

[54] **TYNED CRYOSURGICAL PROBE**

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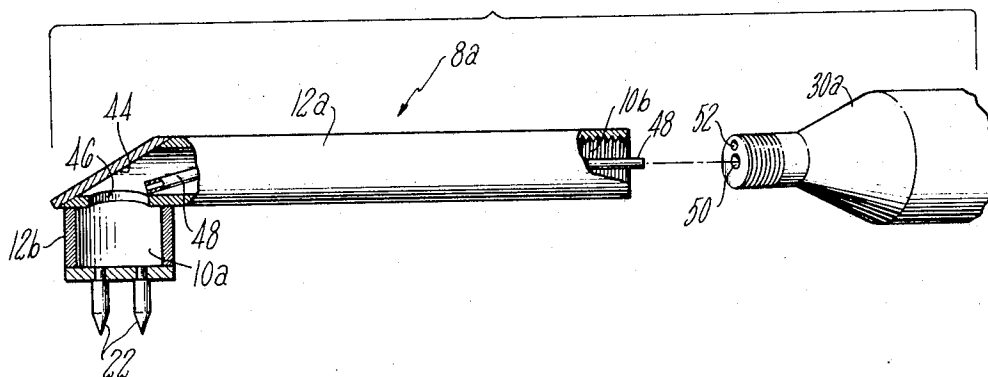
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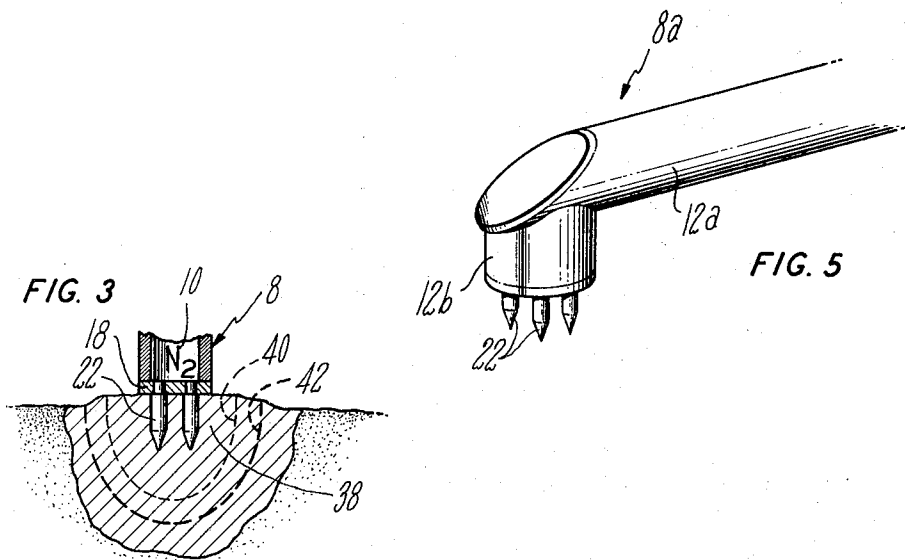
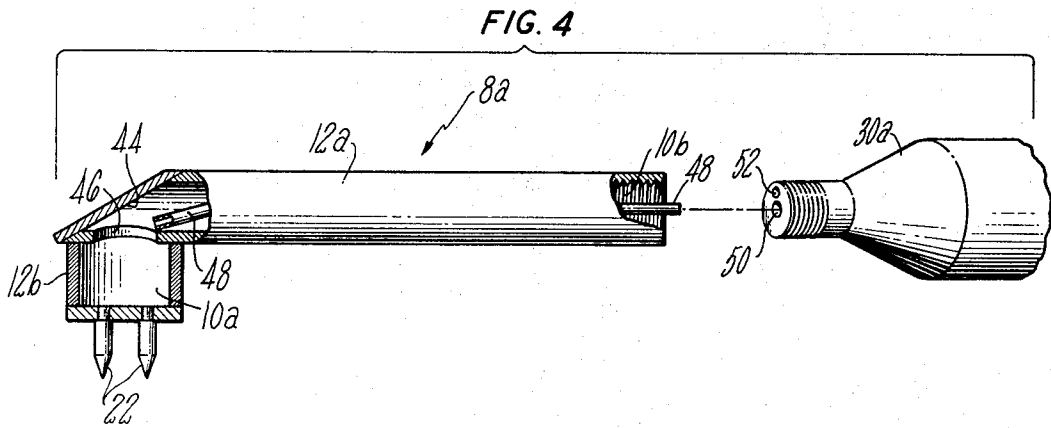
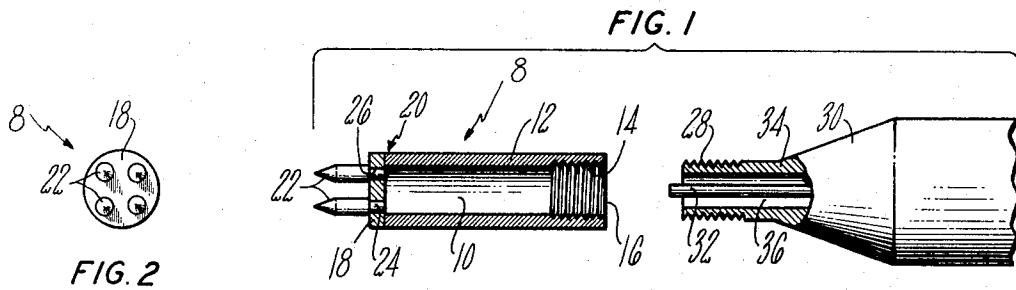
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[57] **ABSTRACT**

