

CLAIMS

1. An inhaler for delivery of a medicament by inhalation, the inhaler comprising:
an inhaler body for receiving a canister having a dispensing valve;
5 a drive mechanism comprising a biasing means and a moving component, the drive mechanism for driving the canister, when received in the inhaler body, from a rest position in which the valve is closed to at least an actuating position in which the valve is open, the drive mechanism driving the canister when the biasing means is released from a loaded configuration to move the moving
10 component from a first position to a second position;
a resetting mechanism for resetting the drive mechanism by moving the moving component from the second position to the first position and reloading the biasing means to the loaded configuration; and
a return mechanism for returning the canister from the actuating position to the
15 rest position;
wherein the return mechanism comprises a damping system, the damping system configured to enable the canister to automatically return from the actuating position to the rest position within a predetermined time period measured from the release of the biasing means from the loaded configuration;-
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2. ~~The inhaler of claim 1, wherein the damping system is configured such that the predetermined time period comprises a first time segment and a second time segment, wherein movement of the canister from the actuating position to the rest position is slower during the first time segment than during the second time~~
25 ~~segment.~~
3. ~~The inhaler of claim 1, wherein the damping system is configured such that the predetermined time period comprises a first time segment and a second time segment, wherein the canister is maintained in the actuating position during the first time segment and returns from the actuating position to the rest position during the~~
30 ~~second time segment.~~
4. ~~The inhaler of claim 2 or 3, wherein the damping system is configured such~~

that the second time segment immediately follows the first time segment.

5. — The inhaler of claim 2, 4 or 4, wherein the first time segment is in the range of about 0.05 to 2.00 secs, optionally in the range of about 0.10 to 1.75 secs, optionally in the range of about 0.20 to 1.50 secs, optionally in the range of about 0.30 to 1.25 secs, optionally in the range of about 0.40 to 1.20 secs

6. — The inhaler of any one of claims 2 to 5, wherein the first time segment is at least about 0.20 secs, optionally at least about 0.30 secs, optionally at least about 0.40 secs.

7. — The inhaler of any one of claims 2 to 6, wherein the second time segment is in the range of about 0.10 to 2.00 secs, optionally in the range of about 0.30 to 1.80 secs, optionally in the range of about 0.40 to 1.70 secs, optionally in the range of about 0.60 to 1.60 secs, optionally in the range of about 0.80 to 1.50 secs, optionally in the range of about 1.00 to 1.40 secs.

8. — The inhaler of any one of claims 2 to 7, wherein the second time segment is less than about 2.0 secs, optionally less than about 1.75 secs, optionally less than about 1.50 secs, optionally less than about 1.25 secs, optionally about 1.20 secs.

9. — The inhaler of any one of claims 2 to 8, wherein the first time segment combined with the second time segment is a total time of less than about 2.5 secs, optionally less than about 2.00 secs, optionally less than about 1.75 secs, optionally less than about 1.50 secs.

10. — The inhaler of any one of the preceding claims, wherein the damping system comprises a rotary damper.

11. — The inhaler of claim 10, wherein the damping system further comprises comprising a rod, the rod coupled with a shaft of the rotary damper such that the rod rotates with the shaft, the rod rotation being controlled by the shaft rotation in at least a first direction of rotation.

12. — ~~The inhaler of claim 11, wherein the rod is moveable relative to the shaft in an axial direction.~~

13. — ~~The inhaler of claim 12, wherein the moving component comprises a cam follower and the rod comprises a cam track for receiving the cam follower, the cam track and the cam follower being configured such that the cam follower abuts an edge of the cam track and applies an axial moving force to the rod when the moving component moves from the first position to the second position.~~

14. — ~~The inhaler of claim 13, wherein the cam track and the cam follower are configured such that the axial moving force applied by the cam follower to the edge of the cam track axially moves the rod in a direction away from the shaft and the rod thereby applies a driving force to the canister to drive the canister from the rest position to at least the actuating position.~~

