EN

EUROPEAN QUALIFYING EXAMINATION 2013

Paper A(E/M)

Electricity / Mechanics

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Client's Letter

Dear Ms Manda Taire

[01] I am a doctor and treat patients with pulmonary diseases. Pulmonary diseases, such as asthma, cause lung secretions. To dislodge these secretions, I rhythmically drum on a patient's back with my fingers. A drawback of this drumming treatment is that the patient cannot administer it themselves.

[02] Published document D1 discloses a respiratory device which enables a patient to administer a drug for dislodging lung secretions. A drawback of this treatment is that the drug sometimes has unwanted side-effects.

[03] I have invented respiratory devices which provide a similar effect to the drumming treatment, and which overcome the above drawbacks. The effect is achieved by generating air pressure pulses which propagate into the lungs where they dislodge secretions. I will now describe examples of the respiratory devices I have invented. Fig. 1a shows a patient using a respiratory device according to a first example of my invention. Fig. 1b shows the same device in cross section. Figs. 2, 3, 4, 5 and 6 show cross sections of devices according to the 2nd, 3rd, 4th, 5th and 6th examples of my invention respectively.

[04] The device of Figs. 1a and 1b is arranged to generate air pressure pulses when air is exhaled through it with the device orientated as shown. The device comprises a mouthpiece 1 through which the patient can exhale, a conduit 2 having a funnel shaped portion 2a, and a ball 3.

[05] The conduit 2 connects the mouthpiece 1 to the exterior of the device. The mouthpiece 1 and the conduit 2 are preferably made of plastic. The ball 3 is located in the funnel shaped portion 2a of the conduit 2. The smallest diameter of the funnel shaped portion 2a is less than the diameter of the ball 3. The ball 3 is preferably made of metal.

[06] When the ball 3 (shown with a solid line) is in its lowest position in the funnel shaped portion 2a of the conduit 2, it is in a blocking position where it prevents air from flowing between the mouthpiece 1 and the exterior of the device via the conduit 2. An air pressure force acts upwards on the ball 3 due to its exposure to the air pressure in the mouthpiece 1. Since the conduit 2 is open to the exterior of the device, a further air pressure force acts downwards on the ball 3 due to its exposure to the ambient air pressure.

[07] When the patient exhales into the device, the air pressure in the mouthpiece 1 increases above the ambient air pressure so that a resultant air pressure force acts upwards on the ball 3. As long as the air pressure in the mouthpiece 1 is less than an air pressure threshold, the ball 3 is retained in the blocking position by the gravitational force acting on the ball 3.

[08] When the air pressure in the mouthpiece 1 reaches the air pressure threshold, the resultant air pressure force acting on the ball 3 overcomes the gravitational force, so that the ball 3 suddenly moves upwards out of the blocking position (as shown by the dashed lines). Air then flows through the conduit 2, the air pressure in the mouthpiece 1 rapidly decreases and an air pressure pulse is thus generated. The air pressure pulse propagates into the lungs where it dislodges secretions.

[09] If the patient continues to exhale gently into the device, the gravitational force acting on the ball 3 returns it to the blocking position. The air pressure in the mouthpiece 1 then increases again. In this way a sequence of air pressure pulses is generated during a single exhalation.

[10] The device is simple and cheap to manufacture. However, if the patient exhales too hard into the device, the ball 3 may leave the funnel shaped portion 2a of the conduit 2. In this case, only one air pressure pulse is generated, which has a limited therapeutic effect. Furthermore the ball 3 may get lost.

[11] The respiratory device of Fig. 2 differs from the device of Figs. 1a and 1b only that it additionally has a perforated wall 24 and a rubber layer 25. The wall 24 is glued the rim of the funnel shaped portion 2a of the conduit 2. The wall 24 has an inner surface against which the ball 3 can bounce. The wall 24 prevents the ball 3 from leaving the conduit 2 and helps to rapidly return the ball 3 to the blocking position so that more air pressure pulses can be generated during a single exhalation than with the device of Figs. 1a and 1b.

[12] The rubber layer 25 is located on the inner surface of the funnel shaped portion 2a of the conduit 2. The rubber layer 25 exerts a frictional force on the ball 3 which contributes to retaining it in the blocking position. Compared to the device of Figs. 1a and 1b, a higher air pressure in the mouthpiece 1 of this device must be reached before the ball 3 is ejected from the blocking position. Consequently the air pressure pulses it generates are more intense. As an alternative to the rubber layer 25, the ball 3 could be coated with a rubber layer.

