A DEVICE FOR TRANSPORTING PARTICLES, HOLDING A CONTAINER AND SENSING VARIATION IN PRESSURE

FIELD OF THE INVENTION

The present invention generally relates to a device for transporting particles, a device for holding a container and a device for sensing variation in pressure.

BACKGROUND

Pharmaceutical drugs typically consist of two substances – one, the active pharmaceutical ingredient or commonly called the active ingredient, and the other the excipient or the base for the pharmaceutical drug. The active ingredient is the biologically active component in the drug and is used for reliving symptoms or treating diseases for which the drug is consumed. The active ingredients are typically very expensive and toxic to humans when consumed beyond the prescribed quantity.

During the manufacture of pharmaceutical drugs, the active ingredients which are usually supplied in polythene bag containers need to be transferred to the processing units for mixing with the excipients and for carrying out other processing activities down the line. As the active ingredients are toxic in large quantities and expensive, during transferring, care should be taken not to pollute the industrial environment with the active ingredient. The transferring accuracy is also very critical as only a calculated quantity of the active ingredient needs to be transferred to the processing unit.

Current systems in place for extracting the active ingredient and transferring comprise a sealed metallic drum for placing a bag or container of the active ingredient. The system also employs a vacuum based suction device which is introduced into the drum for sucking the active ingredient. The drum also has a glove box through which the user inserts his hands to manipulate the suction device for sucking the active ingredient and/or for adjusting the container's position. After sucking the active ingredient from the container, it is transferred to a powder transfer chamber, where it is stored temporarily before it is ejected into the processing unit. The system may also involve charging the active ingredient into the processing unit through a chute or a manhole.

However, it is known in the art that these systems pose difficulties in manipulating the suction device and adjusting and holding the container by the user having to introduce his hands through the glove box. Introducing the hands through the glove box is also quite dangerous for the user as his hands are in the proximity of equipments operating under low or negative pressure. Because of the intermittent storage in the powder transfer chamber, there is a certain downtime for the system which cannot be avoided. This can slow down the overall operation of the system. Moreover, this also involves frequent maintenance activities.

SUMMARY

In accordance with an aspect of the invention, there is provided a device for transporting particles, the device comprising a first conduit and a second conduit. The first conduit has an outlet at a first end and the outlet extends to a position proximate a second end of the second conduit. The first conduit is arranged to be connected to a fluid supply. A flow of fluid from the outlet of the first conduit is arranged to create a negative pressure across the second end of the second conduit, thereby forming a pressure gradient to enable transporting particles from a container and away from the second end of the second conduit.

There is provided a device for holding a container, comprising a sealing structure and a holding structure. The sealing structure is for accommodating a portion of the container arranged for holding and maintaining a fluid and pressure tight seal between the container and the device. The holding structure defines an opening in the device, the opening arranged for accommodating and enabling displacement of a particle transportation device. The particle transportation device is arranged to transport particles from the container.

A device for sensing variation in pressure, wherein the device comprises a housing having an enclosed space. The space is fluid-tight. There is a flexible impermeable membrane positioned across the housing and separating the housing into a first portion and a second portion. The membrane is gravitationally biased to sag into the first portion. The fluid inlet is arranged to be connected to the first portion of the device for introducing fluid into the first portion. When there is an increase in pressure of the fluid in the first portion, the device is arranged to displace the membrane into the second portion to trigger an actuator.

BRIEF DESCRIPTION OF DRAWINGS

Fig 1 is a front elevation view of a device for transporting particles;

Fig 2 is a top plan view of the device for transporting particles;

Fig 3 is a front sectional view of the device for transporting particles illustrated in Fig 2 along an axis 3-3';

Fig 4 is a front elevation view of an outlet assembly;

Fig 5 is a top plan view of a device for holding a container;

Fig 6 is a front elevation view of the device for holding a container;

Fig 7 is a front sectional view of the device for holding a container illustrated in Fig 5 along an axis 7-7';

Fig 8 is a bottom view of the device for holding a container;

Fig 9 shows an arrangement of a sealing structure in the device for holding a container holding the container of particles;

Fig 10 shows an arrangement of a holding structure in the device for holding a container accommodating a particle transportation device;

Fig 11 is a device for sensing variation in pressure under normal operating condition;

Fig 12 is a device for sensing variation in pressure under conditions of increased pressure.

