of the invention is at least to eliminate these disadvantages and for that purpose provides a method of the kind indicated above, characterised in that it comprises the selective immersion of the piece of metallized textile material in an electroless metal bath. This method might be called plating or galvanizing without current.

With the same purpose the invention provides a method of the kind mentioned above, characterised in that the electrodes are deposited by evaporation.

Further the invention relates to heating devices which are especially applicable in the medical field, such as for the adjustable heating of containers with blood, a heated operating table or heated operating blankets.

According to a following aspect of the relevant invention

a device is further provided by comprising a heating element for humidifying a gas- or gas-mixture stream.

Thereby the humidifying fluid is in particular sterilized water and the gas- or gas-mixture stream a stream of oxigen and/or air. These humidifying devices are known and are especially applied in the medical field. Many of these known devices are connected with a reservoir of sterile water for the supply of humidifying fluid.

The invention now aims at simplifying the known humidifying devices and to improve their humidifying action, as well as reducing the chance of bacterial growth.

For this purpose the invention provides a device of the kind mentioned in the beginning, characterised in that the heating element comprises a strip-shaped heater unit, arranged to be brought into an encircling connection with a container with fluid provided with an inlet and an outlet.

As a result of these measures it is not necessary in the first place to provide a second heatable container for vaporizing the humidifying fluid and in the second place no pressure- and fluid connections between the supply container with humidifying fluid and the container for the humidifying fluid to be vaporized are necessary.

Preferably the heating element is arranged to be brought into an encircling connection with a disposable container pre-filled with sterilized water.

Finally the invention provides a device for humidifying a gas or gas-mixture stream, comprising a container provided with a gas-inlet, a gas-outlet and a fluid-inlet, as well as a heating element provided with a heater unit applied, at least in operation, in an encircling connection with the container. The container and the heating element have a configuration, analogous to a heating-up apparatus for small milk bottles for sucklings. Said holder then has a fluid connection with a supply container of vaporizing fluid, e.g. a disposable container pre-filled with sterilised water.

The purpose of the invention is to provide a heating element with a heater unit which is not restricted to application with a container of a certain configuration and for that purpose provides a device of the kind last-mentioned above, characterized in that the heater unit is strip-shaped.

As a result of this measure the heater unit can be applied in close contact with containers of various configurations.

A further aspect of the invention is, as will appear later on, that the regulation of the temperature by the heating element is such that preferably such a quantity of heat is supplied to the container as is necessary to provide energy necessary for humidification of a gas- or gas-mixture stream led through the humidifying fluid, so that the temperature of the humidified gas- or gas-mixture stream does not become higher than the surrounding temperature, which prevents the occurrence of condensation in the relevant conduits.

Preference is given, for a heater unit, to the use of an angular piece of metallized textile material with electrodes applied over the entire length of two opposite sides.

The invention will be more fully explained with reference to a possible embodiment of the invention and with reference to the attached drawing, in which:

Fig. 1 is an oxigen humidifying device, connected with an incubator, according to a possible embodiment of the invention applied on neonatal care;

Fig. 1A is a detailed view of the adjusting parts with temperature and relative humidity scale respectively of the adjusting element of a heating element of the air humidifying device as shown in fig. 1;

Fig. 2 is a detailed view of the heater unit of e.g. the device as shown in fig. 1; and

Fig 3 is a strongly simplified block diagram of a possible control circuit for a heating element according to the invention in question.

The invention is not restricted to the heating- and humidifying device shown in fig. 1, but can especially, but not exclusively, be applied in the medical field with several advantages as a heating device. As advantageous embodiments can be mentioned a heating device for blood bags, which need to be kept at a temperature of around 37 degrees C, a heated operating table or an operating blanket to keep the patient to be treated, warm and a physiotherapeutic heating unit as replacement of paraffin cushions, thermogeneous wadding and infrared lamps. It will be apparent that this enumeration is not exhaustive.

Fig. 1 shows with reference 8 an incubator, in which there is a neonatal 19. The purpose of the humidifying device is to keep the relative humidity of the oxigen or air or a mixture of both supplied by means of pipe 5 up to the desired level. Thereby it should be prevented that the stream of humidified oxigen in the conduit 5 causes condensation as a result of cooling, in which case the condensate can be a breeding ground for bacteria. For this purpose the temperature of the humidified stream of oxigen flowing into conduit 5 is kept lower than or the same as the surrounding temperature. Here it needs to be considered that the temperature in the incubator 8 will generally be higher than the surrounding temperature of the conduit 5, so that with a relative humidity of 100% in the conduit 5, this will be lower inside the incubator 8. Although not shown it is possible to place the conduit 5 inside the incubator 8 and more in particular the container of humidifying fluid 1 and the heater unit 6 to be discussed hereinafter, because, as also to be discussed, the heater unit 6 has been arranged in such a manner that it can be sterilized.

