

Feb. 3, 1970

E. M. FOUNTAIN

3,492,996

VENTRICULO-ATRIAL SHUNT

Filed Feb. 9, 1966

2 Sheets-Sheet 1

Fig. 1

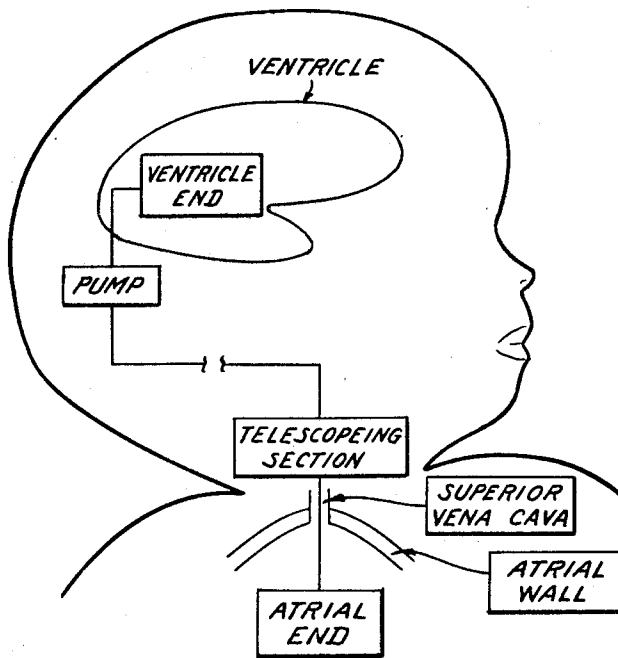


Fig. 2

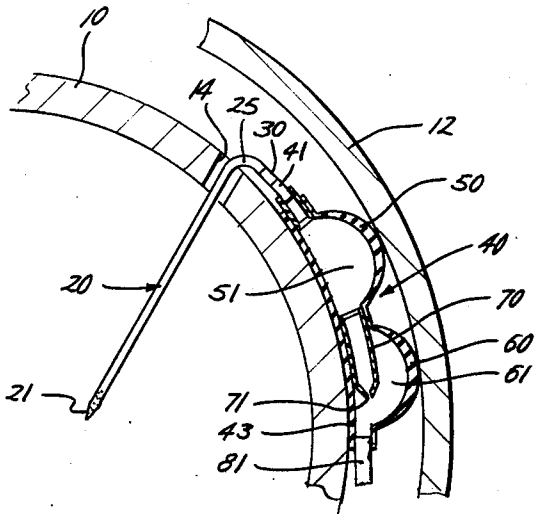
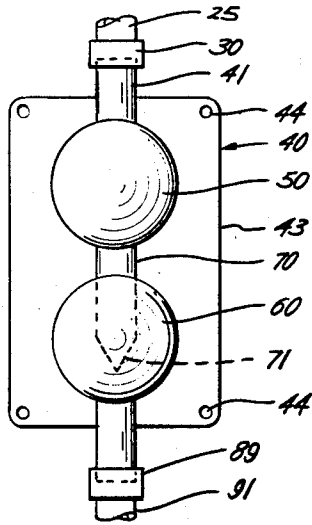


Fig. 3



Edmund M. Fountain
INVENTOR.