[13] The device of Fig. 3 comprises a mouthpiece 1 through which a patient can inhale, a conduit 32 having a funnel shaped portion 32a, an elastic string 34, an annular magnet 35 and a ball 3 made of steel. The device is arranged to generate air pressure pulses when air is inhaled through it, with the device orientated as shown. The annular magnet 35 exerts a magnetic force on the ball 3. The ball 3 is retained at the bottom of the funnel shaped portion 32a of the conduit 32 by a retaining force constituted by the magnetic force and the gravitational force acting on the ball 3. In this position the ball 3 prevents air from flowing through the conduit 32.

[14] When the patient inhales air from the device, the air pressure in the mouthpiece 1 decreases. The ball 3 is exposed to the air pressure in the mouthpiece 1 and to the ambient air pressure so that a resultant air pressure force acts upwards on the ball 3.

[15] When the air pressure in the mouthpiece 1 reaches an air pressure threshold, is lower than the ambient air pressure, the resultant air pressure force acting on the ball 3 overcomes the force retaining the ball 3, so that the ball 3 is suddenly ejected upwards from its position shown in Fig. 3. Air then flows through the conduit 32, the air pressure in the mouthpiece 1 rapidly increases and an air pressure pulse is thus generated.

[16] When the ball reaches a certain height within the funnel shaped portion 32a of the conduit 32, the elastic string 34 becomes taut and helps to rapidly return the ball 3 to the bottom of the funnel shaped portion 32a of the conduit 32, where it again prevents air from flowing through the conduit 32.

[17] The fourth (Fig. 4), fifth (Fig. 5) and sixth (Fig. 6) examples of my invention are convenient to use because they are very compact. In these examples, instead of a ball, a flap which can rotate about a pivot forms a blocking element.

[18] The device of Fig. 4 comprises a mouthpiece 1 through which a patient can exhale, a conduit 42 comprising a transversal wall 46 with a through-hole 47, a pivoted flap 43, a resilient pad 44, and a magnet 45 embedded in the transversal wall 46. The conduit 42 connects the mouthpiece 1 to the exterior of the device. The pivoted flap 43 is mounted in the conduit 42 on the right-hand side of the transversal wall 46. The flap 43 is made of a magnetic material such as steel. The device is arranged to generate air pressure pulses when air is exhaled through it, with the device orientated as shown in Fig. 4.

[19] When the flap 43 (shown with a solid line) is vertical in the conduit 42, it closes the through-hole 47 so that air is prevented from flowing through the conduit 42. An air pressure force acts on the flap 43 due to its exposure to the air pressure in the mouthpiece 1. Since the conduit 42 is open to the exterior of the device, a further air pressure force acts on the flap 43 due to its exposure to the ambient air pressure.

[20] When the patient exhales into the device, the air pressure in the mouthpiece increases so that a resultant air pressure force acts laterally on the flap 43. As long as the air pressure in the mouthpiece 1 is less than an air pressure threshold, the flap 43 is retained in the vertical position by the magnetic force exerted by the magnet 45. The air pressure threshold is greater than the ambient air pressure.

[21] When the air pressure in the mouthpiece 1 reaches the air pressure threshold, the resultant air pressure force acting on the flap 43 overcomes the magnetic force, so that the flap 43 suddenly pivots out of the vertical position. Air then flows through the conduit 42, the air pressure in the mouthpiece 1 rapidly decreases and an air pressure pulse is thus generated. The air pressure pulse propagates into the lungs where it dislodges secretions.

[22] When the flap 43 reaches a substantially horizontal position in the conduit 42 (as shown by the dashed line), it hits the resilient pad 44 and bounces off it. This helps to rapidly return the flap 43 to its vertical position in the conduit 42. A sequence of air pressure pulses can thus be generated during a single exhalation.

[23] The device of Fig. 5 generates air pressure pulses when a patient inhales. It differs from the device shown in Fig. 4 only in that the flap 43 is mounted on the left-hand side of the transversal wall 46 facing the mouthpiece 1 and the resilient pad 44 is mounted between the mouthpiece 1 and the transversal wall 46 so that the flap 43 can bounce off it.

