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EP 0 496 379 B1

Description

BACKGROUND OF THE INVENTION

(Field of the Invention)

The present invention generally relates to an infusion device suited, but not exclusively limited thereto, for the infusion of medical solutions to a patient. More specifically, the present invention relates to a peristaltic infusion pump utilizing the peristaltic action to accomplish a pumping of a fluid medium through a flexible and compressible tubing.

(Description of the Prior Art)

An example of prior art peristaltic pump assemblies is schematically shown in Figs. 6 to 8 of the accompanying drawings. Fig. 6 is a schematic top plan view of the prior art peristaltic pump assembly; Fig. 7 is a schematic side view as viewed in a direction perpendicular to a drive shaft 3, showing a portion of the housing; and Fig. 8 is a schematic cross-sectional view, on an enlarged scale, taken along the line C-C in Fig. 6.

The illustrated peristaltic pump assembly comprises a housing including at least top and bottom walls 1a and 1b connected together so as to define a cam chamber therebetween. A drive shaft 3 having one end drivingly coupled with any suitable drive motor, for example, a stepper motor, extends rotatably, but axially non-movably through associated annular bearings 2 mounted on those walls 1a and 1b in any known manner. A plurality of round cam plates 4 are situated within the cam chamber between the top and bottom walls 1a and 1b and are rigidly mounted on the drive shaft 3 for rotation together therewith. Generally rectangular finger plates 5 equal in number to the number of the cam plates 4 are also operatively accommodated within the cam chamber, each of said finger plates 5 having an aperture defined therein to accommodate the associated cam plate 4. As will become clear from the subsequent description, each of the finger plates 4 is movable between retracted and projected positions in a direction perpendicular to the drive shaft 3 during the rotation of the drive shaft 3 and, hence, that of the associated cam plate 4.

A stationary back-up plate 6 is positioned parallel to the drive shaft 3 and in the vicinity of the projected position of each finger plate 5 with a flexible and compressible infusion tubing 7 extending therebetween. This infusion tubing 7 has an upper end fluid-connected with a well-known source of infusion solution (not shown) and a lower end fluid-connected with an injection needle or a

infusion catheter (not shown) and then to a patient. For the purpose of discussion, a portion of the infusion tubing 7 between a finger tip 5a of one of the finger plates 5 closest to the top wall 1a and a finger tip 5a of another one of the finger plates 4 closest to the bottom wall 1b and along the stationary back-up plate 6 is hereinafter referred to a pumping section of the infusion tubing 7.

As best shown in Figs. 6 and 8, the round cam plates 4 are eccentrically mounted on the drive shaft 3 along the longitudinal axis of the drive shaft 3 in a manner which will create a peristaltic action by the movement of finger plates 5 as will be described later. With the round cam plates 4 so mounted eccentrically on the drive shaft 3, each round cam plate 4 generally has protruding and retracting lobes opposite to each other with respect to the axis of the drive shaft 3, the protruding lobe representing a maximum radius a_1 radially away from the axis of the drive shaft 3 while the retracting lobe represents a minimum radius a_2 radially away from the axis of the drive shaft 3 as shown in Fig. 8. These cam plates 4 are so eccentrically mounted on the drive shaft 3 for rotation together therewith that the respective protruding lobes will be sequentially displaced an angle of $n/360$ degree about the axis of the drive shaft 3 from each other in a direction circumferentially of each cam plate 4, wherein n represents the number of the cam plates 4. So far illustrated in Fig. 8, the eight cam plates 4 are employed and, hence, the respective protruding cam lobes are circumferentially displaced 45 degrees about the axis of the drive shaft 3. In any event, the round cam plates 4 are eccentrically mounted on the drive shaft 3 in a helical pattern along the axis of the drive shaft 3.

Each of the apertures defined in the finger plates 5 and operatively accommodating therein the respective cam plates 4 is so shaped and so sized that, during one complete rotation of the associated cam plate 4 together with the drive shaft 3, the respective finger plate 5 can be driven or slid reciprocally between the projected and retracted position in a linear direction perpendicular to the axis of the drive shaft 3. Therefore, the rotation of the cam plates 4 together with the drive shaft 3 and within the apertures in the associated finger plates 5 causes the respective finger plates 5 to sequentially move between the projected and retracted positions thereby creating a peristaltic action by which the pumping section of the tubing 7 are progressively squeezed by the respective finger tips 5a of the finger plates 5 in cooperation with the stationary back-up plate 6 to accomplish a continuous volumetric displacement of the infusion solution through the pumping section of the infusion tubing 7.

The foregoing example of the prior art peristaltic pump assembly is substantially disclosed in, for example, United States Patents No. 4,617,014, issued October 14, 1986; No. 4,690,673, issued September 1, 1987; and No. 4,952,124, issued August 28, 1990, and Japanese Patent Application, Laid-open Publication No. 2-290 509 dated Nov. 30, 1990.

Briefly speaking, the prior art peristaltic pump assembly of the type referred to above is of a design wherein the finger plates 5 successively driven by the cam plates 4 sequentially squeeze the pumping section of the infusion tubing 7 while producing a zone of occlusion that is progressively moving along said pumping section in a direction conforming to the direction of flow of the infusion solution.

When it comes to a mass production of the peristaltic pump assemblies with a view that the resultant products can be made available at a reduced price, any dimensional deviation among the component parts of identical design and/or shape used in one or more lots of the peristaltic pump assemblies may cause the pump assemblies of the different lots to exhibit a different pumping performance, for example, a different pumping rate. By way of example, the illustrated peristaltic pump assembly employs one or more groups of component parts of identical design and/or shape such as a group of the cam plates 4 and a group of the finger plates 5. If one lot of the cam plates and another lot of the cam plate have a dimensional deviation from each other, not only may the single peristaltic pump assembly exhibit a fluid pumping rate deviating from the design parameter if such single peristaltic pump assembly employs the cam plates selected from these different lots of cam plates, but the peristaltic pump assemblies of one batch may also exhibit a fluid pumping rate varying from that of the peristaltic pump assemblies of a different batch.

