United States Patent [19]

Thomas

[11] **3,876,340**

[45] **Apr. 8, 1975**

[54] **PERISTALTIC PUMP HAVING PIVOTAL REACTION MEANS**

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[22] Filed: **Aug. 9, 1973**

[21] Appl. No.: **386,883**

[30] **Foreign Application Priority Data**

Aug. 9, 1972 United Kingdom 37078/72

[52] **U.S. Cl.** **417/475**; 417/477

[51] **Int. Cl.** .. **F04b 43/08**; F04b 43/12; F04b 45/06

[58] **Field of Search** 417/475, 477

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[57] **ABSTRACT**

A peristaltic pipe in which there are several side-by-side flexible pumping tubes each having its own set of pumping rollers which are moved sequentially into a tube flattening position, along the tube for a predetermined length and then cut out of contact with the tube to perform the pumping action. Each tube has its own support against which it is pressed by the rollers and the support is resiliently yieldable in order to avoid placing excess flattening pressures on the tube.

In a preferred case, each support is a spring loaded block which may be of resilient material, each set of rollers is carried on a rotatable spider, and the spiders are rotatable simultaneously.

3 Claims, 7 Drawing Figures

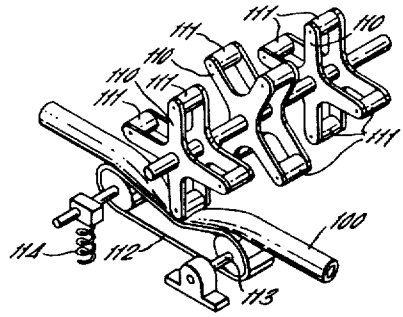


FIG. 1.

