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Armao

[11] **3,889,680**

[45] **June 17, 1975**

[54] **CRYOADHESION PREVENTING CRYOSURGICAL INSTRUMENTS**

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[52] **U.S. Cl.** **128/303.1**; 62/293

[51] **Int. Cl.²** **A61B 17/36**

[58] **Field of Search** 62/293; 128/303.1

[56] **References Cited**

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3,298,371	1/1967	Lee	128/303.1
3,369,550	2/1968	Armao	128/303.1
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3,786,814	1/1974	Armao	128/303.1

Primary Examiner—Channing L. Pace

Attorney, Agent, or Firm—Wenderoth, Lind & Ponack

[57] **ABSTRACT**

The cryosurgical instruments disclosed have a sheath of porous material spaced from a heat conducting core, and an anti-cryoadhesion material which is cooled to cryogenic temperatures and thus also acts as a cryogenic fluid is pumped through the space between the sheath and the core. A part of the material is exuded through the sheath to prevent sticking of the material of the sheath to the tissue with which the instrument is in contact, and the remainder of the material is recirculated. The porous sheath can be removably attached to the instrument so that a sheath in the shape of a probe or surgical blade can be used on the instrument.

16 Claims, 8 Drawing Figures

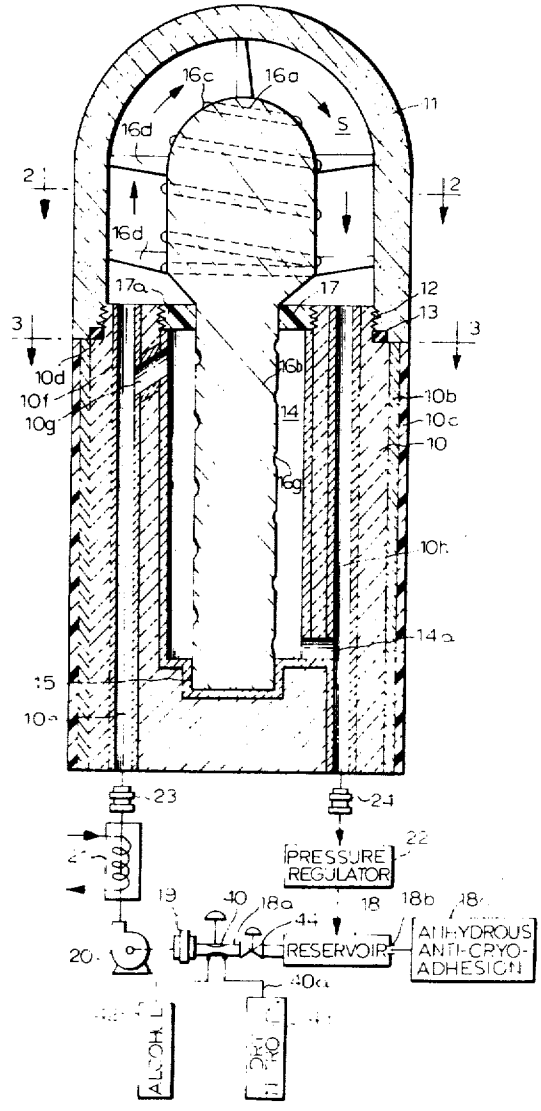
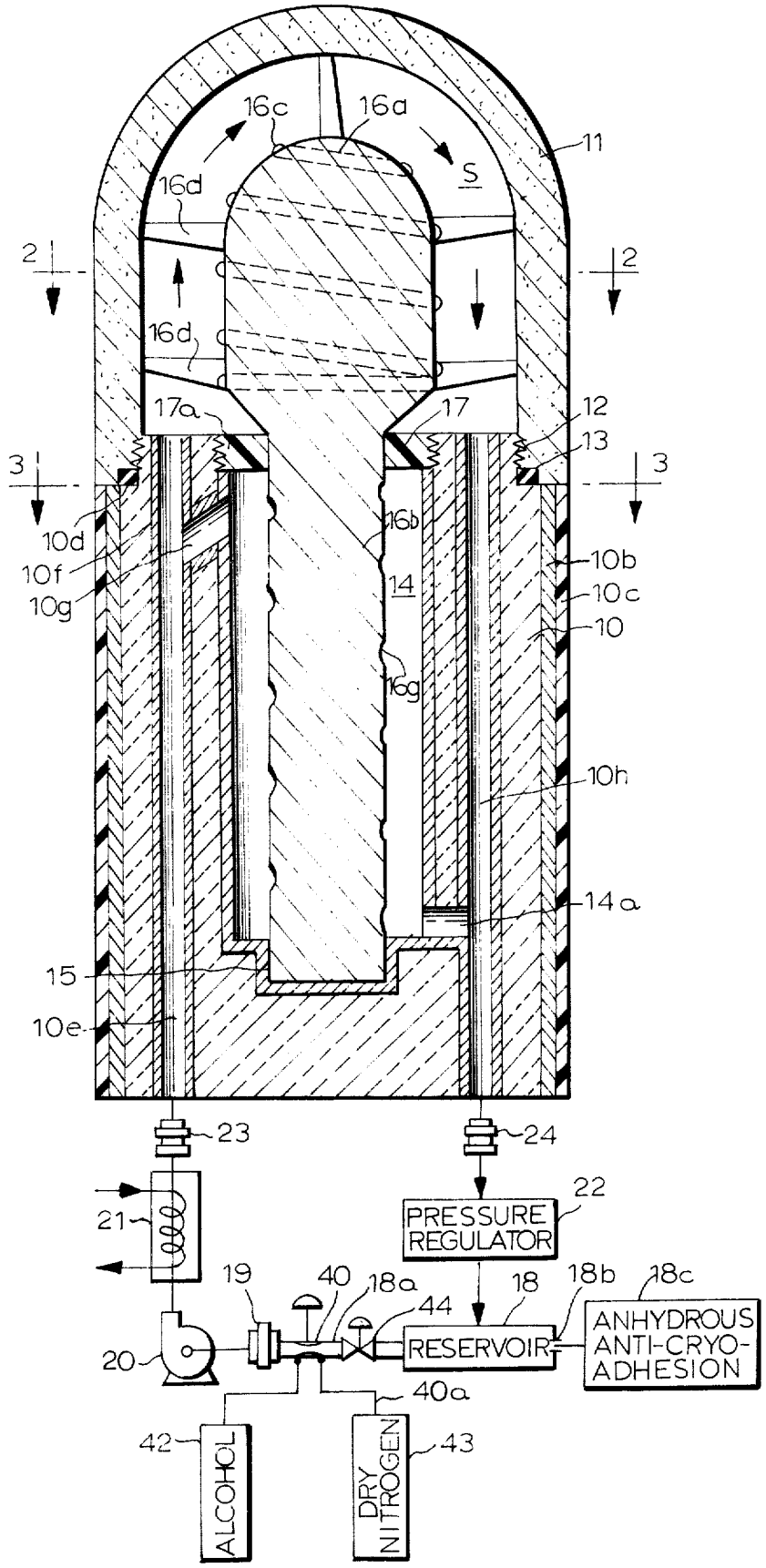


