



(11)

EP 1 612 423 A1

(12)

EUROPEAN PATENT APPLICATION

(43) Date of publication:
04.01.2006 Bulletin 2006/01

(51) Int Cl.:
F04B 43/12 (2006.01)

(21) Application number: **05291198.9**

(22) Date of filing: **03.06.2005**

(84) Designated Contracting States:
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR
HU IE IS IT LI LT LU MC NL PL PT RO SE SI SK TR**
Designated Extension States:
AL BA HR LV MK YU

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(30) Priority: **30.06.2004 FR 0407259**

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(54) **Peristaltic pump comprising a bearing member and a counter-member adapted to cooperate with a tube**

(57) The peristaltic pump (1) comprises:

- a sensor (53, 57) of the force exerted between the bearing member (19) and the counter-member (24) between which a tube (6) is held; and
- a processing unit comprising means for determining,

from the signal supplied by the sensor (53, 57), if predetermined conditions indicative of correct positioning of the tube (6) between the bearing member (19) and the counter-member (24) have been satisfied.

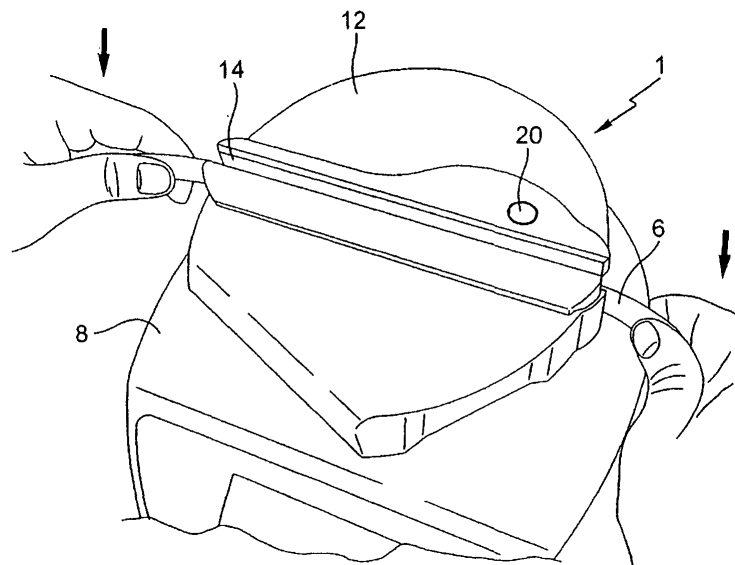


Fig.9

Description

[0001] The invention relates to the general field of peristaltic pumps.

[0002] It relates more particularly to a peristaltic pump comprising a bearing member and a counter-member between which a tube on which said pump must act is gripped.

[0003] A peristaltic pump, as used in the medical field' in particular, is a pump whose rotor is provided incorporating rollers that progressively compress the cross section of an elastic tube to move a liquid along the tube.

[0004] This kind of pump is therefore used to circulate a fluid inside a tube by operating only on the tube, without coming into contact with the liquid. This type of pump is therefore suitable for any application requiring the fluid to remain in a confined atmosphere, for example to avoid contamination of the fluid when working in a sterile environment. A peristaltic pump is generally adapted to operate in an environment where the concept of sterility is of primordial importance. The pump must therefore not only fulfill its function of circulating a fluid and preventing its contamination by the' environment, but also avoid contamination of the environment by the pump itself. The various components of the pump must therefore be easy to clean, where appropriate by being demountable, at the same time as ensuring a perfect seal.

[0005] A peristaltic pump typically comprises a rotor comprising rollers at its periphery and a mobile jaw adapted to assume an open position, in which it is moved away from the rotor so that an elastically deformable tube on which the pump has to act may be placed between the jaw and the rotor, and a closed position, in which the mobile jaw is moved toward the rotor so that the tube is gripped between a curved bearing surface on the mobile jaw and at least one roller of the rotor.

[0006] Peristaltic pumps of the above kind are known in the art in which the mobile jaw comprises an excrescence formed by a bearing member and in which the pump body is provided with a counter-member disposed so that, when the jaw is in its open position, the member is moved away from the counter-member and, when the mobile jaw is in its closed position, the bearing member is moved toward the counter-member so that, when a tube is fitted into the pump, the tube is gripped between the bearing member and the counter-member. This gripping action generally has the function of holding the tube in place while the pump is operating.

[0007] The peristaltic pumps available at present generally allow visual inspection of the correct position of the tube between the rotor and the mobile jaw when the latter is in the closed position. Similarly, correct circulation of the fluid inside the tube may be monitored visually or automatically on the upstream and/or downstream side of the pump.

[0008] The object of the invention is to improve the above type of pump.

[0009] To this end, the invention provides a peristaltic

pump comprising a rotor incorporating rollers and a mobile jaw that is provided with a bearing member and assumes:

- 5 - an open position in which it is moved away from the rotor, the bearing member then being moved away from a fixed counter-member on the pump, with the result that a tube on which said pump must act may be fitted between the jaw and the rotor, on the one hand, and between the bearing member and the counter-member, on the other hand, and
- 10 - a closed position in which the mobile jaw is moved close to the rotor, which moves the bearing member toward said counter-member, with the result that said tube is gripped between a curved bearing surface of the mobile jaw and at least one roller of the rotor, on the one hand, and between the bearing member and the counter-member, on the other hand,
- 15 this pump being characterized in that it further comprises:
 - 20 - a sensor of the force exerted between the bearing member and the counter-member; and
 - 25 - a processing unit comprising means for determining, from the signal supplied by the sensor, if predetermined conditions indicative of correct positioning of the tube between the bearing member and the counter-member have been satisfied.
- 30

[0010] The above kind of pump therefore has access at all times to information relating to the force that is exerted by the tube when it is fitted into the pump. This force being representative of the elastic behavior of the combination of the tube and the liquid that it conveys, various measurement or monitoring parameters can be monitored in this way.

[0011] Firstly, the sensor may provide information relating to the presence or the absence of a force exerted between the bearing member and the counter-member.

[0012] The processing unit therefore has access to information indicating that the tube is in place or, to the contrary, that a misoperation has occurred since the tube is not in position between the bearing member and the counter-member.

[0013] To obtain the best results, the force sensor may be integrated into the counter-member.

[0014] In this case, the counter-member may comprise a first assembly that comprises:

- 50 - a base provided with means for fixing it to the pump;
- a test body comprising a curved portion and rigidly connected by one of its ends to the base and comprising a contact member at its other end;
- 55 - a strain gauge applied to the curved portion of the test body.

[0015] The counter-member may also comprise a sec-

ond assembly identical to and independent of the first assembly in order to be able to carry out independent measurements relating to the two passages of a dual passage tube.

[0016] According to one preferred feature of the invention, the processing unit comprises a memory in which a signal-pressure coefficient is stored, the processing unit being adapted to process the value of the signal supplied by the force sensor according to said signal-pressure coefficient to obtain the pressure of the fluid circulating in the tube.

[0017] Thus the sensor may provide information relating to the pressure of the fluid circulating in the tube. The processing unit then has access to a conversion coefficient for the force measured by the fluid pressure sensor. The above kind of pump may therefore provide a display of the instantaneous pressure of the fluid circulating in the tube.

[0018] For enhanced measurements, the following features may be implemented independently of each other:

- the processing unit may comprise a module for compensating creep of the tube adapted to measure periodically the value of the signal supplied by the force sensor and to recalibrate the sensor dynamically as a function of the lowest measured value of said signal;
- the processing unit may comprise a module for filtering pulsation of the pump;
- the pump may comprise a motorized device for closing the mobile jaw at a variable speed;
- the closure device may provide a first or approach speed and a second or closure speed lower than the approach speed;
- the contact member may have a plane bearing surface adapted to come into contact with the tube;
- the contact member may be a rigid member attached to the test body.

[0019] Also, the pump may have additional functions by virtue of the following features, which may be implemented independently of each other:

- the processing unit may be adapted to slave the rotation speed of the rotor to indications supplied by the force sensor;
- the processing unit may be adapted to stop the pump if the force exerted between the bearing member and the counter-member exceeds a predetermined threshold.

[0020] Other features and advantages of the invention will become apparent in the light of the following description of a preferred embodiment of the invention, which is given by way of nonlimiting example and with reference to the appended drawings, in which:

- figure 1 is a perspective view of a peristaltic pump and its accessories ready for operation;
- figure 2 is a bottom perspective view of a protective cap placed on the top of the pump shown in figure 1;
- figure 3 is a plan view of the pump shown in figure 1 when the protective cap shown in figure 2 has been removed;
- figure 4 shows a rotor incorporating rollers that is visible on top of the pump in figure 3;
- figure 5 is a view similar to figure 3 when the rotor shown in figure 4 has been removed;
- figure 6 is a different perspective view of the pump shown in figure 1;
- figure 7 is a view to a larger scale of the framed portion VII of figure 6;
- figure 8 is a view in longitudinal section of the top of the pump shown in figures 1 and 6, showing the placing of the tube into the protective cap;
- figure 9 is a perspective view showing manual fitting of the tube into the pump shown in figures 1 and 6;
- figure 10 is a diagrammatic view similar to figure 9 showing lateral adjustment of the tube shown in figure 9;
- figure 11 is a perspective view of the head of the pump shown in figure 3;
- figure 12 is a perspective view similar to figure 11 also showing the mobile jaw shown in figure 2;
- figure 13 is a side view of the assembly shown in figure 12 in section on a plane passing through the rotor incorporating rollers and a cam actuating the mobile jaw;
- figures 14 to 16 are plan views of the pump head shown in figure 12, showing the mobile jaw in different positions;
- figures 17 to 19 are views from below, from the side, and from in front, respectively, of the counter-member shown in figure 12, facing a bearing member of the mobile jaw;
- figures 20 to 22 show the counter-member, in a similar manner to figures 17 to 19, but after receiving a treatment intended to seal it;
- figure 23 is a view in longitudinal section of the counter-member shown in figure 18, showing the cooperation between the counter-member, the bearing member and the pipe, which in this figure is seen in section; and
- figure 24 is a diagram representing the disposition of the force sensor and the processing unit and their connection to certain elements of the pump.

[0021] Figure 1 shows a peristaltic pump 1 in one of the applications of this type of pump.

