

Oct. 16, 1962

A. E. WHITEHEAD

3,058,473

REMOTELY DIRECTING CATHETERS AND TOOLS

Filed Nov. 27, 1959

3 Sheets-Sheet 1

PRIOR ART

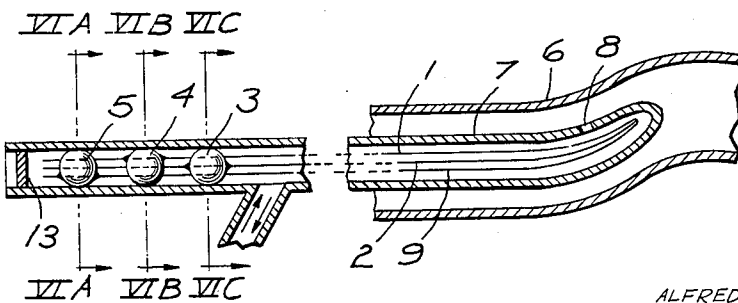
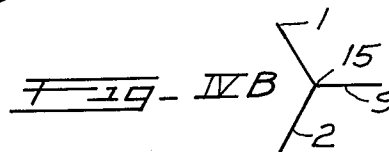
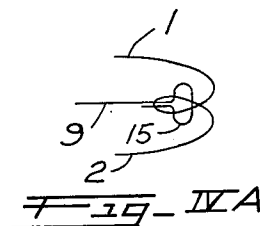
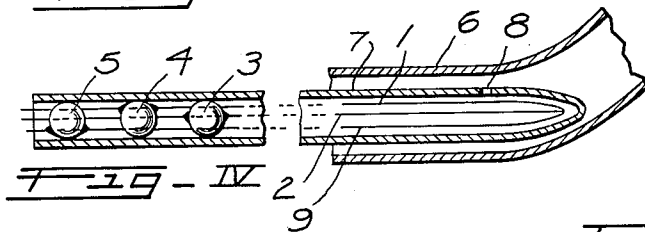
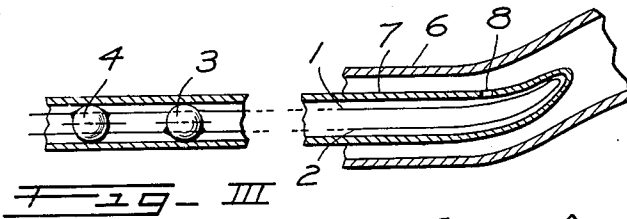
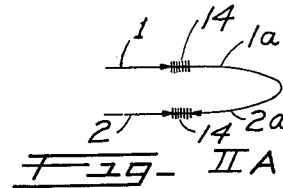
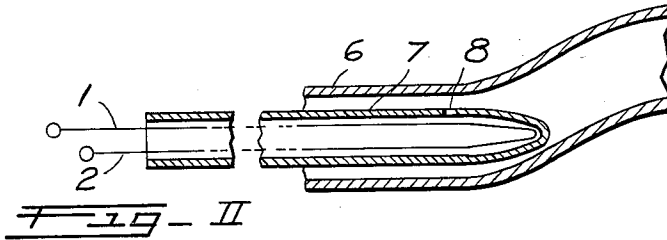
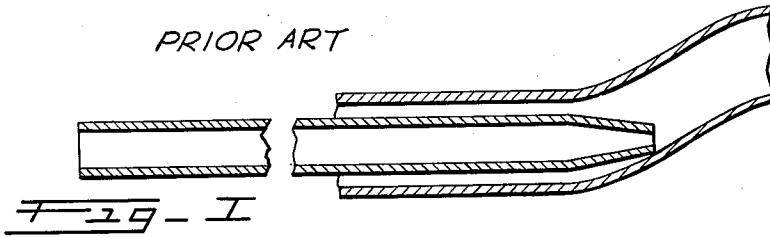