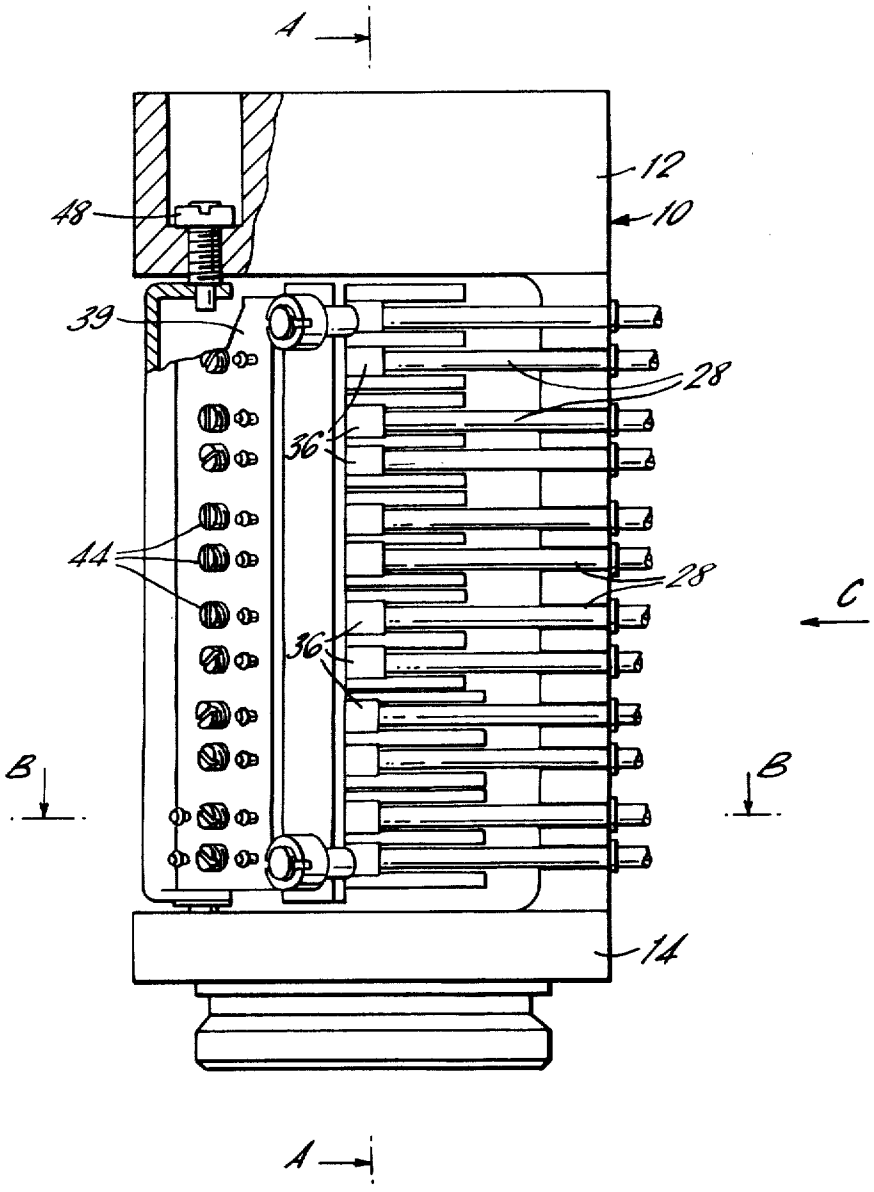


FIG. 2.

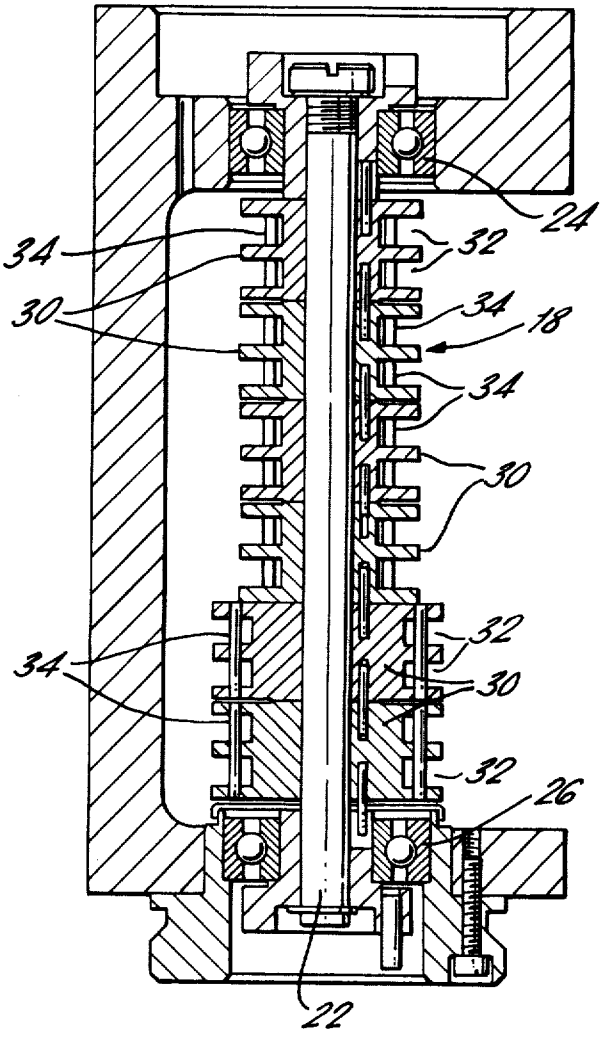


FIG. 3.