In the embodiment of the invention shown in fig. 1 the container of humidifying fluid 1 is a filled container with a supply of humidifying fluid. However, the container can also be provided with a fluid inlet for connection with a container for the humidifying fluid. In the embodiment shown in fig. 1 the container is preferably a disposable container prefilled with sterilized water, as then the danger of bacteria is smallest and containers of said kind are quite frequently used in medical surroundings. Most of these containers are provided with at least two openings that can be shut off, shown diagrammatically in fig.1 as gas inlet 9 and gas outlet 10. The gas inlet 9 is, by means of conduit 4, connected with an outlet 3 of a supply of gas or gas-mixture. The gas outlet 10 is connected, by means of conduit 5, with the incubator 8.

When the gas outlet 3 is opened, the gas streams to the incubator 8 via conduit 4, gas inlet 9, fluid, the surface of which is indicated by reference 2, outlet 10 and pipe 5.

Reference 6 shows a heater unit embodying the invention, provided with a cover or bag element18 and a connecting element 7 with a possibly rigid synthetic casing. Said heater unit will be more fully explained hereinafter with reference to fig.2. Heater unit 6 is a part

of a heating element, further comprising the regulation element 15. The regulation element 15 is connected, by means of a cable 14, with the connecting element 7 of the heater unit 6. The regulation element 15 comprises an adjusting element 30, the externally visible parts of which are shown in fig.1, said parts with the relevant scales are shown in detail in fig.1A When fig.1A is discussed this matter will be referred to. The adjusting element 15 is connected with a cable 11 with a plug, which, as shown, can be plugged into a wall socket 13, preferably provided with ground connection.

With the embodiment shown in fig. 1 is in operation the sterilized water in the disposable container can in the very first place be brought up to the required temperature e.g. 26 degrees C. Then an oxigen stream can be led through the sterilized water in the disposable container, causing the oxigen obtaining a relative humidity of 100 %. For humidifying the dry oxigen stream energy is required, as a result of which heat will be drawn from the supply of sterilized water in the container, were it not for the fact that the adjusting element 15, via the cable 14, supplies current to the heater unit in such a manner that the water supply is kept at 26 degrees C. For scanning the water temperature the connecting element 7 is provided with a temperature sensor 20, which, on application of the heater unit around the container 1 is in close contact with the latter. In this manner the sensor 20 provides a feedback signal for the adjusting element15, which will be explained in more detail with reference to fig. 3. Assuming now that the temperature inside the incubator 8 is 32 degrees C and the surrounding temperature of the conduit 5 has a value which lies between 26 and 32 degrees C, then the relative humidity of the humidified oxigen stream will be 70% in the incubator and that of the humidified oxigen stream inside the conduit 5 will have a value between 100 and 70 % respectively. Consequently there will be no condensation in the conduit 5 and with the described, in practice excessive, temperature difference of 6 degrees C a relative humidity of 70 % can be achieved inside the incubator. This distinguishes the device in question from known devices of this kind, where heater units of a relatively large capacity are used for substantially heating the water in the container, as a result of which the relative humidity of the humidified oxigen stream can be far and even very far above 100 %, which in the first place causes condensation with all resulting disadvantages and further consumes an

unnecessarily large amount of energy. It may be noted that the ward temperature of an intensive care department,where incubators are stationed, is generally not greatly different from the temperature inside the incubator, e.g. 31 and 32 degrees C respectively.

Fig. 1A shows in more detail the externally visible parts of the adjusting element 30. In particular a movable part, in this embodiment a button with a flange 17 and a fixed part, i.e. a part of the wall 26 of the casing of the adjusting element. On the flange 17 of the button a scale for the relative humidity is indicated, which according to a certain formula is related to the linear temperature scale 32 applied to said part of the casing 26. For an operator it is now very simple with a certain set temperature, in this case 26 degrees C, whereby the humidified oxigen stream flowing in pipe 5 has a relative humidity of 100%, that the relative humidity inside the incubator with a temperature of 32 degrees C will be 70 %.