DETAILED DESCRIPTION

Reference will now be made in detail to an exemplary embodiment of the present invention, examples of which are illustrated in the accompanying drawings. While the invention will be described in conjunction with the embodiment, it will be understood that they are not intended to limit the invention to these embodiments. On the contrary, the invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the invention as defined by the appended claims. Furthermore, in the following detailed description of embodiments of the present invention, numerous specific details are set forth in order to provide a thorough understanding of the present invention. However, it will be recognized by one of ordinary skill in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components, and circuits have not been described in detail as not to unnecessarily obscure aspects of the embodiments of the present invention

For purposes of brevity and clarity, descriptions of embodiments of the present invention are limited hereinafter to a device for transporting particles, holding a container and sensing variation in pressure. This however does not preclude embodiments of the invention where fundamental principles prevalent among the various embodiments of the invention such as operational, functional or performance characteristics are required.

An exemplary embodiment of the invention, a device for transporting particles, is described with reference to Figs 1 to 4. The device 100 as illustrated in Fig 1 and 3 is preferably used for transporting particles of an active ingredient from a container. Active ingredients are key components of pharmaceutical drugs and are used in their manufacture. During the manufacturing process, active ingredients are transferred from containers holding them to processing units. The processing unit may also be referred to as reactor or blender. Transporting particles of active ingredients refer to transporting them from their containers.

The device 100 comprises a first conduit 102 and a second conduit 104. The first conduit 102 has a first end 106. The first conduit is provided with an outlet 108 at the first end 106. The second conduit 104 has a second end 110. When the device is put into use, the first conduit is arranged to be connected to a fluid supply 114 by way of a valve 112. The second conduit 104, along with the valve 112 form a second conduit-valve assembly. The valve 112 can be opened to allow a fluid to flow from the fluid supply to the first conduit or closed to stop the fluid from flowing through the first conduit. The fluid used is preferably a gas and more specifically an inert gas, such as nitrogen. The nitrogen used may be dry. The advantage of using nitrogen or an inert gas, is that, nitrogen or the inert gas does not react with the active ingredient that is being transported, resulting in the physical and chemical properties of the active ingredient being maintained the same before and after transportation into the processing units.

The outlet 108 of the first conduit extends to a position proximate the second end 110 of the second conduit 104. The outlet 108 extends such that the fluid flowing out of the outlet is proximate to the second end 110 of the second conduit 104. The flow of fluid from the outlet 108 is at a high speed such that a negative pressure is created across the second end 110 of the second conduit 104. The negative pressure is created due to Bernoulli's effect. The other advantage of leveraging Bernoulli's principle is that the particles are aerated and therefore results in a smooth transfer of the particles through the device 100.

Referring to Fig 4, the outlet 108 is shaped in the form of a nozzle and has a tip 116 which has a constricted aperture compared to the portion of the outlet away from the tip 116. The

flow of the fluid through the outlet 108 to the tip 116 increases the velocity of the fluid and applying Bernoulli's effect, a negative pressure is induced. Since the tip 116 of the outlet 108 is proximate the second end 110 of the second conduit, the negative pressure is applied across the second end 110. The pressure gradient caused by the negative pressure across the second end of the second conduit and the ambient pressure existing in the container enables the particles in the container to be transported through the second conduit and away from the second end of the second conduit. The advantage of this arrangement is that a suction is created only across the second end of the second conduit and a vacuum system need not be employed in transferring the particles through the second conduit. Another advantage of this arrangement is that the fluid flowing through the first conduit is directed by the outlet into the second conduit, so that the particles in the container are not blown away or disturbed from their places by the gust of the fluid.

The device is designed such that either the first conduit or the second conduit is an elongated structure. Preferably, as illustrated in Fig 3, the first and the second conduit are elongate structures. The advantage of this arrangement is that it enables the device to probe deep into the container, especially when the level of the particles in the container has reached the bottom of the container. An elongate device also enables the user to manipulate the device to the sides or the bottom edges of the container to suck the particles completely out of the container, to prevent any wastage of the particles. This is particularly beneficial as particles of active ingredients are quite expensive.

Preferably, as illustrated in Fig 3, the first conduit and the second conduit are positioned adjacent each other in the device. This enables the device to be compact resulting in easy manoeuvrability inside the container of particles which does not have much space.

