

May 22, 1956

F. G. KEYES

2,746,264

MINIATURE COOLING UNIT

Filed July 17, 1953

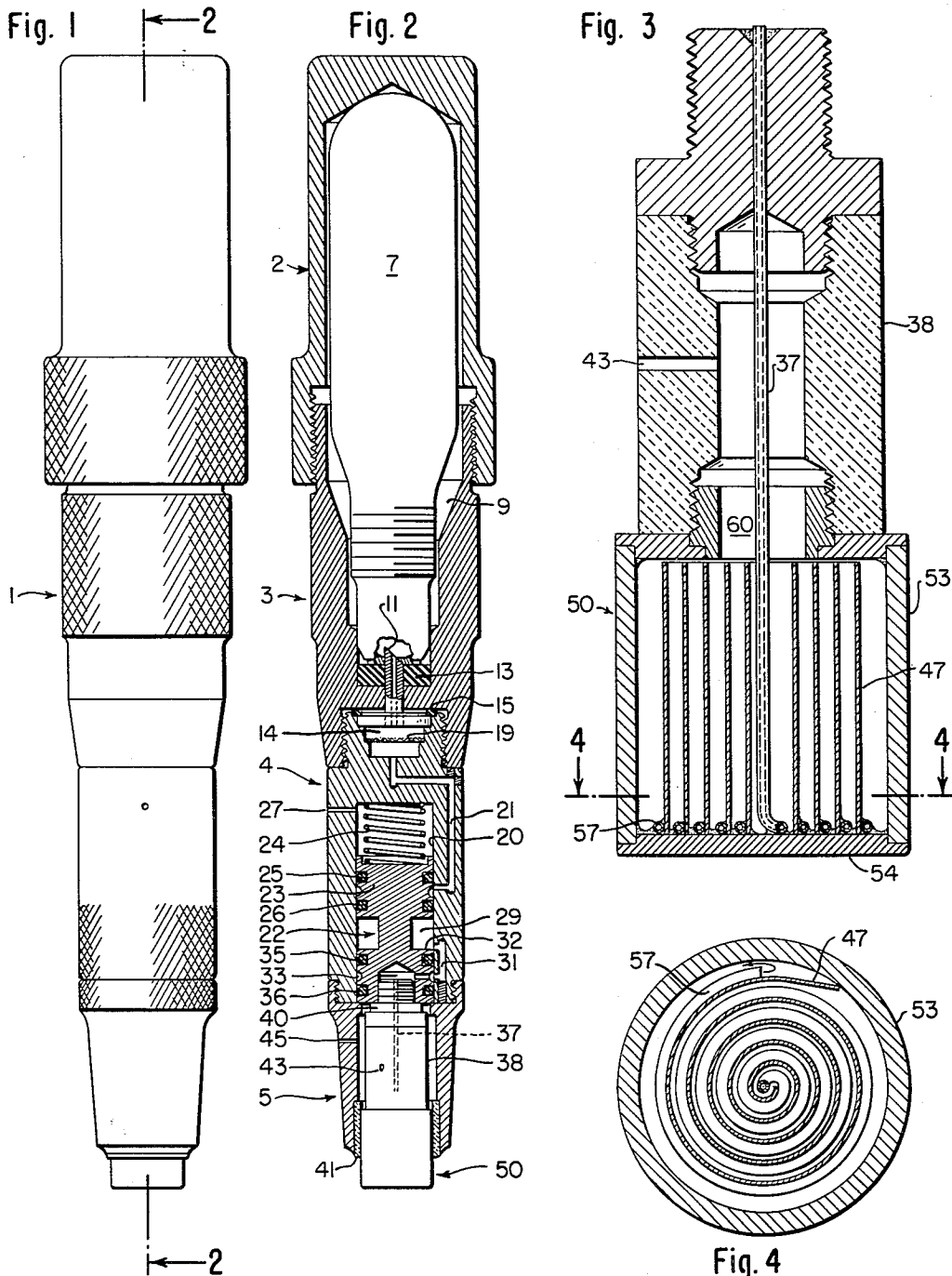


Fig. 4

INVENTOR.
FREDERICK G. KEYES

BY *Kenway, Jerny, Witter*
+ *Heldreth*

ATTORNEYS

- 1

2,746,264

MINIATURE COOLING UNIT

Frederick G. Keyes, Cambridge, Mass., assignor to Alfred Bicknell Associates, Inc., Cambridge, Mass., a corporation of Massachusetts

Application July 17, 1953, Serial No. 368,760

7 Claims. (Cl. 62—92)

The present invention relates to a miniature refrigeration unit and in particular to a miniature portable refrigeration unit especially adapted for use in desensitizing skin regions in preparation for a hypodermic injection or the like.

Hypodermic injections may be made substantially painless by bringing the temperature of the skin surrounding the area of the injection down to a temperature between freezing and 40 degrees Fahrenheit. While devices exist which will freeze the skin for minor operations, such devices are not useful for this purpose since freezing the skin results in an increase in pain and sensation after the freezing wears off. If however the skin is chilled to a temperature just above the freezing point, then the procedure is effective to eliminate all sensation both during and after the injecting.

Accordingly, it is the object of this invention to provide a convenient and economical miniature refrigeration device which can be used quickly and conveniently to desensitize localized areas of the skin without freezing. More specifically, it is an object of the invention to provide a compact self-contained refrigeration unit, capable of hand-held operation, which may conveniently be operated to deliver a charge of refrigerant to a cooling surface in contact with the skin of the patient, so as to chill the selected skin area rapidly and effectively. It is a further object of this invention to provide such device which will use capsules of refrigerant in order to be completely portable and which will automatically meter the supply of refrigerant to the skin-contacting element as desired in amounts sufficient to effect the desired chilling without freezing.