Fig. 2 shows in more detail the strip-shaped heater unit 6. As said before the strip-shaped heater unit is arranged to be brought into an encircling connection with a container with fluid provided with an inlet and an outlet,the container preferably being a disposable container pre-filled with sterilized water, said containers can have varying forms and dimensions. The heater unit 6 comprises a cover or bag element 27 preferably of textile material and with a consequently dimensioned piece of profile foam 41.Such a bag element 27 can be sterilized in a simple manner. The bag element 27 is closed off by the connecting element 7 with the temperature sensor 20 for contact with the wall of the container. On placing the heater unit in an encircling connection, that is around the container 1 first the connecting element 7 with the temperature sensor 20 is placed against the wall of container 1, after which the bag element 27 is tightly folded around the container 1 into the direction of the other end of the bag element 27, and is fixed by means of a connecting element (not shown), preferably wavelock tape. In this manner the temperature sensor 20 is in close contact with the wall of the container 1, whilst also a rectangular piece of metallized textile material, indicated by reference 21, is in close contact with the wall of the container 1 for the heating of the fluid. The rectangular piece of metallized textile material has two electrodes 23 and 24, applied over the entire length to preferably the short sides, whereby

the electrodes are preferably applied to either side of the rectangular piece of metallized textile material 21. The advantage of placing the electrodes at the short sides is that the electrodes are short and therefore less sensitive to failures. For obtaining an optimum heating effect the weaving direction of the piece of metallized textile material is perpendicular to the long sides of the electrodes, preferably also rectangular. Also for obtaining an optimum heating effect the metal of the rectangular piece of metallized textile material is nickel. For a suitable transfer of the current supplied to the electrodes 23,24, over the width of the rectangular piece of metallized textile material the resistance of the electrodes needs to be lower, to an extent of a factor 10, than that of the part of the piece of metallized textile material without electrodes. The material of the electrodes is preferably copper. In fig. 2 the weaving direction of the metallized textile material is indicated by reference 22.

The application of the electrodes 23, 24, to the metallized textile material 21 forms a part of this invention. In this connection textile material should be given a wide interpretation, comprising e.g. woven fabric, hosiery, felt, , formed from threads, fibres, or yarns and paper. Preferably the metallizing is such that every fibre or thread is surrounded by metal lining, the thickness of which can be a fraction of a micrometer. Known is providing in electrodes by tucking up litzwire with a special sort of yarn, with due attention to the wire tension. Inherent to this method are long assembly times of the heater unit, bad contacting and an increase in resistance due to contact-resistance fluctuation between the metallize textile material and the litzwire. Most important is in that case that bad contacting can lead to an early end of the heater unit. Said contacting problem might be solved by soldering the litzwire on the metallized textile material, but the disadvantages of that is that as a result the flexibility of the textile material is lost and the transition from rigid to non-rigid part may lead to tearing and consequently destruction of the metallized textile material.

A solution to this problem according to the invention in question is the selective depositing by evaporation of the electrodes. Difficult, however, is in that case that a large part of the metallized textile material needs to be masked to prevent depositing by evaporation.

A method that ought to be given preference for applying electrodes to a piece of metallized textile material according to the invention in question comprises the selective immersion of the piece of metallized textile material in an electroless metal bath, e.g. a piece of nickel plated textile material in an electroless copper bath, or the plating or galvanising (not in the sense of zincplating a metal), without the application of current, of the metallized textile material. Selective implies here immersion to a chosen depth, e.g. to the extent of a few millimetres. A specific example of the contacting process of a nickel plated textile material is as follows. First the nickel plated textile material is immersed in a nickel activator bath for cleaning the nickel layer and to enable the copper layer to adhere well, e.g. 30 seconds in a 30 grammes per litre solution of circuitprep 40 of SEL-REX (registered trademark of OMI International). The immersion depth is then mainly equal to the desired width of the electrode e.g. around 3 millimetres. After the nickel plated textile material has been treated with the activator, very careful rinsing is necessary, preferably first in an alcohol solution and after that in deionised water. After that the activated nickel plated textile material is selectively provided with a copper layer by e.g. hanging it during 25 minutes in an electroless copper bath, e.g. oxitron PCB 50 of SEL-REX (both trademarks of OMI International) to a depth, which is greater than the immersion depth for activating, e.g. about 5 millimetres. This difference in immersion depth is chosen to prevent chemical residue from staying behind in the part of the nickel plated textile material not covered with copper and affecting by its agressive action the textile material, as a result of which said material would ultimately be destroyed in operation.