15. — ~~The inhaler of claim 13 or 14, wherein the cam track comprises at least a first section and a second section, the first section being substantially aligned with the axis of the rod and the second section being curved about a portion of the outer surface of the rod in a direction substantially away from the first section of the track.~~

16. — ~~The inhaler of claim 15, wherein the first section of track is configured to allow axial movement of the rod relative to the cam follower and the second section of the track is configured to allow axial and rotational movement of the rod relative to the cam follower.~~

17. — ~~The inhaler of claim 16, wherein the rotational movement of the rod is damped by the rotational damper and the axial movement of the rod is not damped by the rotational damper.~~

18. — ~~The inhaler of claim 15, 16 or 17, wherein the second section of the track is substantially helical about the portion of the outer surface of the rod.~~

19. — ~~The inhaler of any one of claims 13 to 18, wherein the rod comprises a pair~~

~~of cam tracks diametrically opposed on the rod outer surface, optionally wherein the second sections of the cam tracks are helical and the helices are either both right handed or both left handed.~~

5 ~~20. The inhaler of any one of claims 13 to 19, wherein the cam track is~~
configured such that a first section of the cam track is configured such that the
damping system enables the canister to automatically return from the actuating
position to the rest position initially at a first speed and is further configured such
that the damping system enables the canister to automatically return from the
10 actuating position to the rest position at a second speed at a later time within the
predetermined time period.

~~21.2. The inhaler of any one of the preceding claims, further comprising a load-~~
relieving mechanism configured to support ~~at least one of the moving component~~
15 ~~and at least a part of the damping system in a spaced apart position in which the~~
moving component and/or the part of the damping system is not in contact with the
canister, when the canister is received in the inhaler body.

~~22.3. The inhaler of claim 22, wherein the load-relieving mechanism is~~
20 configured to release the moving component and/or the part of the damping system
to thereby bring the moving component and/or the part of the damping system,
under the load of the biasing means, into contact with the canister, when the
canister is received in the inhaler body.

25 ~~23. The inhaler of claim 22, when dependent on any one of claims 14 to 18, wherein~~
~~the load-relieving mechanism is configured to release the moving component to~~
~~thereby bring the rod of the damping system, under the load of the biasing means,~~
~~into contact with the canister, when the canister is received in the inhaler body,~~
~~such that the rod is enabled to apply the driving force to the canister to drive the~~
30 ~~canister from the rest position to at least the actuating position.~~

~~24. The inhaler of claim 23, wherein the load-relieving mechanism is configured such~~
~~that the cam follower does not abut the edge of the cam track when the load~~

relieving mechanism is supporting the moving component and/or the part of the damping system.

5 25. ~~The inhaler of any one of the preceding claims, wherein the damping system comprises a linear damper.~~

10 26. ~~The inhaler of claim 25, wherein the linear damper is a hydraulic damper comprising a generally cylindrical reservoir containing an incompressible fluid and an elongate piston arranged coaxially through the reservoir and protruding at both a proximal and a distal end from the reservoir, relative to the canister when received in the inhaler body, the piston configured to slide linearly back and forth through the reservoir along the co-axis.~~

15 27. ~~The inhaler of claim 26, wherein the linear damper further comprises a lower seal for sealing the proximal end of the piston relative to the reservoir and an upper seal for sealing the distal end of the piston relative to the reservoir, such that fluid egress from the reservoir is substantially minimised or prevented.~~

20 28. ~~The inhaler of claim 27, wherein the reservoir of the linear damper comprises a proximal chamber having a first diameter and a distal chamber having a second diameter, the first diameter being less than the second diameter and optionally further comprising an intermediate section between the proximal and distal chambers, the intermediate section having a diameter that increases from a proximal end adjacent the reservoir proximal chamber to a distal end adjacent the reservoir distal chamber.~~

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30 29. ~~The inhaler of claim 28, wherein the linear damper further comprises a piston seal inside the reservoir, the piston seal surrounding the piston and affixed thereto and having a diameter such that it seals against the inside of the proximal chamber of the reservoir of the linear damper.~~

30. ~~The inhaler of claim 29, wherein the piston comprises a fluid flow channel, the fluid flow channel having an inlet beyond the proximal end of the piston seal and an~~

outlet beyond the distal end of the piston seal and configured such that fluid may flow between the proximal chamber and the distal chamber even when the piston seal is positioned so as to fluidly isolate the proximal chamber from the distal chamber.

