United States Patent

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[54] HEAT EXCHANGER FOR BLOOD DURING TRANSFUSIONS

6 Claims, 3 Drawing Figs.

[52] **U.S. Cl.** **128/399,** 128/214, 165/46, 165/133
[51] **Int. Cl.** **A61f 07/00**
[50] **Field of Search** 128/214, 214.2, 254, 258, 399, 402, 403; 165/46, 133

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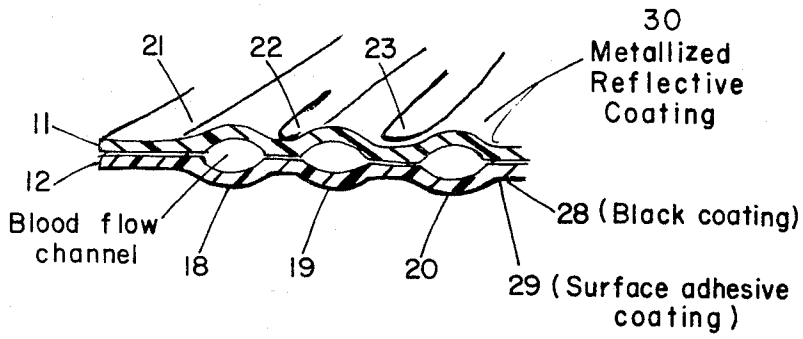
ABSTRACT: Means for controlling the temperature of intravenous fluids being administered to a patient and comprising a pair of relatively thin films of flexible silicone rubber bonded together to form a generally rectangular parallelepiped having a pair of opposed major surfaces and having a plurality of generally parallelly disposed flow channels extending therebetween, the flow channels being arranged transversely to the elongated axis of said parallelepiped; means defining an inlet orifice along one edge thereof communicating with an inlet manifold at one end of said parallel flow channels and an outlet orifice along the opposite edge thereof communicating with an outlet manifold at the opposite end of said flow channels; and a highly thermally emissive coating applied along one of said major surfaces, and a highly thermally reflective coating applied to the opposed major surface.



