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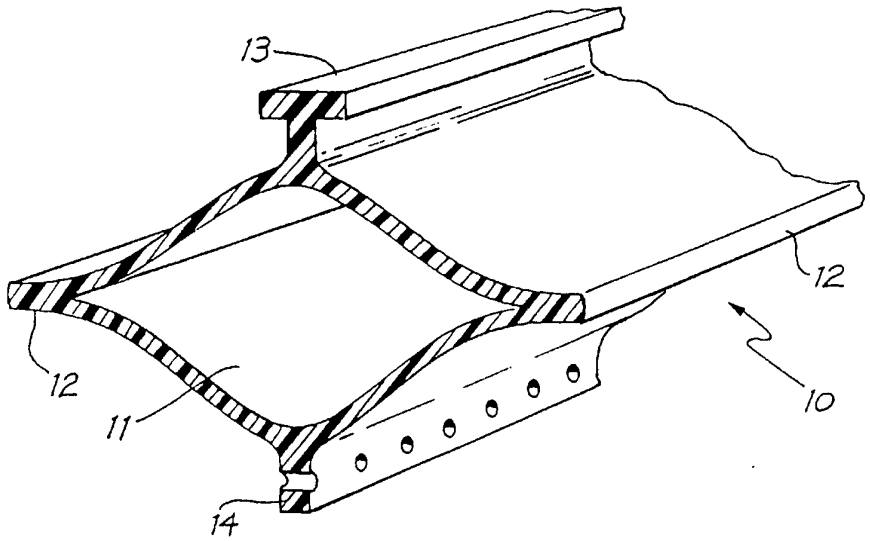
(54) Title: PERISTALTIC PUMP TUBE



(57) Abstract

A peristaltic pump element or tube (10) has flanges (13, 14) adapted to be gripped by a device which applies a force to the element or tube (10) to restore it to its fully open condition after the element or tube (10) has at least been partially collapsed by a pumping stroke.

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PERISTALTIC PUMP TUBE

Technical Field

The present invention relates to peristaltic pumping and more particularly to the form and function of the pumping tube or element employed in peristaltic pumps.

Background Art

Heretofore the pumping tube or element has been generally of a circular cross-section formed from plastics materials in medical applications and from rubber or neoprene for larger scale pumping such as in dealing with slurries as the scaling effects are detrimental to the use of plastics materials. An important aspect of the prior art pumping tubes has been the necessity to rely upon their natural resilience so that the tube, under its own action, returns to substantially its undeformed shape between pumping strokes.

With prior art pumping tubes or elements, particularly as used in harsh environments such as for the pumping of mineral slurries or sewage the element has had a limited life and so far proven uneconomic and also suffered problems in relying on the resilience of the material of the element to return to its undeformed shape after each pumping stroke.

Recent developments in this field have been undertaken by Joseph Bertony with Australian patent applications filed under numbers PM1246, PM3661, PM8258 and PM8115 in the name of Transportation Technologies Pty Limited. The Bertony peristaltic pump system induces peristaltic motion by the sequential application of positive and negative pressure to a flexible tubular membrane. The positive and negative pressure is applied to the membrane via a pressurising liquid chamber at each pumping station or element and there are typically six such pumping stations or elements connected in series. The positive hydraulic pressure applied to the exterior of

each membrane in sequence is followed by a reducing hydraulic pressure to provide a positive displacement force to the membrane to return it to its compressed shape.

The present invention aims to ameliorate the problems of the prior art and provide an alternative to the Bertony peristaltic pump in providing a pumping tube or element shaped so as not to be totally reliant on the natural resilience associated with the combination of shape and materials of the element to provide the necessary restoring force to return the element to its undeformed shape.

Description of the Invention

In a first aspect the present invention consists in a pumping tube or element adapted to be actively forced to return the element to its original shape after being at least in part flattened by a compressive force, said element comprising means adapted to be contacted by mechanical means to apply a restoring force to said element to return the element to its unflattened shape.

In a second aspect the present invention provides a pumping tube or element as aforesaid adapted to have forces applied in two orthogonal directions normal to the axis of the element via mechanical means to return the element to its uncompressed shape.

In a still further aspect the present invention provides a peristaltic pumping station comprising a pumping tube or element of the first aspect wherein mechanical means are adapted to grip opposed surfaces of the element, at least when the element is in an at least partially flattened condition, and apply oppositely directed forces to the element to return the element to its unflattened shape.

In yet another aspect the present invention provides a peristaltic pumping station of the further aspect comprising a pumping tube or element of the second aspect wherein there are means for mechanically applying forces

laterally of the gripped opposed surfaces in conjunction with the oppositely directed forces applied to the element.

One embodiment of the present invention provides a tubular element of a generally double convex lens-shaped cross-section, said element having laterally projecting flanges extending axially of the tube, and preferably a pair of flanges or ribs projecting from the tube in a plane substantially orthogonal to a plane containing the lateral ribs or flanges.

In a second embodiment of a pumping element there is provided a tubular element of a generally flattened or convex - convex lens shaped cross section having means for gripping opposed convex surfaces to separate those surfaces under the action of mechanical force applying means.