After that renewed rinsing in the manner described above is necessary. After that the rectangular selectively copper plated piece of nickel plated textile material needs to be provided with a protection layer, e.g. by immersion in a stabilizer bath, such as TPS CU of SEL-REX (trademarks of Oxy Metal Industries International) to prevent oxidation of the metal layers. Again thorough rinsing in the indicated manner is necessary and ultimately drying, after which the textile material can be treated with urethane spray to insulate and protect both the nickel layer and the copper layer of the metallized textile material. Through the immersion process electrodes are automatically applied on either

side, and in particular with a connecting bridge part. The most important advantages of this method are that the flexibility of the textile material does not change and an impeccable contacting is realised. Besides that the copper electrodes can be well soldered. The resulting pieces of metallized textile material provided with electrodes can now be applied in all kinds of heating devices, thanks to the maintained flexibility, through which tears in operation can be prevented; if desired with the inclusion of the regulation device embodying the invention in question, to be more fully explained hereinafter.

Another method which has proved to be satisfactory is the suitably electrolytic galvanizing with the application of e.g. silver or gold.

Referring back to fig. 2 the explanation of the heater unit embodying the invention in question will now be completed. As indicated with 25 and 26 conductors are soldered on the electrodes 23 and 24. Further a printed circuit board 28, preferably of flexible and heat resistant material has been provided, on which of course conductor traces have been provided, connecting the solder points 25, 26 via the conductors with connecting points in the connecting element 7, in their turn having a connection with the cable 14. Further a second temperature sensor 40 has been provided to the printed circuit board 28, also connected, by means of conductor traces, with connecting points in the connecting element 7. The second temperature sensor is in thermal contact with the piece of metallized textile material 21. Providing the printed circuit board is not necessary but advantageous. Preferably the printed circuit board extends halfway to the piece of metallized textile material and at the end turned away from the connecting element 7 the second temperature sensor 40 is connected. The function of the second temperature sensor will be more fully explained hereinafter with the explanation of the regulation unit embodying the invention in question.

Fig. 3 shows a strongly simplified block diagram of the regulation element 15 embodying the invention. The adjusting element 30 provides a signal representative for the desired temperature to a combination element31. Further the combination element 31 receives a signal from a safety element 37, incorporated in a feedback loop. Both the first and the second temperature sensor are incorporated in the safety element. The first sensor, which is physically incorporated in the connecting element 7, provides a signal which is representative for the temperature

of the container 1 and preferably has a linear temperature dependence. So the combination element receives an adjusting signal and a feedback signal and, in case of a deviation between these signals, a control element 32 changes the supply of current through a switching element 33. The switching sequence thereby determines the current,which is supplied to the heater unit 6 by means of the cable 14. If e.g. the feedback signal of the safety element 37 indicates that the temperature is lower than the one set by the adjusting element 30, then the control element 32 will have the switching element 33 supply the current with longer time intervals. The regulation is, therefore, of an on/off-regulation type. In case that the second temperature sensor 40 detects that the heater unit 4 exceeds a maximum temperature, e.g. the softening temperature of a synthetic container of e.g. 74 degrees C, then the signal of the safety element 37 interrupts the switching by the switching element 33. Further an alarm element 36 is provided, which, after the elapse of an adjustable delay time of the delay element 35, gives an optical and/or audible indication that for a certain time, e.g. in the stretch from 0 to 18 minutes no switching by the switching element 33, and therefore no supply of energy to the heater unit, has taken place.

The second temperature sensor 40, e.g. NTC, mounted on the printed circuit board 28, is incorporated in the feedback loop with a maximum temperature detector in the safety element 37. However, this is not necessary as also a separate maximum temperature detector, not incorporated in the feedback loop may be provided, which prevents switching by the switching element 33 when a certain maximum temperature is exceeded.

CLAIMS

1. Method for applying electrodes to a piece of metallized textile material, characterised in that said method comprises the selective immersion of the piece of metallized textile material in an electroless bath.

2. Method as claimed in claim 1, characterised in that a rectangular piece of metallized textile material is used.

3. Method as claimed in claim 2, characterised in that the rectangular piece of metallized textile material is immersed with two facing sides over the entire length.

4. Device as claimed in claim 3, characterised in that the rectangular piece of metallized textile material is immersed with the short sides.

5. Method as claimed in any of the previous claims 2-4, characterised in that the rectangular piece of metallized textile material is immersed with the weaving direction perpendicular to the surface of the immersion bath.

