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(71) Applicant: **Tecnologia Regenerativa Qrem, S.L.**
08014 Barcelona (ES)

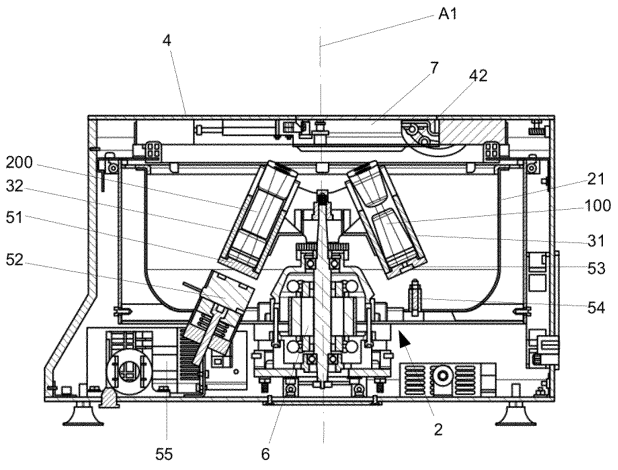
(72) Inventors:
- **TOLOSA GONZÁLEZ, Emiliano Gabriel**
  08026 Barcelona (ES)
- **NOGUERA FERRER, Nuria**
  08014 Barcelona (ES)
- **CARDUS VILA, Ricard**
  08197 Sant Cugat Del Vallès (ES)
- **ESCUER JULIEN, Josep Maria**
  08014 Barcelona (ES)

(74) Representative: **ZBM Patents - Zea, Barlocci & Markvardsen**
Rambla Catalunya, 123
08008 Barcelona (ES)

(54) **FLUID CENTRIFUGE AND METHOD FOR CENTRIFUGING A FLUID USING A CENTRIFUGE**

(57) Fluid centrifuge and method for centrifuging a fluid with a centrifuge: the fluid centrifuge comprising: a frame, a rotor rotatably mounted about an axis of rotation, on the frame, and a cover for protecting the frame and the rotor, wherein the rotor comprises a unique holder intended to receive a cartridge with a fluid to be centrifuged, and the cover comprises an opening adapted to the size of the holder to allow insertion and removal of a cartridge; the application further comprises a method for centrifuging a fluid with a centrifuge, comprising: providing a fluid in a holder of a rotor of the centrifuge; subjecting the fluid to a predetermined centrifugation cycle; sensing the position of the holder relative to a centrifuge frame and stopping the rotor so that the holder is positioned in correspondence with an opening of the centrifuge.

FIG. 3



EP 3 603 813 A2

Description

[0001] This application claims the benefit of the Spanish Patent Application P201700492 filed on March 29th, 2017.

[0002] The present application belongs to the field of fluid centrifuges and methods for centrifuging fluids, in particular for biological fluids such as blood and/or blood derived components, bone marrow or fatty tissue.

BACKGROUND ART

[0003] Centrifuges for biological fluids are known which are employed in laboratory environment. They are devices configured for subjecting samples of biological fluids to rotation. Through the centrifugal force that is achieved during its operation, it is possible to accelerate sedimentation processes in fluids. In this way, the different components of the fluid can be separated.

[0004] Centrifuges essentially comprise a rotor driven by a motor, a frame and a cover for protecting the rotor. The rotor is provided with a plurality of housings, distributed around its axis of rotation. Fluid samples are usually placed in a series of test tubes or pipes, each of which is inserted into a corresponding housing in the rotor. This rotor is located in a bucket shaped chamber.

[0005] The samples can be placed and handled by the user in the rotor housings through the cover, which opens and enables access to the bucket.

[0006] These devices are generally intended for research laboratories and are versatile, since they are used for different types of fluids and different applications, and are intended to centrifuge several samples simultaneously. Consequently, they usually require manual adjustment of the centrifugation parameters on the part of the user, for example speed and time, depending on the fluid, components to be separated, etc.

[0007] On the other hand, in order to avoid imbalances and vibrations, these centrifuges may require all the rotor housings to be filled with similar samples, or the samples to be positioned symmetrically around the axis of rotation, or they may require mechanisms for balancing the rotor when samples are placed only in some of the housings, such as a mechanical system being of similar weight and shape to that of the actual sample in order to achieve a perfect balance in rotation of the rotor.

[0008] This is particularly relevant in relatively large centrifuges, for example for test pieces of the order of 200 cm^3 or larger, since imbalances in this case may already be significant.

[0009] Therefore, the use of such known centrifuges, especially of a certain size, is generally intended for specialized personnel, and their cost is relatively high.