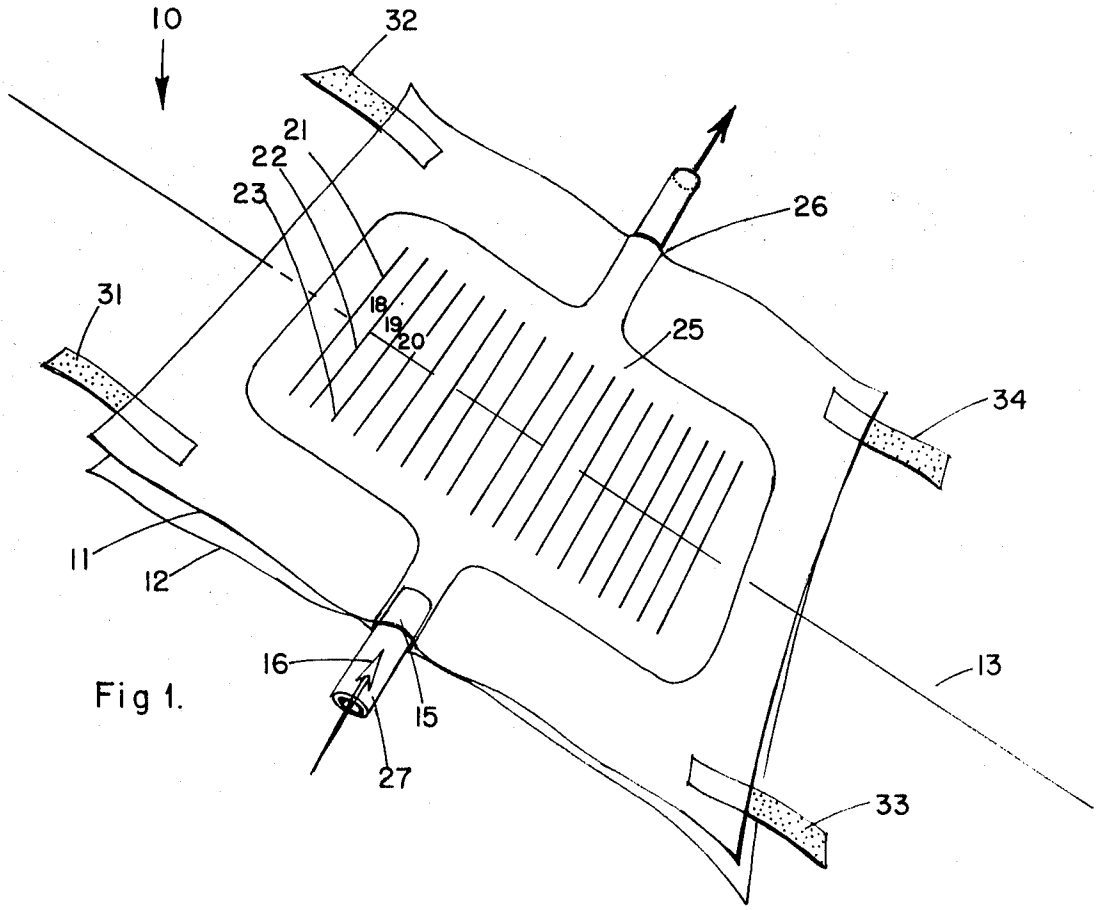


Fig 1.

Fig 2.

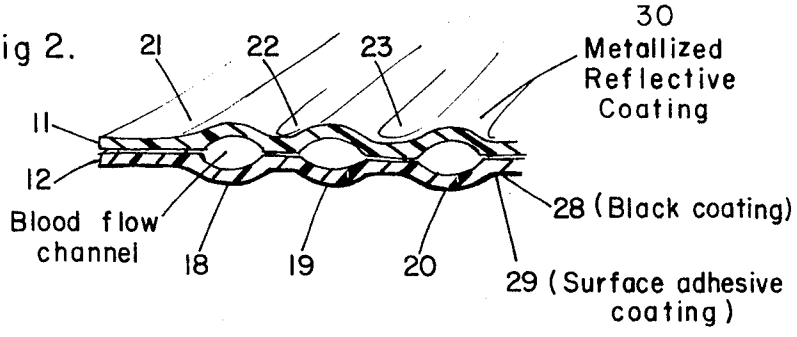
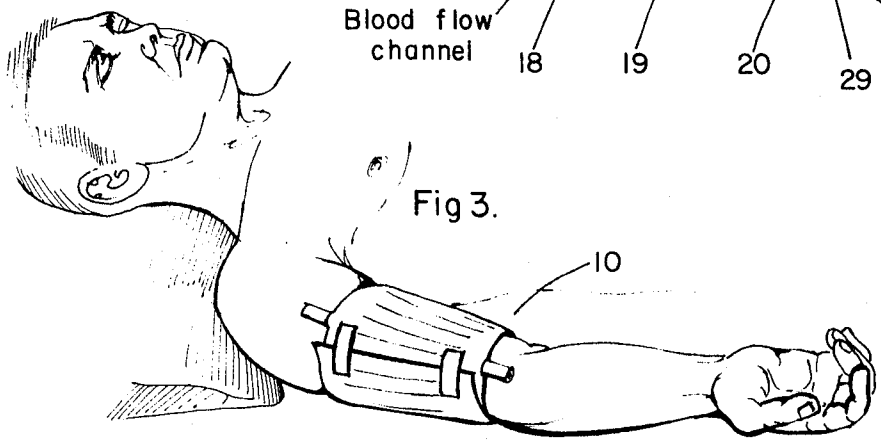


Fig 3.



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HEAT EXCHANGER FOR BLOOD DURING TRANSFUSIONS

The present invention relates generally to a means for controlling the temperature of intravenous fluids being administered to a patient, and more particularly relates to such a structure which is adapted to be secured to the surface of either the patient or attending party for bringing the temperature of intravenous fluids to a level closely approximating that of the normal system.