Let it be assumed that there are patients who require an equal quantity of the same infusion solution to be injected, the use of the peristaltic pump assemblies of varying pumping performance may result in the injection of the correspondingly varying quantities of the infusion solution into the respective patients and/or in that the quantity of the infusion solution actually injected may vary from that specified by a doctor or an attendant nurse. This is not desirable and should be minimized or substantially eliminated.

US-A-4,954,046 discloses a peristaltic pump containing alignment means for the optimal positioning of a camshaft with respect to a pumping section of a infusion tube depending on the tolerances of the pump mechanism. The pump mechanism contains a plurality of fingers coupled to the

camshaft. The alignment means include a cylindrical bushing having an eccentric hole therethrough for adjustably rotating the bushing and thereby tilting the axis of rotation of the camshaft with respect to the tube. Because of the eccentric the camshaft is laterally displaced with respect to the tube simultaneously. On that account no precise lateral guidance of the fingers is possible which may increase the wear and tear of the pump mechanism and may cause a more or less noisy operation of the pump.

SUMMARY OF THE INVENTION

Accordingly, the present invention has been devised with a view to substantially eliminating the above discussed problems inherent in the prior art peristaltic pump assemblies and has for its essential object to provide an improved peristaltic pump assembly capable of accommodating any possible deviation in dimension, shape and/or profile of some component parts of identical design.

To this end, the present invention provides a peristaltic pump assembly for pumping a fluid medium from a fluid source through a tubing having a compressible pumping section, which assembly comprises a housing including at least one support wall; a drive shaft journaled substantially loosely to the support wall; a plurality of cam plates eccentrically mounted on the drive shaft in a helical pattern along the drive shaft and rotatable together with the drive shaft for, during a rotation of the drive shaft, driving finger plates sequentially in a direction perpendicular to the drive shaft to cause respective finger tips of the finger plates to engage the pumping section thereby producing a moving zone of occlusion along the pumping section for pumping the fluid medium; and an adjustment mechanism mounted on the support wall for adjustably displacing the drive shaft together with the cam plates and the finger plates in a direction perpendicular thereto.

The adjustment mechanism comprises a shaft bearing plate mounted on the support wall for movement in a linear direction parallel to the direction of movement of each finger plate and through which the drive shaft extends rotatably, and a drive means for adjustably moving the bearing plate in the linear direction.

According to the present invention, if a gap between the finger tip of any one of the finger plates, when is driven to a projected position to create the zone of occlusion along the pumping section, and a back-up members is desired to be adjusted, the drive means should be manipulated to move the shaft bearing plate thereby causing the drive shaft together with the cam plates and the finger plates. This drive means may comprise a

pair of wedge places disposed on respective sides of the shaft bearing plate, and an adjustment screw member for each of the wedge plates.

Therefore, even though the peristaltic pump assemblies as manufactured and/or assembled have a varying pumping performance, such variation can be compensated for by operating the adjustment mechanism in each of the peristaltic pump assemblies so that they can come to exhibit a uniform pumping performance.

BRIEF DESCRIPTION OF THE DRAWINGS

This and other objects and features of the present invention will readily become apparent from the following description taken in conjunction with a preferred embodiment thereof with reference to the accompanying drawings, in which:

Fig. 1 is a schematic top plan view, on an enlarged scale, of a peristaltic pump assembly embodying the present invention;

Fig. 2 is a cross-sectional view taken along the line A-A in Fig. 1, showing only a top wall of the housing for the peristaltic pump assembly;

Fig. 3 is a cross-sectional view taken along the line B-B in Fig. 1, showing an arrangement of cam plates and finger plates within the pump assembly housing;

Figs. 4 and 5 are schematic top plan views of the peristaltic pump assembly showing an adjustment held in different operative positions, respectively;

Fig. 6 is a schematic top plan view of the prior art peristaltic pump assembly;

Fig. 7 is a lateral side view of the top wall of the housing for the peristaltic pump assembly shown in Fig. 6; and

Fig. 8 is a cross sectional view taken along the line C-C in Fig. 6.

DETAILED DESCRIPTION OF THE EMBODIMENT

Referring to Figs. 1 to 5 and particularly to Figs. 1 to 3, a peristaltic pump assembly embodying the present invention comprises a housing including at least top and bottom walls 11a and 11b spaced apart from each other and connected together so as to define a cam chamber therebetween. A drive shaft 13 having one end drivingly coupled with any suitable drive motor (not shown), for example, a stepper motor, extends rotatably, but axially non-movably through associated annular bearings 12 mounted on those walls 11a and 11b operatively accommodated respectively in the top and bottom walls 11a and 11b in a manner as will be described later.

A plurality of round cam plates 14 are situated within the cam chamber between the top and bot-

tom walls 11a and 11b and are rigidly mounted on the drive shaft 13 for rotation together therewith. Generally rectangular finger plates 15 equal in number to the number of the cam plates 14 are also operatively accommodated within the cam chamber, each of said finger plates 15 having an aperture defined therein to accommodate the associated cam plate 14. Each of the finger plates 15 is movable between retracted and projected positions in a direction perpendicular to the drive shaft 13 during the rotation of the drive shaft 13 and, hence, that of the associated cam plate 14.

A stationary back-up plate 16 is positioned parallel to the drive shaft 13 and in the vicinity of the projected position of each finger plate 15 with a flexible and compressible infusion tubing 17 extending therebetween. This infusion tubing 17 has an upper end fluid-connected with a well-known source of infusion solution (not shown) and a lower end fluid-connected with an injection needle or a infusion catheter (not shown) and then to a patient. For the purpose of discussion, a portion of the infusion tubing 17 between a finger tip 15a of one of the finger plates 15 closest to the top wall 11a and a finger tip 15a of another one of the finger plates 15 closest to the bottom wall 11b and along the stationary back-up plate 16 is hereinafter referred to a pumping section of the infusion tubing 17.