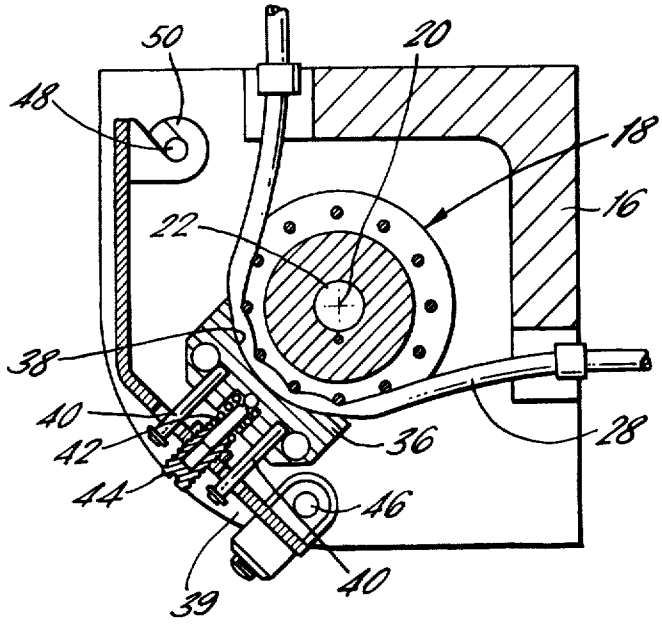
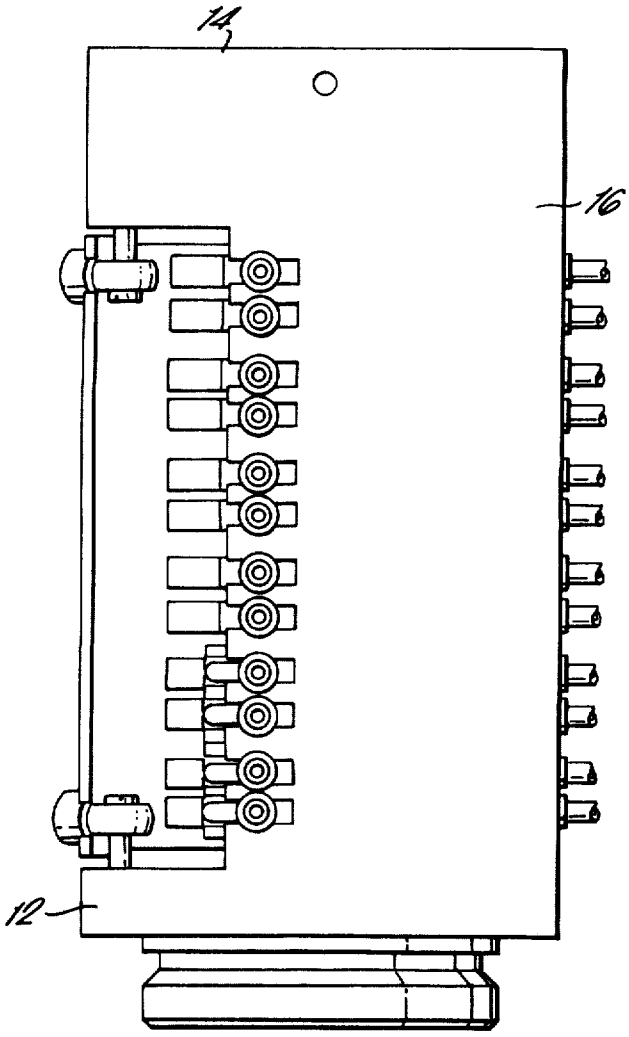


FIG. 4.



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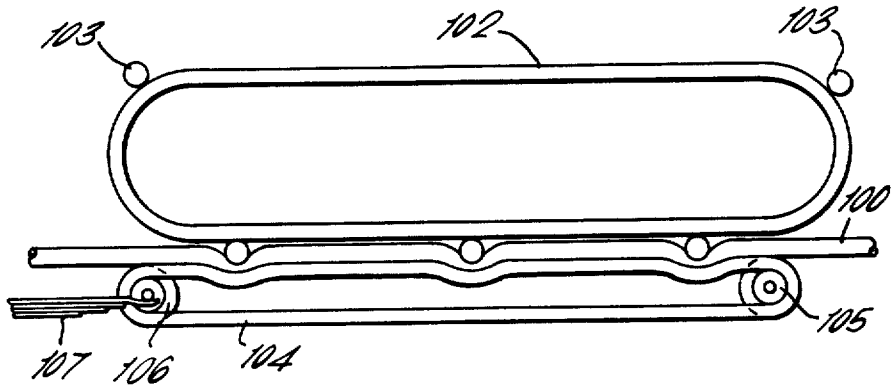


FIG. 6.

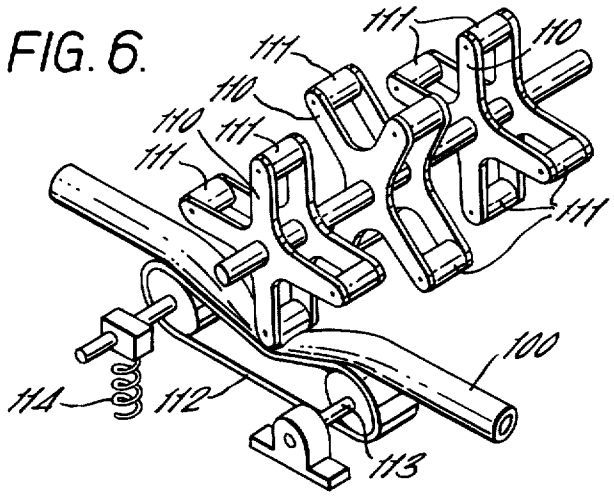
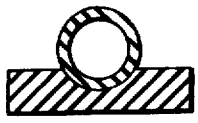


FIG. 7.



