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(71) Applicant: **FISONS plc**
Fison House Princes Street
Ipswich Suffolk IP1 1QH(GB)

(72) Inventor: **Bowley, Alan Reginald**
Department of Physics & Bio-Engineering
Raigmore Hospital Inverness Scotland(GB)
Inventor: **Ross, Derek William**
North of Scotland Blood Transfusion Service
Raigmore Hospital Inverness Scotland(GB)

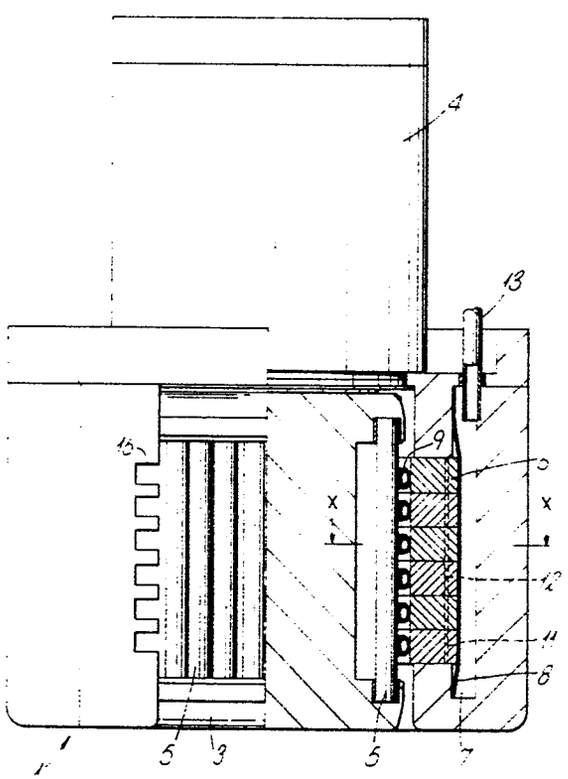
(74) Representative: **Craig, Christopher Bradberry et al**
Fisons plc 12 Derby Road
Loughborough Leicestershire LE11 0BB(GB)

(54) A peristaltic pump.

(57) A peristaltic pump (l) capable of compressing a flexible walled tube (9) between a pressure member (5) and a pressure plate (6).

In order for the force applied to the flexible walled tube (9) to be constant the pressure member (5) and pressure plate (6) are hydraulically biased together. In particular the pressure member (5) and pressure plate (6) are biased together by means of compressed air contained in a pressure chamber (7).

Fig.2.



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A PERISTALTIC PUMP

This invention relates to a peristaltic pump comprising a movable pressure member and a pressure plate.

Peristaltic pumps are used in the delivery of fluids for a variety of medicinal and industrial purposes. Some conventional pumps comprise a rotor upon which a plurality of pressure members, eg rollers are mounted, and a pressure plate. In use a flexible-walled tube or a plurality of such tubes running substantially parallel to each other are positioned between the pressure plate and the pressure members so that on rotation of the rotor the pressure members are successively brought into contact with the tubing, the latter being repeatedly compressed and released causing a fluid contained in the tube to progress through the tubing and be delivered as discrete unit volumes. The total volume of fluid that can be delivered is dependent upon, in that it will be a multiple of, the minimum volume of fluid that can be delivered as a discrete unit volume, which is itself controlled by the distance between adjacent pressure members. The closer the pressure members are together, the smaller the discrete unit volume which can be delivered. When small total volumes of fluid are to be delivered the discrete unit volume should be as small as possible.

When the discrete unit volume is small there are difficulties in achieving consistently accurate delivery. Such consistent accuracy may be achieved if the force applied to compress the tube is constant. In conventional peristaltic pumps where the pressure members and pressure plates are at a fixed distance from each other, variation in the wear of the tubing, or in the fluid to be pumped, can, amongst other things, lead to variation in the force applied to compress the tube. Compensation for such variation has in the past been provided for in peristaltic pumps employing mechanical springs either acting on the pressure members or on the pressure plate, eg as described in UK Patent No 1,556,294. Such peristaltic pumps are mechanically complex and are difficult to set up accurately, especially when the pump is accommodating a plurality of flexible-walled tubes.

