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(54) PRESSURE REDUCING SECOND STAGE FOR UNDERWATER USE

DRUCKMINDERNDE ZWEITE STUFE FÜR UNTERWASSEREINSATZ

DEUXIÈME ÉTAGE DE RÉDUCTION DE PRESSION POUR UNE UTILISATION SOUS L'EAU

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Description

[0001] The present invention relates to a pressure reducing second stage for underwater use.

[0002] Breathing gas supplying devices or pressure reducing second stages for underwater use are known which are connectable to pressure reducing first stages intended to reduce the high pressure (200-300 bar) of a breathing gas contained in a tank, usually a diving cylinder, to a predetermined intermediate value, which second stages reduce the pressure of the gas from said intermediate value to a value physiologically suitable for breathing.

[0003] A second stage supplying breathing gas for underwater use comprises a case with an inner chamber provided with:

- a pressurized gas inlet connectable, through a gas supply conduit or hose, to a pressure reducing first stage, which inlet is provided with a device with a valve reducing the pressure of the gas entering said chamber,
- an inhalation/exhalation port through which the breathing gas supplied in the inner chamber of the case is inhaled by the user and through which the user supplies the exhaled gas into the chamber, which port is connected to a inhalation/exhalation mouthpiece tube,
- an exhaled gas exhaust outlet provided with a non-return valve.

[0004] Patent US 4,002,166 describes a pressure reducing second stage provided with a bypass tube for conveying the incoming breathing gas after opening the reduction valve, directly from the supply conduit to the inhalation/exhalation mouthpiece tube, by-passing the inner chamber of the case.

[0005] The second stage provides the bypass tube, outside the case, to have a connection tangent to the mouthpiece tube and that provides a vane with an adjustable angle to be provided inside the mouthpiece tube.

[0006] Patent EP 937640 describes a pressure reducing second stage wherein the bypass tube is formed integrally inside the case of said second stage.

[0007] In known pressure reducing second stages for underwater use, provided with the bypass tube or not, considering the second stage used by a user in the upright position, the breathing gas inlet is placed on the case on the right or left of the inhalation/exhalation port connected to a inhalation/exhalation mouthpiece tube, and said second stage is connected to a pressure reducing first stage for a gas contained in a tank, usually a diving cylinder, through a gas supply conduit or hose that passes above the right or left shoulder of the user, when the gas tank is worn on the user back.

[0008] Such configuration of the second stage, with the gas inlet on the case at the right or left of the inhalation/exhalation port, is particularly uncomfortable when the breathing gas tank, generally a diving cylinder, is not worn on the back but it is placed at the right or left side of the user that is when the pressure reducing first stage connected to the gas tank is in a position considerably lower than the user mouth having to hold, by a mouthpiece connected to the inhalation/exhalation mouthpiece tube, the pressure reducing second stage, such to make it possible to breath underwater.

[0009] In this case the relative position of the breathing gas tank and of the scuba diver mouth are such that it is almost impossible to find a path of the gas supply conduit or hose connecting first and second stages in such a manner not to have a twisting effect thereon, resulting in the user being uncomfortable, except taking a very long hose (with consequent adverse effects on ergonomics, drag in water, costs) or using a joint (with consequent adverse effects on costs and reliability).

[0010] Generally in order to overcome such drawback gas supply conduits or hoses are used having such a length to pass behind the user head and to reach the user mouth not from the bottom but from the side, of the user face, such that the end portion of the supply conduit connected to the side inlet provided on the case of the second stage is substantially horizontal and it does not generate rotations of the second stage that make holding of the inhalation/exhalation mouthpiece tube in the user mouth little comfortable and therefore making breathing underwater little comfortable. This however results in an increase in drag due to a greater friction in water.

[0011] Another known solution to overcome such drawback is to place between the side inlet of the case and the supply conduit or hose a L-shaped joint allowing the second stage to be kept in the proper position in the mouth eliminating the twisting effect exerted by the supply conduit or hose connected to said second stage.

[0012] However such solution has the drawback that the joint is a potential point of failure or leakage that may cause breathing gas to escape with also serious consequences if the user is underwater far away from the surface.

[0013] Moreover it is known that the configuration of the second stage with gas inlet on the case at the right or left of the inhalation/exhalation port is particularly uncomfortable when the second stage is used as a secondary gas source that is as a source of gas to be supplied to a second scuba diver.

[0014] It is a common practice, when underwater, to use a diving regulator composed of a pressure reducing first stage connected through hoses to two pressure reducing second stages, so called "octopus" configuration, one of which is used by the scuba diver carrying the diving regulator for breathing and the other one is carried as an emergency and it is used, if necessary, to supply breathing gas to a second scuba diver in difficulty, for example a second scuba diver having his/her diving regulator not operating or having depleted his/her personal gas supply contained in the diving cylinder. In such situations the scuba diver with enough gas supply gives his/her sec-

ondary second stage to the other scuba diver in difficulty placed in front of him/her or by his/her side but it is known that the position of the gas inlet on the case on the right or left of the inhalation/exhalation port does not facilitate such operation since the hose connecting the first stage and the secondary second stage, in order to allow such operation, not only has to be long enough but has also to follow a S-shaped path, with consequent adverse effects on ergonomics.

[0015] Currently although the efforts for improving the operating conditions of the pressure reducing second stages, above all as regards the user effort in inhaling and exhaling the known pressure reducing second stages have not completely achieved optimal operating conditions.

[0016] Such optimal conditions consist in making the breathing effort in underwater condition, as much similar as possible to the one necessary in normal environment conditions. On one side the user has not to perform suck efforts for inhaling the supplied air, but on the other side the latter has not to be supplied at an excessive pressure therefore air being forced into the user respiratory tract.

[0017] The invention aims at overcoming the drawbacks of the known pressure reducing second stages, by providing a pressure reducing second stage that is simple and inexpensive to be manufactured and adjusted, that can be used comfortably by the user without the need of complicating the configuration of diving equipment with elements such as long hoses, or joints, while optimizing ergonomics and decreasing drag in water.

[0018] The aim of the present invention is also to make the breathing more comfortable as possible making the breathing effort as much similar as possible to that of normal environment conditions.

[0019] The aim of the present invention is also to provide a pressure reducing second stage easy and comfortable to be used as a secondary second stage for breathing gas, thus making the breathing gas supply to a scuba diver in difficulty more safe and comfortable, with the consequent advantage of reducing panic and stress in water.

[0020] A further aim of the present invention is to provide a pressure reducing second stage wherein both the gas inhalation and exhalation phases are facilitated, thus allowing inhalation and exhalation effort to be reduced. The invention achieves the aims described above by a pressure reducing second stage for underwater use comprising the combination of characteristics of claim 1.

[0021] Said combination of characteristics comprises:

- a case provided with a breathing gas inlet and with an inhalation/exhalation port through which the gas supplied into the case is inhaled by the user and through which the user supplies the exhaled gas into the case, said case being provided with an exhaled gas exhaust outlet with a non-return valve,
- the gas inhalation/exhalation port being connected to an inhalation/exhalation mouthpiece tube through which the breathing gas is inhaled by the user and through which the gas is exhaled into the case,
- the breathing gas inlet in the case being connected to a breathing gas pressure reducing device provided with a hollow cylindrical element or pipe, which hollow cylindrical element has a breathing gas inlet port communicating, through a valve, with a gas supply conduit, which valve is interposed between said supply conduit and said inhalation/exhalation mouthpiece tube for said breathing gas,
- said case being provided with pressure sensitive means for controlling the opening/closure of said valve,
- and wherein the breathing gas inlet in the case is provided in the lower portion of said case, considering the second stage used by a user in the upright position and said hollow cylindrical element of the pressure reducing device being connected to said inlet on the case such that its axis is vertical or substantially vertical with reference to the upright position of the user, that is substantially parallel to the longitudinal axis, or cranio-caudal axis, that is to the intersection of the sagittal plane with the coronal plane of the user body;

a bypass tube, supplying said breathing gas from the pressure reducing device directly into the inhalation/exhalation mouthpiece tube, the bypass tube being connected, at one end thereof, to an port provided on the shell wall of the hollow cylindrical element of the pressure reducing device, and at the opposite end to an port provided on the shell wall of the inhalation/exhalation mouthpiece tube.

[0022] By means of such characteristic the use of a second stage implemented according to the present invention is particularly advantageous if used for reducing the pressure of a breathing gas contained into a tank carried on one side of the user since the gas supply conduit or hose can connect the second stage to the pressure reducing first stage provided on the tank in a substantially straight manner without being bent, thus avoiding both the interruption of the gas flow due to clogs and the risk of moving the second stage from the proper position in the user mouth, making its use little comfortable.

[0023] The second stage implemented according to the present invention is advantageous also if used for reducing the pressure of a breathing gas contained in a tank carried at the front of the user, for example attached to the buoyancy control device, since it allows the gas supply conduit or hose to connect the second stage to the pressure reducing first stage, provided on the tank, without clogging the hose, for example said hose following a substantially U-shaped path, leaving, at the same time, complete freedom of movement to the user.

[0024] The bypass tube allows the gas inhalation action to be facilitated, making the breathing action more comfortable and physiologically suitable.

[0025] According to another characteristic of the

present invention, in order to facilitate the gas exhalation at any depth the second stage is used and in order to make it as much similar as possible to natural breathing when out of water, said case is provided with a second exhaled gas exhaust outlet with a non-return valve.

[0026] Said two outlets can be placed at the sides of the breathing gas inlet in the case connected to said hollow cylindrical element of the pressure reducing device.

[0027] As described in more details below, in order to convey the gas escaping from the bypass towards the user mouth, in said second stage of the present invention, in the inhalation/exhalation mouthpiece tube there is provided a baffle tongue placed substantially diametrically with the orientation transverse to the axis of the bypass tube and with extension substantially parallel to the axis of said inhalation/exhalation mouthpiece tube.

[0028] The function of said baffle tongue or tongue is to convey the flow supplied through the bypass tube towards the mouthpiece such to improve the comfort of the second stage.

[0029] In one embodiment said tongue is provided substantially at a level coinciding with the central diametral position of the mouthpiece tube or at an intermediate level between said central diametral position and the upper semi-circumference with reference to the second supply stage in the condition worn by the user and with the user in the upright position.

[0030] In particular in said worn and upright position of the user the tongue extends substantially horizontally or parallel to the transversal plane of the user head according to the medical definition of said plane and/or parallel or coinciding with the diametral plane coinciding with the greater diameter of the mouthpiece in the condition mounted on the inhalation/exhalation mouthpiece tube.

[0031] According to a characteristic said tongue axially extends from a position where it substantially overlaps the outlet port of the bypass tube in the inhalation/exhalation mouthpiece tube, with one end thereof facing towards the inside of the pressure reducing second stage, up to the opposite end region of said inhalation/exhalation mouthpiece tube, that is facing the user and intended to be coupled to a mouthpiece element.

[0032] According to variant embodiments it is possible to provide different configurations of the tongue.

[0033] According to further variant embodiments, the tongue can be perfectly flat or can have a curved pattern according to one of the two axial and radial directions or according to both the directions and with radii of curvature different from each other and constant or variable along the angle extension of the curved shape.

[0034] Still according to further variant embodiments the tongue can also end with a substantially diametral leading edge, in the region downstream of the outlet port of the bypass tube in the inhalation/exhalation mouthpiece tube and it can extend till overlapping said outlet port by an appendage extending said leading edge of the tongue.

[0035] According to further characteristics said appendage can have different shapes and dimensions according to one embodiment it has a shape like a cap or half-shell.

[0036] In one embodiment, in particular said rear appendage has a first curvature according to one axis parallel to the axis of the inhalation/exhalation mouthpiece tube having a predetermined length substantially corresponding to the axial distance of the outlet port of the bypass tube in the inhalation/exhalation mouthpiece tube from the rear side of the tongue and an end portion with a cap-like shape.

[0037] As an alternative said extension has only one radius of curvature around a single axis oriented in the diametral direction of the inhalation/exhalation mouthpiece tube, or in the direction parallel to the tongue and to the rear edge thereof, such that the appendage has a curved pattern of the end radially aligned with the outlet port of the bypass tube in the inhalation/exhalation mouthpiece tube.

[0038] Also in this case the appendage can have a plan shape or a plan projection shape substantially rectangular or tapered or curved at the free end.

[0039] According to a further characteristic the tongue can be mounted removably in the inhalation/exhalation mouthpiece tube by means of cooperating means coupling it with the inner shell wall of said inhalation/exhalation mouthpiece tube.

[0040] In one embodiment the tongue can be coupled by snap fit, form fit, by force fit or by means of mutually removable locking means into two axial straight guides provided along the inner shell wall of the inhalation/exhalation mouthpiece tube, on two diametrically opposite sides of said wall and each one of said guides is intended to house the corresponding axial peripheral edge of the tongue.

[0041] In the case of a removable mounting it is possible to provide a kit comprising the pressure reducing second stage according to the present invention and a series of different tongues that have different shape and dimension characteristics and that can be mounted alternatively inside the inhalation/exhalation mouthpiece tube.

[0042] This allows the behavior of the second stage to be easily adjusted in a way corresponding to the personal needs of the user.

[0043] As an alternative to the tongue described above, according to one embodiment of the present invention a part of the port provided on the shell wall of the inhalation/exhalation mouthpiece tube putting the bypass tube in connection with said mouthpiece tube is surrounded by a wall protruding inside the mouthpiece tube and that curves in the direction of the port of the mouthpiece tube opposite to the port for the connection with the case, such to form a cap extending above said port in the shell wall of the mouthpiece tube and conveying the breathing gas flow coming from the bypass tube towards the user mouth.