6. Method as claimed in any of the previous claims, characterised in that for the metal of the rectangular piece of metallized textile material nickel is chosen.

7. Method as claimed in any of the previous claims, characterised in that for the metal of the metal bath copper or silver or gold is chosen.

8. Method as claimed in any of the previous claims, characterised in that the selective immersion is executed in such a manner and the metal of the rectangular piece of metallized textile material and that

of the metal bath are chosen to the effect that the resistance of the electrodes applied is lower, to an extent of a factor 10, than that of the part of the rectangular piece of metallized textile material without said electrodes.

9. Method as claimed in any of the previous claims, characterised in that before the selective immersion in an electroless metal bath the piece of metallized textile material is immersed in an activator bath for the metal of the piece of metallized textile material.

10. Method as claimed in claim 9, characterised in that the immersion in an activator bath is executed to a depth less than with immersion in an electroless metal bath.

11. Method for applying electrodes to a piece of metallized textile material, characterised in that the electrodes are deposited by evaporation, or applied by electrolytic galvanizing.

12. Method as claimed in any of the previous claims, characterised in that as a final action a protection layer is applied to both main surfaces of the piece of metallized textile material provided with electrodes.

13. A device comprising a heating element for humidifying a gas- or gas-mixture stream, characterised in that the heating element comprises a strip-shaped heater unit, arranged to be brought into an encircling connection with a container with fluid provided with an inlet and an outlet.

14. Device as claimed in claim 13, characterised in that the heater unit is arranged to be brought into an encircling connection with a disposable container pre-filled with sterilized water.

15. Device for humidifying a gas- or gas-mixture stream, comprising a container provided with a gas inlet, a gas outlet and a fluid inlet, as well as a heating element provided with a heater unit applied, at least in operation, in an encircling connection with the container, characterised in that the heater unit is strip-shaped.

16. Device as claimed in any of the claims 13-15, characterised in that the heater unit comprises a rectangular piece of metallized textile material with electrodes applied to two facing sides, over the entire length.

17. Device as claimed in claim 16, characterised in that the electrodes are applied to the short sides.

18. Device as claimed in claim 16 or 17, characterised in that the electrodes are rectangular and applied with the long sides perpendicular to the weaving direction of the piece of metallized textile material.

19. Device as claimed in any of the claims 16-18, characterised in that the electrodes are applied to either side of the piece of metallized textile material.

20. Device as claimed in any of the claims 16-19, characterised in that the electrodes are applied by immersion in an electroless metal bath.

21. Device as claimed in any of the claims 16-19, characterised in that the electrodes are applied by depositing by evaporation or electrolytic galvanising.

22. Device as claimed in any of the claims 16-21, characterised in that the metal for the piece of metallized textile material is nickel.

23. Device as claimed in any of the claims 16-22, characterised in that the metal of the electrodes is copper or silver or gold.

24. Device as claimed in any of the claims 16-23, characterised in that the resistance of the electrodes is lower, to an extent of a factor 10, than that of the part of the piece of metallized textile material without electrodes.

25. Device as claimed in any of the claims 16-24, characterised in that the heater unit comprises a bag element, in which the piece of metallized textile material, extended, is incorporated.

26. Device as claimed in claim 25, characterised in that the bag element is closed off by a connecting element for the electrodes.

27. Device as claimed in claim 26, characterised in that in the bag element the electric connection between the electrodes and connecting points in the connecting element has been effected by soldering conductors in between.

28. Device as claimed in claim 27, characterised in that the conductors form at least part of a flexible, heat resistant printed circuit board, extending over at least part of the length of the piece of metallized textile material in the bag element.

29. Device as claimed in claim 28, characterised in that the printed circuit board extends across substantially half the length of the piece of metallized textile material.

30. Device as claimed in any of the claims 13-29, characterised in

that the heating element comprises an electronic regulation switch for regulating the current to be supplied to the heater unit.

31. Device as claimed in claim 30, characterised in that the regulation switch is housed in a separate unit, which is connected with the connecting element by means of a cable and comprises a regulation element for adjusting the temperature to be assumed or maintained by the container.

32. Device as claimed in claim 31, characterised in that the regulation element comprises a movable and fixed part, whereby the externally visible parts have a temperature scale and a relative humidity scale related to it respectively.

