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(54) **Title:** METHOD FOR ENCAPSULATION AND RELEASE OF FRAGILE INSECTS

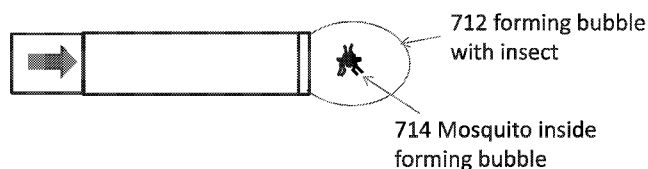


Fig. 7.3

(57) **Abstract:** A method of distributing fragile insects in a distribution involving a wind shear, comprises, encapsulating the insects into a bubble and then releasing the bubble into the wind shear so that the bubble protects the insect from the wind shear. The insect may be inserted before or after formation of the bubble at any stage of the insect life cycle and the bubble may be uniform or made of a slow dissolving and a quick dissolving part. The bubbles are useful for aerial distribution of sterile male mosquitoes.

METHOD FOR ENCAPSULATION AND RELEASE OF FRAGILE INSECTS

BACKGROUND

There are today large regions in the Americas, Africa and Asia that suffer from vector-born diseases transferred by insects, in particular, mosquitoes. The diseases include in particular Dengue fever, and Malaria, which are infectious disease carried and spread by bites from female mosquitoes.

There have been many attempts at a safe and effective means to control vector-born disease, specifically Dengue and Malaria, over sizeable regions, including urban areas by controlling the mosquito population. One method is to release sterile males. The sterile males mate with the females in place of fertile males and in this way prevent reproduction.

A problem with the attempts has been effective distribution of the sterile males. It is not possible to release the insects from aircraft as is done with chemicals and crop dusting, as the airspeeds and wind shear involved generally kill the insects. This is particularly true of mosquitoes which are relatively fragile. Land-based distribution on the other hand is very labour-intensive and it is very difficult and costly to get a reasonable distribution of males, into all of the kinds of places where the mosquitoes congregate. One method that is used involves slow release of sterile males from a cage on a slowly moving vehicle. However this limits the release to areas that have vehicle access, and mosquito distribution pays little regard to vehicle access.

The need for aerial release systems is described in the literature. The following are selected quotes:

The Sterile Insect Technique for Controlling Populations of *Aedes albopictus* (Diptera: Culicidae) on Reunion Island Mating Vigour of Sterilized Males states that provided suitable aerial release systems can be developed and the surface of the treated area is large enough, aerial releases would ensure a cost-effective area-wide coverage.

The Sterile Insect Technique: can established technology beat malaria? International Atomic Energy Agency, 2006, stated, "Aerial releases, although never tried with mosquitoes, have a number of potential benefits over ground releases. The release sites can be further away from the facilities, extending the geographical scope of the operation greatly. The need for good ground access to the field sites is no longer valid

for daily releases, although for monitoring purposes it would still be desired. In addition, the number of staff required for aerial releases is lower and aerial releases can benefit from existing on-board navigation equipment to accurately release the mosquitoes in the designated areas....However, unlike the robust medfly, mosquitoes are rather fragile creatures. Handling, packing and release methods for mosquitoes need to be developed and tested to assess the impact of aerial release on male behaviour and longevity...".

Historical applications of induced sterilisation in field populations of mosquitoes, David A Dame, Christopher F Curtis, Mark Q Benedict, Alan S Robinson and Bart GJ Knols, 2009 states "...Sterile mosquito releases conducted to date have relied on ground release. Relatively simple packaging, transport methodology, release containers and shelters have been devised for pupal and adult releases, but no work has been initiated on methods of aerial distribution. Certainly, in urban programmes ground release might suffice, but the availability of satisfactory aerial release methods could provide timelier and more effective distribution with reduced opportunity for pre-release damage to the sterile males. Production and release of millions per day will demand expedited delivery mechanisms to prevent losses in quality and competitiveness".

SUMMARY OF THE INVENTION

As mosquitoes are considered fragile, they may not survive the impact of the violent wind shear when being release out of an airplane.

The present embodiment provides a method and a device for the creation of a protection layer between harmful (for the insect) wind shear and the fragile insects, more specifically when being released out of a vehicle moving at a high speed, above 50 km / hr such as a car or above 100 km/hr such as agricultural airplane.

The present embodiment involves the creation of the protection layer during the release of the insects from a storage container and prior to being inserted into the outside air.

In some embodiments the protection provided is for insects being released out of a release device such as the release device presented in US Provisional patent application US 62/053,242 filed September 22, 2014, Method and Apparatus for Artificial Distribution of Insects, the contents of which are hereby incorporated by reference as if fully set out herein.

The protection layer involves the encapsulation of insects, or more particular fragile insects,

A method and device for encapsulating insects by usage of bubble like geometry elements is provided, so that insects are not exposed to violent wind shears the moment they exit the aircraft.

The bubble solution is insect friendly, meaning that it does not harm the insect, in particular maintains the insect's ability to fly and mate in the wild.

The protection layer may provide protection by absorbing the violent wind shear and in some cases may even burst due to their impact.

In another embodiment the bubble inner surface walls may be of such material as to enable the insect, for example a mosquito, to stand upon the bubble walls and rest without bursting the bubble.

The surface walls may contain elements such as sugar, so that upon bursting when touching the ground, the insect, or specifically the mosquito, may have food and water it can eat immediately after the release.

The encapsulation of the insect happens in real time during the release mission, and uses bubble solution to create the desired bubbles for the protection of the insects.

Encapsulation of the insects into bubbles in real time, saves a lot of space, since the required storage space for bubble solution liquid is considerably lower than the required storage space for paper bags for the same amount of insects. Also the bubble solution may be degradable, thus provide less left overs and dirt on the ground as opposed to paper bags.

In one embodiment the insect is blown by an air pulse into a bubble during its formation. A first bubble is started but is not yet completed. An insect is blown into the bubble making it bigger due to the increase in air volume and finally the bubble is completely formed and blown away.

In another embodiment first a strong bubble is fully created, and then an insect is inserted into the bubble using a pipette like device, without bursting the bubble due to its flexible surface.

In another embodiment first a strong bubble is fully created, and then insect pupa are inserted into the bubble using a pipette like device, without bursting the bubble due to its flexible surface. More specifically if the insect is a mosquito then the pupa is

inserted into the bubble together with a sufficient amount of liquid such as water. In the case of a pupa which requires water for life support, the strong bubble is made according to a formula which is designed to last from a few hours up to a few days, typically a day. By contrast, in the case of a bubble for an adult mosquito the bubble formula is typically designed to on a time scale of a few seconds to a few minutes.

Upon emergence of the mosquito from the pupa, the mosquito may rest inside the bubble and breathe the air within the bubble. Upon bursting of the bubble the mosquito may then emerge out of the bubble.

One structure for the bubble comprises a relatively quick degrading part and a relatively slow degrading part. The relatively quick degrading and relatively slow degrading parts may both comprise polyvinyl acetate. The relatively quick degrading part may comprise around 80% hydrolyzation of the acetate groups and the relatively slow degrading part may comprise over 90% hydrolyzation of the acetate groups.

In embodiments the bubble has a burst pressure of at least three atmospheres. The bubble may have a burst pressure not exceeding five atmospheres.

Bubbles may be released singly, in chains or in a sheet.

In one possible structure, the bubble is fully formed from the quick dissolving material and then partly coated with the slow dissolving material.

Different bubbles may have relatively quick dissolving parts having respectively different rates. That is to say the different bubbles release the insects at different rates, achieving a stagger effect.

One bubble structure involves inserting a mechanical stopper into the bubble for release by a pressure wave caused by landing. The pressure wave forces the stopper out, allowing the insects to be released.

Another structure involves inserting a tube into the bubble to keep an exit path open.

Another structure involves constructing the bubble with a cap of a third material. The third material is a relatively faster dissolving material than the quick dissolving material itself and as it evaporates, it leaves an opening for insect escape.

According to a first aspect of the present invention there is provided a method of distributing fragile insects in a distribution involving a wind shear, comprising:

delivering the fragile insects with a pulse of air through a delivery pipe;

inserting bubble-forming liquid into a bubble forming head to partly form a bubble;

controlling simultaneous arrival of the insect and the pulse of air at the bubble forming head with the partly formed bubble to complete formation of the bubble with the insect inside; and

releasing the bubble into the wind shear, the bubble protecting the insect from the wind shear.

According to a second aspect of the present invention there is provided a method of distributing fragile insects in a distribution involving a wind shear, comprising:

forming a bubble;

piercing the bubble;

inserting the insect via the piercing into the bubble; and

releasing the bubble into the wind shear, the bubble protecting the insect from the wind shear.

An embodiment may comprise inserting the insect into a pipette; and piercing the bubble with the pipette to insert the insect.

In an embodiment, the bubble is formed from a water-soluble solution.

In an embodiment, the water soluble solution gives a high viscosity at low concentrations.

An embodiment may comprise a polymer with molecular weights above 1 million.

In an embodiment, the polymer comprises 0.4% by weight of hydroxyethyl cellulose (MW 1.3 million) and poly ethylene oxide (MW 4 million).

In an embodiment, the solution comprises n-propanol.

In an embodiment, the solution comprises 80gr of Dibromostearic acid mixed with 10 gr glycerol and 10gr of washing up liquid.

In an embodiment, the bubble comprises a relatively quick degrading part and a relatively slow degrading part.

In an embodiment, the relatively quick degrading and relatively slow degrading parts both comprise polyvinyl acetate.

In an embodiment, the relatively quick degrading part comprises around 80% hydrolization of the acetate groups and the relatively slow degrading part comprises over 90% hydrolization of the acetate groups.

In an embodiment, the bubble has a burst pressure of at least three atmospheres.

5 In an embodiment, the bubble has a burst pressure not exceeding five atmospheres.

An embodiment may comprise assembling a plurality of bubbles into a chain or a sheet prior to release.

10 In an embodiment, the bubble is fully formed from the quick dissolving material and then partly coated with the slow dissolving material.

An embodiment may comprise forming a plurality of bubbles, each with relatively quick dissolving parts having respectively different dissolving rates.

According to a third aspect of the present invention there is provided a method of distributing fragile insects in a distribution involving a wind shear, comprising:

15 standing the fragile insects;
forming a froth around the fragile insects using a neutral froth-forming solution;
releasing the froth into the wind shear, the froth protecting the insect from the wind shear.

20 According to a fourth aspect of the present invention there is a method of distributing material in a distribution involving a wind shear, comprising:

delivering the material with a pulse of air through a delivery pipe;
inserting bubble-forming liquid into a bubble forming head to partly form a bubble;

25 controlling simultaneous arrival of the material and the pulse of air at the bubble forming head with the partly formed bubble to complete formation of the bubble with the material inside; and

releasing the bubble into the wind shear, the bubble protecting the material from the wind shear.

30 According to a fifth aspect of the present invention, there is provided a method of distributing material in a distribution involving a wind shear, comprising:

forming a bubble;
piercing the bubble;

inserting the material via the piercing into the bubble; and
releasing the bubble into the wind shear, the bubble protecting the material from the wind shear.

According to a sixth aspect of the present invention there is provided a method

- 5 for forming a capsule for transport and timed release of insects comprising:
- providing a first relatively slow dissolving material;
 - providing a second relatively fast dissolving material;
 - providing insect material to encapsulate in the capsule; and
 - forming the capsule from the relatively fast dissolving material and the
- 10 relatively slow dissolving material with the insect material inside, such that dissolving of the relatively fast dissolving material provides an exit from the capsule for the insects.

Unless otherwise defined, all technical and/or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which

15 the invention pertains. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of embodiments of the invention, exemplary methods and/or materials are described below. In case of conflict, the patent specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be necessarily limiting.

20 BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

Some embodiments of the invention are herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of embodiments of the invention. In this regard, the

25 description taken with the drawings makes apparent to those skilled in the art how embodiments of the invention may be practiced.

In the drawings:

Fig. 1 is a simplified diagram illustrating a mosquito life cycle. Eggs 10 are laid and can be stored on paper.

30 Fig. 2 is an illustration for mosquito and pupa within a bubble.

Fig. 3 illustrates a device for encapsulation of insects within bubbles.

Fig. 4 is a close up view of one of the elements of the encapsulation device from Fig. 3.

Fig. 5 illustrates another embodiment for encapsulation of insects within bubbles.

Fig. 6 illustrates another embodiment for encapsulation of insects within bubbles.

5 Figs. 7.1-7.4 illustrate the process and principles for encapsulation of insects in real time.

Figs. 8.1-8.5 illustrate another process and the principles for encapsulation of insects in real time.

Fig. 9 illustrates a step during the encapsulation process for the device from Fig.

10 3.

Fig. 10 illustrates a step during the encapsulation process for the device from Fig.

3.

Fig. 11 illustrates a step during the encapsulation process for the device from Fig.

3.

15 Fig. 12 illustrates a step during the encapsulation process for the device from Fig.

3.

Fig. 13 illustrates a step during the encapsulation process for the device from Fig.

3.

Fig. 14 illustrates a step during the encapsulation process for the device from Fig.

20 3.

Fig. 15 illustrates a step during the encapsulation process for the device from Fig.

3.

Fig. 16 illustrates an integrated system for delivering stored insects towards encapsulation device and then moving the bubbles through the distribution pipes towards
25 a release point.

Fig. 17 illustrates another embodiment and a step during the encapsulation process for the device from Fig. 3.

Fig. 18 illustrates a step during the encapsulation process for the device from Fig.

3.

30 Fig. 19 illustrates a step during the encapsulation process for the device from Fig.

3.

Fig. 20 illustrates a step during the encapsulation process for the device from Fig. 3.

Figs. 21.1-21.2 illustrate an integrated system for delivering stored insects towards encapsulation device located within an aerial release device.

Fig. 22 illustrates a step during the encapsulation process for the device from Fig. 5.

Fig. 23 illustrates a step during the encapsulation process for the device from Fig. 5.

Fig. 24 illustrates a step during the encapsulation process for the device from Fig. 5.

Fig. 25 illustrates a step during the encapsulation process for the device from Fig. 5.

Fig. 26 illustrates a step during the encapsulation process for the device from Fig. 6.

Fig. 27 illustrates a step during the encapsulation process for the device from Fig. 6.

Fig. 28 illustrates a step during the encapsulation process for the device from Fig. 6.

Figs. 29.1-29.7 illustrate a process for generating a bubble and using another device to puncture the bubble and insert insects without bursting the bubble.

Fig. 30 illustrates a bubble structure based on two materials according to an embodiment of the present invention.

Fig. 31 illustrates another bubble structure based on two materials according to an embodiment of the present invention.

Fig. 32 illustrates a bubble structure having a quick and a very quick dissolving part that forms a small hole in the ceiling of the bubble according to an embodiment of the present invention.

Fig. 33 illustrates a bubble structure for delayed release of material, according to an embodiment of the present invention.

Figs. 34A-34C illustrate embedding of material into a bubble during formation of the bubble at three different stages of the insect lifecycle according to embodiments of the present invention.

Figs. 35A – 35C likewise illustrate embedding of material into a bubble after bubble formation, at three different stages of the insect lifecycle according to embodiments of the present invention

Figs. 36A – 36C illustrate slow release of insects from a bubble crossing over
5 different stages of the insect lifecycle according to embodiments of the present invention

Fig. 37 illustrates a structure of the bubble in which the slow dissolving material is applied as a partial coating on a complete bubble of the quick dissolving material according to an embodiment of the present invention.

Figs. 38A -38C are a simplified diagram showing the bubbles prepared for
10 release singly, in chains or in sheets, according to embodiments of the present invention.

Fig. 39 illustrates a bubble with a stopper as a release mechanism according to embodiments of the present invention; and

Fig. 40 illustrates a bubble with a release pipe according to an embodiment of the present invention.

15 DESCRIPTION OF SPECIFIC EMBODIMENTS OF THE INVENTION

The present invention, in some embodiments thereof, relates to a method and apparatus for inserting insects into bubbles, and, more particularly, but not exclusively, to the distribution of insects within these bubbles as part of disease control programs, pollination programs and the like. The present invention also relates to formation of the
20 bubbles and suitable chemical formulations and processes therefor.

Before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not necessarily limited in its application to the details of construction and the arrangement of the components and/or methods set forth in the following description and/or illustrated in the drawings and/or the Examples. The
25 invention is capable of other embodiments or of being practiced or carried out in various ways.

Reference is now made to FIG. 1, which is a simplified diagram illustrating the mosquito life cycle. Eggs 10 are laid and can be stored on paper. Larvae 12 emerge and live underwater, float upside down to the surface of the water and breathe through
30 a breathing tube emerging from the water surface. A pupa is formed 14, also under

water, but needs to breathe so comes to the surface. The adult 16 emerges from the pupa and is terrestrial.

FIG. 2 is an illustration showing mosquito and pupa within a bubble.

FIG. 3 illustrates a device for encapsulation of insects within bubbles.

5 FIG. 4 is a close up view of one of the elements of the encapsulation device of Fig. 3.

FIG. 5 illustrates another embodiment of encapsulation of insects within bubbles.

10 FIG. 6 illustrates another embodiment of encapsulation of insects within bubbles.

An operational method for encapsulation of insects with reference to Figs. 7.1-7.4, and Figs. 8.1-8.5 is now described.

15 In Figs. 7.1-7.4 insects, together with the existing air in the tank, are pushed forward simultaneously towards a bubble ring 704. A solution chamber 720 is connected directly or via solution delivery tube and provides bubble solution to cover the ring continuously during the creation of the bubbles due to the flow of air coming from air flow source 700. As the bubbles are forming and insects move forward, they are encapsulated as can be seen in 712 and 716, within the bubble. The bubble is sufficiently strong as not to burst from the impact of the mosquito. The velocity of the
20 air flowing within the pipe is calibrated to ensure the energy of the insect is also low enough to prevent bursting of the bubble.

Referring now to Figs. 8.1-8.5, insects wait to be encapsulated inside an insect launching cell 802. First a bubble starts to generate due to flow of air coming from bubble air flow 810, and the bubble ring 804 is covered with bubble solution from
25 solution chamber 808.

The amount of time the bubble air flow 810 pushes air, and the associated air velocity can be calibrated in such a way that the process can be controlled to enable creation of a single bubble not yet fully completed, as seen in forming bubble 804.

30 Once the bubble has a bubble forming shape 816, the insect air flow source 800 may push air forwards together with insects, delivering the insects through port 812, which serves as a connector towards the bubble, and the bubble continues to grow due

to the flow of air approaching it. The bubble is then measured before disconnecting from the device.

Once the insect has entered into the bubble, or into the stream of air flow coming from bubble air flow 810, then insect air flow 800 may turn off until the next operation.

After the insect has entered into the bubble the bubble air flow 810 will generate a strong pulse of air to disconnect the bubble and complete its creation, resulting in the bubble seen as 820 insect inside bubble.

Returning now to a consideration of Figs 3 and 4, and mosquitoes arrive at the device through delivery pipe 300. The mosquitoes may arrive from an outlet of an insect storage device such as 306, being pushed forward in the pipe by blower 314. The storage device 306 may keep the temperature within it low in order to reduce mobility of the insects, using a cooling system 302 for example. When delivering the insects they may pass through a pipe which is heated by a 334 heating source, long enough to raise their temperature once again.

The mosquitoes arriving at block wheel 332 and may be stopped by a wheel net being aligned with the inner side of the pipe.

The block wheel 332 gradually rotates to a position in which it does not interfere with the passage of the mosquitoes through it. Fig. 10 illustrates such a wheel having different positions for allowing and blocking passage. Spinning wheel 402 inside bubble chamber 400 starts to rotate, moving ring position so that a ring covered with bubble solution faces the pipe. During the transition the block wheel 332 and the step wheel 1002 may be in sync being connected by the same motor as shown in Fig. 10. Thus, as the step wheel 1002 rotates to its next position, as shown in Fig. 11, fixing the next ring facing the pipe, at the same time the block wheel 332 blocks the delivery of additional insects using block wheel net 1100.

