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(54) Title: LAUNCHER FOR UNMANNED AERIAL VEHICLES

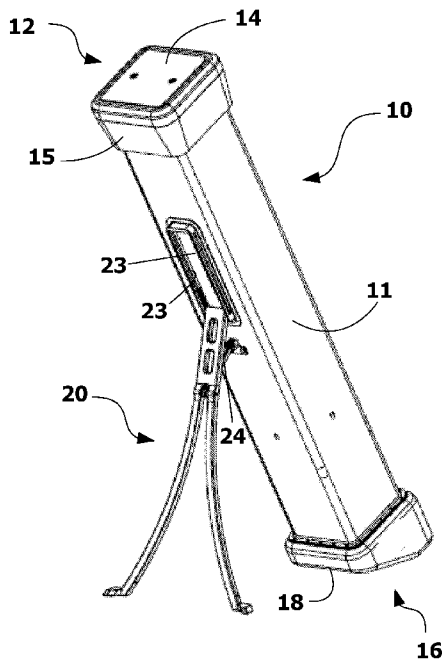


Fig. 1

(57) Abstract: A launcher for unmanned aerial vehicles (UAV), the launcher having a foldable UAV stowed within said launcher, the launcher includes, a launch tube configured as a UAV launcher and a UAV carrying case. The launcher further includes a pneumatic booster connected to said UAV for accelerating said UAV during launching phase. The launcher further includes a separation mechanism operated to permits separation of the booster from the UAV when the UAV leaves the launcher tube and to transfer the kinetic energy that is created from the pneumatic booster to the UAV in the launching phase. The UAV is propelled off of the launch tube by the booster that transmits thrust in the launch tube to the space below said booster. The UAV which is connected to the booster by the separation mechanism is pushed out of the launcher tube body and leaves the launch tube, the booster is separated from the UAV by the separation mechanism and the UAV is automatically deployed. The UAV propellers are activated to propel the UAV and driven the UAV.

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## LAUNCHER FOR UNMANNED AERIAL VEHICLES

### FIELD OF THE INVENTION

The present invention relates to launchers for unmanned aerial vehicles (UAV), and more particularly to UAVs' launchers tubes for stowing and launching.

### BACKGROUND OF THE INVENTION

A pneumatic launcher is basically a device that uses compressed air (or some kind of gas) to launch something. Typically, there is an air chamber pressurized with air. All this air is released suddenly and this energy is what propels a projectile or any other object such as but not limited to unmanned air vehicle (UAV). There are many different types of pneumatic launchers. The air can be released by several different methods. One type of pneumatic launcher is a UAV pneumatic catapult launcher (hereafter catapult) is intended to accelerate UAVs to launch speed. The UAV pneumatic catapult typically include attachable rail parts, assembled length of couple of meters, carriage with pulling cable, battery operated air compressor with compressed air reservoir and pneumatically operating main valve with remote trigger. All components are packed into one or more cases for easy transportation and handling. Another type of pneumatic launcher is for example a pneumatic tube launcher.

Such issues of UAV tube launchers are addressed for example in US8505430 and US7584925.

US8505430 discloses an unmanned aerial vehicle (UAV) launch tube that comprises a tethered sabot configured to engage a UAV within a launcher volume defined by an inner wall, the tethered sabot dimensioned to provide a pressure seal at the inner wall and tethered to the inner wall, and wherein the tethered sabot is hollow having an open end oriented toward a high pressure volume and a tether attached within a hollow of the sabot and attached to the inner wall retaining the high pressure volume or attach to the inner base wall. A

system comprising a communication node and a launcher comprising an unmanned aerial vehicle (UAV) in a pre-launch state configured to receive and respond to command inputs from the communication node.

US7584925 discloses a portable unmanned air vehicle and launcher system that includes a foldable unmanned air vehicle having a pressure tube; a launch gas reservoir for holding launch gas; a launch tube operatively connected to the launch gas reservoir and having a free end that is positioned in the pressure tube of the air vehicle; a free piston positioned within the launch tube; and a free piston stop to prevent the free piston from leaving the launch tube. A first portion of the launch gas in the launch gas reservoir is released into the launch tube and forces the free piston from an initial position to an end position at which the free piston is stopped by the free piston stop.

One object of the present invention is to provide an UAV launcher system that is transportable and can be carried by a one person. Another object of the present invention is to provide a system to launch a foldable UAV very quickly without the need to assemble parts for the UAV launching. Yet another object of the present invention is to provide a system to launch a foldable UAV even in a limited space and without the need of runway or rails for a UAV takeoff. Yet another object of the present invention is to provide a one person transportable UAV launcher with a foldable UAV placed inside the UAV launcher. Yet another object of the present invention is to provide a UAV launching system which is also used as a UAV protecting packaging when a foldable UAV is carried by a person as a back-pack. Conventional foldable UAVs are transported in pieces and assembled when needed. Another object of the present invention is to provide a transported fully assembled foldable UAV. Thus, does not suffer reliability problems associated with lost, broken or improperly assembled individual components.

## SUMMARY OF THE INVENTION

The present invention relates to launchers for unmanned aerial vehicles (UAV), and more particularly to UAVs' launchers tubes for stowing and launching.

In accordance with an embodiment of the present invention there is provided a launcher for unmanned aerial vehicles (UAV), the launcher having a foldable UAV stowed within said launcher, the launcher includes, a launch tube configured as a UAV launcher and a UAV carrying case. The launcher further includes a pneumatic booster connected to said UAV for accelerating said UAV during launching phase. The launcher further includes a separation mechanism operated to permits separation of the booster from the UAV when the UAV leaves the launcher tube and to transfer the kinetic energy that is created from the pneumatic booster to the UAV in the launching phase. The UAV is propelled off of the launch tube by the booster that transmits thrust in the launch tube to the space below said booster. The UAV which is connected to the booster by said separation mechanism is pushed out of the launcher tube body in a preferably constant acceleration thereby leaves the launch tube, the booster is separated from the UAV by the separation mechanism and the UAV is automatically deployed. The UAV propellers are activated to propel the UAV and driven the UAV.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention may be understood upon reading of the following detailed description of non-limiting exemplary embodiments thereof, with reference to the following drawings, in which:

**Fig. 1** is a perspective view of a UAV launcher in accordance with some embodiments of the present invention with an exemplary deployable bipod where the UAV launcher is ready to launch the UAV;

**Fig. 2** is a perspective view of a UAV launcher in accordance with some embodiments of the present invention with deployable bipod in a stowed position where the UAV launcher is ready for transportation;

**Fig. 3** is a perspective bottom portion sectional view of the UAV launcher that shown in Fig. 1;

**Fig. 4** is an exploded side view of the UAV launcher including a foldable UAV;

**Fig. 5** is a perspective rear view of a pneumatic booster in accordance with one embodiment of the present invention;

**Fig. 6** is a perspective front view of the pneumatic booster that is shown in Fig. 5;

**Fig. 7** is a perspective view of an air seal means in accordance with some embodiments of the present invention;

**Fig. 8** is a perspective view of a complementary quick release connector assembly installed in the bottom portion of the launcher body;

**Fig. 9** is an exploded of some parts of the quick release connector assembly that is shown in Fig. 8;

**Fig. 10** is a perspective view of the connector assembly that shown in Fig. 8;

**Fig. 11** is a perspective view of swing arms construction mechanism in accordance with some embodiments of the present invention;

**Fig. 12** is a perspective view of a conic choke valve protruding outwardly from the socket of the connector assembly that is shown in Fig. 8;

**Fig. 13** is a perspective exploded view showing some of the parts of the connector assembly that is shown in Fig. 8;

**Fig. 14** is a side cross sectional view of the bottom portion of the launcher body, the connector assembly that is shown in Fig. 8 and the conic choke valve in accordance with the present invention;

**Fig. 15A** illustrating schematically the stowed UAV in the launcher in accordance of some embodiments of the present invention before the UAV take-off.

**Fig. 15B** illustrating schematically the UAV in the launcher in the early launch stage;

**Fig. 15C** illustrating schematically the UAV in the launcher in the early launch stage with sliding out conical-shaped choke valve tubes arranged in a telescopic configuration and sliding out from one another;

**Fig. 16** is a perspective exploded view of the telescopic conic-shaped choke valve in accordance of the present invention;

**Fig. 17** is a side view of the booster and the separation mechanism and the UAV tail section, where the separation mechanism grabs the UAV tail section in accordance of the present invention;

**Fig. 18** is one of a plurality of tail UAV grabber arms in accordance of the present invention; and

**Fig. 19** is an exploded view showing the booster and the separation mechanism including the booster air brakes in accordance of the present invention.

The following detailed description of the invention refers to the accompanying drawings referred to above. Dimensions of components and features shown in the figures are chosen for convenience or clarity of presentation and are not necessarily shown to scale. Wherever possible, the same reference numbers will be used throughout the drawings and the following description to refer to the same and like parts.

## **DETAILED DESCRIPTION OF EMBODIMENTS OF THE INVENTION**

Referring first to **Fig. 1**, there is shown a launch tube **10** configured in accordance with some embodiments of the present invention as a UAV launcher and a UAV carrying case. The launch tube **10** includes a body **11** of square-shaped cross section. The body **11** is operatively used for storing the folded UAV and also is used as a launch rail for the UAV takeoff when the body **11** is positioned in a predetermined UAV launching angle and the UAV is ready for takeoff from body **11**. The outer surface of body **11** of the launcher is also used as a protective transport tube. This tube, which totally encloses the UAV,

prevents damage to the UAV structures when transported to and from one place to another.

In some embodiments of the present invention body **11** is made of a material that minimizes attenuation of electromagnetic waves such as but not limited to fiberglass layer. The thickness of the fiberglass body **11** is preferably less than one millimeter in order that the body will be light enough for carrying and minimizing attenuation of electromagnetic waves that comes to or from the UAV's antennas during maintenance or before flight. A shock absorber material such as but not limited to Polystyrene which totally encloses body **11** can be used to prevent damage to the UAV structures when transported to and from one place to another. Another layer of thin fiberglass encloses body **11** and the shock absorber for reducing the damages of shock absorber and body **11**.