33. Device as claimed in any of the claims 30-32, characterised in that the regulation switch is of the on/off type.

34. Device as claimed in any of the claims 30-33, characterised in that the regulation switch comprises a feedback loop with a temperature sensor, incorporated in the connecting element for contact with the container.

35. Device as claimed in any of the claims 30-33, characterised in that the regulation switch comprises a maximum temperature detector, provided with a second temperature sensor thermically coupled with the piece of metallized textile material , for switching off the current supply in case that a maximum temperature is exceeded.

36. Device as claimed in claim 35, characterised in that the container is a synthetic container, characterised in that the maximum temperature is related to the softening temperature of the synthetic material.

37. Device as claimed in claim 36, characterised in that the maximum temperature is about 74 degrees C.

38. Device as claimed in any of the claims 13-37, characterised in that the heater unit is provided with a fixing element for fixing the heater unit in an encircling connection around the container.

39. Device as claimed in claim 38, characterised in that the fixing element comprises wavelock tape.

40. Heating device, characterised in that it comprises a piece of metallized textile material provided with electrodes, which is made by or with the application of a method as claimed in any of the claims 1-12 and/or a heating element, as individually explained in any of the claims 13-39.

41. Heating device as claimed in claim 40, characterised in that it is obviously arranged for heating containers with blood.

42. Heating device as claimed in claim 40, characterised in that it is obviously arranged to be used in relation with an operating table.

43. Heating device as claimed in claim 40, characterised in that it is arranged as a physiotherapeutic heating unit.

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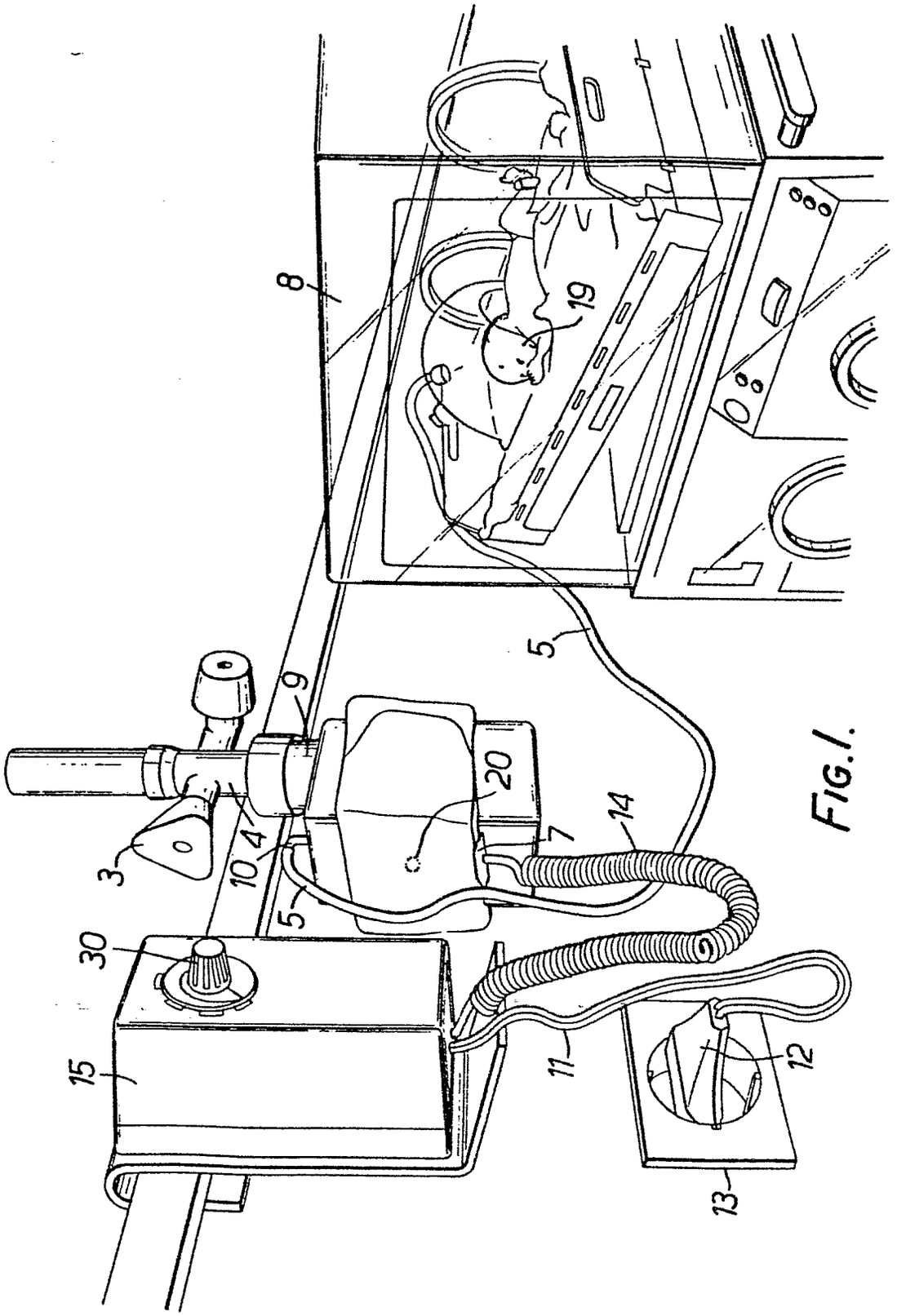