Moving now to Fig. 12, the shutter serving as port opens and enables transfer of insects to the launching cell 1300 as shown in Fig. 13.

Once inside the launching cell 1300, the shutter 1400 is closed, and then as seen in Fig. 15, a pulse of air coming from compressor 308, see Fig. 3, travels through secondary pipe 318, causing the bubble to disconnect, forming the final encapsulation stage, and producing disconnected bubble 1500 with encapsulated insects.

In yet another embodiment, described in Figs. 17-20, a process for encapsulation of mosquitoes without a shutter or a launching cell is described.

Referring now to Fig. 17, insects 1700 arrive and are stopped by wheel net 1702. As seen in Fig. 18, step wheel 1804 rotates spinning wheel 1806, placing the next
5 bubble ring covered with bubble solution in position. The step wheel and the blocking wheel are in sync. Mechanical synchronization may for example be achieved by connecting the motor which drives 1804 step wheel also to the blocking wheel, as seen in Fig. 18. During the transition the blocking wheel net 1802 opens, enabling passage of the insects towards the exit point, the insects being pushed by air inside the pipe coming
10 from blower 314.

Reference is now made to Fig. 19, which shows the blocking wheel in the next position. When the step wheel positions the next bubble ring 1906, then the blocking wheel has completed a rotary move and now the blocking wheel net 1902 blocks the way for further insects.

Referring to Fig. 20, the insects are now blown towards the exit using air flow coming from a secondary air pipe 2002. The air moving through the ring is covered with bubble solution and creates the bubble while the mosquitoes enter the bubble as it is being created. The bubble does not burst due to the bubble characteristics.

Figs. 21.1-21.2 illustrate an insect storage unit being connected to an aerial
20 release system as described in applicant's copending US Provisional patent application 62/053,242 filed September 22, 2014, Method and Apparatus for Artificial Distribution of Insects ("US 62/053,242"), and a device for encapsulation of insects in real time is mounted on and will now be described with reference to Figs. 22-25.

In Fig. 22, insects 2204 travel through insect delivery pipe 2202 and stop before
25 lower block net 2214 preventing them from exiting the exit point 2210.

In Fig. 23, the delivery pipe 2302 has been shifted sideways by the air piston 2310, and thus the insects can now enter the 2304 launching cell, as the 2306 lower block net does not block the insects for long.

The insects cannot at this point exit the pipe since the pipe exit is now blocked
30 by the upper block net 2300.

The insects are transferred into the launching cell 2304.

The launching cell now returns to its original position as the air piston 2410 also returns to its original position. During the transition between Fig. 23 and Fig. 24, the solution wiper 2308 wipes the launching cell surface edges with bubble solution.

5 The launching cell is in its original position in Fig. 24, in which the lower block net 2402 prevents additional insects entering the already full launching cell.

Once launching cell 2412 is in position, then air pulse 2408 shoots through the pipe, causing the formation of bubbles and pushing the insects through the exit point 2500 into the bubbles being formed, causing a real time encapsulation of insects in the bubble 2502.

10 Another embodiment for a device for encapsulation of insects is now described with reference to Figs. 26-28.

Reference is now made to Fig. 26 which shows insects travelling along a delivery pipe directly into launching cell 2604 and being blocked by upper block net 2602. Air piston 2600 then moves only the launching cell, to the other side, in contrast
15 with the previous embodiment, preventing the entrance of additional insects towards the launching cell due to the position of the cell in parallel with the lower block net 2700, as shown in Fig. 27. During the movement of the launching cell, the exit area gets covered with solution from the solution wiper 2702.

Referring to Fig. 28, now, ready for launch, air pulse 2806 is shot through the
20 pipe, causing air to exit through the exit point 2802 while carrying bubble solution, thus forming a bubble. While forming the bubble, insects from the launching cell are pushed out and enter the bubble during its formation, and hence being encapsulated as seen in bubble 2800.

The air piston 2808 then moves back the 2804 launching cell for the next release
25 of insects inside a bubble.

Returning now to Fig. 16, and a process is shown according to another embodiment, in which an insect encapsulation device receives mosquitoes from one end. The output bubbles may be sufficiently strong to be delivered into the distribution pipes, and they travel through the pipes using the encapsulation device outlet air flow,
30 until reaching the release exit point. The exit point may be that located at the tube cover seen on Fig. 16, or part of the aerial release device described in US Provisional patent

application US 62/053,242 filed September 22, 2014, Method and Apparatus for Artificial Distribution of Insects.

Another embodiment for encapsulation of insects is described in Figs. 29.1-29.7.

In the embodiment of Fig. 29, bubble 2900 is formed and then delivered to the encapsulation device. Subsequently, puncturing device 2902 punctures the bubble 2908 by moving to puncturing position 2904. A structure for the bubble may be that of the solid bubble described herein. The bubble is flexible such that upon puncturing and retrieving the puncturing device the bubble does not burst. Once inside, insects 2910 are pushed within the puncturing device 2906 and therethrough into already existing bubble 2912. Puncturing device 2914 is then moved out of the bubble without the bubble bursting. The bubble then travels towards the exit point of the device and is released as bubble 2916 with encapsulated insects.

Discussed now in greater detail are possible bubble solutions for the creation of the proposed protection layer as a life support system. Existing known bubble solutions from the literature are discussed as well as why these solutions may not be adequate for the present purposes. They are followed by bubble solutions which are adequate for a life support system and a protection layer for the release process.

Polymer Requirements to be used as part of bubble solution formula:

There are two main requirements for the polymers to be good bubble-formers. Firstly, they should be water-soluble and secondly they should give a water solution with a high viscosity at low concentrations. Polymers with molecular weights above 1 million are particularly advantageous in strengthening the bubbles. e.g. 0.4% by weight of hydroxyethyl cellulose (MW 1.3 million) and poly ethylene oxide (MW 4 million) gave strong bubbles when mixed with Fairy as surfactant.

1. Fairy/Dawn Formulations:

Fairy™ and Dawn™ are similar, widely-used dish-washing detergents sold in Europe and the USA respectively. Most bubble-making formulations that appear in popular internet web-sites contain at least 10% of one of these. One of their major components (15-30%) are anionic surfactants from the families of alkyl sulfates (ROSO_3^-) and alkyl sulfonates (RSO_3^-) such as sodium lauryl ethyl sulfate and lauryl sulfonate. Unfortunately these anionic surfactants are considered to be skin irritants and

ecologically damaging due to their slow biodegradation. Therefore they are not adequate for release over vast areas, specifically populated areas.

Much research is being carried out in the world to find alternatives to the alkyl sulfates and sulfonates. One of the ideas is to replace the polar head groups (sulfate and sulfonate) with polar groups from natural sources such as sugars and amino acids. In addition weak links such as ester and amide bonds are built into the surfactant to aid in biodegradation. e.g. alkyl polyglucosides, alkyl glucamides, and alkyl glucose esters, are characterized by high rates of biodegradation. For natural hydrophobic chains, fatty acids are the first choice for surfactants e.g. fatty acid ethoxylates and sorbitan esters of fatty acids.

Additional Bubble Strengtheners from the literature: According to “The chemistry and physics of Soap bubbles” by David Katz, Sodium 9,10-Dibromostearate Solution” can be used to strengthen soap bubbles in aqueous solutions. Oleic acid also proved useful in this respect.

2. Prior Art: US Patent 2008/0176977 A1:

This patent describes the production of strong, long-lasting bubbles (half-lives of hours and days) by mixing a solution of a water soluble polymer, preferably partially hydrolyzed polyvinyl alcohol (PVA), with one or two surfactants and one or more quick drying solvents. Unfortunately most of the solvents used, with the exception of water, are toxic or at least narcotic and are therefore not suitable for life support systems.

However, volatile alcohol n-propanol is at least twenty times less toxic to humans than others. Thus as long as there is air inside the formed bubble, n-propanol may not kill the mosquitoes.

4. Alternative to US Patent 2008/0176977 A1:

The bubble may be hardened by causing the PVA to cross-link due to a chemical reaction. Well-known cross-linking reagents are acid catalyzed glutaraldehyde and derivatives of triazine such as described in US Patent 5084541 (melamine triisocyanate, tricarbamoyl triazine and their oligomers) and in WO 1993010117 (tris pyrrolidonyl triazine). The reactions with the triazine derivatives are relatively faster than that of glutaraldehyde and progress rapidly at room temperature.

5. Solid Bubbles

This is a somewhat different concept in which, as the bubble loses water and dries, it may turn into a solid sphere. In order to achieve this, one can take advantage of the fact that polyvinyl alcohol (PVA) cross-links and strengthens in the presence of glutaraldehyde plus glycolic acid. The formula includes preparation of bubbles from a 10% solution of PVA in water to which may be added 8% glutaraldehyde and 10% glycolic acid relative to the PVA.

Additional surfactant such as the Nonidet P40 substitute may be added.

6. Frothing:

The following is an alternative approach – instead of blowing regular bubbles, the present embodiment makes use of the concept of frothing.

In the mining industry, water and surfactants are used to separate useful ores from rocks etc. Frothing and its building blocks are discussed in Hamid Khoshdast & Abbas Sam. The Open Mineral Processing Journal. 2011,4,25-44.

Froths are three phase systems of air, water and solid particles. The appearance of a froth is different from bubbles in that a froth somewhat resembles a foam i.e. has multiple rather than individual bubbles. However poor froths can consist of agglomerations of a few bubbles only and may therefore be relevant for housing the mosquitoes.

Frothers have been categorized by whether they are active in acidic, basic or neutral media. For contact with living mosquitoes, clearly the neutral frothers are to be preferred.

Neutral frothers include:

aliphatic alcohols such as methyl isobutyl carbinol;

cyclic alcohols and natural oils such as alpha terpineol with borneol (natural or synthetic);

alkoxy paraffins such as 1,1,3 triethoxy butane;

polypropylene glycol ethers;

polyglycol ethers;

polyglycol glycerol ethers.

7. Solid Islands and Food for the Mosquito:

Instead of particles of minerals, one can generate light froths using particles of clays and foods as the solid phase. The clays may provide a dry spot for the mosquito to stand on,

and the food could support the mosquito once the bubble has landed and burst. Such food particles could include sugars, starch, protein etc. Furthermore, the surfactants used for generating froths can be different from those used in detergents like Fairy. The most widely used neutral material is methyl-isobutyl carbinol (MIBC) but there are many others (see para 6 above). It should be noted that froths have a longer life-time than the typical single bubble since the froth bubbles are continually coalescing and reforming.

Discussed below are a number of specific bubble solution formulas:

Example 1: Bubble strengthening solutions may be prepared with Polyvinyl pyrrolidone in Deionized Water (DW), Poly(styrene sulfonic acid co-Maleic acid) Na salt in DW and 2-hydroxy ethyl cellulose in DW. After mixing with Fairy[®] dishwashing liquid (5-10%) bubbles may readily form but only those from 2-hydroxy ethyl cellulose solution survive. Maximum bubble lifetime may be expected to be about 30 sec.

Example 2: Glycerol may be added to the formulation with 2-hydroxy ethyl cellulose in example 1 thus prolonging bubble life to ~60 sec.

Example 3: In accordance with “The preparation of Sodium 9,10-Dibromostearate Solution” by A.L. Kuehrer (J. Chem. Edu., 35, 337, 1958) and “The chemistry and physics of Soap bubbles” by David Katz, a Sodium Oleate formulation may be prepared:

0.4 gr of NaOH may be dissolved in 96.8 gr of DW;
2.8 gr of Oleic Acid (Sigma) may be added and then stirred.

The resulting solution, ~100 gr of 3% Sodium Oleate may be mixed with 100 gr of Glycerol until a homogeneous solution is obtained.

No bubbles form as result, but after mixing with Fairy (10%) stronger bubbles are formed. While this solution produces less bubbles upon blowing, when mixed with 2-hydroxy ethyl cellulose formulation (from example 1), it, produced bubbles with lifetimes of ~70-80 sec.

Example 4: 9-10 Dibromostearic Acid synthesis

Bromine (~1mol = 163.5gr) may be gradually added through a dropping funnel onto 1mole of Oleic Acid (~283.2gr) with stirring. The end point is when the brown color just fails to disappear. Excess Bromine may be removed by drying overnight in a vacuum.

4% of Dibromostearic acid solution is prepared and adjusted to pH= 10 with 1N NaOH.

The resulting solution may be mixed with glycerol at 1:1 ratio and stirred until homogeneity is obtained.

The surfactant alone may not foam and no bubbles are produced. After mixing with Fairy (~10% w/w), bubbles are produced that are stronger than those produced with polymers and a lot less water was lost due to dripping in air. Life-times in excess of one minute are achieved.

Example 5: 2gr HEC (M.W. ~1,300,000) is mixed for 3 days with 500ml tap water. 80 gr of the resulting solution is mixed with 10gr glycerol and 10gr Fairy for ~30min.

Stable bubbles are obtained.

Example 6: 80gr of Dibromostearic acid is mixed with 10 gr glycerol and 10gr of Fairy. Elimination of Fairy from the Formulation.

2.5gr of Polyethylene Oxide, PEO (M.W.~4,000,000) is mixed for 3 days with 1L tap water.

$1 \times 10^{-5} \text{M}$ NaCl solution in 1L tap water was prepared. 10mls (1%) of Nonidet P40 substitute (Octylphenyl Polyethylene Glycol, Fluka) nonionic surfactant may gradually be added to the NaCl solution. Some foaming is observed even after 5ml (0.5%). Some weak bubbles are obtained from this solution upon blowing.

The surfactant solution is mixed at 1:1 ratio with the PEO solution. The resulting formulations may produce strong and stable bubbles.

Reference is now made to Figs 30 and 31, which show two different structures of a capsule made of at least two dissolvent materials with different dissolvent rates, so called for reference only – DM (dissolvent material), QDM, MDM and SDM corresponding to Quick, Medium and Slow DMs.

The easily soluble film - QDM - may dissolve if water vapor condenses on it in the night-time for example (vapors from the inside and perhaps dew from the outside). The QDM may be made from a water-soluble polymer such as polyvinyl alcohol (PVA), or hydroxyl methyl or hydroxyl propyl cellulose which will slowly dissolve in water and open a window through which the mosquito may emerge, while the bottom of the capsule remains. The PVA film may be 10-50 microns thick (PVA of the type 80% hydrolyzed and 20% vinyl acetate (PVA should be below ~90% in order to dissolve. The film may dissolve within hours whereas PVA 100% hydrolyzed is hardly soluble in

water. By mixing the two, the time to dissolution may be regulated from a few hours to several days, providing the option to encapsulate eggs which need to remain in water a few days until the mosquitoes emerge, through encapsulation of pupa, up to encapsulation of adult mosquitoes (or other insects such as flies).

5 In more detail, it is noted that the comonomer of vinyl alcohol is usually vinyl acetate since polyvinyl alcohol (PVA) is made from polyvinyl acetate (PVAc). The acetate groups are hydrolyzed by base to the alcohol. When about 80% of the acetate groups have been hydrolyzed to alcohol, the copolymer is at its most water-soluble composition. Further hydrolysis >90%, reduces the solubility due to crystallization of
10 the polymer but it can still be made into a film.

The slowly soluble film SDM may be a water-insoluble or relatively slowly dissolving polymer may be selected from polyolefins or polyvinyl acetate which may produce transparent films of 10-50 micron thickness.

If using for the water-soluble polymer the 80%PVA, then it is preferred to
15 choose for the water-insoluble polymer a 100% PVA, because this will ease the connecting process between the two polymers.

Thus a capsule made of the two kinds of PVA could be a useful combination to make the capsules of Figs 30 and 31. The two types of film may be joined together by thermal welding or glued with a viscous water solution of polyvinyl alcohol (10-20% by
20 weight).

In more detail, the slowly dissolving polymer film –SDM– is an optimization between conflicting requirements. On the one hand it has to be relatively inert to water but on the other hand, plastics that are inert to water do not biodegrade easily and will remain on the land until they degrade slowly by a combination of oxygen and/or
25 sunlight.

So the slowly soluble plastic has to be sufficiently polar to slowly absorb water so that bacteria and fungi may digest it. There are also grades of polyolefins known as OXO grade that contain metal salts that cause them to photodegrade relatively quickly, that is over weeks to months, despite the fact that they are hydrophobic.

30 The thickness of the films is also a compromise. Thicker films may better resist the impact on hitting the ground but on the other hand will dissolve more slowly. Plastic films are available in general from about 10-50 microns thickness.

In order to connect the two films, any suitable technique for gluing or adhering plastics may be used. A common solvent or mixture of solvents may be applied to the plastics which are then pressed together until the solvent evaporates. There are quick adhesives such as the cyanoacrylates. They tend to hydrolyze which is an advantage in the present embodiments. There is a wide range of epoxy adhesives which harden in 5-30 minutes. These are stronger and more stable than the cyanoacrylates but will stay as longer lasting residues on the ground. In addition, there are various processes that generate heat such as microwaves, infrared and arcs all of which can melt thermoplastics and cause them to adhere to each other. The bond between different plastic may not be long-lasting which may be an advantage in this application.

A further option is to make the different walls with different thicknesses of the same material. In such a case, no bonding is required.

Within the capsules of Figs 30 and 31, a mosquito at any stage of the life cycle can be injected, either during or after the creation of the capsule as will be discussed below. In the case of eggs, pupae or larvae, after a few days on the ground mature mosquitoes will emerge from the water and will then be enabled to escape from the container.

An advantage of using capsules is reducing the drift – given that the capsule weight (together with water) is higher than the single mosquito, the release is expected to fall closer to the release point with less scatter.

The packaging may be sufficiently strong and flexible to absorb the impact of falling from a typical height of 100-350m.

In an embodiment, capsule geometric structure may be such that when thrown, that is when for example released from an aircraft, an orientation is preserved such that the SDM remains below and QDM remains above.

Construction of the capsules of Figs. 30 and 31, can be based upon well-known packaging solutions. Just to name two examples:

1. Blister Package – is a thermoplastic cavity typically with an aluminum or paper backing. In the present embodiments the transparent blister may be water-insoluble polylactic acid while the backing material may be a water-soluble polymer such as polyvinyl alcohol and the other materials mentioned above.

2. Bubble Packaging- these are air-filled thermoplastic bubbles. They are available as sheets or rolls of all sizes.

For the purpose of the present embodiments, thermoplastic bubbles may be made of biodegradable polylactic acid.

5 Referring now to Fig. 32, there is shown formation of and embedding insects within a capsule with different DMs and different dissolvent rates. In bubble 3200, the QDM comprises a standard QDM 3201-medium, and a faster QDM 3202. As the faster QDM 3202 evaporates, an opening on the ceiling may be created, enabling the mosquitoes to emerge through the hole, while preventing the water on the bottom from
10 evaporating too quickly.

Referring now to Fig. 33, another embodiment describes the option to encapsulate material that is released more slowly, and the encapsulation provides it some protection. The material may be insect, fragile insect, gas etc. In this embodiment, the material does not need water.

15 Reference is now made to Figs. 34A - C, which illustrate possible injection scenarios before a capsule is closed. Fig. 34A shows larvae 3401 with water 3402 in the rearing unit 3403, where injection may be by means of a pipette or a needle 3. Fig. 34B shows a rearing unit with water, and eggs 3404. Fig. 34C shows the rearing unit without water and with adult mosquitoes 3405. Knocked down mosquitoes are obtained
20 by cooling - typically to around 4 degree Celsius, or by using chloroform, and remain in the knocked out state until the chloroform evaporates or the temperature rises -typically to above 8 degree Celsius. The material is inserted into the half capsule 3406 formed by the SDM and then the capsule is capped with the QDM 3407.

Reference is now made to Figs. 35A, 35B and 35C, which show possible
25 injection scenarios, after the capsule is already formed. Injection may be by means of a pipette or a needle into one of the package cells. When picking the material from the left hand side storage compartments, the pipette may also suck a certain volume of water together with the material. In Fig. 35A, larva 3501 are sucked from storage unit 3502 and injected together with water 3503 into a closed capsule 3504. In Fig. 35B, eggs
30 3505 are sucked from the storage unit, and in Fig. 35C eggs 3505 are injected with water into the capsule.