SUMMARY OF THE INVENTION

[0010] In a first aspect, the present disclosure discloses a fluid centrifuge that may comprise:

a frame,

a rotor rotatably mounted about an axis of rotation, on the frame, and a cover for protecting the frame and the rotor, wherein

the rotor may comprise a unique holder intended to receive a cartridge with a fluid to be centrifuged, and the cover may comprise an opening adapted to the size of the holder to allow insertion and removal of a cartridge.

[0011] The expression "opening adapted to the size of the holder" should be interpreted in the sense that the opening is shaped and sized such only the holder intended to receive a cartridge can be comfortably accessed, with the cover keeping the rest of the rotor and other mechanisms of the centrifuge protected and preventing the user from accessing other parts/elements thereof.

[0012] As a result of such features, a safe and easy-to-use fluid centrifuge is obtained. The user only has to insert/remove the cartridge through the opening adapted to the size of the holder; the user bi-univocally finds a unique holder where the cartridge is received with the fluid to be centrifuged.

[0013] A specific positioning of several test tubes or fluid containers is not required to avoid imbalances, and balance is not required to be carried out or checked by the user. The centrifuge may be handled and activated, for example, by a doctor or nurse in the context of a medical consultation.

[0014] According to one example, the fluid centrifuge may comprise a stopping device configured to stop the rotor so that the holder intended to receive the cartridge is arranged in correspondence with the opening. This feature further facilitates the use of the centrifuge, since the user will always find the cartridge accessible through the opening after centrifugation, without the need to rotate the rotor manually to match the holder to the opening.

[0015] As a result of the fact that the opening of the cover is adapted to the size of the holder, safety is improved since the machine structure is stiffened in case of accidental catastrophic breakage of a rotor shaft while the rotor is rotating at high speed.

[0016] In one example, the stopping device may comprise an electromagnetic brake that may comprise a pair of mutually magnetically linkable members, one member being formed integral with the rotor and the other member being formed integral with the frame.

[0017] In another example, the stopping device may comprise a sensor for sensing the position of the rotor relative to the frame, so that the electromagnetic brake is operable according to a signal from said position sensor.

[0018] In a further example of the fluid centrifuge, the position sensor may comprise a magnet formed integral with the holder and a magnetic field detector formed integral with the frame.

[0019] In one example, the fluid centrifuge may comprise a motor for rotating the rotor about the axis of rota-

tion, wherein the stopping device may comprise a processing unit configured for controlling the operation of the motor.

[0020] In another example, the motor may be a stepper motor.

[0021] In another example, the motor may be of the (permanent magnet) "BLDC" synchronous type.

[0022] In some examples, the fluid centrifuge may comprise a motor for rotating the rotor about the axis of rotation, wherein the stopping device may comprise an encoder associated with the motor.

[0023] According to some examples, the holder may be mounted on the rotor in an oscillating manner.

[0024] In a further example, the holder may comprise a housing adapted to the shape of the cartridge.

[0025] According to one example, the rotor may comprise a counterweight arranged symmetrically to the holder relative to the axis of rotation.

[0026] According to another example, the rotor may comprise an additional holder intended to receive the counterweight.

[0027] In other examples, the additional holder may be mounted on the rotor in an oscillating manner.

[0028] According to one example, the cover may comprise an openable lid in correspondence with the opening.

[0029] In one example, the rotor may comprise a pair of longitudinal members joined together through a cross member so that an "H" is defined, wherein the longitudinal members may be arranged symmetrically to one another relative to the axis of rotation.

[0030] In some examples, the holder intended to receive the cartridge may be arranged between the pair of longitudinal members.

[0031] In other examples, the additional holder intended to receive the counterweight may be arranged between the pair of longitudinal members.

[0032] In one example, the holder may comprise a housing intended to receive a unique cartridge with fluid to be centrifuged.

[0033] In a second aspect, a method for centrifuging a fluid with a centrifuge is disclosed herein, which may comprise:

providing a fluid in a holder of a rotor of the centrifuge; and subjecting the fluid to a predetermined centrifugation cycle;

sensing the position of the holder relative to a centrifuge frame and stopping the rotor so that the holder is positioned in correspondence with a centrifuge opening, wherein the opening is adapted to the holder size.

[0034] Thanks to this method, the ease of use of the centrifuge is improved, since the holder will always be in correspondence with the opening when the cartridge has to be inserted and/or removed by the user.

[0035] According to one example, the holder may be arranged in an oscillating manner relative to the rotor so that the angle of inclination of the holder relative to an axis of rotation of the rotor may vary when subjecting the fluid to a predetermined centrifugation cycle.

[0036] In another example, one member may be magnetically attached to the rotor and another member may be formed integral with the frame in order to stop the rotor.