[24] When the patient inhales air from the device, the air pressure in the mouthpiece 1 decreases. When the air pressure in the mouthpiece 1 reaches an air pressure threshold, which is less than the ambient air pressure, the resultant air presssure force acting on the flap 43 overcomes the force retaining the flap 43 in the vertical position, so that it suddenly pivots out of the vertical position. Thus an air pressure pulse is generated.

[25] I am also developing devices which generate air pressure pulses when both inhaling and exhaling, by means of a single blocking element which suddenly moves out of a blocking position in which air is prevented from flowing between a mouthpiece and the exterior of the device via a conduit. In these devices the blocking element moves out of the blocking position when the air pressure in the mouthpiece reaches an air pressure threshold (which is greater than the ambient air pressure) and also moves out of the blocking position when the air pressure in the mouthpiece reaches a further air pressure threshold (which is less than the ambient air pressure). The blocking element can have different forms. As in the previous examples, the device is arranged so that when the blocking element is in the blocking position, a retaining force for retaining the blocking element in this position acts on the blocking element.

[26] Such a device is shown in Fig. 6. The device comprises a mouthpiece 1 through which a patient can inhale and exhale, a conduit 62, resilient pads 64a and 64b, a magnet 65 and a rectangular flap 63 made of magnetic material.

[27] The conduit 62 has a tube portion of rectangular cross section in which the flap 63 is mounted. The top of the flap 63 is mounted on a pivot, the bottom of the flap 63 has a rounded edge so that it can pivot out of the vertical position shown in Fig. 6. The flap 63 is retained in the vertical position by a magnetic force exerted by the magnet 65. When the flap 63 is in this position, it prevents air from flowing through the conduit 62.

[28] When the patient exhales air through the device, the device operates in a similar way to the device shown in Fig. 4. The flap 63 oscillates between the vertical position in which it is momentarily retained by means of the magnet 65, and a horizontal position where it bounces off the resilient pad 64a. A sequence of air pressure pulses can thus be generated during a single exhalation.

[29] When the patient inhales air through the device, the device operates in a similar way to the device shown in Fig. 5. The flap 63 oscillates between the vertical position in which it is momentarily retained by the magnet 65, and a horizontal position where it bounces off the resilient pad 64b. A sequence of air pressure pulses can thus be generated during a single inhalation.

[30] Last week I was surprised to find another published document, D2. D2 also discloses a respiratory device for dislodging lung secretions by generating air pressure pulses. Like my invention it can be used by a patient without assistance.

[31] Please draft a set of claims and an introductory part of the description for a European patent application to protect my invention. Please assume that the drawings accompanying this letter will form part of the application. Please note that I will not pay any claim fees for this patent application or fees for any further patent applications.