Fig. 5

INVENTOR.
ALFRED E. WHITEHEAD

BY
Christel & Bean
ATTORNEYS

Oct. 16, 1962

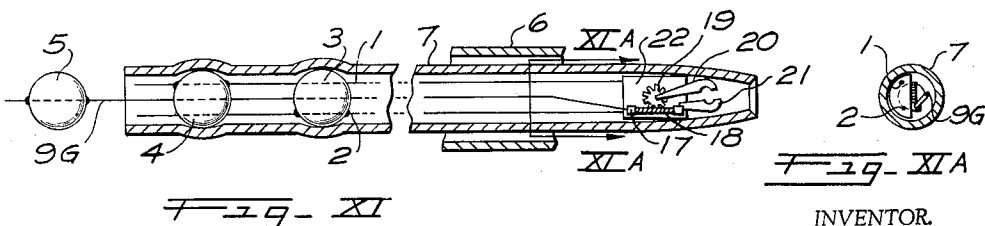
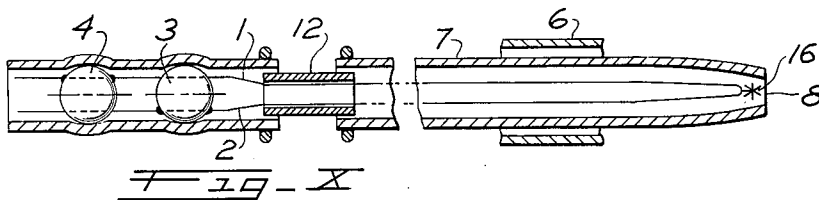
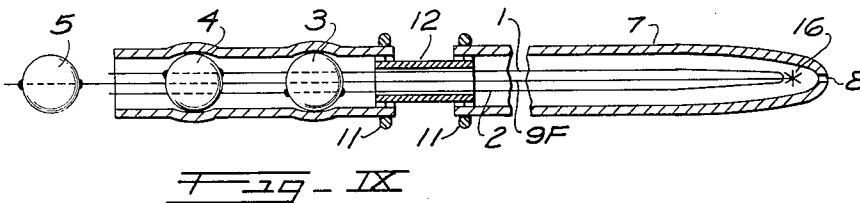
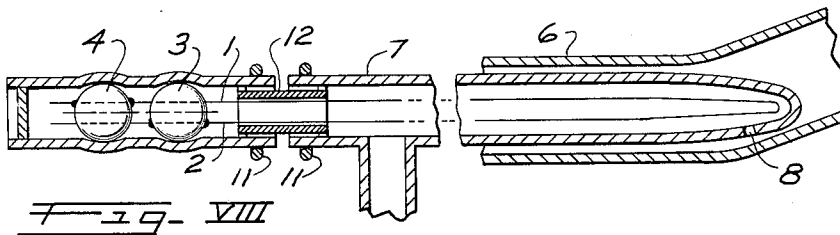
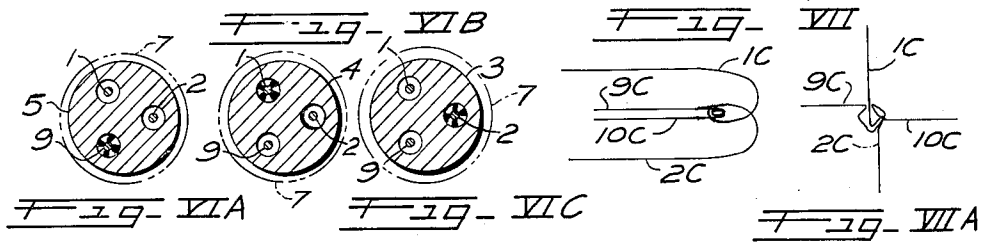
A. E. WHITEHEAD