[0022] In the present example, the pump 1 comprises accessories such as a bottle rack 2 and a flow drawer 3. This configuration is used to pump the liquid contained in a bottle 4 toward two containers 5 through a tube connected at one end to the bottle 4 and at the other end to the containers 5.

[0023] In this example the tube 6 comprises two separate passages sealed with respect to each other and connected to each other by a longitudinal web 7 that is easy to cut.

[0024] The peristaltic pump 1 comprises a pump body 8 on which are disposed a display 9 and control keys 10.

[0025] The pump 1 also comprises a pump head 11 (shown in figure 3) which is covered by a protective cap 12 in figure 1.

[0026] Figure 2 is a bottom perspective view of the protective cap 12 when it has been removed from the pump 1. The protective cap 12 comprises an envelope 13 in the form of a cover adapted to cover the mobile elements of the pump head 11 to prevent the user coming into contact with them. The envelope 13 comprises a straight groove 14 of sufficient width for the tube 6 to slide therein.

[0027] A mobile jaw 15 is fixed to the inside wall of the envelope 13 by three screws 16. The general shape of the mobile jaw 15 is that of a crescent moon, the inside wall of its curved portion comprising a curved bearing surface 17 of circular arc shape. On respective opposite sides of this bearing surface 17 the mobile jaw 15 comprises a tooth 18 and a bearing member 19, both adapted to cooperate with the tube 6, like the bearing surface 17.

[0028] The mobile jaw 15 further comprises a hole 20 through the wall of the envelope 13 (see figure 1).

[0029] A round hole 21 communicating with an oblong hole 22 is also formed in the thickness of the mobile jaw 15. In figure 13, which shows the profile of the oblong hole 22, it is apparent that the latter comprises a shoulder 22' substantially halfway through the thickness of the mobile jaw 15. The round hole 21 does not include this shoulder.

[0030] Figure 3 shows the pump head 11 when the protective cap 12 has been removed. The pump head 11 takes the form of a plate on which are fixedly mounted a counter-member 24, a stop pin 25, and a shaft 23 adapted to be inserted into the hole 20 in the mobile jaw 15 to enable the jaw to rotate.

[0031] The pump head 11 also receives a rotatably mounted rotor 26 incorporating rollers and a plate 27 from which projects an eccentric finger 28.

[0032] Figure 4 represents the rotor 26 incorporating rollers when removed from the pump 1. The rotor 26 comprises two flanges 29 between which are rotatably mounted three cylindrical rollers 30 and two centering rollers 31, the cylindrical rollers 30 being regularly spaced at 120° to each other around the contour of the flanges 29.

[0033] The flange 29 that is the upper flange in figure 4 comprises a flat 32.

[0034] The disposition of the cylindrical rollers 30, the centering rollers 31 and the flat 32 may be seen in figure 14.

[0035] Figure 5 shows the pump head shown in figure 3 when the rotor 26 has been removed. This figure shows a drive shaft 33 which drives rotation of the rotor 26 to fulfill the main function of the pump 1.

[0036] Figure 6 is a perspective side view of the pump 1, a framed portion VII of this figure showing the cooperation of the tube 6 and the cap 12.

[0037] Figure 7, which is a view to a larger scale of the framed portion VII of figure 6, shows the portion of the groove 14 in which the tube 6 is engaged. This portion of the groove 14 is delimited by a bottom 35 in the shape of a circular arc and two facing lateral walls 36. Each of these lateral walls 36 comprises a retaining boss 37, the two bosses 37 being disposed face-to-face.

[0038] The portion of the groove 14 visible in figure 7 forms a locating member adapted to receive the tube 6 when the latter is pressed into it and to enable sliding of the tube relative to the longitudinal axis along which it extends, in other words parallel to itself.

[0039] Note that when the tube 6 is pressed into this portion of the groove 14 (see figure 9) to obtain the assembly shown in figure 7, the tube 6 first slides down the lateral walls 36, until its lower passage comes into contact with the bosses 37, which creates a hard point to be overcome in order to press the tube 6 all the way in.. The user then continues to press in the tube 6, which elastically deforms the lower passage of the tube, which then takes up a position facing the bottom 35. The web 7 of the tube 6 takes up a position between the two bosses 37, which retains the tube 6 in the direction of the portion of the groove 14 shown in figure 7.

[0040] Although the lower passage of the tube 6 is retained in its housing by the bosses 37, a clearance remains between the tube 6 and the locating member, which allows the sliding previously referred to (see figure 10).

[0041] The tube 6 is also removed by elastically deforming the lower passage of the tube 6, which likewise overcomes the hard point.

[0042] Figure 8 shows in section the position of the tube 6 as just described.

[0043] Figure 11 is a perspective view of the pump head 11 in the figure 3 configuration.

[0044] Figure 12 shows the pump head 11 when the mobile jaw 15 has been fitted; this figure shows the jaw separated from the cover 12, in order to show the cooperation of the mobile jaw 15 with the components mounted on the pump head 11.

[0045] Figure 13 is a view in section of the assembly shown in figure 12 and shows in particular the mounting of the plate 27 on the pump head 11.

[0046] The plate 27 is fastened to a drive shaft 38 that is mounted on bearings and rotates relative to the pump head 11. The shaft 38 is fastened to a gear 39 meshing with a worm gear 40 that is driven in rotation by a motor (not shown).

[0047] Figures 14 to 16 are plan views of the assembly shown in figure 12 in three particular positions of the mobile jaw 15 defined by the eccentric finger 28, that is to say by the angular position of the plate 27.

[0048] Figure 14 shows the eccentric finger 28 in a position allowing the mobile jaw 15 to be fitted to the

pump head 11.

[0049] In figure 15, the mobile jaw 15 is in the same position as in figure 14 but the eccentric finger 28 is in a position in which it locks the mobile jaw 15 and prevents it from being extracted from the pump head 11.

[0050] Figure 16 represents the mobile jaw when closed by the eccentric finger 28.

[0051] The successive positions represented in figures 14 to 16 are not visible from the outside in normal use of the pump 1, this region being covered by the cap 12 that is normally fitted over the jaw 15.

[0052] Figures 17 to 19 are various views of the counter-member 24 that is mounted on the pump head 11.

[0053] Referring to figure 19, the counter-member comprises an upper test body 41, a lower test body 42, and two flanges 43 which connect the test bodies 41, 42 to each other and whose shape follows the contour of the test bodies 41, 42.

[0054] Figure 18 shows the shape of the flanges 43 forming the lateral walls of the counter-bearing 24. The flanges 43 are rigidly fixed to each of the test bodies 41, 42 by a locating pin 44 and a fixing screw 45.

[0055] The figure 17 bottom view also shows the surface of the lower test body 42 that is fixed to the pump head 11. This surface incorporates a cable orifice 46 between two tapped bores 47 in respective bosses 48.

[0056] The counter-member 24 further comprises an upper contact member 49 and a lower contact member 50 rigidly fixed to the upper test body 41 and the lower test body 42, respectively.

[0057] Given the position of the pins 44 and the screws 45 securing the test bodies 41, 42 to the flanges 43, the test body 41, 42 may be deformed when a force is applied to the contact members 49, 50.

[0058] Figures 20 to 22 are views of the counter-member 24 analogous to figures 17 to 19; here the counter-member 24 comprises a resilient seal 51 that fills up the interstices between the flanges 43 and the test bodies 41, 42 fitted with their contact members 49, 50. The resilience of this seal provides the sealing effect and at the same time allows relative movement of the test bodies 41, 42 and the flanges 43. The material of the resilient seal 51 must have a negligible stiffness compared to that of the test bodies 41, 42 and the flanges 43. The test bodies 41, 42 may be made from a high strength martensitic stainless steel, for example, conforming to the French standard AFNOR Z40 CNV 14, and tempered/annealed to an HRC hardness of 45, whereas the flanges 43 and the contact members 49, 50 may be made of ordinary stainless steel; in this case the resilient seal 51 may be made of silicone. Generally speaking, all interstices and orifices between the test bodies 41, 42, the contact members 49, 50 and the flanges 43 may be filled in by this kind of seal, to obtain a perfect seal.

[0059] Figure 23 is a side view of the counter-member 24 in longitudinal section, showing the shape of the test bodies 41, 42.

[0060] Each of the test bodies comprises a base 52

from which extends a curved portion 53 which has at its end a dovetail mortise 54 in which a dovetail tenon 55 on the corresponding contact member 49, 50 engages. Each base 52 comprises transverse holes 56 for inserting the pin 44 and the screw 45 and an orifice 56' for fixing a rear wall (not shown).

[0061] Each of the test bodies 41, 42 has a strain gauge 57 fixed to the inside wall of the curved portion 53. The strain gauges 57 are adapted to measure deformation of the curved portion 53 to which they are fixed. Such deformation may occur when the counter-member 24 is fixed to the pump head 11 by screws inserted into the tapped holes 47 and a force is exerted on one of the contact members 49, 50.

[0062] Note that deformation of the curved portion 53 of one of the test bodies is independent of deformation of the curved portion 53 of the other test body, since the test bodies 41, 42 are connected only at their base 52, via the flanges 43.

[0063] The strain gauges may be connected into a Wheatstone bridge, for example, in a manner that is well known in the field of mechanical engineering.

[0064] Cables (not shown) passing through the orifice 46 connect each of the gauges 57 to the control circuitry of the pump 1.

[0065] Figure 24 is a diagrammatic representation of a processing unit 58 connected to the counter-member 24 and various components of the pump 1, such as the motor driving the rotor 26, the motor driving the eccentric finger 28, input peripherals such as the keys 10, and output peripherals such as the display 9.

[0066] The processing unit 58 comprises a module 59 for compensating creep of the tube 6, a module 60 for controlling closing of the mobile jaw 15, and a module 61 for filtering pulsation of the pump 1.

[0067] The functions of the processing unit, whose operation is explained hereinafter, may be provided by appropriate electronic circuitry or by an appropriately programmed data processing device.

[0068] The peristaltic pump 1 that has just been described operates in the manner indicated hereinafter.

[0069] When the pump 1 is started, the mobile jaw 15 is in the position shown in figure 15, which corresponds to the position of the cap 12 shown in figures 9 and 10, and the rotor 26 is also in the position shown in figure 15, with the flat 32 disposed so that a rectilinear passage is formed between the rotor 26 and the jaw 15. The locating members of the cap 12 are then aligned with this rectilinear passage.