FIG.1


16c
16a
11
S
16d
2
2
16d
17a
17
12
13
3
3
10d
16b
10b
10f
14
10c
10g
10
16g
10h
14a
15
10e
23
24
21
PRESSURE REGULATOR
22
19
40
18a
18
18b
18c
44
ANHYDROUS ANTI-CRYO-ADHESION
20
RESERVOIR
40a
42
43
ALCOHOL
DRY NITROGEN

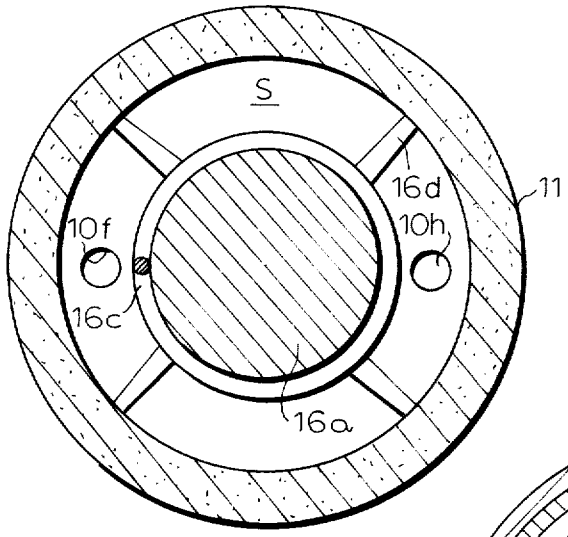


FIG.2

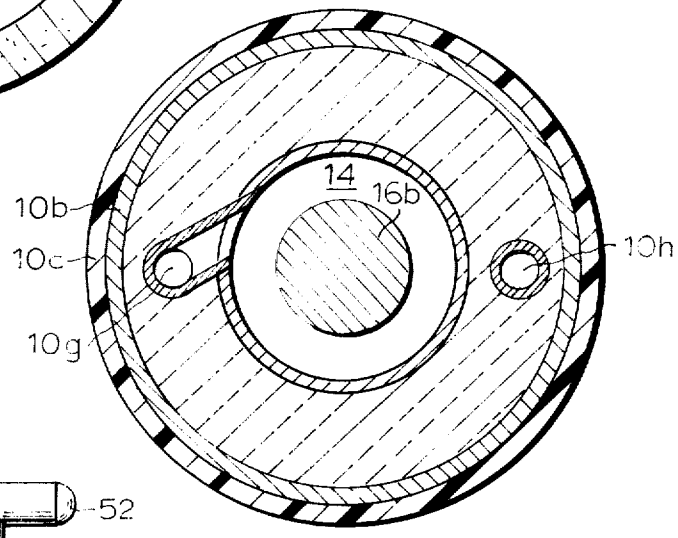


FIG.3

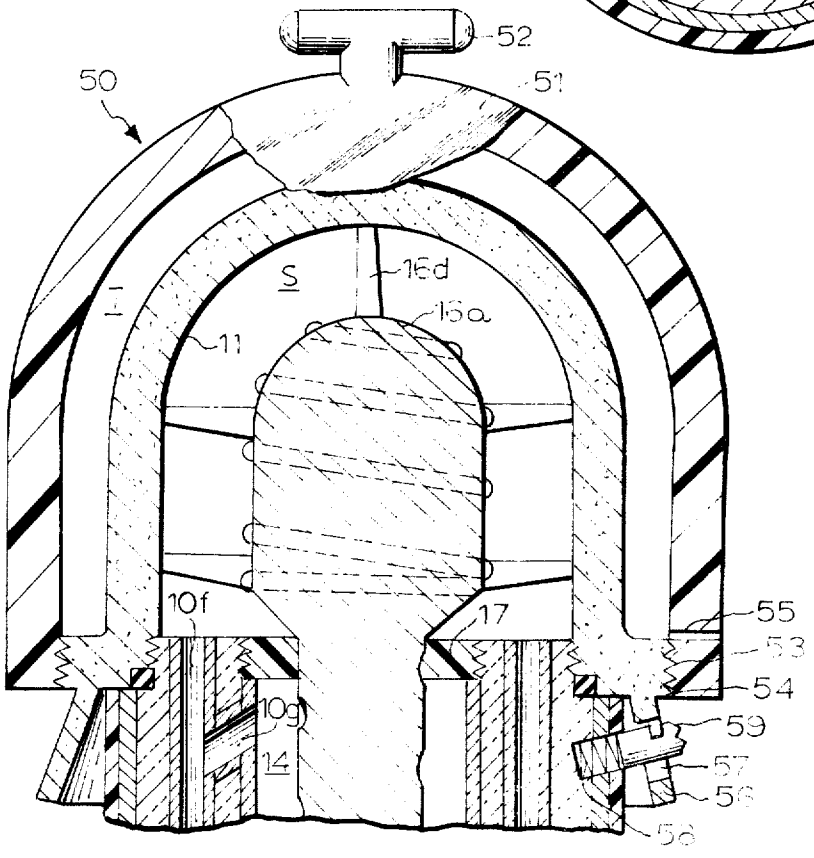


FIG.4

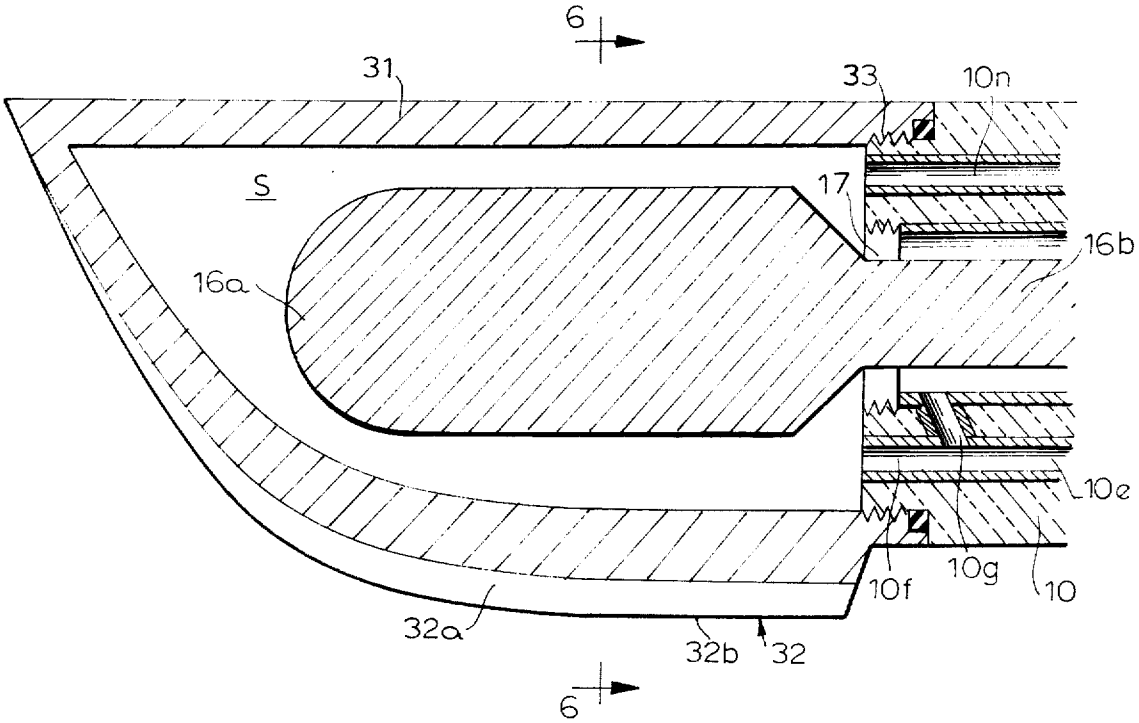

6
31
33
10n
S
17
16b
16a
10e
10f
10g
10
32a
32b
32
6

FIG.5

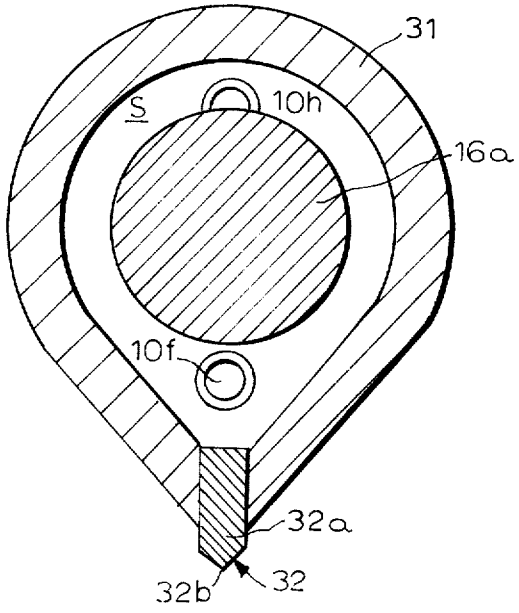

31
S
10h
16a
10f
32a
32b
32

FIG.6

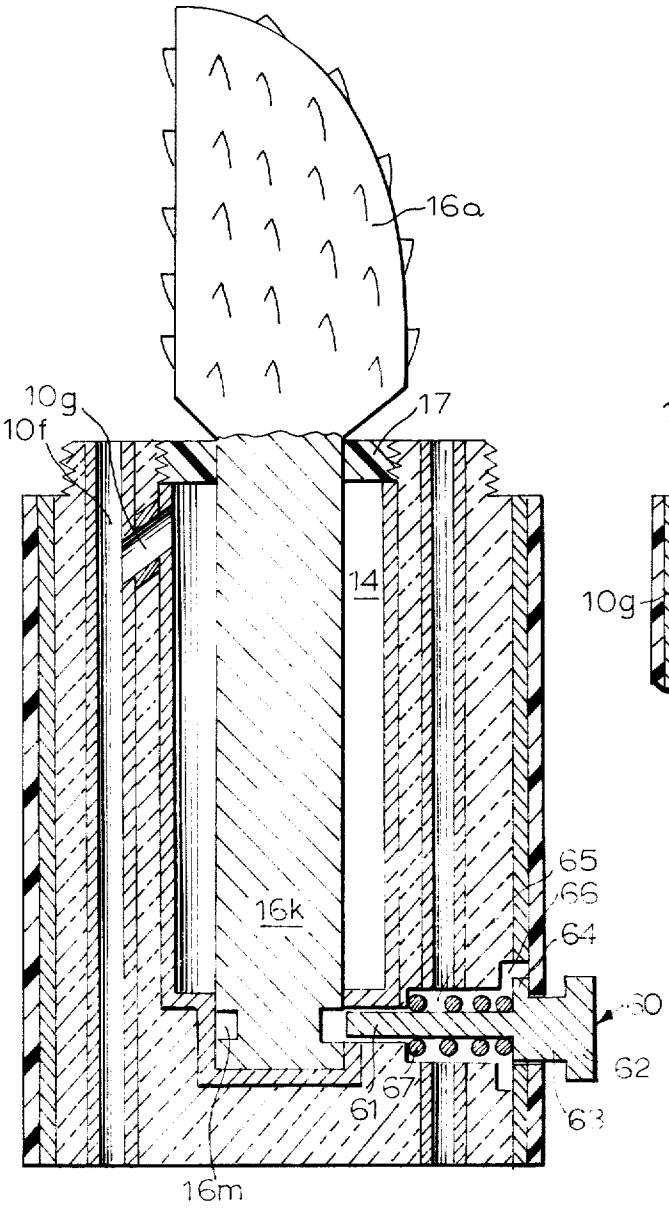

16a
10g
10f
17
14
16k
65
66
64
60
62
67
61
63
16m

FIG. 7

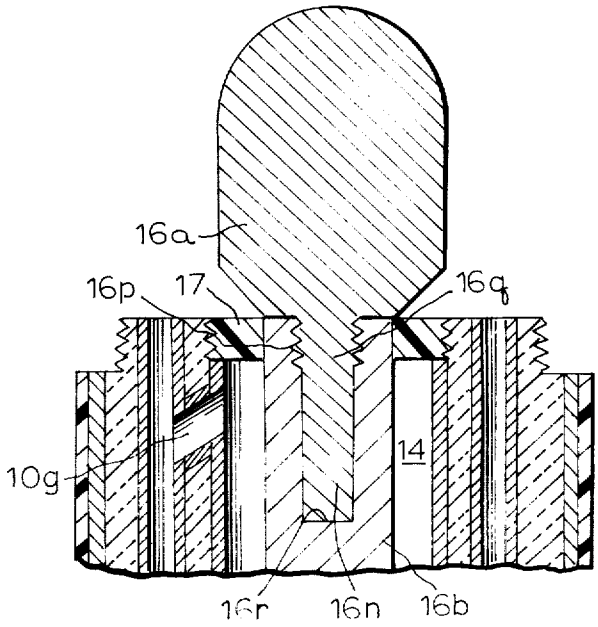

16a
16p
17
16q
14
10g
16r
16n
16b

FIG. 8

CRYOADHESION PREVENTING CRYOSURGICAL INSTRUMENTS

BACKGROUND OF THE INVENTION

There has recently been considerable development of techniques and instrumentation for use in cryosurgery, i.e. surgery which involves the use of cryogenic instruments cooled to cryogenic temperatures. A characteristic of all of these techniques is the cryoadhesion between tissue and the metal of the instrument being used. This is, of course, desirable in such surgical procedures as cataract removal or the removal of cholesterol plaques from blood vessel walls, and in fact, is what makes these techniques workable. However, in other areas, cryoadhesion has limited the use of cryosurgical techniques to probes of various designs and shapes. Even here, when it is necessary to treat tissue cryogenically and thereafter remove the probe, it is necessary to apply heat in some manner to overcome the cryoadhesion. This is usually accomplished by passing a heating fluid through the instrument or providing miniature heating devices in the instrument. Such measures are not only crude, but more important, they are time consuming and thus can be dangerous where rapid withdrawal of the instrument becomes necessary.