Brief Description of the Drawings

The present invention will now be described by way of example with reference to the accompanying drawings, in which:-

Fig. 1 is an isometric view of a section of a first embodiment of a pumping element in accord with the present invention;

Fig. 2 is a schematic sectional view of a mechanical recovery system of a peristaltic pump of a first pump embodiment acting on a pumping element in accord with Fig. 1;

Fig. 3 is a schematic sectional view of a shape of pumping roller of a peristaltic pump interacting with a flange of the element of Fig. 1;

Fig. 4 is an exploded view of components of a second embodiment of a peristaltic pump of the invention;

Fig. 5 is a perspective view of the assembled pump of Fig. 4 exclusive of the pumping element;

Fig. 6 is a cutaway and partial cross-sectional view of the pump components of Fig. 4;

Fig. 7 is a partial cross-sectional view of the pump

of Fig. 5 showing the pump element in its flattened state; and

Fig. 8 is a similar cross-sectional view of Fig. 7 but showing the pump element in its opened state; and

Fig. 9 is a perspective view of a modified version of the pump of Fig. 5 having two pumping elements.

Best Modes

The embodiment of a pumping element 10 as shown in Fig. 1 comprises a lens-shaped tubular section 11 comprising lateral flanges 12 and top and bottom flanges 13, 14 respectively.

In use the element 10 is fitted within a bed 18 of a peristaltic pump which is shaped so that the bed grips the lower flange 14.

As shown schematically by Fig. 3 a peristaltic pumping roller 20 contacts element 10 and compresses it by contacting the upper surface of section 11 and the top of flange 13. After a pumping stroke by roller 20 there follows a restoring action on the element 10 as shown schematically in Fig. 2.

Referring now to Fig. 2 restoring forces are applied to element 10 by means of lateral rollers 15 travelling along element 10 in contact with flanges 12 to impart a lateral restoring force to element 10 while flange 13 is drawn upwardly by mechanism 16 travelling along flange 13 which is formed as a rail shape whereby rollers 17 contact the underside of lateral projections of flange 13 and mechanism 16 imparts a vertical force to element 10 as shown in Fig. 2 to draw the upper surfaces of section 11 away from the lower surfaces which are restrained by means of flange 14 within the pumping bed 18.

Other specific forms of pumping tube or element can be readily envisaged having regard to this disclosure once it is understood that such an element is not reliant upon the inherent resilience of the material from which it is

made nor its shape to achieve the required restoring action after a peristaltic compressive pumping stroke and that positive restoring forces are to be applied to the element after each compression of the element.

The second embodiment of a peristaltic pump and its associated pumping element is shown in Figs. 4-8. The pump 40 comprises a pump body or bed 41 for the pumping element 42. An oscillating pumping disc 43 fits into body 41 with the element 42 sandwich between the body and the disc. A rotatable armature 44 comprising three radial arms 45 is mounted in the body 41. Two arms 45 project radially of the armature 44 on a common circle while the third arm 45 is axially displaced relative to those two arms. That axial displacement of arms 45 can best be seen in Figs. 5 and 6 with Fig. 5 demonstrating the fitment of disc 43 on armature 44 such that two radially arms 45 on a common circle are on one side of disc 43 while the other arm 45 which is axially displaced is on the other side of disc 43 thereby providing the disc with a permanent slant relative to the axis of the armature and the body 41. The components shown in Fig. 6 display armature 44 in side elevation; element 42 in side elevation with diametrical sectioning of the tube; and body 41 with disc 43 in composite sectional and cutaway view.

The ends of arms 45 are mounted with low friction rollers 46 which, when the armature 44 is rotated in the configuration as shown in Fig. 5, causes disc 43 to oscillate relative to the axis of pump body 41. That oscillation of disc 43 provides a rolling and not sliding contact motion against the element 42 so as to impart a wave like compressive force to the element 42 as armature 44 is rotated.

Element 42 comprises a tubular passage 47 with inlet 48 and outlet 49 extending out of body 41 through opening 50 in the body. Bulbous projection 60 on the disc 43

rocks into and out of opening 50 to progressively open passage 47 on the outlet 49 and close passage 47 on the inlet 48 as disc 43 is acted upon by rotating armature 44.

So as to provide a positive restoring force to open bore 47 of element of 42 as disc 43 oscillates under the action of armature 44 element 42 comprises a plurality of projections 51 in opposed pairs circumferentially around opposite sides of element 42. Projections 51 on the side of body 41 are clamped to body 41 by passing through respective bores 52 with each such projection 51 being retained by means of a washer 53 and split pin 54 as shown in Figs. 7 and 8. Projections 51 adjacent disc 43 are each retained in the disc by means of a radially projecting bolt 55 in the manner shown in Figs. 7 and 8.

Various means are contemplated for clamping opposite sides of element of 42 between discs 43 and body 41 and in another form projections 51 could be held by having projections 51 extending further out through body 41 with each having a coil spring fitted between washer 53 and body 41 around each projection 51.

In a still further embodiment the peristaltic pump of Figs 4-8 can be formed so as to provide a peristaltic pumping action to two elements 42 by providing the arrangement of Fig. 5 with a further pump body 41 inverted and fitted to the structure as shown in Fig. 5 with a second element 42 mounted between that further body and disc 43. For a two element pump of this kind the disc angles at the periphery of disc 43 must be the same relative to the plane of the disc to effect essentially the same pumping action in each element 42. In that way a single disc 43 and armature 44 can provide a pumping action to two elements 42 instead of only one as shown in the embodiment of Figs. 4-8.