[0037] Further objects, advantages and features of embodiments of the invention will become apparent to those skilled in the art from the description, or may be learned by practice thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038] Particular embodiments of the present description will be described in the following by way of a non-limiting example, with reference to the appended drawings, in which:

Figure 1 is a diagrammatic perspective view of a fluid centrifuge with a lid in a closed position according to the description;

Figure 2 is a diagrammatic perspective view of the fluid centrifuge in figure 1 with the lid in an open position according to the description;

Figure 3 is a diagrammatic view of a longitudinal section of the fluid centrifuge in figure 1;

Figure 4 is a diagrammatic perspective view of a rotor of the fluid centrifuge according to the description:

Figure 5 is a diagrammatic perspective view of the rotor in figure 4 in a fluid centrifuge frame according to the description.

DETAILED DESCRITION OF EMBODIMENTS

[0039] One example of the fluid centrifuge according to the present description, which has been designated as a whole with reference numeral 1, has been illustrated in figure 1.

[0040] Figure 1 shows a diagrammatic perspective view of the fluid centrifuge 1 with a lid 7 in a closed position and figure 2 shows the same fluid centrifuge 1 but with the lid 7 in an open position and from another point of view.

[0041] Figure 3 shows a diagrammatic view of a longitudinal section of the fluid centrifuge 1. In general, the enclosed figures show that the fluid centrifuge 1 may comprise:

a frame 2 which may comprise a bucket 21;

a rotor 3 rotatably mounted about an axis of rotation A1, on the frame 2, and

a cover 4 for protecting the frame 2 and the rotor 3;

a chamber where the rotor 3 is located and where centrifugation is carried out may be defined between the cover 4 and the bucket 21,

the rotor 3 comprises a unique holder 31 intended to receive a cartridge 100 with a fluid to be centri-

fuged; examples of the rotor 3 are described below, and

the cover 4 comprises an opening 41 adapted to the size of the holder 31 to allow insertion and removal of a cartridge 100. The opening 41 may take on any shape adapted to the size of the holder 31. In the illustrated examples, the opening 41 is formed in a protective member 42 comprised in the cover 4. Such protective member 42 may be formed integral with the rest of the cover 4 or it may be a separate part but being an additional part of the cover. In other words, cover is understood as the set of elements that are placed on the rotor and the rest of mechanisms of the device in order to protect them and prevent the user from gaining access to them.

[0042] The holder 31 is the unique holder that is intended to receive a cartridge with a fluid that it is desired to centrifuge in order to separate its components, although, as will be pointed out below, it is possible that the centrifuge has for example a further additional holder, with a different function.

[0043] The term cartridge refers herein to a container capable of receiving a sample of fluid to be centrifuged. Said cartridge may have a suitable internal configuration, for example through channels or tubes (not shown), for subjecting the fluid sample to the centrifugal force. The cartridge may be of a fungible nature for example in cases where biological fluids such as blood and/or derivatives thereof are to be centrifuged.

[0044] For example, the cartridge may have the configuration described in WO2016174180 A1.

[0045] In other examples not illustrated herein, the cartridge 100 may comprise more than one sample to be centrifuged and/or the unique holder 31 may be adapted to receive more than one cartridge 100.

[0046] The fluid centrifuge 1 may comprise a stopping device configured to stop the rotor 3 so that the holder 31 intended to receive the cartridge 100 can be arranged in correspondence with the opening 41 as it will be explained below. Figure 2 shows how the cartridge 100 arranged in the holder 31 remains in correspondence with the opening 41 so that it can be easily removed or inserted by the user and without fear of making a mistake.

[0047] In one example, the stopping device may comprise an electromagnetic brake which in turn comprises a pair of mutually magnetically linkable members 51, 52: one member 51 may be formed integral with the rotor 3 and the other member 52 may be formed integral with the bucket 21 of the frame 2.

[0048] The stopping device may comprise a sensor 3 for sensing the position of the rotor relative to the frame 2. This allows the electromagnetic brake to be actuated according to a signal from said position sensor, which may be direct or through a processing unit 55 as will be described below. The position sensor may comprise a magnet 53 formed integral with the holder 31 and a magnetic field detector 54 formed integral with the bucket 21 of the frame 2. When the magnet 53, which can rotate together with the holder 31, passes over the magnetic field detector 54, it detects this and outputs the corresponding signal, so that the electromagnetic brake comes into operation stopping the rotor 3 in the predetermined position.

[0049] The fluid centrifuge 1 may comprise a motor 6 operatively linked to the rotor 3 for rotating the rotor 3 about the axis of rotation A1. The stopping device may comprise the processing unit 55 configured for controlling the operation of the motor 6. The processing unit 55 can thus activate, accelerate, brake and/or stop the operation of the motor 6. The fluid centrifuge 1 may also comprise a user interface such as a display screen 8 for controlling/managing centrifugation. Said display screen may be arranged on a protruding portion of the fluid centrifuge 1 so as to improve user readability. In the figures enclosed herein, such protruding portion has a wedge-shaped cross-section.