A further disadvantage of the necessity of providing some source of heat to overcome the cryoadhesion of the surgical instrument to tissue is that it is not at all useful in a surgical instrument which must be moved during use, such as a moving knife. Manifestly, it is impossible to both cool cryogenically to obtain the benefits of the cyrogenic temperatures, and, at the same time, heat to avoid or overcome cryoadhesion.

My prior U.S. Pat. No. 3,391,690 has recognized that tissue will adhere to cryogenically active surgical instruments. The disclosure in this patent states that cryoadhesion can be prevented by the simple application of a viscous lubricant to the tissue contacting components of said instruments.

However, permanent coverings or coatings of Paralene, Kel-F, Teflon Silicones and Lubrichrome, etc. have proved to be of insufficient practical value in the prevention of cryoadhesion of tissue to the cryogenically active surgical instruments. It is recognized by those skilled in the art that even minute tabs or shreads of tissue that will adhere or freeze to the activated instrument will cause stripping away of the cryogenically treated tissue adjacent to the instrument upon its withdrawal or movement. This stripping away or disturbance of the cryosurgicaly treated zone of tissue will expose a raw denuded highly vascular area and invariably leads to profuse hemorrhaging, thus negating any beneficial effects of cryogenic surgery.

In my application Ser. No. 315,314, filed Dec. 15, **1972,** now U.S. Pat. No. 3,786,814, there is disclosed a method of preventing cryoadhesion and cryosurgical instruments for carrying out this method. In all of the instruments, there are two systems needed, one for circulating the cryogenic fluid, and the other for supplying the anticryoadhesion material to the tissue contacting surfaces of the instrument. This arrangement necessarily requires a sophisticated apparatus for handling the two materials.

OBJECTS AND SUMMARY OF THE INVENTION