[0044] According to another embodiment said cap-like

wall extends for a given portion in the longitudinal direction inside said inhalation/exhalation mouthpiece tube partially surrounding the port provided on the shell wall of the inhalation/exhalation mouthpiece tube, and bending in the direction of the port of the mouthpiece tube opposite to the port for the connection to the case such to form inside said mouthpiece tube a tube extending in the longitudinal direction of the mouthpiece tube and placed at the lower shell wall of the inhalation/exhalation mouthpiece tube.

[0045] These and other characteristics and advantages of the present invention will be more clear from the following description of some embodiments shown in the annexed drawings wherein:

Fig.1a is a front view of a known pressure reducing second stage provided with a bypass tube,

Fig.1b is a broken plan view of one embodiment of a known pressure reducing second stage provided with bypass tube outside the case,

Fig.1c is a partially sectional top view of one embodiment of a known pressure reducing second stage provided with bypass tube integrated within the case,

Fig.2 is a perspective view of a second pressure reducing second stage provided with a bypass tube according to one embodiment of the present invention,

Fig.3 is a side view of a pressure reducing second stage provided with a bypass tube according to one embodiment of the present invention,

Fig.4 is a bottom view of a pressure reducing second stage provided with bypass tube according to one embodiment of the present invention,

Fig.5 is the inhalation/exhalation mouthpiece tube and the outlet of the bypass tube of a pressure reducing second stage provided with said bypass according to one embodiment of the present invention,

Figs. 6-10 are side sections of different embodiments of the outlet of the bypass tube of a pressure reducing second stage provided with said bypass tube according to the present invention.

Figures 11 and 12 are a section according to an axial plane of the inhalation/exhalation mouthpiece tube and a perspective section of a first variant embodiment respectively wherein in the inhalation mouthpiece tube a diametral tongue is mounted substantially oriented in the axial direction of said inhalation/exhalation mouthpiece tube,

Figures 13 and 14 are like figures 11 and 12 one variant of said tongue.

Figures 15 to 17 each one is a top plan view of one of three different embodiments of the tongues.

Figures 18 and 19 are a top and bottom perspective view of a series of tongues having different dimensions and made according to a further embodiment substantially corresponding to that of figures 13 and 14.

Figures 20 and 21 are views similar to those of figures 18 and 19 with a further variant embodiment of the baffle tongue.

[0046] With reference to figures 1a, 1b, 1c they show a pressure reducing second stage 1 for underwater use provided with a bypass tube 101, according to prior art.

[0047] The function of the pressure reducing second stage for underwater use is to reduce the pressure of breathing gas coming from a pressure reducing first stage and to supply it at ambient pressure depending on how deep the scuba diver is.

[0048] A pressure reducing first stage for underwater use allows high pressure of air contained in the diving cylinder (200-300 bar) to be reduced to an intermediate pressure of 8/10 bar higher than ambient pressure. The second stage, connected to the first stage, therefore allows pressure to be further reduced.

[0049] Such as shown in figures 1b and 1c said second stage 1 is composed of a case 106 containing pressure sensitive means for controlling the opening/closure of a valve of a device reducing the pressure of a breathing gas conveyed in said device through a supply conduit 103, from a pressure reducing first stage (not shown) connected to a breathing gas source, generally a diving cylinder.

[0050] As it is known the pressure reducing device of the second stage, connected to an inlet provided on the case 106, comprises a hollow cylindrical element 107 or pipe, with a breathing gas inlet port 117 communicating, through a valve, with a gas supply conduit 103 connected to a pressure reducing first stage (not shown).

[0051] Such as shown in figure 1b in second stages according to prior art all or a part of the hollow cylindrical element 107 is provided, considering the second stage worn by a user in the upright position, on a side portion of the case 106, like a cylindrical extension of the side peripheral wall of the case itself.

[0052] Otherwise such as shown in figure 1c the hollow cylindrical element 107 is provided integrated within the case, made as a hollow side protrusion of the case itself, extending in a radial direction, such that the breathing gas inlet port 117 of the hollow cylindrical element 107 is formed on the wall of the case 106 itself.

[0053] At the breathing gas inlet port 117 a seal fastening terminal can be provided, for example like a bushing, for connecting said supply conduit 103 with said hollow cylindrical element or pipe 107.

[0054] Inside the hollow cylindrical element 107 a shutter 108 for a valve seat 104 is slidably mounted, particularly a piston-like shutter with enlarged head connected as one piece with a stem engaging in a hole provided on a wall opposite to the breathing gas inlet port 117.

[0055] The valve seat 104 is composed of a radial narrowing, inside the hollow cylindrical element 107, defining an aperture, along the central longitudinal axis of said hollow cylindrical element 107, with sharp edges that can cooperate with the surface of the head of the shutter 108 such to guarantee said seat 104 to be perfectly sealed

when the shutter is in the closing position that is abutting against the valve seat 104.

[0056] A spring 109 urges the shutter 108 with a predetermined force in the firm closing direction. The shutter 108 is pivoted, in a known manner, to a lever 110 that is oscillating and that is operated by a deformable diaphragm 111 forming a part of the outer wall of the case 106.

[0057] The case 106, through a port, communicates with an inhalation/exhalation mouthpiece tube 102 through which the breathing gas inhaled by the user is exhaled into the case 106.

[0058] The inhalation/exhalation mouthpiece tube is provided with a mouthpiece 105.

[0059] In prior art only one exhaust outlet 113 is provided on the case 106 for the exhaled air that is supplied into the case 106 through the mouthpiece tube 102 and the inhalation/exhalation port.

[0060] Said outlet is provided with a non-return valve 123, like a membrane, opening as the pressure inside the case 106 increases due to the gas flowing during the exhalation phase and that is kept in the closed condition by the elasticity of the material said non-return valve 123 is made of.

[0061] During the inhalation phase the vacuum generated inside the case 106 causes the diaphragm 111 to push on the lever 110 acting against elastic means 109, that is the spring, and it moves the shutter 108 away from the valve seat 104, in the opening position, therefore the pressurized gas, from the supply conduit 103 can enter, from the inlet port 117, through the valve seat, into the hollow cylindrical element 107 of the reducing device and it can goes out from an outlet port 112, provided on the shell surface of said hollow cylindrical element 107, to which a dedicated supply conduit 101, so called bypass tube, is connected.

[0062] The pressure reducing device, acting for reducing and regulating the pressure of the breathing gas by adapting it to the ambient pressure, therefore has a valve seat 104 interposed between a gas inlet port 117 at an intermediate pressure (coming from the pressure reducing first stage) and a gas outlet port 112 at a reduced pressure.

[0063] Said bypass tube, connected to the outlet port 112, conveys the breathing gas directly into the inhalation/exhalation mouthpiece tube 102, without the gas passing inside the case 106.

[0064] Such as shown in the figures, for example figure 1c, said outlet port 112 for the gas towards the bypass tube 101 and therefore in the inhalation/exhalation mouthpiece tube 102 is composed of a side slot 112 provided in the shell wall of the hollow cylindrical element 107.

[0065] As it is known the bypass tube 101 can be outside the case (figure 1b) or it can be obtained as one piece in the thickness of the wall of the case 106 of said second stage 1 (figure 1c).

[0066] In the embodiments shown as prior art, particularly figure 1b, said hollow cylindrical element 107 passes through the wall of the case 106 only at one point where it is sealingly fastened to the case 106 and it is connected, by the open end, to the gas supply conduit 103 while it has such a length to end, by the other closed end, inside the case 106 itself.

[0067] However according to known, not shown, embodiments, said hollow cylindrical element 107 can end, even by the end not connected to the gas supply conduit 103, outside the case, by an end element that constitutes an axial pushing assembly manually drivable from the outside of the case 106, which pushing assembly acts on the elastic means that is on the spring 109 that in turn acts on the shutter 108 of the valve seat 104. As it is known said pushing assembly composed of several elements coaxial and fitted with each other in a sealing manner, for example by O-rings, has an end outside the case, that can be held by the user, such as a knob, and one end inside the case, abutting against an axially slidable abutment for the spring 109, such that a rotation of the external part causes said abutment to axially translate and therefore leads to a different pre-load condition of the spring 109 on the shutter 108 of the valve seat 104.

[0068] Figures 1a, 1b, 1c therefore show a pressure reducing second stage 1 for underwater use provided with a bypass tube 101, according to the prior art and wherein, considering the second stage 1 used by a user in the upright position, the inlet for the breathing gas in the case 106 and the hollow cylindrical element 107 are arranged on the right or left side of said case 106, that is at the side with respect to the inhalation/exhalation mouthpiece tube 102.

[0069] Figures 2 to 10 on the contrary show other embodiments of a second stage 1 according to the present invention.

[0070] Such as shown in figure 2 in the second stage of the present invention the inlet for the breathing gas in the case 106 is provided in the lower portion of said case 106, considering the second stage 1 used by a user in the upright position and the hollow cylindrical element or pipe 107 of the pressure reducing device is connected to said inlet on the case 106 such that its longitudinal axis is vertical or substantially vertical and perpendicular to the longitudinal axis of the inhalation/exhalation mouthpiece tube 102.

[0071] For illustrative and descriptive simplicity purposes, in the text the term "hollow cylindrical element or pipe 107" means both a hollow cylindrical element 107 provided outside the case 106 and a hollow cylindrical element 107 integrated into the case 106 it being like a lower hollow extension of the case 106 itself.

[0072] According to the present invention the case 106 is provided with a second exhaled gas exhaust outlet 113 with a non-return valve 123: such as shown in figures 4 and 5 the two exhaust outlets 113 are placed at the sides of the breathing gas inlet in the case 106 connected to said hollow cylindrical element 107 of the pressure reducing device.

[0073] The two exhaust outlets 113 facilitate the exhaled gas to come out from the case 106, in practice by halving the breathing effort in water with respect to a conventional scuba regulator.

[0074] The second stage 1 of the present invention can be provided with a bypass tube 101 for conveying the incoming breathing gas, upon the opening of the pressure reducing valve, directly from the supply conduit 103 to the inhalation/exhalation mouthpiece tube 102, bypassing the inner chamber of the case.

[0075] Such as shown in the figures said bypass tube, considering the second stage as used for breathing by a user in an upright position, is located at the rear part of the second stage 1, that is in the part of the second stage 1 opposite to the deformable diaphragm 111 that forms a part of the outer wall of the case 106.

[0076] According to the shown embodiment the bypass tube 101 is composed of a hollow cylindrical element provided outside the case 106 but it is also possible to provide said tube 101 to be made as a hollow cylindrical element integrated in the case 106 it being like a rear hollow extension of the case 106 itself.

[0077] Such as shown in figures 6 to 10 the bypass tube 101 is connected, at one end thereof, to an outlet port 112 provided on the shell wall of the hollow cylindrical element 107 of the device reducing the pressure of the breathing gas, and at the opposite end to an port 112' provided on the shell wall of the inhalation/exhalation mouthpiece tube 102.

[0078] With the valve seat 104 in the open position, the pressurized gas from the supply conduit 103 can enter into the hollow cylindrical element 107 and pass, through the port 112, into the bypass tube 101 and then go, through the port 112', into the inhalation/exhalation mouthpiece tube 102.

[0079] According to one embodiment shown in figures 7 to 10 a portion of the port 112' provided on the shell wall of the inhalation/exhalation mouthpiece tube 102 is surrounded by a wall protruding into said inhalation/exhalation mouthpiece tube 102 and it bends in the direction of the port of the mouthpiece tube 102 opposite to the port in connection with the case 106 such to form a cap-like wall 121 above said port 112' which cap 121 conveys the breathing gas from the bypass tube towards the user mouth.

[0080] Figure 6 shows a section of a pressure reducing second stage 1 with a bypass tube 101 free from said cap-like wall 121 while figure 7 shows a second stage 1 with a bypass tube provided, inside said inhalation/exhalation mouthpiece tube 102, with said cap-like wall 121, with the aperture facing the portion of the mouthpiece tube 102 in contact with the user mouth when using the second stage 1.

[0081] According to a further embodiment shown in figures 8-10 it is possible to provide said cap-like wall 121 to extend longitudinally for a given portion inside said inhalation/exhalation mouthpiece tube 102 such to form inside said mouthpiece tube 102 a tube extending lengthwise of the mouthpiece tube 102 and placed at the lower shell wall of the inhalation/exhalation mouthpiece tube 102, considered in the common condition of use.

[0082] Figure 5 shows the port delimited by the shell wall of said tube 121 extending for a given portion inside the inhalation/exhalation mouthpiece tube 102: as it is clear from the figure the port of the tube 121 is faced towards the portion of the mouthpiece tube 102 retained in the mouth by the user by a mouthpiece 105 such to convey the gas from the bypass tube 101 to the user mouth.

[0083] Said cap-like wall and particularly said tube 121 allow the Venturi effect inside the inhalation/exhalation mouthpiece tube 102 to be regulated in order to improve the breathing effort and to make more natural and simple breathing in water.

[0084] According to one embodiment said tube 121 inside the inhalation/exhalation mouthpiece tube 102 has a length ranging from 5 to 10 mm.

[0085] It is possible to provide said tube 121 inside the inhalation/exhalation mouthpiece tube 102 to have a length equal to 7 mm.

[0086] Such as shown in figure 10, the portion of the tube 121 facing the port of the pipe 102 opposite to the port for the connection with the case 106 has an enlargement flare.

[0087] Said enlargement flare can have an angle ranging from 5 to 15°.

