United States Patent

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[54] **COLLAPSIBLE FILTER FOR FLUID FLOWING IN CLOSED PASSAGEWAY**
7 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **128/1,** 128/214, 128/325, 210/448
[51] **Int. Cl.** **A61b 19/00**
[50] **Field of Search** ..... 128/1, 214, 325, 348—350, 345; 210/448

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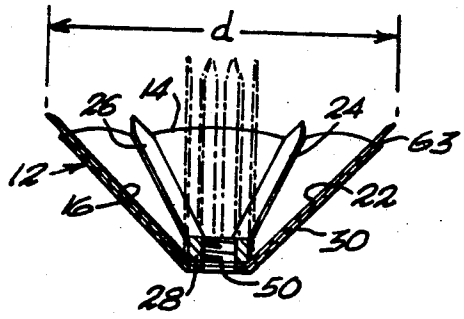
ABSTRACT: A filter of umbrella type configuration including a skeletal framework and a hood of filtering media for lodgment in spanning relation of a vein or passageway of the human body to filter fluid flowing in a closed passageway.



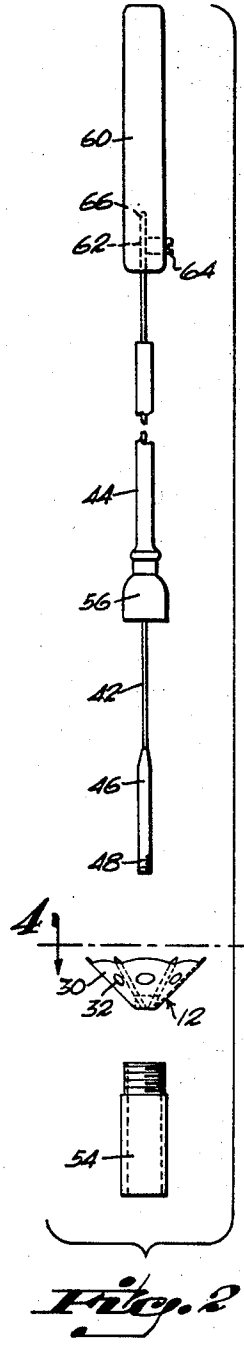


Fig. 2

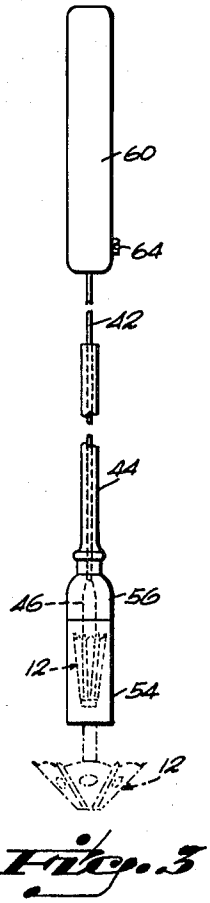


Fig. 3

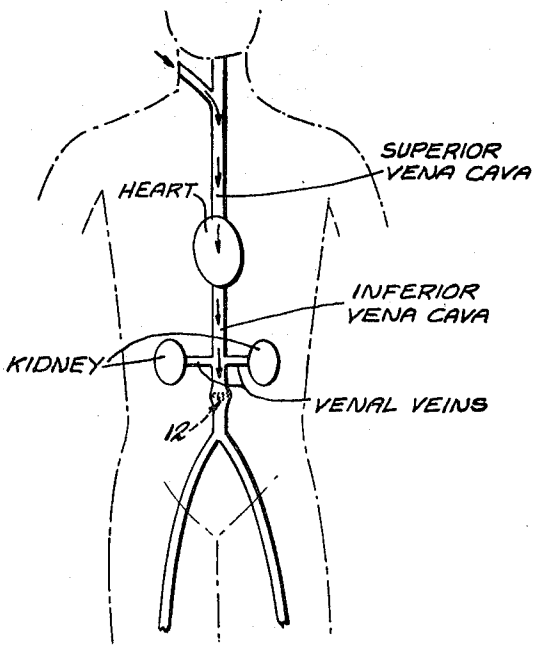


Fig. 1

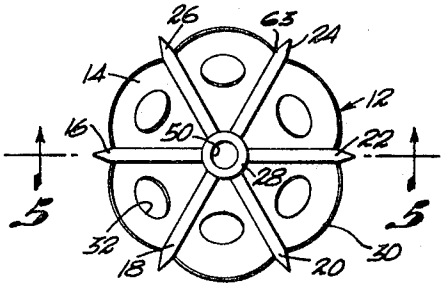


Fig. 4

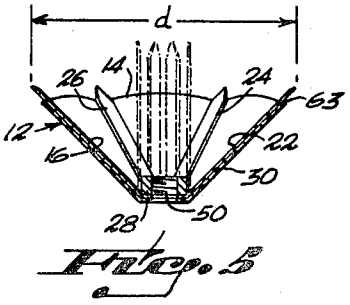


Fig. 5

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COLLAPSIBLE FILTER FOR FLUID FLOWING IN CLOSED PASSAGEWAY

This is an invention of a filter which is to be included in spanning relation of the cross section of the return flow vein to the heart, known as the inferior vena cava, which is located upwardly of or above the juncture of the two main return veins for the blood supply leading from the legs of a person, and which proceeds directly to the heart preliminarily to being pumped through the body again through the arteries, including, particularly, one of the arteries leading to the lungs.

The problem which occasions the need of the filter is that a person after an operation, by reason of lying flat for extended lengths of time, seems to develop clots which are carried by the veins upwardly toward the heart and, by reason of the above structure of the human body, through the inferior vena cava. As these clots enter the heart at least some are pumped outwardly through the artery which leads to the lungs. It is here that by reason of the numerous small passageways which characterize the lungs that the clots block certain of the blood passageways. This may lead to sudden death because here the clots act so that the blood flow to the lungs is interrupted or obstructed and the rejuvenation required by the oxygenation process cannot take place.

In the past, this problem has been met by a major surgical operation which requires a tying of the inferior vena cava and the collateral circulation which results is relied upon to provide passageways for the transmittal of satisfactory blood flow to the heart. Because this major surgical operation of tying the vena cava is usually performed on a person who has already been weakened by other surgery, it is considered a generally dangerous operation, by reason of the fact that it is major and requires a rather extensive incision through the trunk area to reach the vena cava to tie it.