It is an object of the present invention to provide cryosurgical instruments for use in carrying out cryosurgical techniques which require only a single system for supplying a fluid which is an anticryoadhesion material which also acts as a cryogenic fluid.

This object is achieved by providing an instrument having a porous sheath thereon through which an anticryoadhesion material which also acts as a cryogenic fluid is exuded, which material both cools the tissue with which the instrument is in contact and prevents sticking of the material of the instrument to the tissue. One specific material is fluorinated polyether. A single system supplies the anticryoadhesion material, cools it to a cryogenic temperature, and recirculates the portion of the fluid which is not exuded through the porous sheath. The porous sheath is preferably removably attached to the instrument so that different sheaths can be used on a single basic instrument.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described in greater detail hereinafter in connection with the accompanying drawings, in which:

FIG. **1** is a partly sectional elevation view and partly schematic view of a cryogenic probe according to the present invention with a removable sheath member thereon;

FIGS. **2** and **3** are sectional views taken on lines **2—2** and **3—3,** respectively, of FIG. **1**;

FIG. **4** is a partial section view showing a cover;

FIG. **5** is a sectional elevation view of the upper part of the instrument of FIG. **1** showing the different form of sheath thereon;

FIG. **6** is a section taken on lines **5—5** of FIG. **4**; and

FIGS. **7** and **8** are partial sectional views showing removable cores.

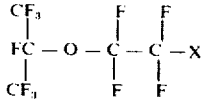
DETAILED DESCRIPTION OF THE INVENTION

In its most elementary form, the instrument of the present invention has a porous sheath spaced from a core of a heat conducting material, and a circulation system is provided for circulating a fluid through the space which is an anticryoadhesion material which also acts as a cryogenic fluid.