The invention solves the problem of how to design a peristaltic pump which is not mechanically complex and in which the force applied to a flexible walled tube accommodated between the pressure member and pressure plate is constant.

According to the invention we provide a peristaltic pump comprising a moveable pressure member and a pressure plate, capable of compressing a flexible walled tube between the pressure member and the pressure plate, characterised in that the pressure member and the pressure plate are capable of being hydraulically biased together.

We prefer the pressure plate to be capable of being hydraulically biased towards the pressure member.

The hydraulic biasing means preferably comprises a pressure chamber capable of receiving a fluid. The hydraulic biasing means is preferably situated adjacent to the pressure plate. The pressure chamber may take the form of a flexible bag or, more preferably, is a solid walled chamber being open on one side. The open side is preferably that adjacent to the pressure plate, in which case the pressure chamber may be separated from the pressure plate by a flexible partition. The peristaltic pump may be provided with a plurality of pressure chambers. We prefer there to be two pressure chambers.

The fluid may be a gas or a compressible liquid. We prefer the fluid to be a gas, eg compressed air. The pressure chamber is preferably provided with a fluid inlet/outlet aperture which may be connected to a fluid supply, eg an air compressor, so that the desired pressure may be obtained and maintained in the pressure chamber. When there is a plurality of pressure chambers we prefer each to be separately connected to the fluid supply.

We prefer the fluid supply to the hydraulic biasing means to be capable of adjustment between an operating mode in which the hydraulic biasing means is provided with fluid such that the pressure member and pressure plate are hydraulically biased together and a non-operating mode in which the fluid supply to the hydraulic biasing means is restricted and the pressure member and pressure plate are not hydraulically biased together. We particularly prefer the peristaltic pump to be such that when the power supply to the pump is switched off the fluid supply to the hydraulic biasing means, eg pressure chamber is restricted at the same time. The force of the pressure plate on the tube is thereby released when the pump is not in use, which prevents the tubes from becoming distorted.

The flexible bag or flexible partition is preferably of a flexible, non-gas-permeable material for example neoprene or silicone rubber.

The pressure plate is preferably mounted in the pump so as to be slidable towards the pressure member. The pressure plate may be provided with means for limiting its sliding motion towards the pressure member. Such provision may prevent damage to the flexible-walled tube if the force produced by the hydraulic biasing means exceeds the desired maximum. The limiting means may take the form of a shoulder which is capable of co-operating with a corresponding lip on the peristaltic pump. The surface of the pressure plate which is capable of contacting the flexible walled tube may be flat, but is preferably arcuate. The peristaltic pump may be provided with one pressure plate or preferably a plurality of pressure plates. We prefer to provide one pressure plate for each individual tube accommodated in the peristaltic pump such that in use, each pressure plate contacts only one tube. We prefer each pressure plate to be individually mounted so as to be slidable towards the pressure member. When each pressure plate is individually mounted the position of each pressure plate may vary with respect to the others, such that manual individual adjustment of each pressure plate is not necessary and each pressure plate compensates for variation in the force applied to the tube it contacts.

The peristaltic pump is preferably provided with a plurality of pressure members. We prefer the pressure member to be a cylindrical roller. We prefer the number of pressure members, eg rollers, to be more than I0, preferably greater than 20, eg 25. We prefer the pressure members to be mounted upon and regularly radially disposed around a rotor parallel to its axis of rotation.

We prefer the rotor to be centrally provided in the pump and to be capable of bidirectional movement.

The rotor may be driven by a stepping motor or equivalent drive system which is able to turn the rotor through precisely determined angles.

We prefer the peristaltic pump to be capable of accommodating a plurality of flexible-walled tubes running substantially parallel to each other and each being capable of being compressed between a pressure member and a pressure plate. Flexible-walled tubes, for use in a peristaltic pump according to the invention, may be made of a resilient, elastic material, eg. silicone rubber. The diameter of the tubes may vary according to the fluid to be pumped and the desired delivery volume.

The advantage offered by peristaltic pumps according to the invention is mainly that of constantly accurate delivery of small discrete unit volumes, eg 5 micro-litres, of fluid.