[0050] In a case not illustrated where said motor 6 is a stepper motor, the electromagnetic brake may be dispensed with, since the angular displacement of the motor 6, and therefore the angular position of the rotor 3 driven by the motor 6, can be known at all times. This information can be sent to the processing unit 55 so as to control at all times the operation of the motor 6.

[0051] In other examples not illustrated, the motor 6 may be of the "BLDC" synchronous or permanent magnet type. The English acronym "BLDC" refers to "Brushless DC" (brushless DC motor). In a similar manner to the example above, with the BLDC synchronous type motor 6 the electromagnetic brake may be also dispensed with since the angular displacement of the motor 6, and thus the angular position of the rotor 3 that is driven by the motor 6, can be known. This information can also be sent to the processing unit 55 for controlling the operation of the motor 6.

[0052] In another example not illustrated, the stopping device may comprise an encoder associated with the motor 6. The rotational speed, the angular displacement of the motor 6, etc. can be encoded from the rotation of the motor 6. This information can be sent to the processing unit 55 for controlling at all times the operation of the motor 6. In this way, the position sensor described above may be dispensed with.

[0053] Figures 3-5 show that the holder 31 may comprise a housing or space adapted to the shape of the cartridge 100. The shape and size of the holder 31 conform to the shape and size of the cartridge 100. In this way, holding of the cartridge 100 is optimal for subjecting it to the centrifugation process and allows it to be inserted and removed simply; incorrect positioning of the cartridge 100 can also be prevented when not correctly inserted into the adapted housing, for example with the cartridge 100 upside down.

[0054] Continuing with figures 3-5, it can be seen that the rotor 3 may comprise a counterweight 200 symmetrically arranged to the holder 31 relative to the axis of

rotation A1. In this way, the cartridge 100 arranged in the unique holder 31 intended to receive a cartridge with fluid to be centrifuged and separated is balanced. The fluid centrifuge 1 may comprise an additional holder 32 intended to receive the counterweight 200. Thus, the counterweight 200 could for example be another cartridge that may be filled with water or another liquid or fluid or solid, so that it is of the same weight and its mass distribution is similar to the cartridge with the fluid to be centrifuged that is placed in the holder 31. In this way, it is simple to adapt the centrifuge to a specific application, in which the cartridges with the fluid to be centrifuged will have a certain weight.

[0055] In other examples not illustrated, the counterweight 200 may be arranged in the rotor 3 without the additional holder 32.

[0056] When a holder 31 and an additional holder 32 are provided, the stopping device may comprise the magnet 53 of the position sensor formed integral with the holder 31. The additional holder 32 may be formed integral with any of the members 51, 52 of the electromagnetic brake: in one example the member 51 may be a plate or the like made of ferromagnetic material and the other member 52 may be an electromagnet that is actuated when the magnet 53 is detected by the stopping device. No further details will be given for the electromagnet internal structure since it may be any within the reach of those skilled in the art.

[0057] Figure 3 shows that the member 52, which may be the electromagnet, and more specifically its longitudinal axis, may be inclined relative to the axis of rotation A1, so that it is aligned relative to the additional holder 32 where the member 51, which may be the plate or piece of ferromagnetic material, is located. That is, in a resting state the two members of the electromagnetic brake are tilted the same amount relative to the axis of rotation A1. With such electromagnet arrangement, maximum efficiency thereof is ensured when the additional holder 32 (and/or holder 31) reaches or is about to reach its minimum inclination relative to the axis of rotation A1, corresponding to the resting state.

[0058] When an additional holder 32 is not available, the member 51 may be located elsewhere in the rotor 3.

[0059] The holder 31 and the additional holder 32 may be configured as a sheath like receptacle so as to be able to receive, respectively, the cartridge 100 and the counterweight 200. Such receptacles may have an upper mouth through which the cartridge is inserted or removed; in addition, the opening of said mouth may extend over the receptacle side walls, leaving a free surface for accessing the cartridge 100 and thus improving handling thereof.

[0060] The stopping device may comprise a sensor 3 for sensing the position of the rotor relative to the frame 2. This allows the electromagnetic brake to be actuated according to a signal from said position sensor. The position sensor may comprise a magnet 53 formed integral with the holder 31 and a magnetic field detector 54 formed integral with the frame 2. When the magnet 53 passes over the magnetic field detector 54, it detects this and outputs the corresponding signal, so that the electromagnetic brake comes into operation stopping the rotor 3 in the predetermined position.

[0061] A liquid centrifuge 1 is illustrated in figures 2-3 where an openable lid 7 is shown in correspondence with the opening 41 of the cover 4. Such lid 7 can be opened when the rotor 3 remains in a resting state.

