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INHALATION DEVICE

The present invention relates to a suction tube for drawing powder containing medicament from a blister and an inhaler for administering dry powder by inhalation comprising the same.

It is known in the treatment of respiratory conditions, such as asthma, to provide certain medicaments in the form of a dry powder for inhalation. It is also known to provide individual doses of such powders in the blisters of a blister pack element.

WO-A-97/40876 discloses an inhaler for administering dry powder by inhalation which comprises a support unit for supporting a blister pack element having a plurality of blisters formed therein, with each blister containing a dose of powder containing medicament, and a suction tube configured so as to be insertable into a respective one of the blisters and through which a dose of powder is in use drawn on inhalation by a user. The support unit of this inhaler includes a chamber having a hinged lid for holding the suction tube when not in use.

It is an aim of the present invention to provide an improved suction tube for drawing powder containing medicament from a blister.

Accordingly, the present invention provides a suction tube for drawing powder containing medicament from a blister comprising a cavity sealed by a covering film, the suction tube comprising an elongate body which includes an inlet section at one end thereof, which inlet section includes an inlet and a cutting assembly comprising a cutting blade which includes a cutting edge for making a cut in the covering film of a blister and at least one ram blade which includes a bearing surface for bearing on the covering film of the blister and pushing the same into the cavity of the blister, an outlet section at the other end thereof, which outlet section includes an outlet and provides a mouthpiece, and an inhalation channel

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providing fluid communication between the inlet and the outlet through which powder is in use drawn on inhalation by a user.

Preferably, the cutting edge of the cutting blade extends axially forward of the bearing surface of the at least one ram blade such that the covering film of a blister is at least partly cut by the cutting blade before the bearing surface of the at least one ram blade contacts the covering film of the blister.

More preferably, the cutting blade is disposed axially forward of the bearing surface of the at least one ram blade such that the covering film of a blister is cut by the cutting blade before the bearing surface of the at least one ram blade contacts the covering film of the blister.

Preferably, the cutting blade extends across the inlet.

Preferably, the inlet is substantially co-axial with the longitudinal axis of the body.

Preferably, the cutting blade is substantially co-axial with the longitudinal axis of the body.

Preferably, the cutting blade includes at least one cutting point.

More preferably, the cutting blade includes first and second sections which taper to a cutting point.

Preferably, the cutting blade includes at least one transverse opening axially rearward of the cutting edge thereof.

Preferably, the cutting blade is substantially planar.

Preferably, each ram blade includes at least one transverse opening.

In one embodiment the at least one transverse opening is axially rearward of the bearing surface of the ram blade.

In another embodiment the at least one transverse opening extends axially rearwardly from the bearing surface of the ram blade.

Preferably, the at least one transverse opening is asymmetrically located in the ram blade

Preferably, the at least one ram blade is substantially planar.

Preferably, the inlet section includes supplementary air inlet openings into the inhalation channel at an axial position rearwardly adjacent the inlet.

Preferably, the cutting assembly includes first and second ram blades disposed on opposite sides of the cutting blade.

More preferably, each ram blade is disposed substantially the same radial distance from the cutting blade.

Preferably, the cutting assembly is configured such that the distance between the endmost points of the bearing surface of each of the ram blades is approximately the same distance as the distance between the endmost points of the effective cutting length of the cutting blade and the adjacent endmost points of the bearing surface of each of the ram blades.

Preferably, the axial position of the inlet is such that when the inlet section is located in a blister the inlet is located below the surface defining the opening of the cavity of the blister.

Preferably, the inlet section includes at least one surface which defines a shoulder which in use is located at the upper surface of the blister.

The present invention also extends to an inhaler for administering powder containing medicament by inhalation which comprises the above-described suction tube.

Preferably, the inhaler further comprises a support unit for supporting a blister pack element, wherein the support unit includes a wall member which includes a plurality of openings adjacent which the blister pack element is in use disposed such that a blister is located beneath each opening.

More preferably, the inlet section of the suction tube includes at least one surface which defines a shoulder that acts to limit the extent to which the suction tube can be inserted into the openings in the wall member.

Preferably, the openings in the wall member of the support unit each include at least one radial extension which each include a web member and the inlet section of the suction tube includes at least one resiliently-biased arm which supports a catch member and is configured to fit into the at least one radial extension of the openings in the wall member, with the catch member and the web member being configured to engage one another when the suction tube is inserted into one of the openings in the wall member.

More preferably, the openings in the wall member of the support unit each include first and second radial extensions and the inlet section of the suction tube includes first and second resiliently-biased arms.

Still more preferably, the first and second radial extensions of the openings in the wall member and the first and second arms of the inlet section of the suction tube are radially opposed.

Medicaments suitable for administration by the powder inhaler of the present invention are any which may be delivered by inhalation and include, for example, β2-adrenoreceptor

agonists, for example, salbutamol, terbutaline, rimiterol, fenoterol, reproterol, adrenaline, pirbuterol, isoprenaline, orciprenaline, bitolterol, salmeterol, formoterol, clenbuterol, procaterol, broxaterol, picumeterol, TA-2005, mabuterol and the like, and their pharmacologically acceptable esters and salts; anticholinergic bronchodilators, for example, ipratropium bromide and the like; glucocorticosteroids, for example, beclomethasone, fluticasone, budesonide, tipredane, dexamethasone, betamethasone, fluocinolone, triamcinolone acetonide, mometasone and the like, and their pharmacologically acceptable esters and salts; antiallergic medicaments, for example, sodium cromoglycate and nedocromil sodium; expectorants; mucolytics; antihistamines; cyclooxygenase inhibitors; leukotriene synthesis inhibitors; leukotriene antagonists; phospholipase-A2 (PLA2) inhibitors; platelet aggregating factor (PAF) antagonists and prophylactics of asthma; antiarrhythmic medicaments; tranquilisers; cardiac glycosides; hormones; antihypertensive medicaments; antidiabetic medicaments; antiparasitic medicaments; anticancer medicaments; sedatives; analgesic medicaments; antibiotics; antirheumatic medicaments; immunotherapies; antifungal medicaments; antihypotension medicaments; vaccines; antiviral medicaments; proteins; polypeptides and peptides, for example, peptide hormones and growth factors; polypeptide vaccines; enzymes; endorphines; lipoproteins and polypeptides involved in the blood coagulation cascade; vitamins; and others, for example, cell surface receptor blockers, antioxidants, free radical scavengers and organic salts of N,N'-diacetylcystine.

