

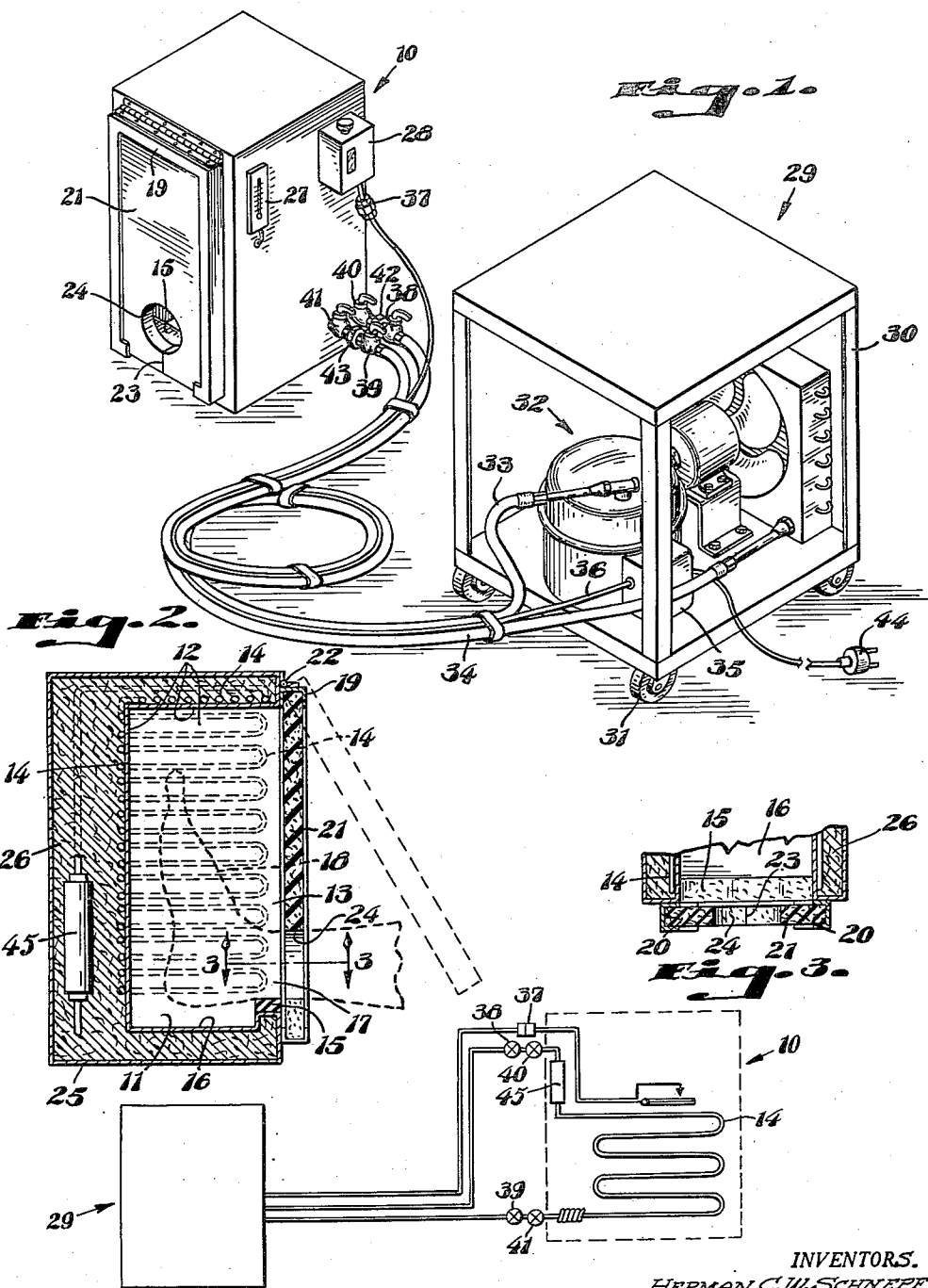
March 4, 1958

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2,825,338

APPARATUS FOR PRE-AMPUTATION FREEZING

Filed Dec. 22, 1952



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APPARATUS FOR PRE-AMPUTATION FREEZING

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Application December 22, 1952, Serial No. 327,342

1 Claim. (Cl. 128—402)

The present invention relates to a method and apparatus for freezing an extremity of a patient's limb preliminary to amputation of the limb; and the invention is particularly concerned with the provision of method and apparatus details whereby improved control over the condition of the limb extremity can be achieved while the risk of deleterious effects upon the patient is substantially reduced and analgesia is much more quickly and effectively established.