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31. The inhaler of claim 30, wherein the hydraulic damper is coupled to the moving member such that movement of the moving component from the first position to the second position, when the biasing means is released from the loaded configuration, drives the piston proximally the piston thereby applying a driving force to the canister to drive the canister from the rest position to at least the actuating position.

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32. The inhaler of claim 31, wherein the channel of the piston is configured such that fluid flow therethrough is restricted to thereby minimise or prevent axial movement of the piston in the distal direction relative to the reservoir until the canister has reached at least the actuating position.

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33. The inhaler of claim 31 or 32, wherein the channel of the piston is configured such that fluid flows therethrough at a restricted rate from the proximal chamber to the distal chamber, thereby enabling the piston to move axially in the distal direction.

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34. The inhaler of claim 33, wherein the piston is configured such that a driving force from a return spring of the canister is sufficient to drive the piston axially in the distal direction, optionally wherein the return spring of the canister is further assisted by at least one additional return spring of the inhaler.

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35. The inhaler of claim 33 or 34, wherein the linear damper is configured such that axial movement of the piston in the distal direction is for the first time segment at a first speed determined by the piston channel followed in the second time segment at a second speed when the piston seal passes into the distal chamber and thereby fluid flows around the outside of the piston seal.

36. The inhaler of any one of claims 29 to 35, wherein the piston seal comprises a lip seal comprising concentric rings separated by a thinner section, the lip seal

configured to flex radially inwardly or outwardly under fluid pressure to allow or minimise fluid flow around the outside of the piston seal.

5 37. The inhaler of any one of claims 25 to 36, further comprising a load-relieving mechanism configured to support at least one of the moving component and at least a part of the damping system in a spaced apart position in which the moving component and/or the part of the damping system is not in contact with the canister, when the canister is received in the inhaler body.

10 38. The inhaler of claim 37, wherein the load-relieving mechanism is configured to release the moving component and/or the part of the damping system to thereby bring the moving component and/or the part of the damping system, under the load of the biasing means, into contact with the canister, when the canister is received in the inhaler body.

15 39. The inhaler of claim 38, wherein the load-relieving mechanism is configured to release the moving component to thereby bring the proximal end of the piston, under the load of the biasing means, into contact with the canister, when the canister is received in the inhaler body, such that the piston is enabled to apply the
20 driving force to the canister to drive the canister from the rest position to at least the actuating position.

25 40. The inhaler of any one of claims 26 to 39, wherein the incompressible fluid comprises silicone oil, optionally medical grade silicone oil and/or optionally silicone oil with a viscosity of 250 cSt.

30 41. The inhaler of claim 25, wherein the linear damper is a hydraulic damper comprising a generally cylindrical reservoir containing an incompressible fluid and an elongate piston arranged coaxially with the reservoir and protruding at proximal end from the reservoir, relative to the canister when received in the inhaler body, the piston configured to slide linearly back and forth into and out of the reservoir along the co-axis.

5 ~~42. The inhaler of claim 41, further comprising an elongate piston arranged coaxially with the reservoir and protruding at distal end from the reservoir, the elongate piston comprising a sealing section at a proximal end thereof, wherein the reservoir comprises a distal chamber and a proximal chamber that are fluidly isolated by the sealing section.~~

10 ~~43. The inhaler of claim 42, wherein the sealing section comprises a channel therethrough configured to allow fluid flow between the distal chamber and the proximal chamber such that movement of the sealing section is enabled and thus movement of the pistons is also enabled.~~

15 ~~44. The inhaler of any one of the preceding claims, wherein the biasing means comprises a spring, the spring optionally having a spring force when compressed in the range of about 45 to 85 N, optionally in the range of about 50 to 80 N, optionally in the range of about 55 to 75 N, optionally in the range of about 55 to 65 N.~~

20 ~~45.4.~~ The inhaler of any one of the preceding claims, further comprising a breath-triggering mechanism configured to hold the biasing means in the loaded configuration and to release the biasing means to move the moving component from the first position to the second position in response to airflow in the inhaler.