The launch tube **10** has a frontal opening **12** for takeoff and launching of the UAV that the launch tube body **11** contains. This opening is normally closed by a square-shaped cover **14**. The front portion of the body **11** may include front bumper **15** which can be any protective rim, guard or pad, preferably made of rubber for absorbing shock and preventing damage to the UAV from bumping. The rear end portion **16** of the launching tube **10** presents a footing bumper structure **18**. The launch tube **10** further includes foldable bipod attachment **20**. The bipod **20** when is in a fully deployed position with the rear end footing structure creates a steady stand plane for the launch tube and provide stability along at least two axes (side-to-side and up-and-down). The bipod **20** is in fully deployed position when the launch tube **10** is in ready to launch position angle for example as illustrated in **Fig. 1**. The launcher **10** for example can be position in any predetermined selected launching angle when the bipod is in deployed position. The deployable bipod **20** may includes a hinged arm **24** hinged in one end to bipod **20** and the other end of the arm is hinged to the UAV body **11**. The bottom portion of the body **11** may include rails **23** opposite to one another where the upper portion of the bipod can pivotally slide there between the rails **23**. Arm **24** operatively limits the bipod to pivotally rotate up to the angle launch position. When the bipod is in a closed position for example as shown in **Fig. 2**



the bipod is folded approximately parallel to the launch tube body **11** allowing easier carrying of the UAV launcher containing the UAV by a person as a backpack. Other suitable bipod or tripod known in the prior art can be used with embodiments of the present invention.

Referring now also to **Fig. 3**, the rear end portion **16** may include a safety mechanism means **31** which is used to help prevent an accidental launching of a UAV in the pneumatic launcher tube **10** and helping to insure safer handling. The rear end portion **16** may further include a trigger **32** and/or a launching mechanism. The safety mechanism means **30** can include a safety pin **31** or a switch, a button or a lever that when set to the "safe" position, prevents the activation of the pneumatic launcher **10**. The safety mechanisms **31** can be a block or latch that prevents the trigger **32** and/or launching mechanism from moving. The rear end portion **16** may further includes an electrical switch **35** for electrically activating the UAV electrical power source(s).

Referring to **Fig. 4** there is shown an exploded view of the UAV launcher **10** with an exemplary foldable UAV stowed within the UAV launcher body **11**. The UAV launcher **10** further includes a pneumatic UAV booster **36** which is typically a launch compressed gas reservoir that preferably holds compressed air at substantially different from the ambient pressure. In some embodiments of the present invention the booster **36** may hold other compressed gases or liquids. The UAV is propelled off of the launch tube **11** by the compressed air in booster **36** as will be describe later in more detail. The launcher **10** further includes a folded UAV **38**. The booster **36** is used for accelerating the UAV **38** in the launching phase inside body **11**. This booster **36** is mounted to the UAV **38**. The booster **36** can however be released from the UAV **38** by a separation mechanism **39**. The construction of the separation mechanism **39**, thus, which will be described later in more details permits separation of the booster **36** from the UAV **38** when the UAV **38** leaves the launcher body **11**, which entails great saving in weight and kinetic energy. An exemplary of a folded UAV **38** is shown in **Fig. 4**. The UAV **38** includes a fuselage **40**, foldable wings **42** and UAV elevators and rudders **44** which are foldable. The fuselage **40** is positioned centrically to the center axis of

the launch tube body **11**. Payloads and control electronics, not shown, for operating the elevators and rudder **44** included in the fuselage **40**. Also include in the fuselage is a motor which may be a regular DC motor driving foldable propellers **46** when the propeller is in a full deployable position. The propeller has dimensions to fit into the tube body at least in some position particularly when the propeller is in a full folded position. The propellers are operatively and may automatically rotate when the UAV is launched and leaves the UAV body. The launcher **10** further includes sabot **48** configured to engage the UAV within the launcher volume defined by the inner walls of body **11**. The sabot keeps the UAV centered in the inner walls of body **11**, the sabot is further desirable to fill the undesirable but necessary gap between UAV and the inner walls of body **11**. The sabot **48** generally includes one or more pieces held in place by a loose connection, not shown. When the sabot **48** reaches the end of body **11**, the shock of hitting still air pulls the parts of the sabot away from the UAV **38**, allowing the UAV **38** to continue in flight. In some embodiments of the present invention the sabot is loosely connected on the upper portion of foldable wings **42** in such a way that when the UAV is released, the sabot is further assists wings **42** to fully deploy in the initial flight stage when the UAV leaves body **11**.

Referring to **Figs. 5 to 7**, in the preferred embodiment of the present invention booster **36** includes a cylindrical body reservoir **50** that holds compressed air. The booster **36** further includes two pairs of squared frames **52** and **54** positioned in the front and rear ends of the booster respectively. Between each pair of frames, air sealing means **56** such as but not limited to sponge is positioned. The booster **36**, the air sealing means **56** and the frames are positioned centrally to the center axis of the launch tube body **11**. The squared-shaped frames **52** and **54** have squared-shaped cross section dimensions which are slightly smaller than the dimensions of the body's **11** square-shaped cross section and the dimensions of the frames are big enough such that there is a strong seal in association with the squared-shaped cross section sealing means **56** to trap propellant gases/compressed air behind the booster, and keep the UAV centered in the inner walls of body **11**. It should be noted that in some

embodiments of the present invention the booster may have other shapes and designs and the booster body is not limited to a cylindrical shape.

At the bottom portion of booster **36** centrically to the center axis of the launch tube body **11** positioned a connector assembly **57** having an orifice **59**. Referring also to **Figs. 8** and **9**, the connector assembly **57** has a cylindrical portion **58** which fits freely into a socket **60**, of a complementary quick release connector assembly **61**, but with O-rings **62** for sealing the clearance between the cylindrical portion **58** and the sides of the socket/sleeve **60**. The connector assemblies **57** and **61** are secured together by a plurality of balls, not shown, located at angular-spaced positions around the circumference of sleeve **60** on conic-shaped holes **65** and in position to engage a circumferential groove **66** in the cylindrical portion **58** of connector assembly **57**. These balls are located in opening in the sleeve **60**. The balls are held against outward displacement and forced to remain engaged in the groove **66** by a slide ring **68** which is movable longitudinally on the outside sleeve **60**. This slide ring **68** is held by a conventional snap ring, not shown, located in a groove **72** in the outside surface of the sleeve **60**. The upper portion of the slide ring **68**, contacts with the snap ring to prevent the slide ring from coming off the sleeve **60**. The slide ring **68** can be moved against the pressure of a conventional coil compression spring, not shown, to bring an end portion **76** of the slide ring **68** over the balls. This end portion **76** is of large enough diameter to permit the balls to move outwardly far enough to let the cylindrical portion **58** of the connector assembly **57** pass freely into and out of the socket **60**. This detachable connection means **57** and **61** is conventional and is merely representative of detachable connecting means for securing the connector assembly to a complementary connector assembly.

Referring to **Figs. 10** and **11**, complementary quick release connector assembly **61** further include swing arms construction mechanism **79** mechanically connected to trigger **32** and to the slidable sleeve **68**. The end portion of arms **80** and **82** are shaped to be able to engage and fit with pins **84** and **86**. The pins **84** and **86** are extended outwardly and perpendicularly to the outer surface of sleeve **68**. When the trigger **32** is triggered, trigger **32** causes

swing arms **82** and **80** to mechanically swing backwards around hinge **71** to a certain degree, enough to grab pins **84**, **86** and push sleeve **68** backwards and thereby, balls **64** move outwardly far enough to let the cylindrical portion **58** of the connector assembly **57** pass freely out of the socket **60** by utilizing the force of the released pressurized air in the booster **38** through orifice **59**. Swing arms construction mechanism **79** further include a safety ring **90**, which is part of the safety mechanism, extending perpendicularly to arm **80**. In a safety mode, the safety pin **31** is inserted through the ring **90** thereby, preventing from the swing arms construction mechanism **79** to swing and lock the trigger switch **32** from triggered and/or move. The safety pin **31** is housed in a safety pin housing **33** and a safety pin grabbing means **37** such as a flattened head is attached to the upper end of the safety pin **31** for enabling pulling the safety pin manually. When the safety pin **31** is pulled upwards enough such that pin **31** is no longer passes through the ring **90**, the safety mechanism is thus set to "off" position and the trigger can be activated/moved and the arms can swing backwards when triggered and therefore the sleeve **68** is also able to slide backwards for releasing cylindrical portion **58** of the connector assembly **57** out of the socket **60** of connector assembly **61** as described above. A latching means not shown can be used to latch the safety pin **31** to be remains in the pulled up position after the safety pin **31** was pulled up. Support **92** can be used for attaching the quick release connector assembly **61** to the inner side **94** of the launcher rear portion **16** as shown for example in **Fig 8**.

Referring to **Figs. 12** and **13**, connector assembly **61** further includes an exemplary of valve stem **100** which opens to admit gas to reservoir **50** and is then automatically closed and kept sealed by the pressure in the reservoir **50** or a spring or both, to prevent gas from escaping. The valve stem **100** is housed in a valve housing **102**. Referring also to **Fig. 14**, a valve stem **100** further includes valve cover **104**. When the cover **104** is open by a user, a compressor, not shown, can be used for filling pressurized air into the reservoir **50** through the valve stem **100** and/or modifying the compressed air in the compressed gas reservoir **50** in order to maintain a desired working pressure in the compressed gas reservoir **50**.

The connector assembly **61** further includes a choke valve **106** which in accordance of the present invention is a cone-shaped tube **106** that tapers smoothly from a flat base **108**. The cone-shaped tube **106** is inserted inside sleeve **60**. The rear portion of the cone-shaped tube **106** is positioned between valve housing **102** and sleeve **60**. A conventional O-rings seals, not shown, are positioned between valve housing **102** and sleeve **60** for preventing compressed air to escape from reservoir **50**. The cone-shaped tube **106** has a length size of approximately the length size of reservoir **50** as shown for example schematically in **Fig. 15A**. When connector assemblies **61** and **57** are connected to one another and cone-shaped tube **106** is inserted through orifice **59** of connector **57** inside reservoir **50**, the rear portion of the conical-shaped tube **106** engages with the open of orifice **59**. The choke valve **106** is used in accordance of the present invention to regulate the gas released from the pressurized gas reservoir **50** for the UAV **38** takeoff, when the connectors **57** and **61** are disconnected from one another. Because of the conical-shape of the choke valve **106** a constant or approximately constant gas pressure release is created in the launcher pneumatic mechanism when the two connectors **61** and **57** are released. In order to obtain a constant acceleration or approximately constant acceleration of the UAV along the body **11** there is a need to maintain a constant or approximately constant gas pressure in the increased chamber that is, the increased space below the booster **36** as the booster **36** moves upwards towards the upper portion of body **11**. Because the booster **36** along with the UAV moves upwards in body **11** during the launching phase there is a need to release higher amount of pressurized gas from orifice **59** in order to maintain a constant or approximately constant air pressure in an increased chamber/space. This action is done by utilizing the conical-shaped tube **106**. As mentioned above the conical-shaped tube **106** is positioned inside of the booster **36** and the gas that is released from the reservoir to the launcher body **11** is passed in the cut between the choke valve **106** and orifice **59**. It should be noted that in some embodiments of the present invention the pressurized gas release in the increased chamber can be regulated during the launching phase to different gas pressure levels and choke valve **106** may not

limited to conical-shape, other chock valve shapes can be used for regulating the gas pressure in the increased chamber.