The round cam plates 14 are eccentrically mounted on the drive shaft 13 along the longitudinal axis of the drive shaft 13 in a manner which will create a peristaltic action by the movement of the finger plates 15 as will be described later. With the round cam plates 14 so mounted eccentrically on the drive shaft 13, each round cam plate 14 generally has protruding and retracting lobes opposite to each other with respect to the axis of the drive shaft 13, the protruding lobe representing a maximum radius radially away from the axis of the drive shaft 13 while the retracting lobe represents a minimum radius radially away from the axis of the drive shaft 13. These cam plates 14 are so eccentrically mounted on the drive shaft 13 for rotation together therewith that the respective protruding lobes will be sequentially displaced an angle of $n/360$ degree about the axis of the drive shaft 13 from each other in a direction circumferentially of each cam plate 14, wherein n represents the number of the cam plates 14. So far illustrated in Fig. 3, the eight cam plates 14 are employed and, hence, the respective protruding cam lobes are circumferentially displaced 45 degrees about the axis of the drive shaft 13. In any event, the round cam plates 14 are eccentrically mounted on the drive shaft 13 in a helical pattern along the axis of the drive shaft 13.

Each of the apertures defined in the finger plates 15 and operatively accommodating therein the respective cam plates 14 is so shaped and so sized that, during one complete rotation of the associated cam plate 14 together with the drive shaft 13, the respective finger plate 15 can be driven or slid reciprocally between the projected and retracted position in a linear direction perpendicular to the axis of the drive shaft 13. Therefore, the rotation of the cam plates 14 together with the drive shaft 13 and within the apertures in the associated finger plates 15 causes the respective finger plates 15 to sequentially move between the projected and retracted positions thereby creating a peristaltic action by which the pumping section of the tubing 17 are progressively squeezed by the respective finger tips 15a of the finger plates 15 in cooperation with the stationary back-up plate 16 to accomplish a continuous volumetric displacement of the infusion solution through the pumping section of the infusion tubing 17.

In any event, the peristaltic pump assembly so far described is substantially identical in construction with the prior art peristaltic pump assembly shown in and described with reference to Figs. 6 to 8. However, in accordance with the present invention, a unique design has been made to allow the drive shaft to displace in a direction perpendicular to the back-up plate 16 and also conforming to the direction of movement of each finger plate 15 so that the plural peristaltic pump assemblies manufactured or assembled while embodying the present invention can be adjusted to exhibit a uniform pumping performance.

As best shown in Fig. 1, each of the top and bottom walls 11a and 11b of the housing for the peristaltic pump assembly has a generally rectangular opening 21 defined therein, having its longitudinal sense oriented in a direction parallel to the direction of movement of each finger plate 15. This rectangular opening 21 is delimited by a pair of long side lips 21a and 21b and a pair of short side lips 21c and 21d. An adjustment mechanism for adjustably displacing the drive shaft 13 in a direction parallel to the direction of movement of each finger plate 15 and perpendicular to the, back-up plate 16 is operatively accommodated within the rectangular opening 21 defined in each of the top and bottom walls 11a and 11b, the details of which will subsequently be described. It is, however, to be noted that, since the adjustment mechanisms within the respective rectangular openings 21 are of identical construction, reference will be made to only one of the adjustment mechanisms, that is, the adjustment mechanism accommodated within the rectangular opening 21 in the top wall 11a for the sake of brevity.

The adjustment mechanism associated with each of the top and bottom walls 11a and 11b comprises a generally trapezoidal bearing plate 22 having a long side edge 22a of a length smaller than the length of each of the long side lips 21a and 21b, a short side edge 22b parallel to the long side edge 22a, and a pair of inclined edges 22c and 22d each continued at its opposite ends to the long and short side edges 22a and 22b and inclined an equal angle relative to the longitudinal axis of the rectangular opening 21. This bearing plate 22 carries the corresponding annular bearing 12 for the support of the drive shaft 13 and is displaceable between first and second positions in a direction parallel to the longitudinal axis of the rectangular opening 21.

The adjustment mechanism also comprises first and second positioning wedge plates 23 and 24 movably accommodated within the opening 21 and positioned on respective sides of the bearing plate 22. Each of the wedge plates 23 and 24 is of, a shape having a short side edge 23a or 24a parallel to the long side lip 21a, a long side edge 23b or 24b parallel to the long side lip 21b, a transverse edge 23d or 24d parallel to each short side lip 21c or 21d and of a length smaller than that of each short side lip 21c or 21d, and an inclined edge 23c or 24c.

The bearing plate 22 has guide protuberances 25 and 26 protruding outwardly from the inclined edges 22c and 22d thereof and extending a distance equal to the length of the associated inclined edges 22c and 22d. On the other hand, each of the first and second wedge plates 23 and 24 has a guide groove defined in the associated inclined edge 23c or 24c and extending a distance equal to the length of such associated inclined edge 23c or 24c. As best shown in Fig. 3, in an assembled condition, the first and second wedge plates 23 and 24 are positioned within the opening 21 on respective sides of the bearing plate 22 with the guide protuberances 25 and 26 slidably engaged in the associated guide grooves in the inclined edges 23c and 24c of the respective first and second wedge plates 23 and 24.

With all of the plates 22, 23 and 24 so mounted as hereinabove described, care must be taken that, regardless of the position of any one of the bearing plate 22 and the first and second wedge plates 23 and 24 within the opening 21, the sum of the respective lengths of the first and second wedge plates 23 and 24 plus the length of the bearing plate 22, all as measured along the imaginary line drawn so as to pass through the axis of the drive shaft 13 in a direction parallel to the longitudinal axis of the opening 21 should be equal to or substantially equal to the length of any one of the long side lips 22a and 22b. Unless this require-

ment is satisfied, the relative positioning of these plates 22, 23 and 24 would result in a undesirable rattling motion of any one of the plates 22, 23 and 24 within the opening 21 which may in turn result in an undesirable oscillatory motion of the drive shaft 13.

For avoiding any possible separation of any one of the plates 22, 23 and 24 outwardly from the opening 21 and also for enabling any one of the first and second wedge plates 23 and 24 to be adjustable along the associated guide protuberance 25 or 26 of the bearing plate 22, the top wall 11a is formed with two pairs of axially aligned bearing holes all extending in a direction perpendicular to the direction of movement of each finger plate 15, the bearing holes 27 and 28 of one pair being axially aligned with each other for accommodating an adjustment bolt member 31 while the bearing holes 29 and 30 of the other pair are axially aligned with each other for accommodating an adjustment bolt members 32. On the other hand, each of the first and second wedge plates 23 and 24 has a threaded bore 33 or 34 defined therein so as to extend parallel to the associated transverse edge 23d or 24d for threaded engagement with the associated adjustment bolt member 31 or 32.