The primary object of the invention, then, is to provide a method and apparatus whereby a limb extremity may have its temperature reduced, quite quickly, to a value such as to halt the flow of body fluids within the extremity, by exposure to a completely circumambient atmosphere of extremely low temperature. A further object of the invention is to provide a method and apparatus whereby, after the quick establishment of optimum temperature throughout the extremity under treatment, the temperature of such circumambient atmosphere may be changed in such a fashion that the extremity will be held at optimum temperatures for whatever period may be desirable, and with minimum discomfort to the patient and minimum attention on the part of the nursing staff. A further object of the invention is to provide means whereby the above optimum conditions may be achieved and maintained through exposure of the extremity to a dry atmosphere of desired temperatures.

A still further object of the invention is to provide specific apparatus, including a chamber in which the extremity under treatment may be received, means for maintaining any desired temperature conditions within such chamber, and barrier means, so constructed as to accommodate itself to the patient's limb in the region immediately proximal to the extremity under treatment, such barrier means being capable of substantially preventing heat exchange and/or air flow between the atmosphere within said chamber, to which the extremity is exposed, and the atmosphere without said chamber, to which the remainder of the patient's limb is exposed.

Further objects of the invention will appear as the description proceeds.

To the accomplishment of the above and related objects, our invention may be embodied in the form illustrated in the accompanying drawings, attention being called to the fact, however, that the drawings are illustrative only, and that change may be made in the specific construction illustrated and described and in the specific steps stated, so long as the scope of the appended claims is not violated.

Fig. 1 is a perspective view of one form of apparatus embodying our invention and adaptable for use in the practice of our process;

Fig. 2 is a central vertical section through the freezer cabinet;

Fig. 3 is a fragmental section taken substantially on the line 3, 3 of Fig. 2; and

Fig. 4 is a diagrammatic illustration of the refrigerating mechanism associated with the freezer cabinet.

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In the case of individuals suffering from diabetes mellitus, arteriosclerosis, obliterative arterial diseases and the like, and sometimes in the case of vasoplastic conditions, a minor injury to a toe or any other portion of a foot, and sometimes to a hand, will frequently result in the development of spontaneous gangrene. When such a condition arises, it is almost invariably found that it is necessary to amputate the limb, preferably just below the knee, leaving two and one-half to three inches of tibia. The site of amputation is, of course, dictated primarily by the fact that blood supply, upon which spontaneous repair is dependent, is usually optimum here, and by the fact that the best of prosthetic devices are designed for association with such a stump.

Almost invariably, when such a gangrenous condition develops, it is found that the patient's general condition is such that immediate amputation is contra-indicated. In diabetic patients, for instance, gangrene usually will not thus develop unless the patient has lost stabilization; and in many instances, a period of four to ten days will elapse before satisfactory stabilization can be achieved. In the other abnormal conditions above mentioned, it is usually highly important that the patient shall have treatment to improve his general condition before he is subjected to the shock of amputation.

Localized treatment of the infected region by heating, poulticing and the like, is utterly ineffective to inhibit the development and diffusion and absorption of the noxious products of necrosis and to prevent an ascending lymphangitis, and is almost equally ineffective to provide analgesic relief for the patient. It is deemed essential to halt the spread of infection, and it is highly desirable to provide a reasonable degree of comfort for the patient, during the treatment required to prepare the patient for surgery.

It is conventional, therefore, to chill the affected extremity to a degree sufficient to halt the flow of body fluids in the affected region; and, prior to our invention, the only procedure used for that purpose has involved the use of an ice-packed boot, with attendant serious disadvantages, well known to those versed in the art.

We have discovered that, through the use of proper refrigerating apparatus, it is possible to eliminate or alleviate all of the objectionable features of the previously used procedure. In the accompanying drawings, we have illustrated one form of apparatus in which our invention may be embodied, and through which our novel method may be practiced. In those drawings, the reference numeral 10 indicates generally a cabinet formed to define a chamber 11 surrounded on five sides by preferably plane walls and having, at its sixth side, an open entryway 17. Evaporator coils 14 are suitably secured in heat-exchanging relationship to all of the walls 12. The bottom of the entryway is located somewhat above the floor 16 of the chamber 11 and is provided with a pad 15, preferably of sponge rubber, upon which the region of a patient's leg immediately proximal with respect to his foot 18 may be reasonably comfortably supported at a level such that the patient's heel is spaced above the chamber floor 16, as is clearly illustrated in Fig. 2.