[0088] According to one embodiment said enlargement flare has an angle of 10°.

[0089] The length of 7 mm of said tube 121 with a flare of 10° allows the Venturi effect to be optimized in order to improve the breathing action.

[0090] The present invention relates also to a pressure reducing second stage such as that shown in figures 1a, 1b and 1c that is a second stage where the inlet for the breathing gas in the case 106 connected to a breathing gas pressure reducing device is provided, considering the second stage as worn by a user in the upright position, on a side portion of the case 106, and wherein the port 112' of the bypass tube 101 provided on the shell wall of the inhalation/exhalation mouthpiece tube 102 is surrounded by a cap-like wall 121 as described above or said wall projects inside the mouthpiece tube 102 such to form a tube 121 extending in the lengthwise direction of the mouthpiece tube 102 and placed at the lower shell wall of the inhalation/exhalation mouthpiece tube 102.

[0091] Figures 11 and 12 show a variant embodiment wherein unlike the previous embodiments the bypass tube comes out flush with the inner shell wall of the inhalation/exhalation mouthpiece tube 102. In figures 11 and 12 as in figures 13 and 14 the parts of the pressure reducing second stage having the same configuration and/or function are denoted by the same reference numerals as in the figures about the previous embodiments.

[0092] In the inhalation and exhalation mouthpiece tube 102 at the diameter and with an orientation transverse to the axis of the bypass tube 101 a tongue 200 is

provided. This latter has a substantially flat shape and it extends in a position substantially parallel to the transverse plane of the user head in the upright position and with the second stage in the worn condition that is in the position of use. The term transverse plane has to be meant as corresponding to the definition of sectional planes of the human body defined in the medical field.

[0093] The tongue 200 axially extends from the end of the inhalation and exhalation mouthpiece tube 102 opposite to the case of the second stage and it ends in a position radially overlapping the outlet port of the bypass tube 101 in said mouthpiece tube 102.

[0094] In the embodiment of figures 11 and 12, starting from a given axial distance from the edge of the tongue 200 at the end of the inhalation/exhalation mouthpiece tube 102, the tongue takes a cap-like or concave shape 202, the side axial edges protruding downwards for the remaining lengthwise extension of the tongue and ending by a closed head side with a rounded shape 203 at or radially overlapping the outlet port of the bypass tube 101.

[0095] Along said side axial edges having the protrusion towards the side of the mouthpiece tube associated to the bypass tube, the tongue has such an extension in the diametral direction that said edges are spaced from the inner wall of the mouthpiece tube 102, the tongue being fastened to said walls only by the end portion where it is substantially flat and starting from the end of the mouthpiece tube 102 opposite to the case of the second stage.

[0096] The tongue according to such embodiment can have a plan shape like the one of figures 15 or 17 or of figures 18 and 19. In such examples the tongue 200 has a flat part 204 placed at the end of the mouthpiece tube 102 and extending up to the region radially overlapping the outlet port of the bypass tube by an appendage 205.

[0097] Such appendage can be made like a cap, half-cap, spoon or the like and generally it has a convex shape closed by a side wall oriented towards the outlet port of the bypass tube on the two axial sides and on the end side opposite to the flat part of the tongue.

[0098] Figures 18 and 19 show top and bottom perspective views of a series of three different tongues with cap-like appendages 205 that are different from each other as regards the size that is the dimensions both in the axial and radial direction of the inhalation/exhalation mouthpiece tube 102.

[0099] According to a constructional characteristic not shown in detail, the tongue is fastenable in a removable manner inside the inhalation/exhalation mouthpiece tube 102, by means of coupling means cooperating with axial straight portions of the two opposite side edges of the flat part 204 of the tongue 200.

[0100] They can be any coupling means such an snap means, by elastic force, or by coupling teeth and grooves and the person skilled in the art can choose among the several variants available in his/her common knowledge.

[0101] An advantageous embodiment provides along opposite sides of the inner shell wall of the mouthpiece tube 102 a pair of guides, for example in the form of two ribs radially projecting inwards and spaced from each other to an extent corresponding to the thickness of the tongue. They cooperate each one with one of the side axial edges of the tongue and preferably of the straight portion.

[0102] The locking can take place by the elasticity of the material of the mouthpiece tube 102 and by the fact that the distance between axial ribs forming the guides cooperating with the axial edges of the tongue is selected such to generate an elastic force fit of the tongue. The locking force can be selected such that the fastening in place is reliable, while being it possible to manually remove the tongue.

[0103] As it is clear from figures 18 and 19 when the tongue is not firmly fitted in the mouthpiece tube, but when it is possible to remove and replace it, it is possible to associate to the pressure reducing second stage of the present invention a series of tongues different from one another as regards configuration and/or dimensions and that can be fitted alternatively to one another. This guarantees the operating conditions of the second stage to suit the user in a tailor-made manner above all as regards efforts necessary for breathing.

[0104] The series of tongues can be sold as a kit associated to the scuba regulator or as an accessory.

[0105] Figure 16 shows a variant embodiment of the tongue 200. In this case the rear leading edge 201 that is the edge facing the air stream coming from the second stage towards the mouthpiece tube 102, is slightly curved in the direction of said outlet port of the bypass tube. Said curvature is preferably made according to an axis of curvature diametral and parallel to the tongue 200.

[0106] Figures 13, 14 and 20, 21 like figures 11 and 12, 15 e 17 and 18, 19 show a variant embodiment of the tongue 200. The arrangement and orientation in the inhalation mouthpiece tube 102, as well as the extension in the axial direction thereof are substantially the same as those in the embodiment according to figures 11 and 12.

[0107] However in this case, the appendage 205 like a cap or similar shape extends with a protruding portion 206, substantially straight and oriented with its longitudinal axis in the direction substantially parallel to the axis of the inhalation/exhalation mouthpiece tube 102 towards the edge of the flat part 204 of the tongue, ending at a given distance from said edge.

[0108] Said protrusion 206 can be made in the form of two opposing and coaxial curved tongues 1206 that start from the lower side of the flat part 204 of the tongue. In particular the two opposing curved tongues complete with each other such to form a channel with a curved wall like a circular sector symmetric with respect to the plane perpendicular to the plan extension of the flat part of the tongue, axial and central with respect to the diametral extension of the tongue.

[0109] Moreover in one embodiment the lower side of the flat part 204 of the tongue is substantially tangent to

said curved wall of said channel.

[0110] Still according to one embodiment, such as shown, the protrusion 206 has a radius higher than that of the appendage 205 with which therefore it is connected by a frustum conical shape of said appendage.

[0111] By means of said protrusion 206, the baffle, that is the tongue 200 according to such variant embodiment guarantees higher performances since it collects and conveys a greater amount of flow to the mouthpiece 105, therefore causing the diaphragm region to be sucked more thus resulting in a greater aperture of the valve.

[0112] Obviously also for such embodiment the characteristics about the methods for fastening or coupling the inhalation/exhalation mouthpiece tube 102 are valid and the possibility of providing several variants different from each other as regards dimension characteristics of the base arrangement are valid.

[0113] Still according to a further characteristic in common to the embodiments of the tongues 200 according to figures 18 and 19 and 20, 21 the leading edge of the tongue 200, that is the edge of the substantially flat part 204 facing the inside of the second stage is made as curved in a manner symmetric to the central axis parallel to the axis of the inhalation/exhalation mouthpiece tube 102 and it starts with an initial substantially radial and straight portion at the respective sides edges by protruding towards a common vertex coinciding with a point along the central axis of the outer surface of the appendage 205 by a curved portion.

[0114] The invention is not limited to the embodiments described above but variants and/or changes can be made to the second stage of the present invention without departing from the described and claimed inventive concept.

Claims

1. Pressure reducing second stage (1) for underwater use comprising:

- a case (106) provided with a breathing gas inlet and with an inhalation/exhalation port through which the gas supplied into the case is inhaled by the user and through which the user supplies the exhaled gas into the case, said case (106) being provided with an exhaled gas exhaust outlet with a non-return valve,
- the gas inhalation/exhalation port being connected to an inhalation/exhalation mouthpiece tube (102) through which the breathing gas is inhaled by the user and through which the gas is exhaled into the case (106),
- the breathing gas inlet in the case (106) being connected to a breathing gas pressure reducing device provided with a hollow cylindrical element or pipe (107), which hollow cylindrical element (107) has a breathing gas inlet port (117) communicating, through a valve, with a gas supply conduit (103), which valve is interposed between said supply conduit (103) and said inhalation/exhalation mouthpiece tube (102) for said breathing gas,
- said case (106) being provided with pressure sensitive means for controlling the opening/closure of said wherein the breathing gas inlet in the case (106) is provided in the lower portion of said case (106), considering the second stage (1) used by a user in the upright position and said hollow cylindrical element (107) of the pressure reducing device being connected to said inlet on the case (106) such that its axis is vertical or substantially vertical, with reference to the upright position of the user, that is substantially parallel to the longitudinal axis, or cranio-caudal axis, that is the intersection of the sagittal plane with the coronal plane of the user body;

and in that there is provided a tube (101), so called bypass tube, supplying said breathing gas from the pressure reducing device directly into the inhalation/exhalation mouthpiece tube (102), upon the opening of the pressure reducing valve, the bypass tube (101) being connected, at one end thereof, to an port (112) provided on the shell wall of the hollow cylindrical element (107) of the pressure reducing device, and at the opposite end to an port (112') provided on the shell wall of the inhalation/exhalation mouthpiece tube (102);

characterized in that in the inhalation/exhalation mouthpiece tube (102) there is provided a tongue (200) placed substantially diametrically with orientation transverse to the axis of the bypass tube (101) and with extension substantially parallel to the axis of said inhalation/exhalation mouthpiece tube (102), and

said tongue (200) axially extends from a position where it substantially overlaps the outlet port of the bypass tube (101) in the inhalation/exhalation mouthpiece tube (102), with one end thereof facing towards the inside of the pressure reducing second stage, up to the opposite end region of said inhalation/exhalation mouthpiece tube (102), that is facing the user and intended to be coupled to a mouthpiece element (105).

2. Second stage (1) according to claim 1 **characterized in that** said case (106) is provided with a second exhaled gas exhaust outlet (113) with a non-return valve (123), said two outlets (113) being placed at the sides of the breathing gas inlet in the case (106) connected to said hollow cylindrical element (107) of the pressure reducing device.

3. Second stage (1) according to claim 1 or 2, **characterized in that** said tongue (200) is provided sub-

stantially at a level coinciding with the central diametral position of the mouthpiece tube (102) or at an intermediate level between said central diametral position and the upper semi-circumference with reference to the second stage in the condition worn by the user and with the user in the upright position.

4. Second stage (1) according to one of the claims 1 to 3, **characterized in that** in said worn and upright position of the user the tongue extends substantially horizontally or parallel to the transverse plane of the user head according to the medical definition of said plane and/or parallel or coinciding with the diametral plane coinciding with the greater diameter of the mouthpiece (105) in the condition mounted on the inhalation/exhalation mouthpiece tube (102).

5. Second stage (1) according to one or more of the preceding claims 1 to 4, **characterized in that** the tongue has one of the following configurations:
completely flat; with a curved pattern at least for a part thereof according to at least one of the two axial and radial directions or according to both the directions and with radii of curvature different from each other and constant or variable along the angle extension of the curved shape.

6. Second stage (1) according to one or more of the preceding claims 1 to 5, **characterized in that** said tongue (200) ends with a substantially diametral leading edge, in the region downstream of the outlet port of the bypass tube (101) in the inhalation/exhalation mouthpiece tube (102) and it extends till overlapping said outlet port by an appendage (205) extending said leading edge of the tongue (200).

7. Second stage (1) according to claim 6, **characterized in that** said appendage (205) has different shapes and dimensions of a base configuration like a cap or spoon or half-shell.

8. Second stage (1) according to claim 6 or 7, **characterized in that** said appendage (205) alternatively has one configuration selected among one of the following:

a first curvature according to one axis parallel to the axis of the inhalation/exhalation mouthpiece tube (102) and with a predetermined length substantially corresponding to the axial distance of the outlet port of the bypass tube (101) in the inhalation/exhalation mouthpiece tube (102) from the rear side of the tongue (200) and an end portion with a cap-like shape;
only one radius of curvature around a single axis oriented in the diametral direction with respect to the inhalation/exhalation mouthpiece tube, or in the direction parallel to the tongue (200) and to the rear edge thereof.

9. Second stage (1) according to one or more of the preceding claims 6 to 8, **characterized in that** said appendage (205) has a protrusion (206) overlapping the lower side of the tongue (200) from which said appendage comes from.

10. Second stage (1) according to one or more of the preceding claims 1 to 9, **characterized in that** the tongue (200) is mounted removably in the inhalation/exhalation mouthpiece tube (102) by means of cooperating means coupling it with the inner shell wall of said inhalation/exhalation mouthpiece tube.

11. Second stage (1) according to one or more of the preceding claims 1 to 10, **characterized in that** it is provided in combination with a series of different tongues (200) that have different shape and dimension characteristics and that can be mounted alternatively inside the inhalation/exhalation mouthpiece tube.

12. Second stage (1) according to claim 1 or 2 **characterized in that** a portion of the port (112') provided on the shell wall of the inhalation/exhalation mouthpiece tube (102) is surrounded by a wall protruding into said inhalation/exhalation mouthpiece tube (102) and it bends in the direction of the port of the mouthpiece tube (102) opposite to the port in connection with the case (106) such to form a cap-like wall (121) above said port (112') which cap (121) conveys the breathing gas from the bypass tube (101) towards the user mouth.