PERISTALTIC PUMP HAVING PIVOTAL REACTION MEANS

BACKGROUND OF THE INVENTION

This invention relates to peristaltic pumps of the type comprising several flexible pumping tubes which are disposed side by side in parallel planes. Rollers are used to perform the pumping action by being moved sequentially into contact with the tubes to flatten the tubes, along the tubes for a predetermined length and out of contact with the tubes. Such pumps are used for the mixing of different liquids which are pumped by the different tubes of the pump to a mixing station.

DISCUSSION OF THE PRIOR ART

One known form of peristaltic pump arranged for pumping several liquids simultaneously and mixing them in a predetermined proportion, comprises several deformable tubes disposed side-by-side each in the path of a succession of movable rollers, each arranged to flatten the tubes simultaneously over a short length against a rigid support and to advance the flattened simultaneously and unidirectionally along the tubes. This known pump has several disadvantages. In particular, when the several liquids are to be mixed in proportions other than equal proportions, the tubes have to be of different diameters, the cross sectional areas being in the proportions the liquids are to bear to one another. When several tubes of different diameters are flattened simultaneously by the same roller, difficulties arise because each tube when flattened by the roller tends to wrap itself around the roller and force the roller to rotate at a speed which will eliminate slip against that tube. As the different diameter tubes try to impose different rates or rotation on the roller, the result is some degree of slip between each tube and the roller. Furthermore, it is also difficult to squeeze flat several tubes of different diameters simultaneously against a rigid support without the use of excessive pressures. This is possible if the wall thicknesses of all the tubes of different diameters are identical, but such identity of as many as 12 tubes is very difficult to achieve, and indeed because the attraction of the peristaltic pump is that it is cheap and simple, efforts to create identical wall thicknesses of the tubes would detract from the desirable features of the pump, usually, therefore, the excess pressures are tolerated.

Wrapping of the tubes around the rollers and high pressures on the tubes result in high wear on the tubes. Furthermore, the high pressures mean high operating torques. Under such conditions the tubes rapidly lose their full powers of restitution so that there is a rapid decrease in the volume delivered by the pump at any given speed.

In one proposal to eliminate or reduce the aforesaid wrap around, large roller diameters have been used, but large rollers pose their own problems. For example, a large roller flattens the tube over a comparatively long length producing comparatively long interruptions and hence surges in liquid flow as the flattened portion fills up each time the roller leaves the tube. Such interruptions and the resultant surges occur simultaneously in several tubes compressed simultaneously and can result in severe surging in the line receiving the delivery from all the tubes.

OBJECTIVES OF THE INVENTION

It is a main object of the invention to provide a peristaltic pump in which excess pressures on the pumping tubes is avoided.

It is a further object of the invention to provide a peristaltic pump in which slip between individual tubes and the pumping rollers is avoided.

It is yet another object of the invention to provide a peristaltic pump in which the relative proportions of liquids delivered by the pump can be changed without the necessity of having to utilize tubes of different diameter.

It is a still further object of the invention to provide a peristaltic pump which is of simple construction capable of being easily dismantled and is capable of having components interchanged easily.

These and other objects of the invention will appear more clearly from the description of the several embodiments of the invention illustrated in the accompanying drawings.

BRIEF DESCRIPTION OF THE INVENTION

A peristaltic pump according to the invention incorporates several side-by-side deformable tubes located in parallel planes, several sets of rollers, one set for each tube, the rollers of each set being arranged to be brought into successive moving contact with the associated tube whereby each roller flattens the tube over a portion, and is moved unidirectionally along the tube and is removed from the tube and several reaction means, one for each tube, each rotation means presenting a resiliently yieldable surface which is located to act as an abutment against which the tube will be pressed by the associated rollers.

Preferably, each reaction means includes a block which is spring urged to engage the associated tube. The block preferably is of resilient material and the yieldable surface may be curved to conform to the cross sectional shape of the tube which it engages.