Best Regards
Yves Toucracher

Client's Drawings

FIG. 1a

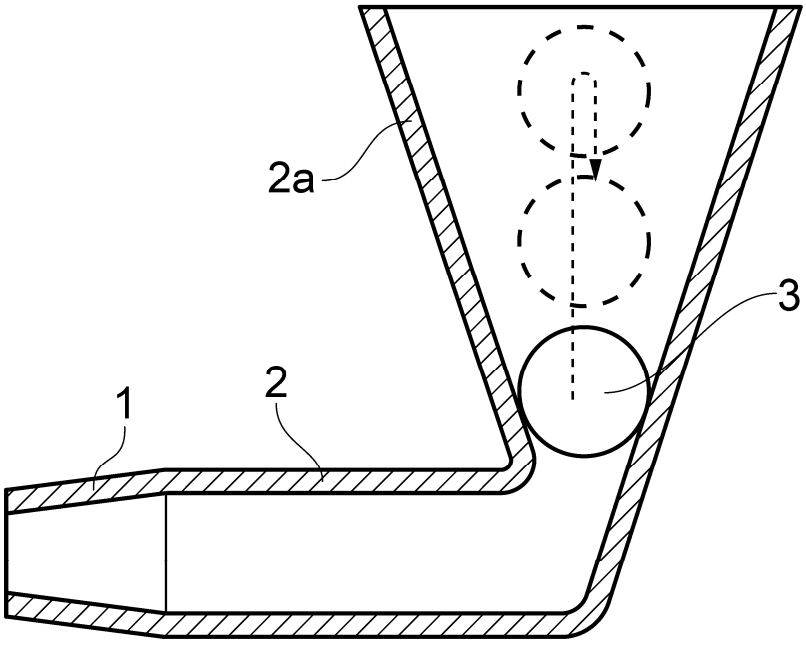

FIG. 1b

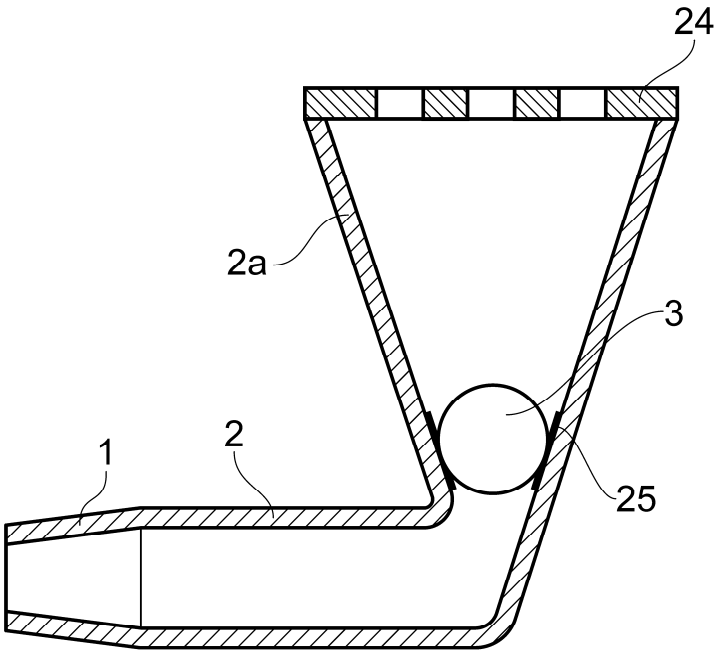

FIG. 2

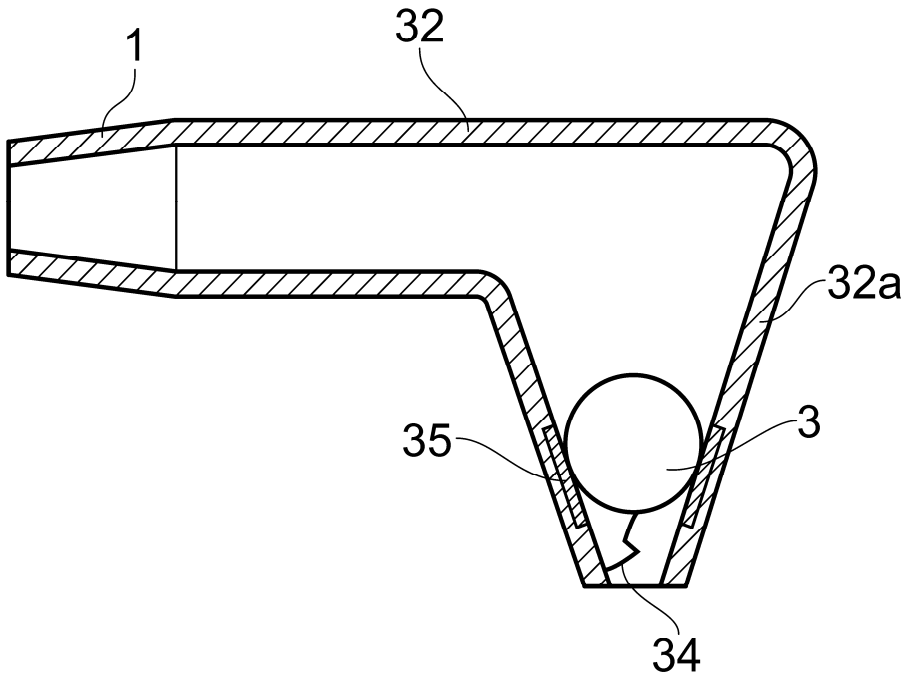

FIG. 3

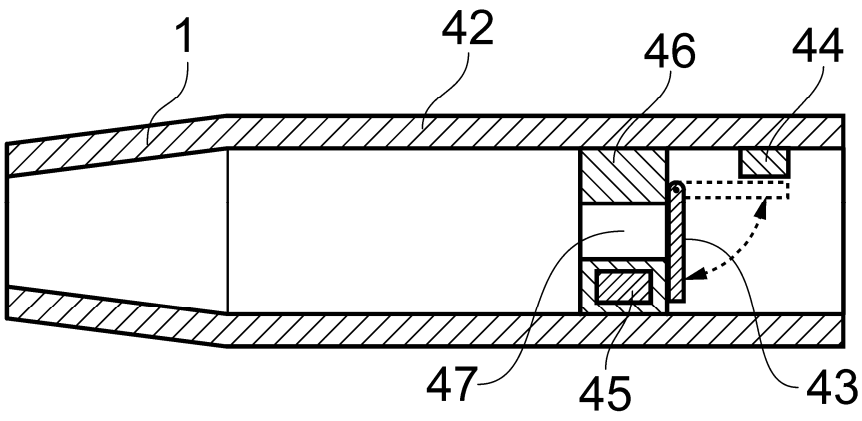

FIG. 4

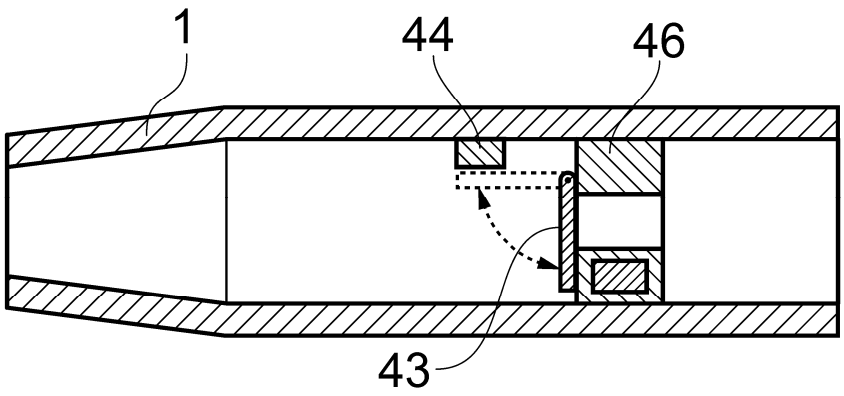

FIG. 5

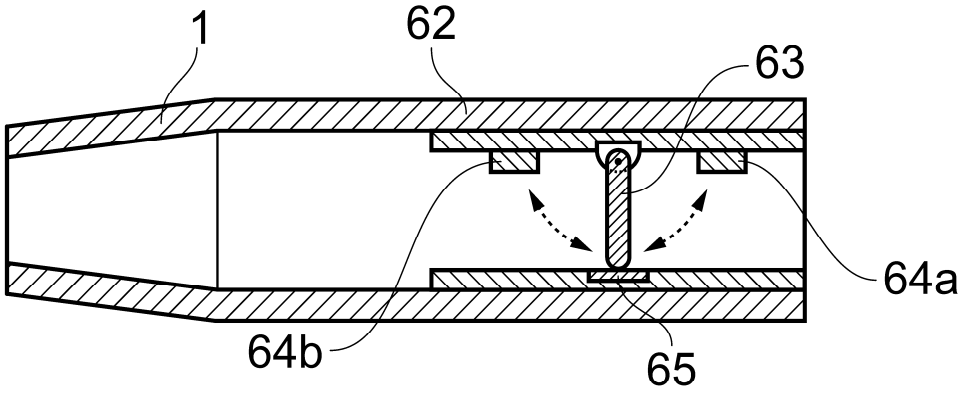

FIG. 6

Document D1

[01] The present article describes a respiratory device for dislodging lung secretions by administering a drug. The drug is inhaled in the form of a spray. The drug is very effective at dislodging lung secretions, provided that the patient completely empties their lungs before inhaling it.

[02] Fig. 1 shows the device in cross section. The device comprises a mouthpiece 101, an air conduit 102, an opening 108 and a whistle 109. The whistle 109 comprises a chamber containing a ball 103. The air conduit 102 is connected to the whistle 109 and to a drug applicator 110. The drug applicator 110 comprises a nozzle 112 and a canister 111 containing a drug.