3,058,473

REMOTELY DIRECTING CATHETERS AND TOOLS

Filed Nov. 27, 1959

3 Sheets-Sheet 2



INVENTOR.
ALFRED E. WHITEHEAD

BY

Christel & Bean
ATTORNEYS

Oct. 16, 1962

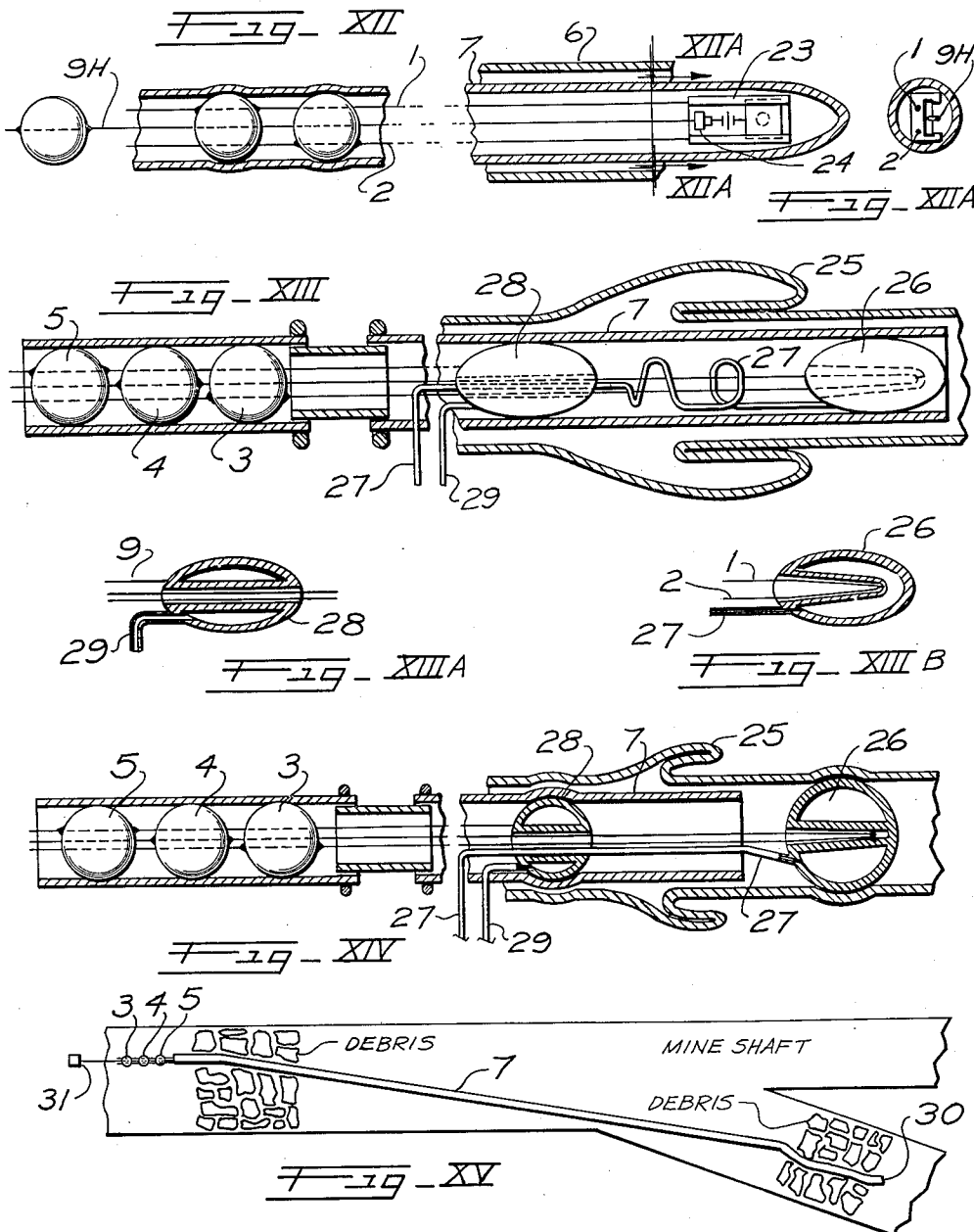
A. E. WHITEHEAD

3,058,473

REMOTELY DIRECTING CATHETERS AND TOOLS

Filed Nov. 27, 1959

3 Sheets-Sheet 3



INVENTOR.
ALFRED E. WHITEHEAD

BY

Christel & Bean
ATTORNEYS

1

3,058,473

REMOTELY DIRECTING CATHETERS AND TOOLS

Alfred E. Whitehead, 223 Garrison Road,
Williamsville, N.Y.