[0070] First of all, a tube 6 is fitted to the pump 1. To this end, as shown in figure 9, the user holds the tube 6 in both hands and inserts it into the groove 14. Because of the bosses 37, this pressing in maneuver has to overcome a hard point, as previously explained, for the tube 6 to reach the appropriate position in the locating members formed at each end of the groove 14, as shown in figure 7.

[0071] Referring to figure 10, the user may then slide

the tube 6 laterally, in either direction, to adapt the length of tube available on either side of the cover 12 as a function of the accessories to which the tube 6 is connected (see figure 1).

[0072] Once this operation has been effected, intervention of the user insofar as the positioning of the tube 6 in the pump 1 is concerned is no longer necessary.

[0073] Using the control keys 10, the user indicates that he wishes to start the pump 1, which drives rotation of the plate 27 via its drive system until the mobile jaw 15 reaches the position shown in figure 16, in which the tooth 18 of the jaw 15 clamps the web 7 of the tube 6 against the immobilizing pin 25.

[0074] When this position is reached, the motor stalls and draws a higher current. When this consumption peak is detected, the motor is stopped.

[0075] As the jaw 15 closes, the tube 6 is wrapped around the rotor 26 and at the same time slides as required in the locating members of the cap 12.

[0076] The tube 6 is finally held on either side of the rotor 26 by the cooperation of the tooth 18 and the immobilizing pin 25, on the one hand, and by the cooperation of the bearing member 19 and the counter-member 24, on the other hand, which lightly grip both passages of the tube 6.

[0077] The mobile jaw 15 is held in this closure position because of the irreversible nature of the system comprising the wheel 39 and the worm 40. The pitch and the helix angle of these components are chosen, in a manner that is well known in the art of mechanical engineering, so that rotation of the worm 40 drives the wheel 39 but rotation of the wheel 39 is not able to drive rotation of the worm 40.

[0078] When the tube 6 has been inserted in this way, the rotor 26 may be rotated to start circulating the fluid contained in the tube 6 thanks to the movement of the rollers 30.

[0079] When the pump 1 is operating, the safety of the user is ensured by the fact that the mobile jaw 15 is in the figure 16 position, that is to say in a position in which removal of the combination of the mobile jaw and the protective cap is prevented by the eccentric finger 28 and the shoulder 22' in the oblong hole 22 in the mobile jaw 15. It is also impossible to remove the cap 12 when the mobile jaw 15 is in the figure 15 position, that is to say when the rotor 26 is not moving but the pump 1 is powered up.

[0080] On the other hand, when the pump 1 is powered down, the eccentric finger 28 resumes the position shown in figure 14, which releases the combination of the mobile jaw and the protective cap, for example to allow cleaning of the components of the pump head 11.

[0081] The pump 1 further comprises means for obtaining, via the counter-member 24, information relating to the tube 6 and to the circulating fluid and to operate accordingly on the pump 1.

[0082] The counter-member 24 is connected to a processing unit (figure 24) that stores in a memory a sig-

nal-pressure coefficient and is adapted to derive the pressure of the fluid circulating in the tube 6 from this signal-pressure coefficient and the voltage delivered by the strain gauges 57 (which is representative of the deformation of the corresponding curved portion 53).

[0083] Once the tube has been fitted, and with the pump head in the figure 16 position, the processing unit first verifies the presence of the tube 6 and its correct placement. To this end, deformation of the curved portions 53 must be confirmed by confirming that the distance between the counter-member 24 and the bearing member 19 of the jaw 15 in the closed position is less than the width of the tube 6 (see figure 23).

[0084] If the presence of the tube 6 is not detected, the pump 1 does not start and displays an error message.

[0085] Once the tube has been positioned correctly and the pump is operating, the processing unit 58 supplies to the output peripherals the instantaneous pressure of the fluid in each of the passages of the tube 6, independently of each other.

[0086] The signal-pressure coefficient is determined empirically, during a preliminary calibration phase, by installing a tube with known characteristics in the pump 1 and applying to it a known pressure. The voltage delivered by the strain gauges 57 is then read off; the pressure corresponding to this value being known, the coefficient may be determined. It may be determined for each new tube used. An average value may be obtained by subjecting a plurality of tubes to this test and determining from the test results a mean coefficient valid for all the tubes.

[0087] The processor unit 58 may use the measured pressure of the fluid in the tube 6 for the following supplementary applications.

[0088] The processing unit 58 includes a module 59 for compensating creep of the tube 6, which improves the reliability of the measurements. To this end, at regular intervals, for example every 20 milliseconds, the module 59 measures the voltage supplied by the strain gauges 57 and effects a dynamic calibration, from one measurement to the next, taking the lowest voltage as the reference value for calculating the zero pressure.

[0089] The processing unit 58 also includes a module 60 for controlling closure of the mobile jaw 15 that is adapted to regulate the speed of the mobile jaw 15 when it moves from its open position to its closed position, leading to compression of the tube 6 between the bearing member 19 and the counter-member 24. Tightening the mobile jaw 15 too quickly disturbs the pressure measurement, because of the elasticity of the tube 6.

[0090] The module 60 may therefore slow down the closing of the mobile jaw (i.e. slow down the motor of the eccentric finger 28) if the pressure measurement is disturbed.

[0091] The module 60 may further be programmed to start the closure of the mobile jaw 15 at a high speed and then to clamp the tube 6 at a lower speed, once the tube 6 reaches the vicinity of the counter-member 24.

[0092] The processing unit 58 further comprises a module 61 for filtering pulsation of the pump 1. The movement of the rotor 26 acting on the tube 6 during the operation of the pump 1 causes cyclic disturbances to the pressure measurement, these disturbances depending on the rotation frequency of the rotor 26.

[0093] The module 61 applies electronic filtering, for example by means of a low-pass RC filter setting a cut-off frequency.

[0094] In the present example, the rotation speed of the rotor 26 is 240 rpm and the rotor comprises three rollers, which corresponds to an angular frequency of 12 Hz. A cut-off frequency of 1.5 Hz may then be defined by an appropriate RC filter; this value gives good results.

[0095] The processing unit 58 may also slave the rotation speed of the rotor 26 to the measured pressure of the fluid in the tube 6. For example, if the processor unit 58 has information relating to the permitted maximum pressure in the tube 6, the rotation speed of the pump may be increased to the maximum and then reduced on demand, if the pressure in the tube 6 approaches its permitted maximum value.

[0096] Similarly, by indicating abnormal variations in fluid pressure, the processing unit 58 may detect incorrect flow of the fluid in the tube 6, linked to clogging of the tubes, for example.

[0097] Variants of the device may be envisaged that do not depart from the scope of the invention. In particular, the tube 6 may comprise a single passage or more than two passages, the counter-member comprising as many test bodies as there are passages.

Claims

1. Peristaltic pump (1) comprising a rotor (26) incorporating rollers (30) and a mobile jaw (15) that is provided with a bearing member (19) and assumes:

- an open position in which it is moved away from the rotor (26), the bearing member (19) then being moved away from a fixed counter-member (24) on the pump (1), with the result that a tube (6) on which said pump (1) must act may be fitted between the jaw (15) and the rotor (26), on the one hand, and between the bearing member (19) and the counter-member (24), on the other hand, and
- a closed position in which the mobile jaw (15) is moved close to the rotor (26), which moves the bearing member (19) toward said counter-member (24), with the result that said tube (6) is gripped between a curved bearing surface (17) of the mobile jaw (15) and at least one roller (30) of the rotor (26), on the one hand, and between the bearing member (19) and the counter-member (24), on the other hand, this pump (1) being **characterized in that** it fur-

ther comprises:

- a sensor (53, 57) of the force exerted between the bearing member (19) and the counter-member (24); and
- a processing unit (58) comprising means for determining, from the signal supplied by the sensor (53, 57), if predetermined conditions indicative of correct positioning of the tube (6) between the bearing member (19) and the counter-member (24) have been satisfied.

2. Peristaltic pump according to claim 1, **characterized in that** the force sensor (53, 57) is integrated into the counter-member (24).
3. Peristaltic pump according to claim 2, **characterized in that** the counter-member (24) comprises a first assembly that comprises:
 - a base (52) provided with means (47) for fixing it to the pump (1);
 - a test body (53) comprising a curved portion and rigidly connected by one of its ends to the base (52) and comprising a contact member (50) at its other end;
 - a strain gauge (57) applied to the curved portion of the test body (53).
4. Peristaltic pump according to claim 3, **characterized in that** the counter-member (24) comprises a second assembly identical to and independent of the first assembly.
5. Peristaltic pump according to any of claims 1 to 4, **characterized in that** the processing unit (58) comprises a memory in which a signal-pressure coefficient is stored, the processing unit (58) being adapted to process the value of the signal supplied by the force sensor (53, 57) according to said signal-pressure coefficient to obtain the pressure of the fluid circulating in the tube (6).
6. Peristaltic pump according to any of claims 1 to 5, **characterized in that** the processing unit (58) comprises a module (59) for compensating creep of the tube (6) adapted to measure periodically the value of the signal supplied by the force sensor (53, 57) and to recalibrate the sensor (53, 57) dynamically as a function of the lowest measured value of said signal.
7. Peristaltic pump according to any of claims 1 to 6, **characterized in that** the processing unit (58) comprises a module (61) for filtering pulsation of the pump (1).
8. Peristaltic pump according to any of claims 1 to 7, **characterized in that** the processing unit (58) is

adapted to slave the rotation speed of the rotor (26) to indications supplied by the force sensor (53, 57).

9. Peristaltic pump according to any of claims 1 to 8, **characterized in that** the processing unit (58) is adapted to stop the pump (1) if the force exerted between the bearing member (19) and the counter-member (24) exceeds a predetermined threshold.
10. Peristaltic pump according to any of claims 1 to 9, **characterized in that** it comprises a motorized device for closing the mobile jaw (15) at a variable speed.
11. Peristaltic pump according to claim 10, **characterized in that** the closure device provides a first or approach speed and a second or closure speed lower than the approach speed.
12. Peristaltic pump according to either claim 3 or claim 4, **characterized in that** the contact member (49, 50) has a plane bearing surface adapted to come into contact with the tube (6).
13. Peristaltic pump according to either claim 3 or claim 4, **characterized in that** the contact member (49, 50) is a rigid member attached to the test body (53).