Alternatively, each reaction means may be defined by a belt of which a face thereof forms the yieldable surface, such belt being spring urged into contact with the associated tube. The belt may be endless and may be supported for pivotal movement about a pivot axis, the spring urging being obtained by means of a spring means acting on the belt at a point spaced from said axis.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of a peristaltic pump according to a first embodiment of the present invention;

FIGS. 2 and 3 respectively are sectional side and end views of the pump shown in FIG. 1, the sections being taken on lines A—A and B—B respectively in FIG. 1;

FIG. 4 is a side view, looking in the direction of arrow C in FIG. 1, of the pump shown in FIG. 1;

FIG. 5 is a diagrammatic side view of a peristaltic pump according to a second embodiment of the invention;

FIG. 6 is a diagrammatic perspective view of part of a peristaltic pump according to a third embodiment of the invention; and

FIG. 7 is a sectional view illustrating an arrangement of a tube and its reaction means which can be utilized in any of the three embodiments of the invention illustrated in the drawings.

Referring to the drawings, and firstly to FIGS. 1 to 4, the peristaltic pump comprises a casing 10 made up of two spaced end plates 12, 14 which are connected by an L-sectioned cross bar 16 so as to define a cavity in which is housed a rotar assembly 18 which is rotatable about axis 20 defined by a shaft 22. Shaft 22 which forms part of rotary assembly 18 is carried by bearings 24, 26 in plates 12, 14 respectively, and the shaft is adapted at an end to be rotated by a suitable prime mover.

The flexible tubes of the pump are illustrated by the reference numeral 28 and it will be observed that in this embodiment of the invention there are twelve such tubes 28 arranged side by side in parallel planes.

Each tube 28 has its respective ends connected to the respective legs of the cross bar 16 by being located in slots in the extremities of such bar 16, and each tube furthermore, as shown, is curved and extends round the shaft 22.

The shaft 22 carries six spiders 30, each being in the form of a bush having twin, parallel circumferential grooves 32. Extending between the opposed side walls of each such groove are freely rotatable rollers 34 which for each spider are located on a pitch circle of the spider 32 and are equi-angularly spaced.

The tubes respectively are located in the 12 grooves 32 and it will be appreciated that, for this pump, the tubes are arranged in six pairs, one pair for each spider 30, and the tubes of each pair will normally carry the same liquid. The spiders 30 however may be of the same of differing sizes, and the rollers 34 of different spiders may be differently spaced depending upon the proportions of liquid components to be pumped. The spiders 30 are removable from shaft 22 and can be replaced by different sized spiders for the pumping of different liquids or proportions of liquids.

The rollers 34 in performing the pumping action, press the tubes 28 against individual reaction means, one for each tube 28, in the form of reaction blocks 36. Each block 36 presents a surface 38 which engages the associated tube 28 and whic is yieldable radially away from shaft 22 as the block 36 is slidably mounted on a carrier frame 39 common to all blocks, by two pins 40 disposed generally radially with respect to the shaft 22 and a compression which 42 reacts between the block 36 and frame 39.

The surface 38 is curved to follow the curvings of the associated tube due to its extending round shaft 22. The spring 42 engages an adjustable plug 44 on the carrier frame 39 and adjustment of the plug 44 adjusts the compression of spring 42 and hence the force with which the block 36 is pressed against the associated tube 28.

The frame 39 is hingedly mounted on casing 10 at hinge pivots 46 and can be swung clear of te tubes 28 by releasing a dawel pin 48 from a slot in a holding lug 50 of the frame 39, whereby the blocks 36 can be repaired, removed and replaced. Heads 40A of pins 40 prevent the blocks 40 from springing from the frame 39 when it is hinged away from tubes 28 as described.

In operation of this embodiment of the invention, the ends of tubes 28 are connected to supply and delivery tubes for the liquids to be pumped and shaft 22 and the spiders 30 are rotated. The liquids are pumped in conventional peristaltic manner but each pair of tubes 28 has its own rollers and each tube has its own reaction means, avoiding on the one hand the relative slipping between roller and tubes where a single roller flattens several tubes, and, as the reaction block 36 can yield resiliently away from the shaft 22, the need for excess pressure (and hence excess torque) to perform the pumping action.

It should be noted that either set of ends of tubes 28 can be the delivery or intake ends depending upon the direction of rotation of shaft 22.

In the embodiment of the invention illustrated in FIG. 5, the tubes 100 of the pump are arranged in straight disposition and are parallel. In FIG. 5, only one tube 100 is shown. The rollers 103 for performing the pumping action on tube 100 are carried by and spaced on an endless belt 102 having a reach facing and adjacent one side of tube 100. The belts 102 of the pump co-operate individually with the tubes 100 but are driven simultaneously to perform the pumping action.