A specific embodiment will now be described by way of example only and with reference to the accompanying drawings in which:

Figure I is a front elevation of a peristaltic pump in accordance with the invention,

Figure 2 is a plan of the pump in partial cross-section,

Figure 3 is a schematic cross-section along the line X-X of Figure 2 in which the rotor has been omitted for the sake of clarity.

The drawings show a peristaltic pump (I) capable of accommodating a plurality of flexible walled tubes (9) between a plurality of pressure members, eg rollers (5) which are mounted upon and radially disposed around a rotor centrally provided in the pump, and a plurality of pressure plates (6) which are slidably mounted in the main body of the pump surrounding the rollers. The pressure plates are capable of being hydraulically biased towards the rollers by means of compressed air supplied to a pressure chamber separated from the pressure plates by a flexible partition.

The pressure plates (6), of which there are twelve, are lined up in two groups of six on either side of the pump (I) parallel to the axis of rotation of the rotor (3). Each pressure plate (6) is in contact with one of I2 flexible walled tubes (9) accommodated in the pump (I) between the rollers (5) and the pressure plates (6). The flexible walled tubes (9) enter and leave the pump through the guide means (I6) provided in the pump (I). The pressure plates (6) are each independently mounted so that they are slidable towards the rollers (5). The surface (I0) of the pressure plates (6) in contact with the flexible-walled tube (9) is arcuate. The pressure plates (6) are provided with a shoulder (II) at the end of the pressure plate (6) away from the tube (9), which shoulder (II) co-operates with a corresponding lip (I2) on the pump (I) which limits the force that the pressure plate (6) can apply to the tube (9).

There are two pressure chambers (7), only one of which can be seen in Figure 2, and two flexible partitions (8) each separating the pressure chambers from one of the two groups of pressure plates (6). Each group of pressure plates along with the pressure chamber (7) is pivotally mounted (I4) on the peristaltic pump such that they may be pivoted from a closed position as shown in Figure I to an open position in which the flexible walled tubes (9) may be easily inserted or removed from the pump (I). The pressure plates (6) and pressure chambers (7) are held in the closed position by means of a clamping bolt (I5a,b). The pressure chamber (7) is provided with a fluid inlet/outlet aperture (I3), connectable to a fluid supply, eg an air compressor, which may be used to provide the desired pressure.

In the operating mode the pressure chamber (7) is filled with compressed air. The slidably mounted pressure plates (6) are thereby biased towards the tubes (9) by the flexible partition (8). As is most easily seen from Figure 3, by the stepping motor (4) upon movement of the rotor (3) in either direction A or B the individual rollers (5) sequentially engage the tubes (9). The tubes (9) are compressed by each individual roller (5) in turn and are released when not compressed, thus allowing a fluid contained in the tubes (9) to progress through the tube and be delivered in discrete unit volumes.

In the non-operating mode the pressure chamber (7) is depressurised by restriction of the compressed air supply from the air compressor to the pressure chamber, which leads to the relaxation of the flexible partition (8) such that the pressure plates (6) are not biased towards the rollers and the flexible walled tubes (9) are not compressed.

Claims

I. A peristaltic pump (I) comprising a moveable pressure member (5) and a pressure plate (6) capable of compressing a flexible walled tube between the pressure member and the pressure plate, characterised in that the pressure member and the pressure plate are capable of being hydraulically biased together.

2. A peristaltic pump (I) according to Claim I, in which the pressure plate (6) is capable of being hydraulically biased towards the pressure member (5).

3. A peristaltic pump (I) according to Claim I, in which the hydraulic biasing means comprises a pressure chamber (7) capable of receiving a fluid.

4. A peristaltic pump (I) according to Claim 2 or 3, in which the hydraulic biasing means is separated from the pressure plate (6) by a flexible partition (8).

5. A peristaltic pump (I) according to any of the above claims, in which the fluid of the hydraulic biasing means is compressed air.

6. A peristaltic pump according to any of the above claims, in which the fluid supply to the hydraulic biasing means is capable of adjustment between an operating mode in which the hydraulic biasing means is provided with fluid such that the pressure member and pressure plate are hydraulically biased together and a non-operating mode in which the fluid supply to the hydraulic biasing means is restricted and the pressure plate and pressure member are not hydraulically biased together.

7. A peristaltic pump (I) according to any of the above claims, in which the pressure plate (6) is mounted so as to be slidable towards the pressure member (5).