[03] As shown in Fig. 2, the patient places the mouthpiece 101 in their mouth and exhales. Exhaled air flows down the air conduit 102 to the whistle 109. The air causes the ball 103 to move rapidly in the chamber, as represented by the dashed lines, so that the whistle 109 generates a pulsed whistling sound. The patient is encouraged to make the sound last as long as possible. When the sound stops, the patient's lungs are empty. As shown in Fig. 3, the patient then pushes the canister 111 upwards with their thumb. This causes the drug to be sprayed from the nozzle 112, which the patient inhales through the mouthpiece 101.

[04] Although the pulsed whistling sound propagates into the lungs as air pressure pulses, the pulses are of such a low intensity that they only have a small effect in dislodging lung secretions.

Drawings Document D1

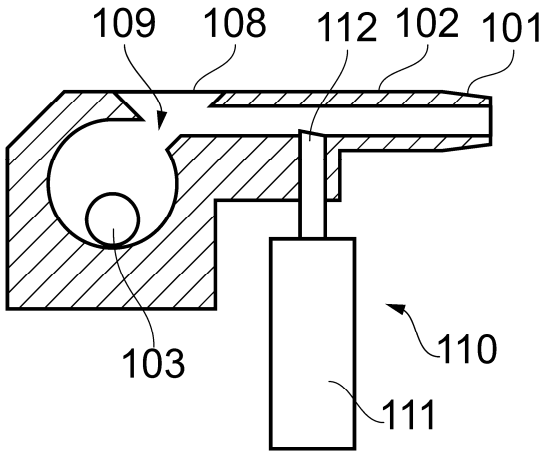

FIG. 1

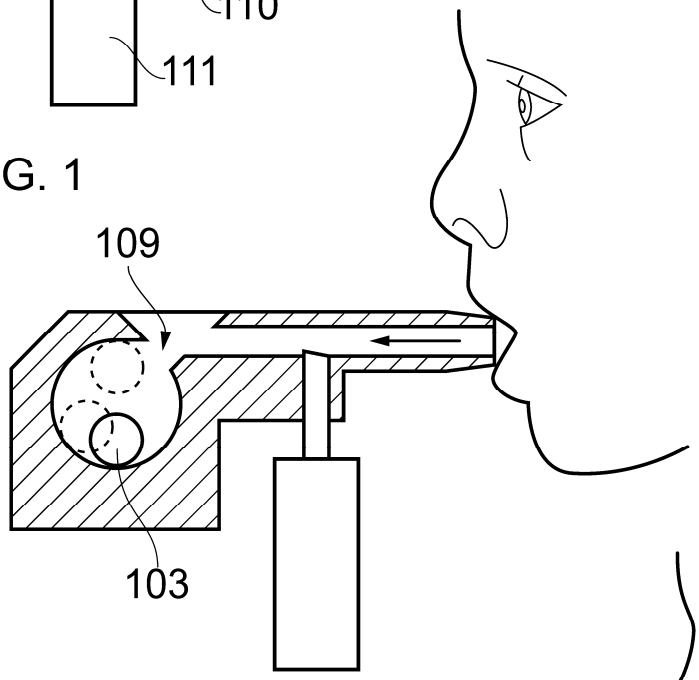

FIG. 2

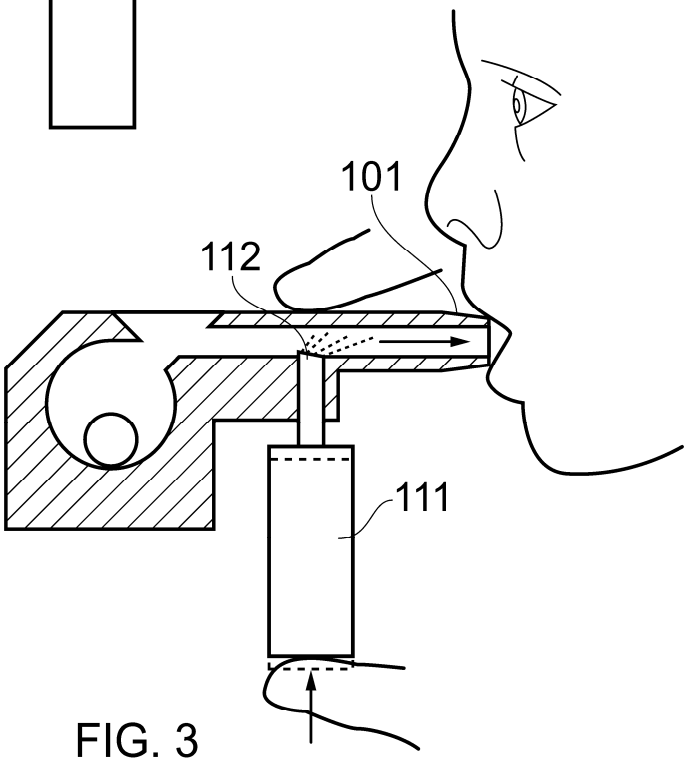

FIG. 3

Document D2

[01] The present article describes a respiratory device for dislodging lung secretions.

[02] Fig. 1 is a perspective view of the device with a part cut away. Fig. 2 shows the device of Fig. 1 in cross section. The device comprises a mouthpiece 201 through which a patient can inhale and exhale, a conduit 202, a rotatable disc 203, and two air pressure sensors 213a and 213b. A first portion of the conduit 202 is connected to the mouthpiece 201, the air pressure sensor 213a is located in this portion of the conduit. A second portion of the conduit 202 is open to the exterior of the device via an opening 214, the air pressure sensor 213b is located in this portion of the conduit. The disc 203 is mounted in the conduit 202 between the first portion and the second portion. Rubber sealing rings 215a and 215b close a gap between the conduit 202 and the disc 203. The device further comprises a housing 216 having a grip 217. The housing 216 contains an electric motor 218, a battery 219 and a control unit 220.