At the present time, elaborate electrical, mechanical, and other devices are utilized for controlling the temperature of fluids being administered to a patient. Frequently, large volumes of fluids such as blood or the like are required for initially priming or preparing the devices, and such volumes being of course, lost. In addition, the presently employed electrical or mechanical units are expensive, and dangerous when a breakdown occurs during use. The apparatus of the present invention is, on the other hand, simple, disposable, sterile, and is essentially foil-safe. The structure provides low resistance to normal fluid flow, and the patient's or attending party's body heat is utilized to regulate the temperature of the intravenous fluid being injected.

Recent studies have shown that the rhythm of the heart may be intrinsically disturbed if solutions at a significantly lower temperature are administered to the heart muscle itself. This disturbing activity may occur when cold blood or other intravenous solutions are rapidly infused.

Briefly, the apparatus of the present invention consists simply of two layers of thin plastic film which is inherently heat sealable, or which is coated with a film of adhesive which will bond the two layers together. Generally parallel flow channels are created so that multiple parallel low-resistance high-flow channels are formed. The structure is placed in series with the intravenous fluids, and is adapted to be secured to the patient's skin or to the skin of an attending party. The inner surface adjacent the body is preferably coated with a highly thermally emissive film in order to absorb heat from the body rapidly, while the outer surface is coated with aluminum or other thermally reflective film in order to prevent or retard radiant dissipation of heat into the environment Therefore, the heat exchange occurs utilizing the body's own temperature regulating mechanisms to achieve the desired temperature of the infused fluid prior to the time that it enters the body of the patient.

Therefore, it is an object of the present invention to provide an improved device which functions as a heat exchanger for intravenous solutions, the structure utilizing the body temperature of the patient or attending party for achieving a temperature balance in the solutions being infused.

It is yet a further object of the present invention to provide an improved heat exchanger device which is fabricated from a pair of thin flexible films bonded together so as to form a plurality of parallelly disposed flow channels, these channels providing a plurality of low-resistance high-flow rate paths.

It is yet a further object of the present invention to provide an improved heat exchanger device for modifying the temperature of intravenous solutions being infused, the structure being adapted to be mounted adjacent the patient's skin or the skin of an attending party, the surface of the heat exchanger device adjacent the skin being coated with a highly thermally emissive film, the surface remote from the patient's skin being coated with a highly thermally reflective coating.

Other and further objects of the present invention will become apparent to those skilled in the art upon a study of the following specification, appended claims, and accompanying drawing wherein:

FIG. 1 is a perspective view of a heat exchanger device prepared in accordance with the present invention;

FIG. 2 is a detail sectional view of the flow channels of the device shown in FIG. 1, this figure showing the thermally emissive and thermally reflective coatings applied to the surface of the structure, along with an adhesive bonding layer; and

FIG. 3 is a view of the device of FIG. 1 secured to the arm of a patient receiving intravenous fluids.

In accordance with the preferred modification of the present invention, the intravenous heat exchanger shown in FIG. 1, and generally designated **10**, includes a pair of opposed films **11** and **12**, these films being bonded together firmly along and around substantially the entire periphery thereof. The structure of FIG. 1 is preferably in the form of a rectangular parallelopiped, having an elongated axis generally parallel to the broken axial line **13**. The films **11** and **12** are provided with an inlet orifice as at **15**, for accommodating fluid flow in the direction of the arrow **16**, the inlet orifice communicating with an inlet manifold as at **17**, the manifold introducing the inlet to a plurality of generally parallelly disposed flow channels as at **18**, **19**, and **20**, for example. Intermediate the individual flow channels **18**, **19**, and **20**, seals are formed between the films **11** and **12**, such as at **21**, **22** and **23**. These seals thereby form a plurality of generally parallelly disposed flow channels which extend between the inlet manifold **17**, and an outlet manifold shown at **25**. The outlet manifold **25** communicates with an outlet orifice as at **26**. In order to accommodate mounting of the structure on an in-line basis, suitable fluid-type coupling arrangements are provided, such as, for example, by the use of extruded tubing or the like which may be bonded to the inlet and outlet orifices, such as at **27**.