Filed Nov. 27, 1959, Ser. No. 855,601

7 Claims. (Cl. 128—349)

This invention relates to a new and useful improvement in remotely directed catheters and remotely operated tools.

The negotiating of turns in a body canal with a catheter presents problems which have not been satisfactorily solved by the prior art. One present type of catheter often has a slightly curved entering end. It is pushed and turned to negotiate turns, which takes time and can damage delicate walls. Another type of catheter is limber, and cannot easily be directed. Still another, stiffer type can be readily directed only when its route lies within narrow limits, approaching a straight line.

Accordingly, an object of my invention is to provide a catheter having means enabling it to negotiate turns in a vein, intestine, larynx, esophagus or other body canal with greater speed and less damage than in the case of the prior art catheters referred to above, and which is remotely directed.

It is also an object of my invention to provide such a catheter as aforesaid having means for the remote operation of tools carried thereby.

Another object of my invention is to provide a catheter-like device having the above described characteristics and which can be used in fields outside of the human body.

In one aspect thereof, a device constructed in accordance with my invention is characterized by the provision of a flexible tube having an entering end adapted for insertion into a passage, at least two flexible push-pull directing members extending along the interior of the tube substantially to its entering end, the directing members being connected to each other at the entering end to provide a directing member apex within the tube at its entering end, the directing members being movable relative to each other lengthwise of the tube for laterally shifting the position of the apex and thereby turning the entering end, and means remote from the entering end for so moving the directing member to selectively position the entering end, the last-named means comprising at least two manipulating members independently movable relative to the tube, one of the directing members being fixed to one of the manipulating members for movement therewith relative to the other of the manipulating members, and the other of the directing members being fixed to the other manipulating member for movement therewith relative to the one manipulating member, whereby the manipulating members can be moved relative to the tube and to each other to selectively push and pull the directing members and thereby turn the entering end.

The foregoing and other objects, advantages and characterizing features of my invention will become clearly apparent from the ensuing detailed description of certain illustrative embodiments thereof, considered in conjunction with the accompanying drawings illustrating the same. In the drawings, which are generally schematic throughout and in which many of the views show parts broken away for ease of illustration:

FIG. I is a longitudinal, sectional view of a prior art catheter, inserted in a body canal having a turn;

FIG. II is a corresponding view of a catheter of my invention;

FIG. IIA is a fragmentary, detail view of a modified directing wire construction;

FIG. III is a view of the catheter of FIG. II, provided

2

with a pair of ball members which have been manipulated to shift the position of the entering end to negotiate the turn;

FIG. IV is a longitudinal, sectional view of a catheter of my invention, provided with a triple directing wire and manipulating ball arrangement;

FIG. IVA is a fragmentary, side elevational view of another directing wire apex construction, useable with the catheter of FIG. IV;

FIG. IVB is a fragmentary, end view of the directing wire apex of FIG. IV;

FIG. V is a longitudinal, sectional view of a catheter, like that of FIG. IV but having an end plug and a lateral conduit, with its entering end shifted to negotiate the turn;

FIGS. VIA, VIB and VIC are transverse sectional views thereof, taken about on lines VIA—VIA, VIB—VIB and VIC—VIC, respectively, of FIG. V;

FIG. VII is a fragmentary, side elevational view of a four wire apex construction;

FIG. VIIA is an end elevational view of FIG. VII;

FIG. VIII is a longitudinal, sectional view of still another catheter of my invention, similar to the catheter of FIG. III but using a split or double catheter construction;

FIG. IX is a longitudinal sectional view of a catheter similar to that of FIG. VIII but having a third wire carrying a brush at the entering end and a manipulating ball member therefor;

FIG. X is a longitudinal, sectional view of a catheter similar to that of FIG. IX but with only two wires and manipulating members and with the brush carried by the directing wire apex;

FIG. XI is a longitudinal, sectional view of a catheter of my invention provided with pliers;

