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D. S. SHERIDAN

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NON-SPARKING MEDICO-SURGICAL TUBES

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Fig.1

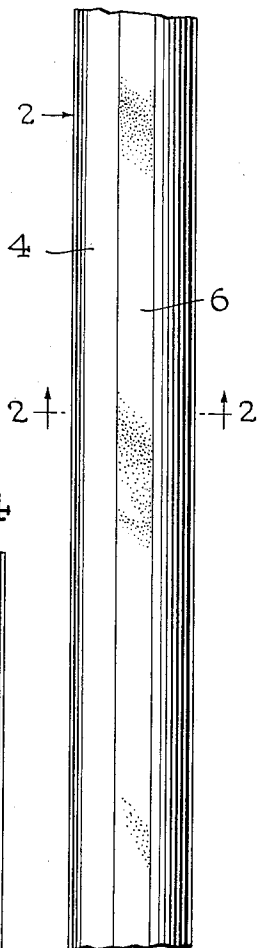


Fig.2

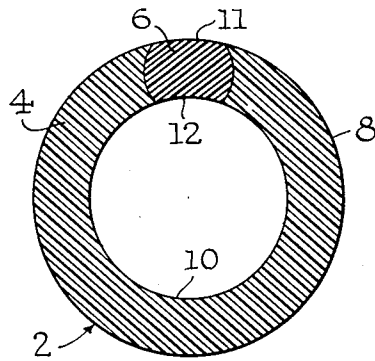


Fig.4

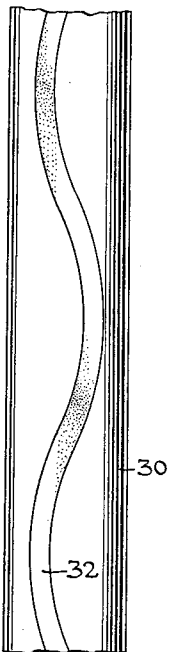


Fig.3

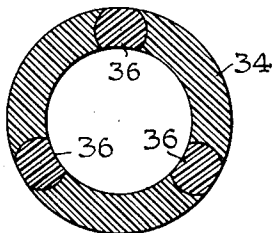
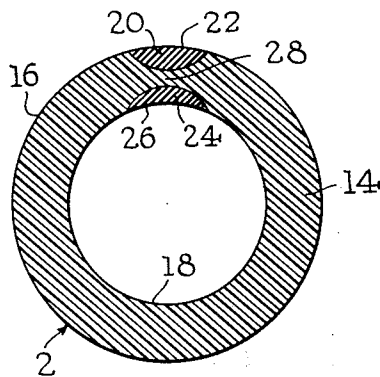


Fig.5

INVENTOR  
David S. Sheridan

BY *Kernon, Palmer + Stewart*

ATTORNEYS

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3,070,132

## NON-SPARKING MEDICO-SURGICAL TUBES

David S. Sheridan, P.O. Box 147, Argyle, N.Y.

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This invention relates to non-sparking medico-surgical tubes, i.e., catheters, cannulae and similar tubular devices designed for use in surgical or medical treatments, which are free of the hazard of causing an electrostatic spark discharge to ignite flammable gas mixing in the area of use of the tubes.

Modern medical and surgical practices require a wide variety of medico-surgical tubes, e.g., catheters, duodenal tubes, nasal cannulae, rectal tubes, oxygen connecting tubes, anesthesia administration tubes, and feeding tubes. These medico-surgical tubes are made from a variety of materials, although rubber and vinyl plastics account for the large bulk of medico-surgical tubes which are made and sold today. In order to prevent cross-infections and to eliminate the cost of sterilizing re-used tubes, the trend today in medical practice is to employ single-use, disposable catheters and other medico-surgical tubes. Because of the economy of production, most of such disposable tubes are formed by extrusion methods from vinyl plastic material.

The vinyl plastic material used to form extruded medico-surgical tubes is compounded from dielectric polymers. These polymers, whether in a plasticized or unplasticized state, when brought in frictional contact with other bodies, e.g., fabrics of cotton, nylon or the like, acquire a strong electrostatic charge.