FIG.1.

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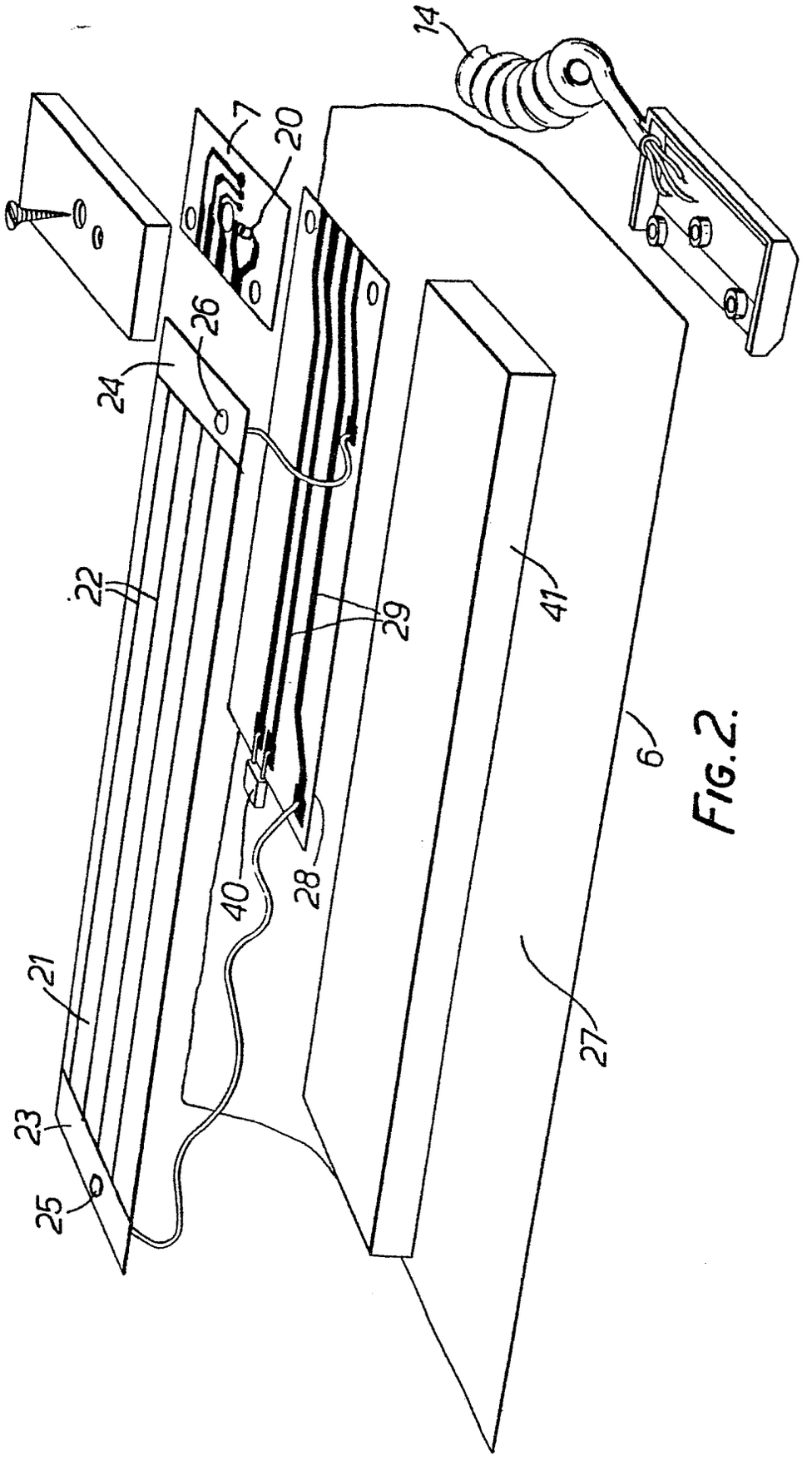

FIG. 2.