Preferably, but not essentially, we provide a barrier which substantially closes the entryway 17. In the illustrated embodiment of the apparatus of the present invention, said barrier comprises a generally U-shaped frame 19 whose base and legs are formed to define a continuous, inwardly-facing channel 20, and a suitably proportioned block 21 of sponge rubber or the like has its top and side edges snugly seated in said channel. Preferably, but not necessarily, the lower ends of the frame arms will be turned slightly inwardly to aid in supporting the block 21 in place in the channel. Said block, of course, spans the area defined within the frame 19, and

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the parts are so proportioned and designed that, when the base of said frame is hingedly supported, as at 22, upon the cabinet above the entryway 17, the barrier will tend to fall by gravity into closing relation with the entryway 17 to the chamber 11.

At its lower edge, the block 21 is substantially centrally provided with a slit 23 which opens through the lower edge of the block and leads into a substantially circular opening 24, proportioned and designed snugly to embrace the patient's leg just above the ankle, when the parts are in the solid line positions of Fig. 2.

The cabinet 10 comprises also an outer shell 25, the region between the walls 12 and the shell 25 preferably being packed with a suitable insulating material such as, for instance, "Fiberglas"; and the shell is suitably welded or otherwise secured to the walls 12 so that the insulating material 26 is hermetically enclosed.

Preferably, a thermometer 27, having a bulb disposed within the chamber 11, is mounted on an outer wall of the cabinet; and a control switch 28, whose function will appear hereinafter, is mounted adjacent the thermometer.

The cabinet as a whole is so proportioned and designed that it may stand, in the attitude suggested in Fig. 1, upon a hospital bed or upon a table suitably located adjacent the bed, and at a level such that the patient's foot may be suspended within the chamber 11, in the manner suggested in Fig. 2, with minimum discomfort to the patient.

A separate unit, indicated generally by the reference numeral 29, comprises a frame 30 mounted on casters 31 and so proportioned and designed that it may be conveniently disposed beneath a conventional hospital bed. A refrigeration system, of any desired form, is indicated generally by the reference numeral 32, and, as shown, will include an electric motor, a compressor, a condenser, and conduits 33 and 34 for establishing the usual refrigeration cycle flow between the unit 32 and the coil 14, one conduit being connected to one end of the coil 14 and the other conduit being connected to the other end of said coil. In what we believe to be the optimum form of our apparatus, the conduits 33 and 34 will be flexible, rubberoid material of such character as to withstand the pressures which are inherent in the system.

A control unit of conventional form is indicated at 35 and is connected by a flexible electric conductor 36, to the switch 28, preferably through a conventional, separable connector, indicated at 37.

The conduit 33 carries, at its outer end, a shut-off valve 38 while the conduit 34 carries a similar shutoff valve 39. Similar valves 40 and 41 are preferably supported upon the opposite ends of the coil 14, to control the same; and connector means 42 and 43 are provided, between the valves on the conduits and the valves on the coil, for connecting said conduits with the coil. Through this arrangement, of course, it is possible, with minimum difficulty, to disconnect the cabinet 10 from the unit 29, through the separable connectors 37, 42 and 43. Since the cabinet 10 is, as above explained, a hermetically tight structure, the entire cabinet unit may be immersed in sterilizing liquid, placed in a steam cabinet, or subjected to dry, sterilizing temperatures as high as 250° Fahrenheit, without the loss of refrigerant and without hazard. We presently believe that the system should use a "Freon" refrigerant which is non-toxic, non-inflammable and non-hazardous.

The switch 28, of course, dominates the control mechanism 35, the arrangement being such that any desired temperature within the chamber 11 may be attained and maintained automatically, upon suitable adjustment of the switch 28. The entire system may be energized, from a conventional lighting circuit, through a plug 44 carried at the end of a flexible conductor.

When it is desired to freeze a limb extremity, according to our method of procedure, the cabinet 10 is placed in a convenient position on or adjacent the patient's bed. Now, the barrier is raised, and the patient's foot is placed

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inside the chamber 11, substantially in the position illustrated in Fig. 2. The patient and the cabinet are mutually adjusted in position until the patient is reasonably comfortable; and thereupon the barrier is lowered to its solid-line position of Fig. 2, the patient's leg passing through the slit 23 and entering the opening 24.