The great hazard associated with possible ignition of flammable gases by electrostatic spark discharge in anesthetizing locations in hospitals has long been known and appreciated. Both hospital personnel and insurance companies are vitally interested, and a number of political subdivisions now have statutes designed to eliminate the hazard associated with electrostatic spark discharge in connection with medical and surgical operations. The sparking hazard is mainly associated with anesthetizing procedures which employ combustible anesthetic agents, including cyclopropane, divinyl ether, ethyl chloride, ethyl ether and ethylene. Hazardous anesthetizing locations are not limited to operating rooms of hospitals, but may include any area of a hospital in which it is intended to administer to a patient any combustible anesthetic agent in the course of examination or treatment. This includes, in addition to operating rooms, such other anesthetizing locations as delivery rooms, anesthetic rooms, corridors, utility rooms and other areas if used for induction of anesthesia with combustible anesthetic agents.

It has become a recognized fact that the electrostatic sparking hazard may be reduced by the use of suitable grounding devices and the use of electrically conductive casters, sheeting, floor coverings, mats and other equipment. Safe practices for employing electrically conductive items in medical and surgical practices have been outlined by the National Fire Protection Association and are described in N.F.P.A. Standard No. 56 entitled, "Recommended Safe Practice for Hospital Operating Rooms."

A principal object of this invention is the provision of non-sparking, medico-surgical tubes made of flexible, dielectric plastic material. Further objects include:

(1) The provision of medico-surgical tubes extruded from dielectric vinyl plastic which may be used in proper combination with grounding and other conductive devices at anesthetizing locations to mitigate electrostatic sparking hazards.

(2) The provision of extruded plastic medico-surgical

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tubes which are capable of being connected to ground to prevent any electrostatic charge from accumulating on the tube during its use in medical or surgical operations.

(3) The provision of medico-surgical tubes made of vinyl plastic, which have an apparent exterior and interior surface resistivity of not over 1 megohm-centimeters.

Other objects and further scope of applicability of the present invention will become apparent from the detailed description given hereinafter; it should be understood, however, that the detailed description, while indicating preferred embodiments of the invention, is given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

These objects are accomplished according to the present invention by forming medico-surgical tubes, by extrusion, from flexible, dielectric plastic material and including as an integral part of the formed tube a stripe of flexible electrically conductive, plastic material extending longitudinally along the exterior wall of the tube, and also a stripe of flexible, electrically conductive, plastic material extending longitudinally along the interior wall of the tube, the stripes being integral with the tubular member and substantially contiguous with the walls so that the medico-surgical tube has substantially smooth exterior and interior walls. The interior and exterior stripes of electrically conductive plastic material may be separate from one another or they may be of such depth that they form a single fused longitudinally extending section in the medico-surgical tube. In any event, the electrically conductive integral stripes so formed in the plastic medico-surgical tube may be connected to ground, whereby the tube is prevented from accumulating any electrostatic charge during its use at an anesthetizing location or any other place where it may be employed in medical or surgical operations.

The success of the present invention is due in part to the discovery that it is not necessary for a tubing made of flexible plastic material to be electrically conductive throughout its entire interior and exterior surfaces in order to prevent an electrostatic charge from accumulating on the tube sufficient to cause a sparking discharge. It involves the further discovery that inclusion of an electrically conductive element such as a strand of wire or the like, on the other hand, within the body of the tube (see, for example, U.S. 2,268,321) is not capable of preventing electrostatic charge from accumulating on a medico-surgical tube. An additional discovery is that obtaining satisfactory nonsparking qualities in a medico-surgical tube requires a stripe of electrically conductive integral plastic, not only on the exterior surface of the tube, but on the interior as well.

A more complete understanding of the new non-sparking medico-surgical tubes of this invention and their method of production can be had by reference to the accompanying drawing, in which:

FIG. 1 is a fragmentary plan view of a medico-surgical tube made in accordance with the present invention;

FIG. 2 is an enlarged cross-sectional view of the medico-surgical tube of FIG. 1, taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged cross-sectional view of a modified form of non-sparking medico-surgical tube made in accordance with this invention.

FIG. 4 is a fragmentary plan view of a modified form of medico-surgical tubes of this invention;

FIG. 5 is an enlarged cross-sectional view of yet another modified form of the new tubes.

Referring in detail to the drawings, the medico-surgical

tube 2 basically consists of a tubular member 4 and an electrically conductive, longitudinal portion 6.