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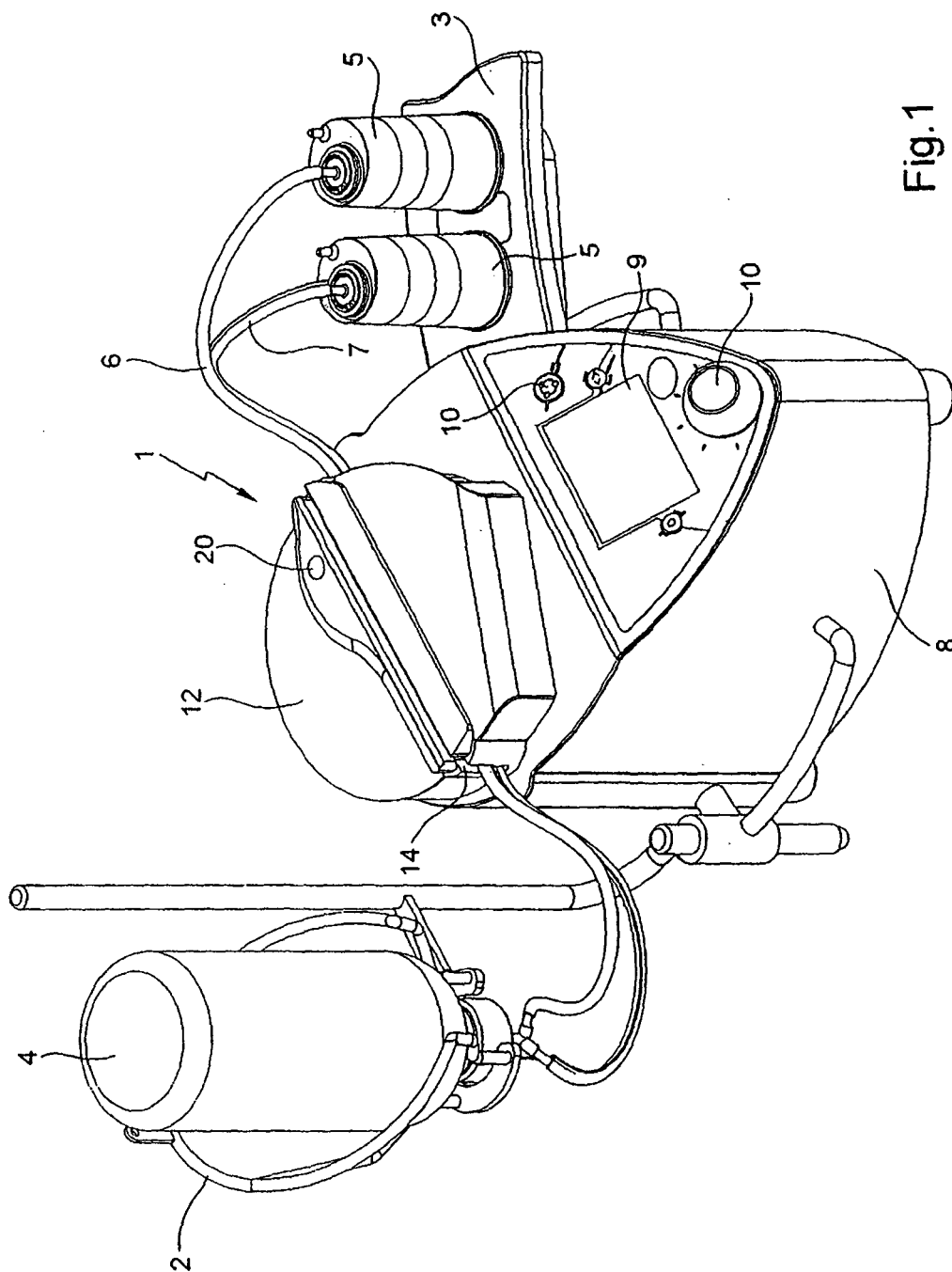