This invention provides a means for inserting a filter to break up the aforesaid characteristic clots in the inferior vena cava, as shown in the drawing, in a manner which is relatively simple and which can be performed under local anesthesia. It comprises the introduction of a filter member, in a manner to be described, into one of the neck veins which is exposed by a small incision. The neck vein, known as the jugular vein, leads to the main neck vein, known as the superior vena cava, and thence to the heart in a generally oppositely disposed position to the entrance mouth of the inferior vena cava through which the aforesaid blood flow for the lower body takes place leading into the heart chamber.

In this invention, a filter is disposed in a carrier which is threaded down the aforesaid passageway to a point below or inferior of the juncture of the renal veins in the inferior vena cava, where it is deposited in spanning relation, the renal veins being the veins through which blood flow from the kidneys returns to the heart.

It is, accordingly, an object of this invention to provide a filter adapted to be traveled through the superior vena cava and into a position in spanning relation of the inferior vena cava.

It is another object of this invention to provide such a filter for the purpose described which includes a skeletal body of generally dome-shaped configuration which is adapted to be collapsed for travel to a predetermined position in a vein within the human body to be released to spring into a position of spanning relation of the vein within which it is lodged to filter blood flowing therethrough.

It is another object of this invention to provide a filter for a vein in the human body and apparatus and method for placing the filter in a position of lodgment in spanning relation of a vein at a point to be filtered.

It is a general object of this invention to provide an improved medical article for use in filtering the blood in the return flow to the heart as it travels through the inferior vena cava, the filter being disposed inferior of the renal veins and comprising a generally dome-shaped skeletal body to support a filtering media with the leading edge of the body facing the direction of flow and with the trailing edge of the body in expanded holding engagement with the walls of the vein.