Each of the adjustment bolt members 31 and 32 extends freely rotatably through the bearing hole 28 or 30, then threadedly through the threaded bore 33 or 34 in the associated wedge plate 23 or 24 and finally freely rotatably through the bearing hole 27 or 29 before it emerges outwardly from the top wall 11a. Accordingly, when any one of the adjustment bolt members 31 and 32 is turned in either direction about its own longitudinal axis, the associated wedge plate 23 or 24 can be moved along a substantially intermediate portion of the respective adjustment bolt member 31 or 32, which is situated within the opening 21, to urge the bearing plate 22 in a direction parallel to the longitudinal axis of the opening 21 or perpendicular to the adjustment bolt member 31 or 32. In practice, the adjustment bolt members 31 and 32 are so turned that the associated edge plates 23 and 24 can be moved in respective directions opposite to each other and also perpendicular to the direction of movement of each finger plate 15 whereby one wedge plate 23 or 24 acts to urge the bearing plate 22 away from the adjacent bolt member 31 or 32 while the other wedge plate 24 or 23 moves so as to accommodate the movement of the bearing plate 22 so urged.

Thus, it will readily be understood that, assuming that the bearing plate 22 is held at a neutral position as shown in Figs. 1 and 3, and if the adjustment bolt members 31 and 32 are so turned that the first and second wedge plates 23 and 24 can be moved upwardly and downwardly as in-

5 dicated by respective arrows in Fig. 4, the bearing plate 22 can be moved a distance L in a direction close towards the back-up plate 16 or leftwards as viewed in Fig. 5. On the other hand, if the adjustment bolt members 31 and 32 are so turned that the first and second wedge plates 23 and 24 can be moved downwardly and upwardly as indicated by respective arrows in Fig. 5, the bearing plate 22 can be moved a distance L in a direction away from the back-up plate 16 or rightwards as viewed in Fig. 5. After this adjustment has been done, the adjustment bolt members 31 and 32 are locked in position by firmly fastening respective lock nuts 35 exteriorly to free ends thereof as best shown in Fig. 1, thereby to avoid any possible loosening of the adjustment bolt member 31 and 32.

The adjustment mechanism of the above detailed design is also employed in the bottom wall 11b as best shown in Fig. 3. In other words, so far illustrated, the adjustment mechanism of the above detailed design is accommodated within each of the rectangular openings 21 defined respectively in the top and bottom walls 11a and 11b of the housing, and the adjustment mechanism in the top wall 11a and the adjustment mechanism in the bottom wall 11b are operated in the same sense because of a symmetrical disposition with respect to the drive shaft 13. Accordingly, in the event that the distance between the back-up plate 16 and the finger tip 15a of each finger plate 15 then held at the projected position is found relatively small or large for a given bore size of the infusion, the adjustment mechanisms should be manipulated to bring the bearing plates 22 towards the first or second positions. As the bearing plates 22 are so moved, the drive shaft 13 is correspondingly displaced close towards or away from the back-up plate 16 together with the cam plates 14 and the associated finger plates 15. Therefore, the distance between the back-up plate 16 and the finger tip 15a of each finger plate 12 in the projected position for a given bore size of the infusion tubing 17 can be kept uniformly to a design parameter among the peristaltic pump assemblies embodying the present invention.

It is to be noted that the distance of movement of each bearing plate 21 from the neutral position to any one of the first and second positions may depend on the angle of inclination of both of the inclined edges 22c and 22d relative to the longitudinal axis of the rectangular opening 21. It is also to be noted that, depending on the size of the peristaltic pump assembly embodying the present invention and/or the rigidity of support of the drive shaft 13 relative to the housing, the adjustment mechanism may not be always provided in each of the top and bottom walls 11a and 11b of the housing.

As will readily be understood by those skilled in the art, the peristaltic pump assembly according to the present invention may be utilized to adjust the flow of a liquid medium flowing through the tubing 17. This is particularly true where the liquid medium flowing through the tubing 17 is pressurized. In this case, when the adjustment mechanisms are held at the position shown in Fig. 4 with the distance minimized between the back-up plate 16 and the finger tip 15a of each finger plate 15 then held at the projected position, the flow rate may be minimized, but when they are held at the position shown in Fig. 5 with the distance maximized between the back-up plate 16 and the finger tip 15a of each finger plate 15 then held at the projected position, the flow rate may be maximized. The extent to which the flow rate is adjustable depends on the amount of displacement, indicated by L in Figs. 4 and 5, of the drive shaft 13 in either direction close towards or away from the back-up plate 16. The amount of displacement L of the drive shaft 13 in the direction close towards the back-up plate 16 may be chosen such that a complete occlusion of the tubing 17 takes place successively along the pumping section of the tubing 17 when each of the finger plates 15 is moved to the projected position and, on the other hand, the amount of displacement L of the drive shaft 13 in the direction away from the back-up plate 16 may be chosen such that a free flow of the liquid medium through the pumping section of the tubing 17 takes place at a rate determined by the pressure of the liquid medium flowing through the tubing 17, or the system head height, the bore size of the tubing 17, and/or the rotational speed of the drive shaft 13.

From the foregoing description of the present invention, it has now become clear that, even though the peristaltic pump assemblies as manufactured and/or assembled have a variation in pumping performance, such variation can be compensated for by the provision of at least one adjustment mechanism, i.e., by displacing the drive shaft in a direction parallel to the direction of movement of each finger plate and close towards or away from the back-up plate, thereby making it possible for all of the peristaltic pump assemblies to have a uniform pumping performance. Accordingly, when using the peristaltic pump assembly of the present invention, a doctor or nurse attendant to the patient need not take the variation in pumping performance into consideration and all he or she needs to take into consideration may be the rotational speed of the drive shaft, the bore size of the tubing actually used and the position of the source of the infusion solution.