Fig.1

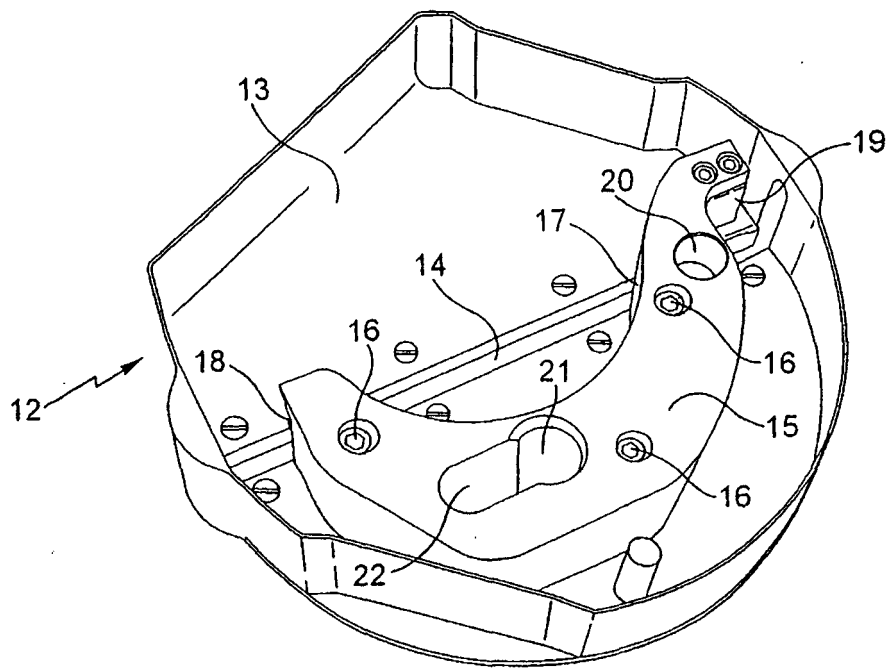


Fig.2

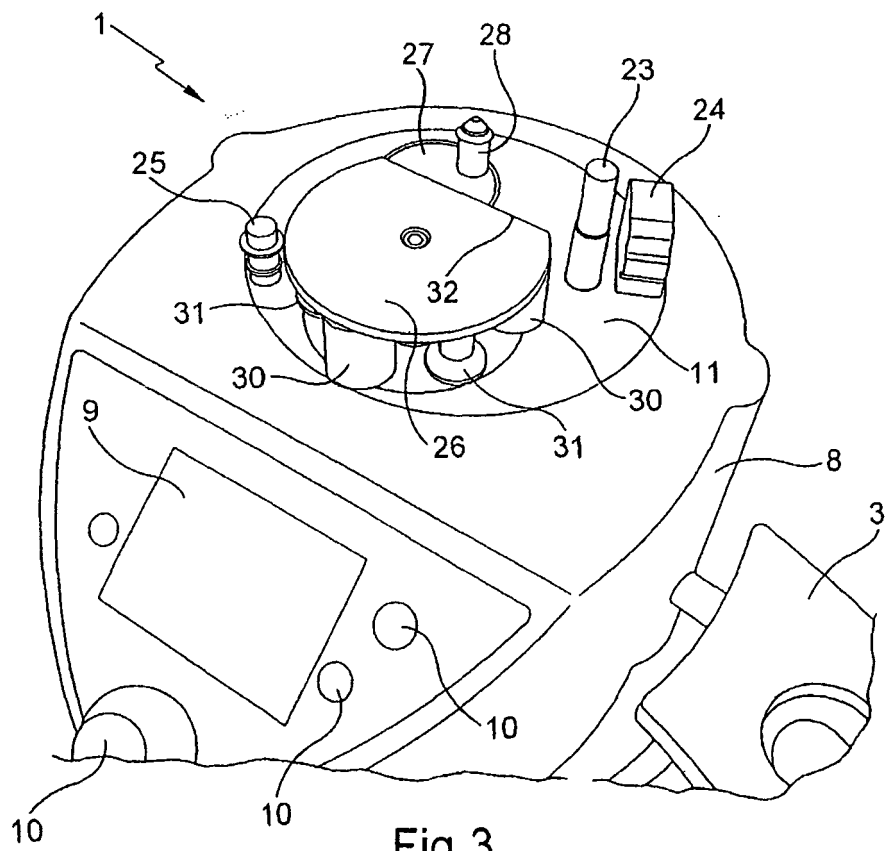


Fig.3

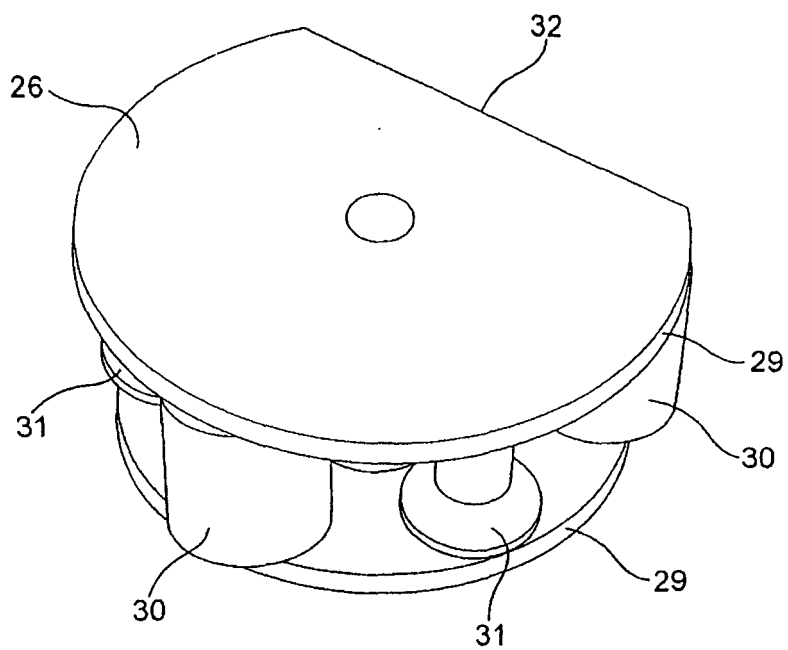


Fig.4

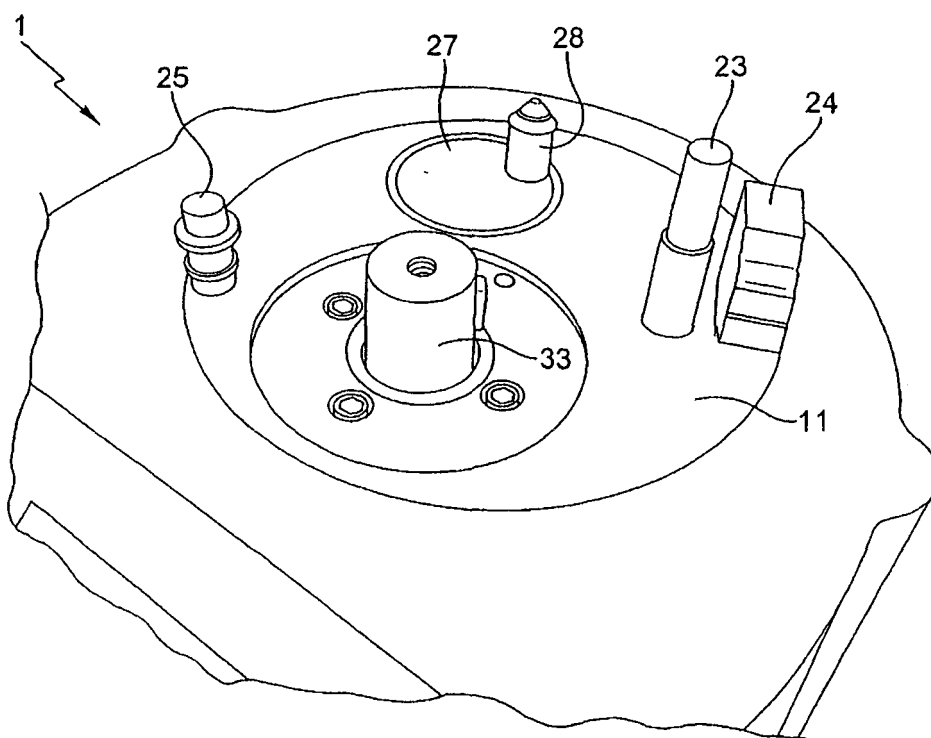
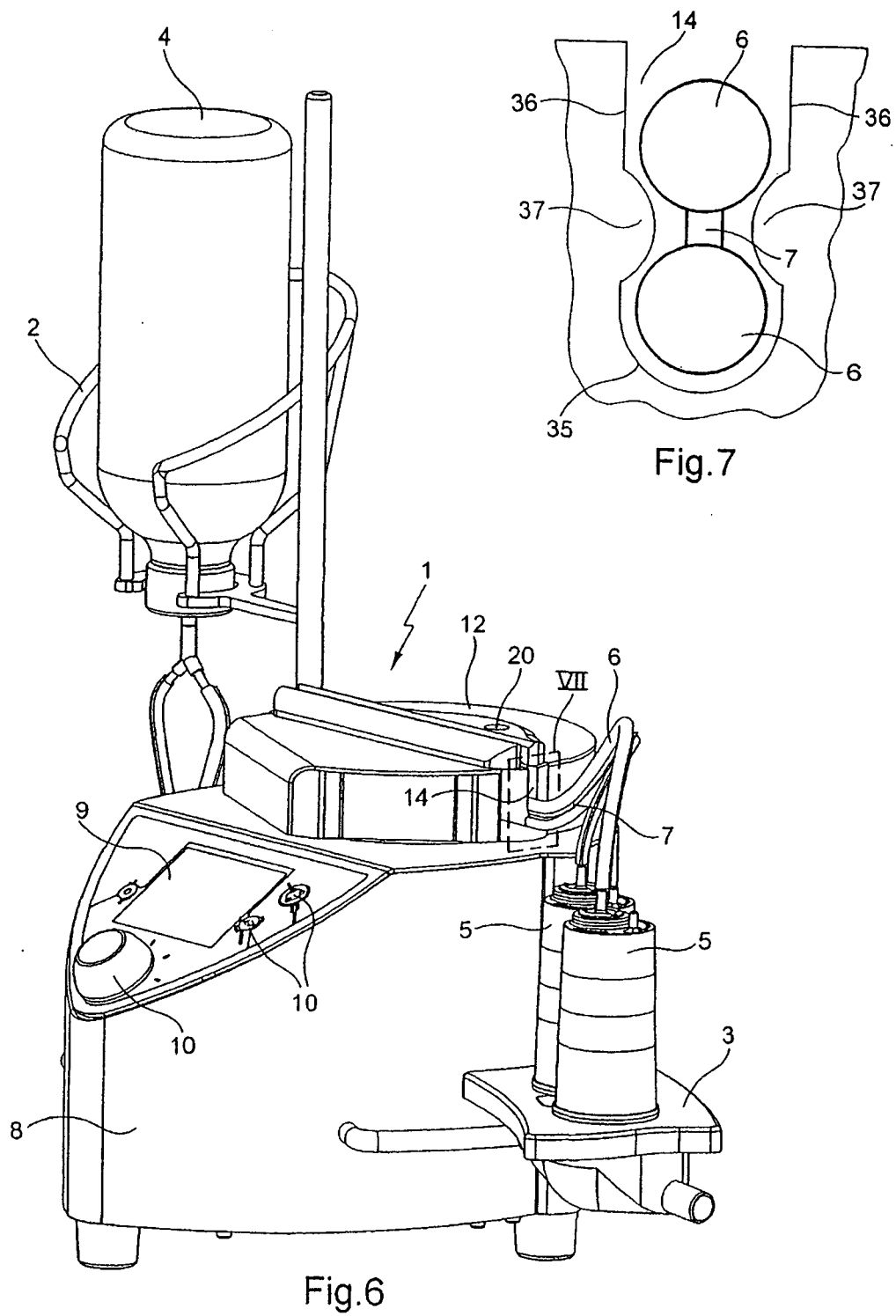