The anticryoadhesion material used in the instruments of the present invention should be a material which is liquid at ambient temperatures and remaining liquid at cryogenic temperatures, e.g. down to about −180°C. so that it overcomes the adhesion between the metal of the cryosurgical instrument and the tissue contacted thereby, and it must also be a material which has a good thermal conductivity so that heat can be conducted through the film of the material from the tissue to the metal of the cryosurgical instrument. Moreover, the material should be inert and non-toxic, since it will come in contact with tissue during the carrying out of the surgical procedures.

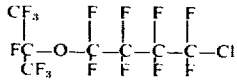
One group of such materials are non-toxic, inert liquid fluorocarbons which remain liquid at cryogenic temperatures, which fluorocarbons are applied to cryosurgical instruments and, as a result of the use of such instruments in cryosurgical treatments, are applied topically to cryosurgically treated tissue. As the temperature drops, these materials do not crystallize but only become increasingly viscous. These materials are available from several sources. One source is the fluorocarbon chemical sold under the trademark MEDIFLOR by 3M Co. One specific fluorocarbon is designated FC47 and is a polyfluorinated tertiary alkly amine having the

general formula $(C_4F_9)_3N$ and has a pour point of −58°F. Another specific fluorocarbon designated FC80 is a cyclic perfluorinated ether and has the general formula c—$C_8F_{16}O$ had has a pour point of −135°F. Another is designated FC88 and has a pour point of approximately −115°C. Another source is the fluorocarbon chemicals sold under the trademark FLUORONETS by Allied Chemical Co. The fluorocarbon chemicals with the designations P-1F, P-1H, P- 1C, P-1D and P-11c have pour points from −85° to −125°C. Among these materials, the materials with the designations P-1F, P-1H and P-1C are polyfluorinated ethers having the general formula:



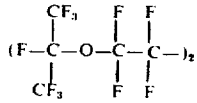
(1)

where X is fluorine, hydrogen or chlorine. The material designated P-11C is a polyfluorinated either having the formula:



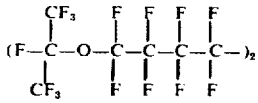
(2)

The materials with designations P-1D and P-11D are perfluorinated polyethers having the formulae:



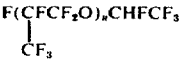
(3)

and



(4)

Another specific material which can be used as the anti-cryoadhesion material is one of a family of polyfluorinated polyethers having the general formula:



where *n* is a whole number in the range of 1–11 inclusive. The materials have pour points from −46°C down, depending on the value of *n*. This material is available from E.I. DuPont de Nemours Co. as FREON E Series Fluorocarbons. The characteristics of the members of the series from **1** to **4** of the material which are pertinent to the present invention are as set forth in Table I. It will be seen from this data that the thermal conductivity is such that the material conducts heat very satisfactorily, yet it remains liquid to very low temperatures. Even though it has a low boiling point, especially the lowest viscosity form of the material, because it will be kept cooled to carry out its function as a cryogenic fluid this characteristic will not detract from its usefulness.

The anti-cryogenic materials described above can be used individually, or they can be blended to obtain viscosities and pour point temperatures intermediate the viscosities and pour points of the individual materials.

In order to make it possible to use a cryosurgical instrument to make a relatively long incision or move over tissue for relatively long distances, special surgical instruments have been devised which provide a constant flow of anti-cryogenic material to the surface thereof which will be in contact with the tissue. Some embodiments of these instruments will be described hereinafter. It should be understood, however, that while the description is of several forms of one form of a probe and one form of scalpel, the same type of structures can be utilized for clamps, biopsy instruments, and the like, without departing from the scope of the present invention. Examples of other such instruments are found in my U.S. Pat. Nos. 3,391,690 and 3,369,550.

One embodiment of a probe according to the present invention is shown in FIGS. **1–3,** and has a body **10** made, for example, of foamed polyurethane, such as is sold under the tradename THURANE by Dow Chemical Co., and having a sheath **10***b* of metal, e.g. stainless steel, thereover and a coating **10***c* of a thermoplastic resin, for example such as is sold under the tradename LEXAN by General Electric Co. The body **10** has a seat **10***d* on the end which is uppermost in FIG. **1.** A porous hollow sheath **11,** made of materials to be described in greater detail hereinafter, is secured to the seat **10***d* by a threaded connection **12** or any other equivalent connection, and the joint is sealed by a gasket **13** in the seat. The gasket could also be included in the edge of the sheath.

In the center of the body **10** is an elongated recess **14** having a socket **15** in the bottom thereof which is slightly smaller in diameter than the diameter of the recess **14.** Positioned in the recess **14** is the shank **16***b* of a core **16** which is of good heat conducting material, the free end of the shank **16***b* being tightly fitted into the socket **15** so as to hold the shank in the recess with the surface of the shank spaced from the wall of the recess. On the other end of the shank **16***b* is a core head **16***a* which projects into the hollow sheath **11** and is shaped so as to leave between the core head **16***a* and the inside surface of the sheath **11** a space S. Spiral lands and grooves **16***c* are provided on the head **16***a*. Struts **16***d* are also provided on the core head **16***a* which engage and support the sheath **11.**

An inlet passage **10***e* extends through body **10** from the lower end to a point near space S and then branches, branch **10***f* leading into space S and branch **10***g* extending to the upper end of recess **14** and opening into the recess **14** tangentially of the wall thereof. Outlet passage **10***h* extends from space S at a point diammetrally opposite branch **10***f* out through the body **10.**

Around the upper end of recess **14** is an exteriorly threaded ring **17** of insulating material which fits in a threaded seat **17***a* in body **10.** The ring **17** engages snugly around the upper end of shank **16***a* in substantially fluid tight relationship. At the lower end of recess **14** is an outlet passage **14***a* which opens into outlet passage **10***h*. The exterior of shank **16***b* can be spirally grooved as at **16***g* to promote spiral flow of liquid along

the shank **16***b*. The wall of the recess could also be grooved or one or the other or both could have spiral lands thereon for the same purpose. Both the inlet and outlet passages are defined by metal tubes extending through the heat insulating material of the body **10.**

A reservoir **18** for fluid anti-cryoadhesioncryogenic material is provided in a single fluid supply system for the instrument, and the reservoir **18** is connected to the inlet passage **10***e* through a filter **19,** a fluid pump **20,** a heat exchanger **21,** and a quick disconnect coupling **23.** The fluid is successively filtered, pumped and cooled to a cryogenic temperature, and supplied to passage **10***e*. The outlet passage **10***h* is connected through a quick disconnect coupling **24** and a pressure regulator **22** to the reservoir. The quick disconnect couplings **23** and **24** make it possible to remove the probe from the supply system and replace it with another probe. A depressor type injection valve **18***b* can be provided in the reservoir **18** through which anti-cryoadhesion-cryogenic material can be supplied from a pressurized container **18***c*, such as an aerosol can or the like.