Although the present invention has been described in connection with the preferred embodi-

ment thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art. By way of example, although each or the bearing plate 22 has been described and shown as having the inclined edges 22c and 22d inclined at the same angle relative to the longitudinal axis of the rectangular opening 21 and the wedge plates 23 and 24 have the respective inclined edges 23c and 24c which are therefore inclined at the same angle relative to the longitudinal axis of the rectangular opening 21, but in the opposite sense to each other, the inclined edges 22c and 22d may be inclined at different angles and, correspondingly, the inclined edges 23c and 24c may have different angles of inclination, but conforming to the inclination of the respective inclined edges 22c and 22d. However, the use of the same angle of inclination is preferred because the distance of movement of the bearing plate 22 and, hence, the distance of displacement of the drive shaft 13, can be maximized.

Also, the or each bearing plate 22 has been described as movable between the first and second positions past the neutral position intermediate therebetween. However, in the practice of the present invention, each or the adjustment mechanism may comprise a shaft bearing plate accommodated slidably in the rectangular opening 21 and a drive means for adjustably moving the shaft bearing plate in one direction.

Accordingly, such changes and modifications are to be understood as included within the scope of the present invention, as defined by the appended claims, unless they depart therefrom.

Claims

1. A peristaltic pump assembly for pumping a fluid medium from a fluid source through a tubing (17) having a compressible pumping section, which assembly comprises:
 - a housing including at least one support wall (11a, 11b);
 - a drive shaft (13) journaled substantially loosely to the support wall;
 - a plurality of cam plates (14) eccentrically mounted on the drive shaft in a helical pattern along the drive shaft and rotatable together with the drive shaft;
 - finger plates (15) generally equal in number to the number of the cam plates and each having a finger tip (15a) engageable with the pumping section, said finger plates being operatively coupled with the cam plates such that the finger plates are successively and sequentially driven in a direction perpendicular to the drive shaft during a rotation of the drive, shaft

to cause the respective finger tips to engage the pumping section thereby producing a moving zone of occlusion along said pumping section for pumping the fluid medium; and

an adjustment mechanism including a drive means for adjustably moving the drive shaft in a direction parallel to the direction of movement of each finger plate, characterized in that the adjustment mechanism comprises a shaft bearing plate (22) of a generally trapezoidal shape having a pair of parallel edges (22a, 22b) and a pair of inclined edges (22c, 22d), said drive shaft (13) extending rotatably through said bearing plate, and said drive means comprises first and second positioning wedge plates (23, 24) each having an inclined edge, (23c, 24c), said wedge plates being positioned on respective sides of the trapezoidal bearing plate (22) with the respective inclined edges (23c, 24c) of said first and second wedge plates slidingly engaged with the associated inclined edges (22a, 22b) of the bearing plate.

2. The peristaltic pump assembly as claimed in claim 1:
wherein said housing includes a pair of support walls spaced apart from each other to define a cam chamber therebetween;
wherein said drive shaft is journaled substantially loosely to the support walls;
wherein said plurality of cam plates is eccentrically mounted within the cam chamber on the drive shaft;
wherein said finger plates are operatively coupled with the cam plates within the cam chamber and wherein said adjustment mechanism is mounted on each of said support walls.
3. The peristaltic pump assembly as claimed in Claim 1 or 2 wherein said support wall (11a, 11b) has a generally rectangular opening (21) defined therein and having a longitudinal axis oriented in a direction conforming to the direction of movement of each finger plate (15), wherein said adjustment mechanism is operatively accommodated within said rectangular opening, and wherein the inclined edge of each of the first and second wedge plates has a length smaller than that of any one of the inclined edges of the bearing plate.
4. The peristaltic pump assembly as claimed in Claim 3, wherein the inclined edges of the trapezoidal bearing plates are inclined at the same angle, but in a sense opposite to each other.

5. The peristaltic pump assembly as claimed in Claim 3, wherein said adjustment mechanism further comprises an adjustment bolt member for each of the wedge plates and extending through the support wall across the rectangular opening, at least a portion of said bolt member within the rectangular opening extending threadingly through the associated wedge plate to allow the latter to be adjustably moved as the bolt member is turned.

Patentansprüche

1. Peristaltikpumpe zum Pumpen eines Fluids von einer Fluidquelle durch eine Leitung (17) mit einem kompressiblen Pumpabschnitt, mit:
 - einem Gehäuse mit mindestens einer Stützwand (11a, 11b);
 - einer Antriebswelle (13), die im wesentlichen lose an der Stützwand gelagert ist;
 - mehreren Nockenplatten (14), die exzentrisch mit einem Schraubenmuster entlang der Antriebswelle an dieser befestigt sind und mit dieser verdrehbar sind;
 - Fingerplatten (15), deren Anzahl im allgemeinen mit der Anzahl von Nockenplatten übereinstimmt, mit jeweils einer Fingerspitze (15a), die am Pumpabschnitt angreift, wobei die Fingerplatten funktionsmäßig auf solche Weise mit den Nockenplatten gekoppelt sind, daß die Fingerplatten aufeinanderfolgend und der Reihe nach in einer Richtung rechtwinklig zur Antriebswelle während einer Umdrehung derselben angetrieben werden, damit die jeweiligen Fingerspitzen am Pumpabschnitt angreifen, um dadurch eine sich den Pumpabschnitt entlang bewegende Verschluszone zu erzeugen, um das Fluid zu pumpen; und
 - einem Einstellmechanismus mit einer Antriebseinrichtung zum einstellbaren Verstellen der Antriebswelle in einer Richtung parallel zur Verstellrichtung jeder Fingerplatte;

dadurch gekennzeichnet, daß der Einstellmechanismus eine Welle-Lagerplatte (22) mit im wesentlichen Trapezform mit einem Paar paralleler Kanten (22a, 22b) und einem Paar schräger Kanten (22c, 22d) aufweist, daß sich die Antriebswelle (13) drehbar durch die Lagerplatte erstreckt und daß die Antriebseinrichtung eine erste und eine zweite Positionierkeilplatte (23, 24) aufweist, von denen jede eine schräge Kante (23c, 24c) aufweist, und die an den jeweiligen Seiten der trapezförmigen Lagerplatte (22) so positioniert sind, daß die jeweiligen schrägen Kanten (23c, 24c) der ersten

und der zweiten Keilplatte gleitend an den zugehörigen schrägen Kanten (22a, 22b) der Lagerplatte angreifen.