In a further embodiment the armature 44 is axially moveable so as to adjust the displacement between disc 43

and the body 41 thereby varying the degree of compression applied to element 42. As shown in Fig. 7 element 42 is compressed to its maximum whereas movement of disc 43 away from the bed of body 41 under the action of axial movement of armature 44 would reduce the amount of maximum compression applied to element 42. By adjusting the amount of maximum compression applied to element 42 the pump may be more suitable for movement of slurries or semi-solids containing particles which would otherwise clog or damage bore 47 of element 42.

Industrial Applicability

As can be seen from the embodiments the rolling motion applied to the pumping tube or element can be provided in a linear form as depicted in the embodiments of Figs. 1-3 or in a circular form as shown in the embodiment of Figs. 1-8. If a sliding motion to any substantial extent is applied to the pumping element the induced friction may lead to premature damage of the element and lead to more regular replacement of those elements.

As is also apparent from the embodiments there is ease of maintenance and repair and replacement of the pumping element in view of the ease of connection and removal of the element from the depicted pumping bodies.

By reason of the characteristics required of the present invention it will be further understood that materials heretofore considered inappropriate for use in the manufacture of peristaltic pumping tubes may be viable. The need to rely on the inherent characteristics of the material and the shape of tube are markedly less significant so a materials having a significantly longer service life but which could not be used in prior art arrangements may be able to be employed thus substantially improving the overall economics of peristaltic pumping. By being able to employ different materials for the tube

or element, peristaltic pumping may become available for the transport of chemically active or abrasive substances.

In a preferred form the tubular element may be produced from a polyurethane material in place of the currently used rubber or neoprene materials.

It is anticipated that by selecting suitable materials and appropriate designs that a pumping tube or element can be produced which is able to be operated with fluids at higher temperatures and pressures than heretofore, for example at pressures up to 100 Bars. By reason of the active deformation to return the tube to its undeformed shape an immediate suction can be applied to the tube in contrast to tubes which are reliant upon their natural resilience to return to their undeformed shape.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit, scope or principle of the invention as broadly described. For example, the cross-sectional shape of the pumping tube or element is of no particular importance other than it must be able to satisfy the functional requirements of the invention. The present embodiment is, therefore, to be considered in all respects as illustrative and not restrictive.

CLAIMS:

1. A pumping tube or element adapted to be actively forced to return the element to its original shape after being at least in part flattened by a compressive force, said element comprising means adapted to be contacted by mechanical means to apply a restoring force to said element to return the element to its unflattened shape.

2. A pumping tube or element as claimed in claim 1 adapted to have forces applied in two orthogonal directions normal to the axis of the element via mechanical means to return the element to its uncompressed shape.

3. A pumping tube or element as claimed in claim 1 or 2 having the general cross-sectional shape of a double convex lens when in its uncompressed shape.

4. A pumping tube or element as claimed in claim 3 comprising a first pair of opposed laterally projecting flanges extending axially of the tube.

5. A pumping tube or element as claimed in claim 4 comprising a further pair of opposed laterally projecting flanges extending axially of the tube, the plane containing said further pair of flanges being orthogonal to the plane containing the first pair of flanges.

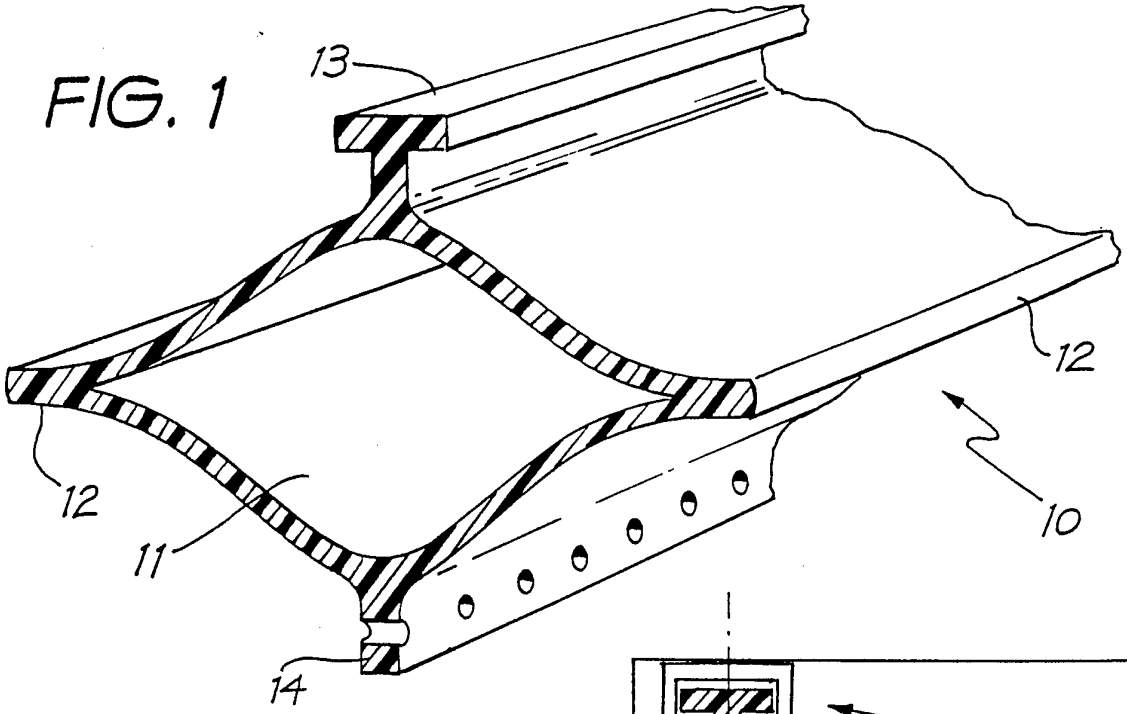
6. A pumping tube or element as claimed in any one of claims 1-4 comprising opposed laterally extending projections adapted to be mutually displaced to return the element to its uncompressed shape.

