July 15, 1969 J. A. GANS 3,455,304

CRYOEXTRACTOR

Filed Oct. 6, 1966

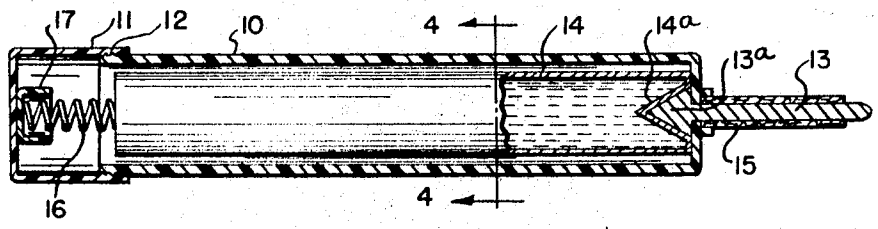

FIG.1

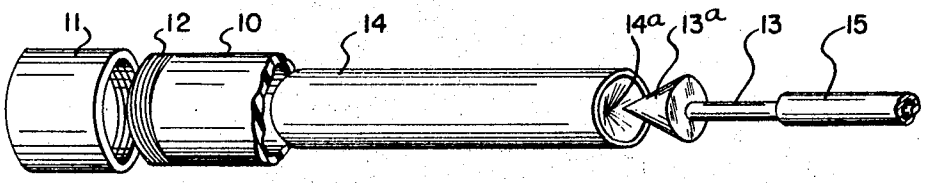

FIG.2

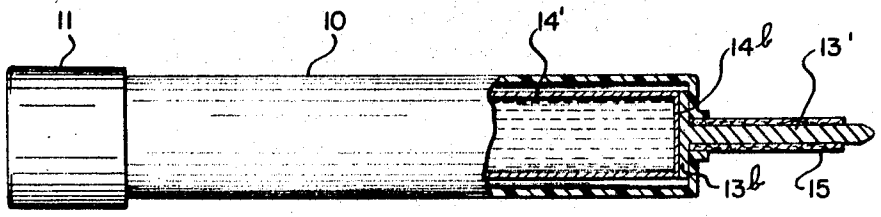

FIG. 3

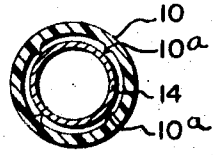

FIG. 4

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United States Patent Office 3,455,304 Patented July 15, 1969

3,455,304

CRYOEXTRACTOR

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Filed Oct. 6, 1966, Ser. No. 584,713
Int. Cl. A61f 9/00
U.S. Cl. 128—303.1 5 Claims

ABSTRACT OF THE DISCLOSURE

A cryoextractor is provided having a cold-conducting cryoextractor tip mounted in one end of the casing and protruding therefrom, having a completely closed capsule wholly within this casing and in cold conducting contact with the tip with the liquid in the capsule which freezes at a temperature below the freezing point of water, and with the end of the casing opposite the tip being open and of such a size that the capsule is removable and insertable through this opening, together with a cap for securely closing that opening. This permits a capsule to be kept in a refrigerator at the desired cold temperature, then taken out of the refrigerator at the time of use and inserted through the open end of the casing even when the capsule is in an unsterile condition, thus necessitating only a sterile casing. After the use the capsule is quickly removable through the opening and can be replaced in the refrigerator for re-use.

This invention relates to improvements in a cryoextractor used in cataract operations and wherein a very cold tip of the instrument is applied to the moist anterior surface of the lens of the eye to which it adheres by freezing, thus enabling the doctor to extract the lens intact.

One of the objects of the present invention is to provide a cryoextractor which is efficient in its operation but which also maintains the sterile condition of the operating area.

Another object of the present invention is to provide a cryoextractor wherein the cooling medium is in a completely closed capsule which provides a cooling medium for one use of the instrument, after which the capsule can be refrozen and used again.

Another object of the invention is to provide a capsule filled with a product of rather low cost but which provides a cold source for cooling the cryoextractor tip, which cold source is free of escaping evaporating gases which can be a source of contamination.

Other objects and advantages of the invention will be apparent from the accompanying drawings and description and the essential features thereof will be set forth in the appended claims.

In the drawings:

FIG. 1 is a central sectional view, enlarged, and taken generally axially through the instrument of this invention with a portion of the cooling capsule broken away to more clearly show the construction;

FIG. 2 is an exploded view showing the significant parts of FIG. 1 in slightly disassembled relationship;

FIG. 3 is a view of a modification; while

FIG. 4 is a sectional view along the line 4—4 of FIG. 1.

Cryoextractors have been heretofore used in cataract operations but those commonly known release non-sterile gases in the operating area which is very undesirable. The present invention overcomes this disadvantage.