Tubular member 4 has a substantially smooth exterior wall 8 and a substantially smooth interior wall 10, these being substantially contiguous with the exterior surface 11 and interior surface 12 of the electrically conductive portion 6 so that the entire tube 2 presents a smooth exterior and smooth bore.

The electrically conductive portion 6 runs longitudinally along the entire length of the tube 4 and is formed of flexible plastic material which is cohesive with the plastic material of the tube 4. The main body of the tube 4 may be made from any suitable flexible water-proof plastic material, and although vinyl chloride homopolymers or copolymers with other vinyl esters, such as vinyl acetate, are especially useful, other usable materials include: pliable or flexible forms of nylon, polyester plastics, polyethylene, vinylidene chloride polymers, cellulose esters, acrylic polymers and the like.

Electrically conductive longitudinal portion 6 is preferably made from the same plastic base material as the remainder of the tubular body 4, although it is possible to form the tubular member 4 of a composition based on one plastic material and the conductive portion 6 from a different plastic material, so long as the two separate plastic materials are cohesive to one another. In any event, if the same base plastic is used to produce the tubular member 4 and longitudinal portion 6, or a different, cohesive plastic is used to form the longitudinal portion 6, an integral structure results which is fluid-tight and which can be subjected to rigorous conditions of use, sterilization or other abuse which it may encounter in medical or surgical operations.

Generally, the plastic material of which tubular member 4 is composed will be unpigmented so that all of the tube, except the longitudinal portion 6, will be transparent. This makes it possible to look through the medico-surgical tube and to view the interior to determine if there is any foreign matter or obstruction within the bore of the tube. If desired, dyes can be incorporated in the plastic material to give the tube a distinct color, thus marking the tube for special uses or other purposes, e.g., oxygen connecting tubes and oxygen nasal cannulae are colored a light green in accordance with established practice in the trade. Pigments may be included in the plastic material comprising tubular member 4 to create an opaque tube, e.g., inclusion of titanium dioxide pigment to produce an opaque white composition which is used in certain forms of Levin style duodenal tubes.

The flexible plastic material used to form the longitudinal portion 6 of the new non-sparking tubes is rendered electrically conductive by compounding the plastic material with a substantial proportion, preferably between about 5 and 40% and especially between about 10 and 30% of a very finely powdered electrically conductive solid material. Finely subdivided metals such as copper, aluminum or silver are examples of electrically conductive materials which may be employed to form electrically conductive plastic material for the longitudinal portion 6 of the non-sparking tubes. However, it is preferable to form the plastic material for the portion 6 of the new tubes using powdered, electrically conductive carbon. Such forms of carbon are standard items of commerce. The use of carbon as the electrically conductive component of the plastic composition is preferred over the use of powdered metals, because of its lack of deteriorating effect upon the plastic matrix and because of its relative inertness to body fluids or other materials with which it comes in contact during normal use of the medico-surgical tube.

The modified form of non-sparking tube as shown in FIG. 3 comprises a tubular member 14 having a smooth outer surface 16 and smooth inner surface 18. A stripe 20 of flexible electrically conductive plastic material is embedded in the exterior surface 16 and has its exterior

surface 22 contiguous with the surface 16 of the tubular member 14, so that the entire outer surface of the tube is completely smooth. A second stripe 24 of flexible electrically conductive plastic material is embedded in the interior surface 18 of the tube member 14, also having a surface 26 which is contiguous with the interior surface 18.

Since the inclusion of a substantial amount of electrically conductive powder in the plastic material causes some reduction in tensile strength of the plastic material, the form of non-sparking medico-surgical tube shown in FIG. 3 may have a slight advantage in applications where tensile strength or bursting strength of the tube are of importance, since the tube 2 includes an unfilled web portion 28 which runs longitudinally of the tube between the electrically conductive stripes 20 and 24. In the modified form of tube 30 shown in FIG. 4, the longitudinally extending electrically conductive tube portion 32, is formed as a sinusoidal line rather than a straight line as in FIG. 1. Spiral configurations for the conductive line may also be used.

In the modification shown in FIG. 5, the tube 34 is provided with a plurality of integral electrically conductive portions 36.