Reference is now made to Figs 36A, 36B and 36C, which show three different release scenarios for mosquitoes from the capsule of Fig. 30. As explained above, the QDM may be adjusted to dissolve at different timings for different capsules, increasing the likelihood for the success of the release – for some, the cover may dissolve before
5 all mosquitoes emerge and the water may evaporate quicker, for others, the cover may dissolve more slowly and may retain the mosquitoes that emerge, for a certain amount of time.

Another benefit is that the mosquitoes that are retained remain until later, producing a staggered release, increasing the likelihood that a wild female will meet and
10 mate with one of the sterile males.

Fig. 36A shows a capsule 3600, in which mosquito 3601 has hatched before the QDM dissolves. The mosquito clings to the SDM wall. That is to say, Fig 36A represents a situation in which the mosquito emerges before the ceiling has been dissolved and can cling in the meantime to either wall of material type slow or to wall
15 of material type quick.

Fig. 36B shows the QDM having dissolved before all pupa 3602 have hatched. Mosquitoes that have already hatched 3601 can fly away directly and the water is left to evaporate. That is to say, Fig 36B shows a situation in which the ceiling dissolves first and only then some of the mosquitoes start to emerge, while others remain in the pupa
20 stage.

Fig. 36C shows a mosquito 3601 that has hatched before the QDM has dissolved. The mosquito clings to the QDM wall. In the latter case the wall is tougher and takes longer to dissolve, and there is more water. That is to say, Fig 36C represents a situation in which the mosquitoes have already emerged but the ceiling has not
25 dissolved yet, and mosquitoes can cling to the material of the slow type.

Reference is now made to Fig. 37, which is a simplified diagram showing another option for staggered release functionality. The entire capsule 3700 is first created using a QDM. Then the part that is required to dissolve slower is coated with an SDM 3701. The injected material to be released may be injected after the capsule is
30 created. The structure may thus be flexible so as not to collapse in on itself during the injection process.

In the embodiment of Fig. 37, the slow-dissolving material 3701 may be a different polymer film or even a layer of epoxy adhesive painted on the initial polymer film 3700. For example 80% hydrolyzed PVA may be used for the QDM and >90% hydrolyzed PVA may be used for the SDM on the outside.

5 Reference is now made to Figs. 38A, 38B and 38C, which illustrate three structures for releasing the capsules. Fig. 38A illustrates release of single capsules, Fig. 38B illustrates a way of packaging the capsules as chains. Chains of capsules may be created and released at once. Capsules may be loosely connected to each other in the chains so that upon release in mid air, they may separate to cover a larger area.

10 Fig. 38C illustrates packaging the capsules as sheets. Capsules may be loosely connected to each other such that upon release in mid air, they may separate to cover a larger area, or being stored in sheets, and disconnected before loading capsules into release device inside air vehicle, vehicle etc.

 Reference is now made to Fig. 39, which illustrates a capsule 3900 which may
15 be closed by a loose-fitting stopper 3901. A shock wave developed inside the container as it hits the ground may cause the stopper 3901 to pop out. The capsule 3900 may be closed by the stopper 3901 after the capsule contents, water 3903 and insect material 3902, have been added. The stopper may be made of cork or wood so as to be biodegradable.

20 Reference is now made to Fig. 40, which illustrates an additional way of allowing the mosquito to escape. Bubble 4003 containing water 4002 and insect material 4001 has a narrow tube 4000 fixed in which keeps a hole open in the bubble wall. Insect 4004 simply escapes through the opening. Construction of the embodiment of Fig. 40 is simplified if both the bubble and the tube are made from the same polymer.
25 For example, the container and the tube could be biodegradable poly lactic acid or water-soluble PVA.

 It is noted that having at least a small vent, irrespective of whether it is intended for the insect to escape thereby, may be useful for managing impact pressure waves and the like.

30 It is further noted that the closed capsules or bubbles may have a burst pressure of 3 – 5 atmospheres to ensure that they remain intact between release and landing.

It is expected that during the life of a patent maturing from this application many relevant chemical formulae for bubbles and bubble solutions will be developed and the scope of the corresponding terms are intended to include all such new technologies *a priori*.

5 As used herein the term “about” refers to $\pm 10\%$.

The terms "comprises", "comprising", "includes", "including", “having” and their conjugates mean "including but not limited to".

The term “consisting of” means “including and limited to”.

10 As used herein, the singular form "a", "an" and "the" include plural references unless the context clearly dictates otherwise.

Throughout this application, various embodiments of this invention may be presented in a range format. It should be understood that the description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the invention. Accordingly, the description of a range should
15 be considered to have specifically disclosed all the possible subranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed subranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies
20 regardless of the breadth of the range.

Whenever a numerical range is indicated herein, it is meant to include any cited numeral (fractional or integral) within the indicated range. The phrases “ranging/ranges between” a first indicate number and a second indicate number and “ranging/ranges from” a first indicate number “to” a second indicate number are used herein
25 interchangeably and are meant to include the first and second indicated numbers and all the fractional and integral numerals therebetween.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment, and the above description is to be construed as if this
30 combination were explicitly written. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable subcombination or as suitable in any other

described embodiment of the invention, and the above description is to be construed as if these separate embodiments were explicitly written. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

5 Although the invention has been described in conjunction with specific embodiments thereof, it is evident that many alternatives, modifications and variations will be apparent to those skilled in the art. Accordingly, it is intended to embrace all such alternatives, modifications and variations that fall within the spirit and broad scope of the appended claims.

10 All publications, patents and patent applications mentioned in this specification are herein incorporated in their entirety by reference into the specification, to the same extent as if each individual publication, patent or patent application was specifically and individually indicated to be incorporated herein by reference. In addition, citation or identification of any reference in this application shall not be construed as an admission
15 that such reference is available as prior art to the present invention. To the extent that section headings are used, they should not be construed as necessarily limiting.

WHAT IS CLAIMED IS:

1. A method of distributing fragile insects in a distribution involving a wind shear, comprising:
 - delivering said fragile insects with a pulse of air through a delivery pipe;
 - inserting bubble-forming liquid into a bubble forming head to partly form a bubble;
 - controlling simultaneous arrival of said insect and said pulse of air at said bubble forming head with said partly formed bubble to complete formation of said bubble with said insect inside; and
 - releasing said bubble into said wind shear, said bubble protecting said insect from said wind shear.
2. A method of distributing fragile insects in a distribution involving a wind shear, comprising:
 - forming a bubble;
 - piercing said bubble;
 - inserting said insect via said piercing into said bubble; and
 - releasing said bubble into said wind shear, said bubble protecting said insect from said wind shear.
3. The method of claim 2, comprising inserting said insect into a pipette; and piercing said bubble with said pipette to insert said insect.
4. The method of any one of the preceding claims wherein the bubble is formed from a water-soluble solution.
5. The method of claim 4, wherein said water soluble solution gives a high viscosity at low concentrations.
6. The method of claim 4 or claim 5 comprising a polymer with molecular weights above 1 million.

7. The method of claim 6, wherein said polymer comprises 0.4% by weight of hydroxyethyl cellulose (MW 1.3 million) and poly ethylene oxide (MW 4 million).
8. The method of claim 4, wherein said solution comprises n-propanol.
9. The method of claim 4, wherein said solution comprises 80gr of Dibromostearic acid mixed with 10 gr glycerol and 10gr of washing up liquid.
10. The method of claim 1, wherein said bubble comprises a relatively quick degrading part and a relatively slow degrading part.
11. The method of claim 10, wherein the relatively quick degrading and relatively slow degrading parts both comprise polyvinyl acetate.
12. The method of claim 11, wherein the relatively quick degrading part comprises around 80% hydrolization of the acetate groups and the relatively slow degrading part comprises over 90% hydrolization of the acetate groups.
13. The method of any one of the preceding claims, wherein the bubble has a burst pressure of at least three atmospheres.
14. The method of any one of the preceding claims, wherein the bubble has a burst pressure not exceeding five atmospheres.
15. The method of any one of the preceding claims comprising assembling a plurality of bubbles into a chain prior to release.
16. The method of any one of the preceding claims comprising assembling a plurality of bubbles into a sheet prior to release.

17. The method of any one of claims 10 to 16, wherein said bubble is fully formed from said quick dissolving material and then partly coated with said slow dissolving material.

18. The method of any one of claims 10 to 17, comprising forming a plurality of bubbles, each with relatively quick dissolving parts having respectively different dissolving rates.

19. A method of distributing fragile insects in a distribution involving a wind shear, comprising:

standing said fragile insects;

forming a froth around said fragile insects using a neutral froth-forming solution;

releasing said froth into said wind shear, said froth protecting said insect from said wind shear.

20. A method of distributing material in a distribution involving a wind shear, comprising:

delivering said material with a pulse of air through a delivery pipe;

inserting bubble-forming liquid into a bubble forming head to partly form a bubble;

controlling simultaneous arrival of said material and said pulse of air at said bubble forming head with said partly formed bubble to complete formation of said bubble with said material inside; and

releasing said bubble into said wind shear, said bubble protecting said material from said wind shear.

21. The method of claim 20, wherein said bubble comprises a relatively quick degrading part and a relatively slow degrading part.

22. The method of claim 21, wherein the relatively quick degrading and relatively slow degrading parts both comprise polyvinyl acetate.

23. The method of claim 22, wherein the relatively quick degrading part comprises around 80% hydrolization of the acetate groups and the relatively slow degrading part comprises over 90% hydrolization of the acetate groups.
24. The method of any one of claims 20 - 23, wherein the bubble has a burst pressure of at least three atmospheres.
25. The method of any one of claims 20 - 24, wherein the bubble has a burst pressure not exceeding five atmospheres.
26. The method of any one of claims 20 - 25 comprising assembling a plurality of bubbles into a chain prior to release.
27. The method of any one of claims 20 - 26 comprising assembling a plurality of bubbles into a sheet prior to release.
28. The method of any one of claims 20 - 27, wherein said bubble is fully formed from said quick dissolving material and then partly coated with said slow dissolving material.
29. The method of any one of claims 20 - 28, comprising forming a plurality of bubbles, each with relatively quick dissolving parts having respectively different dissolving rates.
30. A method of distributing material in a distribution involving a wind shear, comprising:
forming a bubble;
piercing said bubble;
inserting said material via said piercing into said bubble; and
releasing said bubble into said wind shear, said bubble protecting said material from said wind shear.

31. The method of claim 30, wherein said bubble comprises a relatively quick degrading part and a relatively slow degrading part.
32. The method of claim 31, wherein the relatively quick degrading and relatively slow degrading parts both comprise polyvinyl acetate.
33. The method of claim 31, wherein the relatively quick degrading part comprises around 80% hydrolization of the acetate groups and the relatively slow degrading part comprises over 90% hydrolization of the acetate groups.
34. The method of any one of claims 30 - 33, wherein the bubble has a burst pressure of at least three atmospheres.
35. The method of any one of claims 30 - 34, wherein the bubble has a burst pressure not exceeding five atmospheres.
36. The method of any one of claims 30-35, comprising assembling a plurality of bubbles into a chain prior to release.
37. The method of any one of claims 30-36, comprising assembling a plurality of bubbles into a sheet prior to release.
38. The method of any one of claims 30 - 37, wherein said bubble is fully formed from said quick dissolving material and then partly coated with said slow dissolving material.
39. The method of any one of claims 30 - 38, comprising forming a plurality of bubbles, each with relatively quick dissolving parts having respectively different dissolving rates.
40. The method of any one of the preceding claims, comprising inserting a mechanical stopper into said bubble for release by a pressure wave caused by landing.

41. The method of any one of the preceding claims, comprising inserting a tube into said bubble to leave an exit path.
42. The method of claim 31, comprising constructing said bubble with a cap of relatively faster dissolving material, thereby to leave an opening for insect escape.
43. A method for forming a capsule for transport and timed release of material comprising:
providing a first relatively slow dissolving material;
providing a second relatively fast dissolving material;
providing insect material to encapsulate in said capsule; and
forming said capsule from said relatively fast dissolving material and said relatively slow dissolving material with said insect material inside, such that dissolving of said relatively fast dissolving material provides an exit from said capsule for said insects.
44. The method of claim 43, wherein the material comprises insect material.