Preferred embodiments of the present invention will now be described hereinbelow by way of example only with reference to the accompanying drawings, in which:

Figure 1 illustrates in use a perspective view of an inhaler in accordance with a preferred embodiment of the present invention;

Figure 2 illustrates an exploded perspective view of the inhaler of Figure 1;

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Figure 3 illustrates a plan view of the inhaler of Figure 1, illustrated with the blister pack assembly separated from the support unit;

Figure 4 illustrates a side view of the inhaler of Figure 1, illustrated with the blister pack assembly separated from the support unit;

Figure 5 illustrates a plan view of the inhaler of Figure 1, illustrated with the blister pack assembly partially loaded into/unloaded from the support unit;

Figure 6 illustrates a side view of the inhaler of Figure 1, illustrated with the blister pack assembly partially loaded into/unloaded from the support unit;

Figure 7 illustrates a plan view of the inhaler of Figure 1, illustrated with the blister pack assembly loaded in the support unit;

Figure 8 illustrates a side view of the inhaler of Figure 1, illustrated with the blister pack assembly loaded in the support unit;

Figure 9 illustrates in enlarged scale a fragmentary vertical sectional view (along section I-I in Figure 1) of the inhaler of Figure 1;

Figure 10 illustrates in enlarged scale a fragmentary vertical sectional view (along section II-II in Figure 1) of the inhaler of Figure 1;

Figure 11 illustrates in enlarged a fragmentary vertical sectional view (along section III-III in Figure 1) of the inhaler of Figure 1;

Figure 12 illustrates a perspective view of the blister pack assembly of the inhaler of Figure 1;

Figure 13 illustrates in enlarged scale a fragmentary exploded perspective view of the blister pack unit of the blister pack assembly of Figure 12;

Figure 14 illustrates a fragmentary vertical sectional view (along section IV-IV in Figure 13) of the blister pack unit of Figure 13;

Figure 15 illustrates a fragmentary vertical sectional view (along section V-V in Figure 13) of the blister pack unit of Figure 13;

Figure 16(a) illustrates in enlarged scale a plan view of the blister pack element of the blister pack assembly of Figure 12;

Figure 16(b) illustrates an underneath plan view of the blister pack element of Figure 16(a);

Figure 16(c) illustrates a side view of the blister pack element of Figure 16(a);

Figure 16(d) illustrates one end view of the blister pack element of Figure 16(a);

Figure 16(e) illustrates the other end view of the blister pack element of Figure 16(a);

Figure 16(f) illustrates a vertical sectional view (along section VI-VI in Figure 16(a)) of the blister pack element of Figure 16(a);

Figure 16(g) illustrates a vertical sectional view (along section VII-VII in Figure 16(a)) of the blister pack element of Figure 16(a);

Figure 17(a) illustrates in enlarged scale a plan view of the attachment member of the blister pack unit of the blister pack assembly of Figure 12;

Figure 17(b) illustrates an underneath plan view of the attachment member of Figure 17(a);

Figure 17(c) illustrates an end view of the attachment member of Figure 17(a);

Figure 17(d) illustrates one side view of the attachment member of Figure 17(a);

Figure 17(e) illustrates the other side view of the attachment member of Figure 17(a);

Figure 18(a) illustrates in enlarged scale a first side view of the suction tube of the blister pack assembly of Figure 12;

Figure 18(b) illustrates a second, orthogonal side view of the suction tube of Figure 18(a);

Figure 18(c) illustrates a plan view of the suction tube of Figure 18(a);

Figure 18(d) illustrates an underneath plan view of the suction tube of Figure 18(a);

Figure 18(e) illustrates a fragmentary perspective view of the suction tube of Figure 18(a);

Figure 18(f) illustrates a vertical sectional view (along section VIII-VIII in Figure 18(a)) of the suction tube of Figure 18(a);

Figure 18(g) illustrates a vertical sectional view (along section IX-IX in Figure 18(b)) of the suction tube of Figure 18(a);

Figure 19(a) illustrates a plan view of the interconnecting member of the blister pack assembly of Figure 12;

Figure 19(b) illustrates a side view of the interconnecting member of Figure 19(a);

Figure 20(a) illustrates a plan view of the support unit of the inhaler of Figure 1, illustrated in the closed or storage configuration;

Figure 20(b) illustrates a side view of the support unit of Figure 20(a), illustrated in the closed or storage configuration;

Figure 20(c) illustrates one end view of the support unit of Figure 20(a), illustrated in the closed or storage configuration;

Figure 20(d) illustrates the other end view of the support unit of Figure 20(a), illustrated in the closed or storage configuration;

Figure 20(e) illustrates a plan view of the support unit of Figure 20(a), illustrated in the open or operative configuration;

Figure 20(f) illustrates a side view of the support unit of Figure 20(a), illustrated in the open or operative configuration;

Figure 20(g) illustrates in enlarged scale a fragmentary vertical sectional view (along section X-X in Figure 20(e)) of the support unit of Figure 20(a), illustrated in the open or operative configuration;

Figure 20(h) illustrates in enlarged scale a fragmentary vertical sectional view (along section XI-XI in Figure 20(e)) of the support unit of Figure 20(a), illustrated in the open or operative configuration;

Figure 20(i) illustrates in enlarged scale a vertical sectional view (along section XII-XII in Figure 20(e)) of the support unit of Figure 20(a), illustrated in the open or operative configuration;

Figure 21(a) illustrates a fragmentary vertical sectional view (along section IX-IX in Figure 18(b)) of the suction tube of Figure 18(a) when partly inserted into a blister;

Figure 21(b) illustrates a horizontal sectional view (along section XIII-XIII in Figure 21(a)) of the suction tube of Figure 18(a) when partly inserted into a blister;