2. Peristaltikpumpe nach Anspruch 1, bei der:
 - das Gehäuse ein Paar Stützwände aufweist, die voneinander beabstandet sind, um dazwischen eine Nockenkammer festzulegen;
 - die Antriebswelle im wesentlichen lose an den Stützwänden gelagert ist;
 - die mehreren Nockenplatten exzentrisch innerhalb der Nockenkammer an der Antriebswelle befestigt sind;
 - die Fingerplatten funktionsmäßig mit den Nockenplatten innerhalb der Nockenkammer gekoppelt sind; und
 - der Einstellmechanismus an jeder Stützwand angebracht ist.
3. Peristaltikpumpe nach einem der Ansprüche 1 oder 2, bei der die Stützwand (11a, 11b) eine in ihr ausgebildete im wesentlichen rechteckige Öffnung (21) aufweist, deren Längsachse in einer Richtung ausgerichtet ist, die mit der Verstellrichtung jeder Fingerplatte (15) übereinstimmt, wobei der Einstellmechanismus funktionsmäßig innerhalb der rechteckigen Öffnung untergebracht ist, und bei der die schräge Kante sowohl der ersten als auch der zweiten Keilplatte eine Länge aufweist, die kleiner ist als diejenige irgendeiner der schrägen Kanten der Lagerplatte.
4. Peristaltikpumpe nach Anspruch 3, bei der die schrägen Kanten der trapezförmigen Lagerplatten unter demselben Winkel, jedoch mit zueinander entgegengesetztem Sinn geneigt sind.
5. Peristaltikpumpe nach Anspruch 3, bei der der Einstellmechanismus ferner ein Einstellschraubenteil für jede Keilplatte aufweist, das sich durch die Stützwand durch die rechteckige Öffnung hindurch erstreckt, wobei sich mindestens ein Abschnitt des Schraubenteils innerhalb der rechteckigen Öffnung mit einem Gewinde durch die zugehörige Keilplatte erstreckt, damit die letztere einstellbar verstellt werden kann, wenn das Schraubenteil verdreht wird.

Revendications

1. Assemblage de pompe péristaltique pour pomper un milieu fluide depuis une source de fluide à travers un tube (17) comportant une section de pompage compressible, assembla-

ge qui comporte:

un carter comprenant au moins une paroi de support (11a, 11b);

un arbre d'entraînement (13) tourillonnant de façon sensiblement lâche par rapport à la paroi de support;

une multiplicité de plaques formant came (14) montées excentriquement sur l'arbre d'entraînement suivant une configuration hélicoïdale le long de l'arbre d'entraînement et aptes à tourner avec l'arbre d'entraînement;

des plaques formant doigt (15), dont le nombre est généralement égal au nombre des plaques formant came et dont chacune comporte une extrémité de doigt (15a) apte à porter contre la section de pompage, lesdites plaques formant doigt étant couplées de façon opérative avec les plaques formant came de telle sorte que les plaques formant doigt sont entraînées successivement et séquentiellement dans une direction perpendiculaire à l'arbre d'entraînement au cours d'une rotation de l'arbre d'entraînement pour amener les extrémités de doigt respectives à porter contre la section de pompage pour produire ainsi une zone mobile d'occlusion le long de ladite section de pompage pour pomper le milieu fluide; et

un mécanisme de réglage comprenant des moyens d'entraînement pour déplacer l'arbre d'entraînement de façon réglable dans une direction parallèle à la direction de déplacement de chaque plaque formant doigt, caractérisé en ce que le mécanisme de réglage comporte une plaque de support d'arbre (22) de forme généralement trapézoïdale ayant une paire de bords parallèles (22a, 22b) et une paire de bords inclinés (22c, 22d), ledit arbre d'entraînement (13) d'étendant à rotation à travers ladite plaque de support, et lesdits moyens d'entraînement comportent des première et seconde plaques de calage en position (23, 24) ayant chacune un bord incliné (23c, 24c), lesdites plaques de calage étant positionnées sur des cotés respectifs de la plaque de support trapézoïdale (22), les bords inclinés respectifs (23c, 24c) desdites première et seconde plaques de calage portant à coulissement sur les bords inclinés associés (22c, 22d) de la plaque de support.

2. Assemblage de pompe péristaltique selon la revendication 1, dans lequel ledit carter comprend une paire de parois de support espacées l'une de l'autre pour définir entre elles une chambre à cames;

dans lequel ledit arbre d'entraînement tourillonne de manière sensiblement lâche par rapport aux parois de support;

dans lequel ladite multiplicité de plaques formant came sont montées de façon excentrique à l'intérieur de la chambre à cames sur l'arbre d'entraînement;

dans lequel lesdites plaques formant doigt 5
sont couplées opérativement avec les plaques formant came à l'intérieur de la chambre à cames;

et dans lequel ledit mécanisme de réglage est monté sur chacune desdites parois de support. 10

3. Assemblage de pompe péristaltique selon la revendication 1 ou 2, dans lequel ladite paroi de support (11a, 11b) a une ouverture généralement rectangulaire (21) définie dans celle-ci 15
et ayant un axe longitudinal orienté dans une direction se conformant à la direction de déplacement de chaque plaque formant doigt (15), dans lequel ledit mécanisme de réglage 20
est logé opérativement à l'intérieur de ladite ouverture rectangulaire, et dans lequel le bord incliné de chacune des première et seconde plaques de calage a une longueur qui est inférieure à celle de n'importe lequel des 25
bords inclinés de la plaque de support.

4. Assemblage de pompe péristaltique selon la revendication 3, dans lequel les bords inclinés de la plaque de support trapézoïdale sont inclinés suivant le même angle, mais dans des sens opposés l'un à l'autre. 30

5. Assemblage de pompe péristaltique selon la revendication 3, dans lequel ledit mécanisme 35
de réglage comporte en outre un élément formant boulon de réglage pour chacune des plaques de calage s'étendant à travers la paroi de support et à travers l'ouverture rectangulaire, au moins une partie dudit élément formant 40
boulon se trouvant à l'intérieur de l'ouverture rectangulaire s'étendant de manière à se visser à travers la plaque de calage associée pour permettre à cette dernière d'être déplacée de façon réglable lorsque l'élément formant 45
boulon est entraîné en rotation.