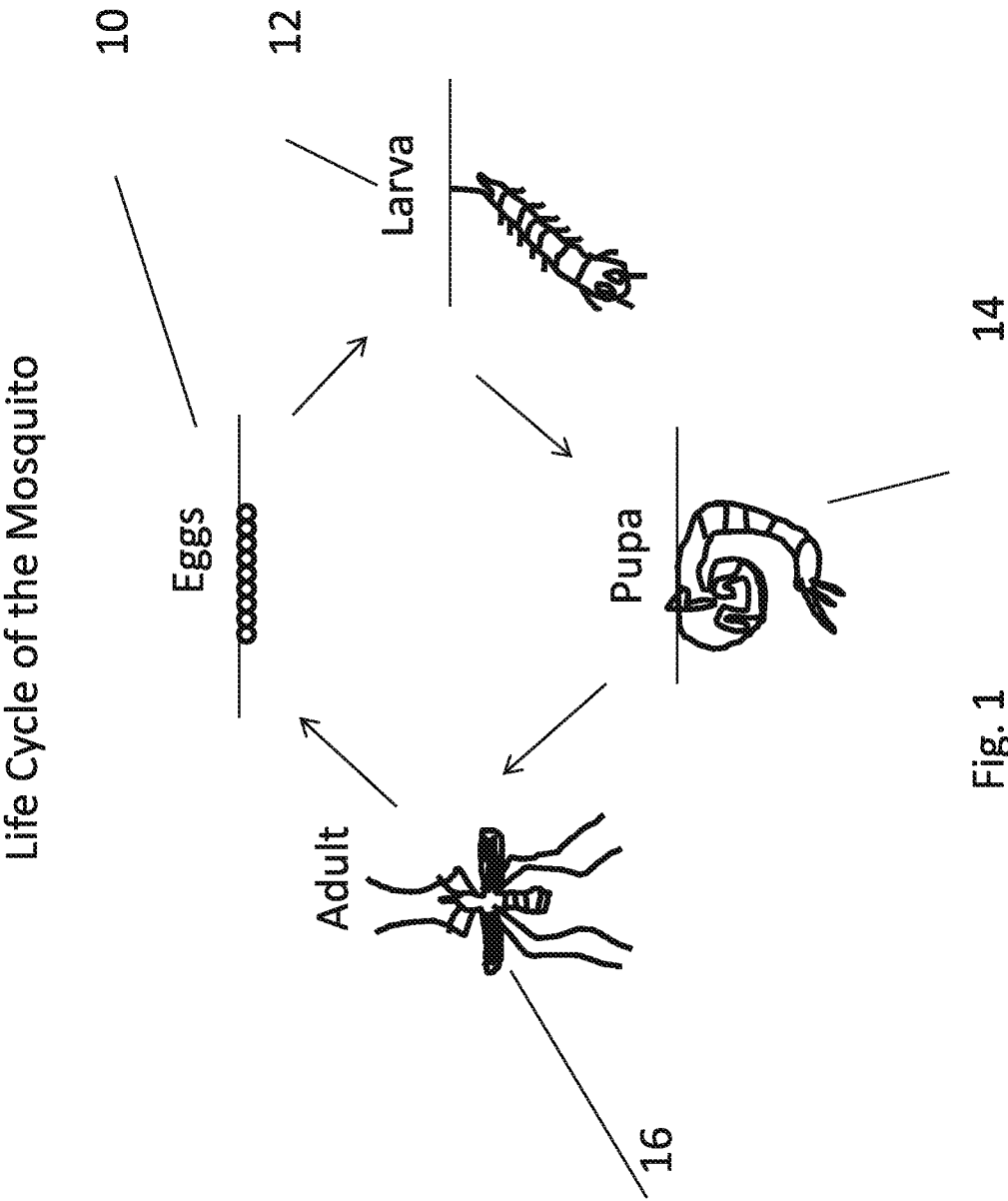


Fig. 1

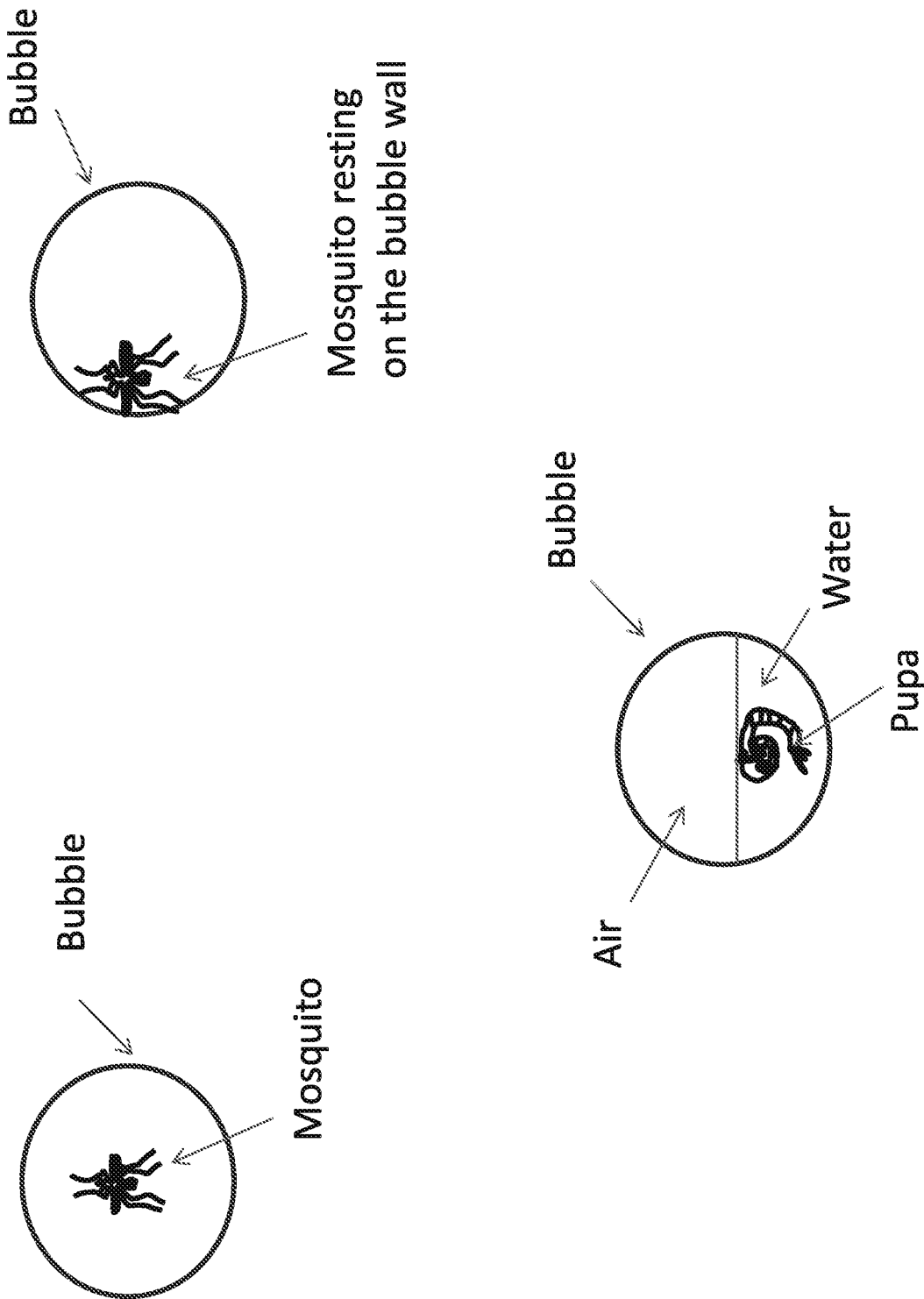
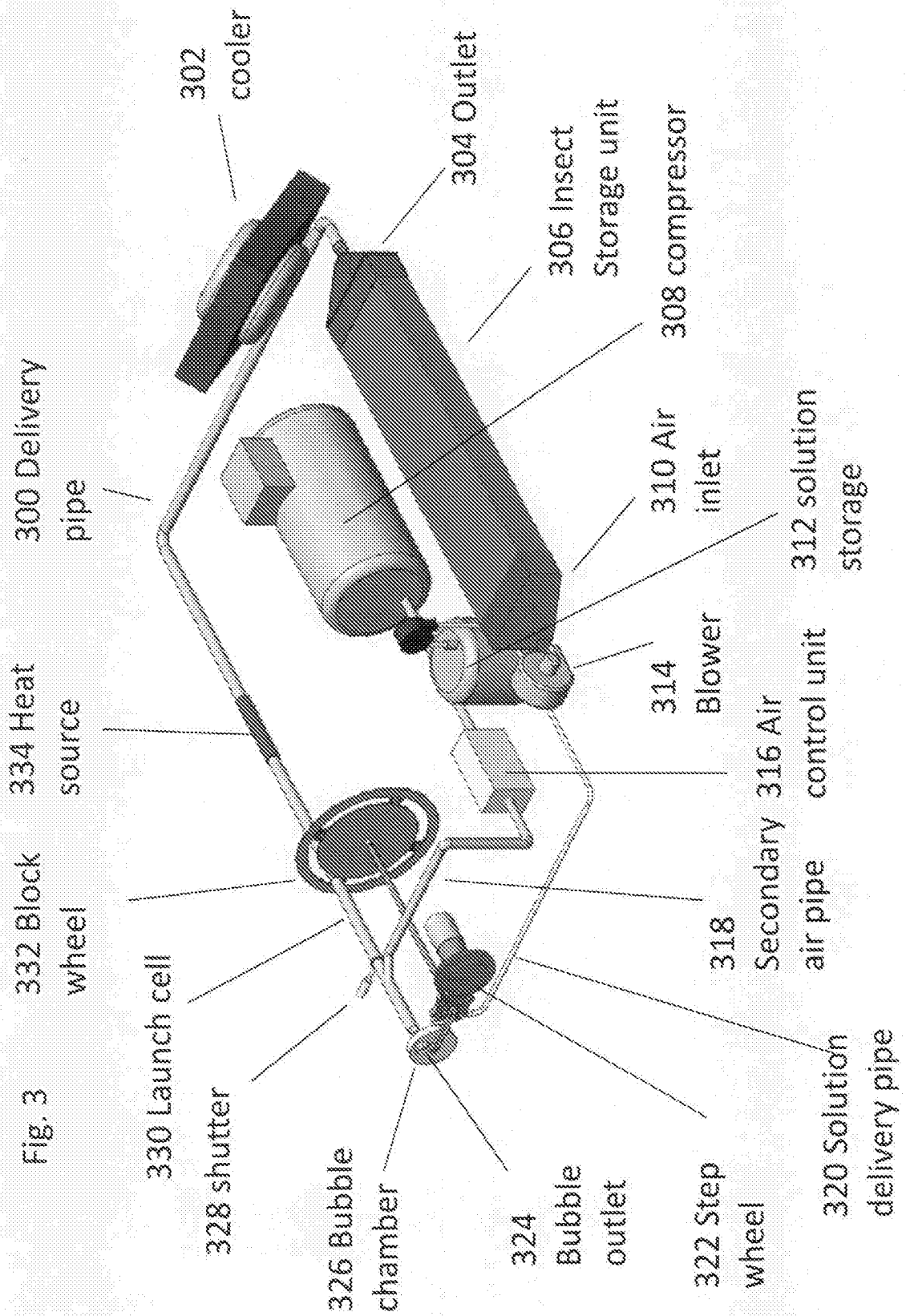
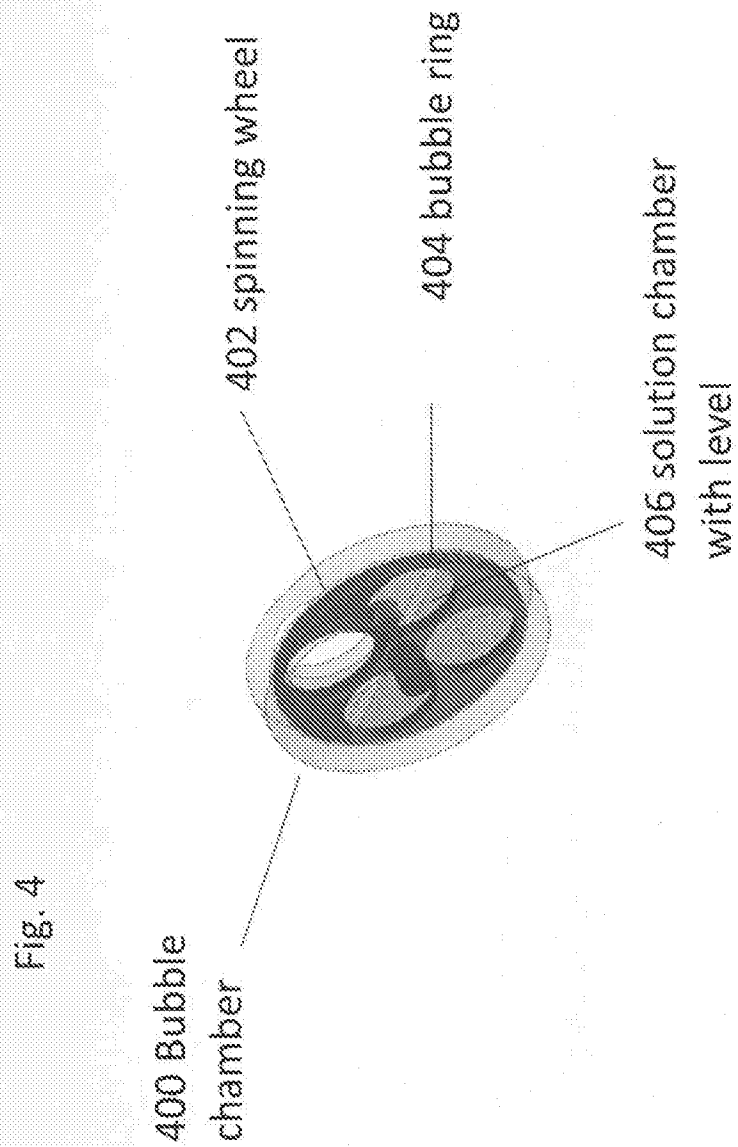
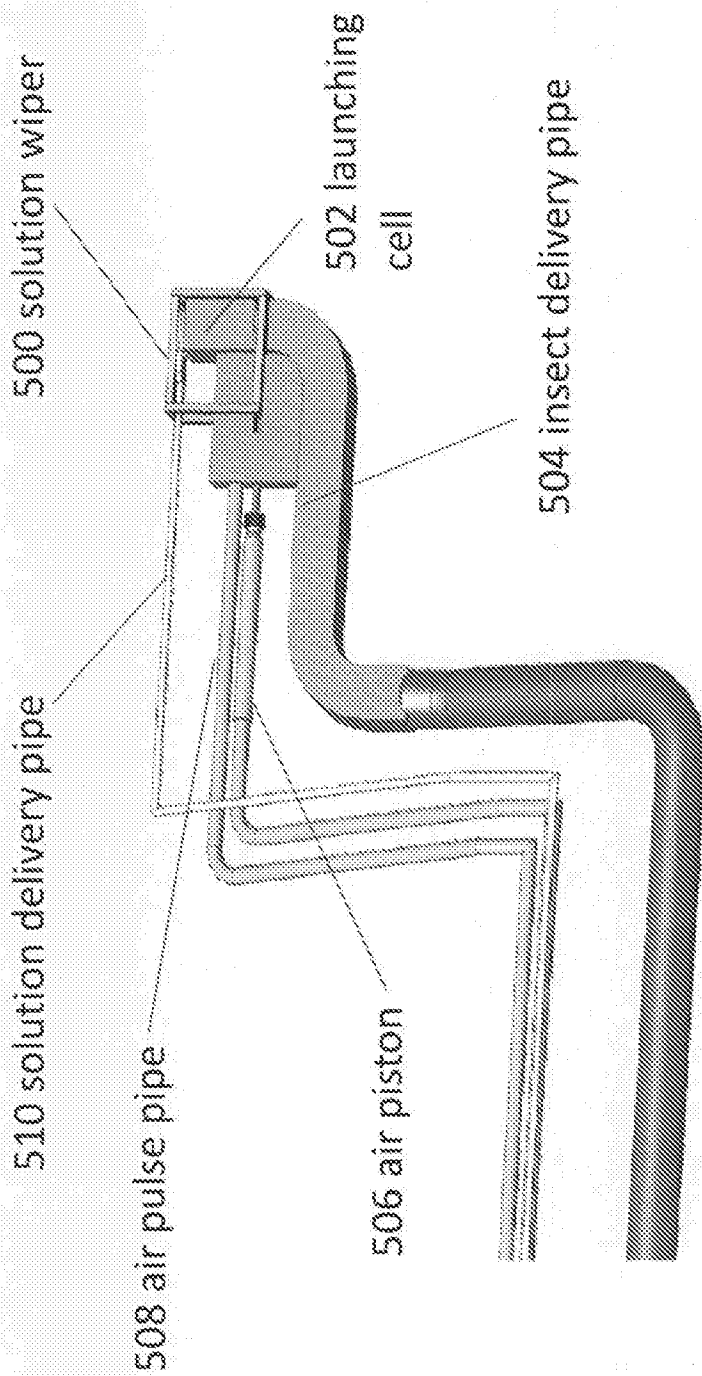


Fig. 2







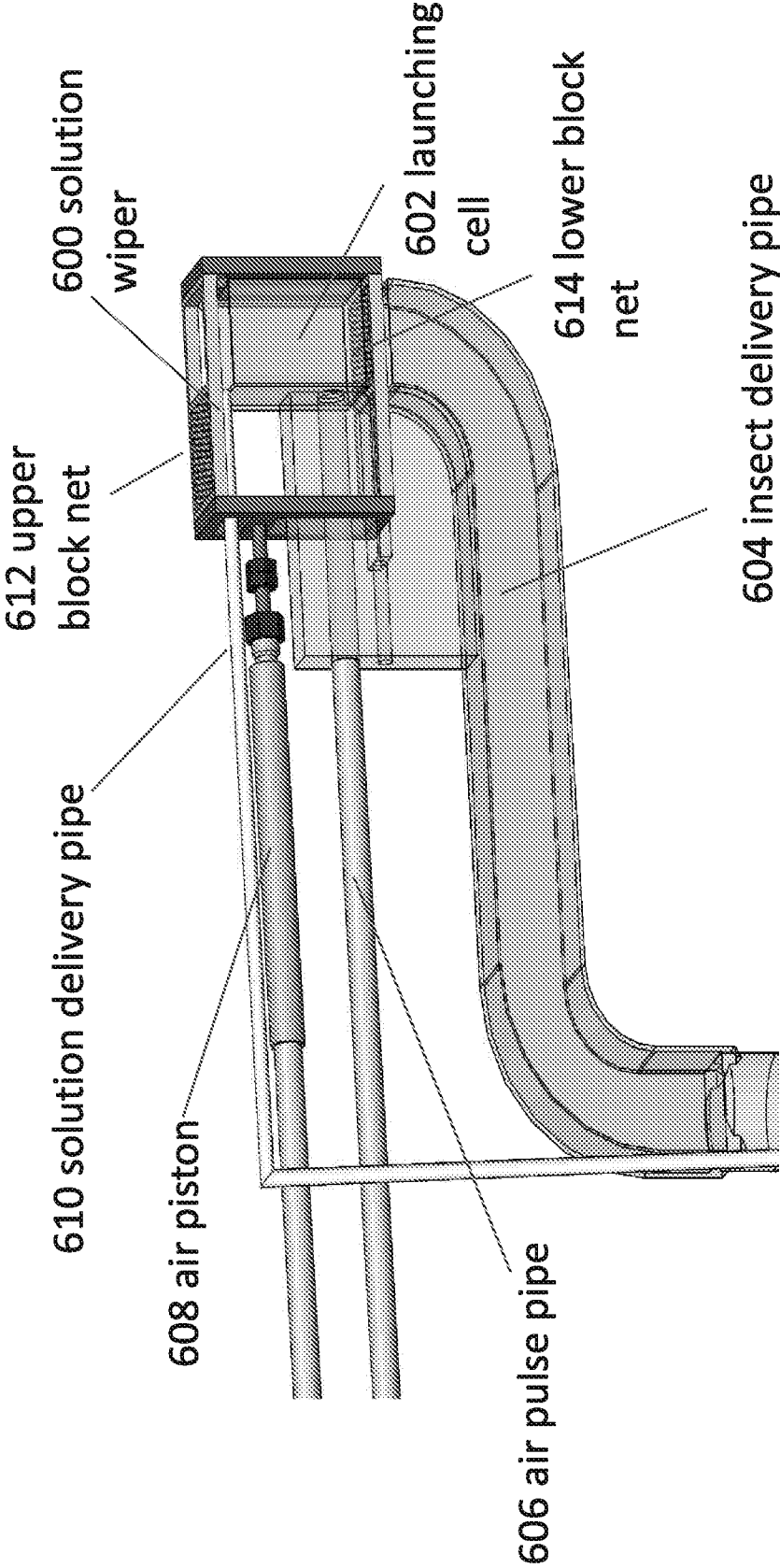
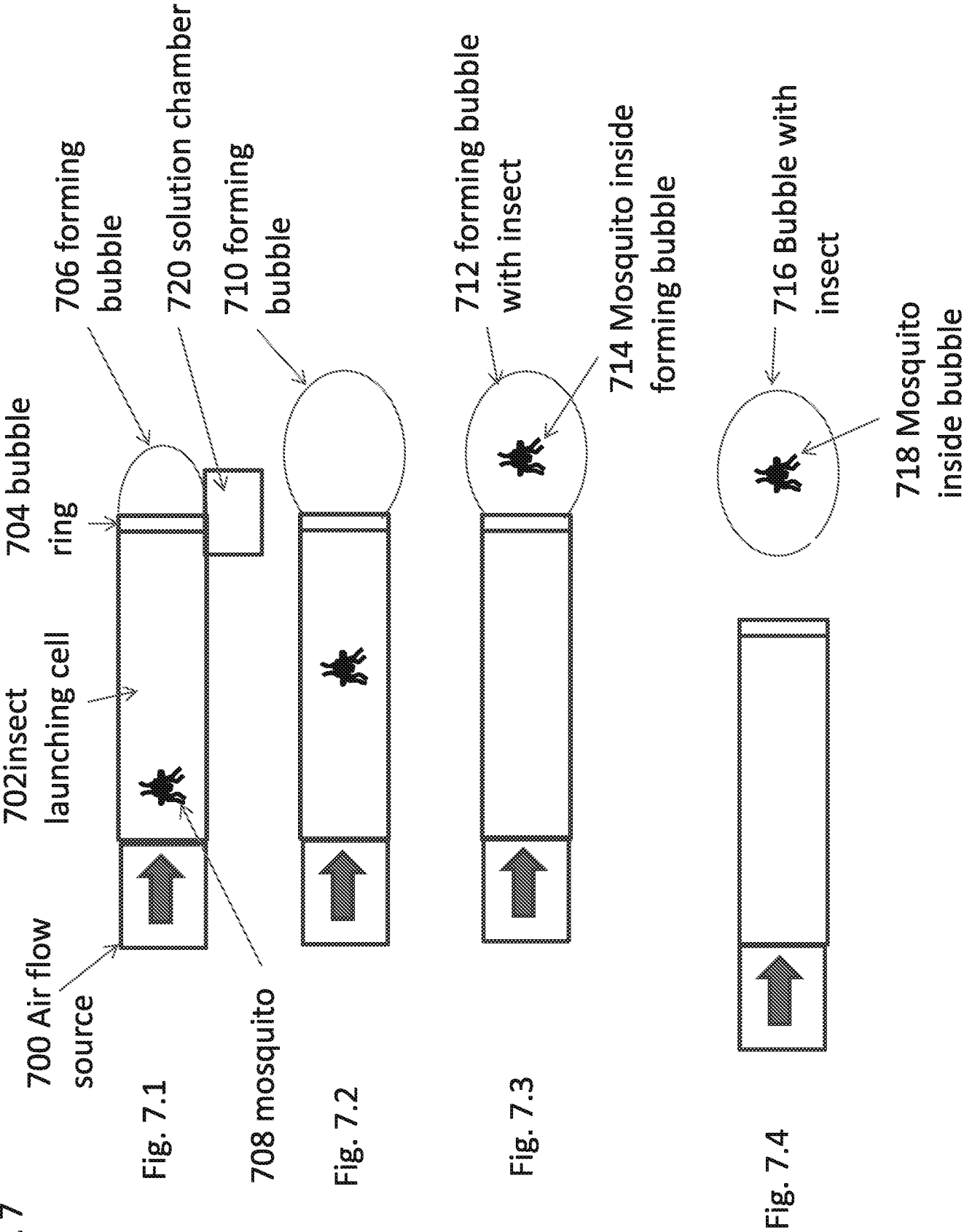