Figure 22(a) illustrates a fragmentary vertical sectional view (along section IX-IX in Figure 18(b)) of the suction tube of Figure 18(a) when further inserted into a blister;

Figure 22(b) illustrates a horizontal sectional view (along section XIV-XIV in Figure 22(a)) of the suction tube of Figure 18(a) when further inserted into a blister;

Figure 23(a) illustrates a fragmentary vertical sectional view (along section IX-IX in Figure 18(b)) of the suction tube of Figure 18(a) when fully inserted into a blister;

Figure 23(b) illustrates a horizontal sectional view (along section XV-XV in Figure 23(a)) of the suction tube of Figure 18(a) when fully inserted into a blister;

Figure 24(a) illustrates a fragmentary perspective view of a first modified suction tube for the inhaler of Figure 1;

Figure 24(b) illustrates a vertical sectional view (along section XVI-XVI in Figure 24(a)) of the suction tube of Figure 24(a);

Figure 24(c) illustrates a vertical sectional view (along section XVII-XVII in Figure 24(a)) of the suction tube of Figure 24(a);

Figure 25(a) illustrates a fragmentary perspective view of a second modified suction tube for the inhaler of Figure 1;

Figure 25(b) illustrates a vertical sectional view (along section XVIII-XVIII in Figure 25(a)) of the suction tube of Figure 25(a);

Figure 25(c) illustrates a vertical sectional view (along section XIX-XIX in Figure 25(a)) of the suction tube of Figure 25(a),

Figure 26(a) illustrates a fragmentary perspective view of a third modified suction tube for the inhaler of Figure 1;

Figure 26(b) illustrates a vertical sectional view (along section XX-XX in Figure 26(a)) of the suction tube of Figure 26(a);

Figure 26(c) illustrates a vertical sectional view (along section XXI-XXI in Figure 26(a)) of the suction tube of Figure 26(a);

Figure 27(a) illustrates a fragmentary perspective view of a fourth modified suction tube for the inhaler of Figure 1;

Figure 27(b) illustrates a vertical sectional view (along section XXII-XXII in Figure 27(a)) of the suction tube of Figure 27(a);

Figure 27(c) illustrates a vertical sectional view (along section XXIII-XXIII in Figure 27(a)) of the suction tube of Figure 27(a);

Figure 28 illustrates a perspective view of a modified blister pack assembly for the inhaler of Figure 1;

Figure 29 illustrates in enlarged scale a fragmentary perspective view of the blister pack unit of the blister pack assembly of Figure 28;

Figure 30 illustrates in enlarged scale a fragmentary exploded perspective view of the blister pack unit of the blister pack assembly of Figure 28;

Figure 31 illustrates an exploded vertical sectional view (along section XXIV-XXIV in Figure 28) of the blister pack unit of the blister pack assembly of Figure 28, and

Figure 32 illustrates an exploded vertical sectional view (along section XXV-XXV in Figure 28) of the blister pack unit of the blister pack assembly of Figure 28.

The inhaler comprises a support unit 1 and a blister pack assembly 3 which in use is loaded thereinto.

The blister pack assembly 3 comprises a blister pack unit 5, a suction tube 7 and an interconnecting member 9 which connects the suction tube 7 to the blister pack unit 5 so as to prevent the suction tube 7 from being inadvertently separated from the blister pack unit 5.

The blister pack unit 5 comprises a blister pack element 11, in this embodiment of generally rectangular shape, which includes a plurality of blisters 12, each containing a dose of powder containing medicament, and an attachment member 13, to which the suction tube 7 is attachable, fixed to the blister pack element 11.

The blister pack element 11 comprises a substantially planar thin sheet 17 which includes a plurality of cavities 19, each defining a part of a respective blister 12, and first and second open channels 21, 23 which are separated by a web member 25 and extend along the longitudinal axis of the blister pack element 11. In this embodiment the sheet 17 is formed of a metal, such as aluminium, and the cavities 19 have a depth of about 4 mm and a diameter at the opening thereof of about 7.5 mm. In alternative embodiments the sheet 17 can be formed of a plastics material or a laminate of metal and plastics material. The first channel 21, in this embodiment a flattened U-shaped section, comprises first and second

opposed side wall members 21a, 21b and a bottom wall member 21c. The first channel 21 is of relatively short length and extends to one narrow end 22 of the blister pack element 11 so as to allow for a sliding fit thereto of mutually configured parts of the attachment member 13 as will be described in more detail hereinbelow. The bottom wall member 21c of the first channel 21 includes a downwardly-directed projection 29 which acts as a detent for fixing the attachment member 13 in position relative to the blister pack element 11 as again will be described in more detail hereinbelow. The second channel 23, in this embodiment of arcuate section, is elongate and includes first and second end wall members 23a, 23b The web member 25 separating the first and second channels 21, 23 includes a groove 35 which extends across the width thereof and along the longitudinal axis of the blister pack element 11.

The blister pack element 11 further comprises a thin film 37, in this embodiment in two sections, which is attached to the substantially planar surface of the sheet 17 thereof so as to cover the openings of each of the cavities 19 and thereby enclose a dose of powder containing medicament in each blister 12. In this embodiment the film 37 is formed of a metal, such as aluminium, and is attached to the sheet 17 by one of welding or an adhesive.

The attachment member 13 comprises an elongate body 39 which is of substantially the same length as the one narrow end 22 of the blister pack element 11, first and second projections 41, 43 which extend from the mid-point of one side surface of the elongate body 39 and together define a U-shaped channel 45 for receiving the first channel 21 in the sheet 17 of the blister pack element 11 and first and second clips 47, 49 which extend from the respective ends of the other side surface of the elongate body 39 and are each separately configured to hold the suction tube 7 when not in use. In this embodiment the clips 47, 49 are configured such that when the suction tube 7 is attached to one of the clips 47, 49 the other of the clips 47, 49 acts as a guard to protect against damage of the suction tube 7. The first projection 41, in this embodiment of rectangular section, is of the same section as the upper, inner surface of the first channel 21 in the sheet 17 of the blister pack element 11 so as to be a close slideable fit therein and includes a groove 42 which extends along the