Other objects and features of the invention will appear from the following description, taken in conjunction with the accompanying drawings in which—

Fig. 1 shows the external appearance of the device.

Fig. 2 is a sectional view taken along the major axis of the device on the line 2—2 of Fig. 1.

Fig. 3 is a sectional view on an enlarged scale of the lower end portion of the device shown in Figs. 1 and 2, showing the heat exchange chamber and contact cooling surface of the device, and

Fig. 4 is a cross-sectional view of the heat exchange chamber, taken on the line 4—4 of Fig. 3.

In Figs. 1 and 2 illustrating the preferred form of apparatus, the case 1 is made in four sections 2, 3, 4, and 5, which are attached together by overlapping threaded flanges. The cap 2 fitting over the body section 3 provides a chamber 9 containing a disposable metal capsule 7 of refrigerant. A hollow pointed needle 11 extends through the end of the refrigerant capsule and the capsule itself is firmly seated on the rubber ring 13 surrounding the needle. This needle extends downward into section 4 of the case to a small chamber 14 sealed by the O-ring 15. Refrigerant which passes through the hollow pointed needle into this chamber is filtered by the filter 19 which separates the chamber 14 from the passage 21 leading to the metering valve.

2

While an ordinary needle valve would be usable, this construction is believed to provide greatly improved convenience and economy. This valve which automatically supplies the correct amount of refrigerant consists of a valve member which in this case is a spool 22 fitted so as to slide in a cylindrical chamber or cavity 20 in section 4 of the casing, and normally urged toward the head of the unit by a coil spring 24. A valve member of rectangular cross section would be equally acceptable, however. In this normal position passage of the refrigerant through the duct 21 is blocked by the flange 23 of this spool. Further sealing of the refrigerant is effected by the O-rings 25 and 26 on either side of the orifice leading to the duct 21. An escape duct 27 is provided through the case to the part of the cylindrical chamber containing the spring to prevent a building up of pressure by any refrigerant passing the O-ring 25.