The new non-sparking medico-surgical tubes are made by extrusion using a multi-orifice tubular extrusion die. Such multi-orifice extrusion equipment is known and is disclosed, for example, in U.S. 2,857,915. The main body of the tube, i.e., tubular member 4 or 14, is extruded through the major orifice of the extrusion die, while the longitudinal conducting portions, 6, 20 or 24 are extruded simultaneously with the main body portion through the minor orifice or orifices of the extrusion die. In the case of the form of tubing shown in FIG. 2, a bi-orifice tubular extrusion die is used, whereas to produce the modified form of tube shown in FIG. 3, a tri-orifice tubular extrusion die is used.

The non-sparking tubes of this invention may be used to form a large variety of medico-surgical tubular devices. These may include nasal cannulae such as disclosed in U.S. 2,693,800, 2,735,432 and applicant's copending application S.N. 752,050, filed July 30, 1958. Also, catheters of the Levin style, X-ray catheters of the type disclosed in U.S. Patents 2,212,334 or 2,857,915, oxygen connecting tubes, rectal tubes, e.g., improved rectal tubes of the type disclosed in applicant's copending application S.N. 746,135, filed July 2, 1958, and medico-surgical tubes of the type having improved integral connector ends such as disclosed in applicant's copending application S.N. 746,134, filed July 2, 1958. The medico-surgical tubes of this invention may be also provided with one or more tapered sections as disclosed in applicant's copending application S.N. 746,175, filed July 2, 1958.

The new tubes may be made and sold in very long continuous lengths of uniform O.D. and I.D. or with tapered sections therein. More commonly, however, the tubing as it is withdrawn from the extrusion die, will be cut into short lengths required for the particular medico-surgical device ultimately involving the tube. In the case of catheters, cannulae and the like, eyes or openings in the required number can be drilled, punched or melted into the tubing to form the necessary inlet openings in the distal ends of the tube.

The non-sparking tubes of this invention will withstand substantially all conditions of use and adverse treatment as any other plastic medico-surgical tubes. They may be manufactured to professional specifications and may be produced in various degrees of flexibility by varying the formulations of the plastic material from which the tubes are extruded. They may be used interchangeably at non-hazardous locations with similar medico-surgical tubes which do not incorporate the non-sparking feature of the tubes of this invention, and they will satisfactorily perform all the functions for which such tubes are known

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to be useful. Since they may be electrically grounded to prevent electrostatic charge from accumulating on the tube during its use, they substantially eliminate the electrostatic spark discharge hazard connected with the use of prior known plastic catheters or other surgical tubes which do not have their non-sparking properties. The conductive line in the new tubes may also be used to conduct electrical current from an applied current source for special purposes, e.g., to provide heating of the tube.

I claim:

1. A non-sparking medico-surgical tube comprising a tubular member having substantially smooth exterior and interior walls, said member being formed of flexible, dielectric, water-proof, plastic material, a continuous stripe of flexible electrically conductive, water-proof, plastic material extending longitudinally along said exterior wall, a stripe of flexible, electrically conductive, water-proof plastic material extending longitudinally along said interior wall, said stripes being integral with said tubular member and substantially contiguous with said walls, said tube being capable of being connected through said stripes to ground to prevent any substantial electrostatic charge from accumulating on the tube during its use.

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2. A non-sparking medico-surgical tube which may be used in anesthetizing locations in hospitals in conformity with safe operating practice for such locations, which consists of a non-fibrous tube of flexible, water-proof dielectric plastic material, a continuous longitudinally extending electrically conductive plastic portion formed integrally with the tube of flexible, electrically conductive, water-proof plastic material, said longitudinal portion having exterior and interior surfaces contiguous with the exterior and interior surfaces of the remainder of the tube, whereby the tube has substantially smooth inner and outer surfaces.

3. Non-sparking medico-surgical tubes as claimed in claim 2, wherein said tubes, exclusive of said longitudinal electrically conductive portion, are transparent to visible light.

#### References Cited in the file of this patent

##### UNITED STATES PATENTS

|           |         |               |
|-----------|---------|---------------|
| 2,268,321 | Flynn   | Dec. 30, 1941 |
| 2,671,185 | Bloom   | Mar. 2, 1954  |
| 2,811,674 | Smith   | Oct. 29, 1957 |
| 2,870,619 | Greczin | Jan. 27, 1959 |