[0062] Turning to figures 3-5, it can be seen that, according to one example, the rotor 3 may comprise a pair of longitudinal members 33, 34 joined together through a cross member 35 so that an "H" is defined. The longitudinal members 33, 34 may be arranged symmetrically to one another relative to the axis of rotation A1. In the example shown, both the holder 31 and the additional holder 32 are respectively arranged between the pair of longitudinal members 33, 34 but it may be the case that some of the holders are not arranged in this way.

[0063] According to another example, the holder 31 may be arranged in an oscillating manner relative to the rotor 3; similarly, and according to a different example, the additional holder 32 may also be arranged in an oscillating manner relative to the rotor 3. To achieve this effect, the receptacles (holder 31 and additional holder 32) may be rotatably attached relative to the rotor 3, such that the relative inclination between the cartridge 100 (e. g. its longitudinal axis) and the axis of rotation A1 may vary during centrifugation. In the examples shown, the receptacles are attached to the longitudinal members 33, 34 by means of pins 36; as a result, the receptacles can be freely rotated relative to the rotor 3 when subjected to centrifugal force.

[0064] In the examples shown in the figures, the holder 31 is displaced relative to the axis of rotation A1.

[0065] A method for centrifuging a fluid with a fluid centrifuge 1 is described below according to some examples.

[0066] The method may comprise:

providing a fluid in the holder 31 of the rotor 3. To this end, the cartridge 100 with the sample of fluid to be centrifuged may be inserted by the user through the opening 41 that is exposed when the lid 7 is in an open position. Since the opening 41 is adapted to the size of the unique holder 31, no possibility of misplacing the cartridge 100 by the user exists;

subjecting the fluid to a predetermined centrifugation cycle. In this case, the user can interact with the fluid centrifuge 1 through a user interface, for example the display screen 8 which may be a touchscreen. In other examples, activation of the centrifugation cycle may be automatic as the lid 7 is closed or it may be through suitable buttons (not shown). The interface may be in data communication with the processing unit 55 which in turn controls the operation of the motor 6. The processing unit 55 may have one or more predetermined centrifugation cycles

stored therein. During centrifugation, the relative inclination angle of the holder 31 and/or the additional holder 32 may be varied relative to the axis of rotation A1 due to the centrifugal force; in this way, separation of fluid components by sedimentation can be facilitated;

sensing/determining the position of the holder 31 relative to the frame 2 of the centrifuge and stopping the rotor 3 such that the holder 31 is positioned in correspondence with the opening 41 of the centrifuge. In order to detect/determine the relative position of the holder 31, various examples may be used, such as those described above: position sensor, stepper motor, encoder associated with the motor, etc. In the example of the position sensor, the magnet 53 formed integral with the holder 31 can be detected by the magnetic field detector 54 and this information may be for example sent to the processing unit 55 that can output an activation command to the electromagnetic brake associated with the additional holder 32. In this way, the holder 31 with the cartridge 100 is stopped in correspondence with the opening 41. The user only has to remove the cartridge 100 without fear of making a mistake.

[0067] In one exemplary case, the cartridge 100 may contain a blood sample (not shown) that is inserted into the centrifuge to separate the different components by sedimentation, taking advantage of the different densities thereof. Once the predetermined centrifugation cycle has been completed, the cartridge 100 can be removed through the opening 41, with the components already separated from each other.

[0068] For example, the method may comprise a centrifugation cycle as described in WO2016174180 A1.

[0069] Although only a number of examples have been disclosed herein, other alternatives, modifications, uses and/or equivalents thereof are possible. Furthermore, all possible combinations of the particular embodiments described herein are also covered by the present invention. Reference signs related to drawings and placed in parentheses in a claim are solely for attempting to increase the intelligibility of the claim, and shall not be construed as limiting the scope of the claim. The scope of the present invention should not be limited by particular examples, but should be determined only by a fair reading of the claims that follow.

Claims

1. Fluid centrifuge (1) comprising:

a frame (2),
a rotor (3) rotatably mounted about an axis of rotation (A1), on the frame (2), and
a cover (4) for protecting the frame (2) and the rotor (3),
characterized in that
the rotor (3) comprises a unique holder (31) intended to receive a cartridge (100) with a fluid to be centrifuged, and
the cover (4) comprises an opening (41) adapted to the size of the holder (31) to allow insertion and removal of a cartridge (100).

2. Fluid centrifuge (1) according to claim 1, wherein it comprises a stopping device configured for stopping the rotor (3) so that the holder (31) intended to receive the cartridge (100) is arranged in correspondence with the opening (41).

3. Fluid centrifuge (1) according to claim 2, wherein the stopping device comprises an electromagnetic brake comprising a pair of mutually magnetically linkable members (51, 52), one member (51) being formed integral with the rotor (3) and the other member (52) being formed integral with the frame (2).