FIG. XIA is a transverse sectional view thereof, taken about on line XIA—XIA of FIG. XI;

FIG. XII is a longitudinal, sectional view of a catheter of my invention provided with a shielded box for a radioactive source;

FIG. XIIA is a transverse sectional view thereof, taken about on line XIIA—XIIA of FIG. XII;

FIG. XII is a longitudinal, sectional view of a catheter of my invention, provided with a pair of inflatable bags and inserted in an intestine having an intussusception;

FIG. XIIIA is a fragmentary, longitudinal sectional view of one of the inflatable bags of FIG. XIII;

FIG. XIIIB is a longitudinal, sectional view of the other inflatable bag of FIG. XIII;

FIG. XIV is a longitudinal, sectional view of the catheter of FIG. XIII, in another condition of operation; and

FIG. XV is a diagrammatic view illustrating the application of a catheter of my invention to a mine disaster.

Referring now in detail to the accompanying drawings, there is shown in FIG. I an illustrative, prior art type of catheter which does not have the directing means of my invention for negotiating turns, and which therefore is subject to various of the above noted disadvantages.

There is shown in FIG. II a catheter 7, constructed in accordance with my invention. It can be made from thinner and more flexible material than the prior art catheter of FIG. I, comprising for example pure rubber having a wall thickness of 1 millimeter and an outside diameter of 1/8 inch. Catheter 7 contains directing members in the form of wires 1 and 2 which can be spring steel music wire. While the wires 1 and 2 comprise a pair of directing members, they can be formed of a single piece of wire, bent upon itself as shown at the left hand, entering end of the catheter to provide a connecting apex between the directing members.

Where great flexibility is required, the construction of FIG. IIA can be used, wherein the last inch of the entering end loop or apex comprises directing member portions 1a and 2a, of smaller diameter spring wire, joined with the drive end wires 1 and 2 at the junctions 14. The portions 1a and 2a can comprise spring wire of .011 inch diameter, with members 1 and 2 comprising spring steel wire having a diameter of .026 inch. The wires 1a and 2a can be reduced both in diameter and in length, to negotiate even sharper turns.

The foregoing dimensions are given by way of example only. The size of the catheter and the directing wires will be varied according to the intended use. Going into an arm vein and then into the heart is one problem, and going into the stomach and then into the pylorus is another, while going into the meatus, or through the larynx to the lungs are still other problems dictating the size and length of the catheters, the diameter and number of directing wires, and the position of hole 8, if one is required.

In the embodiment of FIG. III, manipulating members in the form of steel balls 3 and 4 are provided. Each ball has holes, of approximately number 50 drill size, through the ball to receive directing wires 1 and 2. Wire 1 passes through ball 3 and is soldered or otherwise fastened in ball 4. Wire 2, on the other hand, is soldered in ball 3 and passes through ball 4. Assume, now, that the catheter has come to a curve in a vein or intestine, indicated at 6. The shortest distance between two points, in a flat plane, is a straight line. Also, the peripheral length of an outside arc is greater than the peripheral length of an arc nearer the apex, where the angle of the arcs is identical. The instant invention utilizes these principles, to negotiate the curve, as follows.

The operator pushes ball 4, to which wire 1 is fastened, to the left in FIG. III, while pushing ball 3, to which wire 2 is fastened, to the right. This causes the entering end loop or apex of the connected directing members to turn upward, in the plane of the drawing, and this lateral shifting in position of the directing member apex turns the entering end of catheter 7 in the direction of the curve, as shown in FIG. 3. The operator then pushes the entire catheter to the right, to negotiate the turn. Once the turn is negotiated, manipulating members 3 and 4 are returned to their original positions, and the entire instrument is pushed to the right until the next curve is reached. The directing member wires 1 and 2 and the catheters 7 have sufficient slack or flexibility to move past the curve thus negotiated.