In accordance with these and other objects which will become apparent hereinafter, the instant invention will now be described with reference to the accompanying drawings in which:

FIG. 1 is a diagrammatic view of the human body illustrating the position of lodgment of the filter;

FIG. 2 is a partial and exploded view illustrating equipment for use in depositing the filter and illustrating the filter in an expanded position;

FIG. 3 is a view similar to FIG. 2 but illustrating the filter in a collapsed condition within the housing of the equipment seen in FIG. 2;

FIG. 4 is a top plan view of the filter as is seen along the plane indicated by the line 4–4 of FIG. 2 and looking in the direction of the arrows; and

FIG. 5 is a view taken along the plane indicated by the line 5–5 of FIG. 4 and looking in the direction of the arrows, and illustrating the filter by chain dot lines in a collapsed condition.

Referring to the drawings, wherein like reference characters designate like or corresponding parts throughout the different views, and referring particularly to FIG. 1, the filter is there generally designated by the numeral **12**, and in FIGS. **4** and **5** it is seen to comprise a generally dome-shaped body **14** of open work construction composed of skeletal members such as **16**, **18**, **20**, **22**, **24** and **26** which are arranged in a manner somewhat similar to the struts of an open umbrella canopy, and when in the open position shown in FIG. **5**, span a distance *d* greater than that which characterizes the range of diameters commonly encountered in the inferior vena cava. In the preferred embodiment, the six radiating spokes are of collapsible, resilient, alloy material, that material known as "elgiloy" and being of satisfactory quality. The inward or converging proximal ends of the spokes or frame members converge to a hub **28** and are there united forming the skeletal frame. The distal ends of the struts or spokes all extend somewhat beyond the outer lip or margin of the canopy now to be described, and these ends are preferably sharpened to comprise a holding and gripping means, as will be apparent hereinafter. The canopy portion **30** comprises a suitable filter media of generally sheet form overlaying and being supported on the framework. Preferably, the filtering media includes a plurality of holes in the preferred embodiment, one hole being disposed in the generally triangular portion of the canopy between each of the spokes, and these holes or openings, one of which is designated by the numeral **32** for purposes of clarity, are on the order of about 3 millimeters in diameter and are circular in cross section. It will be seen in FIG. **4** that the pointed distal ends of the spokes appear as circumferential teeth which extend outwardly of the canopy. The hood or canopy is preferably of a flexible, smooth surfaced material, such as a plastic material, and which provides a smooth surface. For purposes which will be apparent hereinafter, there is an axial recess **50** in the hub which is threaded.

The means for inserting the filter will now be described. The means for inserting the filter through the superior vena cava across the heart and down the inferior vena cava to a position of lodgment inferior of the renal veins will now be described, also. These means include a guide wire **42** arranged in coaxial relation within a flexible tubular member **44**, which is known as a catheter. To one end of the guide wire **42** an adapter **46** is provided having a threaded outer or terminal end **48** which is sized for companionate engagement with the threads of the recess **50** of the filter body. The filter **12** is thus adapted to be threadably connected to the end of the adapter as can be seen in FIG. **3**, and, when so connected, a tubular capsule **54** is adapted to be passed axially over the dome-shaped body to collapse it and protectively house it therewithin as is indicated in FIG. **3** in a manner similar to that of a collapsed umbrella; however, with energy of restoration being resiliently stored in the skeletal framework tending at all times to urge the filter into the expanded position seen in FIG. **5**. The adapter **46** is then drawn against the terminal end **56** of the tubular sleeve catheter **44** and is threadably engaged therewith so that the filter is protectively housed within the capsule which in turn is

fixed to travel with the end **56** of the catheter. The resulting structure, it is seen, is such that so long as axial forces are applied on the catheter, to move it axially, the capsule together with the protectively housed filter will travel therewith; however, it will also be apparent that the filter may be expelled from within the capsule **54** by pushing the interior guide wire so as to extend it relative to the catheter and position it from the nested position seen in FIG. **3** into the expanded dotted line position seen in FIG. **3** with the toothed or pointed ends moving outwardly releasing the energy stored in the flexed skeletal framework until restrained by the hood material and in a normal position characterized by a normal spanning diameter *d* seen in FIG. **5**. To transfer axial forces through the wire to the filter, an operator handle or control means **60** is preferably provided in which a receiving socket **62** and lock means **64**, comprising the screw bolt shown, are provided to releasably captivate the end **66** of the guide wire in the operator handle.