As illustrated in Fig 3, the second conduit is housed inside the first conduit in an annular arrangement such that, there is a clearance 118 between an inner surface 120 of the first conduit and an outer surface 122 of the second conduit. An annular arrangement is an arrangement in the form of a ring. The clearance between the first conduit and the second conduit is shaped like a ring. The first conduit 102 enables the flow of fluid through the clearance 118. The clearance 118 communicates with the outlet 108, enabling the flow of the fluid from the clearance 118 to the outlet 108. The compactness of the device is further improved with this arrangement. The first conduit and the second conduit are cylindrical in shape.

The device can also be called a double tube suction device, as it employs two tubes – a first conduit and a second conduit and is used for transporting the particles from the container by suction. The preferred orientation for using the device is with the first end of the first conduit and the second end of the second conduit, which are proximate each other, at the lower end of the device. This is because the process of transporting the particles involves sucking the particles from a container which is usually placed either on the industry floor or on a platform on the floor. The device may also be used orientated sideways, if the container with the particles is placed in a sideward orientation.

As illustrated in Fig 3, the first conduit 102 of the device 100 comprises two detachable sections, an upper body 130 and an outlet assembly 140. The upper body 130 and the outlet assembly 140 are fastened to each other using a suitable fastening arrangement, such as fine screws. The fastening arrangement enables attachment and detachment of the two sections, which is advantageous when another component, different from the upper body and the outlet assembly, is required to be mounted onto the elongate portion of the device, the mounting of which may be obstructed by the projecting outlet 108. Hence, whenever another component different from the upper body and the outlet assembly is to be mounted on the device, the outlet assembly is unscrewed from the upper body to allow the component to be mounted and then the outlet assembly is screwed back to the upper body. It is common knowledge that the fine screw threads that keep the upper body and the outlet assembly fastened provide a good fluid seal to the clearance 118.

As illustrated in Fig 3, the second conduit runs through the length of both the upper body 130 and the outlet assembly 140. Further, the outlet 108 of the first conduit 102 is located on the outlet assembly 140. Once the upper body 130, the outlet assembly 140 and the second conduit 104 are all assembled together, the clearance 118 between the first conduit and the second conduit opens out to the outlet 108. As illustrated in Fig 3, the first conduit 102 is attached to the second conduit-valve assembly only at two points. The first point is the point of origin of the first conduit, which is also the point at which the valve 112 is connected to the first conduit 102. Here, the valve head 113 is mounted on the second conduit 104. As illustrated in Figs 1 and 3, the second point is at an end away from the first point, where a projection 124 of the outlet assembly 140 is located against the second conduit. An inner dimension of the projection 124, such as an inner diameter is such that it snugly fits against an outer dimension, such as an outer diameter of the second conduit 104. The fit is further sealed by the presence of a sealing device, which is further described herein. The inner portion 126 of the projection 124 has a circular groove 128, running along the inner periphery of the projection. The groove 128 is fitted with a sealing device 129, such as an O-

ring, which provides a fluid-tight seal once the second conduit 104, the upper body 130 and the outlet assembly 140 are fitted together. The advantage of this seal is to prevent any fluid leakage through the gap between the projection and the second conduit.

An exemplary embodiment of the invention, a device for holding a container, is described with reference to Figs 5 to 8. The device 200 as illustrated in Fig 5 is used for holding a container, the container filled with powdery material and preferably an active ingredient used in the manufacture of pharmaceutical drugs. During the manufacture of pharmaceutical drugs, active ingredients are transferred from containers holding them to processing units. Transporting particles of active ingredients refer to transporting them from their containers. The process of transporting the particles is effective if the container having the particles is held by a device to provide physical support and rigidity to the system. The container is usually a bag, preferably a bag made of plastics material. Preferably if the bag is made of a transparent material, the user can view the quantity of the active ingredient inside the bag when transporting the same.