Now, the unit 29 is placed in any suitable position such as, for instance, under the patient's bed, and the plug 44 is connected to the lighting circuit. Connections will be made at 37, 42 and 43, the valves 38, 39, 40 and 41 will be opened, and the switch 28 will be set to a position corresponding to a chamber temperature of, for instance, 20° below zero Fahrenheit. Tests have shown that the chamber temperature is very rapidly reduced, so that the indicated temperature is attained within a very few minutes. Obviously, no temperatures even approaching the value above suggested can be attained by means of the ice pack method heretofore practiced. It has been found that analgesia usually arises within two and one-half to three hours and that flow of body fluids within the foot is usually completely halted within substantially the same length of time.

The barrier provided by the block 21 helps, of course, to prevent heat exchange between the interior and the exterior of the chamber 11; but even more importantly it hides the foot from the patient. Under this treatment, the foot changes color rather rapidly, assumes a death-like gray appearance, and frequently begins to collect ice crystals; and it has been found that it is psychologically inadvisable for the patient to have an opportunity to see the foot in that condition.

Once analgesia has been established and the flow of body fluids within the foot has been completely halted, it is desirable to raise the temperature within the chamber 11 to a value just below the freezing point of water. Usually, a temperature of 25° to 30° F. is found to be optimum; and this temperature is maintained, substantially without variation, until just before the amputation is performed.

The quick freezing effected by following the above procedure eliminates the long period of agonizing pain from which the patient must be protected, under previously known procedures, by heavy and long-continued sedation. Thus the deleterious effect of such sedation upon the patient's general condition is largely, if not entirely, avoided. The discomfort resulting from a heavy weight of ice-bearing upon the infected member is completely avoided, since the foot is suspended, entirely out of contact with anything, within the chamber 11. Some slight movement of the limb with respect to the cabinet is permissible, so that even the slight discomfort resulting from the suspension of the limb upon the pad 15 is thus minimized.

But of major importance are the facts that the apparatus of the present application completely eliminates the labor burden, inevitable with previously known procedures, of replenishing the ice supply, disposing of the water resulting from the melting of the ice, and keeping the bed reasonably dry and that the practice of the process of the present application maintains the patient's extremity in a completely dry atmosphere, thereby protecting the patient against the deleterious effects which arise when the ice and ice water of previous procedures come into contact with body tissue.

The barrier block 21 has a further function in that, since it protects the proximal portion of the limb against actual cold air flow thereover from within the chamber 11, the patient may be kept comfortably warm, and the possibility of extension of freezing toward the trunk, beyond the desired region of freezing, is minimized.

Preferably, an accumulator 45 is included in the refrigerating system, and is embedded in the insulation material 26 in the manner illustrated in Fig. 2, whereby maintenance of a constant temperature within the freez-

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ing chamber is facilitated and line freezing back toward the compressor is obviated.

Preferably, the assembly 32 and the switch 28 will be so designed as to maintain any desired temperature within the chamber 11, from ambient temperature to -50° Fahrenheit with a variation not to exceed 2° .

As designed and disclosed, the apparatus guards the patient against deleterious effects resulting from any failure of the refrigerating mechanism. The cabinet is so designed that, even if the unit 29 should break down, the optimum temperature would be maintained within the chamber for a period ample to permit disconnection of the disabled unit 29 and substitution of another equivalent unit, without any possibility of thawing taking place in the patient's foot.

Ordinarily, satisfactory analgesia and effective inhibition of dispersion of toxins through the system can be effected by freezing only the distal end of the limb beyond the ankle or wrist joint. In the extremely unusual case where it is found necessary or desirable to extend the freezing farther toward the trunk, it is entirely possible to do so with the present apparatus by opening the barrier, attaching a rubber sheet in any suitable fashion around the entryway 17, and carrying that sheet to any desired point in the length of the patient's limb. It has been found that the mechanism is capable, when thus used, of maintaining any desired sub-freezing temperature within the entire space enclosed by the rubber sheet.

We claim as our invention:

Apparatus for freezing a limb extremity preliminary to amputation, comprising a cabinet formed to provide a chamber, closed except for an entryway at one side,

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evaporator coils outside said chamber in heat-exchange relation to the walls of said chamber, heat-insulation means outside said chamber, means enclosing said insulation means and said coils and cooperating with said chamber walls to seal said insulation means hermetically from the circumambient atmosphere, barrier means movable into and out of closing relation with said entryway, said barrier means comprising a substantially-rigid, substantially U-shaped frame formed to define an inwardly-facing channel, a block of sponge rubber supported in said channel and spanning said frame, and means hingedly supporting the base of said frame above said entryway, and means for establishing a flow of refrigerant fluid through said coils.

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