8. A peristaltic pump according to Claim 7, in which the pressure plate (6) is provided with means for limiting its sliding motion towards the pressure member.

9. A peristaltic pump according to Claim 8, in which the limiting means is a shoulder (II) provided on the pressure plate (6) which shoulder is capable of co-operating with a corresponding lip (I2) on the peristaltic pump (I).

I0. A peristaltic pump (I) according to any of the above claims, in which the surface (I0) of the pressure plate (6) capable of contacting the flexible-walled tube (9) is arcuate.

II. A peristaltic pump (I) according to any of the above claims, in which there is a plurality of pressure plates.

I2. A peristaltic pump according to Claim II, in which each of the pressure plates is independently mounted so as to be slidable towards the pressure member.

I3. A peristaltic pump (I) acording to Claim II or I2 provided with one pressure plate for each tube accommodated in the pump such that in use, each pressure member (5) contacts only one tube (9).

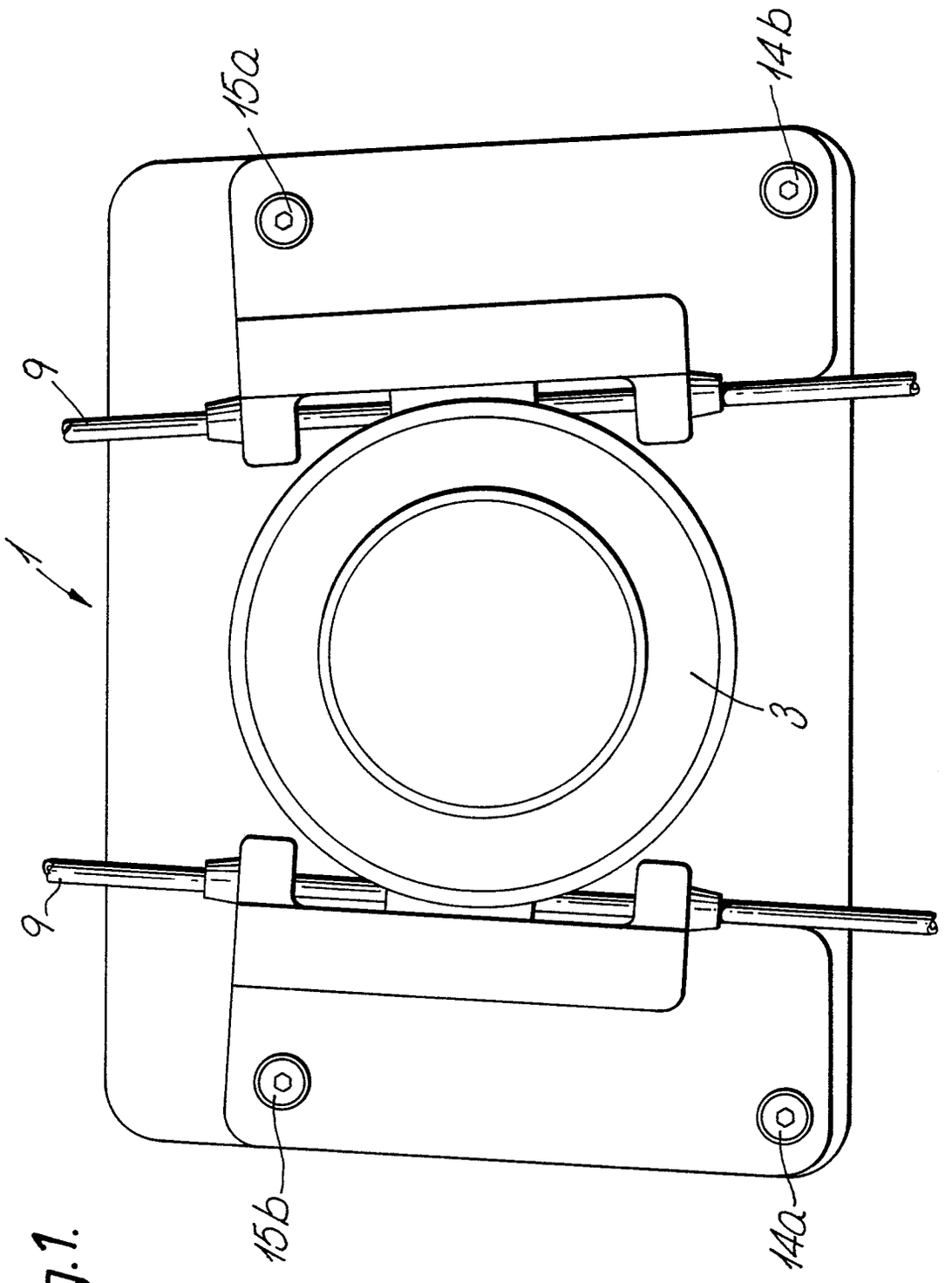
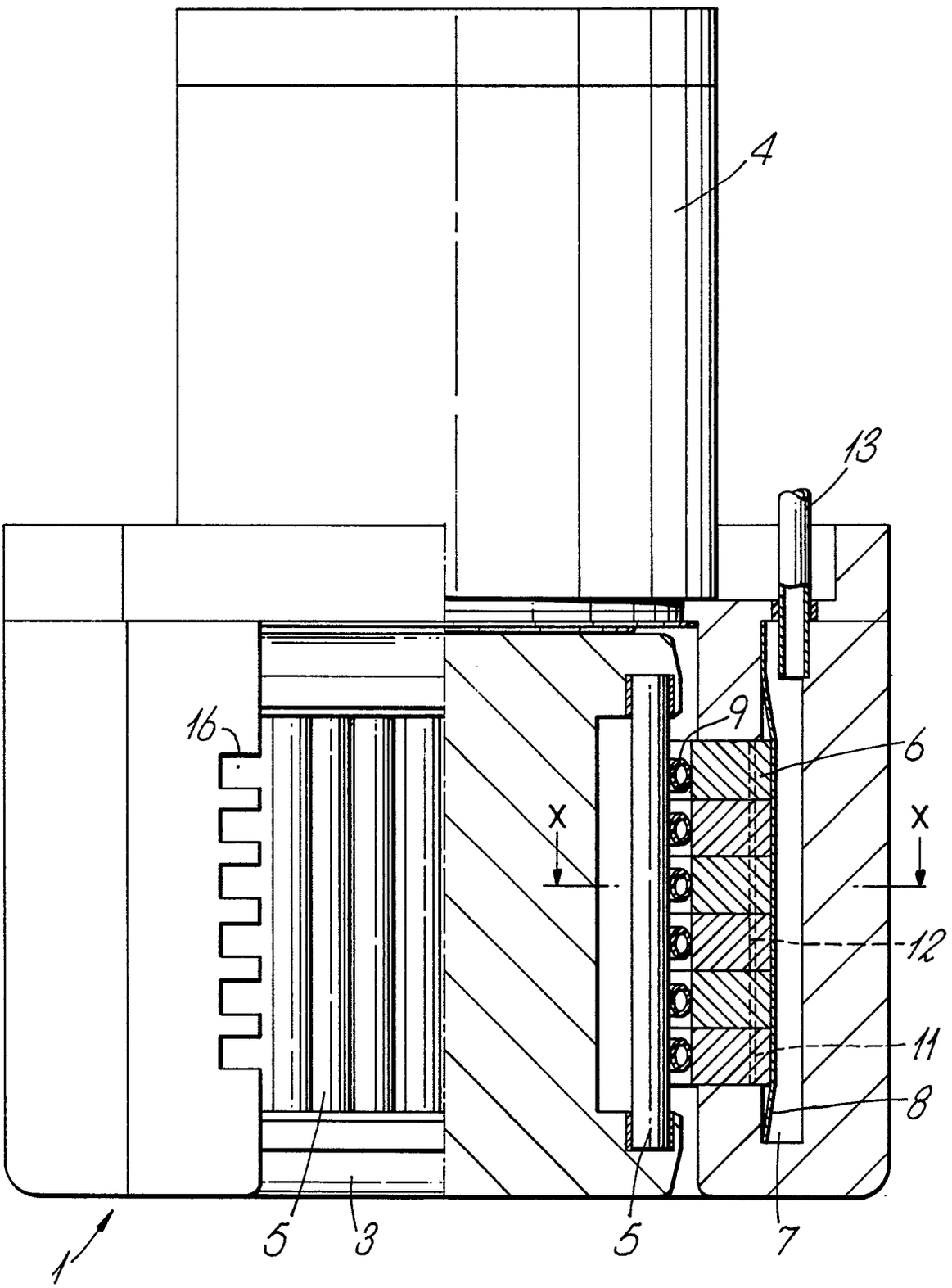


Fig.1.