Freezing of large tissue masses to significant depths is achieved by utilizing a tyned cryosurgical probe having sharpened tynes that are embedded directly into the tissue to be frozen. Nitrogen is delivered in substantially liquid form directly to the exposed ends of the tynes or to metallic surfaces metallurgically bonded thereto. Examples of uses include starting a deep iceball with a tyned probe in accordance herewith and advancing the iceball deeper with other apparatus.

2 Claims, 5 Drawing Figures





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TYNED CRYOSURGICAL PROBE

BACKGROUND OF THE INVENTION

1. Field of Invention

This invention relates to cryosurgery, and more particularly to a tyned cryosurgical probe.

2. Description of the Prior Art

The field of cryosurgery has recently undergone a rebirth, with new techniques for utilizing cryogenic instruments to treat various types of disorders and disfigurements. An important advance has been development of the technique of applying cryogenic fluid, in substantially liquid form, directly to tissue which is to be frozen, as set forth in my prior co-pending application Ser. No. 683,351 filed on Nov. 15, 1967, now U.S. Pat. No. 3,534,739 and entitled CRYOSURGICAL DELIVERY AND APPLICATION OF LIQUIFIED GAS COOLANT. In cases where uncontrolled application of cryogenic fluid may adversely affect surrounding tissue, the cryogen may be confined and its point of contact closely controlled by means of chambers, as set forth in my prior co-pending application Ser. No. 728,536 filed on May 13, 1968 and entitled CRYOGENIC APPLICATION CHAMBERS AND METHODS. In other cases, closed probes in which the cryogen freely circulates may be used.

In each of the above techniques, the application of cryogenic temperatures is limited to the surface of the tissue which is to be frozen. When the surface freezes, it forms ice, which aids in conducting the heat out of the tissue, so that an iceball grows into the tissue over a period of time as the cryogenic temperature is applied. Assuming a round application pattern is used, the iceball which can be formed through surface application generally has a configuration which is less deep than the radius of the surface area of application. Additionally, this necessarily limits the ultimate depth which can be achieved in any given case, since freezing of an extremely large surface area would be required in order to get the desired depth of a much smaller area. In cases where the surface of the tissue to be frozen is relatively dry, in contrast with wet masses, this problem is further compounded.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a cryosurgical probe having an extremely high freezing capability; another object of the present invention is to provide a cryosurgical probe capable of freezing with a greater ratio of depth to surface area than has heretofore been obtainable.

According to the present invention, a closed cryosurgical probe has tynes mounted in the application surface thereof, said tynes being adapted to be inserted into a mass of tissue to be frozen, said probe adapted to receive liquid cryogenic fluid at a surface immediately adjacent and metallurgically bonded to said tynes.

The present invention can be configured in a variety of ways so as to permit utilization in a wide variety of surgical procedures. The invention in accordance herewith is readily adapted to be utilized with a wide variety of cryogenic fluid delivery systems. The invention provides the capability of achieving freezes with large ratios of depth to surface area in a carefully controlled manner.