Referring to FIGS. 1 and 2, this improved cryoextractor includes a casing **10** which may be of any suitable material, but preferably is made of a synthetic plastic, nylon having been successfully used in one embodiment. This casing is closed at the right-hand end except for the tip which will be later described. The casing is normally open at the left-hand end as viewed in FIG. 1 and means is provided for closing this end which in this case is a cap **11** having a threaded connection at **12** with the casing **10**. An operating tip **13** extends from the right-hand end of the casing as viewed in FIG. 1 and this is made of a good heat conductor such as copper or silver. The inner end of this tip must be in cold conducting contact with a capsule **14** which is adapted to cool the tip to a temperature below the freezing point of water or colder. In the embodiment of FIGS. 1 and 2, the mutually engaging ends of the capsule **14** and the tip **13** have interfitting projection and recess portions whereby to increase the cold-conducting area between them. In the form shown, these are at least partially conical and include the conical end **13*a*** on the tip **13** which fits closely a conical recess having walls **14*a*** at the right-hand end of the capsule **14** as viewed in FIGS. 1 and 2. Preferably the casing **10** has a few longitudinal ridges **10*a*** as shown in FIG. 4 to minimize cold loss from the capsule to the casing which acts as a handle.

For more efficient operation, insulation **15** is applied around the tip **13** leaving only the operating end exposed. In the position of the parts shown in FIG. 2, the cold insulation **15** has been slidably moved away from the tip end **13*a*** to more clearly disclose the construction. It is desirable to provide means for maintaining good cold conducting contact between the tip **13** and the capsule **14**. In the drawings, a helical compression spring **16** is shown confined between a cup-like member **17** in the cap **11** and the left-hand end of the capsule **14**. The parts are so arranged that when the threads **12** are connected, the cap holds the spring slightly compressed against the capsule **14**.

The capsule **14** is completely closed and contains a liquid which freezes at —35° centigrade or colder, preferably. In one form of this invention I have utilized a water solution of ethylene glycol material sold commercially as Prestone. Other suitable liquids are alcohol, a salt water solution, or a glycerin solution. These are well known and can be prepared without difficulty. I have successfully used such a Prestone solution freezing at —40° centigrade, although solutions freezing at —50 to —70° centigrade may also be used. It is desirable that the operating end of the tip **13** be cooled to —5° centigrade and this is readily arranged with the cold conducting contact here disclosed between the tip **13** and the capsule **14**.

A modified form is shown in FIG. 3 where all parts having the same function are given the same reference characters and the only difference here is that the capsule **14'** has a flat end **14*b*** contacting a flat circular disc **13*b*** formed at the inner end of the tip **13'** and integral therewith. This provides a good cold conducting surface between the tip **13'** and the capsule **14'** although it does not have the cold conducting area of the first described embodiment.

In use of this invention, a supply of capsules **14** is kept in a refrigerator of any type at any desired temperature, say —35° centigrade or lower. When the implement is to be used, the outer casing is autoclaved for sterility. The cold capsule **14** is transferred unsterile from the refrigerator and slipped into the sterile casing **10** and cap **11** is threaded on the casing as shown in FIG. 1 in a manner familiar to all operating room personnel where unsterile material is locked into a sterile casing so that from that moment on, the instrument is completely sterile to the outside world and further handling is all in a sterile manner. In a few moments the tip **13** is cold enough to be used and after the operation, the warm capsule **14** may be removed and replaced in the refrigerator to be frozen for subsequent use. This provides a sterile operating instrument without the disadvantages of previously known instruments of this general character which use carbon-dioxide, or liquid nitrogen as the cold source and therefore have constant evaporation of gases escaping

from the instrument. As the same time, the fact that the capsules **14** may be re-used many times cuts down the cost of utilizing this improved implement.

The device shown in the drawing is slightly enlarged from one which has been actually used which measured about 4½ inches from the left-hand end of cap **11** to the right-hand end of casing **10** and was about ½ inch in diameter so that it was easily held in the hand of the doctor. The tip **13** extended about ¾ inch from the end of the casing **10**.

What is claimed is:

1. In a cryoextractor, a casing, a cold-conducting cryoextractor tip mounted in one end of said casing and protruding therefrom, a completely closed capsule wholly within said casing and in cold-conducting contact with said tip, a liquid in said capsule which freezes at a temperature below the freezing point of water, the end of said casing opposite said tip being open, said capsule being removable through said opening, and a cap for securely closing said opening.

2. A cryoextractor as defined in claim **1** wherein a spring is compressed between said cap and said capsule when said cap closes said opening whereby to cause one end of said capsule to press against said tip.

3. A cryoextractor as defined in claim **2** wherein mutually interfitting projection and recess portions are provided on said mutually engaging ends of said capsule and tip increasing the cold-conducting area between them.

4. A cryoextractor as defined in claim **3** wherein said mutually interfitting portions are at least partially conical, or interleaved, and concentric relative to said capsule and tip whereby the interfitting action between them is self-centering.

5. A cryoextractor as defined in claim **4** wherein said capsule and casing are cylindrical having their length at least four times their diameter and easily held in the hand of an operator.

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