7. A peristaltic pumping station comprising a pumping tube or element as claimed in claim 4 wherein mechanical means are adapted to grip the first pair of flanges of the element, at least when the element is in an at least partially flattened condition, and which mechanical means apply oppositely directed forces to the element to return the element to its unflattened shape.

8. A peristaltic pumping station as claimed in claim 7

comprising a pumping tube or element as claimed in claim 2 wherein there are further mechanical means for applying forces laterally of the gripped opposed surfaces in conjunction with the oppositely directed forces applied to the element.

FIG. 1



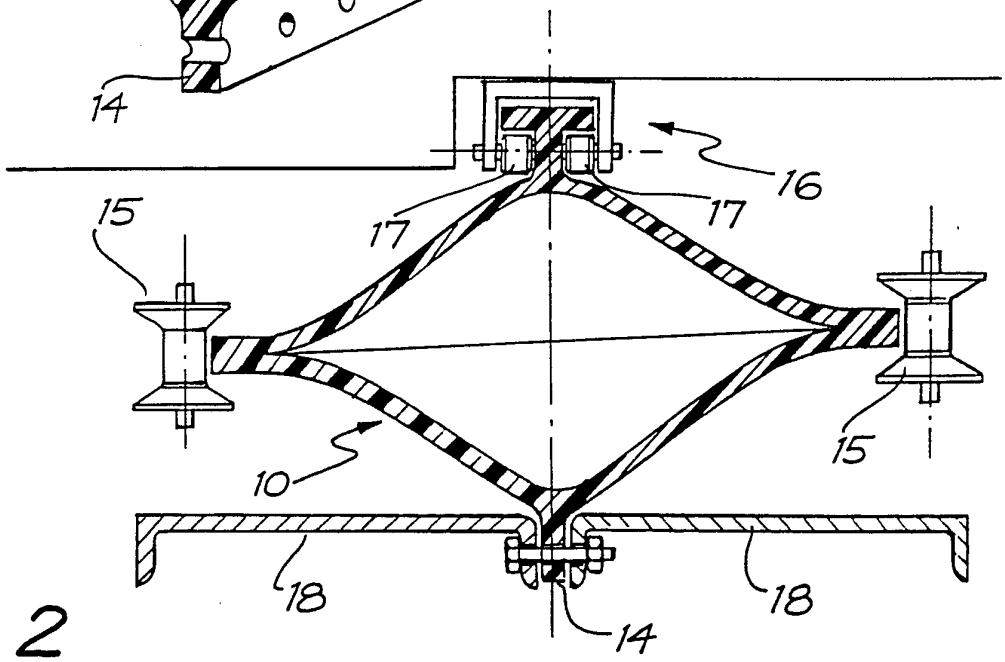


FIG. 2

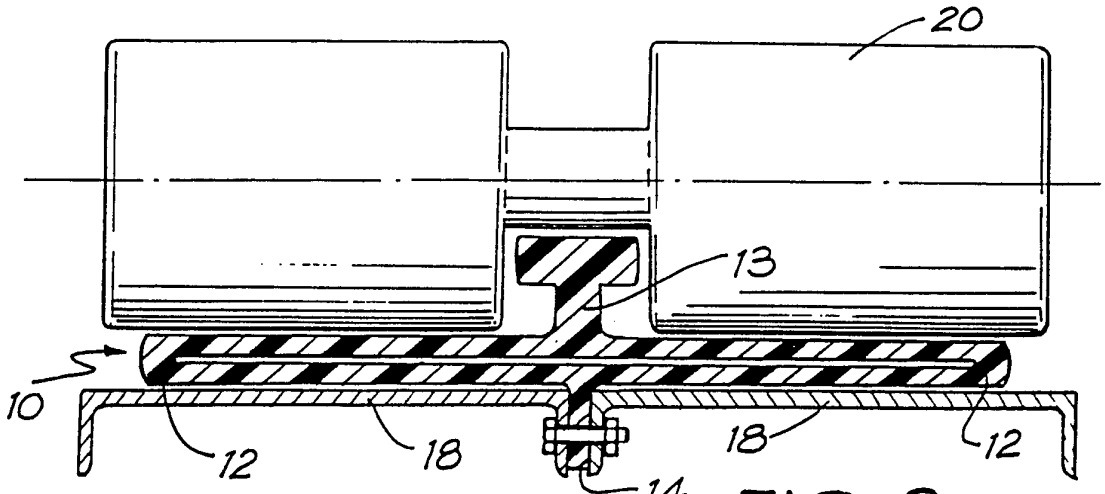


FIG. 3

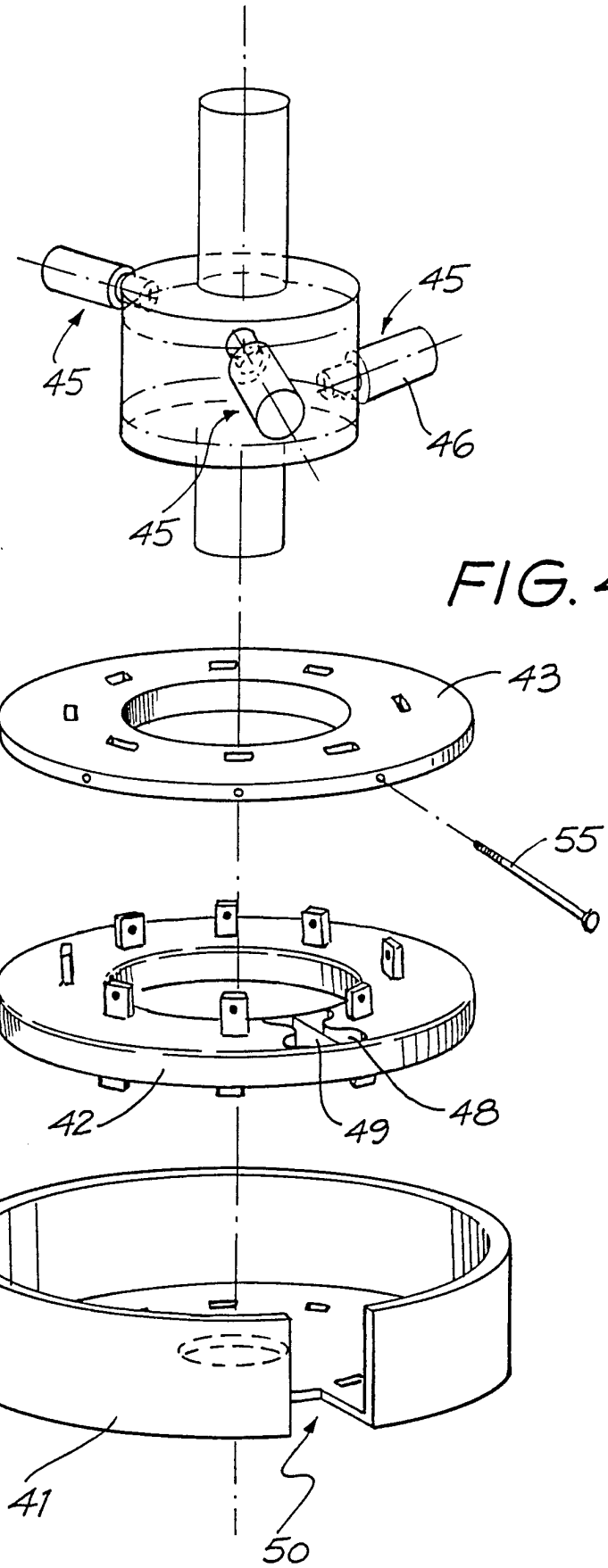


FIG. 4

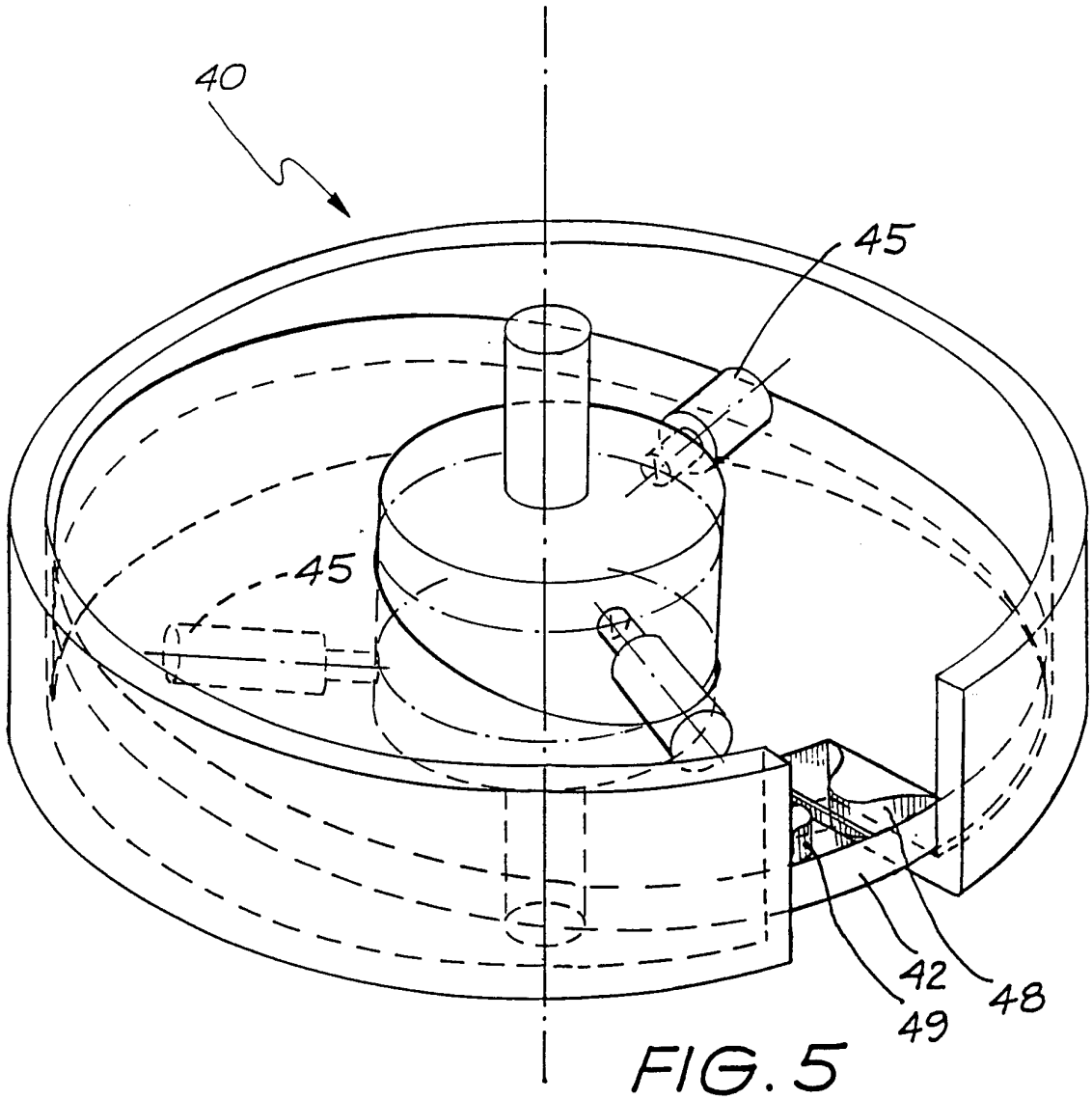


FIG. 5

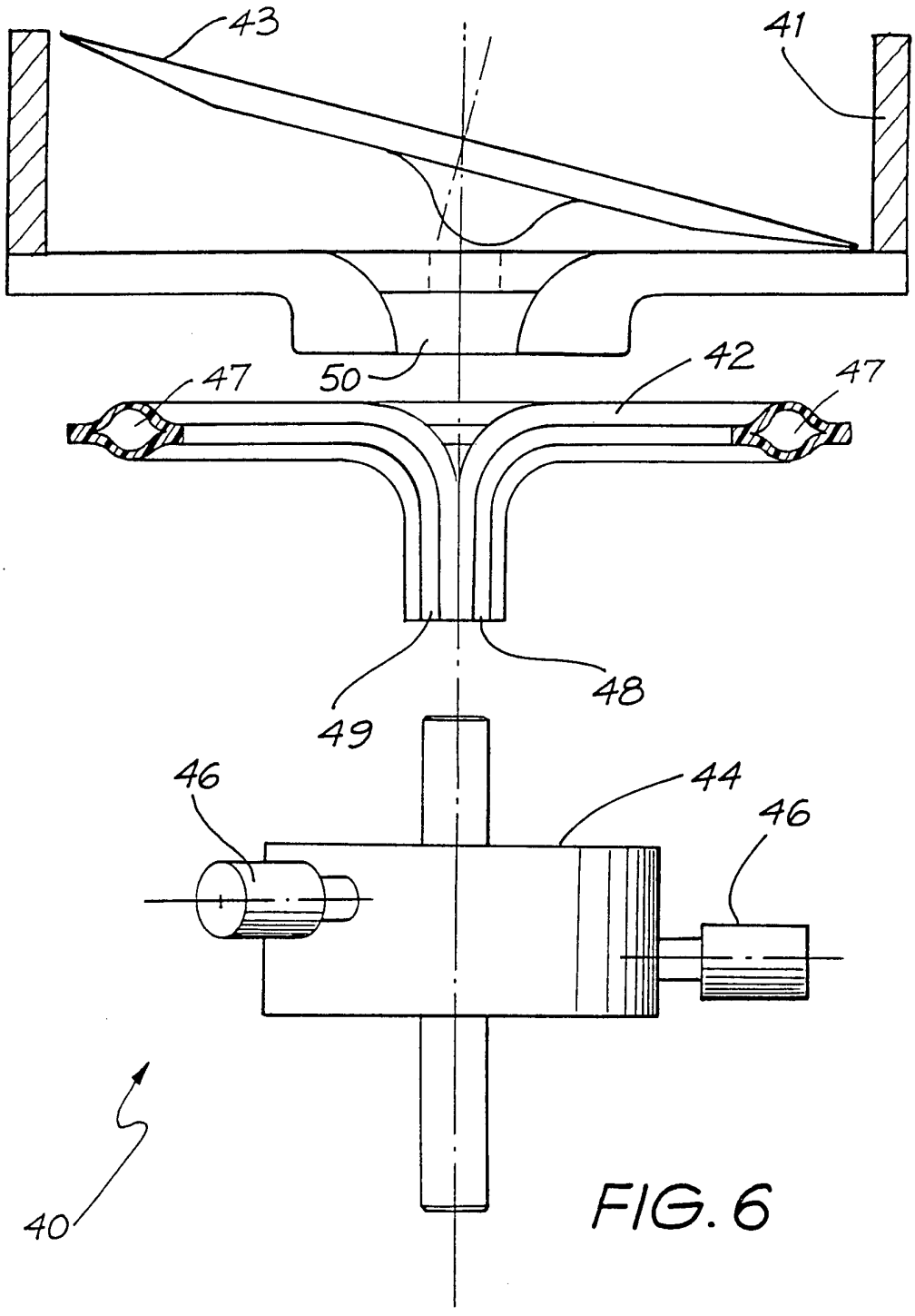


FIG. 6

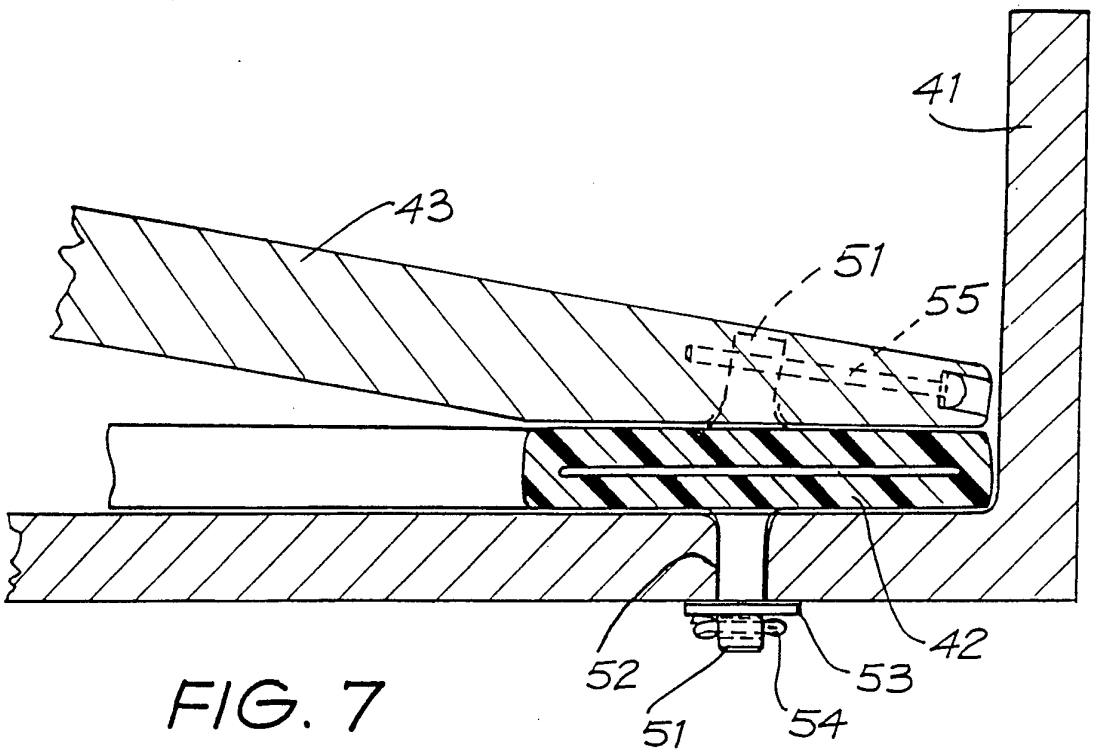


FIG. 7

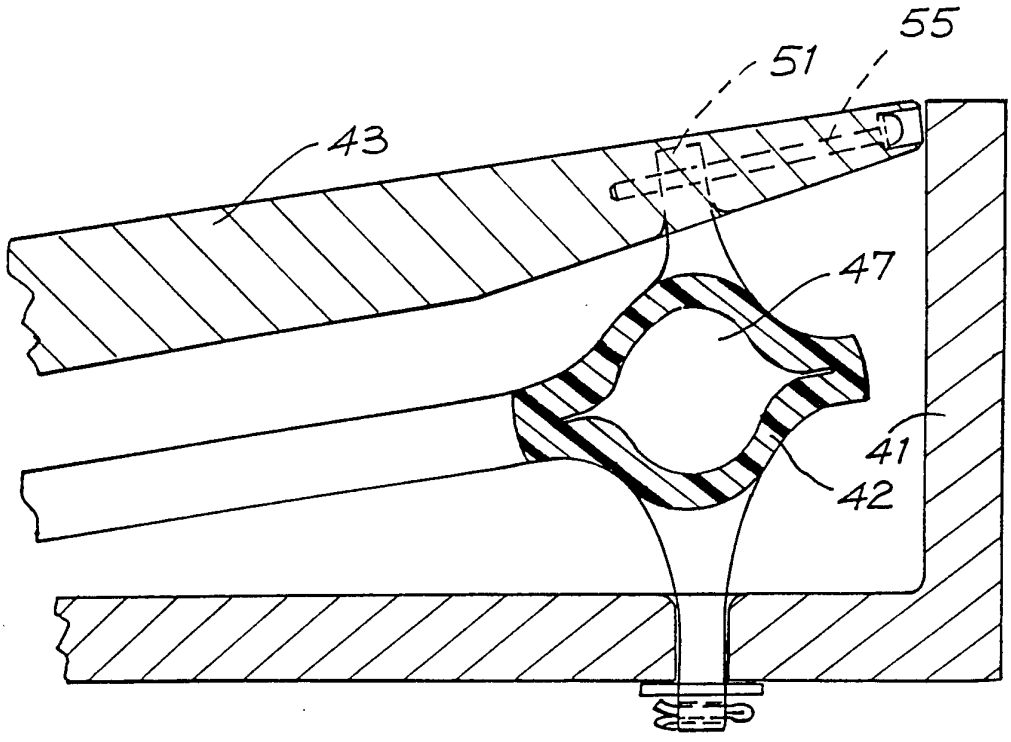