13. Second stage (1) according to claim 12 **characterized in that** said cap-like wall (121) extends longitudinally for a given portion inside said inhalation/exhalation mouthpiece tube (102) such to form inside said mouthpiece tube (102) a tube (121) extending lengthwise of the mouthpiece tube (102) and placed at the lower shell wall of the inhalation/exhalation mouthpiece tube (102), considered in the common use condition, which tube (121) conveys the breathing gas coming from the bypass tube (101) to the user mouth.

14. Second stage (1) according to claim 12 or 13, **characterized in that** said tube (121) into the inhalation/exhalation mouthpiece tube (102) has a length ranging from 5 to 10 mm.

15. Second stage (1) according to one or more of the preceding claims 12 to 14 **characterized in that** said tube (121) in the inhalation/exhalation mouthpiece tube (102) has a length equal to 7 mm.

16. Second stage (1) according to one or more of the

preceding claims 12 to 15 **characterized in that** the portion of the tube facing the port of the mouthpiece tube (102) opposite to the port in connection with the case (106) has an enlargement flare.

17. Second stage (1) according to one or more of the preceding claims 12 to 16 **characterized in that** said enlargement flare has an angle of 10°.

Patentansprüche

1. Druckmindernde zweite Stufe (1) zur Unterwassereinsatz umfassend:

- ein mit einem Atemgaseinlass und mit einer Einatmungs-/Ausatmungsöffnung versehenes Gehäuse (106), durch welche Öffnung das in das Gehäuse zugeführte Gas vom Benutzer eingeatmet wird und das vom Benutzer ausgeatmete Gas in das Gehäuse zugeführt wird, wobei das Gehäuse (106) mit einem Ausatemgasauslass mit einem Rückschlagventil versehen ist,
- die Einatmungs-/Ausatmungsöffnung mit einem Einatmungs-/Ausatmungsmundstückstutzen (102) verbunden ist, durch den das Atemgas vom Benutzer eingeatmet wird und das Gas in das Gehäuse (106) ausgeatmet wird,
- der Atemgaseinlass in dem Gehäuse (106) mit einer Atemgasdruckminderungseinrichtung verbunden ist, die mit einem hohlzylindrischen Element oder Stutzen versehen ist
(107), wobei das hohlzylindrische Element (107) eine Atemgaseinlassöffnung (117) aufweist, die über ein Ventil mit einer Gaszufuhrleitung (103) in Verbindung steht, wobei das Ventil zwischen der Zufuhrleitung (103) und dem Einatmungs-/Ausatmungsmundstückstutzen (102) für das Atemgas angeordnet ist,
- das Gehäuse (106) mit druckempfindlichen Mitteln zum Steuern der Öffnung und Schließung des Ventils versehen ist

wobei bei in der aufrechten Position von einem Benutzer verwendeter zweiter Stufe (1), der Atemgaseinlass im Gehäuse (106) im unteren Abschnitt des Gehäuses (106) angeordnet ist, und das hohlzylindrische Element (107) der Druckminderungseinrichtung derart mit dem Einlass am Gehäuse (106) verbunden ist, dass seine Achse vertikal oder im Wesentlichen vertikal ist in Bezug zu der aufrechten Position des Benutzers, d. H. im Wesentlichen parallel zur Längsachse oder cranio-kaudale Achse, also der Schnittpunkt der Sagittalebene mit der koronalen Ebene des Benutzerkörpers;
und dass ein Rohr (101), so genanntes Bypassrohr, vorgesehen ist, zum Zuführen des Atemgases von der Druckminderungseinrichtung direkt in das Einatmungs-/Ausatmungsmundstückstutzen (102) infolge der Öffnung des Druckreduzierventils, wobei das Bypassrohr (101) an seinem einen Ende mit einer an der Mantelwand des hohlzylindrischen Elements (107) vorgesehenen Öffnung (112) der Druckminderungseinrichtung und am gegenüberliegenden Ende mit einer an der Mantelwand des Einatmungs-/Ausatmungsmundstückstutzen (102) vorgesehenen Öffnung (112') verbunden ist,
dadurch gekennzeichnet, dass
in dem Einatmungs-/Ausatmungsmundstückstutzen (102) eine Zunge (200) vorgesehen ist, die im Wesentlichen diametral mit einer Querausrichtung zur Achse des Bypassrohres (101) angeordnet ist und mit einer Erstreckung im Wesentlichen parallel zur Achse des Einatmungs-/Ausatmungsmundstückstutzen (102), und
die Zunge (200) sich axial erstreckt, von einer Position, in der sie die Auslassöffnung des Bypassrohres (101) in dem Einatmungs-/Ausatmungsmundstückstutzen (102) im Wesentlichen überlappt und dessen eines Ende zur Innenseite der druckmindernden zweiten Stufe weist, bis zum gegenüberliegenden Endbereich des Einatmungs-/Ausatmungsmundstückstutzen (102), das dem Benutzer zugewandt ist und dazu bestimmt ist, mit einem Mundstückelement (105) gekoppelt zu werden.

2. Zweite Stufe (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** das Gehäuse (106) mit einem zweiten Ausatemgasauslass (113) mit einem Rückschlagventil (123) versehen ist, wobei beiden Auslässe (113) an den Seiten des Atemgaseinlasses im Gehäuse (106) angeordnet sind, der mit dem hohlzylindrischen Element (107) der Druckminderungseinrichtung verbunden ist.

3. Zweite Stufe (1) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** die Zunge (200) im Wesentlichen auf einem Niveau vorgesehen ist, das mit der mittleren Durchmesserposition des Mundstückstutzen (102) zusammenfällt oder auf einem Zwischenniveau zwischen der zentralen Durchmesserposition und dem oberen Halbumfang in Bezug auf die zweite Stufe in dem vom Benutzer getragenen Zustand und mit dem Benutzer in der aufrechten Position.

4. Zweite Stufe (1) nach einem der Ansprüchen 1 bis 3, **dadurch gekennzeichnet, dass** in der getragenen und aufrechten Position des Benutzers die Zunge sich im Wesentlichen horizontal oder parallel zur Querebene des Benutzerkopfes erstreckt, entsprechend der medizinischen Definition dieser Ebene und/oder parallel oder zusammenfallend mit der Durchmesserebene, die mit dem größeren Durchmesser des Mundstücks (105) zusammenfällt in dem am Einatmungs-/Ausatmungsmundstückstut-

zen (102) montierten Zustand.

5. Zweite Stufe (1) nach einem oder mehreren der vorhergehenden Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Zunge eine der folgenden Konfigurationen aufweist: vollständig eben; mit einem zumindest teilweisen gekrümmten Verlauf gemäß zumindest einem der beiden axialen und radialen Richtungen oder gemäß beiden Richtungen und mit voneinander verschiedenen Krümmungsradien, die entlang der Winkelerstreckung der gekrümmten Form konstant oder variabel sind.

6. Zweite Stufe (1) nach einem oder mehreren der vorhergehenden Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** die Zunge (200) im Bereich stromabwärts der Auslassöffnung des Bypassrohres (101) mit einer im wesentlichen diametralen Vorderkante in dem Einatmungs-/Ausatmungsmundstückstutzen (102) endet und sich bis zu einem Überlappen der Auslassöffnung durch einen Ansatz (205) erstreckt, der die Vorderkante der Zunge (200) verlängert.

7. Zweite Stufe (1) nach Anspruch 6, **dadurch gekennzeichnet, dass** der Ansatz (205) unterschiedliche Formen und Abmessungen einer Grundkonfiguration wie eine Kappe oder ein Löffel oder eine Halbschale aufweist.

8. Zweite Stufe (1) nach Anspruch 6 oder 7, **dadurch gekennzeichnet, dass** der Ansatz (205) alternativ eine aus der folgenden ausgewählte Konfiguration aufweist: eine erste Krümmung gemäß einer zur Achse des Einatmungs-/Ausatmungsmundstückstutzen (102) parallelen Achse und mit einer vorbestimmten Länge, die im Wesentlichen dem axialen Abstand der Auslassöffnung des Bypassrohrs (101) in dem Einatmungs-/Ausatmungsmundstückstutzen (102) von der Rückseite der Zunge (200) und einen Endabschnitt mit einer Kappenartigen Form entspricht; lediglich ein Krümmungsradius um eine einzige, in diametraler Richtung zum Einatmungs-/Ausatmungsmundstückstutzen oder in Richtung parallel zu der Zunge (200) und zu deren Hinterkante ausgerichtete Achse.

9. Zweite Stufe (1) nach einem oder mehreren der vorhergehenden Ansprüche 6 bis 8, **dadurch gekennzeichnet, dass** der Ansatz (205) einen die Unterseite der Zunge (200) übergreifenden Vorsprung (206) aufweist, von dem der Ansatz ausgeht.

10. Zweite Stufe (1) nach einem oder mehreren der vorhergehenden Ansprüche 1 bis 9, **dadurch gekennzeichnet, dass** die Zunge (200) in dem Einatmungs-/Ausatmungsmundstückstutzen (102) mittels zusammenwirkender Mittel lösbar angebracht ist, die es mit der inneren Mantelwand des Einatmungs-/Ausatmungsmundstückstutzen koppeln.

11. Zweite Stufe (1) nach einem oder mehreren der vorhergehenden Ansprüche 1 bis 10, **dadurch gekennzeichnet, dass** sie in Kombination mit einer Reihe unterschiedlicher Zungen (200) vorgesehen ist, die unterschiedliche Form- und Abmessungsmerkmale aufweisen und die alternativ innerhalb des Einatmungs-/Ausatmungsmundstückstutzen eingebaut werden können.

12. Zweite Stufe (1) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** ein an der Mantelwand des Einatmungs-/Ausatmungsmundstückstutzen (102) vorgesehener Abschnitt der Öffnung (112') von einer in das Einatmungs-/Ausatmungsmundstückstutzen (102) hineinragenden Wand umgeben ist und sich in Richtung der Öffnung des Mundstückstutzens (102) gegenüber der in Verbindung mit dem Gehäuse (106) stehende Öffnung so verbiegt, dass er eine kuppelartige Wand (121) oberhalb der Öffnung (112') bildet, welche Kuppel (121) das Atemgas aus dem Bypassrohr (101) in Richtung des Benutzermundes fördert.

13. Zweite Stufe (1) nach Anspruch 12, **dadurch gekennzeichnet, dass** die kuppelartige Wand (121) sich in Längsrichtung für einen gegebenen Abschnitt innerhalb des Einatmungs-/Ausatmungsmundstückstutzens (102) so erstreckt, dass sie innerhalb des Mundstückstutzen(102) ein Rohr (121) bildet, das sich in Längsrichtung des Mundstückstutzen (102) erstreckt und im gewöhnlichen Gebrauchszustand an der unteren Mantelwand des Einatmungs-/Ausatmungsmundstückstutzen (102) angeordnet ist, welches Rohr (121) das von dem Bypassrohr (101) kommende Atemgas zum Benutzermund führt.

14. Zweite Stufe (1) nach Anspruch 12 oder 13, **dadurch gekennzeichnet, dass** das Rohr (121) in das Einatmungs-/Ausatmungsmundstückstutzen (102) eine Länge im Bereich von 5 bis 10 mm aufweist.

15. Zweite Stufe (1) nach einem oder mehreren der vorhergehenden Ansprüche 12 bis 14, **dadurch gekennzeichnet, dass** das Rohr (121) im Einatmungs-/Ausatmungsmundstückstutzen (102) eine Länge von gleich 7 mm aufweist.

16. Zweite Stufe (1) nach einem oder mehreren der vorhergehenden Ansprüche 12 bis 15, **dadurch gekennzeichnet, dass** der der Öffnung des Mundstückstutzens (102) zugewandte Abschnitt gegenüber der mit dem Gehäuse (106) in Verbindung stehende Öffnung eine Verbreiterungseinsenkung aufweist.

17. Zweite Stufe (1) nach einem oder mehreren der vorhergehenden Ansprüche 12 bis 16, **dadurch gekennzeichnet, dass** die Verbreiterungseinsenkung einen Winkel von 10° aufweist.