Fig. 6

Fig. 7



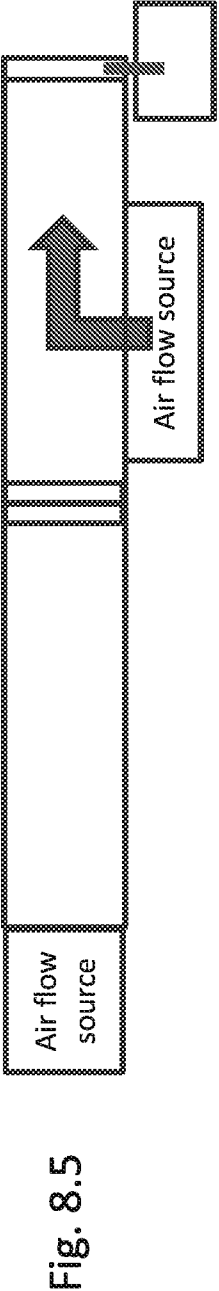
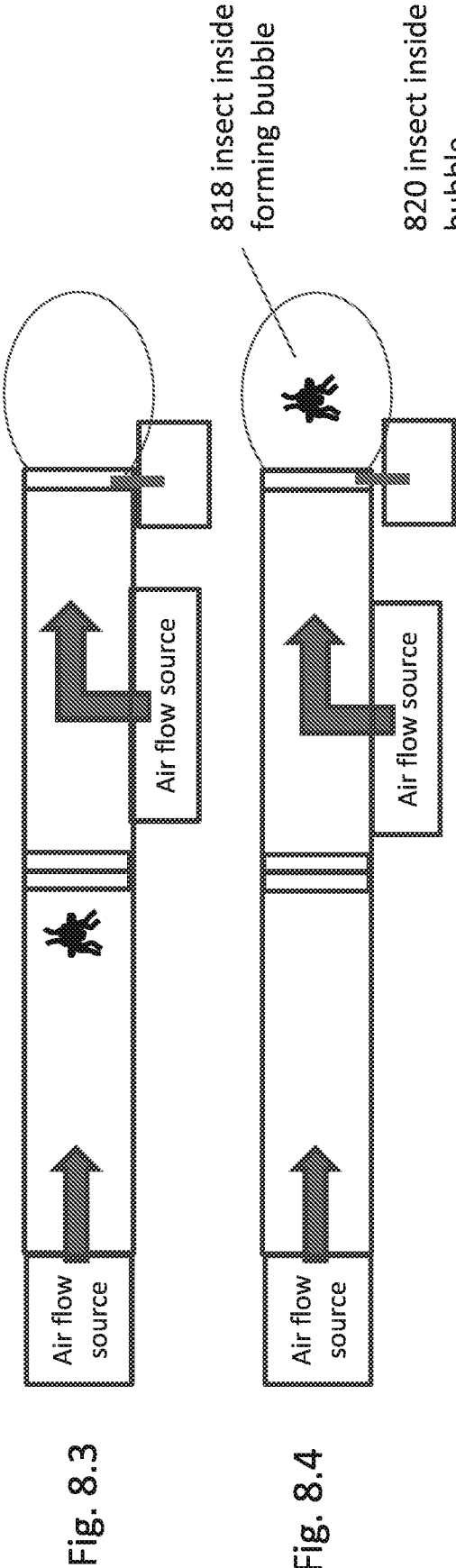
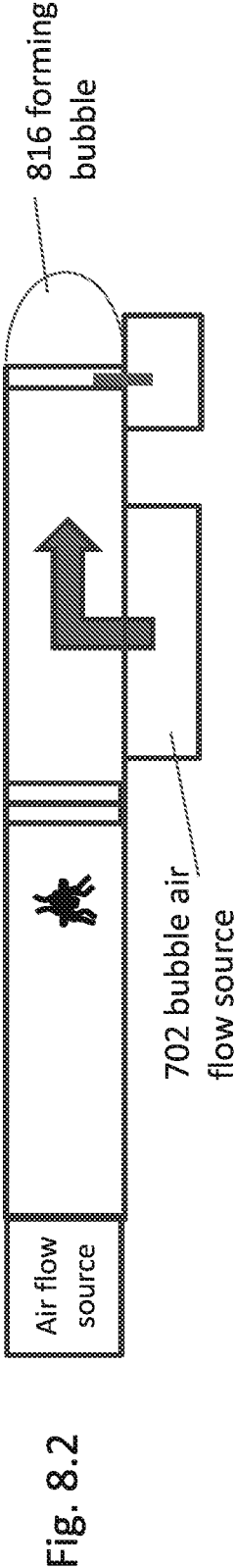
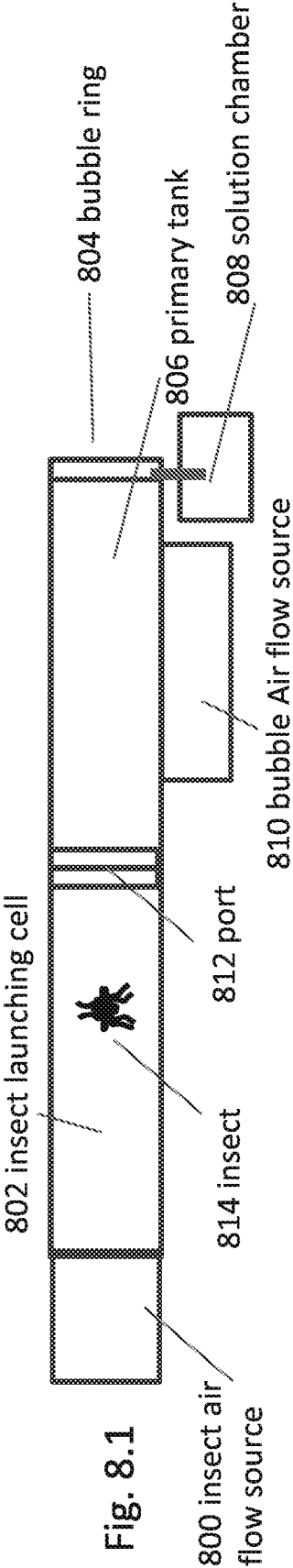


Fig. 9

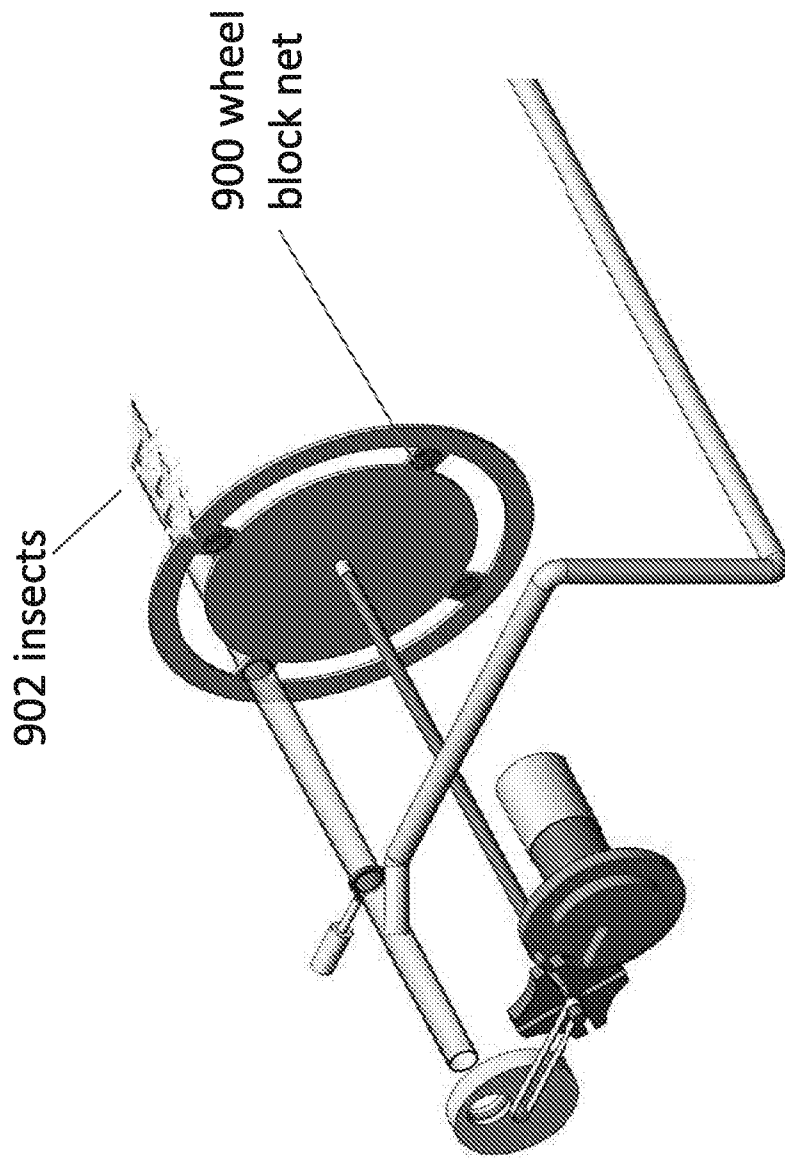
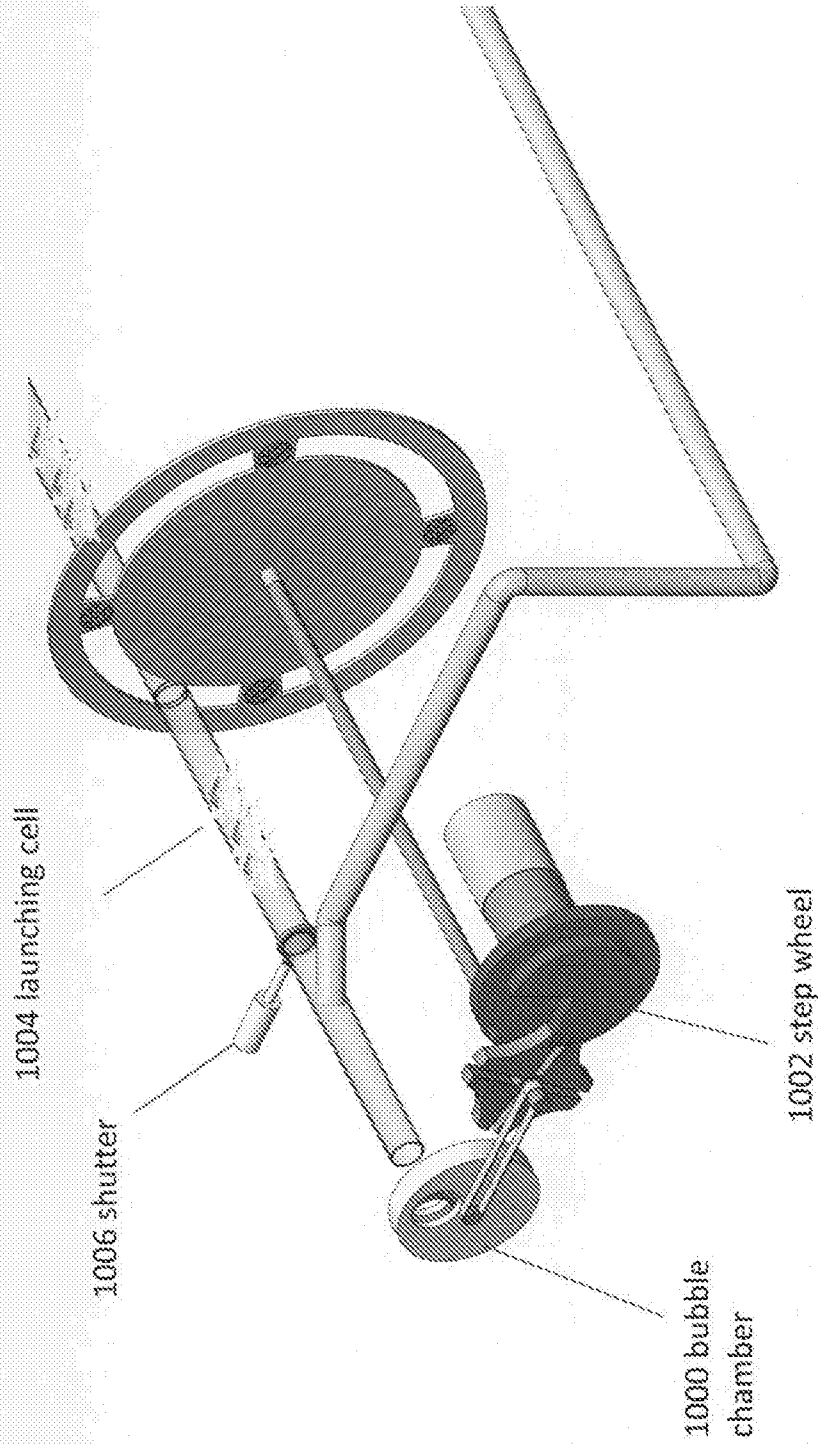