All piping in the fluid supply system leading to and from the base of the instrument body **10** is flexible and is suitably insulated with flexible insulation. The flexible insulation prevents the absorption of heat before the fluid reaches the base of the instrument body **10.** An example of suitable flexible insulated piping is C.V.I. static vacuum insulated radiation-shielded flexible piping, which is manufactured by C.V.I. Corp., a subsidiary of the Pennwalt Corp., Columbus, Ohio 43216.

In operation, fluid anti-cryoadhesion-cryogenic material from reservoir **18** is drawn through the filter **19** through the heat exchanger **21,** sufficient heat being extracted in the heat exchanger **21** to lower the temperature of the material to the desired cryogenic temperature. The cooled fluid then flows through the inlet passage **10***e* and part of it flows through branch **10***f* into the space S. The lands and grooves **16***c* help distribute the fluid evenly while the struts **16***d* prevent vibration of the sheath. The pressure regulator **22** in the return line is set so that the pressure within the space S is sufficient to force some of the fluid material out through the pores in the sheath to prevent sticking of the sheath to the tissue being acted on, while the remainder of the fluid material supplied to space S continues to flow through space S and outlet passage **10***h* and back to the reservoir **18.** Heat from the tissue being acted on flows through the sheath **11** and is taken up by the fluid material. However, since the circulation is not sufficiently rapid to produce rapid cooling of the tissue, which is desirable, due to the necessity to maintain sufficient pressure to cause the exuding of the fluid material through the sheath, the core **16** is provided. This also takes up heat which is transmitted through the circulating fluid material and conducts it from the core head **16***a* to the shank **16***b*. The portion of the incoming fluid material which flows through branch **10***g* is conducted through the recess **14** along the shank **16***b*, from the end closest to the head **16***a* at which the incoming fluid will be coldest, to the other end, and the heat taken up by the core **16** is given up to the circulating fluid material flowing through the recess **14.** The equipment for cooling the fluid to cryogenic temperatures is conventional and will not be described here. It will be clear, however, that the heat can be extracted at locations other than that shown in FIG. **1,** at the reservoir, for example.

The inner portion or core of the probe is preferably made of a good heat conducting low thermal expansion metal. One good metal is a high nickel-iron alloy sold under the trademark INVAR by Carpenter Steel Co. It can be nickel plated to increase corrosion resistance. Alternately, a gold plated solid copper inner portion can be used. Stainless steel, which resists staining during use and can be cleaned and sterilized readily, can also be used. Use of such a metal makes possible rapid transfer of heat from the tissue to the cryogenic fluid. The sheath is preferably thin stainless steel which has been made microporous, for example, by the process disclosed in U.S. Pat. No. 3,352,679, which comprises connecting the stainless steel as an anode in a cell containing a non-polarizing electrolyte and discharging direct current through the cell. The gaskets are silicone rubber, which will withstand cryogenic temperatures.

It will be understood that the sizes of the pores in the stainless steel sheath can be varied, and that anti-cryoadhesive materials are available with different viscositites. Those skilled in the art will be able to provide the proper combination of pore size and viscosity of the anti-cryoadhesive material with a minimum amount of difficulty to give optimum results.

An alternate form of porous material for the sheath is a woven stainless steel wire cloth known as MICROWEAVE, which is available from Microporous Filter Division of Circle Seal Development Corp., Anaheim, Calif. This material is woven from stainless steel wire drawn to a diameter of as small as 0.001 inch and then heat treated to restore the ductility and corrosion resistance. To form this material or the above described materials into a sheath, a die in the shape of the sheath is made and the material is shaped to this die in a four slide forming machine.

In use, the instrument must first be dried thoroughly. One simple way of doing this is by dipping it in a 100 percent anhydrous alcohol solution and purging with dry nitrogen gas. Preferably, however, the whole probe, including the interior passages, is thoroughly dried by means of a purging system described hereinafter. Then the fluid anti-cryoadhesion-cryogenic material is pumped through the passage **10***e* into the space between the sheath **11** and the core **16,** and due to the pressure it is under, it is forced through the porous sheath **11** so as to form a film on the outer surface of the sheath. The flow of fluid is maintained to cool the instrument to the desired temperature, and it is then ready for use.

During the use of the probe, the anti-cryoadhesion property of the fluid material will prevent the metal of the probe from sticking to the tissue which is touched by the probe by providing a physical layer of the material between the tissue and the sheath and also due to the hydraulic pressure of the material which acts to force the tissue away from the surface of the sheath.

Thus, the probe or knife can move through or along tissue in the same manner as room temperature instruments are moved through or along tissue, thereby removing any restrictions on the use of the instrument because of the occurrence of cryoadhesion. At the same time, due to the heat conductivity properties of the fluid material, heat is removed from the tissue being cut so that the benefits of cryogenic surgery can be obtained.

In the use of the device of the present invention and the fluorocarbon anti-cryoadhesive materials disclosed, it has been discovered that whatever toxicity these materials have can be reduced by passing them through a microporous filter, such as a Gelman microporous filter made by Fisher Scientific Co., 711 Forbes Ave., Pittsburgh, Pa. 15219. Moreover, if it is anticipated that large amounts of the fluorocarbon anti-cryoadhesive material are to be used on an individual patient, it may be advantageous to lower the general body temperature of the patient of about 85°F or lower by known hypothermia techniques. This will suppress the general vapor pressure of the fluorocarbon material that will come into contact with the tissue being acted upon.