upper surface of the length thereof The second projection 43, in this embodiment a flattened U-shaped section, comprises first and second opposed side wall members 43a, 43b and a bottom wall member 43c, with the first and second projections 41, 43 being configured such that the first and second side wall members 43a, 43b and the bottom wall member 43c of the second projection 43 are disposed opposite the side and bottom surfaces of the first projection 41. The upper, inner surface of the second projection 43 is of the same section as the outer, lower surface of the first channel 21 in the sheet 17 of the blister pack element 11 so as to be a close slideable fit thereabout, with the side wall members 43a, 43b of the second projection 43 being dimensioned so as to abut a lower surface of the sheet 17 of the blister pack element 11. The bottom wall member 43c of the second projection 43 includes an opening 51 therein for receiving the downwardly-directed projection 29 on the bottom wall member 21c of the first channel 21 in the sheet 17 of the blister pack element 11 when the attachment member 13 is fitted to the blister pack element 11 so as to fix the attachment member 13 in position relative to the blister pack element 11.

The suction tube 7, which will be described in further detail hereinbelow, comprises a generally elongate body 62 which includes an inlet section 63 at one end, which inlet section 63 includes a cutting assembly 64 for cutting the film 37 covering the cavities 19 of the blisters 12 in the blister pack element 11 and an inlet 65 through which powder containing medicament is in use drawn from a respective blister 12 on inhalation by a user, an outlet section 67 at the other end, which outlet section 67 includes an outlet 69 and provides a mouthpiece, and an inhalation channel 71 providing fluid communication between the inlet 65 and the outlet 69. The body 62 of the suction tube 7 includes at the outer surface thereof a plurality of ribs 73 for allowing a user to grip the same securely and a peripheral recess 75 for receiving a part of the interconnecting member 9 as will be described in more detail hereinbelow.

The interconnecting member 9 comprises a line 76 of a flexible material, preferably a plastics material, such as nylon, a clip 77 fixed to one end of the line 76 which is located in

the peripheral recess 75 in the outer surface of the body 62 of suction tube 7 so as to anchor the line 76 to the same and an element 79 fixed to the other end of the line 76 which is of larger dimension than the gauge of the line 76 and is in use located partly in the second channel 21 in the sheet 17 of the blister pack element 11. In this embodiment the clip 77 is part-circular and formed of a resilient material so as to be a snap-fit about the body 62 of the suction tube 7. With this configuration, the line 76 is anchored to the suction tube 7 but yet allows the suction tube 7 to rotate relative thereto. As will become apparent hereinbelow, the suction tube 7, in being rotatable relative to the clip 77 of the interconnecting member 9, has a much greater freedom of movement and thereby facilitates use.

The support unit 1 comprises a housing 81 which includes an opening 82 and defines a cavity 83 into which the blister pack element 11 of the blister pack assembly 3 is in use inserted and a cover member 84 for enclosing the blister pack assembly 3 when not in use.

The housing 81 comprises a first, upper wall member 85 which, in this embodiment, is substantially planar and of rectangular shape. The upper wall member 85 includes an upper, outer surface 85a and a lower, inner surface 85b adjacent which the blister pack element 11 of the blister pack assembly 3 is in use disposed. The upper wall member 85 also includes one free end 86 which defines a part of the opening 82 in the housing 81 through which the blister pack element 11 is in use inserted. The upper wall member 85 further includes a plurality of openings 87 which each overlie a respective one of the openings of the cavities 19 of the blisters 12 in the blister pack element 11 such that each of the blisters 12 can be emptied by inserting the suction tube 7 into a respective one of the openings 87. In this embodiment the openings 87 in the upper wall member 85 are each configured to have the same peripheral shape as the inlet section 63 of the suction tube 7 such that the openings 87 act as guides for guiding the inlet section 63 of the suction tube 7 into a respective blister 12 in the blister pack element 11. Each of the openings 87 includes first and second radial extensions 87a, 87b for receiving mutually configured parts on the inlet section 63 of the suction tube 7 as will be described hereinbelow. The radial

extensions 87a, 87b of the openings 87 each include a web member 89 which includes upper and lower surfaces 89a, 89b that are substantially parallel respectively to the upper and lower surfaces 85a, 85b of the upper wall member 85 of the housing 81. The web members 89 are of lesser thickness than the upper wall member 85 of the housing 81 and are disposed such that the upper and lower surfaces 89a, 89b thereof are stepped back respectively from the upper and lower surfaces 85a, 85b of the upper wall member 85. The upper wall member 85 of the housing 81 further includes an elongate slot 91 which extends from the one free end 86 thereof, in this embodiment along the longitudinal axis of the housing 81, and overlies the second channel 23 in the sheet 17 of the blister pack element 11 when fitted such that the line 76 of the interconnecting member 9 can be drawn thereinto and pass freely therealong. The elongate slot 91 includes a first, narrow section 91a at the upper surface 85a of the upper wall member 85 which is of a width smaller than the smallest dimension of the element 79 of the interconnecting member 9 so as to prevent that element 79 from passing therethrough and a second, wide section 91b at the lower surface 85b of the upper wall member 85 for receiving a part of the element 79 of the interconnecting member 9. In this embodiment the wide section 91b of the elongate slot 91 is arcuate in shape and flares outwardly to the lower surface 85b of the upper wall member 85. The upper wall member 85 of the housing 81 still further includes a plurality of elongate ribs 93 which extend downwardly from the lower surface 85b thereof parallel to the longitudinal axis of the housing 81. The ribs 93 are provided to space the upper surface of the blister pack element 11 from the lower surface 85a of the upper wall member 85 and thereby provide an air flow path to the blisters 12 in the blister pack element 11. Further, in this embodiment, one rib 93 is located on either side of the elongate slot 91 in the upper wall member 85 such that when the blister pack assembly 3 is fitted to the support unit 1 the second channel 23 in the sheet 17 of the blister pack element 11 and the wide section 91b of the elongate slot 91 define an enclosed track in which the element 79 of the interconnecting member 9 is captively held, with the limits of movement of the element 79 along the enclosed track being defined by the end wall members 23a, 23b of the second channel 23 in the sheet 17 of the blister pack element 11. It will be appreciated that this configuration, in not having the line 76 of the interconnecting member 9 fixed at one point,

is advantageous in that the line 76 of the interconnecting member 9 need only be as long as the distance between the furthestmost opening 87 and the elongate slot 91 in the upper wall member 85, which distance, in this embodiment, corresponds to approximately half of the width of the upper wall member 85 The upper wall member 85 of the housing 81 still further includes a recess 94 at that end thereof remote from the opening 82 in the housing 81. This recess 94 provides a means by which a user can push the blister pack element 11 a distance out of the housing 81 so as to facilitate withdrawal of the blister pack assembly 3