Other objects, features and advantages of the present invention will become more apparent in the light of the following detailed description of preferred embodiments thereof, as illustrated in the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a sectioned side elevation of a first embodiment of a cryosurgical probe in accordance with the present invention; FIG. 2 is a front elevation of the embodiment illustrated in FIG. 1;

FIG. 3 is a sectioned, side elevation illustrative of the utilization of a cryosurgical probe in accordance with the present invention in freezing tissue;

FIG. 4 is a partially sectioned, side elevation of a second embodiment of a cryosurgical probe in accordance with the present invention; and

FIG. 5 is a perspective view illustrating further the embodiment of FIG. 4.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIGS. 1 and 2, a simple embodiment of a probe 8 in accordance with the present invention includes a chamber 10 formed by a cylinder 12 which is provided with threads 14 at an open, proximal end 16 thereof, and is closed by a distal end wall 18 at an application end 20 thereof. Metallurgically bonded to the wall 18 are a plurality of tynes 22. In the embodiments herein, the tynes 22 are solid cylinders having conical tips to permit easily piercing tissue to be frozen, and each is provided with a portion 24 having a reduced diameter for insertion into related holes 26 formed in the wall 18, thereby to provide a maximum surface joint for maximum heat conductivity between the wall 18 and the tynes 22, as well as sturdy construction. In accordance with the invention, it is preferred that the tynes 22 be metallurgically bonded to the wall 18; this aspect is satisfied if the wall 18 and the tynes 22 are machined from a single block of starting material, and is equally satisfied if the tynes 22 are soldered, brazed or welded to the wall 18. Although utilization of the reduced portion 24 for insertion into the hole 26 is preferred, the tynes 22 may instead butt onto the outer surface of the wall 18, provided suitable metallurgical bonding is utilized.

The threads 14 are adapted to receive similar threads 28 at the application end of a cryogenic fluid delivery apparatus, a portion 30 of which is illustrated in FIG. 1. The nature of the delivery apparatus is not significant, so long as it is capable of providing cryogenic fluid having a boiling point below -100° C., such as nitrogen, in substantially liquid form to the application end 20 of the probe 8, and venting the gas which results from the cryogen being boiled by the heat of the tissue to which the probe is applied. As illustrated in FIG. 1, such a delivery system may have a coaxial arrangement with an inner tube 32 for delivering the liquid cryogen, spaced from an outer wall 34 so as to provide a passage 36 to permit gases to return toward the instrument. A simple delivery system capable of delivering cryogenic fluid to the probe of FIG. 1 is illustrated in my co-pending U.S. Pat. No. 3,534,739 referred to hereinbefore. Numerous other suitable delivery systems are known and generally available.

Utilization of the present invention is illustrated in FIG. 3. Therein, the probe 8 is forced against substantially the central portion of tissue 38 which is to be frozen, so that the tynes 22 are firmly embedded in the tissue. Then, a flow of cryogenic fluid is provided to the chamber 10 so that the wall 18 and that portion of the tynes 22 exposed to the chamber 10 are in direct contact with the cryogenic fluid. In a preferred utilization of the present invention, nitrogen in substantially liquid form is introduced directly to the chamber 10 so that the tynes are exposed to a temperature of substantially -196° C. (-320° F.). In such utilization, it has been found that the tynes can be maintained at at least -180° C. without regard to the character of the tissue in which it is embedded; even with tissue having a lot of warm blood flowing therethrough, the nitrogen is capable of maintaining the tissue at -180° C. so as to establish a substantial, deep iceball as illustrated by the dotted line 40. The depth of the iceball has been found to be much greater with respect to the cross sectional area of surface which is frozen than is obtainable with any cryosurgical instruments or application methods known in the art heretofore.

One manner of utilizing the present invention is to establish an iceball as described with respect to FIG. 3 hereinbefore, and then advance the margin of freezing still deeper by means of nitrogen applied directly to the surface, after removing the probe 8 from the position shown in FIG. 3. Although this phenomenon is not fully understood, it is believed that this

process results from the fact that the gross heat removed by the tyned probe makes subsequent freezing easier; also, the ice conducts the heat to the surface. This can have the effect of advancing the iceball deeper as illustrated by the dashed lines 42.