FIG. 8

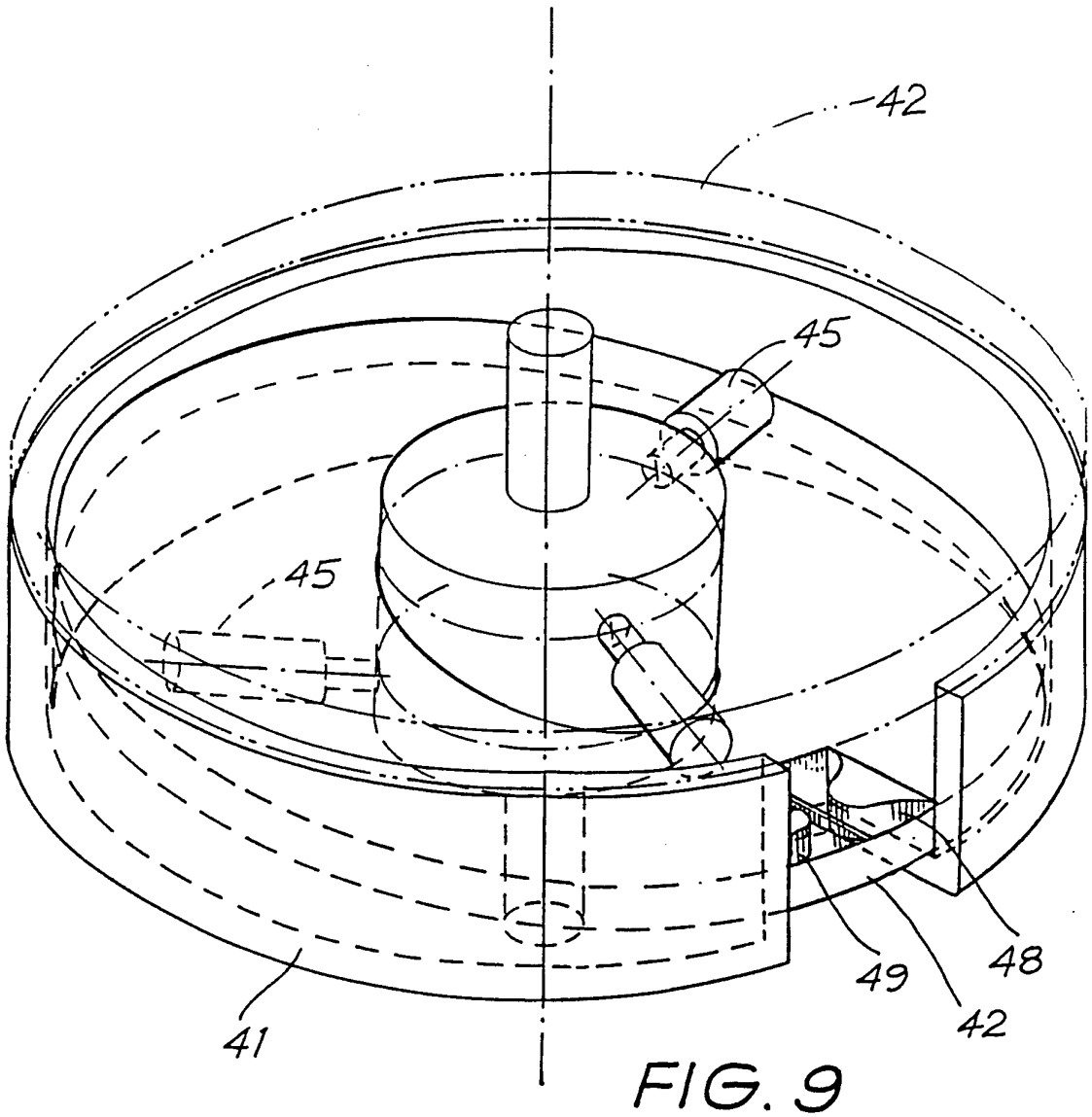


FIG. 9

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU 94/00632

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.[6] F04B 43/08, 43/12

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC F04B 43/08, 43/12

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
	US,A, 2930326 (SIMER et al.) 29 March 1960 (29.03.60)	
X	column 2, line 30-column 4, line 64	1-2, 4-8
	US,A, 4936760 (WILLIAMS) 26 June 1990 (26.06.90)	
X	abstract and drawing figures 1a and 2	1, 3-4, 6
Y	abstract and drawing figures 1a and 2	7
	GB,A, 2179404 (ROBERTSON) 4 March 1987 (04.03.87)	
X	page 3, lines 62-123	1
Y	page 3, lines 62-123	7

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[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	**Citation of document, with indication, where appropriate of the relevant passages**	**Relevant to Claim No.**
X	Derwent Abstract Accession No. 87-269431/38, Class Q56, SU,A, 1288344 (MINSK MINING EQUIP) 7 February 1987 (07.02.87) abstract	1, 3-4, 6-7
X	DE,A, 2708277 (NIKKISO EIKO CO LTD) 31 August 1978 (31.08.78) page 10, line 3-page 11, line 4	1
X	Patent Abstracts of Japan, M995, page 107, JP,A, 2-104990 (KINGO MISU) 17 April 1990 (17.04.90) abstract	1
A	FR,A, 2394695 (SERMEM S A) 1 January 1979 (12.01.79) whole document	

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Patent Document Cited in Search Report		Patent Family Member	
FR	2394695	CH	609427

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