Referring also to **Figs 15A to 15B**, in **Fig. 15A** there is shown schematically a UAV **38** stowed in body **11**, booster **36** is filled with compressed gas and the connector assemblies **57** and **61** are connected to one another, thereby preventing air to escape from booster **36**. In the initial stage of the launching the gas ejection from booster **36**, the wider side of the cone-shaped tube is positioned inside of orifice **59** of connector **57** and thus small amount of gas is released to the launcher body. With the progress of the booster and UAV ejection designated by arrow **109** as shown for example in **Fig. 15B**, the booster **36** moves forward and draws away from connector assembly **61**. The cone-shaped tube that is connected to the connector assembly **61** stays in place in the bottom portion of body **11** and the cross section area between the orifice **59** of connector assembly **57** and the choke valve **106** where pressurized air/gas can escape is getting bigger due to the conical shape of the choke valve and thus more amount of gas **110** is released to the launcher body **11**, to the space bellow booster **36**. Thereby, the pressure of the gas in the growing cavity below booster bottom surface remains approximately equal during the UAV ejection from body **11**. The approximately equal air/gas pressure stays that way during the entire movement of the UAV and its booster until the booster exit the launcher. Thereby, the booster and UAV acceleration remaining approximately equal during the entire launch with no acceleration spikes.

Referring now to **Fig. 15C** and **Fig. 16** in some embodiment of the present invention the choke valve **106** may include a plurality of conical-shaped tubes for example tubes **106A** and **106B** arranged in a telescopic configuration. When the connector assemblies **61** and **57** are connected to one another the cone-shaped telescoping tubes **106A** and **106B** are in a collapsed position. When connectors **61** and **57** are disconnected from one another the collapsed telescoping tubes **106A** and **106B** are automatically sliding out from one to another, lengthening conical-shaped tube formed from its rest/collapsed state conical-shaped tubes **106A** and **106B**. The automatic sliding movement is done by a spring **112**

compressed within the collapsible telescoping tubes and is automatically released when the connectors **61** and **57** are disconnected. Thereby, the released spring provide force for the telescoping tubes **106A** and **106B** to slide of from one to another. This configuration allows more time for the chock valve **106** to release constant amount of compressed air from booster **38** and thus to maintain a constant acceleration of the UAV along the launching runway of body **11**.

Referring to **Fig. 6** and **Figs 17 to 18**, in the upper portion of booster **36** are attached two pairs of rings members **120** and **122**. Each pair of rings positioned opposite to one another and each of the ring members are positioned perpendicular to the upper surface **124** of booster **36**. The upper portion of booster **36** further includes tail UAV grabber arms **130** each of them secured in one end by a hinge **132** to each of the rings respectively. The hinge **132** includes the following hinge members, ring members **120** and **122**, a hinge rode member, not shown, and a pivot tube **134**. The pivot tube is extended from the rear portion of arm **130** and has a groove **136** positioned preferably in the middle of the tube **134**. Groove **136** receives the respective ring **120**, **122** and a respective hinge rod is being inserted through tube **134** and the respective ring **120**, **122**. This arrangement allows arms **130** to be pivotally attached to the upper surface **124** of the booster **36** and thus, each arm **130** has a certain degree of freedom to rotate around the respective axis of the hinge rod member. At the upper portion of UAV tail grabber arm **130** extends downwardly towards the UAV body a protruded element **138**. In the tail section **137** of the UAV disposed grooves, not shown, that receive and/or engaged with the protruded elements **138** when the UAV **38** is stowed in the UAV launcher body **11**. In order that the protruded elements **138** will remain caught in the grooves the grubber further includes upwardly diagonal support arm **140** extended from arm **130** and is constructed to engage with the inner surface of body **11**. This arrangement prevents arms **130** to rotate when the UAV is installed within body **11**. The main purposes of the UAV tail grubber **130** are, one to transfer the kinetic energy that is created from the pneumatic mechanism to the UAV and the second purpose is to protect the UAV motor and/or other parts position at the UAV tail, by keeping enough distance between

the UAV **38** and the booster **36**. The separation mechanism **39** further includes an air brakes means **140**. The air brakes means is preferably made of a flat composite material that has the property to bent when applying force and to return to its flat position when the bending force discontinuous or stops. The air brakes means **140** has two main purposes; one for disengaging the tail grabbing arms **130** and booster **36** from the UAV tail section **137** after the UAV **38** is launched and leaves the launcher **10**. The second purpose, the shock of the air break means **140** hitting still air pull the grabbing arms **130** away from the UAV body. The air brakes means **140** is opened to increase drag and thus the booster flight speed decreases faster relatively to the UAV speed and the booster **36** is drawn away from the UAV. The launcher **10** may further include UAV technician service connector, not shown. This service connector can supply voltage to the UAV that is stowed in body **11** from external power supply that is not the internal power supply in the UAV. This connector may further includes electrical communication channel through which software updates, UAV electrical measurements and built-in self test and other maintenances can be established while the UAV **38** remains in body **11**.

The UAV is launched as follows. The booster **38** transmits thrust to the space below booster **38** in body **11** Thus, the UAV which is connected to the booster **38** by separation mechanism **39** is pushed out of the launcher tube body **11** in a constant acceleration thereby leaves the launch tube **11**. As soon as the UAV is launched the aerodynamic control surfaces **44** and wings **42** of the UAV are fully available for control as soon as the booster **36** and the separation mechanisms **39** are separated from the UAV. However, as soon as the UAV leaves the launch tube **11** wings biased means, not shown, such as spring-biased hinges, causes the wings **42** to deploy in a full deployable position and whereupon latches lock the deployed wings **42** in position. For example, after a turn by approximately 90 degrees, the wings **42** are fully deployed sideways. While the wings biased means initiate the deployment of the wings **42**, the deployment continuous as a result of inertia and air resistance. As the booster **36** and the separation mechanism **39** separate from the UAV and draw away from



the UAV by the deploying of the air brakes **140** and following the launch, thrust development of the booster will decline causing the booster and the separation mechanism **39** to drop off, the UAV continuous and foldable propellers **46** of the UAV are deployed and the propeller motor is activated to propel the UAV propellers and driven the UAV.

In accordance with some embodiments of the present invention a single launch platform, not shown, can be used for launching a plurality of foldable UAVs from a single launch platform or vehicle. Each pre-air pressed and launch ready UAV is individually launch out of its launch tube by compressed air in accordance of the present invention as described above. The UAV launcher configuration and the foldable UAV configuration allow for automatic deployment of wings and tails sections surfaces of the UAV after launch to transform the UAV into flight configuration.

It should be understood that the above description is merely exemplary and that there are various embodiments of the present invention that may be devised, *mutatis mutandis*, and that the features described in the above-described embodiments, and those not described herein, may be used separately or in any suitable combination; and the invention can be devised in accordance with embodiments not necessarily described above.

**CLAIMS**

1. A launcher for unmanned aerial vehicles (UAV), said launcher having a foldable UAV stowed within said launcher, said launcher comprising:

a launch tube configured as a UAV launcher and a UAV carrying case;

a pneumatic booster having a pressurized gas(es) reservoir, said booster is connected to said UAV for accelerating said UAV during launching phase;

a separation mechanism operated to permits separation of said booster from said UAV when said UAV leaves said launcher tube and to transfer the kinetic energy that is created from said pneumatic booster to said UAV in said launching phase;

wherein, said UAV is propelled off of said launch tube by said booster that transmits thrust in the launch tube to the space below said booster,

whereby, said UAV which is connected to said booster by said separation mechanism is pushed out of the launcher tube body thereby, leaves the launch tube, said booster is separated from said UAV by said separation mechanism and said UAV is automatically deployed, UAV propellers are activated to propel said UAV and driven said UAV.

2. A launcher according to claim 1, wherein said booster further comprising a booster connector assembly, said booster connector assembly having an orifice and a cylindrical portion which fits freely into a socket of a complementary quick release connector assembly positioned at the bottom portion of said launcher tube, said cylindrical portion further comprising O-rings for sealing the clearance between the cylindrical portion and the sides of a socket of said complementary quick release connector assembly, said connector assemblies are secured together by a plurality of balls located at angular-spaced positions around the circumference of a sleeve on conic-shaped holes and in position to engage a circumferential groove in said cylindrical portion of said booster connector assembly, said balls are held against outward displacement and forced to remain engaged in the groove by a slide ring which is movable longitudinally on the

outside sleeve , said slide ring can is moved against the pressure of compression spring, to bring an end portion of said slide ring over said balls, this end portion is of large enough diameter to permit said balls to move outwardly far enough to let said cylindrical portion of said connector assembly pass freely into and out of said socket.

3. A launcher according to claim 2, wherein said complementary quick release connector assembly having a choke valve for regulating the gas released from the said pressurized gas reservoir for said UAV takeoff when said connectors assemblies are disconnected from one another.

4. A launcher according to claim 2, wherein said choke valve is a cone-shaped tube that tapers smoothly from a flat base; said cone-shaped tube is inserted inside said sleeve; the rear portion of said cone-shaped tube is positioned between a valve housing and said sleeve; said cone-shaped tube has a length size of approximately the length size of said reservoir, and wherein, when said connector assemblies are connected to one another and said cone-shaped tube is inserted through orifice of said connector inside said reservoir, the rear portion of said conical-shaped tube is engaged with the open of said orifice; because of the conical-shape of said choke valve, when said two connectors are released gas is released below said booster and remains approximately constant during said UAV launching phase.

5. A launcher according to claim 3, wherein said choke valve comprises a plurality of conical-shaped tubes arranged in a telescopic configuration; when said connector assemblies are connected to one another said conical-shaped telescoping tubes are in a collapsed position; when said connectors assemblies are disconnected from one another the collapsed telescoping tubes are automatically sliding out from one to another, lengthening conical-shaped tube formed from its rest/collapsed state conical-shaped tubes.