Through the use of the equipment means for inserting the filter, the filter is lodged in the manner now to be described with reference to FIG. **1**; after a local anesthetic is applied, the neck is opened for access to the neck vein, whereupon the capsule is passed together with the catheter downwardly through the jugular vein, superior vena cava, across the heart, and along the inferior vena cava, until the leading edge of the capsule is beneath the renal veins, a position which may be determined by suitable fluoroscopy material. When this position has been attained, the guide wire is pushed relative to the catheter which ejects the filter in a direction of movement which is opposite to the blood flow in the inferior vena cava. As the trailing or toothed edge of the collapsed filter leaves the capsule, the energy stored in the resilient spokes is released and the filter snaps into spanning relation of the smaller diameter of the inferior vena cava, and, by reason of the direction of the flow of the blood, is pushed into a position of spanning relation with the teeth seating the filter and securing the same in the position shown in FIG. **1**.

Thereafter, counterclockwise rotation of the guide wire **42** will threadably disengage it from the threaded central recess **50** in the filter, and it may be slowly withdrawn together with the catheter along the aforesaid path of insertion. Thereafter, any clots will collect on the upstream side of the filter; that is, on the inferior side thereof, while the filter will permit certain passage of the blood flow to the heart to be pumped to the body including the lungs, and without the complete reliance being placed upon the collateral circulation. Thus, the heart will not have to rely entirely on collateral circulation, and, in addition, the clots will be collected at a point where the same may be treated by a chemical or other means at a later date to dissolve them. Additionally, an anticoagulant substance may be coated over the filter, and particularly on the upstream side face to resist adherence of clots to the filter and to discourage any tendency of the filter to cause clotting by reason of its presence in the vein. In addition, the patient may be treated with other anticoagulant medicines injected into the body by suitable means.

Referring to the hood, it can be seen in FIG. **4** that the outer marginal edge is generally defined by an arc of a radius of curvature such that the center of the arc is different from the center of the hub and is displaced radially outwardly of the axial center line of the body with the centers arranged in a circle about the axis so that there is a slight outer flap portion which will tend to overlay the vein or passageway around the teeth engagement of the filter and seal against the passage of any blood flow except through the filter. The material known as sialastic in sheet form may compose the hood when suitably bonded to the framework. It is preferred that the sharpened teeth or terminal ends of the spokes extend in the order of about 1 millimeter beyond the juncture **63** of the hood and the spokes. It will be apparent in appropriate situations that the skeletal body may be employed with a nonpervious canopy or hood so that the procedure described herein may be employed to block a passageway completely if desirable or a hood may be employed with other types of openings or of a selected porous quality to selectively filter fluids flowing in a passageway in the body.

1. A filter for positioning in spanning relation of a short length of a fluid passageway in the human body comprising a single collapsible skeletal body of struts expandable into a normal generally dome-shaped configuration of generally circular cross section as seen in plan from an axial direction, holding means on said skeletal body to engage the walls of the passageway, and hood means comprising a canopy of filtering media over said struts and spanning the space between the struts, said holding means extending beyond the periphery of the canopy.

2. The device as set forth in claim **1** wherein said skeletal body comprises a body of spoke-shaped members inclined in a generally axial direction.

3. The device as set forth in claim **2** wherein the terminal ends of said spoke-shaped members are pointed and comprise said holding means.

4. The device as set forth in claim **1** wherein said canopy is provided with a plurality of through holes of a diameter in the order of about 3 millimeters.

5. The device as set forth in claim **1** wherein said canopy is of flexible plastic material.

6. The device as set forth in claim **5** wherein said hood is provided with an exterior coating of anticoagulant material.

7. The device as set forth in claim **1** wherein said framework includes a hub with a central axial recess.