With the dual directing wire and manipulating member arrangement of FIG. 3, the entering end of catheter 7 can be moved in one plane. However, it is desirable to tip or move the entering end of catheter 7 in all planes, and this is accomplished with the arrangement of FIG. IV in which a third directing wire 9 and manipulating member 5 are added. Wire 9 extends lengthwise of catheter 7 to its entering end, and is joined to wires 1 and 2 at junction 15. The wires can be brazed at the apex, or joined, as shown in FIG. IVA, with the three wires 1, 2 and 9 being spaced apart 120° as clearly shown in FIG. IVB. In this arrangement, directing wire 1 is soldered in ball 4 and slides in balls 3 and 5. Wire 2 is soldered in ball 3 and slides in balls 4 and 5. Wire 9 is soldered in ball 5 and slides in balls 3 and 4.

The balls 3, 4 and 5 are slightly larger in diameter than the inside diameter of catheter 7. Therefore, the frictional engagement of the balls with the catheter wall causes the balls to stay in adjusted position. The three balls are spaced about 1 inch apart, and if the operator grasps the catheter on the outside, with thumb and forefinger on the "slope-side" of a ball, and squeezes, the ball will move lengthwise of the catheter to a new position therein, and will be held in its new position by frictional engagement with the catheter.

In the embodiment of FIG. V, a plug 13 seals the

directing end of the catheter, and the drive balls 3, 4 and 5 are entirely closed in the catheter. This is done where there is to be no outside contamination, or where pressures are to be maintained in the catheter. In FIG. V the catheter has been manipulated to negotiate the turn in canal 6. This has been done by squeezing balls 3 and 4 to the left, relative to catheter 7, and squeezing ball 5 to the right, shifting the position of the directing member apex and thereby moving the entering end of the catheter to negotiate the turn. The entire structure then is pushed to the right, to place the entering end past the first turn. Balls 3, 4 and 5 then are returned to their original position, relative to the catheter. To facilitate this the relative position of balls and catheter can be marked on the outside of the catheter, and the entire catheter can be marked in centimeters or inches.

Assume that the second curve in FIG. V not only turns down, in the plane of the paper relative to the first curve, but also 45° out of the plane of the paper. To negotiate this curve, ball 5 will be moved to the left, pulling wire 9. Ball 3 is moved even further, relatively, to the left, pulling wire 2 more than ball 5 pulled wire 9. Ball 4 is moved to the right, pushing wire 1. If ball 4 is moved further to the right than ball 3 is moved to the left, the entering end of the catheter will be aligned with the direction of the second curve, and the entire structure can be pushed to the right to negotiate the curve. The three balls then should be returned to their original, straight line positions. Thus, it can be seen that my three wire system has geometric versatility, in positioning the entering point of the catheter.

FIGS. VII and VIIA show a system having four directing member wires. Wire 1c loops on itself at about 180° and returns as wire 2c. Wire 9c also loops on itself, through the loop formed by wires 1c and 2c, and returns as wire 10c. Six, eight or even more wires can be used, in a directing member combination, if the problem dictates such a construction.

Another embodiment of my invention is shown in FIG. VIII. For simplicity, this form reverts to the two-wire system of FIG. III. However, for greater effectiveness, the catheter 7 comprises two catheters or catheter sections joined together by a sleeve 12, which can be metal. The catheters are clamped to sleeve 12, fairly snugly, by elastic bands 11. In operation, if it is desired to curve the entering end of catheter 7 upwardly in the plane of the paper, and also away from the paper at a 40° angle, the right hand catheter, already in the body canal, will be grasped and held while the left hand catheter is revolved counter-clockwise on sleeve 12 through an angle of 40°. Wires 1 and 2 will turn with the left hand catheter, and ball 4 is moved to the left and ball 3 to the right, thereby pulling wire 1 and pushing wire 2. This will shift the position of the directing wire apex, and therefore move the entering end of the catheter to negotiate the turn. The entire structure then is pushed along the canal 6 past the turn. Then, balls 3 and 4 are returned to their original positions in the catheter, although the relative angular position of the catheter sections can be retained, if desired.