The housing 81 further comprises a second, lower wall member 95, in this embodiment substantially planar and of rectangular shape, which is spaced in parallel relation to the upper wall member 85, first and second side wall members 97, 99 which extend between the sides of the upper and lower wall members 85, 95 and an end wall member 101 which extends between the ends of the upper and lower wall members 85, 95 remote from the opening 82 in the housing 81. In this embodiment the side wall members 97, 99 and the end wall member 101 each include a groove 97', 99', 101' into which the peripheral edge at the sides and the other end of the blister pack element 11 of the blister pack assembly 3 is in use located such that the blister pack element 11 is held in position adjacent the lower surface 85b of the upper wall member 85 of the housing 81.

The cover member 84 is hinged to the housing 81, in this embodiment at that end adjacent the opening 82 therein. In a preferred embodiment the housing 81 and the cover member 84 of the support unit 1 are integrally formed of a plastics material such that the hinged connection of the housing 81 and the cover member 84 is provided by a living hinge. The cover member 84 includes a catch member 102 at the free end thereof which is configured to engage the recess 94 in the upper wall member 85 of the housing 81 when the cover member 84 is closed and thereby hold the same closed.

As described hereinabove, the suction tube 7 includes an inlet section 63 which includes a cutting assembly 64 for cutting the film 37 covering the cavities 19 of the blisters 12 in the blister pack element 11.

The inlet section 63 of the suction tube 7 further includes first and second arms 105, 107 which extend forwardly, in the sense of insertion of the suction tube 7 into a blister 12, from respective sides thereof and are biased outwardly. The arms 105, 107 are each configured so as to be a sliding fit in the radial extensions 87a, 87b of the openings 87 in the upper wall member 85 of the housing 81. In this way, the suction tube 7 can only be inserted into an opening 87 in the upper wall member 85 of the housing 81 in one of two orientations, and, as will become apparent hereinbelow, since the cutting assembly 64 has two-fold rotational symmetry, the suction tube 7 can never inadvertently be inserted into a blister 12 with another orientation which may cause the film 37 covering the respective blister 12 to be cut free. It will, of course, be appreciated that in any embodiment where the cutting assembly 64 of the suction tube 7 does not have such rotational symmetry the first and second arms 105, 107 at the inlet section 63 of the suction tube 7 and the radial extensions 87a, 87b of the openings 87 in the upper wall member 85 of the housing 81 can be configured so as to permit the suction tube 7 to be inserted into the openings 87 in the upper wall member 85 of the housing 81 in only one orientation. Each of the first and second arms 105, 107 includes a catch member 109, 111 which is adapted to engage with the web members 89 in the radial extensions 87a, 87b of the openings 87 in the upper wall member 85 of the housing 81. The catch members 109, 111 on the first and second arms 105, 107 each have a first surface 109a, 111a which has a forwardly-directed component and acts as a guiding surface and a second surface 109b, 111b which is substantially orthogonally directed to the longitudinal axis of the body 62 of the suction tube 7 and acts as a locking surface. In use, on fitting the suction tube 7 to the housing 81, the second, locking surfaces 109b, 111b of the catch members 109, 111 snap behind respective ones of the lower surfaces 89b of the web members 89 in the radial extensions 87a, 87b of the openings 87 in the upper wall member 85 of the housing 81 so as to prevent the suction tube 7 from falling out of the respective opening 87 and thereby avoid the need for the user continuously to hold the suction tube 7 in position. It will be appreciated that the catch members 109, 111, in being a snap fit, provide the user with a clear indication that the suction tube 7 is correctly fitted to the housing 81 and hence inserted into a respective one

of the blisters 12 in the blister pack element 11 In this regard, the second, locking surfaces 109b, 111b of the catch members 109, 111 are configured so as to have only a small radial extent such as to allow the suction tube 7 to be removed from a respective one of the openings 87 in the upper wall member 85 of the housing 81 after use on the application of a light force.

The inlet section 63 of the suction tube 7 yet further includes a plurality of lugs 115 which extend radially therefrom and each include a lower surface 115' which defines a first shoulder that acts to limit the extent to which the suction tube 7 can be inserted into any of the openings 87 in the upper wall member 85 of the housing 81 and hence a respective blister 12 in the blister pack element 11. In this embodiment the lugs 115 are configured such that the shoulder defined by the lower surfaces 115' thereof abuts the upper surface 85a of the upper wall member 85 of the housing 81 on the required insertion of the suction tube 7 into one of the openings 87 in the upper wall member 85 of the housing 81. In this way, the suction tube 7 cannot be inserted too far into a blister 12 which could result in the cutting assembly 64 at the inlet section 63 of the suction tube 7 being forced inadvertently through the cavity 19 of any blister 12 on fitting the suction tube 7 to the housing 81.

The inlet section 63 of the suction tube 7 still further includes first and second axially-extending members 117, 119 which each include a lower surface 117', 119' that defines a second shoulder which is axially forward, in the sense of inserting the suction tube 7 into one of the openings 87 in the upper wall member 85 of the housing 81, of the first shoulder defined by the lower surfaces 115' of the lugs 115. In this embodiment the first and second axially-extending members 117, 119 are configured such that the second shoulder defined by the lower surfaces 117', 119' thereof abuts the upper surface of the blister pack element 11 when the first shoulder defined by the lower surfaces 115' of the lugs 115 abuts the upper surface 85a of the upper wall member 85 of the housing 81.

The cutting assembly 64 of the inlet section 63 of the suction tube 7 comprises a cutting blade 127 and first and second ram blades 129, 131 disposed adjacent thereto.