4. Fluid centrifuge (1) according to claim 3, wherein the stopping device comprises a sensor for sensing the position of the rotor (3) relative to the frame (2), so that the electromagnetic brake is operable according to a signal from said position sensor.

5. Fluid centrifuge (1) according to claim 4, in which the position sensor comprises a magnet (53) formed integral with the holder (31) and a magnetic field detector (54) formed integral with the frame (2).

6. Fluid centrifuge (1) according to claim 2, comprising a motor (6) for rotating the rotor (3) about the axis of rotation (A1), wherein the stopping device comprises a processing unit (55) configured for controlling the operation of the motor (6).

7. Fluid centrifuge (1) according to claim 6, wherein the motor (6) is a stepper motor.

8. Fluid centrifuge (1) according to claim 6, wherein the motor (6) is of the "BLDC" synchronous permanent magnet type.

9. Fluid centrifuge (1) according to claim 2, wherein it comprises a motor (6) for rotating the rotor (3) about the axis of rotation (A1), wherein the stopping device comprises an encoder associated with the motor (6).

10. Fluid centrifuge (1) according to any one of the claims 1-9, wherein the holder (31) is mounted on the rotor (3) in an oscillating manner.

11. Fluid centrifuge (1) according to any one of the claims 1-10, wherein the holder (31) comprises a housing adapted to the shape of the cartridge (100).

12. Fluid centrifuge (1) according to any one of the claims 1-11, wherein the rotor (3) comprises a counterweight (200) arranged symmetrically to the holder (31) relative to the axis of rotation (A1).

13. Fluid centrifuge (1) according to claim 12, wherein the rotor (3) comprises an additional holder (32) intended to receive the counterweight (200).

14. Fluid centrifuge (1) according to any one of the claims 12-13, wherein the counterweight (200) is mounted on the rotor (3) in an oscillating manner.

15. Fluid centrifuge (1) according to any one of the claims 1-14, wherein the cover (4) comprises an openable lid (7) in correspondence with the opening (41).

16. Fluid centrifuge (1) according to any one of the claims 1-15, wherein the rotor (3) comprises a pair of longitudinal members (33, 34) joined together through a cross member (35) so that an "H" is defined, wherein the longitudinal members (33, 34) are arranged symmetrically relative to the axis of rotation (A1).

17. Fluid centrifuge (1) according to claim 16, wherein the holder (31) intended to receive the cartridge (100) is arranged between the pair of longitudinal members (33, 34).

18. Fluid centrifuge (1) according to any of the claims 16-17, wherein the additional holder (32) intended to receive the counterweight (200) is arranged between the pair of longitudinal members (33, 34).

19. Method for centrifuging a fluid with a fluid centrifuge, comprising:

providing a fluid in a holder (31) of a rotor (3) of the centrifuge; and
subjecting the fluid to a predetermined centrifugation cycle;

characterized in that it comprises:
sensing the position of the holder (31) relative to a frame (2) of the centrifuge and stopping the rotor (3) so that the holder (31) is positioned in correspondence with an opening (41) of the centrifuge, wherein the opening (41) is adapted to the size of the holder (31).

20. Method according to claim 19, wherein the holder is arranged in an oscillating manner relative to the rotor (3) so that the angle of inclination of the holder (31) relative to an axis of rotation (A1) of the rotor (3) varies as the fluid is subjected to a predetermined centrifugation cycle.

21. Method according to any one of the claims 19-20, wherein one member (51) formed integral with the rotor (3) and another member (52) formed integral with the frame (2) are magnetically linked to stop the rotor (3).