**6.** A launcher according to claim 1, wherein said separation mechanism having UAV grabber arms hinged attached to the upper portion of said booster which is used for transfer the kinetic energy that is created from said pneumatic mechanism to said UAV and to protect the UAV motor and/or other parts position at said UAV, by keeping safety distance between said UAV and said booster.

**7.** A launcher according to claim 1, wherein said separation mechanism having an air brakes means used for disengaging said grabbing arms and said booster from said UAV after the UAV is launched, said air brakes means is opened to increase drag and thus said booster flight speed decreases faster relatively to said UAV speed and said booster is drawn away from said UAV.

**8.** A launcher according to claim 1, wherein said launcher further having service connector.

**9.** A launcher according to claim 1, wherein said launcher further having electrical communication channel through which software updates, UAV electrical measurements and built-in self test and other maintenances can be established while the UAV remains in launcher body.

**10.** A launcher according to claim 7, wherein said air brakes means is made of a flat composite material that has the property to bent when applying force and to return to its flat position when said bending force discontinuous or stops.

**11.** A launcher according to claim 5, wherein said collapsible telescoping tubes further having a spring for automatic sliding movement of said telescoping tubes when said connectors are released from one another; thereby, the released spring provide force for the telescoping tubes to slide off from one to another; this configuration allows more time for the chock valve to release amount of

compressed air from said booster to maintain acceleration of said UAV along the launching runway of said launcher body to remains approximately constant.

**12.** A launcher according to claim 1, wherein said launch tube having a body of square-shaped cross section; said body is operatively used for storing said folded UAV and also is used as a launch rail for said UAV takeoff when said body is positioned in a predetermined UAV launching angle and the UAV is ready for takeoff from said body.

**13.** A launcher according to claim 1, wherein said launcher having at least one bumper for absorbing shock and preventing damage to said UAV from bumping.

**14.** A launcher according to claim 1, wherein said launcher further having a footing bumper structure positioned in the rear portion of said body and a foldable bipod attachment wherein when said bipod is in a fully deployed position with the rear end footing structure creates a steady stand plane for the launch tube.

**15.** A launcher according to claim 1, wherein said launcher is carried by a person as a back-pack.

**16.** A launcher according to claim 1, wherein said launcher further comprising a safety mechanism means which is used to help prevent an accidental launching of said UAV in said launcher tube.

**17.** A launcher according to claim 1, wherein said launcher further comprising a trigger launching mechanism.

**18.** A launcher according to claim 1, wherein said launcher further comprising an electrical switch for electrically activating the UAV electrical power source(s).

**19.** A launcher according to claim 1, wherein said pneumatic booster is a launch compressed gas reservoir that holds compressed air/gas.

**20.** A launcher according to claim 1, wherein said launch tube further comprising sabot configured to engage said UAV within the launcher volume defined by the inner walls of said launch tube, said sabot is loosely connected to the UAV's wings and when said sabot reaches the end of said launch tube, said sabot is assist for deploying the UAV's wings; the shock of hitting still air pulls the parts of said sabot away from said UAV.

**21.** A launcher according to claim 1, wherein said booster further comprising at least one pair of frames between each pair of frames, air sealing means is positioned trap propellant gases/compressed air behind the booster, and keeps the UAV centered in the inner walls of said launch tube.

**22.** A launcher according to claim 2, wherein said complementary quick release connector assembly further comprising swing arms construction mechanism mechanically connected to said trigger and to said slidable sleeve , the end portion of said arms are shaped to be able to engage and fit with pins and said pins are extended outwardly and perpendicularly to the outer surface of said sleeve, and wherein When said trigger is triggered, said trigger causes said swing arms to mechanically swing backwards around a hinge to a certain degree, enough to grab said pins and push said sleeve backwards and thereby, said balls move outwardly far enough to let the said cylindrical portion of said connector assembly pass freely out of the said socket by utilizing the force of the released pressurized air in said booster through said orifice.

**23.** A launcher according to claim 22, wherein said swing arms construction mechanism further comprising a safety ring, which is part of the safety

mechanism, extending perpendicularly to one of said arms, wherein in a safety mode, said safety pin is inserted through said ring thereby, preventing from said swing arms construction mechanism to swing and lock said trigger switch from triggered and/or move; When said safety pin is pulled upwards enough such that said pin is no longer passes through said ring, said safety mechanism is thus set to "off" position and said trigger can be moved and said arms can swing backwards when triggered and therefore said sleeve is also able to slide backwards for releasing said cylindrical portion of said connector assembly out of said socket.

**24.** A launcher according to claim 1, wherein said complementary quick release connector assembly further having a valve stem which opens to admit gas to said reservoir and is then automatically closed and kept sealed by the pressure in said reservoir or a spring or both, to prevent said gas from escaping.

**25.** A launcher according to claim 1, wherein a single launch platform is used for launching a plurality of foldable UAVs from said single launch platform.

**26.** A launcher according to claim 1, wherein said body is made of a material that minimizes attenuation of electromagnetic waves such as but not limited to fiberglass, the thickness of said fiberglass body is preferably less than one millimeter in order that said body will be light enough for carrying and also for minimizing attenuation of electromagnetic waves that comes to or from the antennas of said UAV during maintenance or before flight.

**27.** A launcher according to claim 1, wherein said foldable UAV is pushed out of the launcher tube body in approximately constant acceleration.

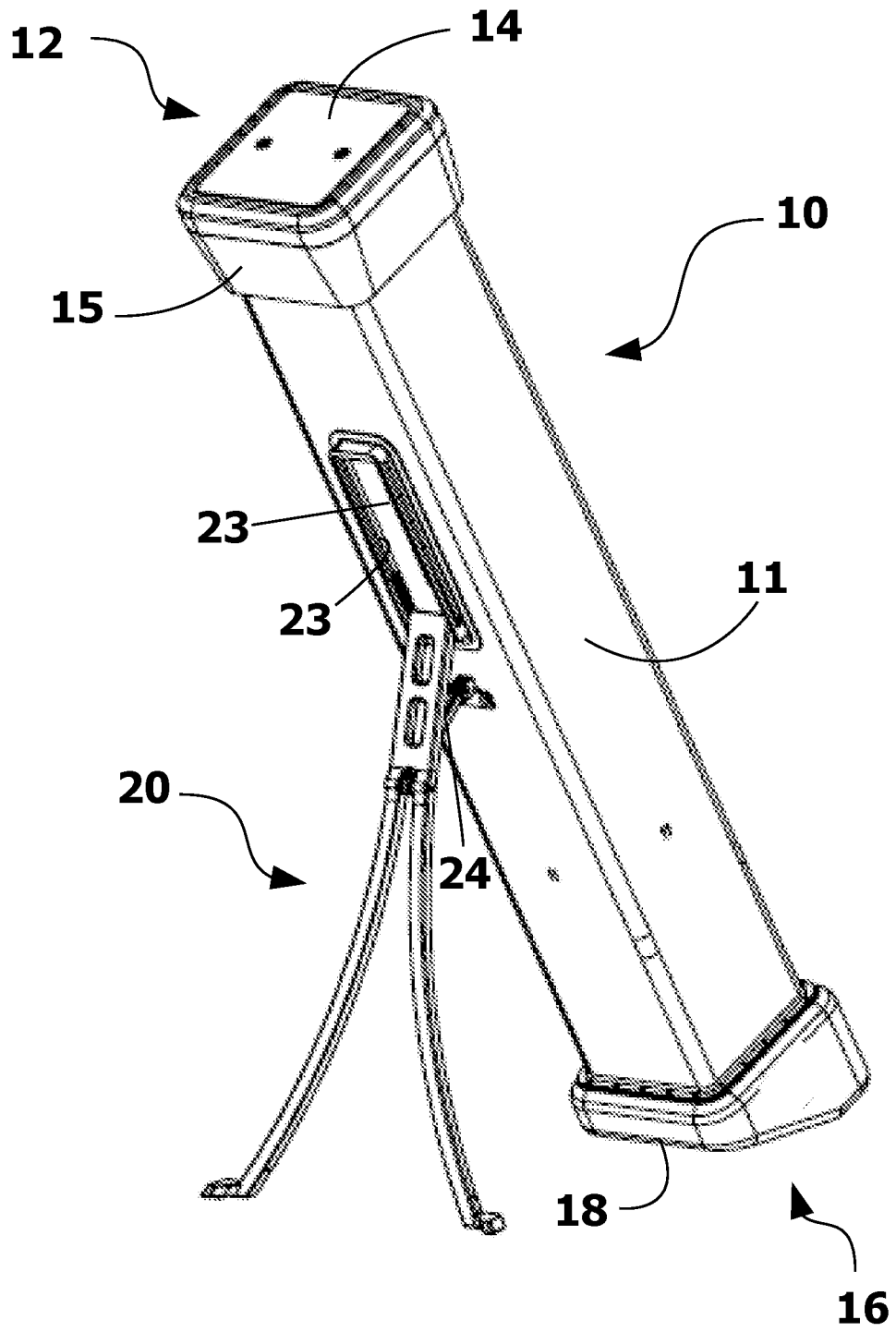
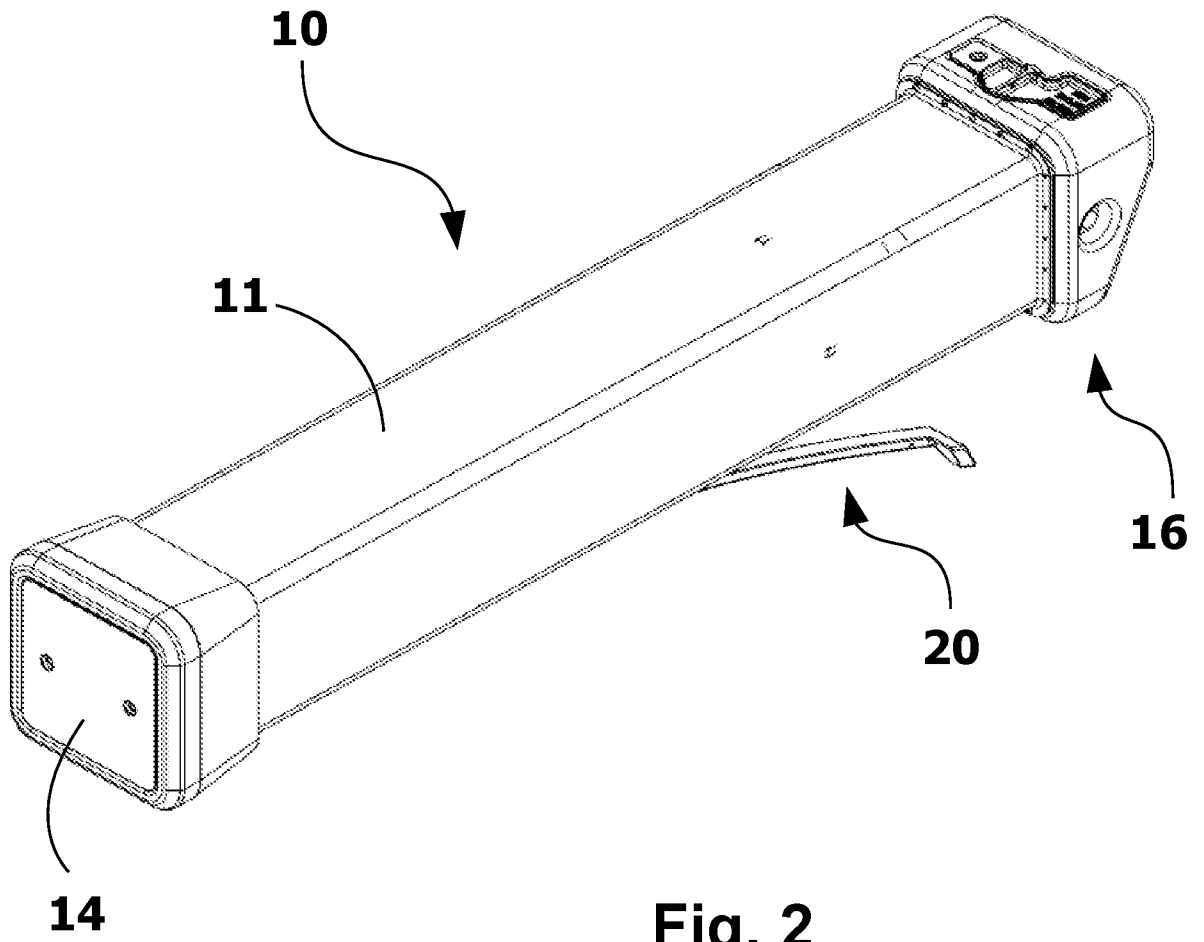