Revendications

1. Deuxième étage de réduction de pression (1) destiné à être utilisé sous l'eau, comprenant :

- un boîtier (106) ayant une entrée de gaz respiratoire et un orifice d'inhalation/expiration à travers lequel le gaz alimenté dans le boîtier est inhalé par l'utilisateur et à travers lequel l'utilisateur alimente le gaz expiré dans le boîtier, ledit boîtier (106) possédant une sortie d'échappement de gaz expiré pourvue d'un clapet de non-retour,
- l'orifice d'inhalation/expiration de gaz étant relié à un tube d'embout buccal (102) d'inhalation/expiration, à travers lequel le gaz respiratoire est inhalé par l'utilisateur et à travers lequel le gaz est expiré dans le boîtier (106),
- l'entrée de gaz respiratoire dans le boîtier (106) étant reliée à un dispositif de réduction de pression de gaz respiratoire pourvu d'un tuyau ou élément cylindrique creux (107), ledit élément cylindrique creux (107) possédant un orifice d'entrée de gaz respiratoire (117) communiquant avec un conduit d'alimentation en gaz (103) par l'intermédiaire d'une valve qui est interposée entre ledit conduit d'alimentation (103) et ledit tube d'embout buccal (102) d'inhalation/expiration pour ledit gaz respiratoire,
- ledit boîtier (106) étant pourvu de moyens sensibles à la pression pour commander l'ouverture/fermeture de ladite valve, dans lequel l'entrée de gaz respiratoire dans le boîtier (106) est prévue dans la partie inférieure dudit boîtier (106), considérant le deuxième étage (1) utilisé par un utilisateur debout et ledit élément cylindrique creux (107) du dispositif de réduction de pression étant relié à ladite entrée sur le boîtier (106) de telle sorte que son axe soit vertical ou sensiblement vertical, avec l'utilisateur debout, c'est-à-dire sensiblement parallèle à l'axe longitudinal, au à l'axe cranio-caudal, qui est l'intersection du plan sagittal avec le plan coronal du corps de l'utilisateur ;

et en ce qu'il comporte un tube (101), ou tube de dérivation, alimentant ledit gaz respiratoire du dispositif de réduction de pression directement dans le tube d'embout buccal (102) d'inhalation/expiration, à l'ouverture de la valve de réduction de pression, le tube de dérivation (101) étant relié par une extrémité à un orifice (112), situé sur la paroi de jupe de l'élément cylindrique creux (107) du dispositif de réduction de pression, et par l'autre extrémité à un orifice (112'), situé sur la paroi de jupe du tube d'embout buccal (102) d'inhalation/expiration ;
caractérisé en ce que
une patte est située dans le tube d'embout (102) d'inhalation/expiration, en position sensiblement diamétrale, orientée transversalement à l'axe du tube de dérivation (101) et s'étendant sensiblement parallèle à l'axe dudit tube d'embout buccal (102) d'inhalation/expiration, et ladite patte (200) s'étend axialement d'une position où elle recouvre sensiblement l'orifice de sortie du tube de dérivation (101) dans le tube d'embout buccal d'inhalation/expiration (102), avec une extrémité orientée vers l'intérieur du deuxième étage de réduction de pression, jusqu'à la région d'extrémité opposée dudit tube d'embout buccal d'inhalation/expiration (102), orientée vers l'utilisateur et conçue pour d'accoupler à un élément d'embout buccal (105).

2. Deuxième étage (1) selon la revendication 1, **caractérisé en ce que** ledit boîtier (106) est pourvu d'une deuxième sortie d'échappement de gaz expiré (113) avec un clapet de non-retour (123), lesdites deux sorties (113) étant placés sur les côtés de l'entrée de gaz respiratoire dans le boîtier (106) reliée audit élément cylindrique creux (107) du dispositif de réduction de pression.

3. Deuxième étape (1) selon la revendication 1 ou 2, **caractérisé en ce que** ladite patte (200) est située à un niveau sensiblement coïncidant avec la position diamétrale centrale du tube d'embout buccal (102) ou à un niveau intermédiaire entre ladite position diamétrale centrale et la semi-circonférence supérieure avec le deuxième étage porté par l'utilisateur et l'utilisateur debout.

4. Deuxième étage (1) selon l'une des revendications 1 à 3, **caractérisé en ce que**, dans ledit état porté par l'utilisateur debout, la patte s'étend sensiblement en direction l'horizontale ou parallèle au plan transversal de la tête de l'utilisateur selon la définition médicale de dudit plan et/ou parallèle ou coïncidant avec le plan diamétral coïncidant avec le grand diamètre de l'embout buccal (105) à l'état monté sur le tube d'embout buccal (102) d'inhalation/expiration.

5. Deuxième étage selon l'une ou plusieurs des revendications précédentes 1 à 4, **caractérisé en ce que** la patte a l'une des configurations suivantes complètement plate ; avec un profil courbe au moins sur une partie de celle-ci selon au moins l'une des deux directions axiale et radiale ou selon les deux directions et avec des rayons de courbure différents, et constants ou variables le long de l'étendue angulaire de la forme courbe.

6. Deuxième étage (1) selon l'une ou plusieurs des revendications 1 à 5, **caractérisé en ce que** ladite patte (200) se termine par un bord d'attaque sensiblement diamétral, dans la zone en aval de l'orifice de sortie du tube de dérivation (101) dans le tube d'embout buccal d'inhalation/expiration (102) et s'étend jusqu'à recouvrir ledit orifice de sortie par un appendice (205) prolongeant ledit bord d'attaque de la patte (200) .

7. Deuxième étage (1) selon la revendication 6, **caractérisé en ce que** ledit appendice (205) présente des formes et des dimensions différentes d'une configuration de base comme un capuchon, une cuillère ou une demi-coquille.

8. Deuxième étage (1) selon la revendication 6 ou 7, **caractérisé en ce que** ledit appendice (205) présente en alternative une configuration choisie dans le groupe des configurations suivantes :

une première courbure selon un axe parallèle à l'axe du tube d'embout buccal (102) d'inhalation/expiration et avec une longueur prédéterminée sensiblement correspondant à la distance axiale de l'orifice de sortie du tube de dérivation (101) dans le tube d'embout buccal d'inhalation/expiration du côté arrière de la patte (200) et une partie d'extrémité avec une forme en capuchon ;
seulement un rayon de courbure autour d'un seul axe orienté dans la direction diamétrale par rapport au tube d'embout buccal d'inhalation/expiration, ou dans la direction parallèle à la patte (200) et au bord arrière de celle-ci.

9. Deuxième étage (1) selon l'une ou plusieurs des revendications 6 à 8, **caractérisé en ce que** ledit appendice (205) comporte une saillie (206) recouvrant le côté inférieur de la patte (200) dont ledit appendice provient.

10. Deuxième étage (1) selon l'une ou plusieurs des revendications 1 à 9, **caractérisé en ce que** la patte (200) est montée de façon amovible dans le tube d'embout buccal d'inhalation/expiration (102) par le biais de moyens de coopération qui l'accouplent à la paroi intérieure de jupe dudit tube d'embout buccal d'inhalation/expiration.

11. Deuxième étage (1) selon l'une ou plusieurs des revendications 1 à 10, **caractérisé en ce qu'**il est pourvu en plus d'une série de pattes (200) différentes, possédant des caractéristiques de forme et de dimension différentes et pouvant être montées alternativement dans le tube d'embout buccal d'inhalation/expiration.

12. Deuxième étage (1) selon la revendication 1 ou 2, **caractérisé en ce qu'**une partie de l'orifice (112') situé sur la paroi de jupe du tube d'embout buccal d'inhalation/expiration (102) est entourée par une paroi faisant saillie dans le tube d'embout buccal (102) d'inhalation/expiration et se courbe dans la direction de l'orifice du tube d'embout buccal (102) opposée à l'orifice lié au boîtier(16), de manière a former une paroi en forme de capuchon (121) au-dessus dudit orifice (112') ledit capuchon (121) transportant le gaz respiratoire du tube de dérivation (101) vers la bouche de l'utilisateur.

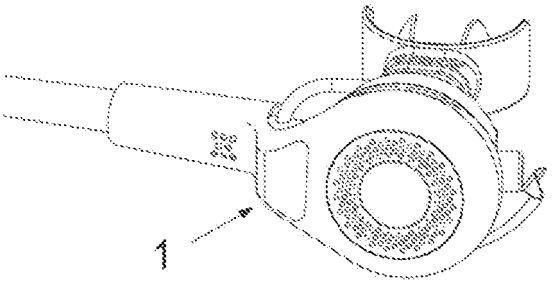
13. Deuxième étage (1) selon la revendication 12, **caractérisé en ce que** ladite paroi en forme de capuchon (121) s'étend longitudinalement pour une partie donnée à l'intérieur dit tube d'embout buccal d'inhalation/expiration (102) de manière à former, à l'intérieur dudit tube d'embout buccal (102), un tube (121) s'étendant sur la longueur du tube d'embout buccal (102) et placé au niveau de la partie inférieure de jupe du tube d'embout buccal d'inhalation/expiration (102), considéré à l'état normal d'emploi, ledit tube (121) transportant le gaz respiratoire venant du tube de dérivation (101) vers la bouche de l'utilisateur.

14. Deuxième étage (1) selon la revendication 12 ou 13, **caractérisé en ce que** ledit tube (121) dans le tube d'embout buccal (102) d'inhalation/expiration a une longueur de 5 à 10 mm.

15. Deuxième étage (1) selon l'une ou plusieurs des revendications 12 à 14, **caractérisé en ce que** ledit tube (121) dans le tube d'embout buccal (102) d'inhalation/expiration a une longueur de 7 mm.

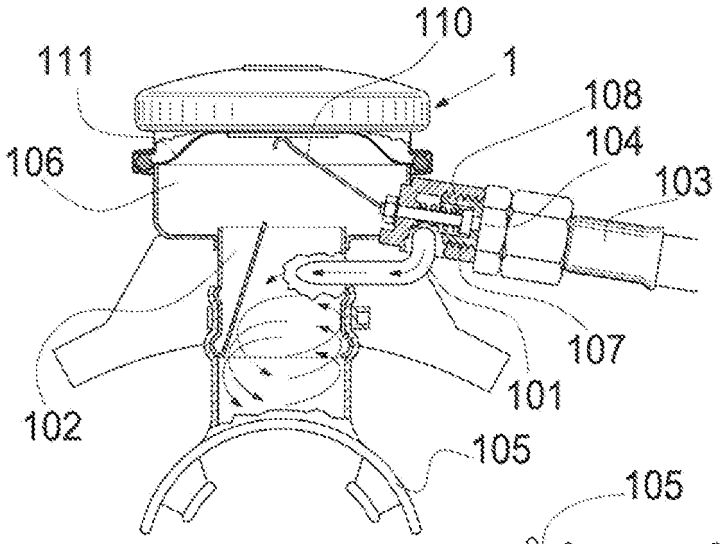
16. Deuxième étage (1) selon l'une ou plusieurs des revendications 12 à 15 **caractérisé en ce que** la partie du tube faisant face à l'orifice du tube d'embout buccal (102) opposé à l'orifice lié au boîtier (106) comporte un évasement d'élargissement.

17. Deuxième étage selon l'une ou plusieurs des revendications précédentes 12 à 16 **caractérisé en ce que** ledit évasement d'élargissement présente un angle de 10°.