The device 200 for holding a container as illustrated in Figs 5 and 6 comprises a disc shaped member 201. As the name implies, the disc shaped member 201 is circular and has a sealing structure 202 disposed towards the periphery of the disc shaped member 201 and a holding structure 214 disposed at the centre of the disc shaped member 201. The sealing structure 202 is arranged for holding a container (not shown in Figs 5 and 6) containing the particles of the active ingredient. Fig 9 shows the arrangement of the structure 202 holding the container 204. As illustrated in Fig 6, the structure comprises a first groove 206, the groove being circular and running circumferentially around an exterior surface 208 of the disc shaped member 201. As illustrated in Fig 9, the groove 206 enables accommodating a portion 210 of the container 204, which is held tight by a clasping member 212 such as a thread or an elastic band. The portion 210 is preferably an upper portion of the container 204. It may also be a portion in the middle of the container. The arrangement of the groove 206 and the clasping member 212 holding the portion 210 of the container provides the advantage of a fluid and a pressure tight seal between the container 204 and the device 200. This seal reduces the possibility of developing any pressure gradient being developed between the container and the atmosphere surrounding the container. It also reduces the possibility of movement of any fluid such as gas or liquid between the container and the atmosphere surrounding the container.

The holding structure 214 comprises an opening 216 as illustrated in Fig 5 and Fig 7. The opening is arranged to accommodate a particle transportation device 218 as illustrated in Fig

10. The particle transportation device requires a good support for it to effectively remove the particles of the active ingredient. It is also required that the transportation device be displaced (upwards and downwards) with respect to the device for holding a container, so that as the level of particles of the active ingredient goes down in the container, the particles can still be effectively removed and transported by the transportation device.

Further, the opening 216 is circular in profile. The outer profile of the particle transportation device 218 which is accommodated in the opening 216 is also circular. The diameter of the opening 216 is slightly larger than the outer diameter of the particle transportation device 218 such that there will be a clearance fit when the particle transportation device 218 is accommodated in the opening 216. A clearance fit is one in which there is a small space of clearance between the mating parts. In this case, the mating parts are the opening 216 and the particle transportation device 218. The clearance fit enables the particle transportation device 218 to be fit conveniently in the opening 216.

As illustrated in Fig 7, the material of the disc 201 surrounding the opening 216 comprises a second groove 220, the groove 220 being circular and running along a circumference of the opening. The second groove 220 is arranged to contain or accommodate a sealing device 222, such as an O-ring to provide a seal to the space arising from the clearance fit explained above. Further, an additional groove and seal arrangement may be provided for reinforcing purposes. As illustrated in Fig 7, the device 200 further comprises a collar 231 and a suitable fastening arrangement 233 such as a set screw to tighten the device 200 against the particle transportation device 218. The presence of the collar 231 serves to spread the tightening force from the fastening arrangement 233 over the portion of the particle transportation device 218 in contact with the collar 231. This is to prevent the outer wall of the particle transportation device 218 getting dented due to the tightening force acting at a single point.

Further, the device 200 has an aperture 224 in the disc shaped member 201. The aperture 224 has a first end 226 and a second end 228. The first end 226 is disposed on a first side 230 of the disk shaped member 201. The second end 228 is disposed on a second side 232 of the disk shaped member 201. The second side 232 is the side which faces the inside of the container 204, when the container 204 is held by the device 200. The first side 230 is the side opposite the second side 232. The first end 226 is arranged to be connected to a fluid supply. Preferably, the fluid in the fluid supply is an inert gas such as nitrogen. The fluid supply may be in the form of a tank, cylinder. An inert gas is used here due to the non-reactive nature of the inert gas, so that the gas does not react with the active ingredient. The second end 228 is arranged to open out into the container, when the container 204 is held

by the device 200. The aperture 224 is used to supply fluid from the fluid supply to the container to keep the container inflated. The advantage of the inflated container is to provide the user with good visual clarity to look into the container and to ease movement of the particle transportation device into the container. Another advantage is to prevent the particles in the container from getting into the device 200.

Further, the device 200 comprises a vent 234 in the disc shaped member 201. The vent 234 has a first end 236 and a second end 238. The first end 236 is disposed on the first side 230 of the disk shaped member 201. The second end 238 is disposed on the second side 232 of the disk shaped member 201. The second side 232 is the side which faces the inside of the container 204, when the container 204 is held by the device 200. The first side 230 is the side opposite the second side 232. The first end 236 is arranged to be connected to any device which works with fluids, such as a pneumatic device, hydraulic device. (not shown in Fig 5 to Fig 10), the functionality of which is described below. The second end 238 opens out into the container, when the container 204 is held by the device 200. When the pressure of the fluid inside the container 204 builds up, it is transmitted through the vent 234 to the pneumatic or hydraulic device connected to the first end 236, which preferably is a pressure sensing device. The increase in pressure transmitted by the fluid is sensed by the pressure sensing device, which then communicates with a control centre to stop the operation of the particle transportation process partially or fully to prevent any accident. A pressure build up inside the container may happen because of any block in the particle transportation device or a faulty working of the fluid supply supplying fluid to the container 204 through the opening 224.