The cutting blade 127 includes a cutting edge 133 which extends across and is located axially forward, in the sense of inserting the suction tube 7 into one of the openings 87 in the upper wall member 85 of the housing 81, of the inlet 65 of the suction tube 7 such that, on insertion of the suction tube 7 into one of the openings 87 in the upper wall member 85 of the housing 81, a cut is made in the film 37 covering the opening of the cavity 19 of the blister 12 therebeneath. In this embodiment the cutting edge 133 of the cutting blade 127 includes a cutting point 133' The cutting blade 127, which in this embodiment is substantially planar, is co-axial with the longitudinal axis of the body 62 of the suction tube 7 and includes first and second flank sections 127a, 127b which taper to an axially-foremost cutting point 127c located on the longitudinal axis of the body 62 of the suction tube 7. In this embodiment the flank sections 127a, 127b of the cutting blade 127 enclose an angle of about 120 degrees. The cutting blade 127 has an effective cutting length approaching that of the diameter of the openings to the cavities 19 of the blisters 12 in the blister pack element 11 such that, on insertion of the suction tube 7 into a respective one of the openings 87 in the upper wall member 85 of the housing 81, the cutting blade 127 cuts the film 37 across the diameter of the opening to the cavity 19 of the respective blister 12. The cutting blade 127 further includes a transverse opening 134 located behind the cutting edge 133 thereof for providing an air flow path therethrough.

The first and second ram blades 129, 131, which in this embodiment are each substantially planar, are located to each side of the cutting blade 127, and, as will be described in more detail hereinbelow, are configured to bear on and push back the film 37 covering the cavity 19 of a respective one of the blisters 12 once cut by the cutting blade 127 and thereby open the blister 12. In this embodiment the first and second ram blades 129, 131 are disposed parallel to, and are the same radial distance from, the cutting blade 127. The first and second ram blades 129, 131 each include a lower, axially-forward surface 129', 131' which is located axially rearward of the axially foremost part of the cutting edge 133 of the cutting blade 127 such that the ram blades 129, 131 act on the film 37 only once at least

partly cut by the cutting blade 127 In this embodiment the bearing surface 129', 131' of each of the ram blades 129, 131 is substantially flat.

In a preferred embodiment the cutting assembly 64 of the suction tube 7 is configured such that the effective length of each of the bearing surfaces 129', 131' of the ram blades 129, 131, that is, the distance between the endmost points of the bearing surface 129', 131' of each of the ram blades 129, 131, is approximately the same distance as the distance between the adjacent endmost points of the bearing surfaces 129', 131' of the ram blades 129, 131 and the endmost points of the effective cutting length of the cutting blade 127. In this way, the film 37 covering the openings of the cavities 19 of any of the blisters 12 in the blister pack element 11 will be broken into flaps 136a-f of substantially equal size.

The action of the cutting assembly 64 of the suction tube 7 is clearly illustrated in Figures 21 to 23. In a first step, as illustrated in Figures 21(a) and 21(b), as the cutting assembly 64 is inserted into a blister 12 the cutting blade 127 makes a cut 135 across the diameter of the film 37 covering the opening of the cavity 19 of the blister 12. In a second step, as illustrated in Figures 22(a) and 22(b), as the cutting assembly 64 is inserted further into the blister 12 the bearing surfaces 129', 131' of the ram blades 129, 131 act on the film 37 and cause the film 37 to tear between adjacent endmost points of the bearing surface 129', 131' of the ram blades 129, 131 and the ends 135' of the cut 135 so as to form six flaps 136a-f. As mentioned hereinabove, in a preferred embodiment the cutting blade 127 and the ram blades 129, 131 are configured such that the flaps 136a-f are of substantially equal size. In a final step, as illustrated in Figures 23(a) and 23(b), the cutting assembly 64 is inserted further into the blister 12 until the second shoulder defined by the lower surfaces 117', 119' of the axially-directed members 117, 119 is at the upper surface of the blister pack element 11. In this position the suction tube 7 is inserted fully into the blister 12. In inserting the cutting assembly 64 further into blister 12 the ram blades 129, 131 cause the flaps 136a-f to be pushed to the wall of the cavity 19 of the blister 12 so as to provide a large opening in the film 37 covering the blister 12 which allows for the ready withdrawal of powder therefrom.

The inlet section 63 of the suction tube 7 still yet further includes first and second upper supplementary air inlet openings 137, 139 into the inhalation channel 71 of the suction tube 7. The first and second upper supplementary air inlet openings 137, 139 into the inhalation channel 71 provide supplementary air flow paths, which, on inhalation by a user, allow supplementary air to be drawn into the inhalation channel 71 and mix with the air and powder mixture drawn through the inhalation channel 71 from a blister 12 in the blister pack element 11. As will be appreciated, the provision of such supplementary air flow paths provides that for each unit volume of air inhaled the user inhales a reduced amount of powder containing medicament. Furthermore, the action of supplementary air mixing with an air and powder mixture drawn through the inhalation channel 71 induces turbulence and assists in the deagglomeration of that powder.

Figures 24 to 27 illustrate modified suction tubes 7 for the inhaler described hereinabove. Structurally, these modified suction tubes 7 are similar to the suction tube 7 of the inhaler described hereinabove and differ only in aspects of the inlet section 63, principally the cutting assembly 64. For this reason, and in order to avoid unnecessary duplication of description, only the structural differences of the suction tubes 7 will be described in detail and reference is made to the preceding description.

Figures 24(a) to (c) illustrate a first modified suction tube 7. This suction tube 7 differs from the first-mentioned suction tube 7 in two aspects. Firstly, the ram blades 129, 131 each include an opening 141, 143 which extends axially rearwardly from the bearing surface 129', 131' thereof for providing shorter air flow paths between the periphery of the cavity 19 of the blister 12 adjacent the ram blades 129, 131 and the inlet 65. Secondly, the inlet 65 to the inhalation channel 71 is located axially forward, in the sense of insertion of the suction tube 7 into a blister 12, of the second shoulder defined by the lower surfaces 117', 119' of the axially-extending members 117, 119 which in use is located at the upper surface of the blister pack element 11. With this configuration, the inlet 65 to the

inhalation channel 71 is located within each blister 12 and thereby forces air to be drawn more deeply into the cavity 19 of the blister 12 on inhalation by a user

Figures 25(a) to (c) illustrate a second modified suction tube 7 This suction tube 7 differs from the first-modified suction tube 7 in that the transverse opening 141, 143 in each of the ram blades 129, 131 is within the respective ram blade 129, 131.