[03] The disc 203 has a slot 221 through which air can flow. When the slot 221 is not aligned with the mouthpiece 201 and the opening 214, the disc 203 is in a blocking position in which it prevents air from flowing through the conduit 202. When the electric motor 218 is not energised and the device is orientated as shown in Figs. 1 and 2, the disc 203 is retained in the blocking position by the gravitational force acting on it. When the slot 221 is aligned with the mouthpiece 201 and the opening 214, air can flow through the conduit 202 via the slot 221.

[04] The air pressure sensor 213a is exposed to the air pressure in the mouthpiece 201 and the air pressure sensor 213b is exposed to the ambient air pressure. The control unit 220 monitors the air pressures sensed by the air pressure sensors 213a and 213b.

[05] To turn on the electric motor 218, the patient holds the device by the grip 217 exhales into the mouthpiece 201. Because the disc 203 is initially in the blocking position, the air pressure in the mouthpiece 201 increases. When the difference between the air pressure in the mouthpiece 201 and the ambient air pressure reaches 0.1 bar, the control unit 220 turns on the electric motor 218. The electric motor 218 exerts a force on the disc 203, causing it to rotate at 120 revolutions per minute. The electric motor 218 remains energised for 30 seconds.

[06] After the electric motor 218 has turned on, the patient continues to exhale into the mouthpiece 201. When the slot 221 comes into alignment with the mouthpiece 201 and the opening 214, air suddenly flows from the mouthpiece 201, through the slot 221 and out of the opening 214. This causes the air pressure in the mouthpiece 201 to rapidly decrease and an air pressure pulse is thus generated. Because the disc 203 is rotating, it returns to the blocking position, and the air pressure in the mouthpiece 201 starts to increase again. In this way a sequence of air pressure pulses is generated during a single exhalation.

[07] If the patient then inhales through the mouthpiece 201, further air pressure pulses are generated whilst the disc 203 rotates. The air pressure pulses generated in the device whilst exhaling and inhaling propagate into the lungs of the patient where they dislodge lung secretions.