The reaction means for each tube in this embodiment is an endless band or belt 104 trained round spaced pulleys 105, 106 so that one reach of belt 104 lies adjacent and engages the opposite side of tube 100 from that faced by belt 102.

This reach of belt 104 is urged resiliently into contact with tube 100 in that pulley 106 is a floating pulley and is urged by a leaf spring 107 towards the tube 100. The belt 104 therefore can in effect pivot resiliently about the axis of pulley 105 to compensate for excess pressure on tube 100 from rollers 103.

The embodiment of FIG. 6 is in effect a combination of the first and second embodiments already described in that it utilizes spiders 110 to carry the rollers 111 as in the first embodiment and each reaction means is a spring leaded belt 112 pivotal about one end 113 and spring leaded at the other end as in the second embodiment except that a coil spring 114 performs the spring leading.

FIG. 7 shows in cross section one of the tubes 28 or 100 and the surface of the associated reaction means which engage the tube and it will be noticed that such surface has a groove in which the tube locates and which conforms to the shape of the tube. This arrangement can be used in any of the embodiments described but the means defining the surface engaging the tube should be compressible for best results.

In practice, as the belts 2 circulate or the spiders 4 rotate the small diameter rollers 5 come against the tubes 1 flattening them over a short distance only so that the fluid in the tubes 1 downstream from the rollers is trapped and as the rollers advance along the tubes the trapped fluid is carried forwardly. In all embodiments described, the resiliently mounted reaction means press the tubes into contact with the rollers so that the sealing action on the flattened parts of the tubes is performed without excessive pressure of the rollers against the tubes as is normally necessary where the tubes rest on a non-yieldable surface. There is thus no unnecessary distortion of the tube material such as occurs in the known type of pump. In such a known pump, because it is impossible to provide exactly the correct clearance between the outer surface of every roller and the rigid surface against which the tube is compressed the clearance must be made smaller than is strictly necessary so that the tube material is actually squeezed and made thinner at the point where the roller is flattening the tube. In the described embodiments of the invention, the resilient yielding of the reaction means flattens the tube only enough to bring the two

walls into contact so that little or no damage is done to the tube itself. This greatly reduces wear on the tube so that the tube life is much increased. Also, the pump retains its volumetric efficiency for a much longer period and the power required to drive the pump is much reduced over a known pump of the same volume because no energy is being wasted in distorting unnecessarily the tube material. In fact, the energy necessary to distort the tube material itself may be considerably greater than the energy required to pump the fluid. Since each tube or pair of tubes has its own set rollers and each tube has its own reaction means, the conditions at each tube adjust themselves and there is no tendency of one tube to attempt to impose its conditions on another tube. Also, since the springs at each reaction means can be adjusted separately there is no necessity to use tubes having exactly the same wall thickness. The reaction adjust themselves to their own individual tubes. Another important advantage is that because of the lower and resilient compression force imposed on each tube by the associated reaction means the pump can be left stopped for long periods with the tubes flattened by the rollers without damage and without change in the pumping rate when the pump is restarted. The use of individual rollers for each tube or pair of tubes facilitates changing a tube without having to dismantle the pump and in fact one tube can be changed even while the other tubes remain in operation.

We have found that tungsten has proved to be the most satisfactory material for rollers of small diameter.

It is to be appreciated that the embodiments of the invention described are given by way of example only and that the scope of the invention is not to be limited thereby but includes modifications and variations falling within the scope of the appended claims.

I claim:

1. A peristaltic pump comprising several side-by-side deformable tubes located in parallel planes, several sets of rollers, one set for each tube, the rollers of each set being arranged to be brought into successive moving contact with the aforesaid tubes whereby each roller flattens the associated tube over a portion of its length and is moved unidirectionally along the tube and is released from the tube, several reaction means, one for each tube, each reaction means comprising an endless belt of which one face forms a resiliently yieldable surface located to act as an abutment against which the tube will be presented by the associated rollers, and which each belt is supported for pivotal movement about a pivot axis, and spring means acting on the belt at a point spaced from said axis for urging the belt into contact with the associated tube.

2. A pump as claimed in claim 1, in which each belt is shaped to present a longitudinal groove to receive the associated tube, and the belt is of a compressive material.

3. A pump as claimed in claim 2 in which the groove is formed in the thickness of the belt.

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