25 ~~46.5.~~ The inhaler of claim ~~44~~5, wherein the breath-triggering mechanism comprises a vane configured to pivot in response to airflow in the inhaler and a latch configured to release the biasing means when the vane pivots.

30 ~~47.6.~~ A method of dispensing medicament from an inhaler, the method comprising:
 releasing a biasing means of a drive mechanism of the inhaler from a loaded configuration;
 moving, by the released biasing means, a moving component of the drive mechanism from a first position to a second position to drive a canister, received in a body of the inhaler, from a rest position, in which a valve of the canister is

closed, to at least an actuating position, in which the valve is open;
automatically returning the canister from the actuating position to the rest
position within a predetermined time period measured from the release of the
biasing means from the loaded configuration, the automatic return of the
canister being regulated by a return mechanism comprising a damping system;
and
resetting the drive mechanism with a resetting mechanism that moves the
moving component from the second position to the first position and reloads the
biasing means to the loaded configuration.

48. ~~The method of claim 47, wherein the step of automatically returning the~~
~~canister within the predetermined time period comprises automatically returning the~~
~~canister during a first time segment during which movement of the canister from~~
~~the actuating position to the rest position is slower than during a second time~~
~~segment.~~

~~49. 7. The method of claim 47, wherein the step of automatically returning the canister~~
~~within the predetermined time period comprises maintaining the canister in the~~
~~actuating position during a first time segment and automatically returning the~~
~~canister from the actuating position to the rest position during a second time~~
~~segment.~~

~~50. The method of claim 48, wherein the second time segment immediately follows the~~
~~first time segment.~~

~~51. The method of claim 48 or 50, wherein the first time segment is in the range of~~
~~about 0.05 to 2.00 secs, optionally in the range of about 0.10 to 1.75 secs, optionally~~
~~in the range of about 0.20 to 1.50 secs, optionally in the range of about 0.30 to 1.25~~
~~secs, optionally in the range of about 0.40 to 1.20 secs.~~

~~52. The method of any one of claims 48-51, wherein the first time segment is at least~~
~~about 0.20 secs, optionally at least about 0.30 secs, optionally at least about 0.40 secs.~~

53. 8. The method of ~~any one of claim 6 or claim 7~~ 48 to 52, wherein the second time segment is in the range of about 0.10 to 2.00 secs, optionally in the range of about 0.30 to 1.80 secs, optionally in the range of about 0.40 to 1.70 secs, optionally in the range of about 0.60 to 1.60 secs, optionally in the range of about 0.80 to 1.50, optionally in the range of about 1.00 to 1.40 secs.

54. 9. The method of any one of claims ~~48-6 to 53~~ 8, wherein the second time segment is less than about 2.0 secs, optionally less than about 1.75 secs, optionally less than about 1.50 secs, optionally less than about 1.25 secs, optionally about 1.20 secs.

55. 10. The method of any one of claims ~~48-6 to 9~~ 54, wherein the first time segment combined with the second time segment is a total time of less than about 2.5 secs, optionally less than about 2.00 secs, optionally less than about 1.75 secs, optionally less than about 1.50 secs.

56. 11. The method of any one of claims ~~48-6 to 9~~ 55 10, wherein the damping system comprises a rotary damper.

57. 12. The method of claim ~~11-56~~ 11, wherein the damping system further comprises a rod, the rod coupled with a shaft of the rotary damper and wherein the rod rotates with the shaft, the rod rotation being controlled by the shaft rotation in at least a first direction of rotation.

58. 13. The method of claim ~~12-57~~ 12, wherein the rod moves relative to the shaft in an axial direction.