Fig. 1





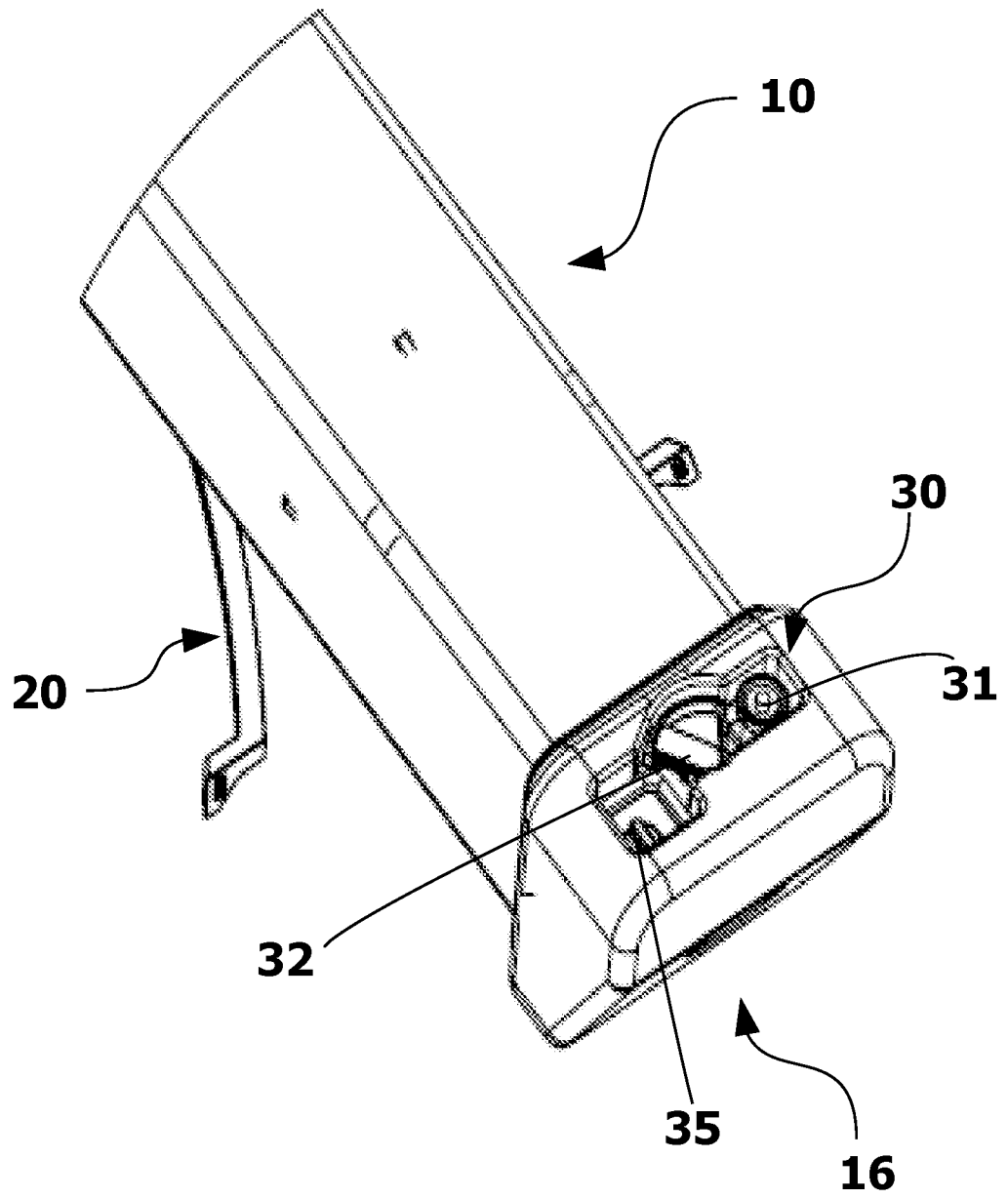


Fig. 3

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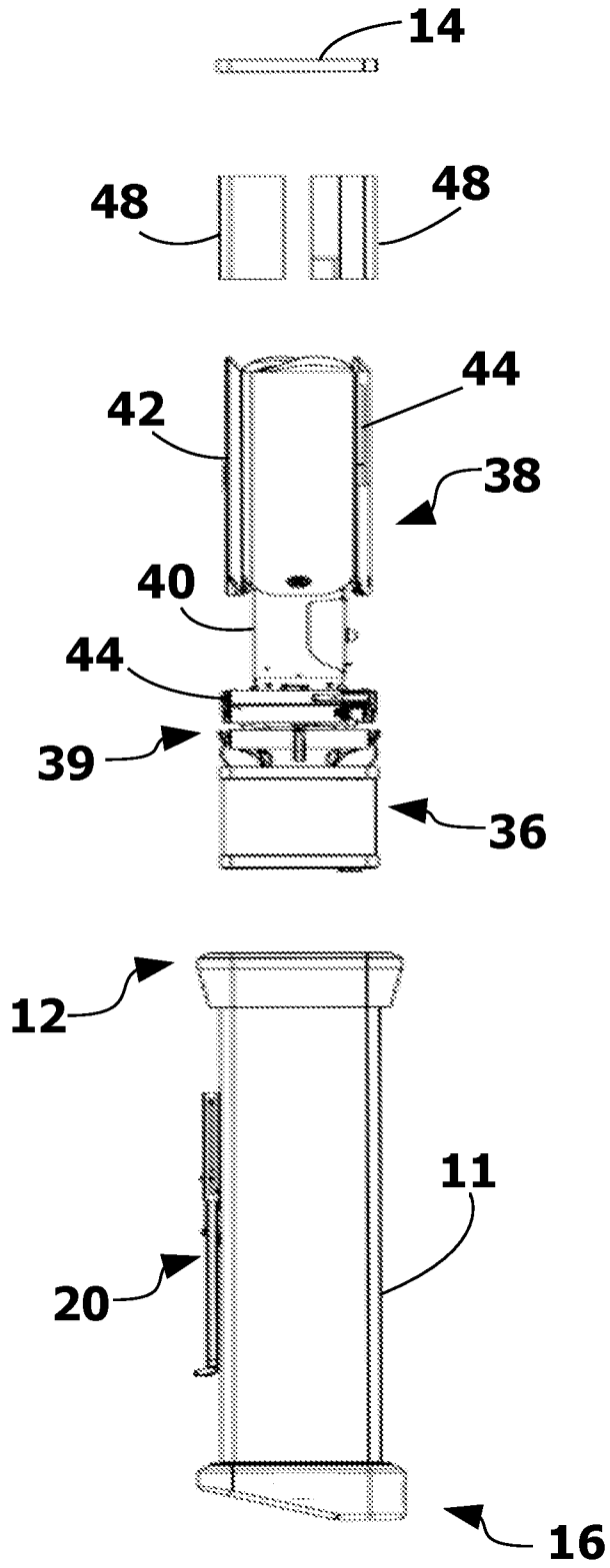