Fig.5



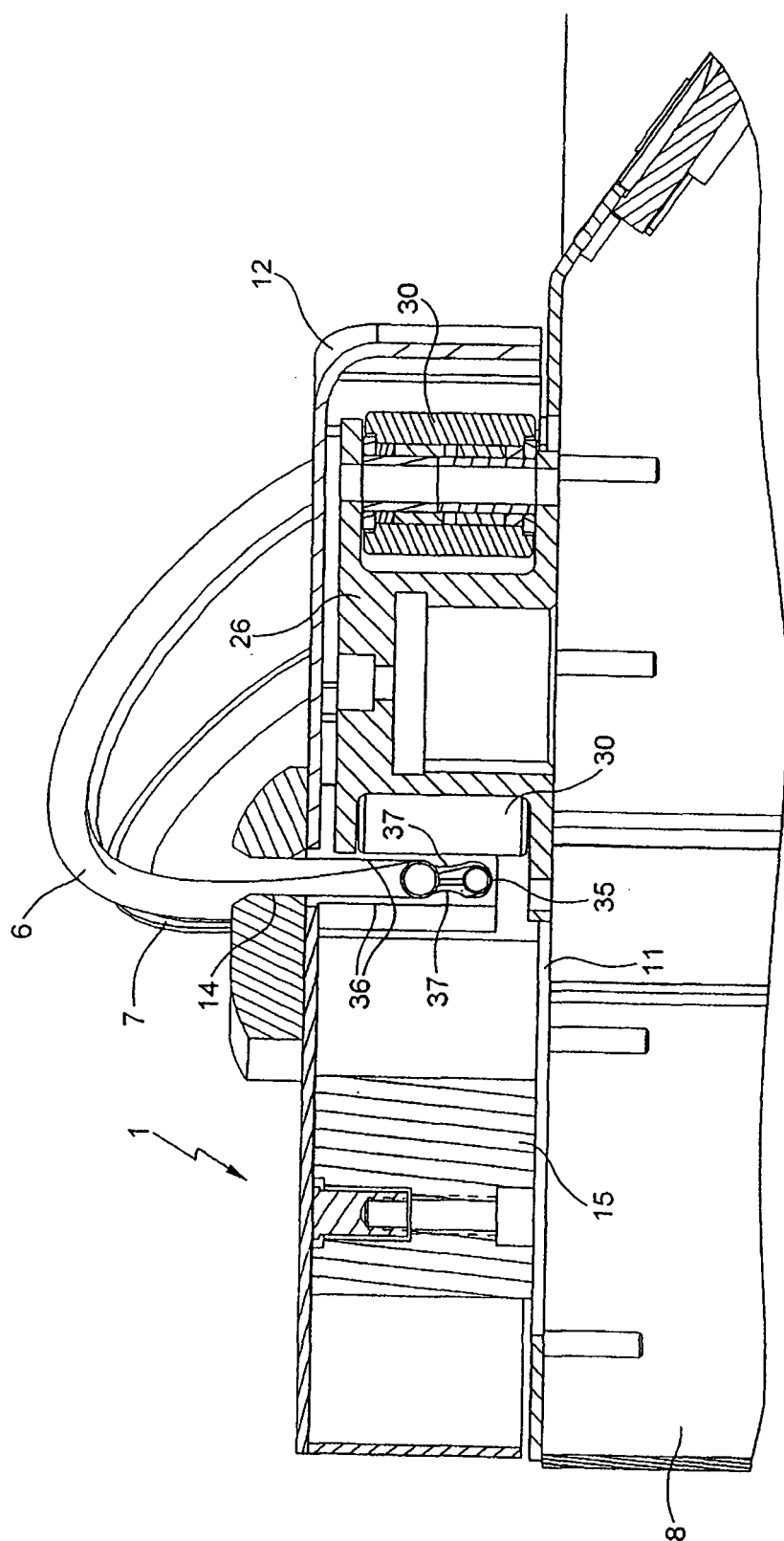


Fig.8

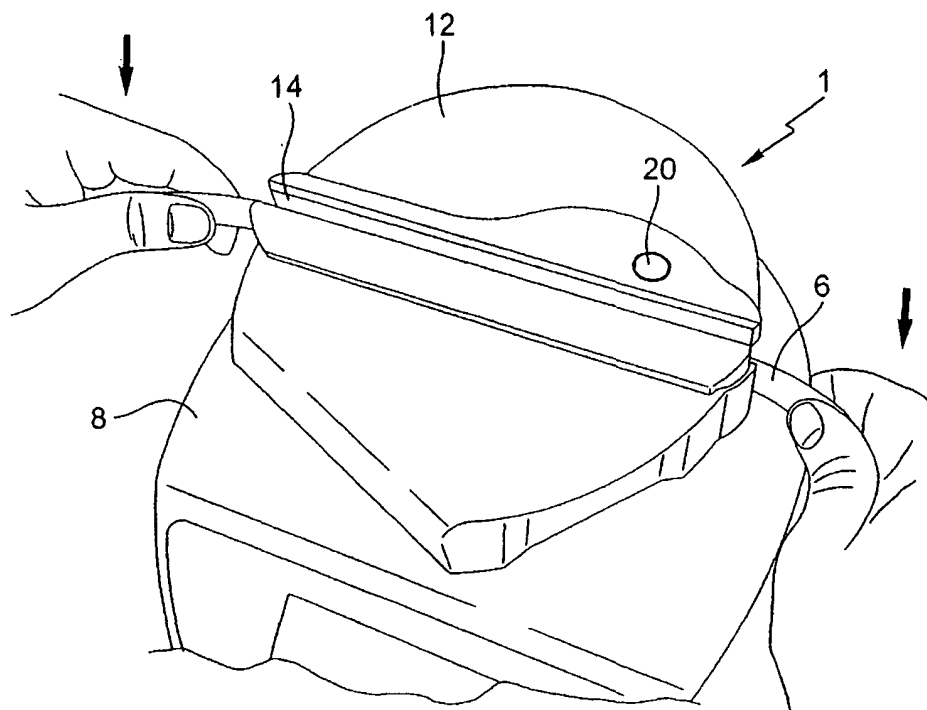


Fig.9

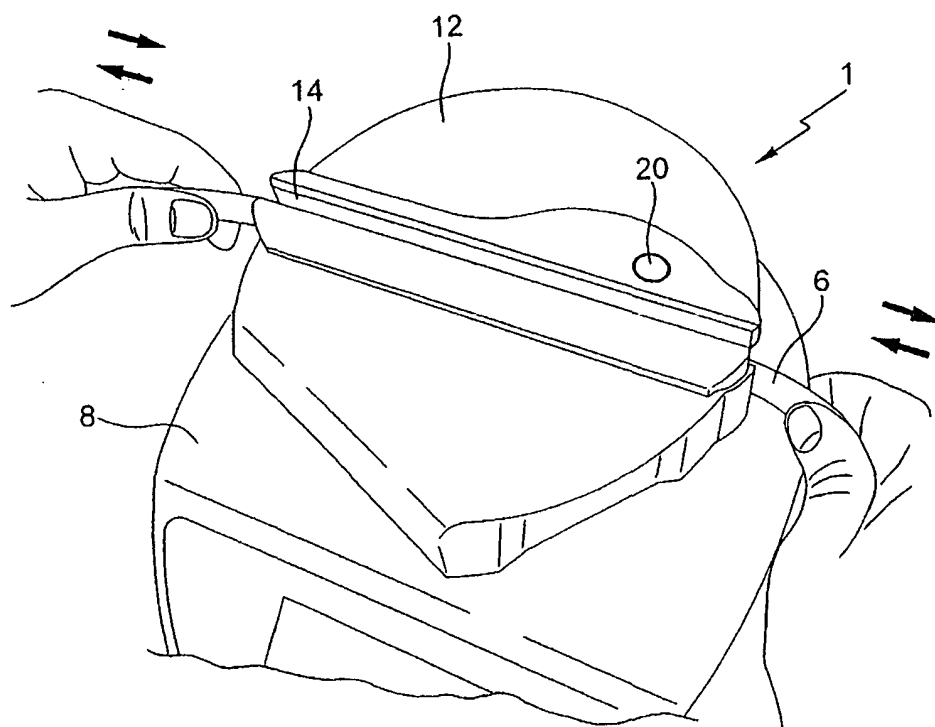


Fig.10

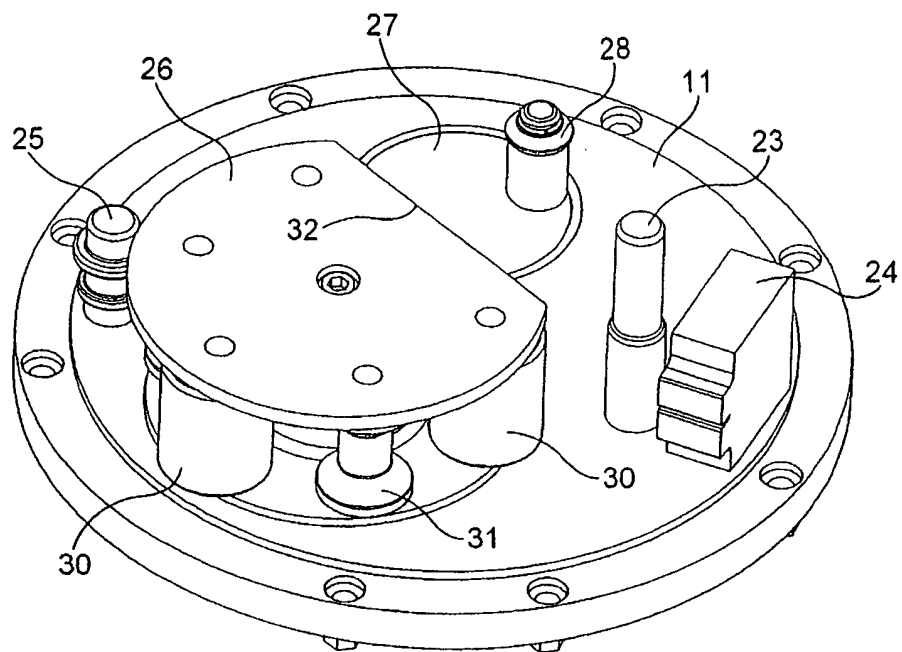


Fig. 11

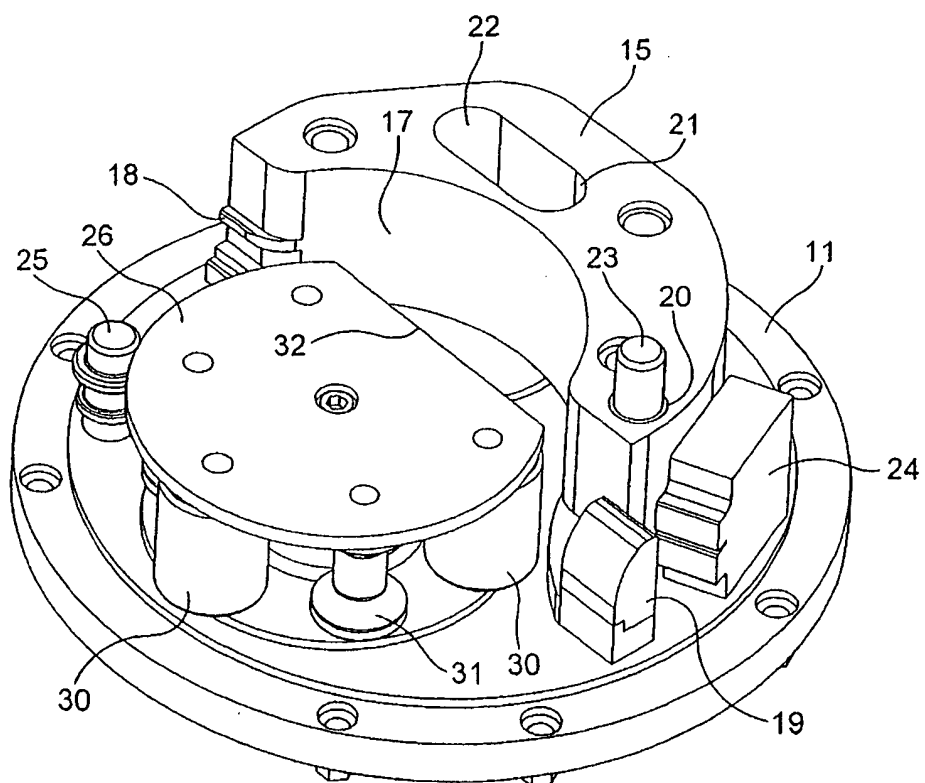
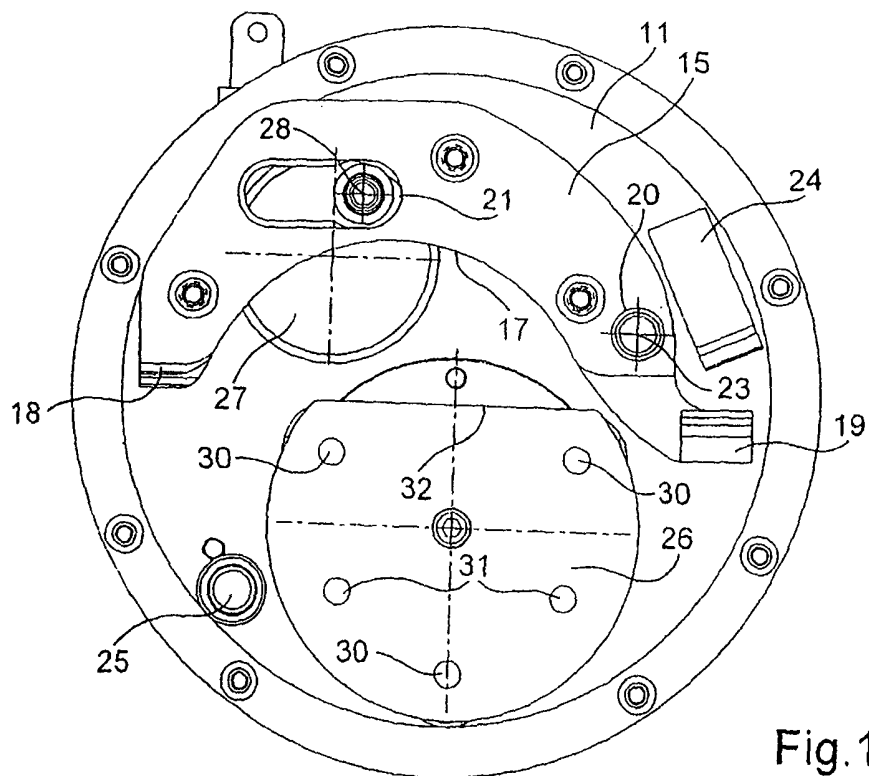
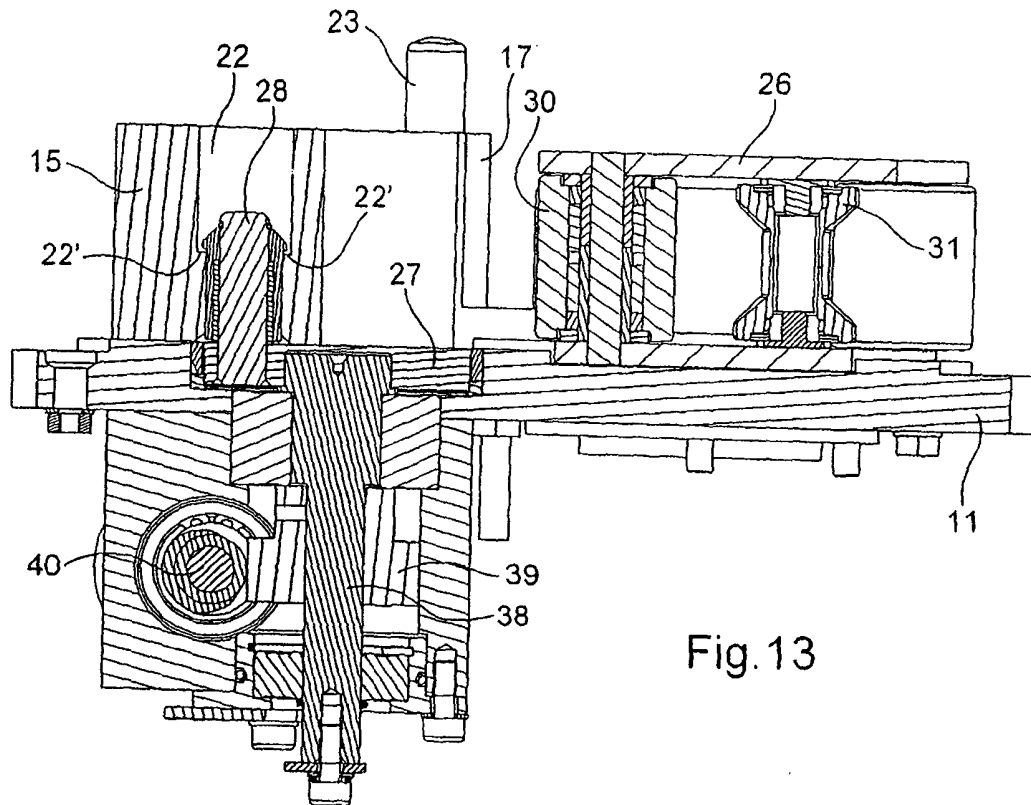