One system for purging the instrument is shown in FIG. **1.** It is most convenient to incorporate it in the supply system so that it can be used on any probe attached to the supply system. A three-way valve **40** is provided in the piping **18***a* between the reservoir **18** and the filter **19,** and the valve **40** is connected to a pressurized supply **42** of anhydrous alcohol, and to a pressurized supply **43** of dry nitrogen gas by appropriate conduits **40**a. A bleed-off valve **44** is provided between the reservoir **18** and the three-way valve **40.**

To carry out purging, with the entire probe and supply system empty, the pump **20** is run at low speed, the valve **40** is set to supply alcohol to the filter **19** and pump **20,** and the bleed-off valve **44** is opened. The alcohol will then be supplied through the supply system and passage **10***e* and branch **10***f* in the probe into the space S within the sheath **11,** and through the branch **10***g* and recess **14,** and will clean and dry the space S and be forced through the pores in the sheath and will clean the recess **14.** The valve **40** is then changed over, and nitrogen under pressure purges the alcohol from the supply system, space S, and the pores of the sheath **11,** the recess **14,** and dries the instrument. The spent alcohol and nitrogen are removed through bleed-off valve **44.** The valves **40** and **44** are then reset, and the instrument is ready to have the anti-cryoadhesion-cryogenic fluid supplied thereto, for example through the valve **18***b.*

Alternatively, the more sophisticated purging system shown in FIG. **15** of my patent referred to above can be connected to the instrument.

As described above, during purging, the alcohol is forced through the pores in the sheath **11.** Depending on the size of the sheath, and hence its surface area, and the size of the pores, the total resistance offered by the sheath to the flow of the alcohol may be less than the resistance offered by the return path from the space S through the pressure regulator **18** and the alcohol in space S in such a situation would all be forced through the sheath. To avoid this situation, it is desirable to provide a cover **50** for the sheath, as shown in FIG. **4.** The cover is comprised of a dome **51,** which is preferably clear plastic, so that the presence of the purging liquid inside of it can be easily seen, which is sufficiently larger than sheath **11** to leave a space between the sheath **11** and dome **51,** and a handle **52** preferably integrally formed with the top of the dome **51.** It will, of course, be possible to make the handle **52** separately and attach it to the dome **51,** if desired. The base of the sheath **11** has an exterior threaded portion **53** onto which interior threads **54** at the base of the dome **51** are threaded to secure the dome and the sheath to each other. The dome **51** further preferably has a very small bleed hole **55** therein, preferably at a position adjacent the position of the entrance into the outlet passage **10***h,* to prevent an air or vapor lock in the space T between the sheath **11** and the dome **51.** Depending from the base of the sheath **11** along the outside of the body **10** is a skirt **56** which is angled outwardly from the body **10** and having an aperture **57** therein, and when the sheath is in position on the body **10,** the aperture **57** is aligned with a bore **58** in the body in which is a spring loaded pin **59** having a rounded top, preferably with a notch therein. The spring loaded pin **59** normally projects out through the aperture **57,** thus holding the sheath **11** against rotation while the dome **51** is unscrewed from the sheath **11.**

In use, if the sheath **11** is already present on the instrument, the cover **50** is threaded onto the threaded portion **53** by means of the handle **52,** and thereafter the purging alcohol is passed through the instrument as described above. The alcohol will be forced through the porous sheath **11** into the space T, but will be blocked from further escape by the dome **51.** Any air trapped in the space T will be forced out of the bleed hole **55.** The bleed hole **55** should not be so large as to allow any appreciable amount of liquid alcohol to escape. Vaporized alcohol can escape, however.

After purging with the alcohol, purging with the nitrogen gas is carried out as described above. The instrument is then ready for use, as described above. Preferably, the cover **50** is removed only after the anti-cryoadhesion cryogenic material begins to come through the sheath **11.**

Alternatively, it may be desirable to make the sheath **11** disposable, and to supply the sheath **11** and the cover **50** as a single unit which is used only one time and then disposed of. When the sheath **11** and the cover **50** are supplied as a single unit, the dome **51** will already be threaded onto the sheath **11.** This unit is attached to the instrument by threading the unit made up of the sheath **11** and cover **50** onto the body **10.** It will be noted that the skirt **56** is angled away from the body **10** so that during the threading of the unit onto the body **10,** the skirt **56** will engage the pin **59** to depress it. When the unit is tightly threaded onto the body **10,** the aperture **57** is aligned with the pin **59** which is then spring urged through the aperture **57.** The pitch of the threads **12** is sufficiently large so that the aperture **57** comes opposite the pin **59** only during the last turn of the sheath **11.** The remainder of the purging procedure is as described above. To remove the sheath **11,** the pin **59** is depressed by engaging a simple pointed tool with the notch in the end of the pin **59** and pushing the pin **59** inwardly and then unscrewing the sheath.

The sheath **11** is shown as having the shape of a simple probe. However, other shapes of sheath can be used. FIGS. **5** and **6** show a sheath **31** having the shape of a scalpel blade. The sheath **31** is generally cylindrical, but along one side thereof it has a blade portion **32***a* with a cutting edge **32***b* therein, preferably formed on a solid metal insert **32.** The contour of the knife edge along the length of the sheath is that of a common form of scalpel. The base of the sheath has internal screw threads **33** the same size as those on the sheath **11** so that the sheath **31** can be threaded onto the body **10** to replace the sheath **11,** thereby transforming the instrument into a cryogenic scalpel. The interior of the sheath **31** is shaped so that it will accommodate the core head **16***a* and leave a space S between it and the

core head through which the fluid anti-cryoadhesion-cryogenic material can flow during the use of the instrument. Other forms of blade shaped sheath which can be used with the present instrument are shown in FIGS. 3, 4*a*–4*e*, 6, 7 and 9–12 of my above-identified patent.

Otherwise, the structure and operation of the instrument are the same as for the instrument in FIGS. 1–3.