50

55

Fig. 1

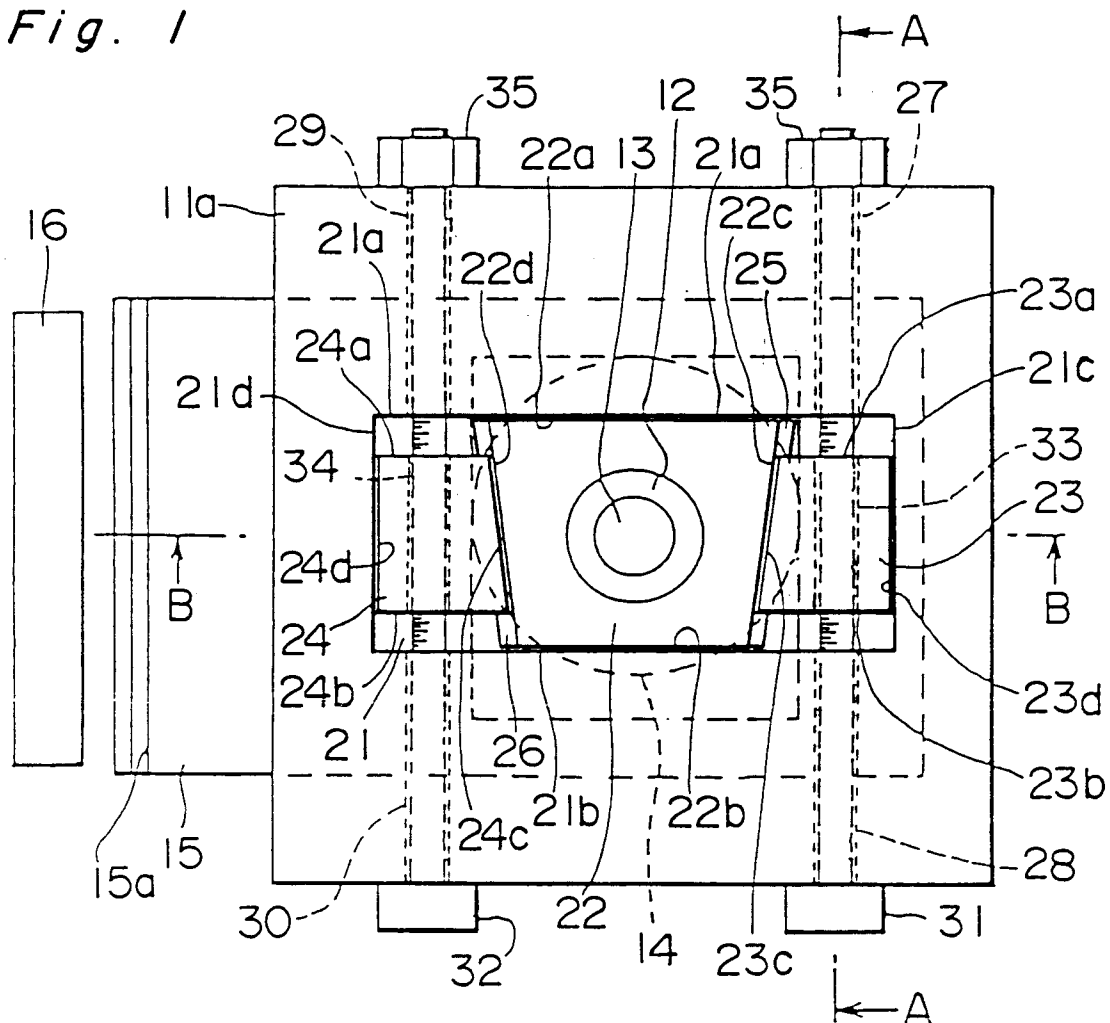


Fig. 2

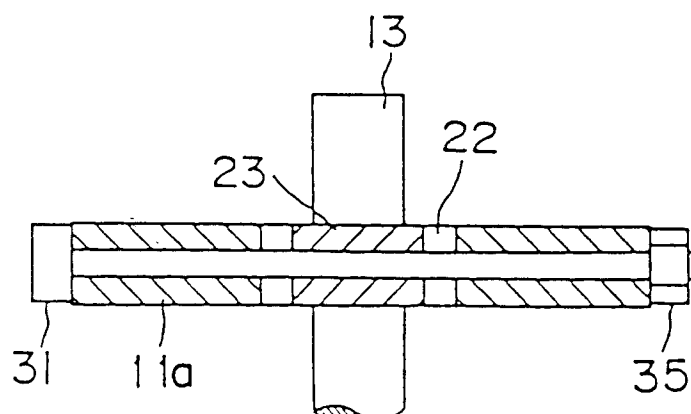


Fig. 3

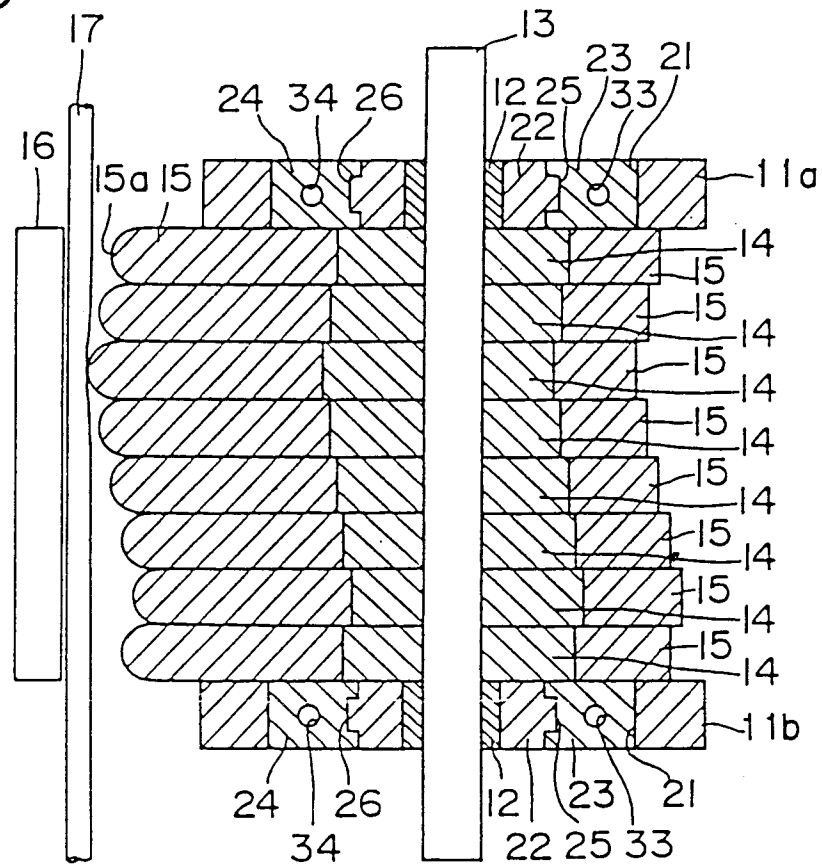


Fig. 4

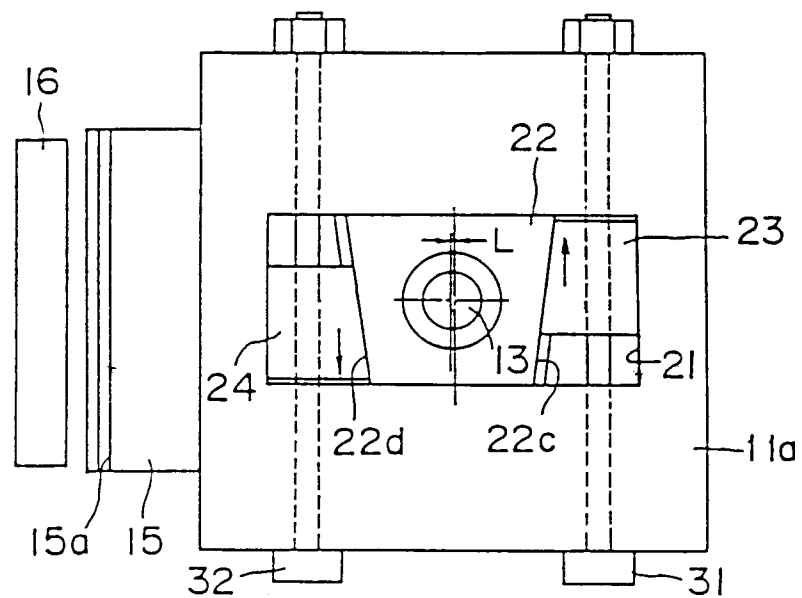