Fig. 12



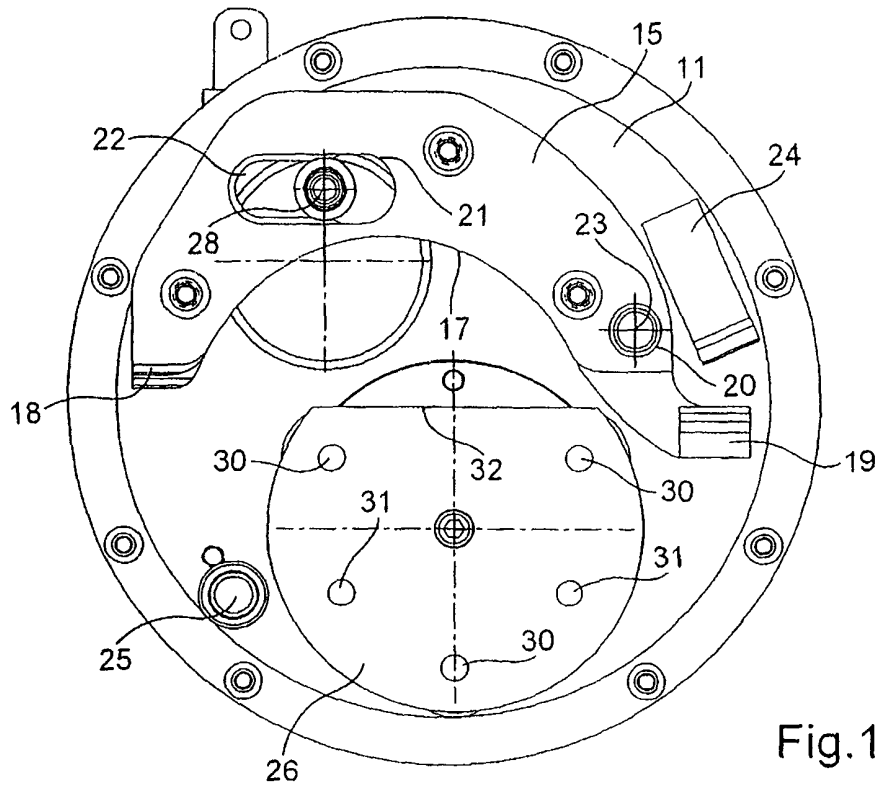


Fig.15

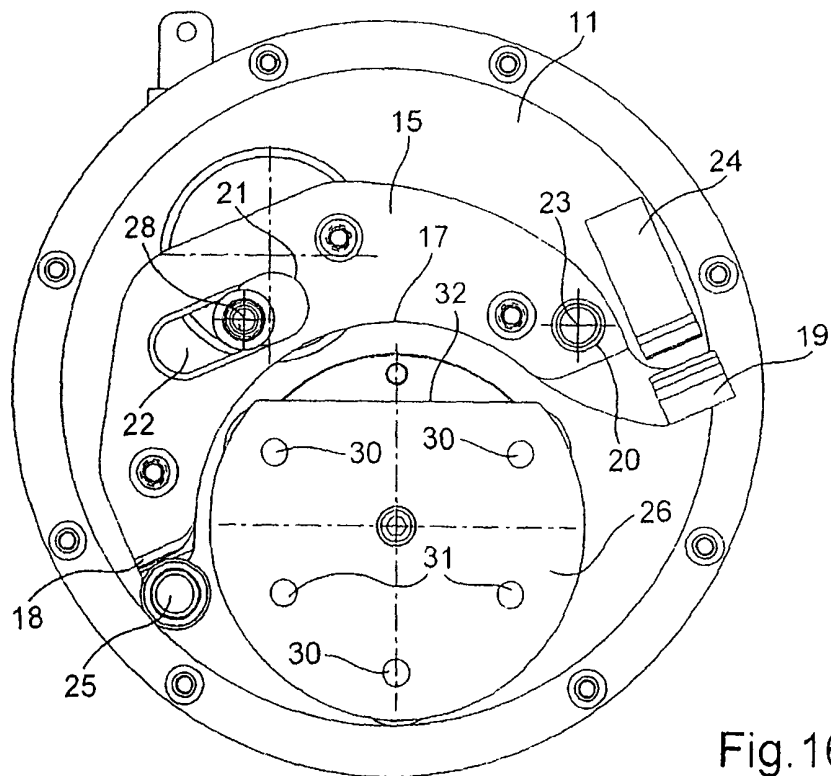
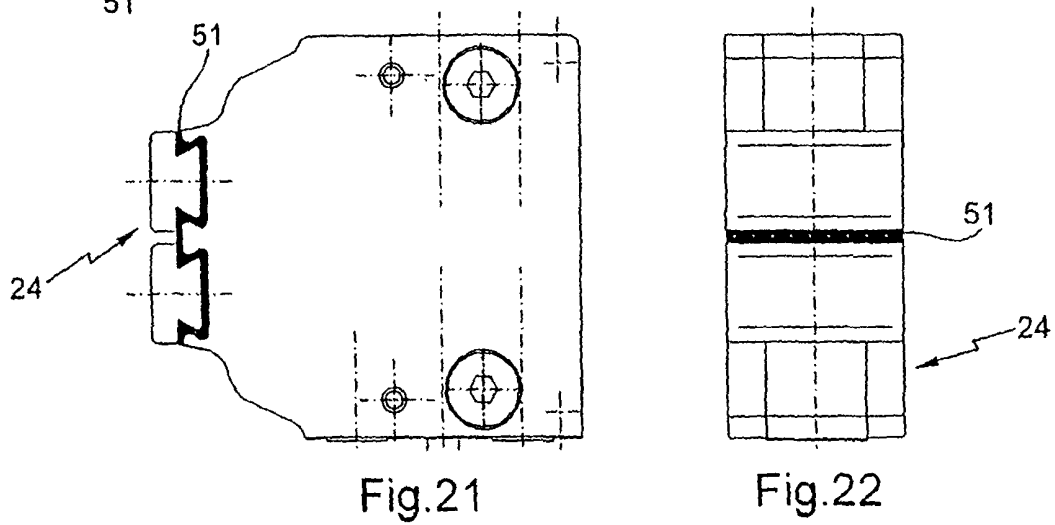
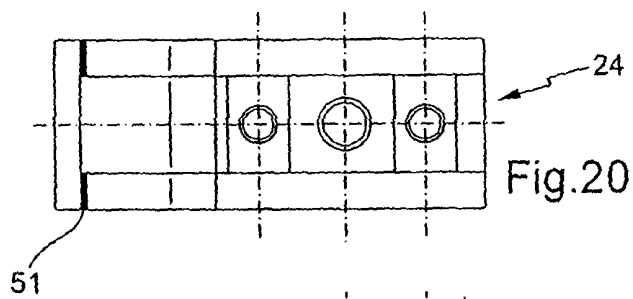
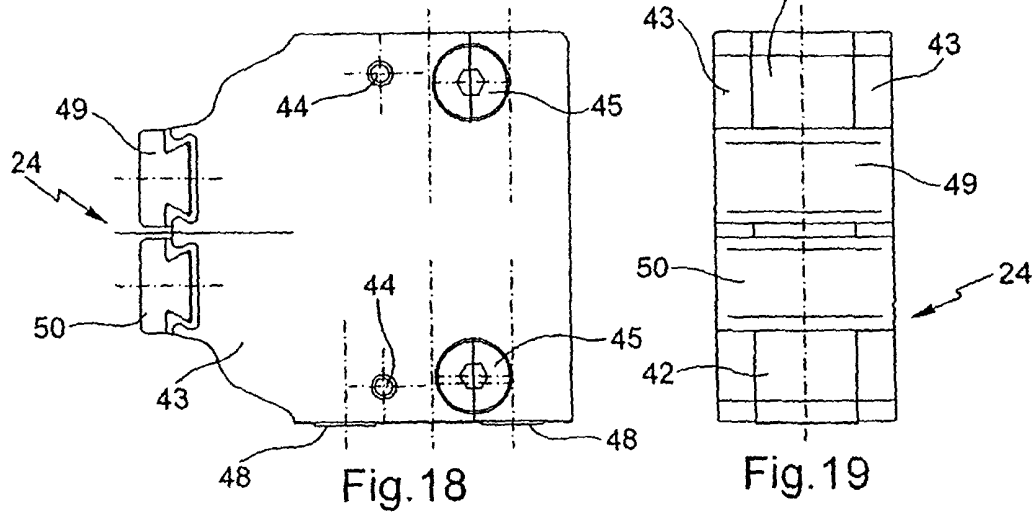
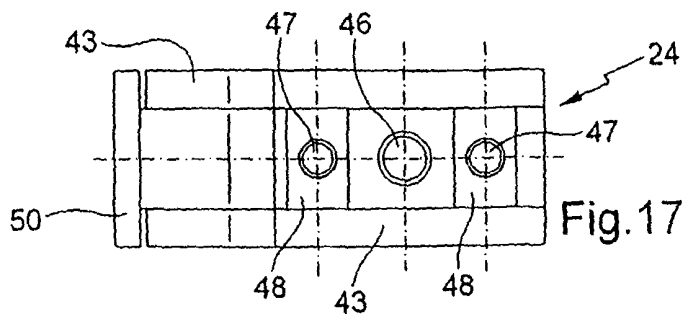
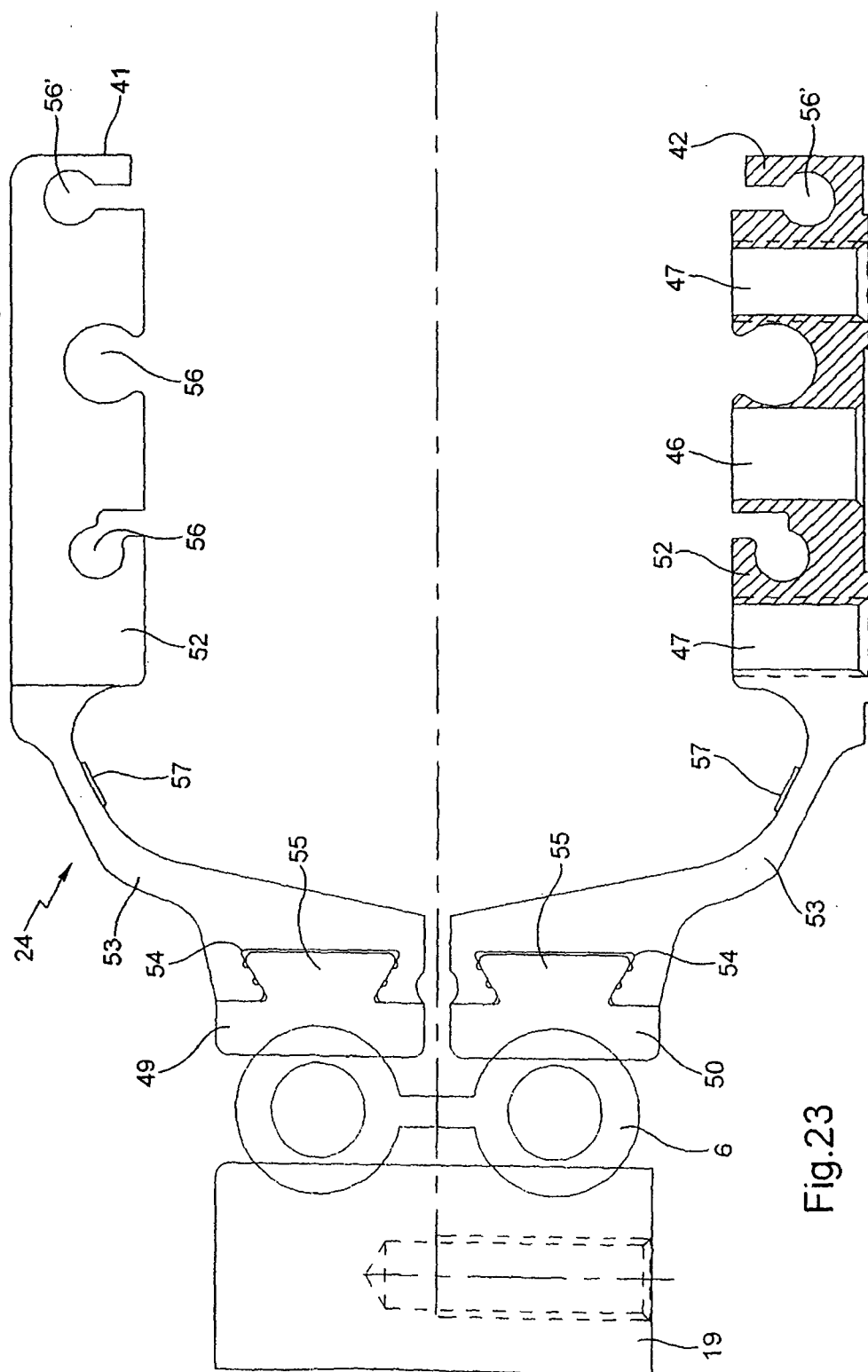