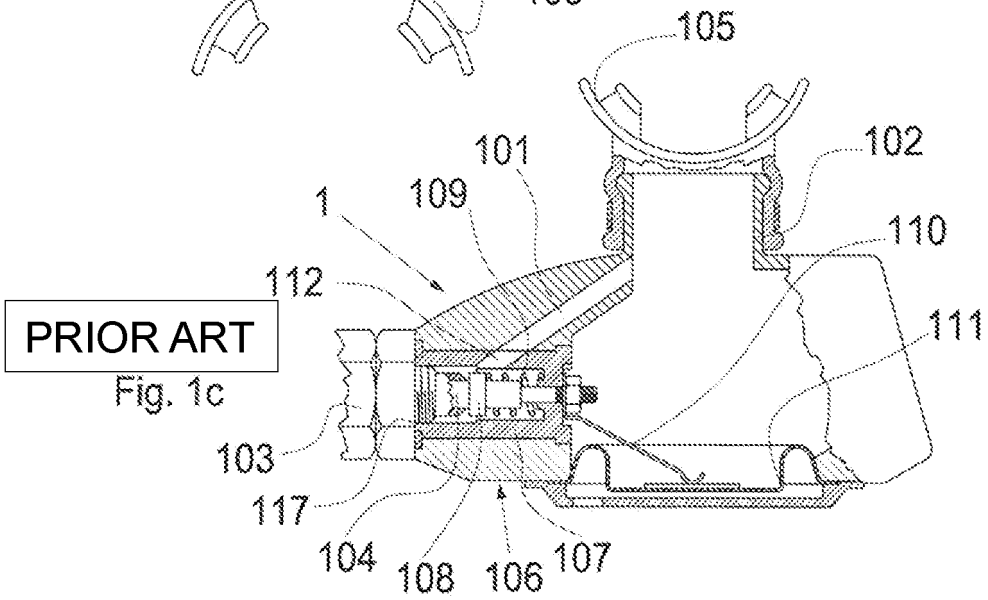
PRIOR ART

Fig. 1a



PRIOR ART

Fig. 1b



PRIOR ART

Fig. 1c

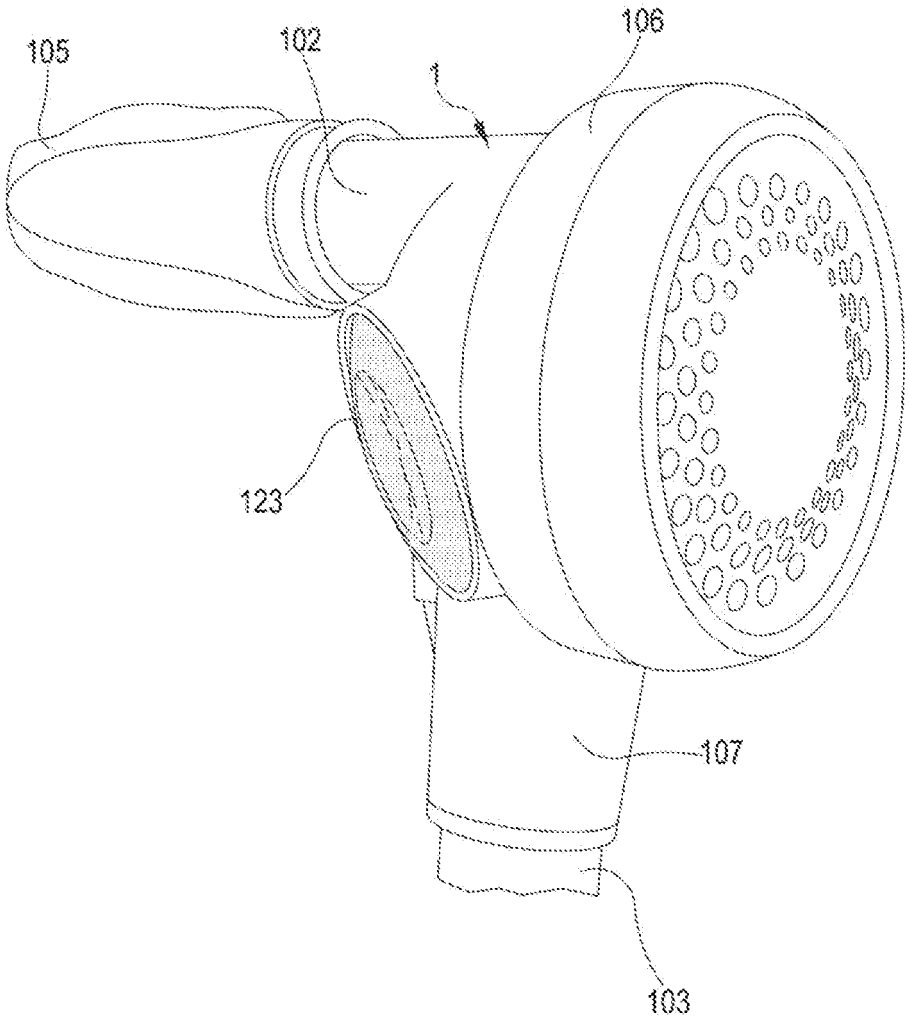


FIG.2

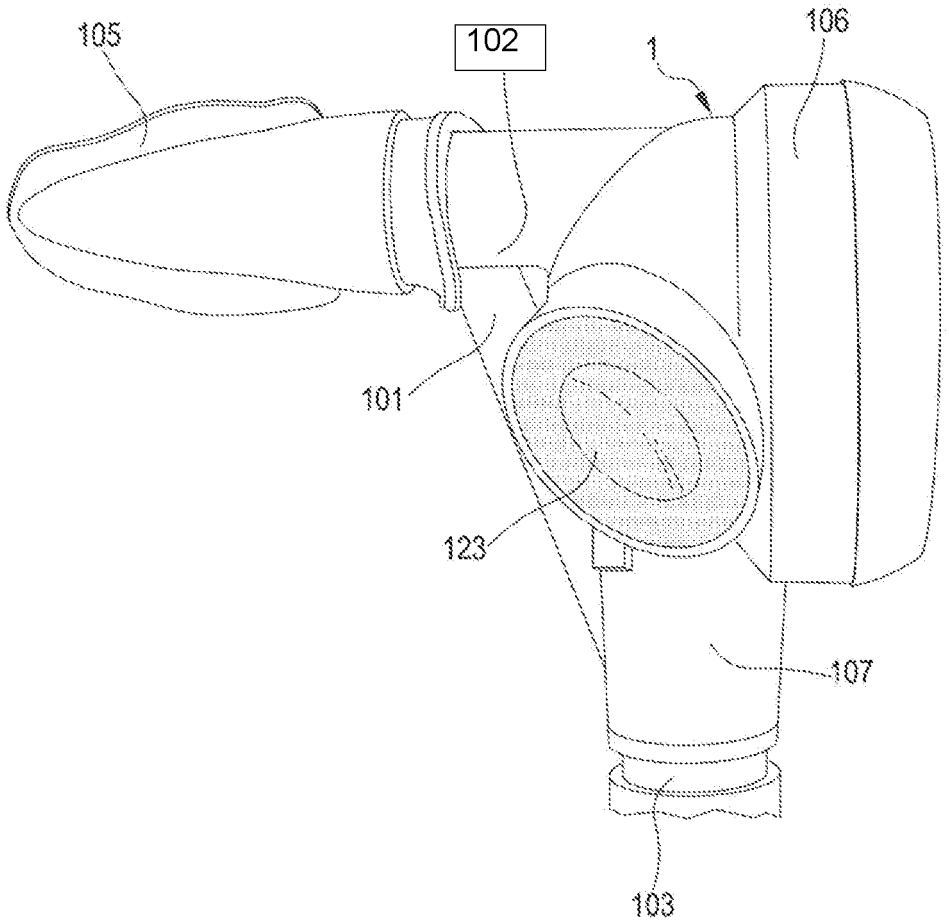


Fig.3

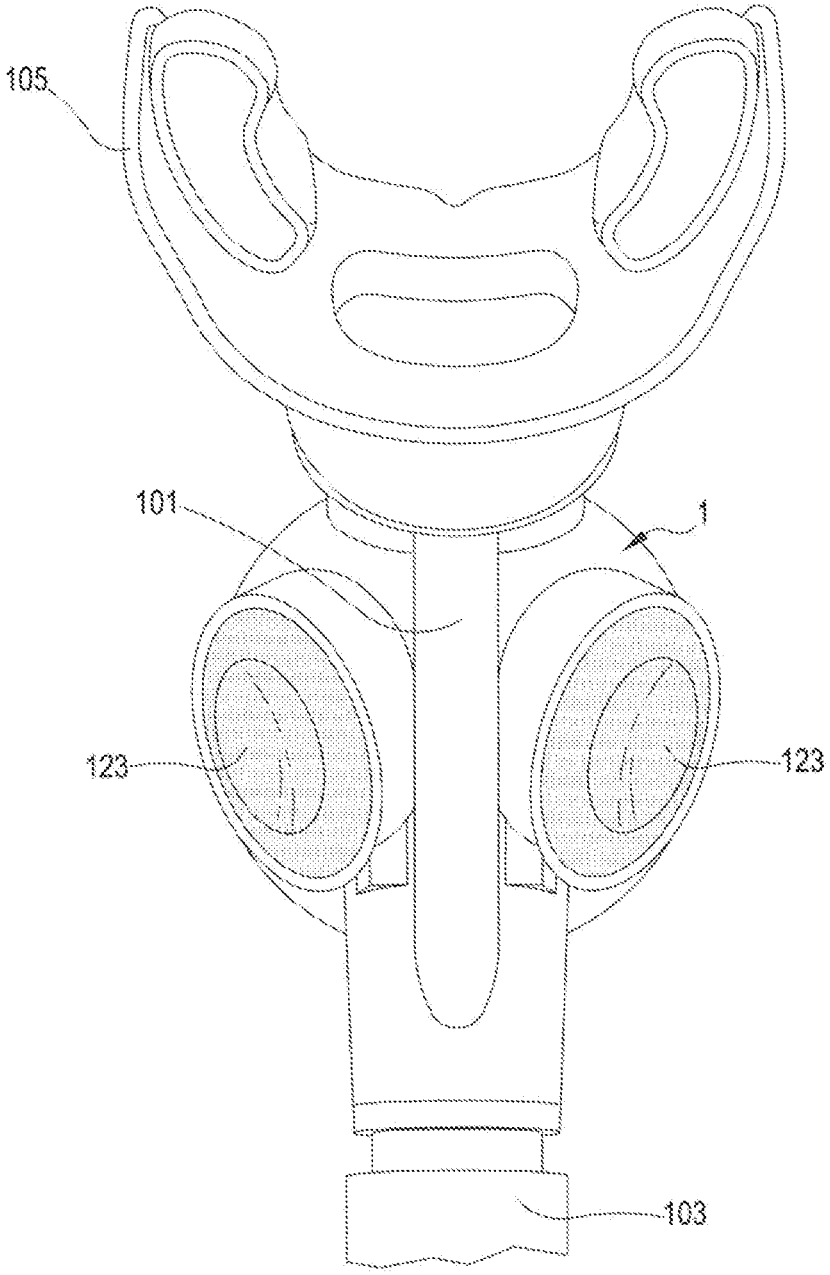


FIG.4

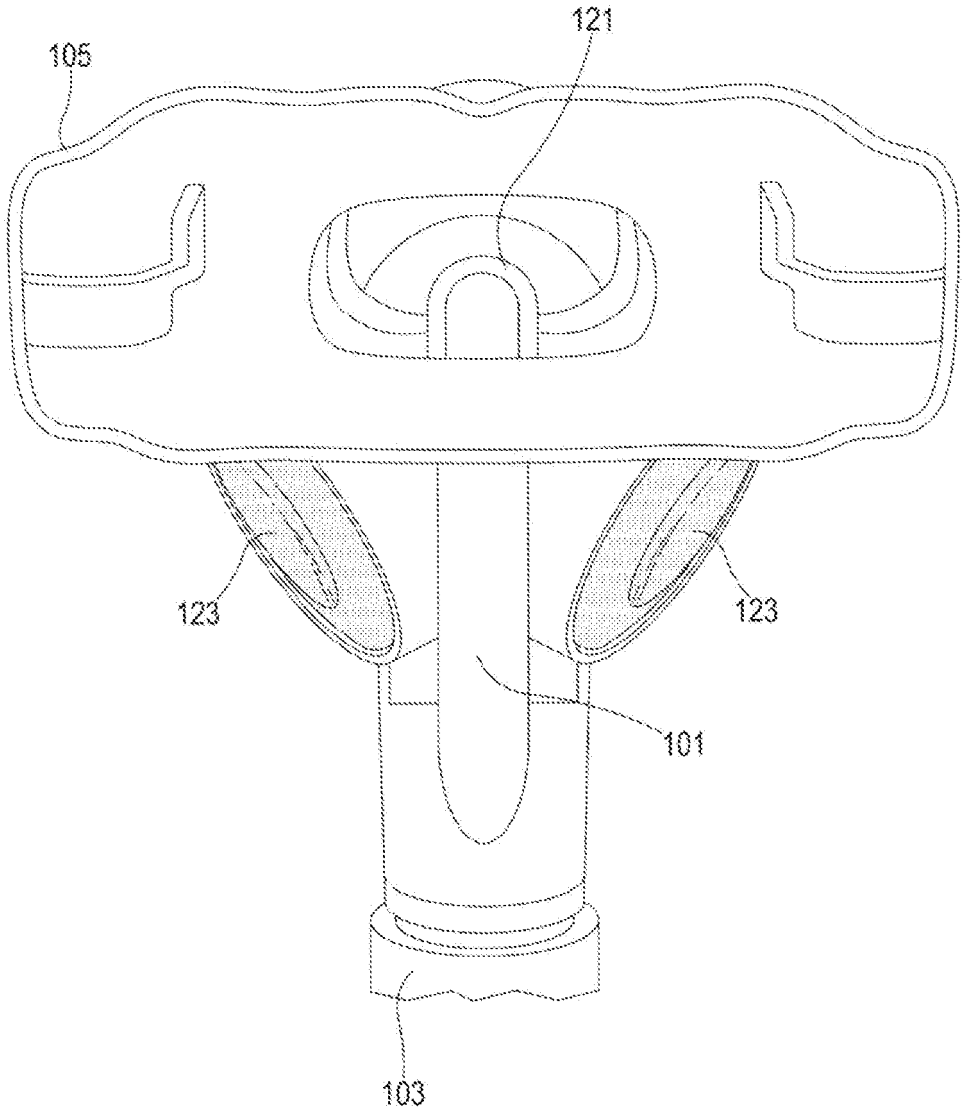
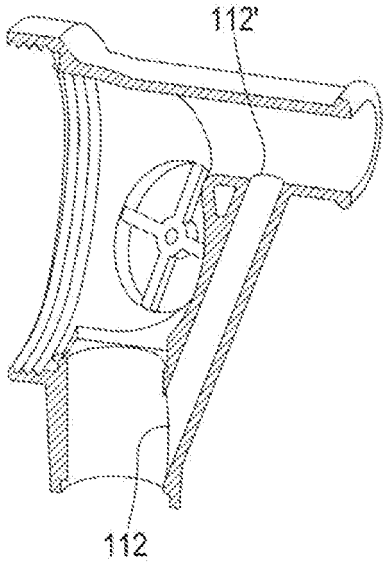