Fig. 5

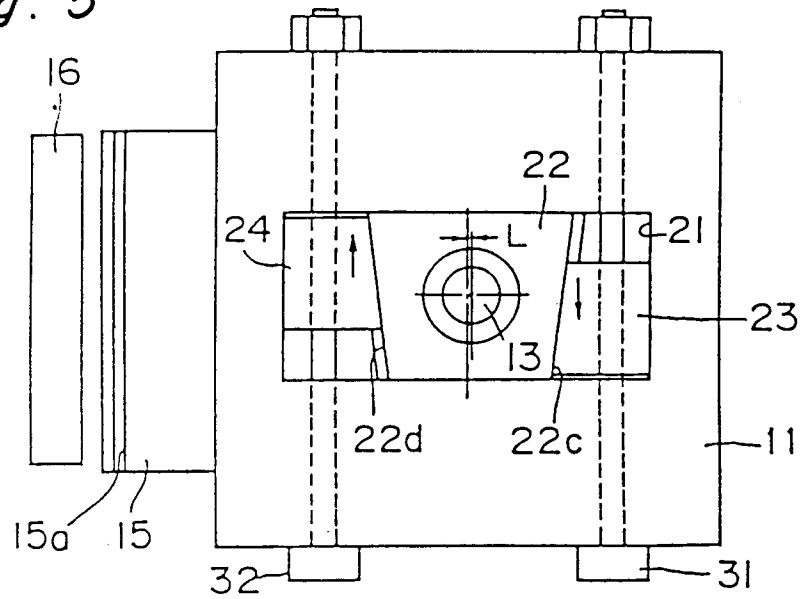


Fig. 6 Prior Art

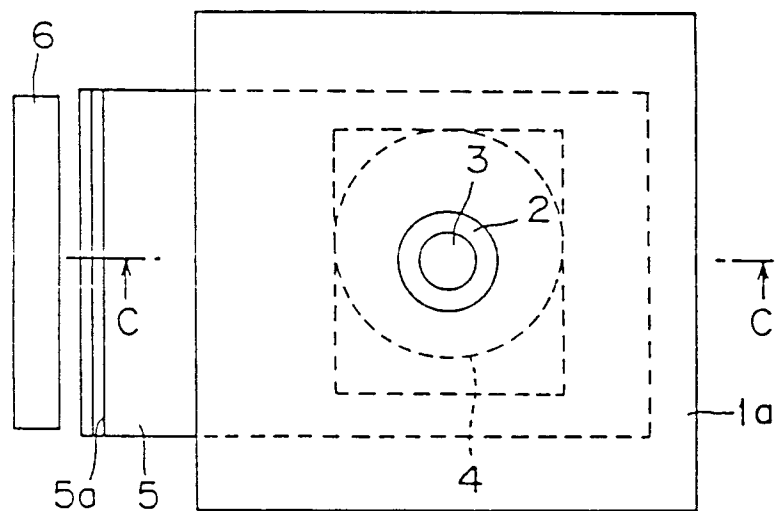


Fig. 7 Prior Art

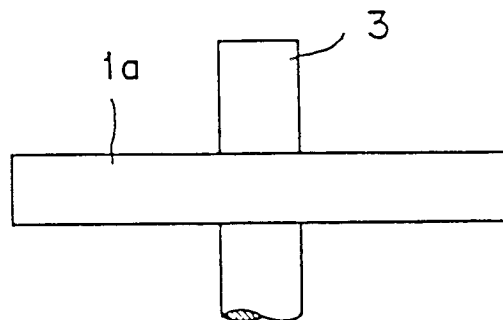


Fig. 8 Prior Art