The central part of the valve member is cut away to provide a recess forming a metering chamber 29 which may be loaded with refrigerant by forcing back the head of the instrument 50 causing the spool 22 to compress the spring 24 until this metering chamber is opposite the inlet port from the supply duct 21. In the normal position as shown, this metering chamber or recess leads to an outlet port supplying the delivery duct 31 in the case. This duct in turn leads to the annular groove 33 cut into the lower flange 32 of the spool 22 which opens to the delivery duct 37 carrying refrigerant to the cooling head 50 of the instrument. This lower flange is supplied with the O-rings 35 and 36 to prevent leakage. The delivery duct 37 is surrounded by an insulating member 38 which serves to minimize transfer of heat from the body of the instrument to the cooling head 50 and to firmly attach the exchanger 50 with the spool 22. Contact between this insulating member and the spool is further minimized by use of the washer 40.

The cooling head 50, construction of which will be more fully described presently is slidably fitted in the insulating member 41 which a protective sleeve preventing heat transfer between the cooling head 50 and the end section 5 of the case. Refrigerant which has expanded through the head 50 is permitted to escape through the outlet 43 in the insulating member and then through the outlet 45 in the case.

The cooling head 50 is shown in section in Fig. 3. It consists of a hollow cylindrical shell 53 having a relatively thick flat end plate 54 constructed of conductive material. The inside of this shell contains a spiral heat exchange chamber formed by a conductive vane 47 firmly attached to the end plate 54 and extending to but not attached to the opposite end of the chamber. The refrigerant line 57 through which the refrigerant is introduced to this chamber is an extension of the supply line 37 and is attached to the spiral vane. The refrigerant is released at the end and the expanding gas passes back along the spiral heat exchange chamber and the delivery line 57 to the outlet 60, which in turn leads to the exhaust port 43 described above. This use of the counterflow principle in a spiral chamber enables all the expanding refrigerant to cool the incoming refrigerant in line 57 attached to the vane forming the spiral chamber. The fact that this vane is attached firmly on at the plate 54 provides maximum cooling of this surface while minimizing heat flow elsewhere.

Under normal conditions the spool valve and the head are maintained in extended position shown in Fig. 2 by means of the coil spring 24, and passage of refrigerant from the supply line 21 into the metering chamber is blocked. A capsule of liquid refrigerant is inserted in the case 3 and the cap 2 is tightened down over it thus forcing the capsule against the seal 13 and finally forcing the needle 11 to puncture the end of the capsule, thus releasing refrigerant through the screen 19 to the supply

line 21. The liquid refrigerant in the capsule is maintained under pressure by the vapor of the refrigerant itself which has a boiling point below room temperature. The preferred refrigerant for this use is dichlorodifluoromethane commonly known in the trade as Freon 12.

When the instrument is to be used, as, for example in anesthetizing a small area of a patient's skin, the operator simply presses the head of the instrument 50 against a convenient surface, thus forcing the head and the spool back against the spring 24 and positioning the metering chamber 29 opposite the inlet port from the supply duct 21 whereupon a charge of refrigerant is admitted into the metering chamber. Pressure on the instrument is then released and the spring restores the parts to the position shown in Fig. 2 whereupon the refrigerant is released through the outlet port to the delivery line 31 and into the heat exchanging head 50. In passing through the heat exchange chamber described above, the refrigerant is vaporized and the vapor expands through this chamber thereby producing a rapid cooling effect both by absorption of the latent heat of vaporization and by expansion. The size of the metering chamber is such as to provide a quantity of refrigerant sufficient to cool the face of the instrument to a temperature of about 33° F.

It will be observed that this device is convenient to handle since the operator requires only one free hand and is economical since the metering chamber supplies only the amount of refrigerant actually needed. As heretofore noted it is particularly useful for mild local anesthesia for hypodermic injections. While the device has been described in terms of a single embodiment it will be understood that considerable variation in the actual construction may be made within the scope of this invention.