FIG.5

FIG.6



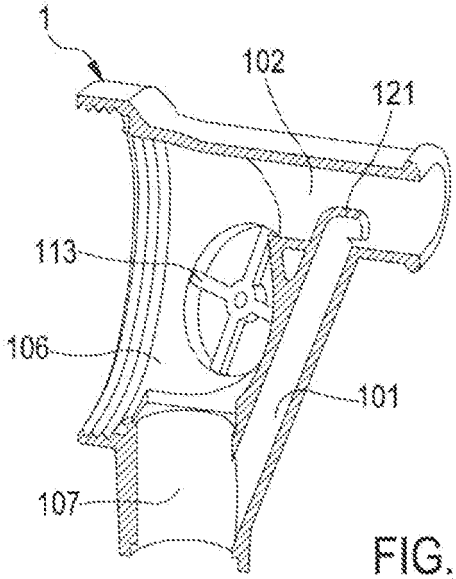


FIG.7

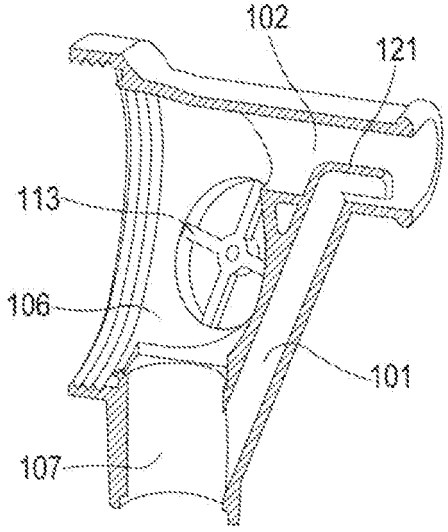


FIG.8

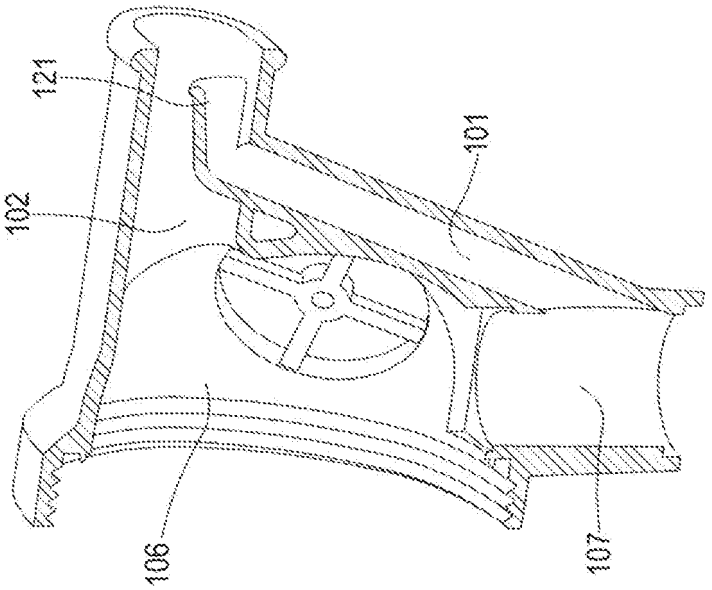


FIG.10

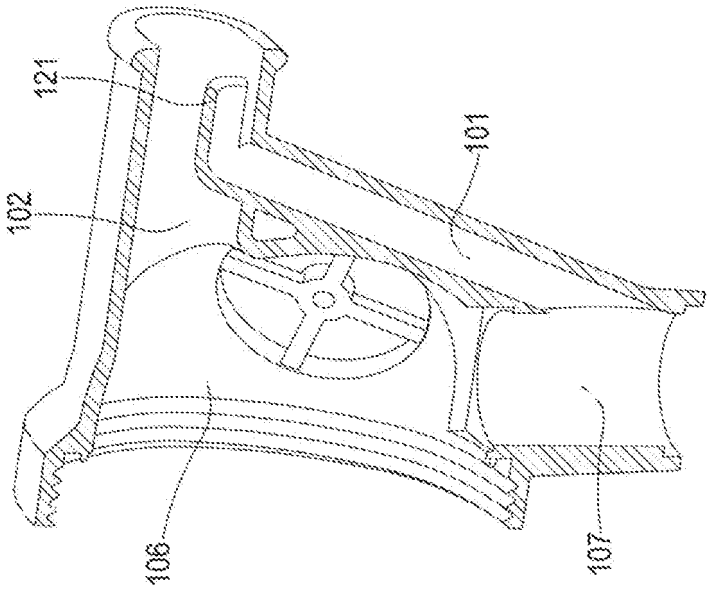


FIG.9

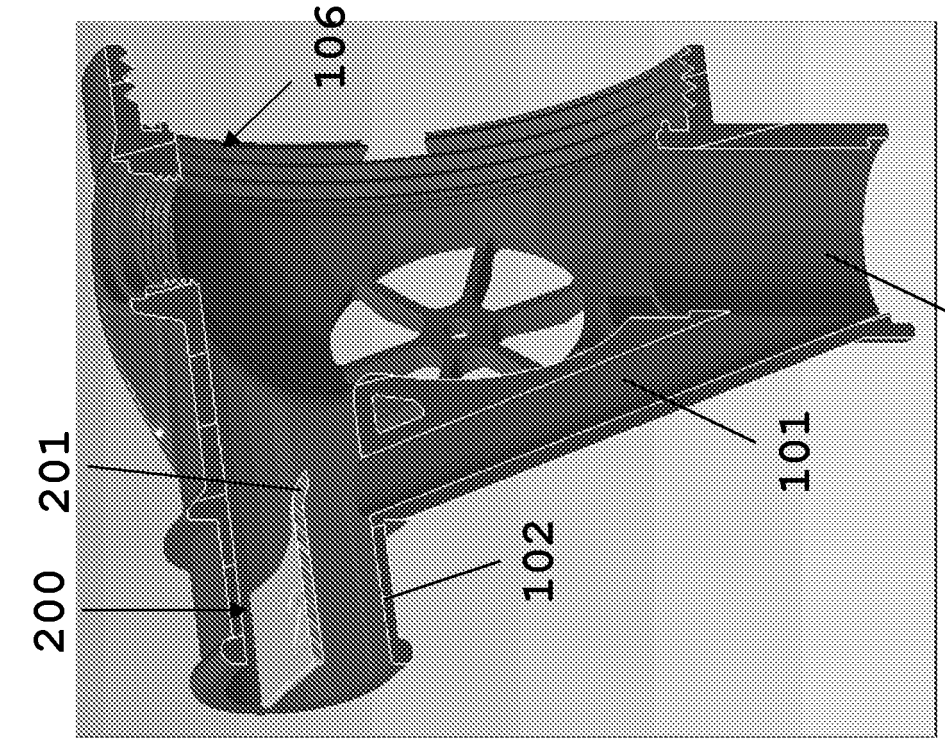


Fig. 12

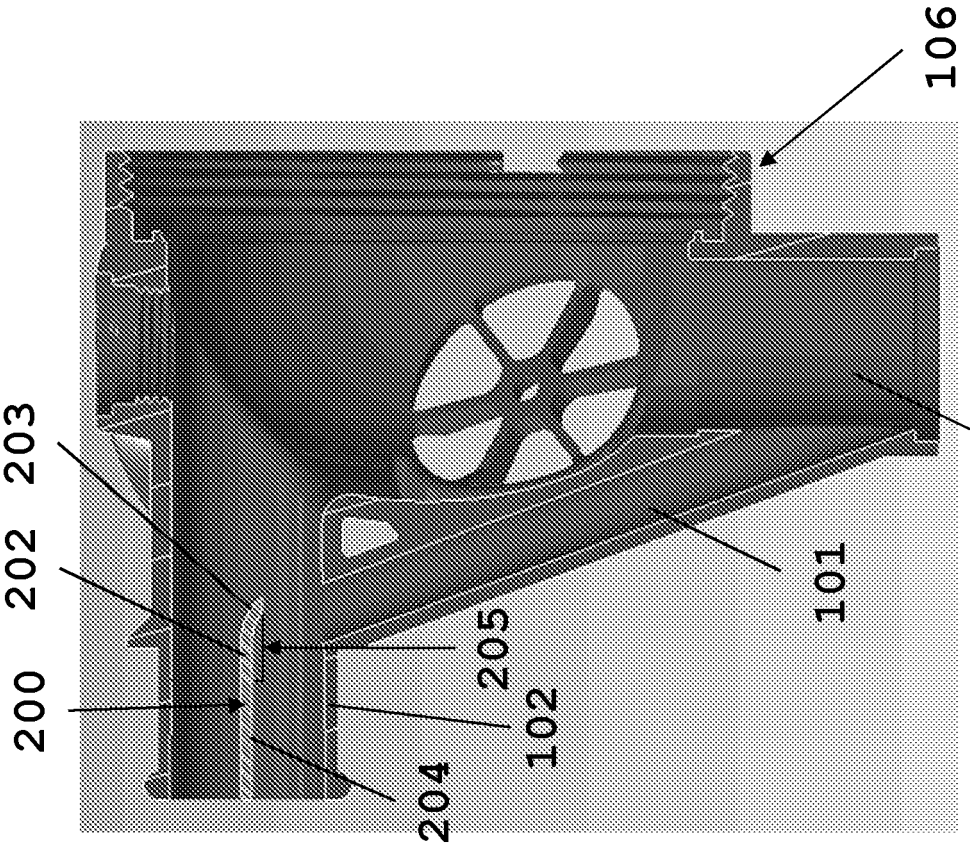


Fig. 11

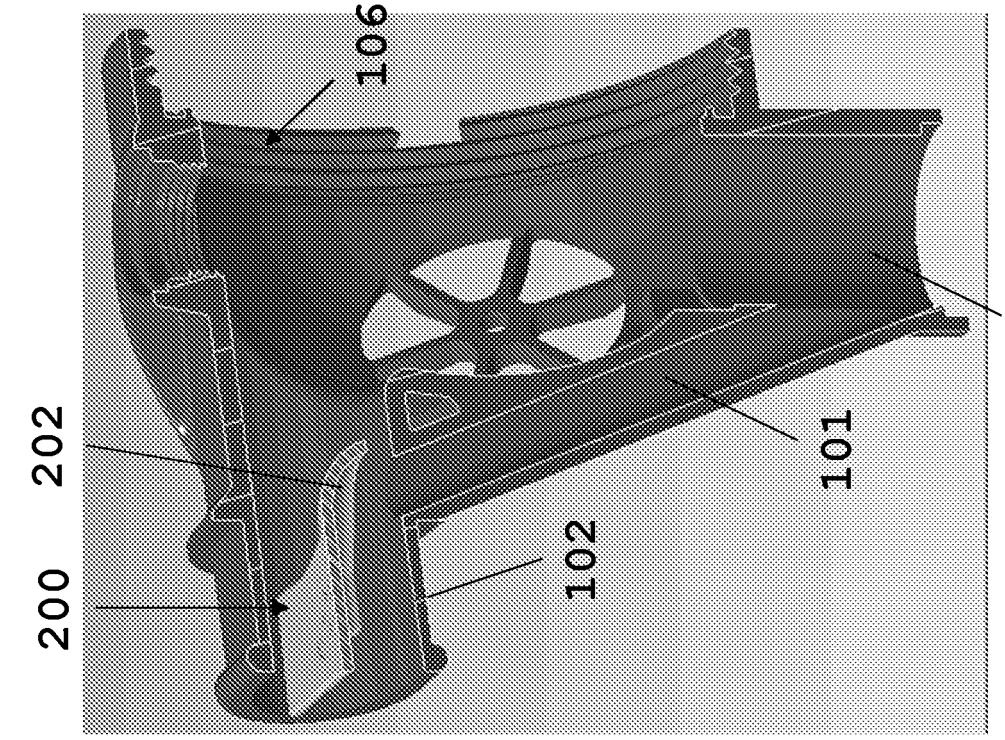


Fig. 14

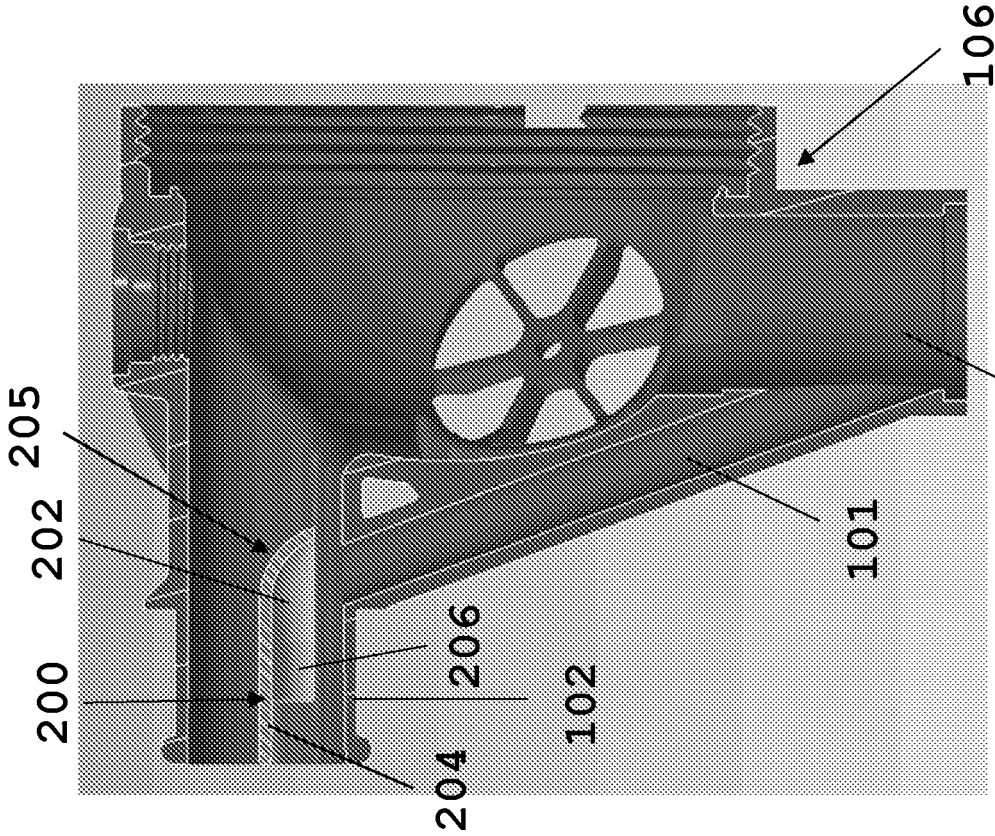


Fig. 13

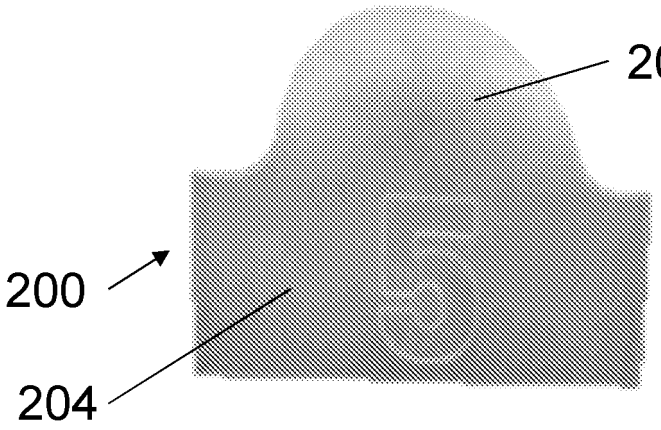