An exemplary embodiment of the invention, a device for sensing variation in pressure, is described with reference to Figs 11 and 12. The device 300 as illustrated in Fig 11 and Fig 12 is used for sensing any variation in pressure, which will be explained below. The device 300 for sensing variation in pressure comprises a housing 302, wherein the housing has an enclosed space 304. The enclosed space 304 is fluid tight so that no liquid or gas can pass through a lining 306 of the housing 302. The device 300 further comprises a flexible impermeable membrane 308. The term “impermeable” implies that it is fluid tight, such that it does allow any liquid or gas to pass through it. The membrane 308 is stretched and positioned across the housing, such that it separates the housing into a first portion 310 and a second portion 312. The first portion 310 is orientated towards the bottom of the housing 302 and the second portion 312 is orientated towards the top of the housing 302. The membrane 308 is flexible allowing it to be deflected into the first portion 310 or into the second portion 312. The membrane 308 is held in its position firmly by a suitable fastening

arrangement 314 in the housing 302, as illustrated in Fig 11. As illustrated in Fig 11, weights 316 and 318 are attached to the centre of the membrane 308, such that the membrane sags into the first portion 310. The sagging is due to the weight acting downwards of the weights 316 and 318. The weights 316 and 318 are suitably and firmly attached to the membrane 308 by a fastening arrangement 320. As described earlier, it is very clear from Fig 11 that the membrane 308 sags into the first portion 310. The weights 316 and 318 act at the geometrical centre of the membrane.

The device 300 further comprises a fluid inlet 322, as illustrated in Figs 11 and 12. The fluid inlet 322 opens into the first portion 310 of the device 300. The fluid inlet 322 is arranged to introduce fluid into the first portion 322. The fluid may be a liquid or a gas. Further, the device 300 comprises an actuator 324 which is located just above the weight 316. The actuator may be a part of a control valve or any controlling device which controls flow through a pneumatic or a hydraulic system. The weights 316 and 318 have a substantially large surface area and are hard, to provide a good surface for contact with the actuator 324.

The device 300, through the fluid inlet 322 is connected to another device or enclosed space (not shown), whose pressure increase has to be determined. The pressure increase may also be in very small quantities. The fluid link between the other device or enclosed space and the device 300 causes the pressure of the fluid in the first portion 310 to increase for an increase in pressure in the enclosed space or other device. This increase in pressure of the fluid in the first portion 310 causes the membrane 308 along with the weights 316 and 318 to be displaced upwards into the second portion 312, which is illustrated in Fig 12. This causes the weight 316 to come into contact with the actuator 324 and push it upwards. This actuates the actuator which controls the control valve to stop the fluid flow in the system.

The weights 316 and 318, by virtue of their mass, control the amount of sagging of the membrane 308 into the first portion 310. It the mass of the weights 316 and 318 are more, the membrane 308 sags more into the first portion 310. In contrast, if the mass of the weights 316 and 318 are less, the membrane 308 sags less into the first portion 310. The masses of the weights 316 and 318 thereby serves to determine the pressure of the fluid required to displace the membrane into the second portion 312. So the cut-off pressure that is required to be sensed to actuate the actuator 324 can actually be varied by varying the masses of the weights 316 and 318.

The device 300 due to the above mentioned design is capable of sensing low pressures. The use of this device can reduce the possibility of explosions in the system due to pressure

increases, as even a slight increase in pressure can be determined. Since the weights 316 and 318 press down on the membrane 308 under the force of gravity requiring no mechanical linkage with the actuator 324, the likelihood of the device jamming is reduced. This improves the reliability of the device.