BY *Robert W. Birk*

ATTORNEY

Feb. 3, 1970

E. M. FOUNTAIN

3,492,996

VENTRICULO-ATRIAL SHUNT

Filed Feb. 9, 1966

2 Sheets-Sheet 2

Fig. 4

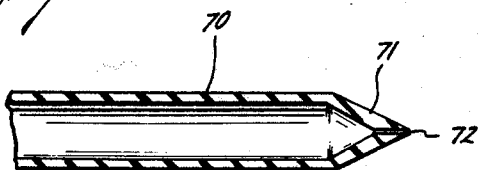


Fig. 5

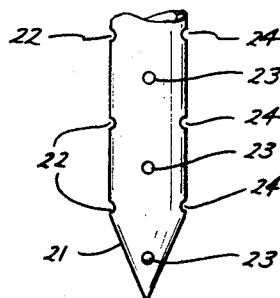


Fig. 6

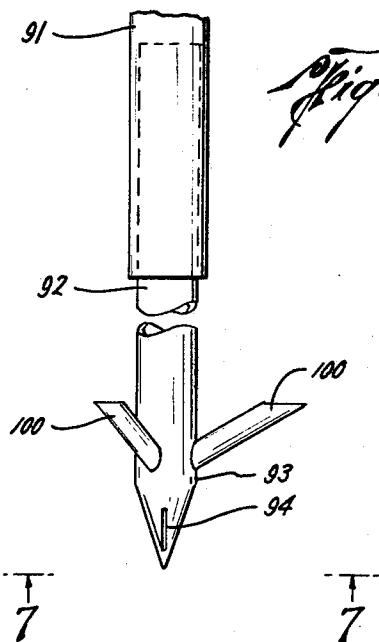


Fig. 7

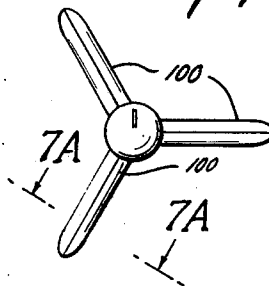
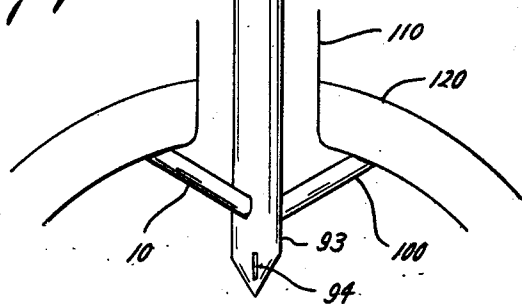


Fig. 7A



Fig. 8



Edmund M. Fountain
INVENTOR.

BY *Robert W. B. Dinkler*

ATTORNEY

1

3,492,996

VENTRICULO-ATRIAL SHUNT

Edmund M. Fountain, Houston, Tex., assignor to Dow Corning Corporation, Midland, Mich., a corporation of Michigan

Filed Feb. 9, 1966, Ser. No. 526,294

Int. Cl. A61m 27/00

U.S. Cl. 128—350

5 Claims

ABSTRACT OF THE DISCLOSURE

This application describes a surgically implantable device for relieving fluid pressure on the brain. The device comprises a ventricular conduit adapted for introduction into the brain, a pumping device attached to the ventricular conduit and an outlet conduit attached to the pumping device and adapted to be inserted into the atrium. The pumping device is a substantially flat, flexible plate adapted to overlie the skull and has a pair of bubble-shaped chambers positioned thereon and adapted for finger manipulation to provide pumping action to clear the conduits of obstructions. The outlet end of the device is provided with flexible wings adapted to hold the device within the atrium or center it in the vein entering the atrium in the event that the end is pulled from the atrium. One-way valves are provided to prevent blood back-flow into the brain.

This invention concerns a new and improved device for treating hydrocephalics, i.e., those persons, usually infants or children being afflicted with, as commonly described, water on the brain. Also, this condition may exist in certain adults whose circulation or absorption of cerebro-spinal fluid is impaired by various inflammatory or tumor processes.

More particularly this invention contemplates a means whereby secreted cerebro-spinal fluid may be directed into the blood stream and thereby throughout the normal course of the body system.

Normally, cerebro-spinal fluid is secreted by the choroid plexus and ventricular lining within the cranial ventricles. Such fluid may enter the vascular system by a route approximated by passing out of the lateral ventricles, through the third ventricle, out the foramina of Magendie and Lushka, into the cisterna magna whenceforth into the subarachnoid spaces and absorbed by the blood system. Such fluids may be absorbed and recycled several times daily.

With hydro-cephalics the cerebro-spinal fluid is unable to be absorbed adequately. Thus, on continued secretion, pressure increases greatly, causing the ventricles to swell or expand. As expansion occurs the wall material becomes thinned. Expansion occurs at the expense of brain substance, and fluids. Thus, in essence, the head becomes a box, closed save for incoming material.

Previous attempts to relieve the extreme pressures and return such cerebro-spinal fluid to the circulation have been fraught with numerous difficulties. For example, flushing of such earlier devices has proved difficult or frequently impossible, and the cardiac portion has not been permitted to lengthen with normal growth of the patient.

Thus, this invention has as its purpose the permitting of relieving of increased intra-cranial pressure by reintroducing cerebro-spinal fluid into the vascular system.

A further object is the provision of a device which may longitudinally extend so as to permit continuous utilization in a growing human.

Yet another object is the provision of means whereby the ventricular end may be flushed.

These and still other objects and benefits will become

2

apparent on considering the following appended description and drawings in which:

FIGURE 1 is a schematic representation of the relative positioning of the shunt ventricular and atrial ends, pump and telescoping portions;

FIGURE 2 is a section through a skull showing positioning of the pump mechanism and ventricular shunt relative thereto;

FIGURE 3 is an elevation of the pump mechanisms and connections thereto;

FIGURE 4 is a section through one end of the ventricular-atrial conduit.