FIG. 1

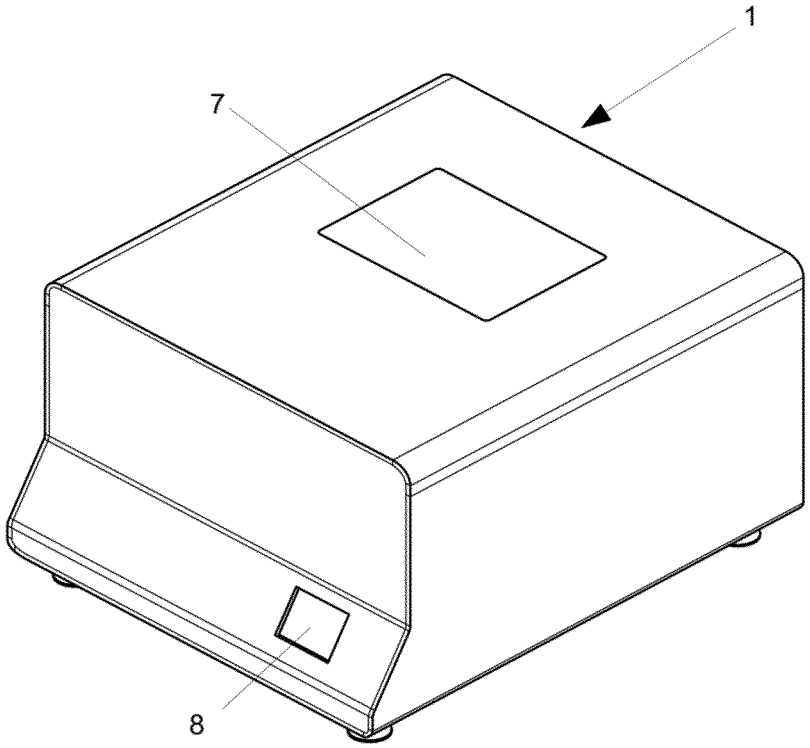


FIG. 2

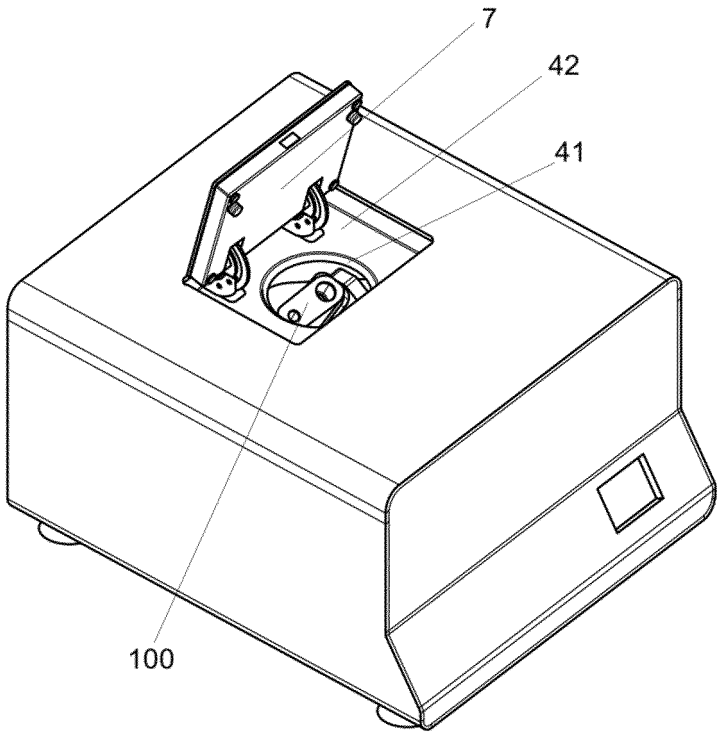


FIG. 3

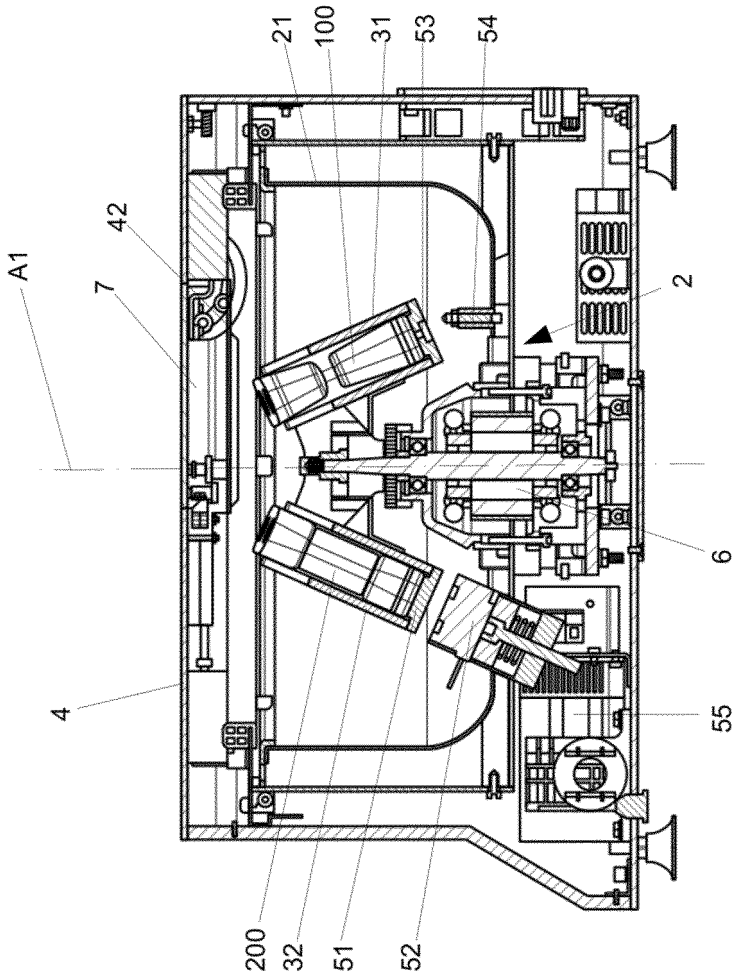


FIG. 4