Drawings Document D2

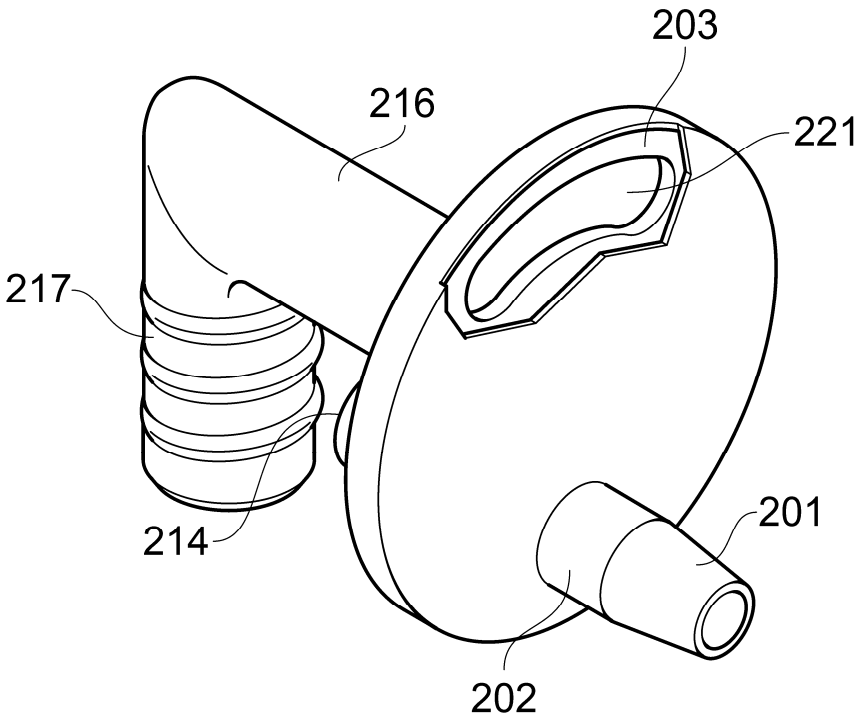

FIG. 1

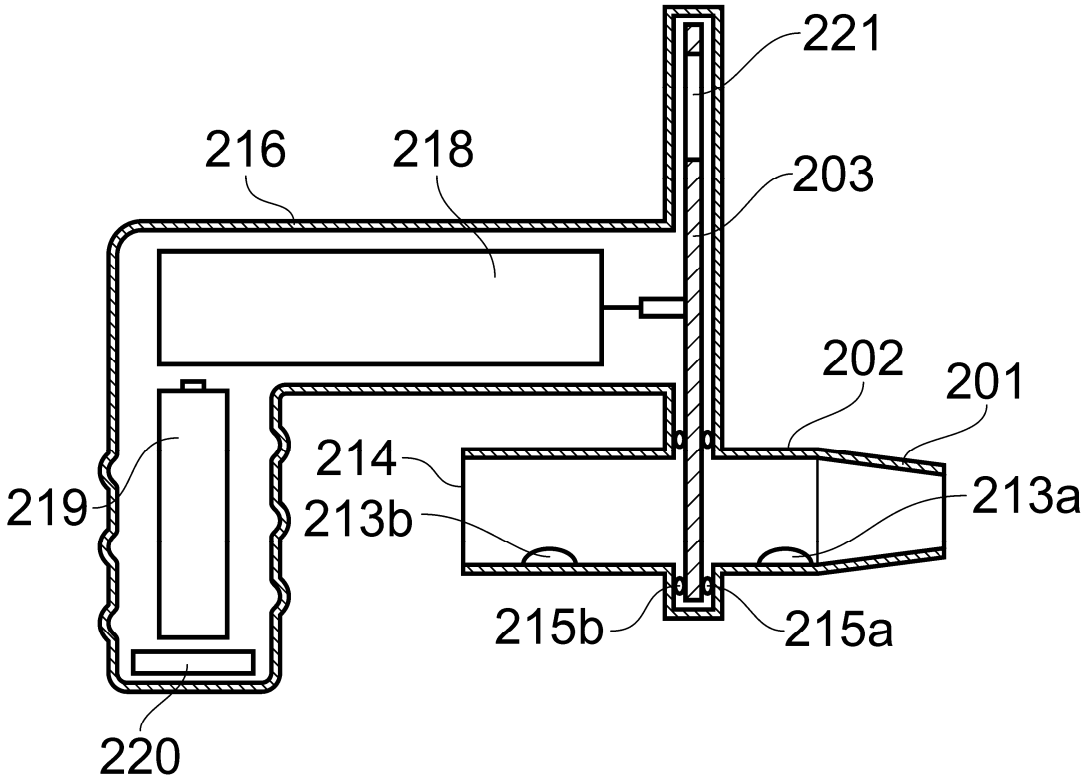

FIG. 2