FIGURE 5 is an enlarged elevation of the end of the ventricular portion of the shunt;

FIGURE 6 is an elevation of the telescoping portion and atrial end of the shunt;

FIGURE 7 is an end view of the shunt atrial end, taken along lines 6—6 of FIGURE 5, and

FIGURE 7a is a section taken along lines 7a—7a of FIGURE 7; and

FIGURE 8 is a section showing the placement of the shunt atrial end relative to the superior vena cava.

Looking first at FIG. 1, for an overall view of the operation of the device, the ventricular end of a shunt device is positioned within a cranial ventricle. Said shunt ventricular end is connected to a pump mechanism, later described, which may be inserted under the scalp. Said pump leads subcutaneously to a telescoping section of a conduit, and thereafter to the atrial end of a shunt, which atrial end is positioned within the atrium of the heart. Said atrial end may be inserted in the jugular vein, through an incision therein, pass therethrough and be prevented from being dislodged from the atrium through or to the superior vena cava by reason of projections near the terminal end of said atrial end.

Look now at FIGURE 2 which depicts the pump and the ventricular portion of the shunt. Said shunt refers to the conduits from either end of the pump. The skull of a person is indicated by the numeral 10, and the scalp by 12. An aperture is shown by 14, which may be a burr hole or even a perforator opening which is substantially smaller.

A ventricular shunt 20, which consists generally of thin flexible hollow conduit, preferably of silicone rubber, has one end 21 inserted within a cranial ventricle, which ventricle is under excessive pressure due to the buildup of cerebro-spinal fluid. Said one end possesses a number of perforations, with the perforations closely bunched and arranged preferably with each grouping being rotated 90° from the adjacent grouping and vertically spaced therefrom, as indicated by groups 22, 23, and 24, respectively (FIG. 5).

The other end 25 may pass through said skull opening 14, to be joined by connector 30, to the ventricular end 41, of pump 40. Said connector may be made of polyethylene, silicone rubber, nylon or other suitable material, and would have an aperture therethrough, communicating both with the ventricular shunt and with conduit-like end 41 of said pump.

The pump 40, actually would perform as a dual pumping mechanism in the following manner. A flexible base portion 43 possesses suture holes 44 for affixing said base to periosteum of skull 10. Spaced toward opposite ends of said base are hemisphere-like bubble portions 50 and 60, which define chambers 51 and 61, respectively, between said bubbles and said base. Actually, said bubbles serve as individual pumps in that each may be compressed so as to eject fluids present within their respective cavities outwardly thereof. Said conduit end 41 is shown to communicate both with ventricular pump 50 and with ventricular shunt 20, by virtue of connector 30. Also, pump 50 communicates with atrial pump 60 by virtue

of ventricular-atrial conduit 70. The atrial end 71 of said conduit terminates within chamber 61 of pump 60. Said atrial end may have a slit 72 formed therein which, in the absence of sufficient pressure against the adjacent walls, would normally be closed. Thus said conduit and slit would function as a one way valve preventing fluids from returning from chamber 61 to chamber 51, i.e., from the atrial shunt through the ventricular shunt thence back into the ventricle.

Atrial pump 60 is linked by conduit 81, by virtue of connector 89, similar to member 30, to the upper member 91 of atrial shunt 90 and communicates therewith by virtue of said conduit, connector and shunt being cylindrically conformed.

Said upper portion 91 will have a larger internal diameter than, and telescopingly receive lower portion 92, both portions consisting of tubing, preferably, again of silicone rubber. The telescoping portion of member 92 may be prevented from sticking by properly coating members 91 and 92.

FIGURES 6, 7, 7a and 8 depict said lower portion of the atrial shunt. The lower or atrial end 93 of member 92, includes one or more slits 94, again functioning as a one-way valve. Positioned closely adjacent thereto are a plurality of slightly upwardly directed, wing-like projections 100. Preferably there are three such projections spaced radially 120 degrees apart around the periphery of the end 93 of the atrial shunt.

It would be beneficial for the device to be substantially treated with a barium-containing substance so that on X-rays being taken, the exact location of all the parts thereof may be determined.