Fig. 10



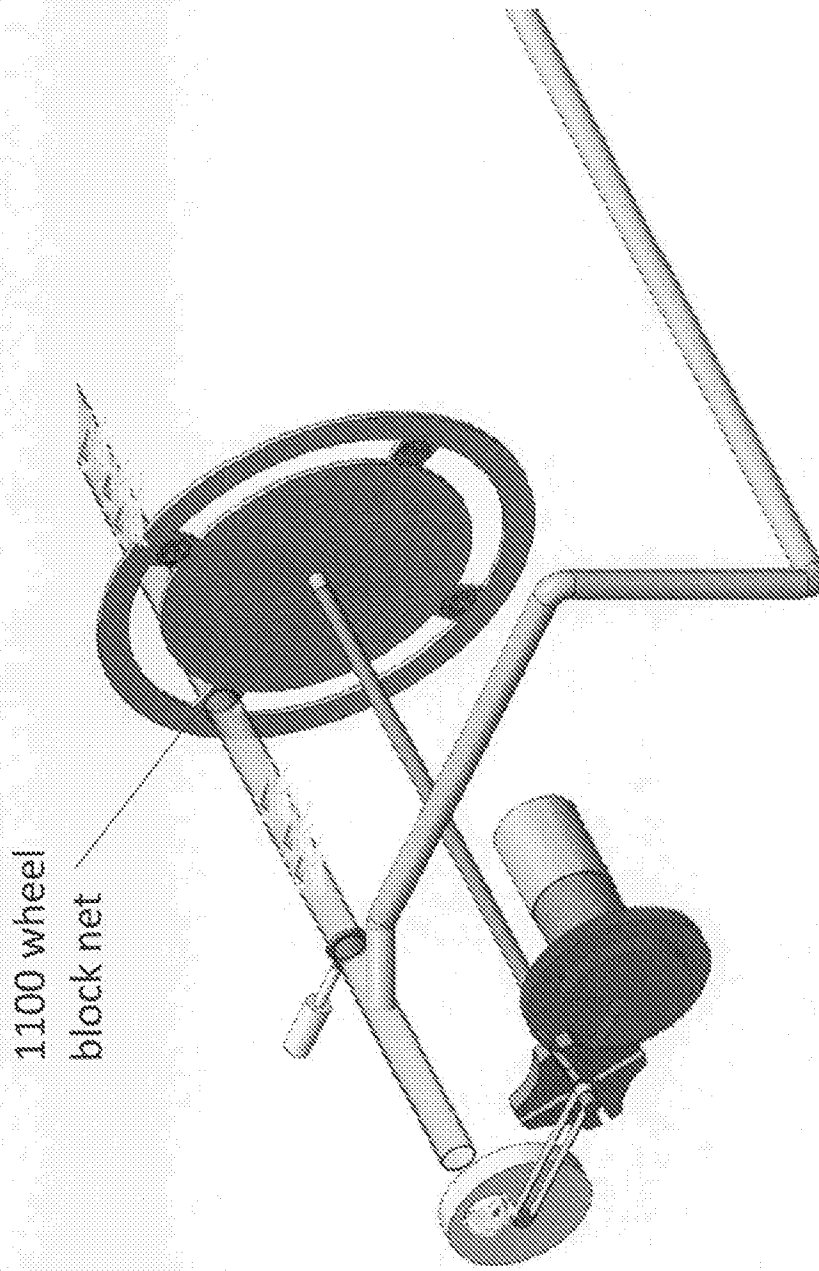


Fig. 11

Fig. 12
1200 shutter

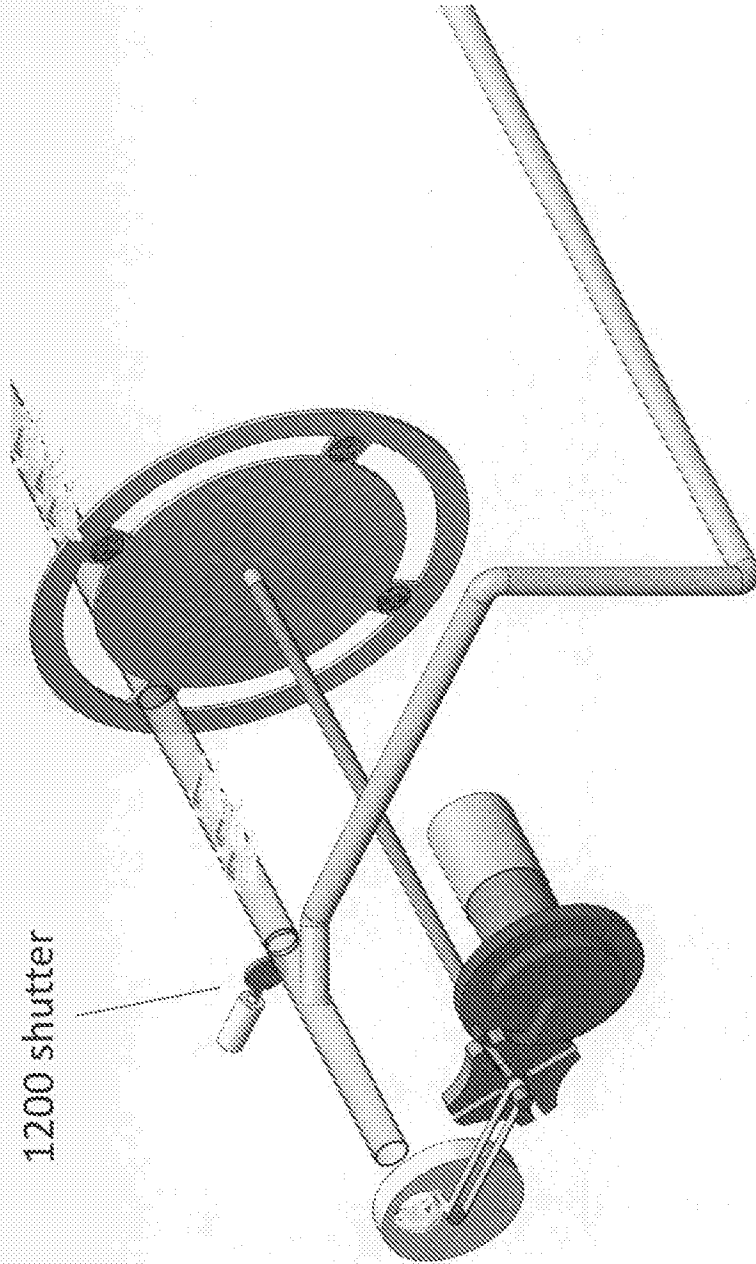


Fig. 13

1300 Launching
cell

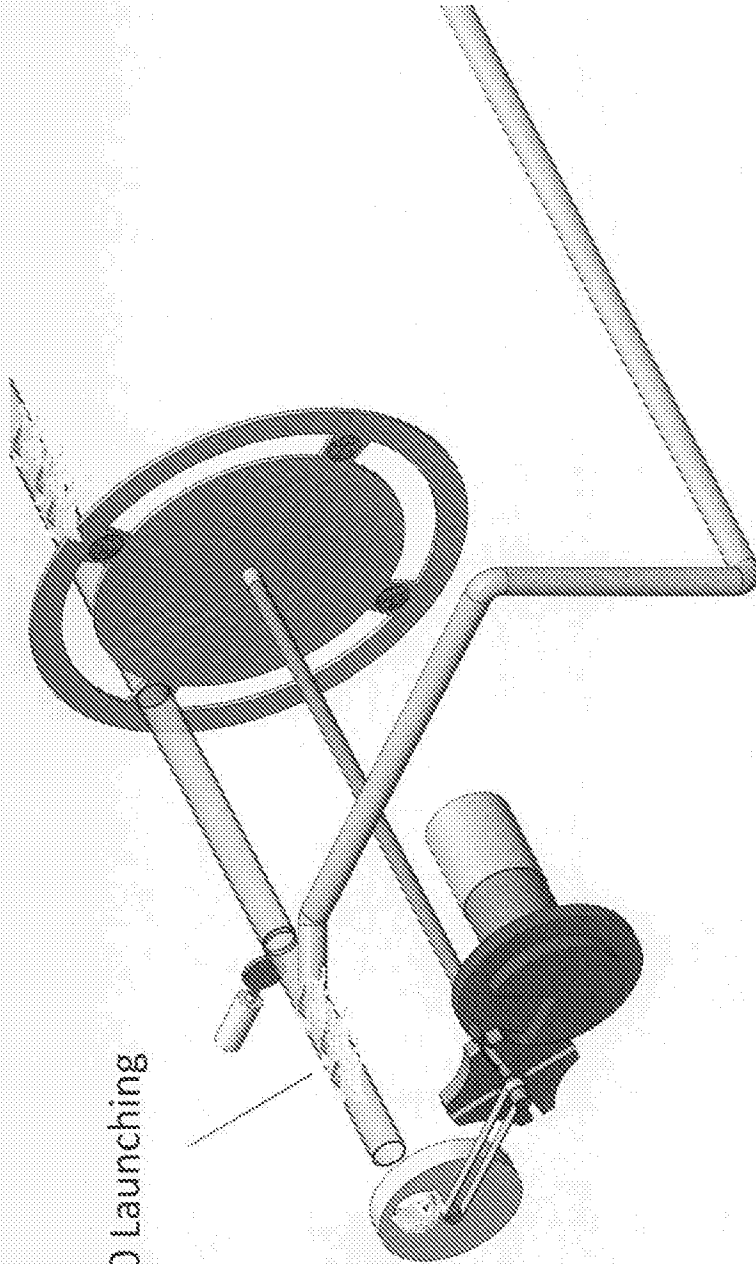


Fig. 14

1400 shutter

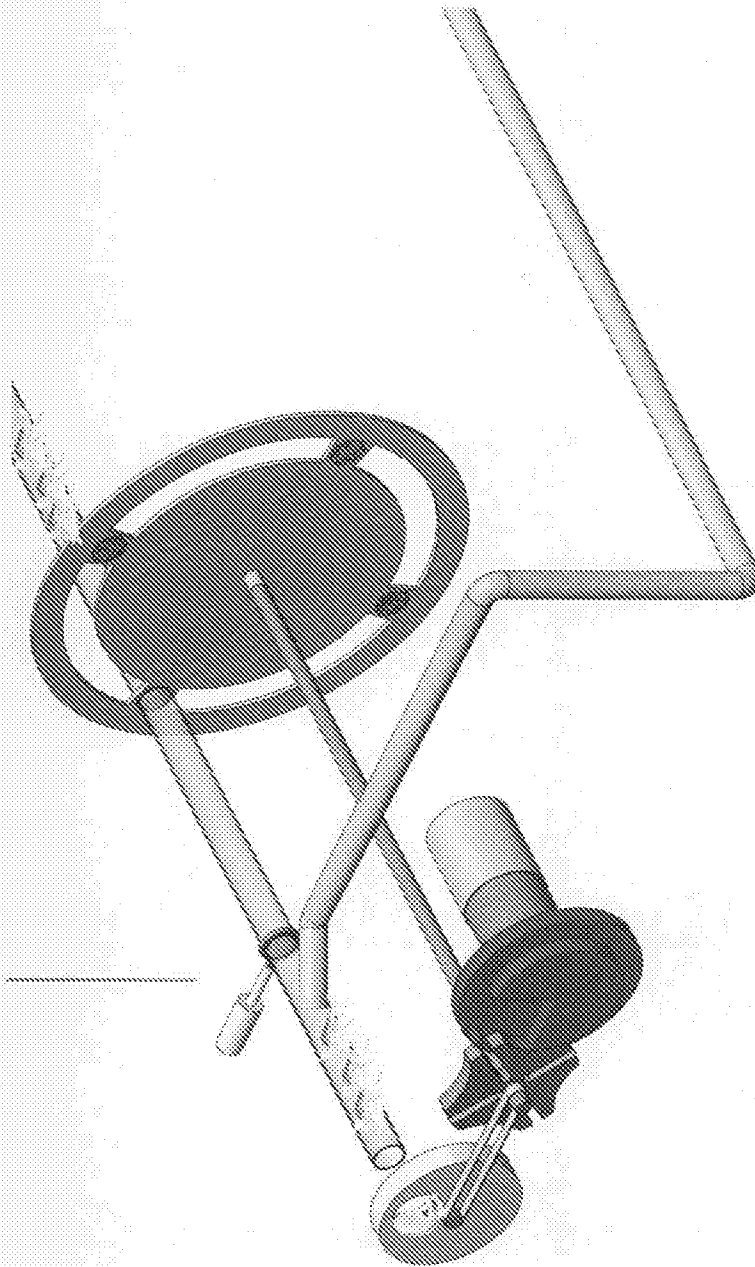
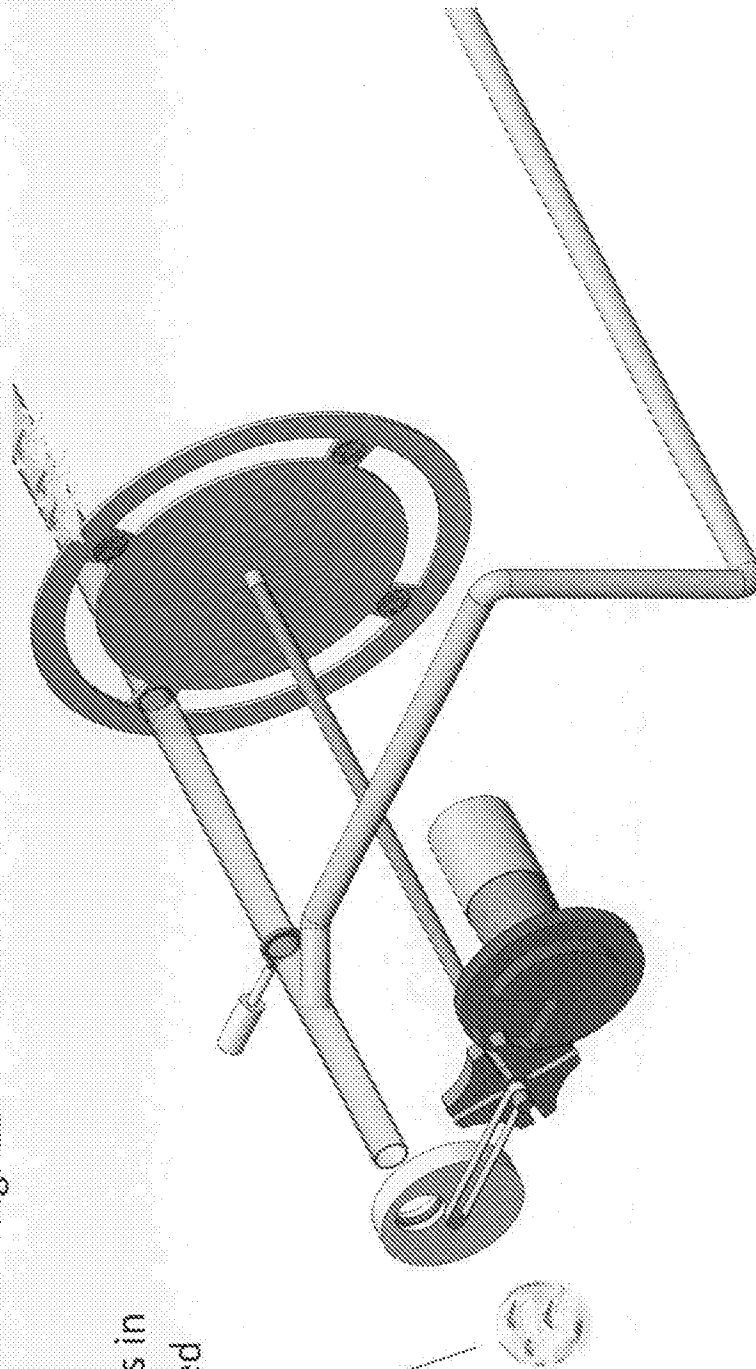