The device for transporting particles 100, the device for holding a container 200 and the device for sensing variation in pressure 300 may be integrated into an apparatus which performs the function of sucking and transporting the particles from the container to the processing units, holding and sealing the container having the particles and providing protection against pressure increases in the apparatus. The device for sensing variation in pressure 300 may be connected to the vent 234 of the device 200 to sense any pressure surges. The second conduit 104 of the device for transporting particles 100 extends into a lengthy channel or conduit which carries the particles mixed with the fluid such as an inert gas to a separator (not shown in figures). The separator is a cyclone separator which works by applying centrifugal force on the mixture, whereby the heavier particles are displaced to the periphery of the separator and fall down to the bottom of the separator, from where it enters the processing unit for preparing pharmaceutical preparations. The nitrogen gas escapes into a channel at the top of the separator and is pumped back into the device for transporting particles 100. Since there is a continuous flow in the path from the container to the processing unit, the process of sucking the particles to depositing them in the processing unit is carried out without any interruptions or any down time in between. This also improves the speed of the process. The use of a cyclone separator also reduces the dust generated in the processing unit as the separated particles drops directly into the processing unit.

CLAIMS

1. A device for transporting particles, the device comprising:
a first conduit and a second conduit, the first conduit having an outlet at a first end; and
the outlet extending to a position proximate a second end of the second conduit, the first conduit arranged to be connected to a fluid supply;
wherein, a flow of the fluid from the outlet is arranged to create a negative pressure across the second end of the second conduit to enable transporting particles from a container and away from the second end of the second conduit.

2. The device for transporting particles as claimed in claim 1, wherein one of the first conduit and the second conduit is an elongate structure.

3. The device for transporting particles as claimed in claim 1, wherein the first conduit and the second conduit are elongate structures.

4. The device for transporting particles as claimed in any one of the preceding claims, wherein the first conduit and the second conduit are adjacent each other.

5. The device for transporting particles as claimed in claim 4, wherein the second conduit is housed within the first conduit in an annular arrangement.

6. The device for transporting particles as claimed in claim 5, wherein the first conduit and the second conduit are cylindrical structures.

7. The device for transporting particles as claimed in any one of the preceding claims, wherein the fluid supply is to supply a fluid to the first conduit, the fluid being an inert gas.

8. The device for transporting particles as claimed in claim 7, wherein the inert gas is nitrogen.

9. A device for holding a container, the device comprising:
a sealing structure for accommodating a portion of the container arranged for holding and maintaining a fluid and pressure tight seal between the container and the device; and
a holding structure, the holding structure defining an opening in the device, the opening arranged to accommodate and enable displacement of a particle transportation device;

wherein , the particle transportation device is arranged to transport particles from the container.

10. The device for holding a container as claimed in claim 9, wherein the sealing structure is a first groove running along a periphery of the device.

11. The device for holding a container as claimed in any one of the preceding claims, wherein the opening is circular in shape and is arranged to form a clearance fit when the particle removal device is accommodated in the opening.

12. The device for holding a container as claimed in claim 11, wherein the opening further comprises a second groove, the second groove being circular and along a circumference of the opening;
wherein the second groove comprises a sealing member arranged to seal a space arising from the clearance fit.

13. The device for holding a container as claimed in claim 12, wherein the sealing member is an O-ring.

14. The device for holding a container as claimed in any one of the preceding claims, the device further comprising an aperture with a first end and a second end;
the first end is arranged to be connected to a fluid supply; and
a second end is arranged to open into the container, when the container is held by the device.

15. The device for holding a container as claimed in claim 14, wherein a fluid in the fluid supply is an inert gas.

16. The device for holding a container as claimed in claim 15, wherein the inert gas is nitrogen.

17. The device for holding a container as claimed in any one of the preceding claims, further comprising a vent having a first end and a second end;
the first end is arranged to be connected to an other device; and
the second end is arranged to open into the container, when the container is held by the device.

18. A device for sensing variation in pressure, the device comprising:
a housing having an enclosed space, the space being fluid-tight;
a flexible impermeable membrane positioned across the housing, separating the housing into a first portion and a second portion, wherein the membrane is gravitationally biased to sag into the first portion;
a fluid inlet arranged to be connected to the first portion of the device for introducing fluid into the first portion;
wherein, the device is arranged to displace the membrane into the second portion to trigger an actuator, by an increase in pressure of the fluid in the first portion.

19. The device for sensing variation in pressure as claimed in claim 18, further comprising a plurality of fastening members, the fastening members positioning the flexible impermeable membrane across the housing.

20. The device for sensing variation in pressure as claimed in claim 18, further comprising a weight attached to the membrane, the weight acting at a geometrical centre of the membrane;
wherein the membrane is gravitationally biased by the weight.