Fig.16





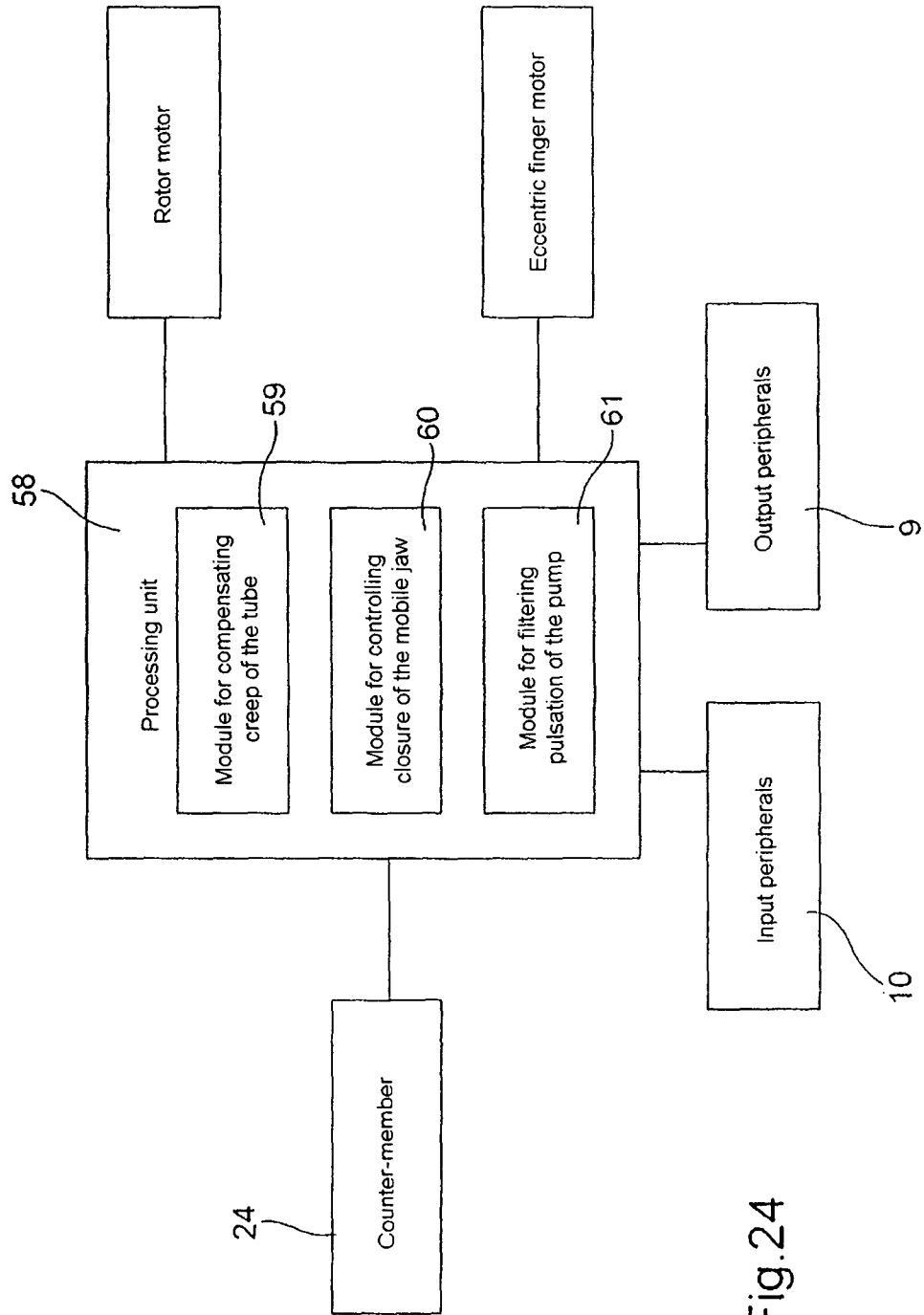


Fig.24



European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 05 29 1198

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	WO 99/47812 A (A.Z.E. MEDICAL, INC) 23 September 1999 (1999-09-23) * abstract *	1-13	F04B43/12
A	US 4 976 590 A (BALDWIN ET AL) 11 December 1990 (1990-12-11) * column 4, line 56 - column 5, line 6 *	1-13	
A	US 4 784 577 A (RITSON ET AL) 15 November 1988 (1988-11-15) * abstract *	1	
A	US 6 164 921 A (MOUBAYED ET AL) 26 December 2000 (2000-12-26) * abstract *	1	
			TECHNICAL FIELDS SEARCHED (Int.Cl.7)
			F04B
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 10 October 2005	Examiner Fistas, N
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EPO FORM 1503 03.82 (P04001)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 05 29 1198

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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10-10-2005

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 9947812	A	23-09-1999	US 5752813 A	19-05-1998

US 4976590	A	11-12-1990	NONE	

US 4784577	A	15-11-1988	NONE	

US 6164921	A	26-12-2000	AT 262648 T	15-04-2004
			AU 1345100 A	29-05-2000
			DE 69915869 D1	29-04-2004
			DE 69915869 T2	03-03-2005
			EP 1135609 A2	26-09-2001
			WO 0028217 A1	18-05-2000
			US 6371732 B1	16-04-2002