The embodiment of FIG. IX is similar to that of FIG. VIII, except that the catheters are placed approximately an inch apart on sleeve 12, whereas the catheters of FIG. VIII can abut each other. Also, a third manipulating member 5 is provided, but in this instance wires 1 and 2 do not pass through it. Further, the wires 1, 2 and 9F are not welded together at their entering end. Instead, wire 1 makes a 180° loop, parallel to the paper, and returns as wire 2. Wire 9F passes through this loop and has a small brush 16 attached to it. Assume that it is desired to take a biopsy at some inner spot in the body, and nowhere else. The catheter is placed in the body canal, in a manner similar to that described with reference to FIG. VIII. When the entering end of the catheter arrives at the suspected area, the right

5

hand catheter is slid to the left, on sleeve 12. This causes brush 16 to pass through the hole 8, which is positioned at the very end of the catheter. If ball 5 is revolved, it will revolve brush 16 and cause it to pick up cells. Now, all three wires are pulled out of the body, by disconnecting the left hand catheter from sleeve 12 while holding the right hand catheter in place. Then, the right hand catheter can be removed.

FIG. X shows an alternate construction for accomplishing this result. In this embodiment, a two wire system is provided, with brush 16 attached to the entering loop. After inserting the catheter to the suspected area, the left hand catheter and its manipulating balls 3 and 4 are moved to the right, by sliding the catheter on sleeve 12 while holding the right hand catheter in place. This moves brush 16 through hole 8, and if the left hand catheter and balls 3 and 4 are revolved, brush 16 will be revolved to pick up cells. Then, the right hand catheter is held in place while the left hand catheter, wires 1 and 2, and the manipulating balls 3 and 4 are removed. Finally, the right hand catheter can be removed.

In the embodiment of FIG. XI, the catheter is provided with a worm driven, clam shell type of pliers. One plier half 20 is attached to worm wheel 19, while the other plier half 21 is part of block 22. A double thrust bearing 17 is provided for worm 18 which is connected to wire 9G. By turning ball 5, the plier halves 20 and 21 can be brought together. Wires 1, 2 and 9G are spaced apart 120°, as shown in FIG. XIA, whereby the catheter can be manipulated, within the body, in the manner outlined with reference to the embodiment of FIG. V.

Turning now to the embodiment of FIG. XII, let it be assumed that a quantity of radium is to be placed in the body, at a certain place, and then beamed in a given direction for a given time. A lead lined metal box 23, containing a quantity of radium fixed to the bottom of the box, has a longitudinally threaded, sliding cover. Directing wire 9H is threaded into the cover through a double thrust bearing 24 provided on box 23. Wires 1 and 2 are fastened to box 23, spaced apart 120°, as shown in FIG. XIIA, whereby the catheter containing box 23 can be manipulated in the body using the method outlined with respect to the embodiment of FIG. V. Once the box is properly placed in the body, ball 5 is revolved to screw open the cover and expose the body to the radium beam. After the proper time has elapsed, ball 5 is rotated in the opposite direction to close the sliding cover, whereupon the entire structure is removed.

FIG. XII shows a catheter 7 applied to the treatment of an intussusception in an intestine. An inflatable bag 26, having a hollow center extending partially through the bag, is provided in catheter 7, along with a second inflatable bag 28 having a hole entirely therethrough. A pump line 27 extends into bag 26, and is provided with slack coils or loops, as shown. Wire 9 is fastened to bag 28, while wires 1 and 2, and pump line 27, pass through the hole in bag 28 and out to the operator. The catheter is inserted in the manner outlined in connection with FIG. V, with bags 26 and 28 deflated. When bag 26 is positioned to the right of the intussusception 25, and bag 28 to the left thereof, the catheter is held in position while balls 3 and 4 are moved to the right. This forces bag 26 out of the catheter, and into the intestine. Leaving wires 1 and 2 where they are, bag 26 is inflated to anchor it in position. Bag 28 then is inflated, through pump line 29, to anchor it in the intestine. Then, balls 3 and 4 are pushed to the right, while ball 5 is pushed to the left, which action unfolds the intussusception, as illustrated in FIG. XIV. Both bags 26 and 28 then are deflated, and the entire instrument removed.