Having thus described my invention, I claim:

1. A refrigeration unit comprising a case, a detachable capsule of compressed refrigerant, means for tapping said capsule, valving means for periodically releasing a metered amount of the refrigerant, and a counterflow heat exchanger for the refrigerant comprising a spiral chamber formed by a spiral vane attached to a flat cooling end surface wherein the refrigerant supply is carried through said spiral chamber in a duct attached to the vane and the expanding gas escaping through the spiral cools the incoming refrigerant.

2. A refrigeration unit comprising a case, a detachable capsule of refrigerant, means for tapping said capsule, a valve member slidably fitted to a chamber in the case and having a metering recess, said case having ducting means with an inlet port and an outlet port to the chamber separated by a distance greater than the length of the metering recess, spring loading means for maintaining the metering recess in registration with the outlet port, a heat exchanger comprising a single spiral expansion chamber for the refrigerant, ducting means connecting the tapping means with the inlet port and the outlet port with the heat exchanger, and means for positioning the metering recess opposite the inlet port.

3. A refrigeration unit comprising a case, a removable cap fitted to the case providing a chamber for a refrigerant capsule, a hollow needle surrounded by a compressible sealing member in said chamber and acting in cooperation with the cap to tap the capsule, a filtering member, a duct

leading from the head of the needle to the filtering member, a multiposition valve member slidably fitted to a chamber within the case, a metering storage recess, ducting means leading from the filter to the metering recess 5 when the valve member is in one position, an expansion chamber for the refrigerant, and ducting means leading from the storage recess to the expansion chamber when the valve is in a second position.

4. A refrigeration unit comprising a case, a detachable capsule of refrigerant, means for tapping said capsule, a valve member movably fitted to a chamber within said case whereby a metering chamber for the refrigerant is formed between the valve member and a surface of said case chamber, an expansion chamber having a surface to be cooled, a supply duct from the tapping means to an inlet port for the metering chamber, a delivery duct from an outlet port from the metering chamber to the expansion chamber, means for moving the valve member to effect flow of a charge from the inlet port to the metering chamber, and means for positioning the valve member to close the valve and permit flow of said charge only from the metering chamber to the expansion chamber.

5. A refrigeration unit comprising a case, a capsule of refrigerant, means for attaching said capsule to said case, means for tapping said capsule, a multiposition valve member movably fitted to said case, a metering chamber, ducting means leading from the tapping means to deliver a measured charge to the metering chamber when the valve member is in one position, an expansion chamber 15 for the refrigerant, and ducting means leading from the metering chamber to release said measured charge to the expansion chamber when the valve is in a second position.

6. A portable refrigerating unit comprising a case to contain a detachable capsule of compressed refrigerant, means for tapping the capsule, a refrigerating head carried by and protruding from the case and movable inwardly of the case, a spring normally holding the head in protruding position, means carried by the head to form a metering recess, means operated by motion of the head inwardly of the case to release a measured charge of compressed refrigerant into the metering recess, and a duct leading from the metering recess to the head to pass the measured charge from the metering recess and expand it into the head.

7. A refrigeration unit comprising a case having a cavity at one end, a capsule of compressed refrigerant, means for attaching the capsule to the case, means for tapping the capsule, a heat exchanger slidably fitted to the end cavity of the case and having a cooling surface projecting outside the case, a metering recess in the case capable of containing a specified amount of refrigerant, valving means operated by compression of the heat exchanger into the cavity to release a charge of refrigerant from the capsule to the metering recess, and ducting means 55 for delivering the charge of refrigerant from the metering recess to the heat exchanger.

References Cited in the file of this patent

UNITED STATES PATENTS

1,625,712	Cremieu	Apr. 19, 1927
2,536,001	Chase	Dec. 26, 1950
2,645,097	Posch	July 14, 1953