It is desirable to make the core **16** interchangable so that core heads can be provided which fit inside of the scalpel shaped sheaths **31** more properly. Two alternate core structures for this purpose are shown in FIGS. 7 and 8. In FIG. 7, the entire core **16** is removably held in the body **10**. At the inner or lower end of the shank **16***k* of the core **16**, as shown in the Figure, is an annular groove **16***m*, and projecting into the groove **16***m* is the end of a shaft **61** of a turnbutton **60**. The shaft **61** extends through a bore **65** through the body **10** and on the outer end of the shaft **61** is a head **62**. Turnbutton holding means is also provided. On an enlarged portion **63** between the shaft **61** and the head **62** is a male portion **64** of a bayonet type joint, the female portion of which are shown at **66***a* and **66***b* around the end of the bore **65**. A spring **67** in the bore **65** urges the turnbutton **60** outwardly of the body **10**.

With the parts in the position shown, the shank **16**k is free of the end of the shaft **61**, and the core **16** can be withdrawn from the body **10** and replaced by a different core with the same shape shank. To hold the shank in the body **10**, the turnbutton is pushed into the bore **65** against the force of the spring **67** and then turned to engage the male and female portions **64** and **66** of the bayonet joint, thus moving the end of the shaft **61** into the groove **16***m* and holding it there. Disengagement is carried out by turning the turnbutton in the opposite direction and releasing the force on it, so as to allow the spring **67** to force the turnbutton to the position as shown in the figure.

The embodiment shown in FIG. **8** is somewhat less complex than that of FIG. **7**. The head **16***a* and the shank **16***b* are separate parts, the head **16***a* having a spindle **16***n* depending therefrom and fitting tightly into a recess **16***r* in the shank **16***b*. Threads **16***q* around the spindle **16***n* where it joins the head **16***a* engage with threads **16***p* around the upper end of the recess **16***r* in the shank **16***b*. The head **16***a* is thus simply unscrewed from the shank **16***b* and replaced by a head with a similar spindle and threads.

It is thought that the invention and its advantages will be understood from the foregoing description, and it is apparent that various changes may be made in the form construction and arrangement of the parts without departing from the spirit and scope of the invention or sacrificing its material advantages, the forms hereinbefore described and illustrated in the drawings being merely preferred embodiments thereof.

TABLE I

n	1	2	3	4
Boiling Point °C	39	101	153	193
Thermal Conductivity J/(m) (Sec) (°C)	311	311	311	311
Vapor Pressure at 52°C psia	21.7	2.03	.023	0.82
Viscosity at 25°C CS	.03	0.6	1.3	2.3

What is claimed is:

1. A cryosurgical instrument comprising a body of heat insulating material, a hollow sheath comprised of a good heat conducting material at least a portion of which is porous, said sheath being on one end of said body, a core of good heat conducting material projecting into said sheath from within said body having the outer surface thereof spaced from the inner surface of said sheath so as to leave a space between said core and said sheath, said body having an inlet passage therethrough opening into said space, said body having an outlet passage therethrough opening out of said space, said body having a heat exchange space along the portion of said core within said body and means for directing a flow of heat exchange fluid therethrough for exchanging heat between said core and fluid flowing in said heat exchange space, and means for supplying a heat exchange fluid to said heat exchange space.

2. A cryosurgical instrument as claimed in claim **1** in which said inlet passage has a branch connected to one end of said heat exchange space and the other end of said space being connected to said outlet passage.

3. A cryosurgical instrument as claimed in claim **1** in which said sheath is detachably mounted on said body.

4. A cryosurgical instrument as claimed in claim **1** in which said sheath is in the form of a probe.

5. A cryosurgical instrument as claimed in claim **1** in which said sheath is in the form of a blade and has a blade portion along one side thereof having a knife edge thereon.

6. A cryosurgical instrument as claimed in claim **1** in which said core is a replaceable core.

7. A cryosurgical instrument as claimed in claim **6** in which the free end of the portion of said core within said body has an annular groove therearound, and a turnbutton movably extending through said body and engageable in and disengageable from said groove for preventing removal of said core when engaged in said groove and freeing the core for removal when disengaged from said groove.

8. A cryosurgical instrument as claimed in claim **6** in which the portion of said core within said body is separate from the portion within said sheath and has a recess therein, and said portion of the core within said sheath has a spindle projecting therefrom and fitting into said recess, and thread means on said spindle and on the portion of said core within said body around the said recess engageable with each other for retaining said spindle in said recess.

9. A cryosurgical instrument as claimed in claim **1** further comprising a cleaning and purging means having a supply of cleaning fluid and a supply of purging gas, valve means for alternately coupling said supplies to the inlet passage of said body, said cleaning and purging means further being connected to the outlet passage of said body.

10. A cryosurgical instrument as claimed in claim **9** further comprising a cover removably secured over said sheath and spaced therefrom for containing the fluid forced through said sheath during cleaning and purging.

11. A cryosurgical instrument as claimed in claim **10** in which said cover has a bleed hole therein adjacent the point where said outlet passage opens out of said space.

12. A cryosurgical instrument as claimed in claim **10** in which said sheath has a base threadedly mounted on

the end of said body and said cover is threadedly attached to said sheath around said base.

13. A cryosurgical instrument as claimed in claim **12** in which said body has spring loaded coupling means thereon for engaging said sheath for preventing said sheath from moving when said cover is removed therefrom.

14. A cryosurgical instrument as claimed in claim **10** in which said cover is transparent.

15. A cryosurgical instrument as claimed in claim **1** further comprising a reservoir for a fluid anti-cryoadhesion-cryogenic material, means coupled to said reservoir for circulating the fluid material from the outlet passage of said body to the inlet passage of said body through said reservoir and including a pump, a filter and a pressure regulator, and further heat exchange means in heat exchange relationship with said means for cooling said fluid material to a cryogenic temperature.

16. A cryosurgical instrument as claimed in claim **15** further comprising a cleaning and purging means having a supply of cleaning fluid and a supply of purging gas and valve means coupled thereto and coupled between said reservoir and said means for circulating the fluid material, whereby said cleaning fluid and said purging gas can be supplied to said instrument through said means for circulating said fluid material for also cleaning and purging said means for circulating the fluid material and said reservoir, and a bleed valve between said valve means and said reservoir for removing cleaning fluid and purging gas from said instrument and said reservoir and said means for circulating the fluid material.

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