Figures 26(a) to (c) illustrate a third modified suction tube 7. This suction tube 7 differs from the first-mentioned suction tube 7 in two aspects. Firstly, the inlet section 63 of the suction tube 7 further includes first and second lower supplementary air inlet openings 147, 149 into the inhalation channel 71 at a position adjacent, but in this embodiment axially rearward, in the sense of insertion of the suction tube 7 into a blister 12, of the second shoulder defined by the lower surfaces 117', 119' of the axially-extending members 117, 119 which in use is located at the upper surface of the blister pack element 11. These first and second lower supplementary air inlet openings 147, 149 provide a supplementary air flow path into the inhalation channel 71 which promotes turbulent flow within the cavity 19 of the blister 12, which turbulence, as will be appreciated, assists in emptying the blister 12. Secondly, the inlet 65 to the inhalation channel 71 is located axially forward, in the sense of insertion of the suction tube 7 into a blister 12, of the second shoulder defined by the lower surfaces 117', 119' of the axially-extending members 117, 119 which in use is located at the upper surface of the blister pack element 11. As described hereinabove in relation to the first-modified suction tube 7, with this configuration the inlet 65 to the inhalation channel 71 is located within each blister 12 and thereby forces air to be drawn more deeply into the cavity 19 of the blister 12 on inhalation by a user.

Figures 27(a) to (c) illustrate a fourth modified suction tube 7. This suction tube 7 differs from the first-mentioned suction tube 7 in two aspects. Firstly, the ram blades 129, 131 each include a transverse opening 141, 143 for providing shorter air flow paths between the periphery of the cavity 19 of the blister 12 adjacent the ram blades 129, 131 and the inlet 65. In this embodiment the openings 141, 143 in the ram blades 129, 131 are

asymmetrically located so as to promote turbulent flow in the cavities 19 of the blisters 12. Secondly, the inlet 65 to the inhalation channel 71 is located axially forward, in the sense of insertion of the suction tube 7 into a blister 12, of the second shoulder defined by the lower surfaces 117', 119' of the axially-extending members 117, 119 which in use is located at the upper surface of the blister pack element 11. As again described hereinabove in relation to the first-modified suction tube 7, with this configuration the inlet 65 to the inhalation channel 71 is located within each blister 12 and thereby forces air to be drawn more deeply into the cavity 19 of the blister 12 on inhalation by a user.

Figures 28 to 32 illustrate a modified blister pack assembly 3 for the inhaler described hereinabove. Structurally, this modified blister pack assembly 3 is similar to the blister pack assembly 3 of the inhaler described hereinabove and differs only in aspects of the blister pack unit 5. For this reason, and in order to avoid unnecessary duplication of description, only the structural differences of the blister pack assemblies 3 will be described in detail and reference is made to the preceding description. This modified blister pack unit 5 differs principally from the blister pack unit 5 of the blister pack assembly 3 of the inhaler described hereinabove in that the sheet 17 of the blister pack element 11 includes a downwardly-depending peripheral skirt 151 and a plurality of downwardly-directed elongate ribs 153 which extend parallel to the longitudinal axis of the blister pack element 11. With this configuration the blister pack element 11 is configured to be a sliding fit in the cavity 83 of the housing 81 of the support unit 1, with the blister pack element 11 being self-supporting by the provision of the skirt 151 and the ribs 153. This modified blister pack unit 5 further differs from the blister pack unit 5 of the blister pack assembly 3 of the inhaler described hereinabove in the manner of the connection of the attachment member 13 in that the blister pack element 11 includes first and second projections 155, 157 at the one end 22 thereof to which the attachment member 13, which is also modified in not including the first and second projections 41, 43, is snap fitted. This modified blister pack unit 5 yet further differs from the blister pack unit 5 of the blister pack assembly 3 of the inhaler described hereinabove in further including moisture-permeable chambers 159 which contain desiccant disposed to the lower surface of the sheet

17 of the blister pack element 11 at at least some of the junctions between the cavities 19 defining the blisters 12 and in including a thin film 161 covering the lower surface thereof.

In use, a user takes the inhaler in one hand and opens up the cover member 84 of the support unit 1 so as to expose the suction tube 7 and the upper wall member 85 of the housing 81. The user then unclips the suction tube 7 from the attachment member 13 and inserts the inlet section 63 of the suction tube 7 through one of the openings 87 in the upper wall member 85 of the housing 81 and into an unused blister 12. In inserting the inlet section 63 of the suction tube 7 into one of the openings 87 in the upper wall member 85 of the housing 81, the user has first to align the arms 105, 107 thereon with the radial extensions 87a, 87b of the openings 87 and then push in the suction tube 7 until the first shoulder defined by the lower surfaces 115' of the lugs 115 abuts the upper surface 85a of the upper wall member 85 and the catches 109, 111 on the arms 105, 107 snap behind the web members 89 in the radial extensions 87a, 87b of the openings 87. The user then takes the mouthpiece provided by the outlet section 67 of the suction tube 7 in his/her lips and inhales so as to withdraw the dose of powder containing powder from the blister 12 and deliver the same into the lungs. After inhalation, the user withdraws the suction tube 7 from the opening 87 in the upper wall member 85 of the housing 81, which will require the application of a light force to overcome the action of the catches 109, 111 on the arms 105, 107 of the suction tube 7, and then clips the suction tube 7 back to the attachment member 13. This pattern of use can be repeated until all of the blisters 12 in the blister pack element 11 of the blister pack assembly 3 have been used. When all of the blisters 12 in the blister pack element 11 have been used, the user withdraws the blister pack assembly 3 form the support unit 1 and replaces that used blister pack assembly 3 with a new blister pack assembly 3.