59. 14. The method of claim ~~13-58~~ 13, wherein the moving component comprises a cam follower and the rod comprises a cam track for receiving the cam follower, the cam follower abutting an edge of the cam track and applying an axial moving force to the rod when the moving component moves from the first position to the second position.

60. 15. The method of claim ~~59~~ 14, wherein the axial moving force applied by the cam follower to the edge of the cam track axially moves the rod in a direction away from the

shaft and the rod thereby applies a driving force to the canister to drive the canister from the rest position to at least the actuating position.

5 ~~61. 16.~~ -The method of claim ~~14~~59 or ~~60~~claim 15, wherein the cam track comprises at least a first section and a second section, the first section being substantially aligned with the axis of the rod and the second section being curved about a portion of the outer surface of the rod in a direction substantially away from the first section of the track.

10 ~~62. 17.~~ The method of claim ~~61~~ 16, wherein the first section of track allows axial movement of the rod relative to the cam follower and the second section of the track allows axial and rotational movement of the rod relative to the cam follower.

15 ~~63. 18.~~ The method of claim ~~62~~ 17, wherein the rotational damper damps the rotational movement of the rod but not the axial movement of the rod.

~~64. 19.~~ The method of claim ~~61, 62 or 63~~ 16, 17 or 18, wherein the second section of the track is substantially helical about the portion of the outer surface of the rod.

20 ~~65. 20.~~ The method of any one of claims ~~59-15~~ to ~~64~~19, wherein the rod comprises a pair of cam tracks diametrically opposed on the rod outer surface, optionally wherein the second sections of the cam tracks are helical and the helices are either both right-handed or both left-handed.

25 ~~66. 21.~~ The method of any one of claims ~~59-15~~ to ~~65~~19, wherein the canister automatically returns from the actuating position to the rest position initially at a first speed along a first section of the cam track and automatically returns from the actuating position to the rest position at a second speed at a later time along a second section of the cam track within the predetermined time period.

30 ~~67. 22.~~ The method of ~~any one of claim 21s 47 to 66~~, further comprising supporting ~~at least one of the moving component and at least a part of the damping system in a spaced apart position by a load-relieving mechanism, the moving component and/or~~

the part of the damping system not directly contacting the canister when supported by the load-relieving mechanism.

5 ~~68.~~ 23. The method of claim ~~67~~ 22, further comprising releasing the moving component and/or the part of the damping system to thereby bring the moving component and/or the part of the damping system, under the load of the biasing means, into contact with the canister.

10 ~~69.~~ The method of claim ~~68~~, when dependent on any one of claims 57 to 62, wherein the load-relieving mechanism releases the moving component to thereby bring the rod of the damping system, under the load of the biasing means, into contact with the canister, enabling the rod to apply the driving force to the canister and driving the canister from the rest position to at least the actuating position.

15 ~~70.~~ The method of claim ~~69~~, the cam follower does not abut the edge of the cam track when the load-relieving mechanism supports the moving component and/or the part of the damping system.

20 ~~71.~~ The method of any one of claims 47 to 70, wherein the damping system comprises a linear damper.

25 ~~72.~~ The method of claim ~~71~~, wherein the linear damper comprises a generally cylindrical reservoir containing an incompressible fluid and an elongate piston arranged coaxially through the reservoir and protruding at both a proximal and a distal end from the reservoir, relative to the canister when received in the inhaler body, wherein the piston slides linearly back and forth through the reservoir along the co-axis.

30 ~~73.~~ The method of claim ~~72~~, wherein the linear damper further comprises a lower seal that seals the proximal end of the piston relative to the reservoir and an upper seal that seals the distal end of the piston relative to the reservoir, such that fluid egress from the reservoir is substantially minimised or prevented.

~~74.~~ The method of claim ~~73~~, wherein the reservoir of the linear damper comprises a

proximal chamber having a first diameter and a distal chamber having a second diameter, the first diameter being less than the second diameter and optionally further comprising an intermediate section between the proximal and distal chambers, the intermediate section having a diameter that increases from a proximal end adjacent the reservoir proximal
5 chamber to a distal end adjacent the reservoir distal chamber.