Fig. 15

1500 insects in
disconnected
bubble



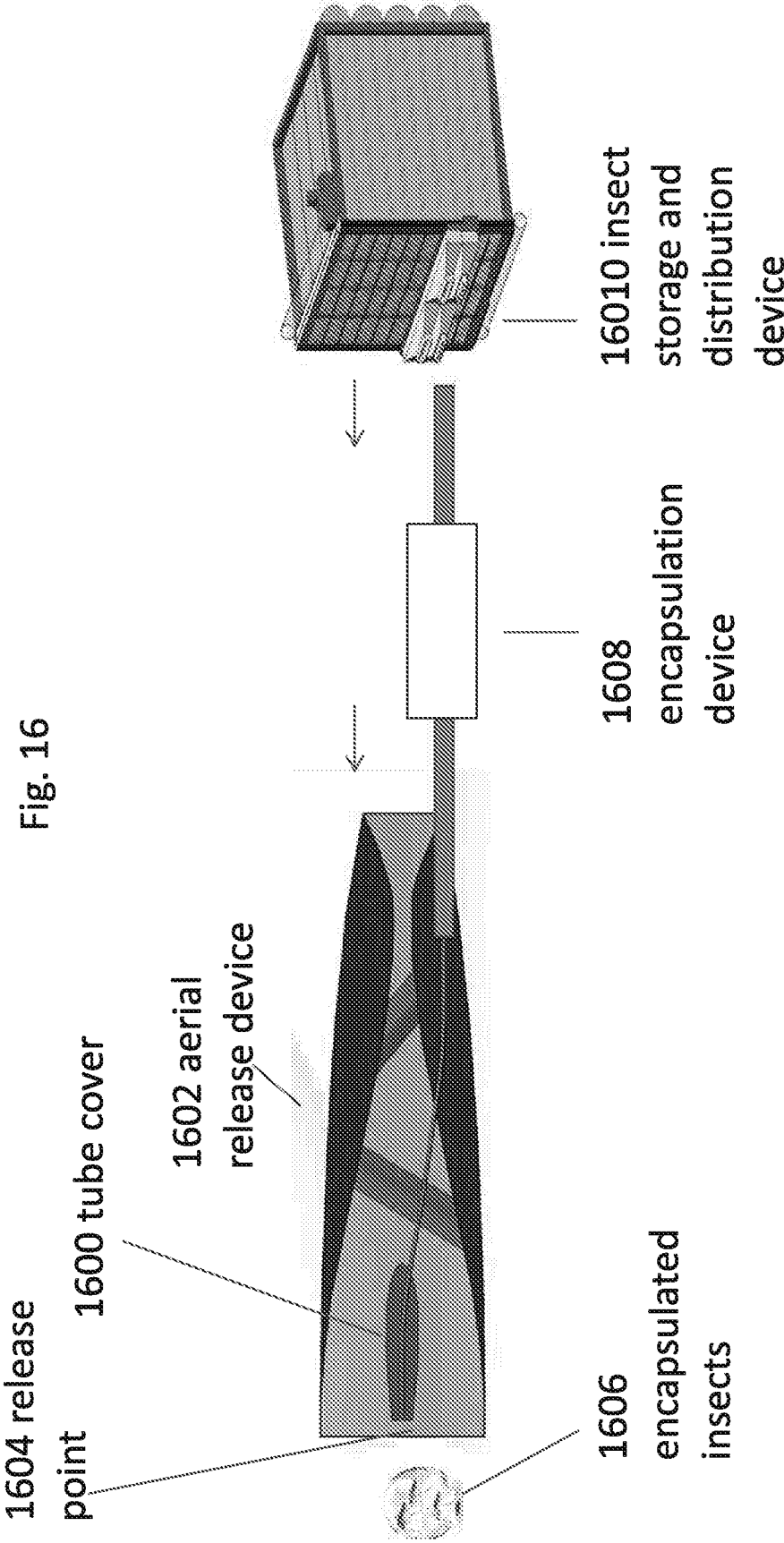


Fig. 17

1700 insects

1702 wheel
block net

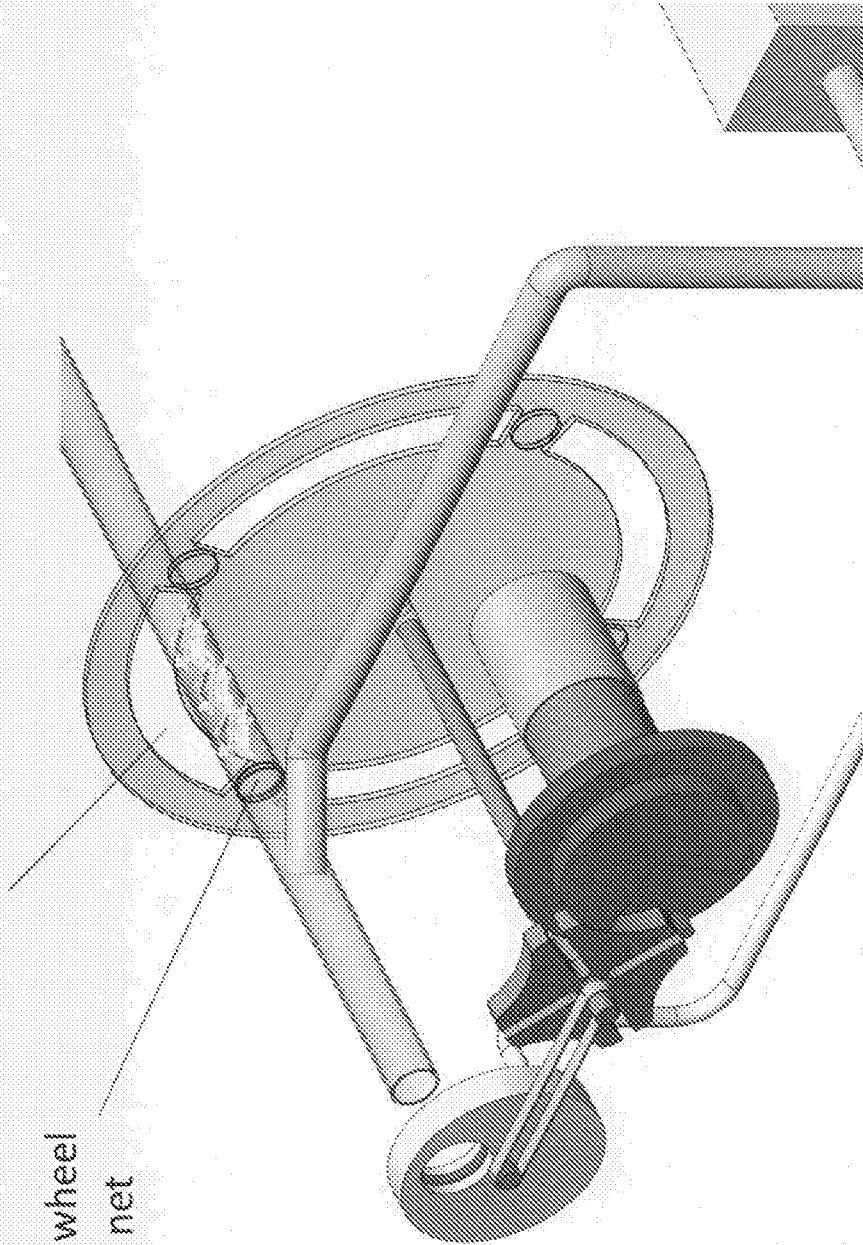
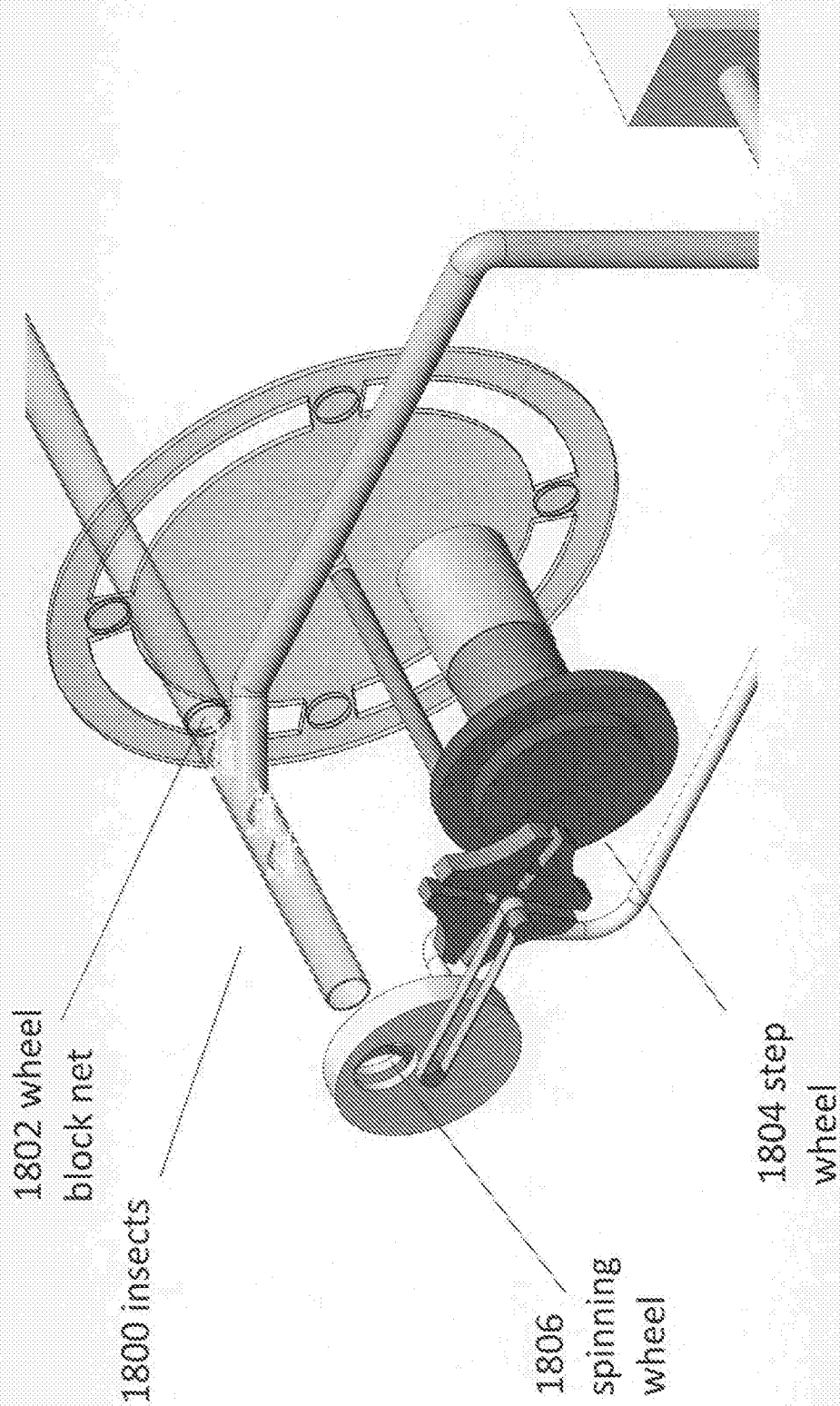
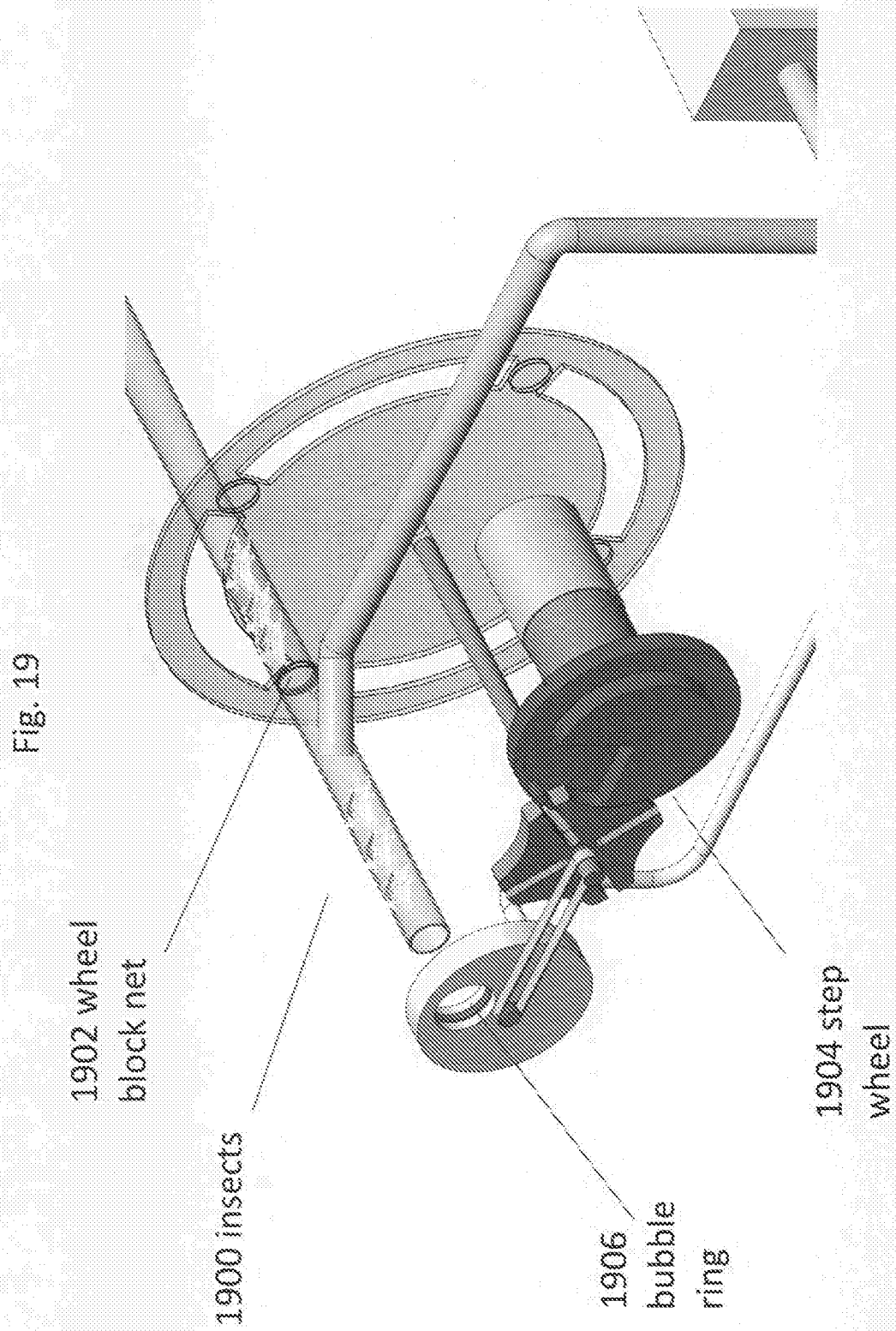
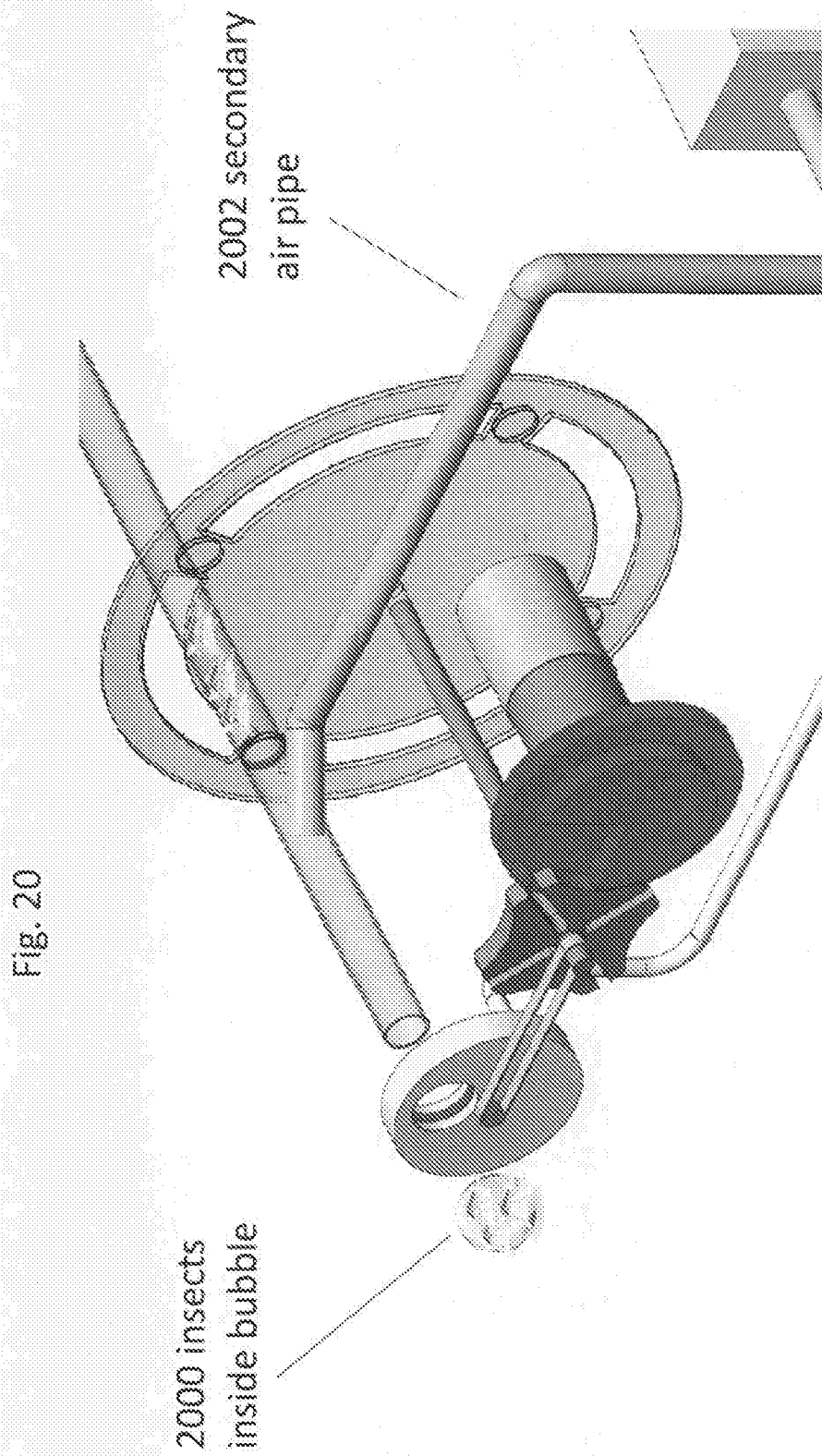
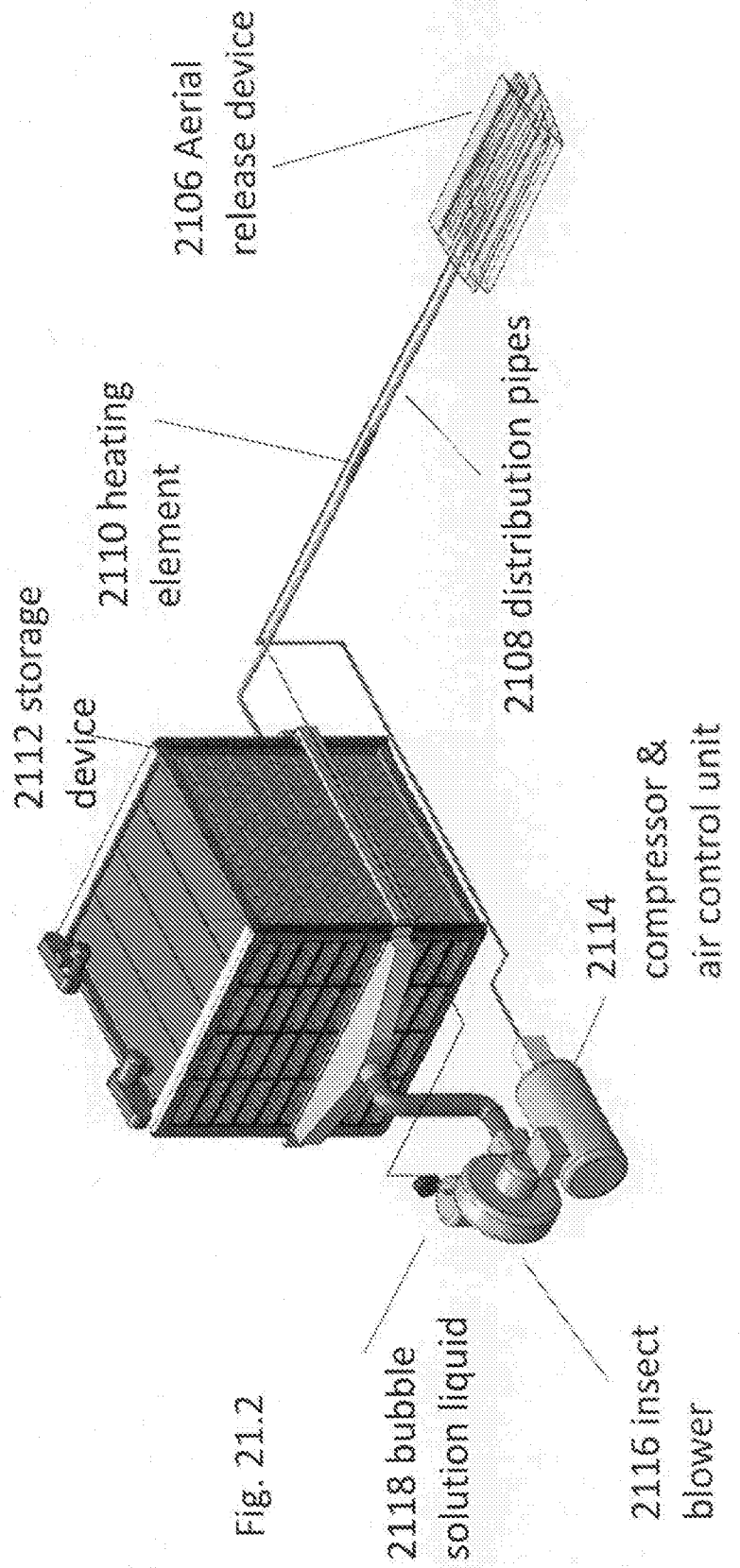
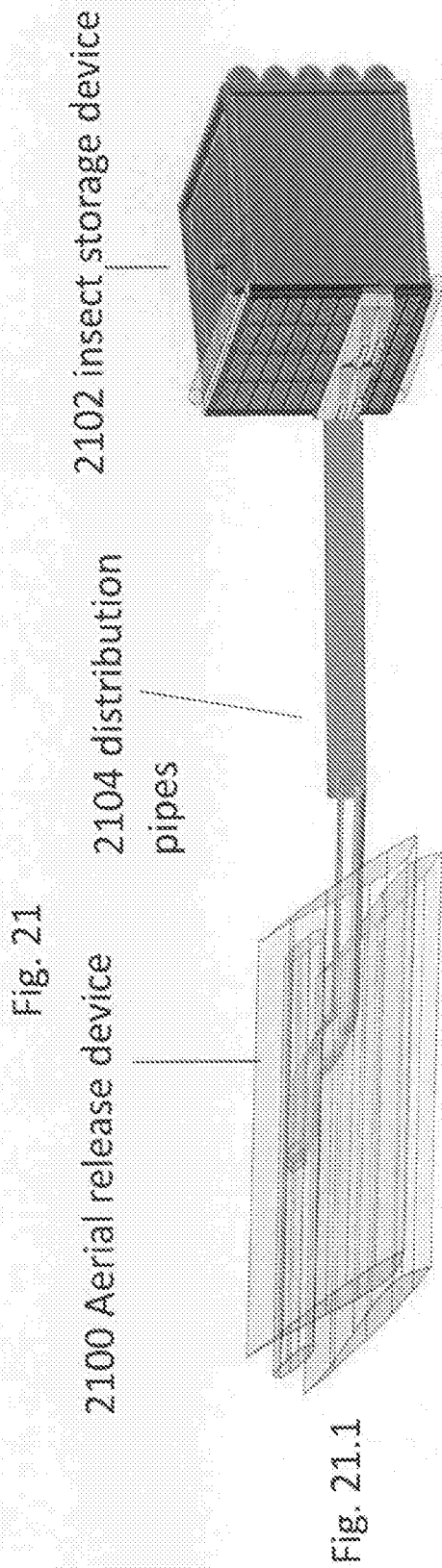