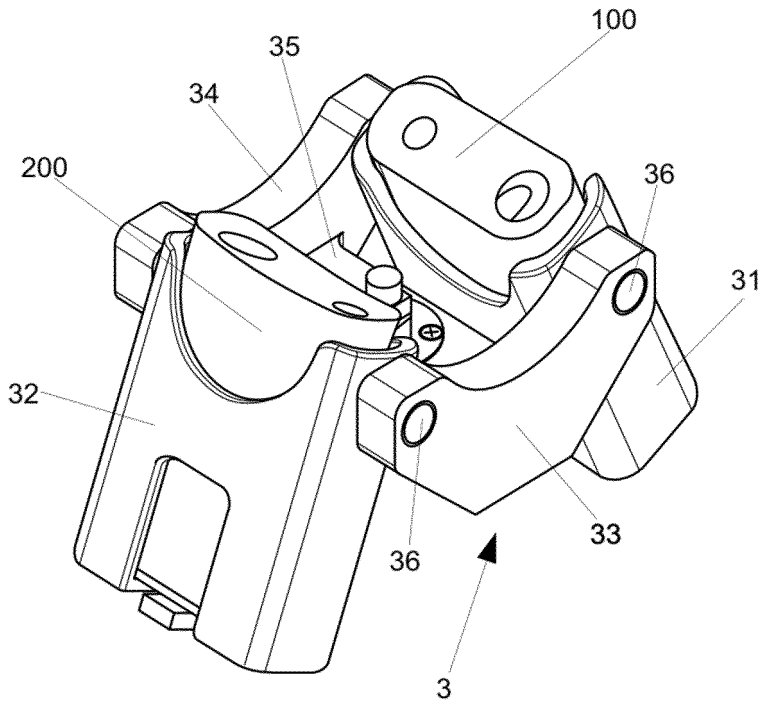
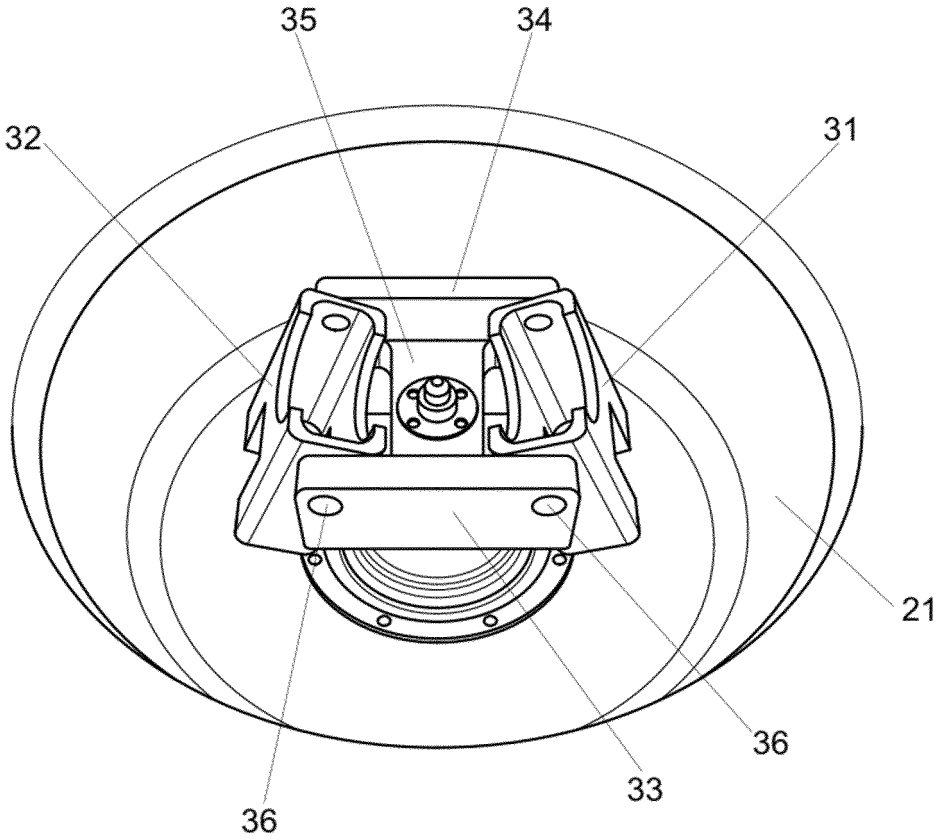


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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