75.— The method of claim 74, wherein the linear damper further comprises a piston seal inside the reservoir, the piston seal surrounding the piston and affixed thereto and having a diameter such that it seals against the inside of the proximal chamber of the reservoir of
10 the linear damper.

76.— The method of claim 75, wherein the piston comprises a fluid flow channel, the fluid flow channel having an inlet beyond the proximal end of the piston seal and an outlet beyond the distal end of the piston seal and wherein fluid flows between the proximal
15 chamber and the distal chamber even when the piston seal is positioned so as to fluidly isolate the proximal chamber from the distal chamber.

77.— The method of claim 76, wherein the step of moving the moving component from the first position to the second position further comprises driving the piston proximally and
20 applying a driving force to the canister to drive the canister from the rest position to at least the actuating position.

78.— The method of claim 77, further comprising the step of restricting the fluid flow through the channel to thereby minimise or prevent axial movement of the piston in the
25 distal direction relative to the reservoir until the canister has reached at least the actuating position.

79.— The method of claim 77 or 78, wherein the channel of the piston is configured such that fluid flows therethrough at a restricted rate from the proximal chamber to the distal
30 chamber, thereby enabling the piston to move axially in the distal direction.

80.— The method of claim 79, further comprising the step of driving the piston axially in the distal direction with a driving force from a return spring of the canister, optionally further

comprising the step of additionally driving the piston axially in the distal direction with a driving force from at least one return spring of the inhaler.

81. — The method of claim 79 or 80, wherein the piston moves axially in the distal
5 direction for the first time segment at a first speed determined by the piston channel followed in the second time segment at a second speed when the piston seal passes into the distal chamber and thereby fluid flows around the outside of the piston seal.

82. — The method of any one of claims 76 to 81, wherein the piston seal comprises a lip
10 seal comprising concentric rings separated by a thinner section, wherein the lip seal flexes radially inwardly or outwardly under fluid pressure and allows or minimises fluid flow around the outside of the piston seal.

83. — The method of any one of claims 71 to 82, further comprising supporting at least
15 one of the moving component and at least a part of the damping system in a spaced apart position by a load-relieving mechanism, the moving component and/or the part of the damping system not directly contacting the canister when supported by the load-relieving mechanism.

20 84. — The method of claim 83, further comprising releasing the moving component and/or the part of the damping system to thereby bring the moving component and/or the part of the damping system, under the load of the biasing means, into contact with the canister.

85. — The method of claim 84, wherein the load-relieving mechanism releases the moving
25 component to thereby bring the proximal end of the piston, under the load of the biasing means, into contact with the canister, enabling the piston to apply the driving force to the canister and driving the canister from the rest position to at least the actuating position.

86. — The method of claim 71, wherein the linear damper further comprises a piston seal
30 inside the reservoir, the piston seal surrounding the piston and affixed thereto sealing against the inside of the reservoir of the linear damper.

87. — The method of claim 86, wherein the piston comprises a fluid flow channel, the fluid

flow channel having an inlet beyond the proximal end of the piston seal and an outlet beyond the distal end of the piston seal and wherein fluid flows between a proximal chamber of the reservoir and a distal chamber of the reservoir through the channel, the proximal and distal chambers fluidly isolated by the piston seal.

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88.— The method of claim 42, wherein the step of moving the moving component from the first position to the second position drives the piston proximally and the piston applies a driving force to the canister and drives the canister from the rest position to at least the actuating position.

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89.— The method of any one of claims 47 to 88, further comprising the step of holding the biasing means in the loaded configuration with a breath-triggering mechanism that releases the biasing means in response to airflow in the inhaler.

15 90.— The method of claim 89, further comprising the step of pivoting a vane of the breath-triggering mechanism in response to airflow in the inhaler, the pivoting vane releasing a latch of the breath-triggering mechanism to release the biasing means.

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