Fig. 4

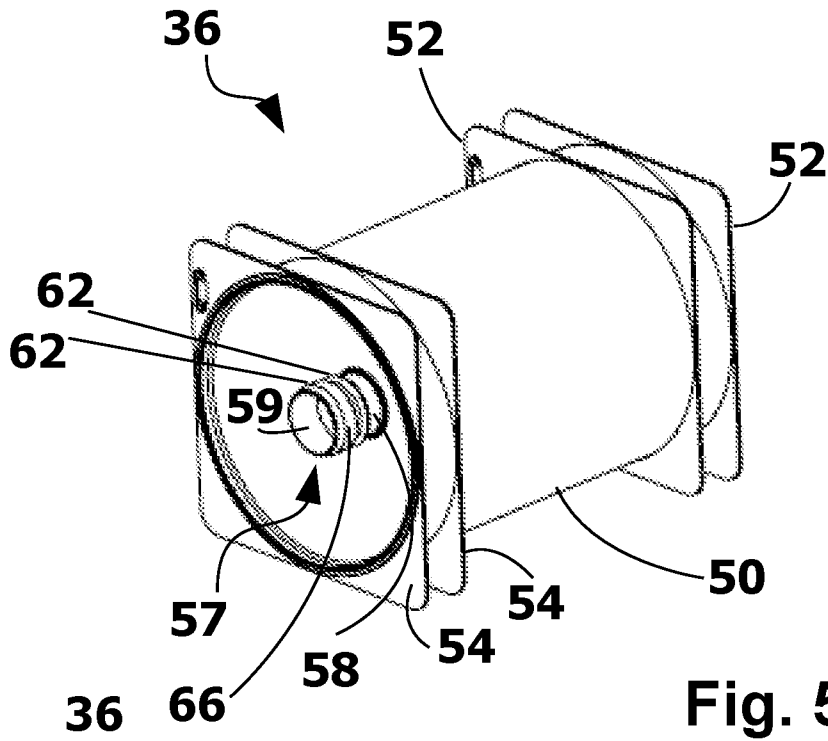


Fig. 5

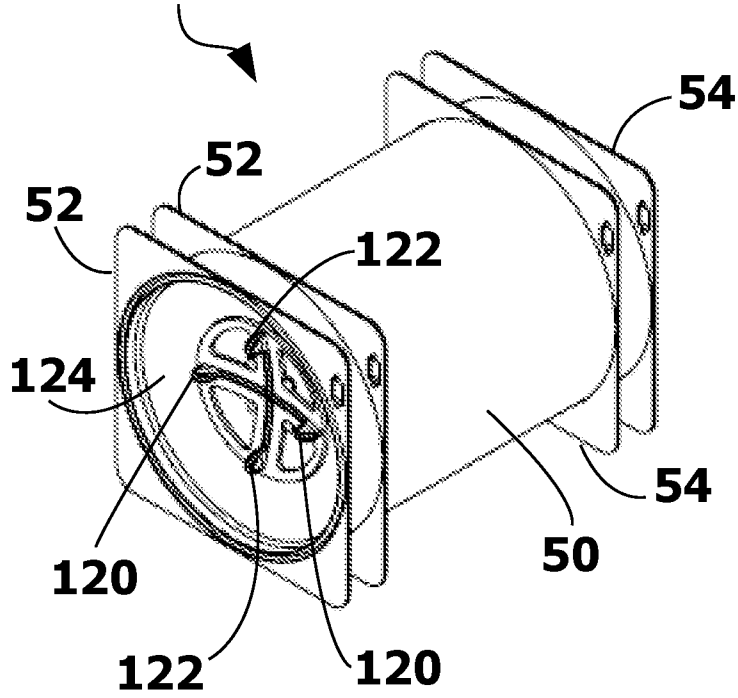


Fig. 6

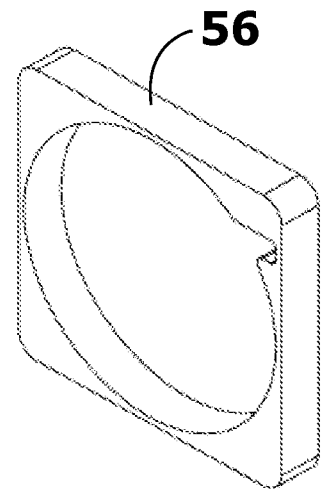


Fig. 7

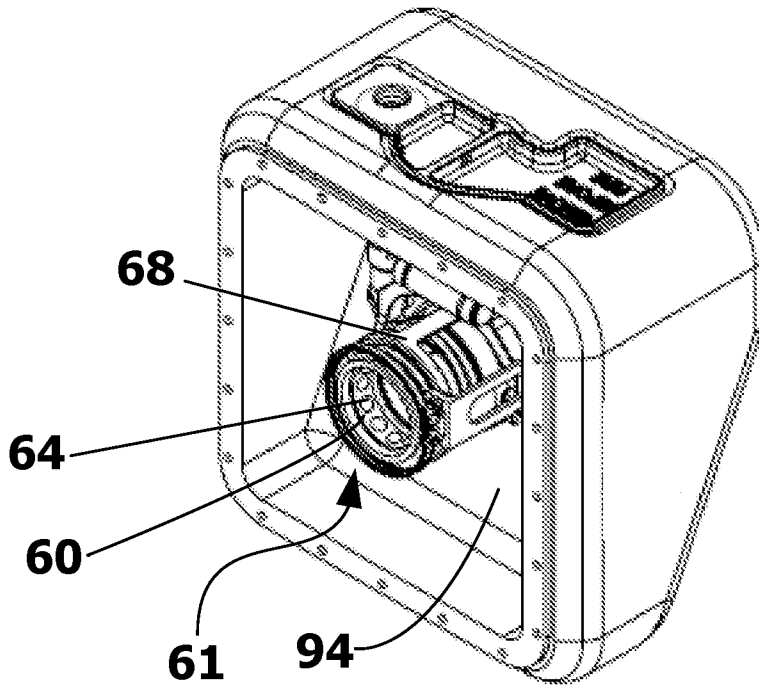


Fig. 8

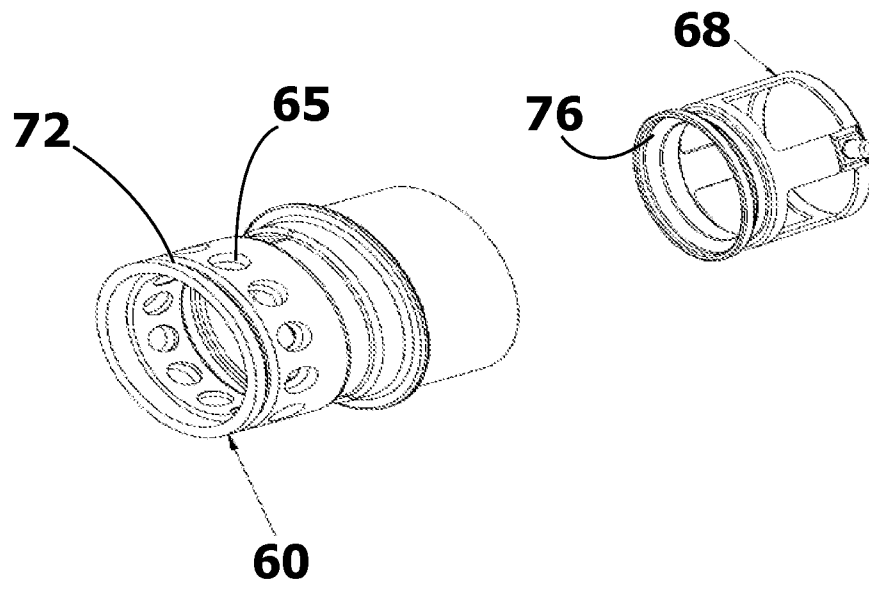


Fig. 9

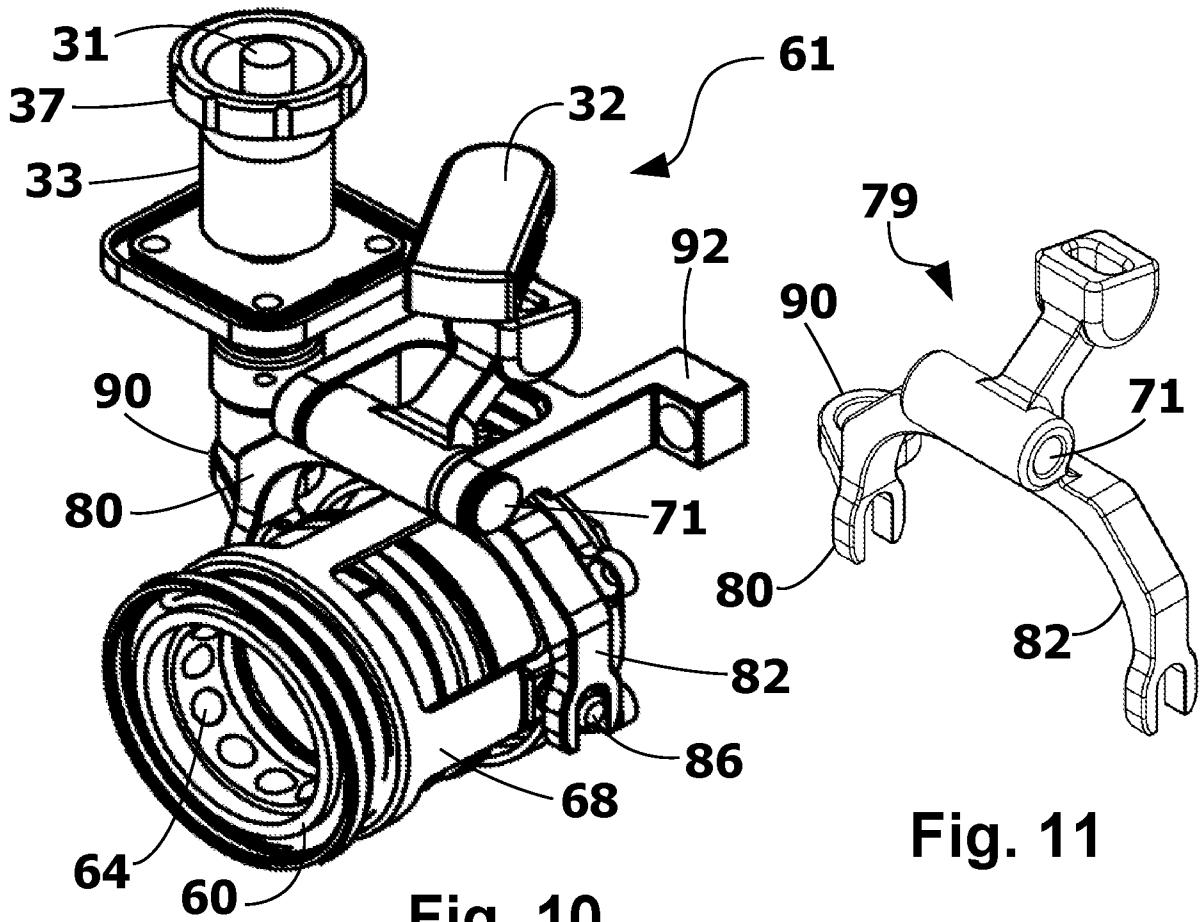


Fig. 10

Fig. 11

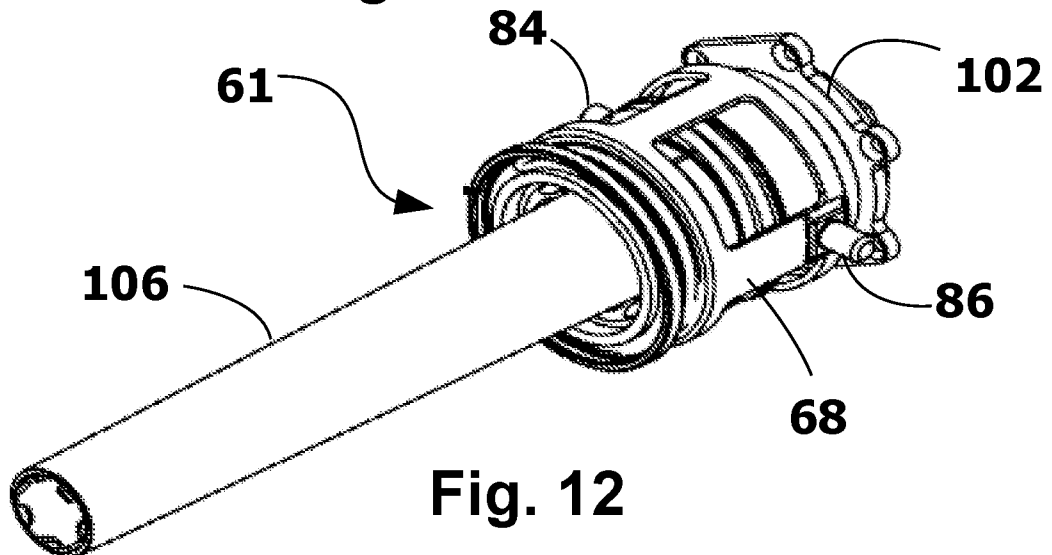


Fig. 12

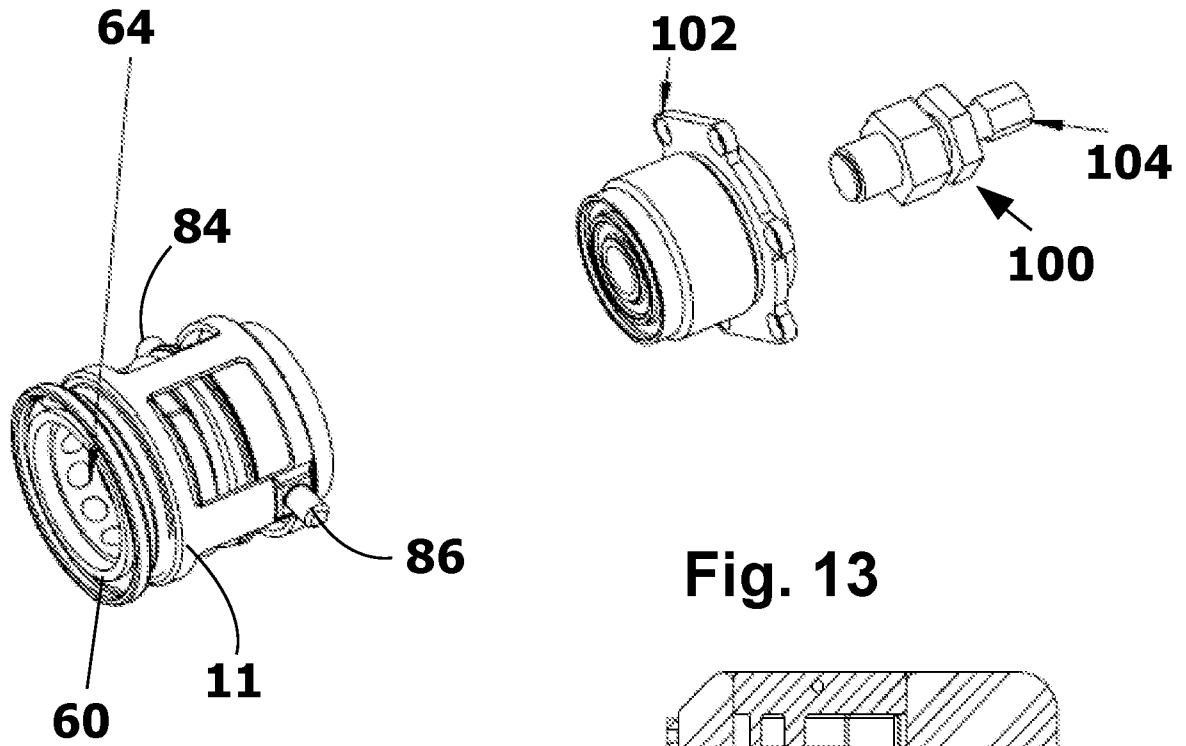


Fig. 13

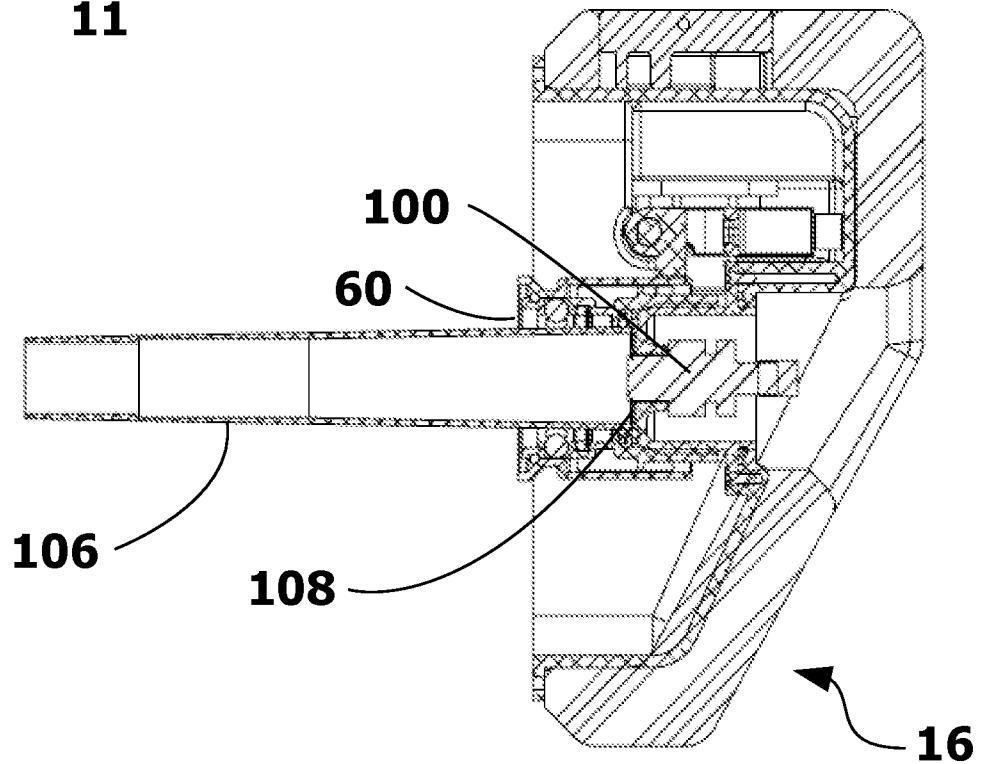


Fig. 14

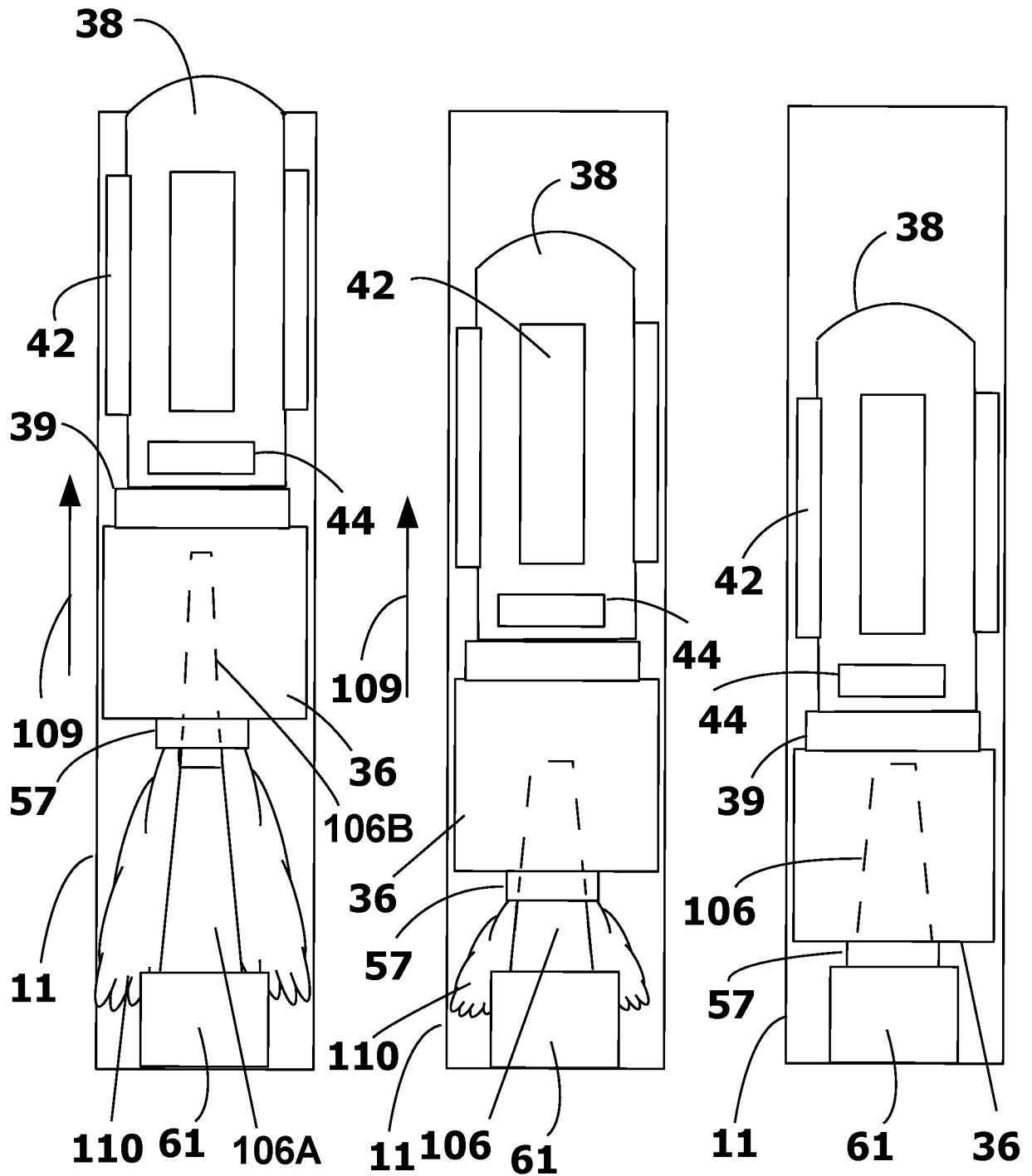
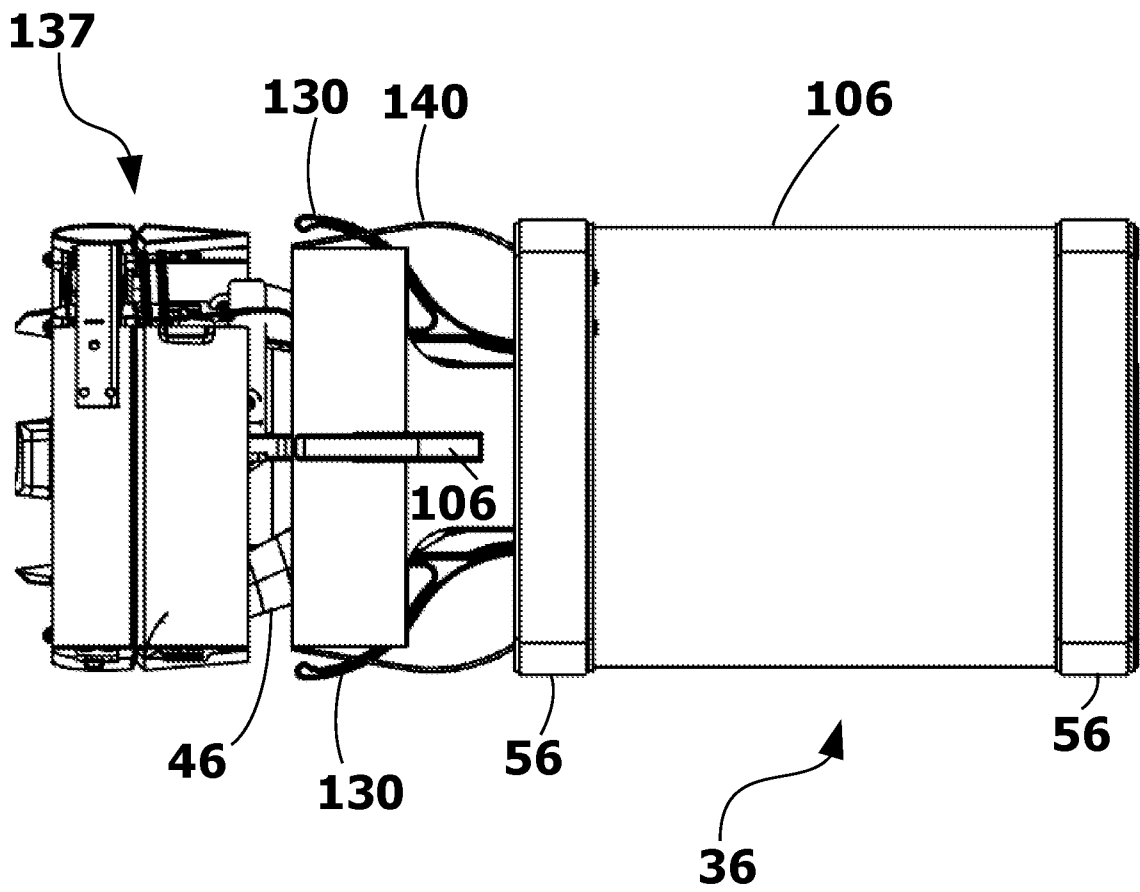