In actual use, ventricular shunt 20 would be inserted through cranial perforation 14 into a cranial ventricle, the brain being under considerable internal pressure. Cerebrospinal fluid would pass through apertures 22, 23 and 24 into the interior of ventricular shunt 20, therethrough, into cavity 51 of pump 50, thence through conduit 70, out one-way valve 72 into chamber 61 of pump 60. Said pump 60 may, by pressing down on the adjacent scalp, and thereby compressing the pump 60, cause such fluids to pass downwardly through conduit 81, connector 89 and into the upper member 91 of atrial shunt 90, from where it would pass through the atrial end 92 of said atrial shunt, out one-way valve 94, into the atrium from which location said fluids may eventually be absorbed into the blood system. Pressure on pump 50 would normally have the same effect. Normally, in the absence of obstructions or occlusions, said pumps would not need to be utilized, in that said fluids would follow the described route without needing assistance.

Normally the linkage from the pumping mechanism to the atrial end of the atrial shunt may be inserted underneath the skin. The lower member 92 of said atrial shunt 90 would be inserted within the jugular vein and course through the superior vena cava, pass downwardly there-through into the atrium. By virtue of projections 100, which may readily bend upwardly, so as to permit downward passage through said superior vena cava 110, said atrial end of said atrial shunt, may not return upwardly through vein 110, in that said projections 100 would rest adjacent atrial wall 120. This would tend to prevent scarring of the superior vena cava wall as well as thrombosis which might occur should member 92 be pulled back within vein 110, and be bound to the wall thereof by a membrane or clot. Even should said atrial end be pulled back within vein 110, said projections 100 would keep said atrial end centered in the stream of blood flowing through said vein, keeping the device operative. Positioning of atrial end 93 is permitted, even in growing children by virtue of the telescoping nature of members 91 and 92.

A further advantage permitted by this device is the flushing of the ventricular end of the shunt. Inasmuch as conduit 70 has a one-way valve 72 at one end, if pump 60 is depressed so as to close said valve, then pressure on valve 50 will tend to force fluids contained in cavity 51 and the ventricular shunt 20 back through the perforations in end 21. Thus, stoppages resulting from occlusion of the ventricular end, perhaps bits of brain matter, debris or clumped leukocytes may be overcome.

Although only a single embodiment of this invention has been described it should be apparent that numerous modifications would be possible by one skilled in the art without departing from the spirit of the invention. The scope of which is intended to be limited only by the following appended claims.

What is claimed is:

1. In a surgically implantable device for relieving excess pressure within the brain comprising a first fluid conduit means adapted for introduction of at least a portion thereof into a brain ventricle, a second fluid conduit means for fluid outlet, a pumping device positioned between said first and second conduit means and interconnecting the same, and a one-way valve positioned in the system to prevent fluid back-flow into the brain, the improvement which comprises:

said pumping device comprising a pair of hemisphere-like, bubble-shaped, thin-walled resilient chamber portions positioned in spaced relationship on a substantially flat, flexible base member, said base member defining the lower boundary of each of said chamber portions, each portion being adjacent to one of said conduits and intercommunicating therewith, said bubble-shaped chamber portions being interconnected by third conduit means including a one-way valve whereby when said pumping device is manipulated, the first conduit can be flushed to clear it of obstructions.

2. The improvement as defined in claim 1 wherein said third conduit means terminates within said chamber adjacent to said second conduit means.

3. The improvement as defined in claim 2 wherein said one-way valve in said third conduit means is provided with a slit which acts as a one-way valve.

4. The improvement as defined in claim 1 wherein: the terminal portion of said second conduit means, which is opposite the end to which said pumping device is connected, is provided with a plurality of wing-like, flexible projections adapted to rest against blood vessel walls of the patient and center the conduit in the flow of the blood.

5. The improvement as defined in claim 1 wherein: said flexible base member is provided with means for attachment of sutures thereto.

References Cited

UNITED STATES PATENTS

2,616,429	11/1952	Merenlender	128—350
2,969,066	1/1961	Holter et al.	128—350
3,020,913	2/1962	Heyer	128—350
3,111,125	11/1963	Schulte	128—350
3,108,595	10/1963	Overment	128—350
3,233,610	2/1966	Wade	128—350
3,288,142	11/1966	Hakim	128—350

OTHER REFERENCES

Lancet: vol. 2 (63), No. 7315, Nov. 9, 1963, pp. 983—984.

Rickham: Brit. Med. Jour., July 1964, p. 173.

Hakim - Valve System for Ventriculo-Atriostomy, Cords Corp. Publication dated Oct. 5, 1965, pp. 3 and 6—8 relied on.

DALTON L. TRULUCK, Primary Examiner