FIG. XV illustrates the application of the catheter of my invention, to a situation outside of the body. Thus,

6

there is shown a plan view of a mine disaster in which the mine shaft is partially obstructed by debris, but with some passages provided through the debris, just as canals provide a passage through the body. Here, the catheter device is larger and stiffer than described above for body use. However, it still will be flexible. The directing wires will be larger, comprising for example spring steel .125 inch in diameter, with the last two inches at the entering end being .05 inch in diameter. The balls 3, 4 and 5 can be the size of a fist. Tube 7, which will be like a catheter, is first used as an orsat sample tube, proceeding toward men who might be trapped by the debris. Later, the tube can be used to pass air, water or liquid food. A sound speaker and receiver 30 can be provided at one end, while a sound sending and receiving device 31 is provided at the other end. In this case, the directing wires will not be soldered in the manipulating balls, but set screws will be used. The catheter tube 7, wires and all should have quick coupling connections at the operating end, so that extensions can be made, and each extension will have larger and stiffer wires.

For exploration of lateral cracks in an ocean bed, or tunnels in the earth, the telephone and orsat tube of FIG. XV can be eliminated, and a Geiger counter and sender can be provided. Then, the Geiger element can be located by radar triangulation from above. For fire fighting, the catheter will be covered with asbestos and a three wire system can be used to direct it to an area not easily reached. Water, and CO₂ can be sent through the catheter, to the otherwise inaccessible area.

Accordingly, it is seen that my invention fully accomplishes its intended objects, providing a catheter which is readily directed to negotiate a turn, in a construction which is adapted to other purposes.

Having fully disclosed and completely described my invention, and its mode of operation, what I claim as new is as follows:

1. In a device of the class described, a flexible tube having an entering end adapted for insertion into a passage, at least two flexible push-pull directing members extending along the interior of said tube substantially to said entering end thereof, said directing members being connected to each other at said entering end to provide a directing member apex within said tube at said entering end thereof, said directing members being movable relative to each other lengthwise of said tube for laterally shifting the position of said apex and thereby turning said entering end, and means remote from said entering end for so moving said directing members to selectively position said entering end, said means comprising at least two manipulating members independently movable relative to said tube, one of said directing members being fixed to one of said manipulating members for movement therewith relative to the other of said manipulating members and the other of said directing members being fixed to said other manipulating member for movement therewith relative to said one manipulating member, whereby said manipulating members can be moved relative to said tube and to each other to selectively push and pull said directing members and thereby turn said entering end.

2. A device as set forth in claim 1, wherein said manipulating members comprise ball members normally held against movement relative to said tube by frictional engagement with an inner wall surface thereof, said ball members being movable along said tube by squeezing the latter closely adjacent the former.

3. A device as set forth in claim 2, wherein said ball members have openings therethrough, said one directing member passing freely through an opening in said other ball member, and said other directing member passing freely through an opening in said one ball member.

4. A device as set forth in claim 1, wherein there are at least three directing members and three manipulating members the third directing member being fixed to the third manipulating member for movement therewith rel-

ative to the first two manipulating members, and the first two directing members being movable with the first two manipulating members relative to said third manipulating member.

5. A device as set forth in claim 1, wherein said tube comprises two sections, said entering end being part of one of said sections and said manipulating members being contained within the other of said sections, said other section being rotatable relative to said one section about the lengthwise axis of said tube.

6. A device as set forth in claim 1, wherein said manipulating and directing members are movable as a unit in opposite directions lengthwise of said tube.

7. A device as set forth in claim 1, wherein said directing members comprise spring wire members.

References Cited in the file of this patent

UNITED STATES PATENTS

2,498,692	Mains	Feb. 28, 1950
2,616,429	Merenlender	Nov. 4, 1952
2,975,785	Sheldon	Mar. 21, 1961

FOREIGN PATENTS

548,462	Great Britain	Oct. 12, 1942
---------	---------------	---------------

OTHER REFERENCES

Bard: "Urological Instruments," eighth edition, received in Patent Office Jan. 26, 1940, page 5, #348 required.