Fig.2.



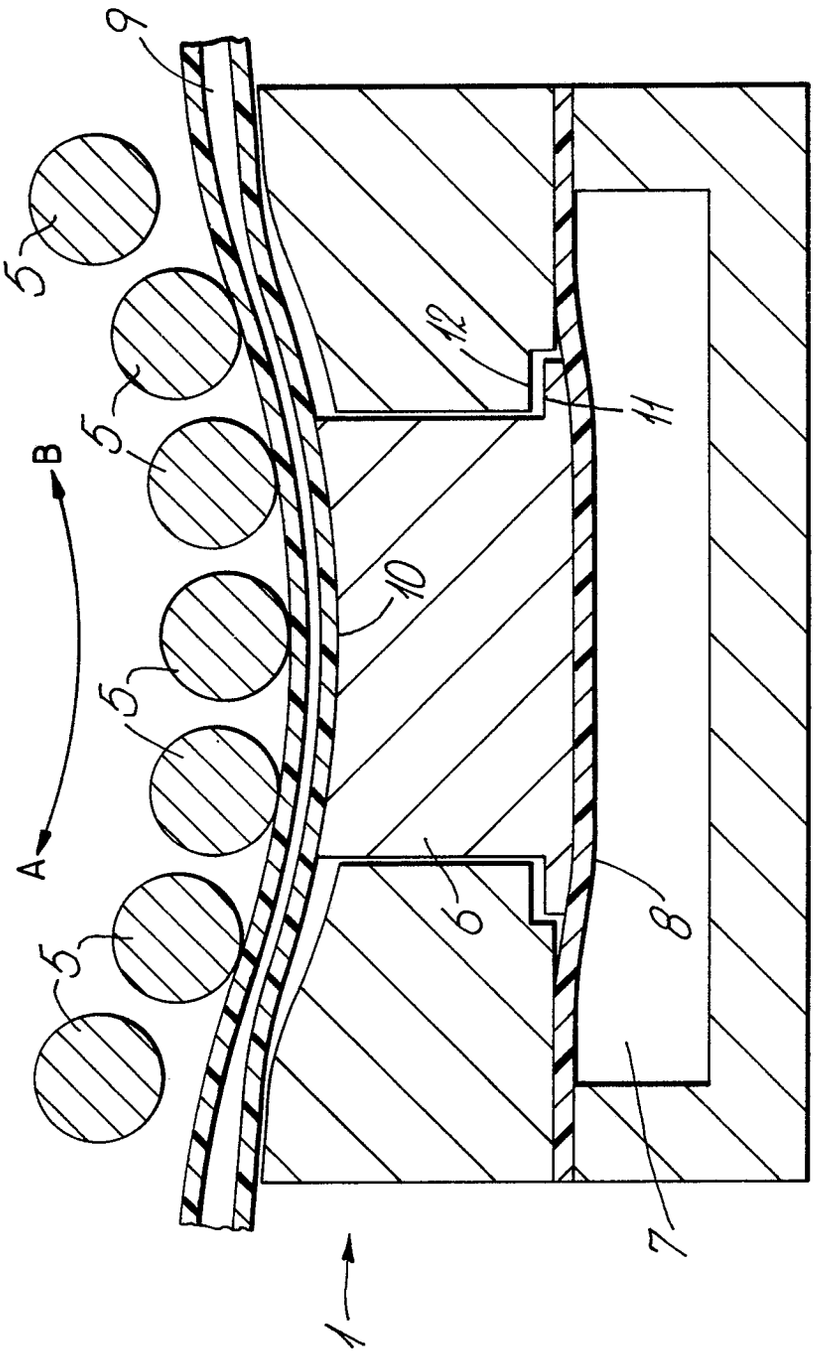


Fig.3.