Fig. 15

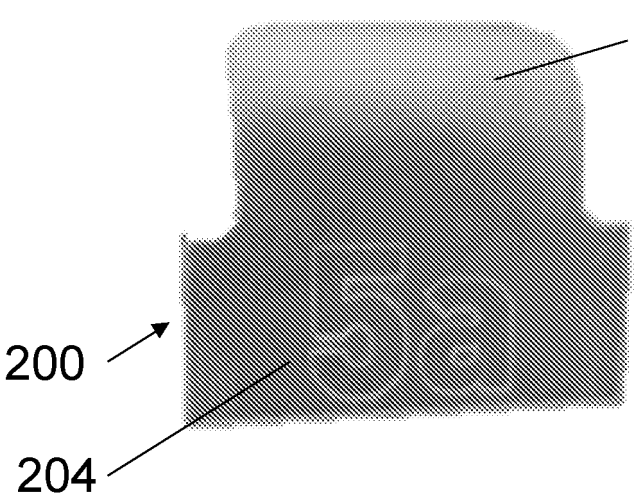


Fig. 16

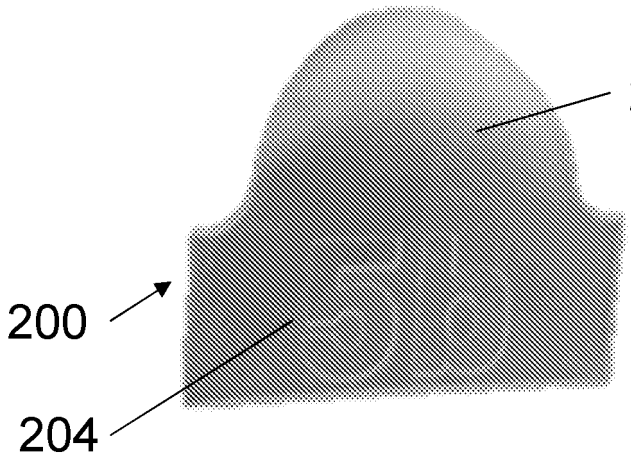


Fig. 17

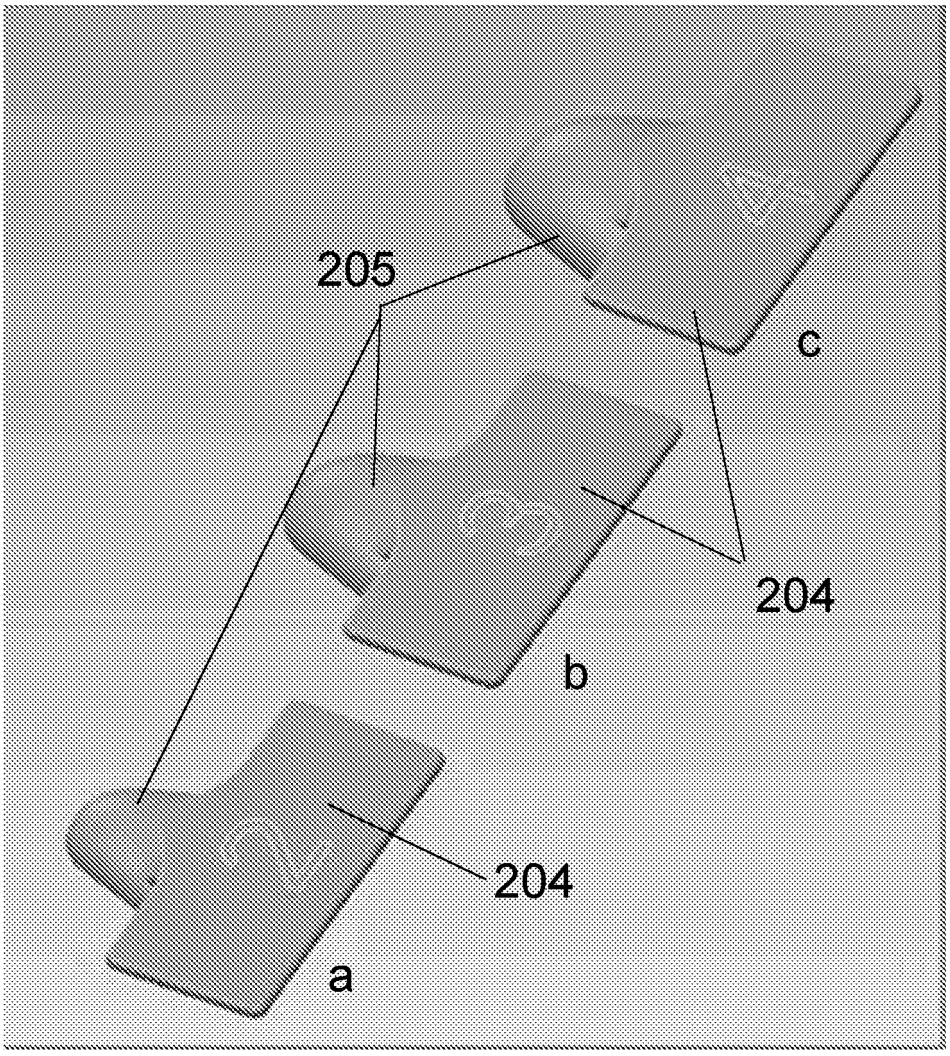


Fig. 18

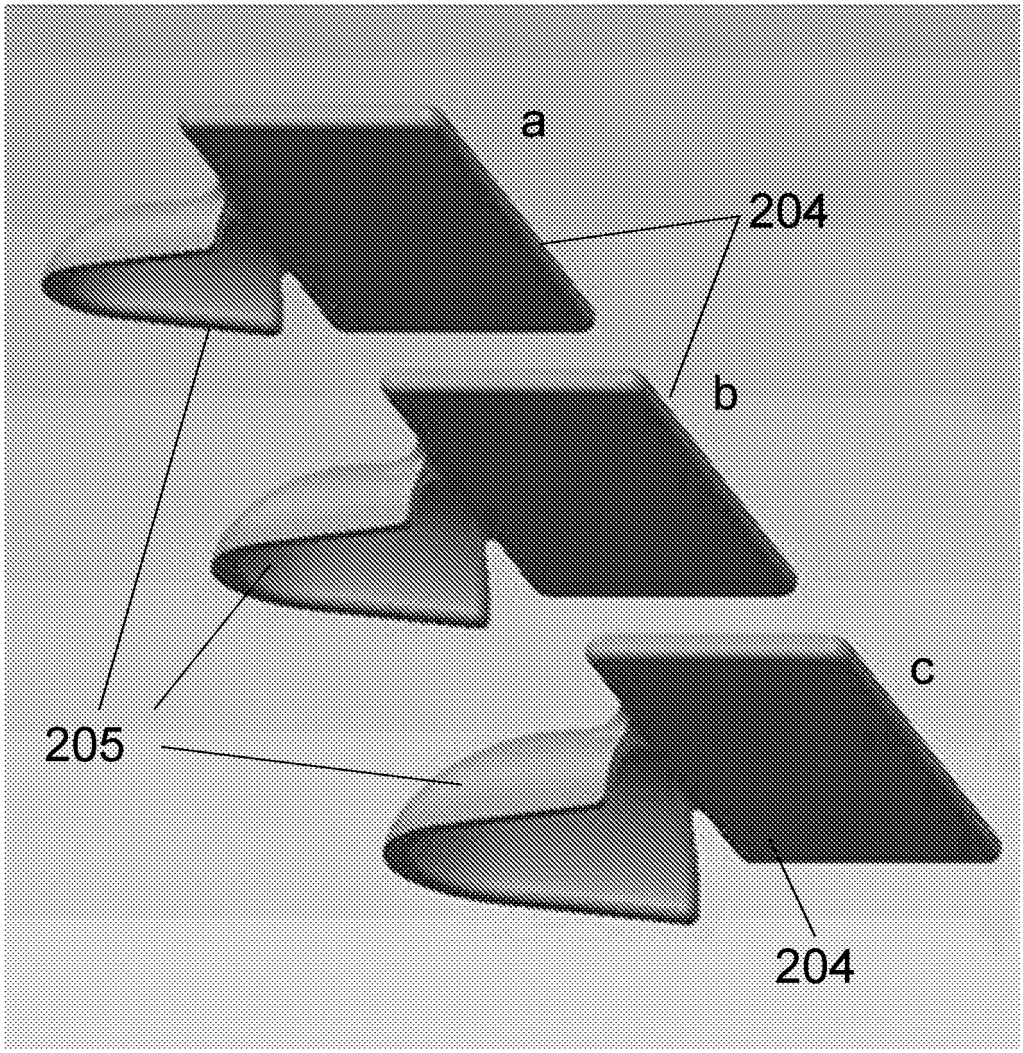


Fig. 19

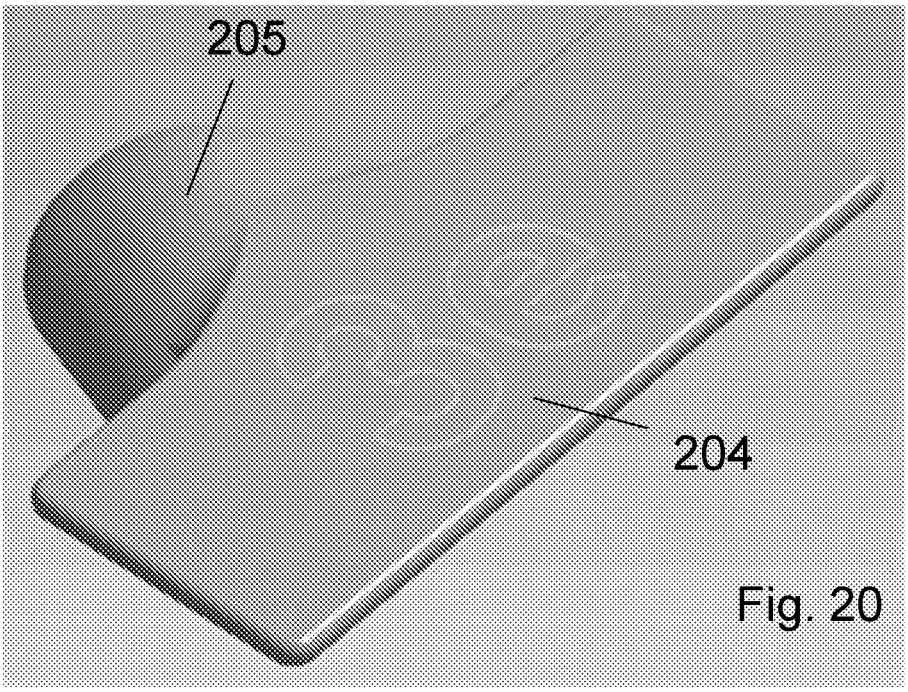


Fig. 20

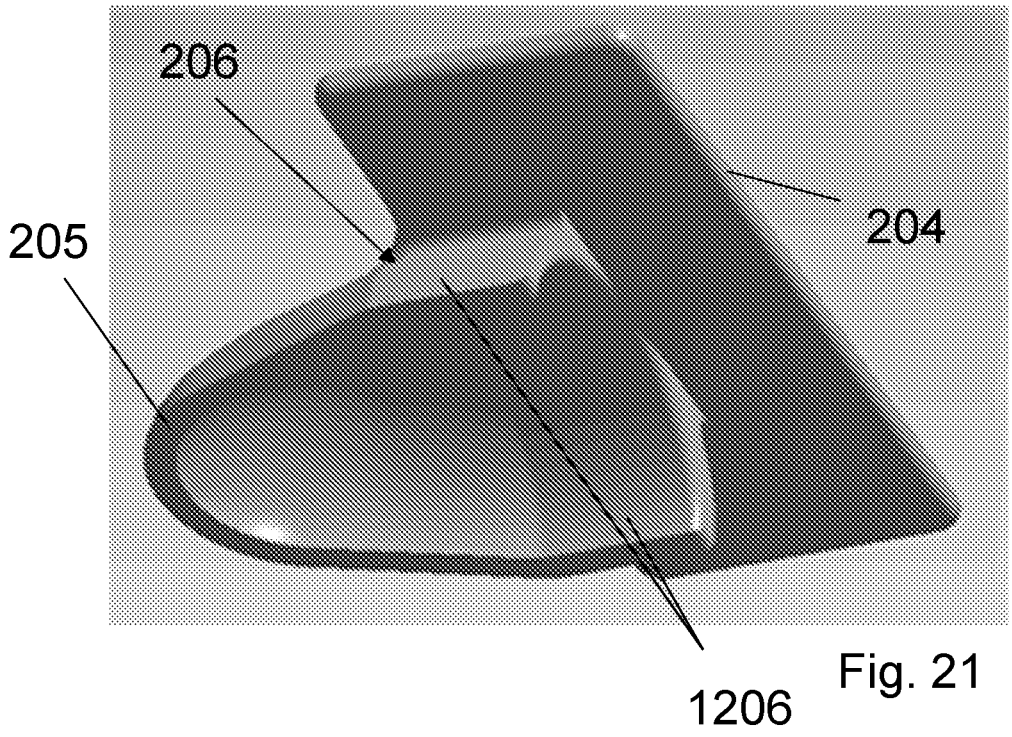


Fig. 21

REFERENCES CITED IN THE DESCRIPTION

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- US 4002166 A **[0004]**
- EP 937640 A **[0006]**