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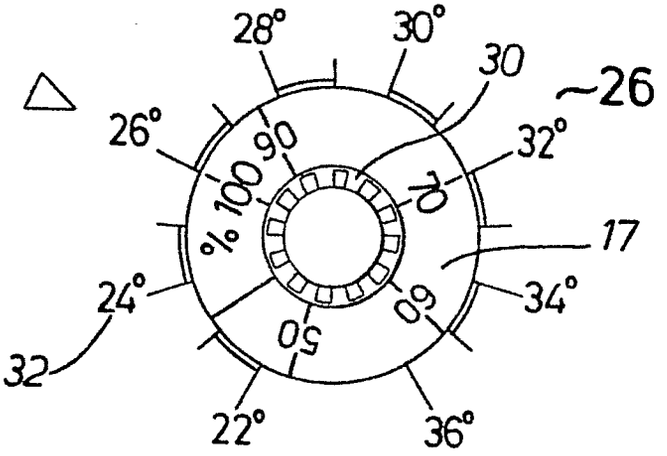

FIG. 1A.

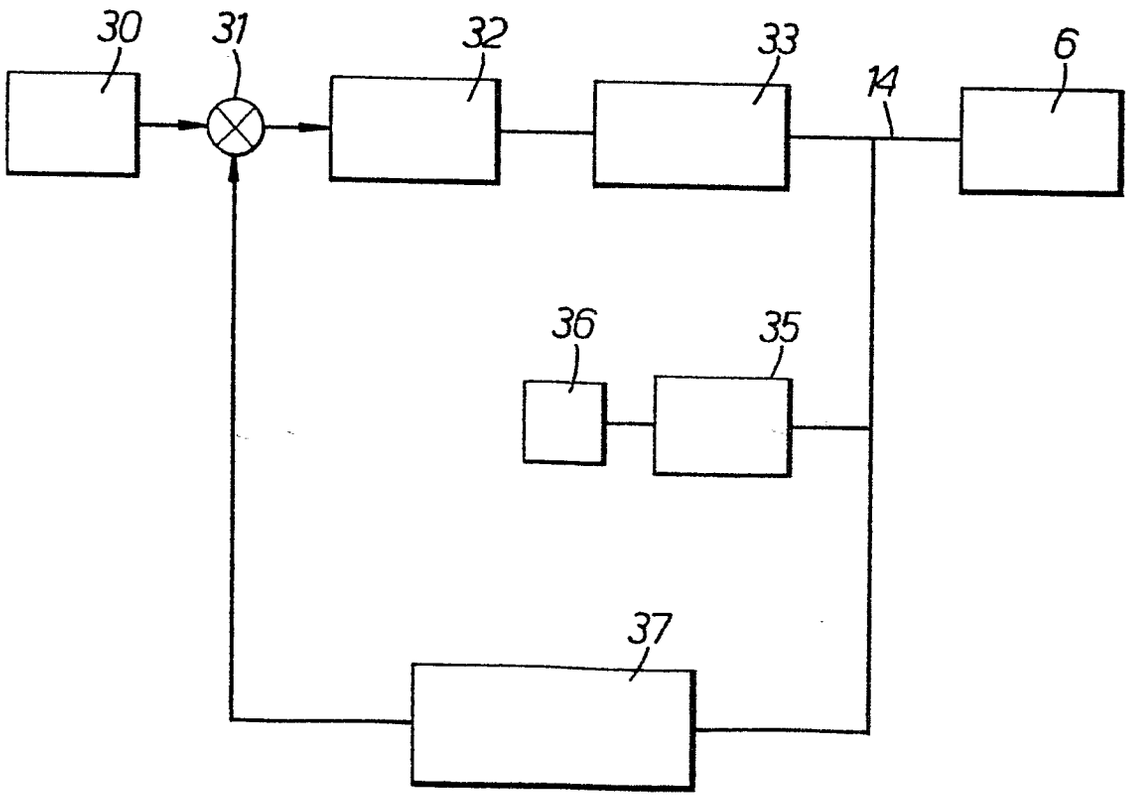

FIG. 3.