Finally, it will be understood by a person skilled in the art that the present invention is not limited to the described embodiments but can be modified in many different ways without departing from the scope of the invention as defined by the appended claims.

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CLAIMS:

1. A suction tube for drawing powder containing medicament from a blister (12) comprising a cavity (19) sealed by a covering film (37), the suction tube comprising an elongate body (62) which includes an inlet section (63) at one end thereof, which inlet section (63) includes an inlet (65), an outlet section (67) at the other end thereof, which outlet section (67) includes an outlet (69) and provides a mouthpiece, and an inhalation channel (71) providing fluid communication between the inlet (65) and the outlet (69) through which powder is in use drawn on inhalation by a user, the inlet section (63) having a cutting assembly (64) comprising at least one cutting blade (127) which includes a cutting edge (133) for making a cut in the covering film (37) of a blister (12) and at least one bearing surface (129',131') for bearing on the covering film (37) of the blister (12) and pushing the same into the cavity (19) of the blister (12) wherein the cutting blade (127) extends across the inlet (65) and the bearing surface (129',131') is in the form of a ram blade (129,131).

2. The suction tube according to Claim 1, wherein the cutting edge (133) of the cutting blade (127) extends axially forward of the bearing surface (129',131') of the at least one ram blade (129,131) such that the covering film (37) of a blister (12) is at least partly cut by the cutting blade (127) before the bearing surface (129',131') of the at least one ram blade (129,131) contacts the covering film (37) of the blister (12).

3. The suction tube according to Claim 2, wherein the cutting blade (127) is disposed axially forward of the bearing surface (129',131') of the at least one ram blade (129,131) such that the covering film (37) of a blister (12) is cut by the cutting

blade (127) before the bearing surface (129',131') of the at least one ram blade (129,131) contacts the covering film (37) of the blister (12).

4. The suction tube according to any of Claims 1 to 3, wherein the inlet (65) is substantially co-axial with the longitudinal axis of the body (62).

5. The suction tube according to any of Claims 1 to 4, wherein the cutting blade (127) is substantially co-axial with the longitudinal axis of the body (62).

6. The suction tube according to any of Claims 1 to 5, wherein the cutting blade (127) includes at least one cutting point (127c).

7. The suction tube according to Claim 6, wherein the cutting blade (127) includes first and second sections (127a, 127b) which taper to a cutting point (127c).

8. The suction tube according to any of Claims 1 to 7, wherein the cutting blade (127) includes at least one transverse opening (134) axially rearward of the cutting edge (133) thereof.

9. The suction tube according to any of Claims 1 to 8, wherein the cutting blade (127) is substantially planar.

10. The suction tube according to any of Claims 1 to 9, wherein each ram blade (129,131) includes at least one transverse opening (141,143).

11. The suction tube according to Claim 10, wherein the at least one transverse opening (141,143) is axially rearward of the bearing surface (129', 131') of the ram blade (129,131).

12. The suction tube according to Claim 10, wherein the at least one transverse opening (141,143) extends axially rearwardly from the bearing surface (129',131') of the ram blade (129,131).

13. The suction tube according to any of Claims 10 to 12, wherein the at least one transverse opening (141,143) is asymmetrically located in the ram blade (129,131).

14. The suction tube according to Claim 13, wherein the at least one ram blade (129,131) is substantially planar.

15. The suction tube according to any of Claims 1 to 14, wherein the inlet section (63) includes supplementary air inlet openings (147,149) into the inhalation channel (71) at an axial position rearwardly adjacent the inlet (65).

16. The suction tube according to any of Claims 1 to 15, wherein the cutting assembly (64) includes first and second ram blades (129,131) disposed on opposite sides of the cutting blade (127).

17. The suction tube according to Claim 16, wherein each ram blade (129,131) is disposed at substantially the same radial distance from the cutting blade (127).

18. The suction tube according to Claim 16 or 17, wherein the cutting assembly (64) is configured such that the distance between the endmost points of the bearing surface (129',131') of each of the ram blades (129,131) is approximately the same distance as the distance between the endmost points of the effective cutting length of the cutting blade (127) and the adjacent endmost points of the bearing surface (129',131') of each of the ram blades (129,131).

19. The suction tube according to any of Claims 1 to 18, wherein the axial position of the inlet (65) is such that when, in use, and the inlet section (63) is located in a blister (12), the inlet (65) is located below the surface defining the opening of the cavity (19) of the blister (12).

20. The suction tube according to any of Claims 1 to 19, wherein the inlet section (63) includes at least one surface (117',119') which defines a shoulder which, in use, is located at the upper surface of the blister (12).

21. An inhaler for administering dry powder by inhalation, comprising the suction tube (7) according to any of Claims 1 to 20.

22. The inhaler according to Claim 21, further comprising a support unit (1) for supporting a blister pack element (11), wherein the support unit (1) includes a wall member (85) which includes a plurality of openings (87) adjacent which the blister pack element (11) is in use disposed such that a blister (12) is located beneath each opening (87).

23. The inhaler according to Claim 22, wherein the inlet section (63) of the suction tube (7) includes at least one surface (115') which defines a shoulder that acts to limit the extent to which the suction tube (7) can be inserted into the openings (87) in the wall member (85).

24. The inhaler according to Claim 22 or 23, wherein the openings (87) in the wall member (85) of the support unit (1) each include at least one radial extension (87a,87b) which each include a web member (89) and the inlet section (63) of the suction tube (7) includes at least one resiliently-biased arm (105,107) which supports a catch member (109,111) and is configured to fit into the at least one radial

extension (87a,87b) of the openings (87) in the wall member (85), with the catch member (109,111) and the web member (89) being configured to engage one another when the suction tube (7) is inserted into one of the openings (87) in the wall member (85).

25. The inhaler according to Claim 24, wherein the openings (87) in the wall member (85) of the support unit (1) each include first and second radial extensions (87a,87b) and the inlet section (63) of the suction tube (7) includes first and second resiliently-biased arms (105,107).

26. The inhaler according to Claim 25, wherein the first and second radial extensions (87a,87b) of the openings (87) in the wall member (85) and the first and second arms (105,107) of the inlet section (63) of the suction tube (7) are radially opposed.