Another embodiment of a probe in accordance with the present invention is illustrated in FIG. 4. Therein, the probe 8a is comprised of two cylinders 12a, 12b mounted at right angles to each other. As is also illustrated in FIG. 5, this probe may be manufactured by providing a 45° cut 44 at the application end of the cylinder 12a, providing a hole 46 through the longer side of the cylinder 12a, shaping the cylinder 12b to match the cylinder 12a (as illustrated in FIG. 5), and joining the cylinders together. In a preferred form as illustrated in FIG. 4, the probe 8a is provided with a nitrogen delivery tube 48 which is spot-welded at a point adjacent to the hole 46 so as to insure that cryogenic fluid will communicate between the chamber 10a provided in the cylinder 12b and the cryogenic fluid tube 48. The tube 48 is adapted to be received by a suitable fluid duct 50 in a cryosurgical delivery instrument 30a, which instrument must provide cryogenic fluid to the probe 8a and vent the gases therefrom as is described with respect to FIGS. 1 and 2 hereinbefore. Notice however that it has been found immaterial to the operation of the present invention whether the cryogenic fluid is delivered through the tube 48 and vented through the chamber 10b formed within the cylinder 12a outside of the tube 48, or whether the cryogenic fluid is delivered to the chamber 10b and the gases thereof vented through the tube 48 and thence through a venting duct 52 in the delivery apparatus 30a. Thus, the present invention is readily adapted to be used with cryogenic delivery instruments 30a which have a center feed and outside return, or an outside feed and a center return, alternatively. The remainder of the probe 8a is similar to that described with respect to the probe 8 of FIGS. 1 and 2 hereinbefore, and will not be described further. However, it is important that there be delivery of cryogenic fluid directly to the chamber 10a so that the tynes 20 receive maximum heat transfer therewith, as described hereinbefore.

A procedure to which the embodiment of FIG. 4 is particularly well-suited relates to large lesions at the base of the tongue with no permanent damage to the large blood vessels that nurture the remainder of the tongue. Thus, while the necrotized area heals, the remainder of the tongue is maintained in a suitably healthy condition, since there has been no loss of blood flow thereto. Alternative procedures which are available include a relatively superficial freeze utilizing surface-applied cryogens and cryogenic probes in accordance with the prior art, and also include the rather drastic procedure of a total glossectomy (in which the entire tongue is

cut off at the base). Thus, a significantly less disabling alternative procedure is made available by the utilization of the present invention.

Other procedures for which the present invention is well-suited, include the removal of any large or especially thick lesions, or any carcinomas of a significant size. Thus, although the direct application of liquid cryogen to the surface of a lesion provides the greatest cooling ability at the surface, the present invention provides an ability to achieve greater depth and therefore finds application in a variety of procedures.

Although the invention has been shown and described with respect to preferred embodiments thereof, it should be understood by those skilled in the art that the foregoing and various other changes and omissions in the form and detail thereof may be made therein without departing from the spirit and the scope of the invention.

Having thus described particular embodiments of my invention, that which I claim as new and desire to secure by Letters Patent of the United States is:

1. In cryosurgery, the method of freezing a mass of soft, living tissue comprising the steps of:

inserting into a mass of soft, living tissue to be frozen a plurality of closely spaced sharp metal tynes which are metallurgically bonded to the outside surface of a metallic wall of a chamber; and

thereafter directing a sufficient flow of liquefied gas cryogenic fluid having a boiling point below -100° C. to the inner surface of the metallic wall of said chamber to which said tynes are metallurgically bonded to solidly freeze the entire portion of said mass included between said tynes.

2. A cryosurgical instrument for destroying living animal tissue by the rapid, active cooling of heat conducting tynes embedded in said tissue, comprising:

a chamber formed of walls and having a proximal end adapted to receive a cryogenic fluid and a distal end closed by a thermally conductive metallic end wall;

a plurality of closely spaced sharp metal tynes adapted to be inserted into living animal tissue which is to be destroyed, said tynes being metallurgically bonded to said end wall of said chamber and oriented outwardly therefrom; and

cryogenic fluid delivery means connected to said chamber and including a reservoir adapted to receive a liquefied gas cryogenic fluid having a boiling point below -100° C., for delivering, with said cryogenic fluid in said reservoir, a sufficient flow of said cryogenic fluid to said proximal end of said chamber, when said chamber is in position with said tynes inserted into the tissue, so as to solidly freeze the entire portion of the tissue included between said tynes.

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