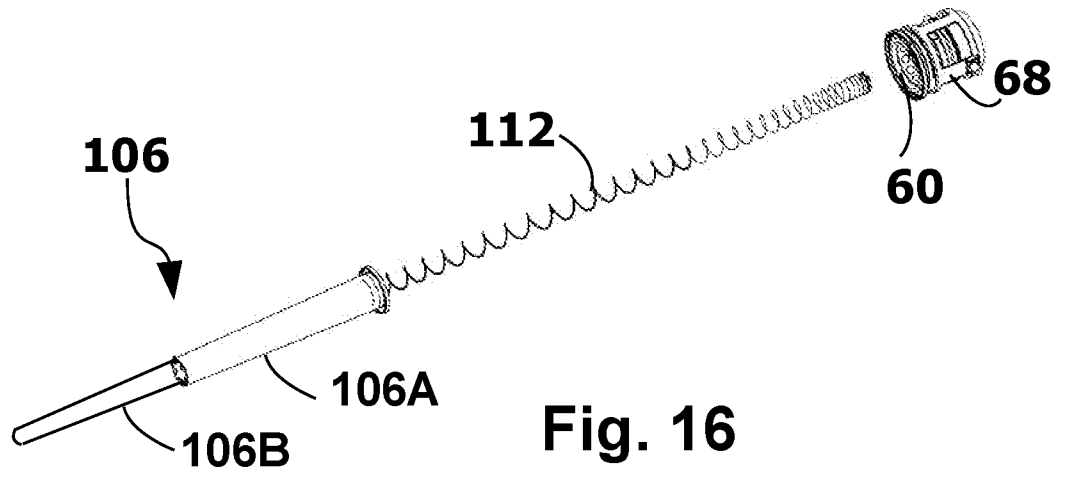


Fig. 15C

Fig. 15B

Fig. 15A





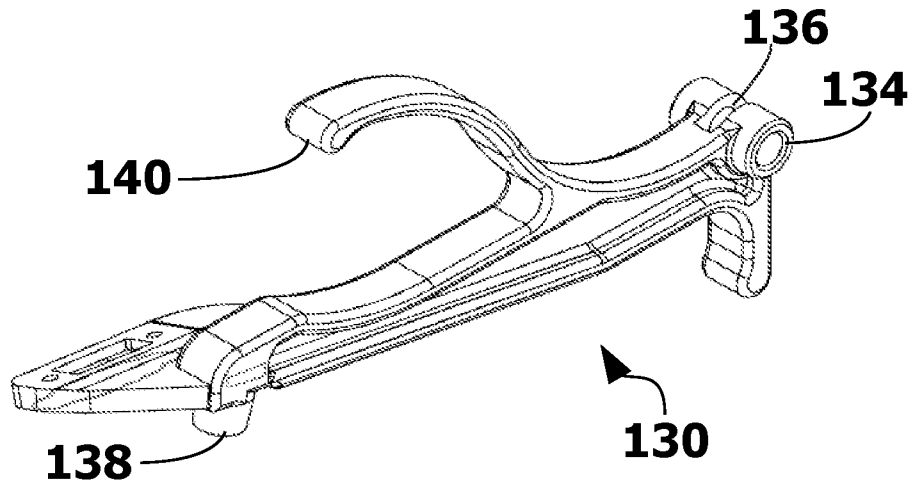


Fig. 18

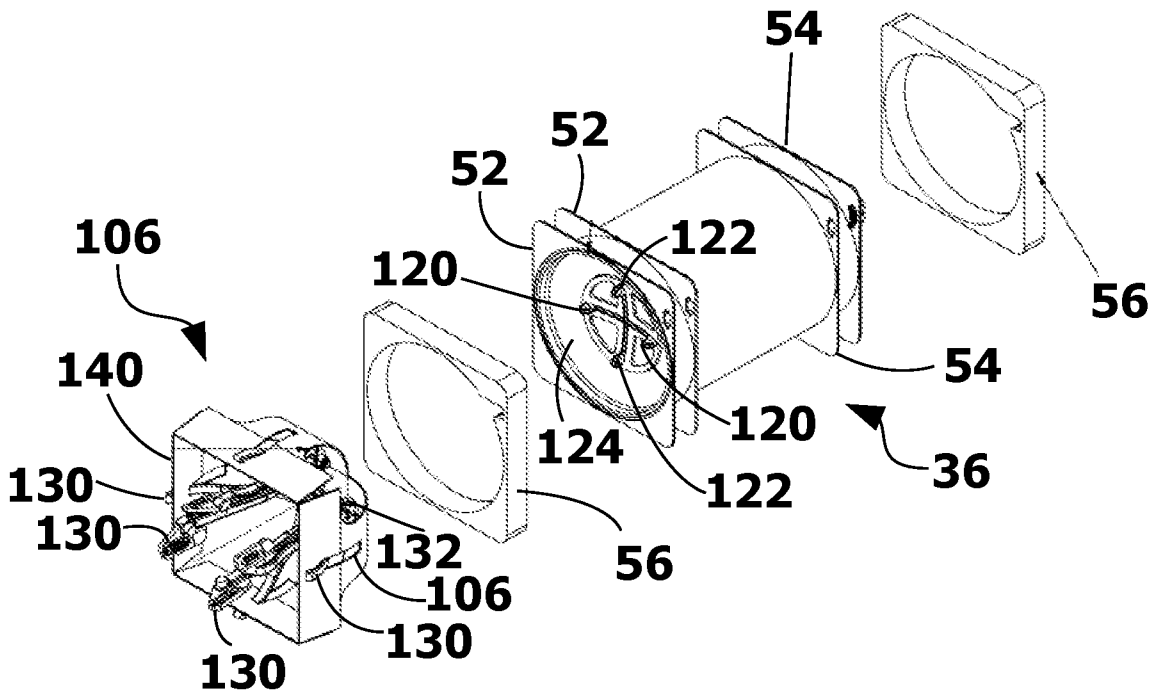


Fig. 19

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/IL2016/050936

A. CLASSIFICATION OF SUBJECT MATTER IPC (2016.01) B64F 1/04, B64C 39/00		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC (2016.01) B64F 1/04, B64C 39/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Databases consulted: THOMSON INNOVATION, Esp@cenet, Google Patents, FamPat database, PatBase		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2015127178 A1 Sylvia et al. 27 Aug 2015 (2015/08/27)	1-27
A	US 8662441 B2 Powell et al. 04 Mar 2014 (2014/03/04)	1-27
A	US 8505430 B2 Miralles et al. 13 Aug 2013 (2013/08/13)	1-27
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 22 Dec 2016		Date of mailing of the international search report 22 Dec 2016
Name and mailing address of the ISA: Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616		Authorized officer COHEN Galit  Telephone No. 972-2-5651806

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