With attention now being directed to FIG. **2** of the drawing, the individual flow channels such as are shown at **18**, **19** and **20**, are separated by bonded webs as at **22** and **23**, as indicated hereinabove. These webs **22** and **23** may be formed by either thermal welding, or adhesive bonding techniques. The lower surface of the structure, such as the lower surface of the film **12**, is provided with a highly thermally emissive coating such as carbon black or the like, this coating being applied directly to the surface of the film **12**, and shown at **28**. In addition, a pressure sensitive adhesive is applied to the film **12** as at **29**, this adhesive permitting direct attachment or bonding of a heat exchanger structure to the surface of the skin of either the patient or the skin of an attending party.

In order to enhance the thermal environment, the outer surface of the upper film **11** is coated with a highly thermally reflective coating such as aluminum or other metallic reflective coating **30**. These materials are, of course, commercially available and may be utilized to an advantage in this type of structure.

As an alternative to the use of a pressure sensitive adhesive film along the base of the structure, strap members such as the straps **31**, **32**, **33**, and **34** may be employed. These straps permit fast attachment of the structure to the skin surface, and also provide for a minimum risk to mechanical compression of the individual flow channels due to a tight bond being formed between the heat exchanger device and the skin surface.

It will be appreciated that the structure is provided with a plurality of generally parallelly disposed flow channels which provide for a high-low rate, maximum exposure to the desirable thermal environment, all of this being accomplished with a minimum of impedance to flow.

It will be appreciated that a variety of materials may be employed, such as, for example, silicone rubber, polyethylene, polypropylene, or the like. For treatment with blood, it is normally desired that silicone rubber be utilized in order to prevent anomalous effects from occurring in the blood solution upon contact with the film surface. This is, of course, desirable inasmuch as surface contact is at a maximum in this type of structure.

The device is readily introduced into flow systems, and is readily attached or secured to the skin surface of either the patient or an attending party. Thus, the device is quick, simple, and reliable. Any failure or rupture of the structure will, of course, result in a fail-safe condition inasmuch as the fluids will be readily visible, thus permitting corrective measures to be taken prior to the time that the patient may be harmed.

For most applications, the device has a size measuring, approximately, 3 inches on a side, with the flow channel preferably being less than about 3 inches in length.

It will be appreciated, of course, that the examples provided herein are for purposes of illustration only and are not disclosed by way of limitation.

What is claimed is:

1. Apparatus for controlling the temperature of intravenous fluids being infused to a patient utilizing a person's body heat comprising:

a. a pair of relatively thin flexible films bonded together to form a generally rectangular parallelopiped having a pair of opposed major surfaces and having a plurality of generally parallelly disposed flow channels extending therebetween:

b. first means defining an inlet orifice along one edge thereof communicating with an inlet manifold at one end of said parallel flow channels and second means defining an outlet orifice along the opposite edge thereof communicating with an outlet manifold at the opposite end of said flow channels said first means adapted to be connected to a source of intravenous fluid and said second means being adapted to be connected into the patient's vascular system; and

c. a highly thermally emissive coating applied along one of said major surfaces and a highly thermally reflective coating applied to the opposed major surface whereby when said apparatus is in operative position, a person's body heat can be transmitted into the flow channels and held therein so as to effect heating of the fluid being infused into the patient.

2. The means as defined in claim 1 being particularly characterized in that said thermally emissive and thermally reflective coatings are applied externally of said generally rectangular parallelopiped.

3. The means as defined in claim 1 being particularly characterized in that said relatively thin flexible films are fabricated from silicone rubber.

4. The means as defined in claim 1 being particularly characterized in that means are provided along said flexible films for attaching the structure to the skin surface of a human.

5. The means as defined in claim 1 being particularly characterized in that pressure sensitive coatings are applied along the surface coated with thermally emissive material for securing said structure to the surface of the skin of a human.

6. The means as defined in claim 1 being particularly characterized in that said rectangular parallelopiped has an elongated axis and a shorter transverse axis, and said parallelly disposed flow channels are generally parallel to said transverse axis.