Fig. 18









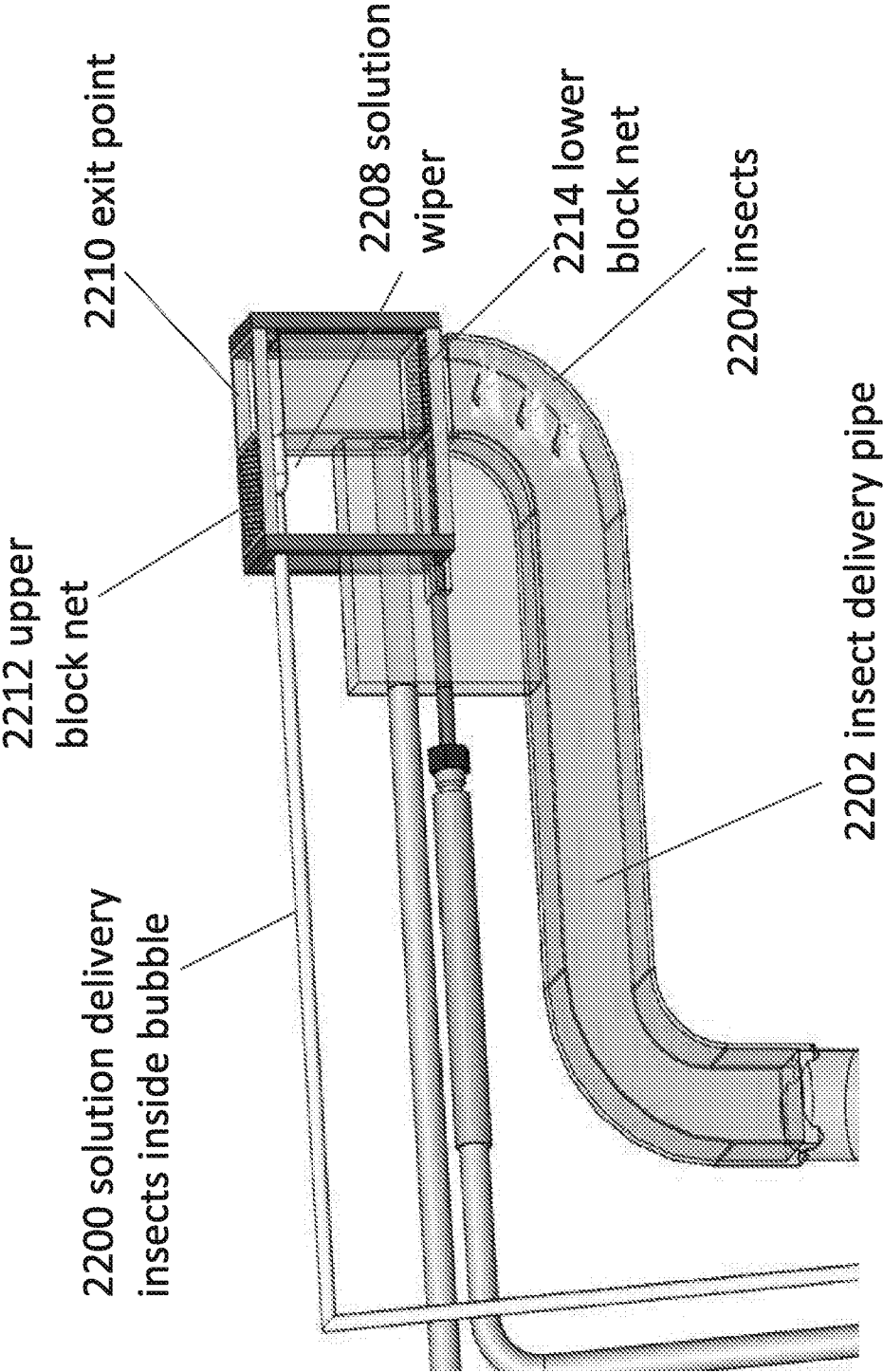


Fig. 22

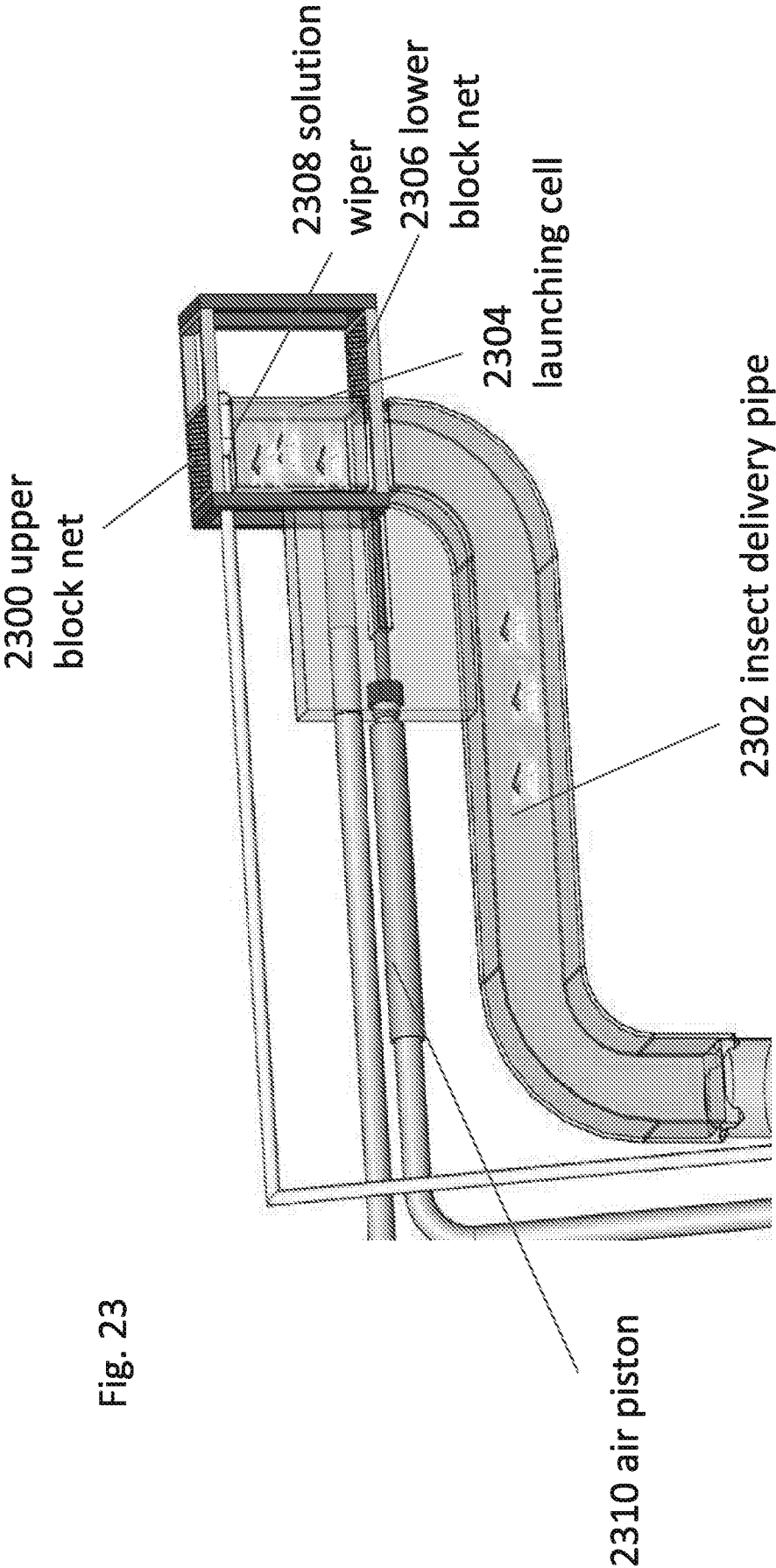


Fig. 23

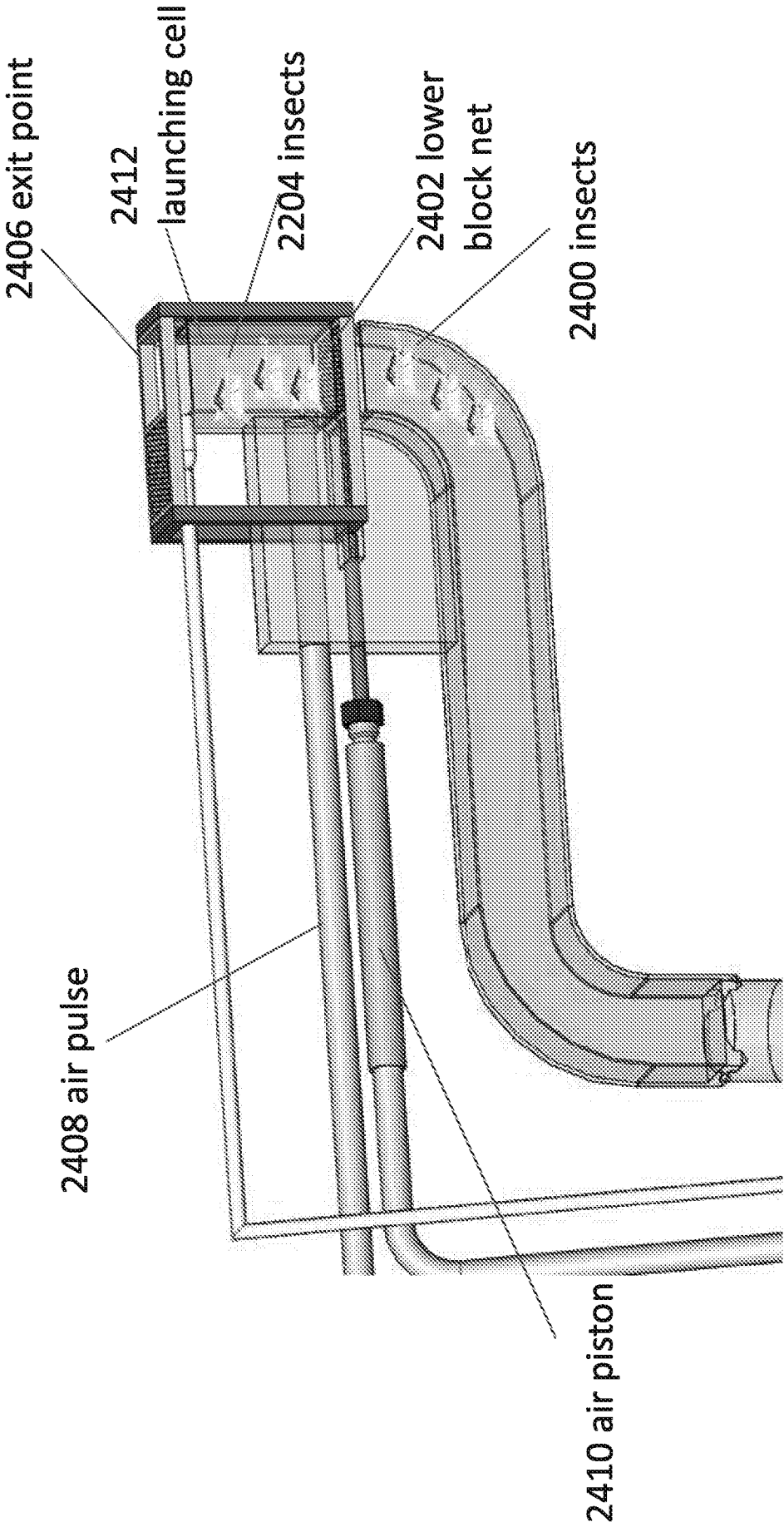


Fig. 24

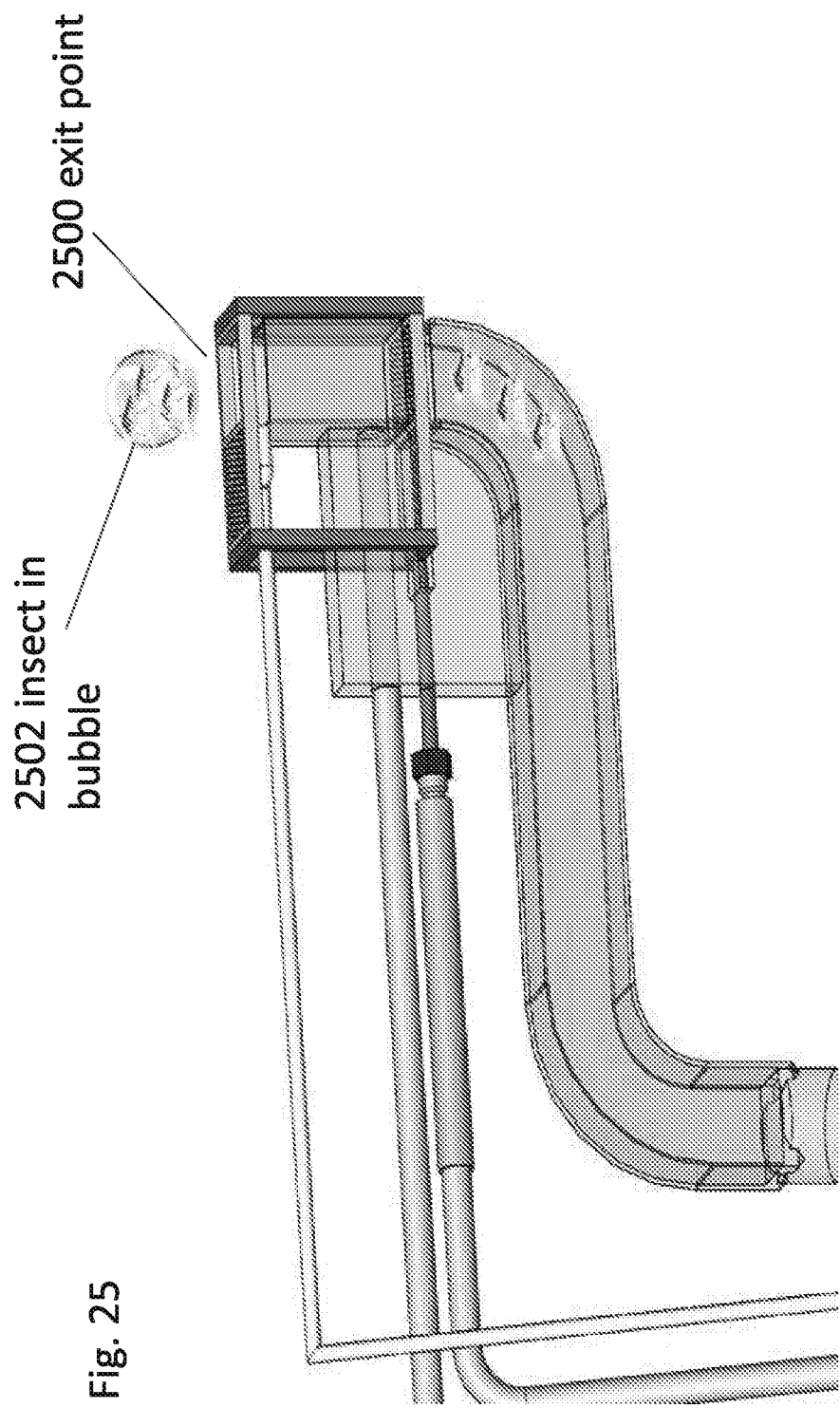


Fig. 25

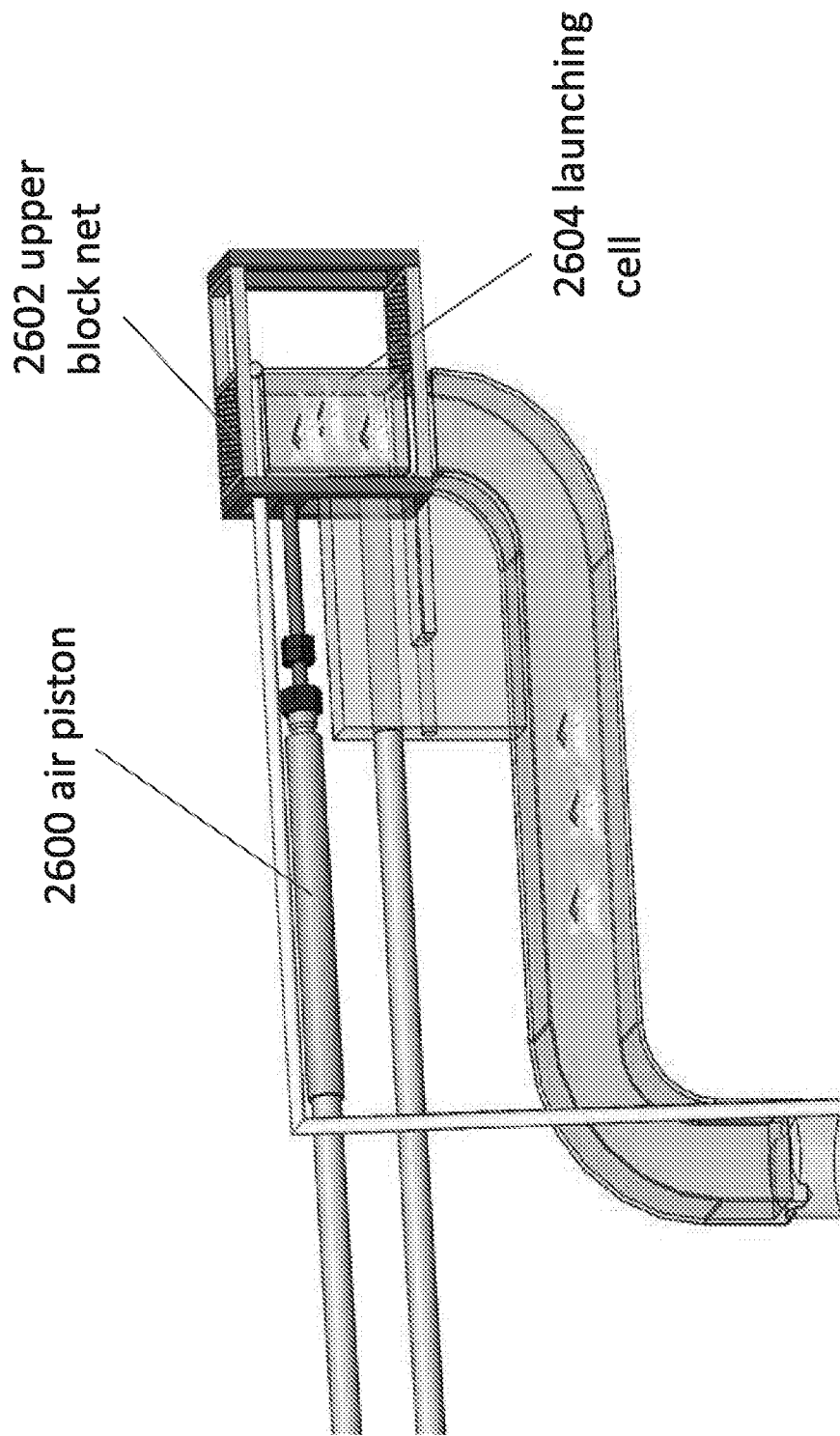
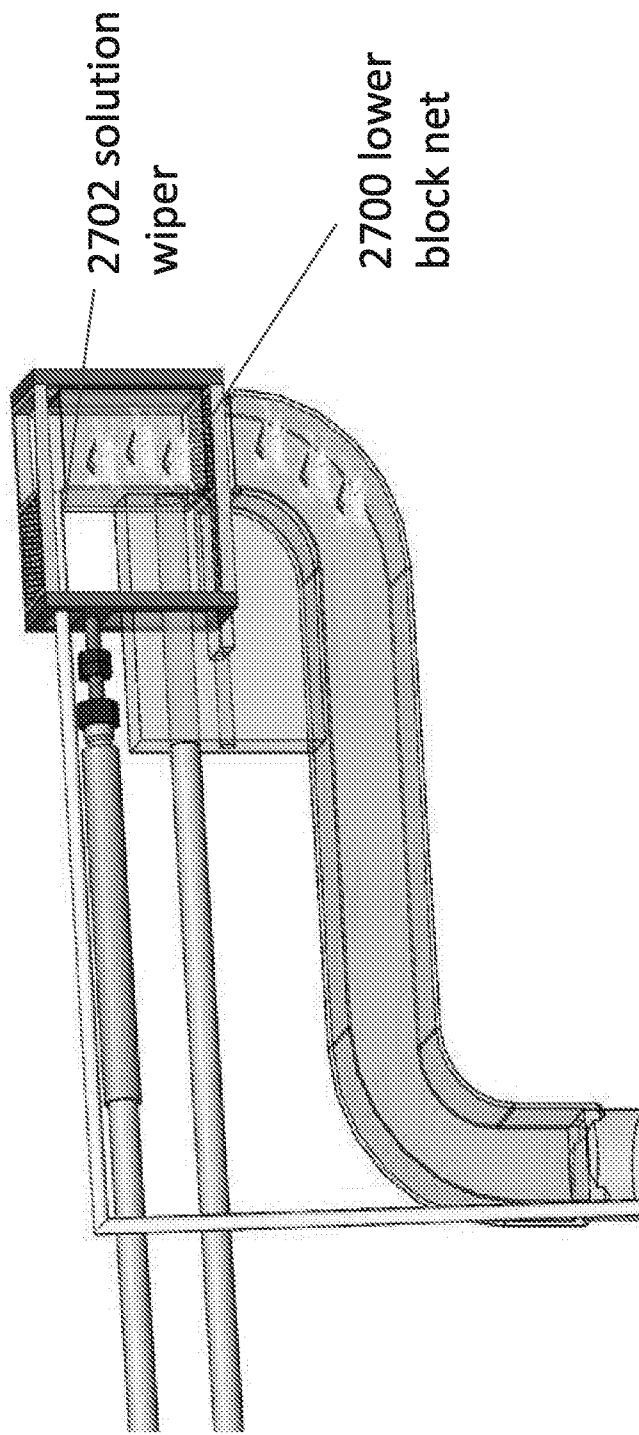


Fig. 26

Fig. 27



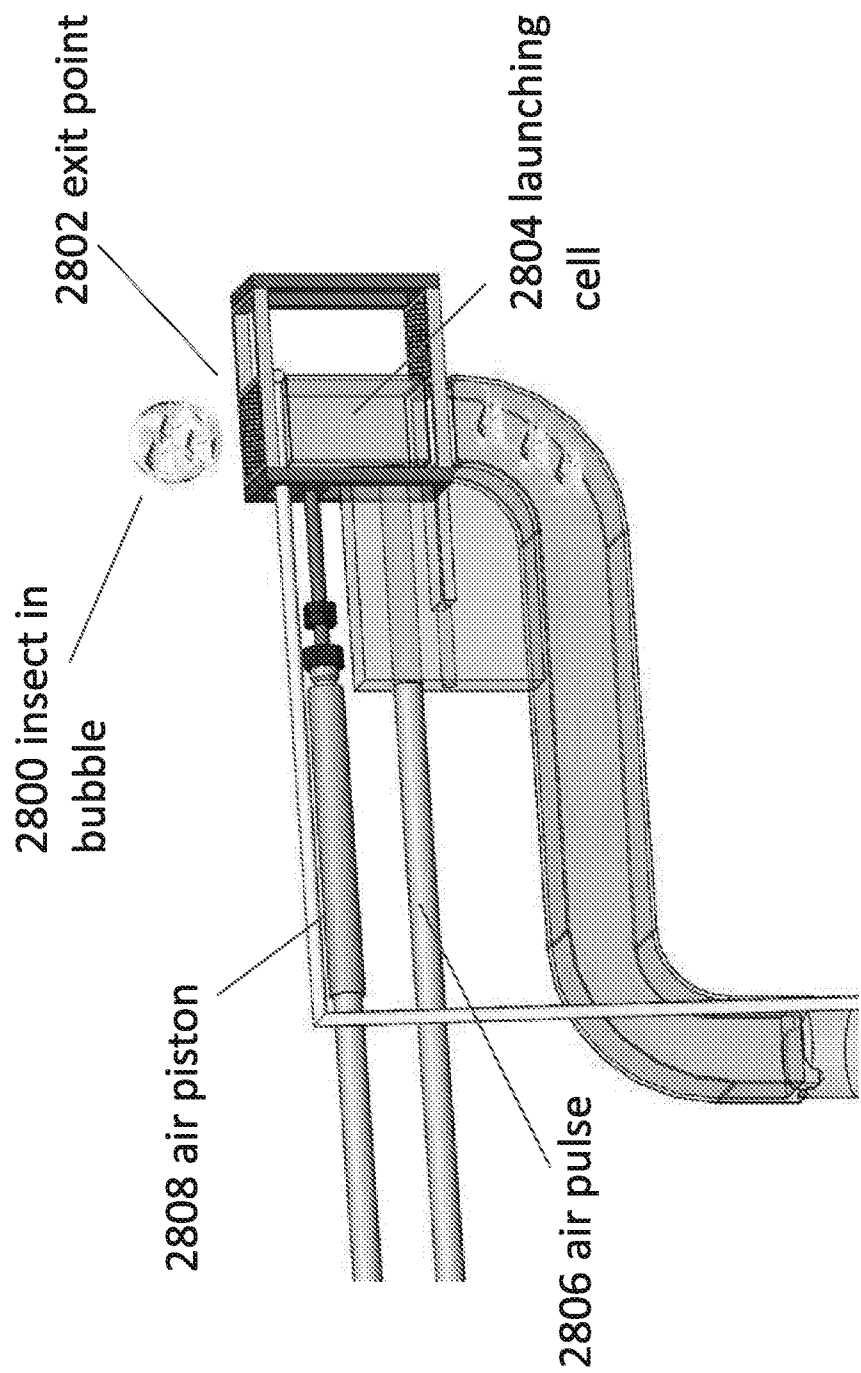


Fig. 28

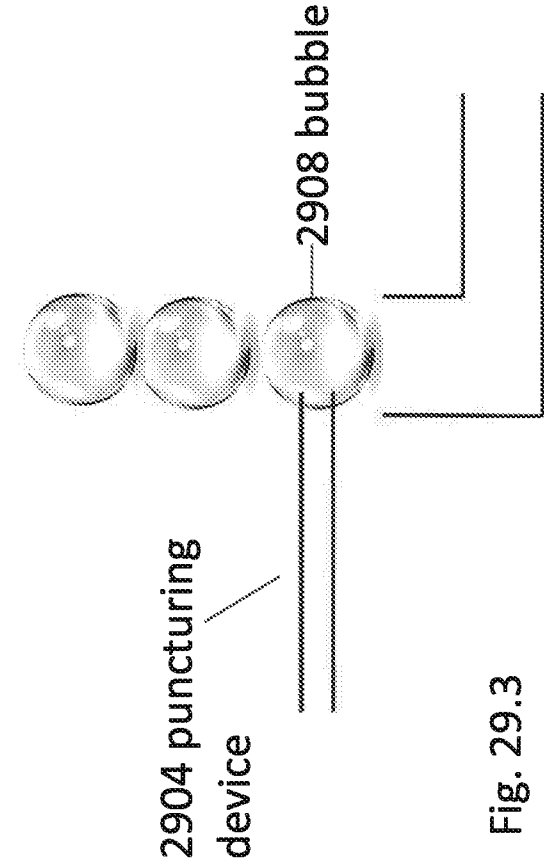
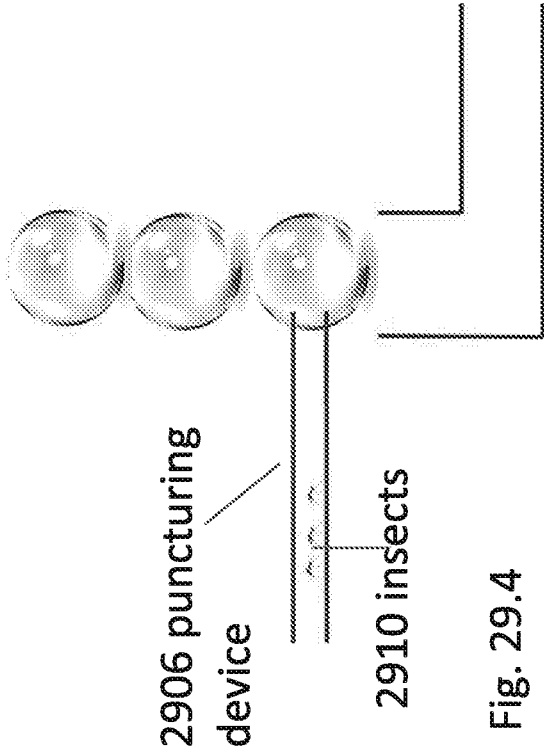
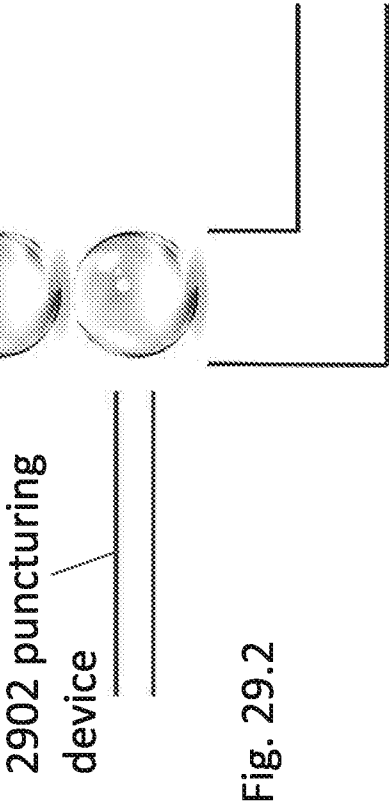


Fig. 29

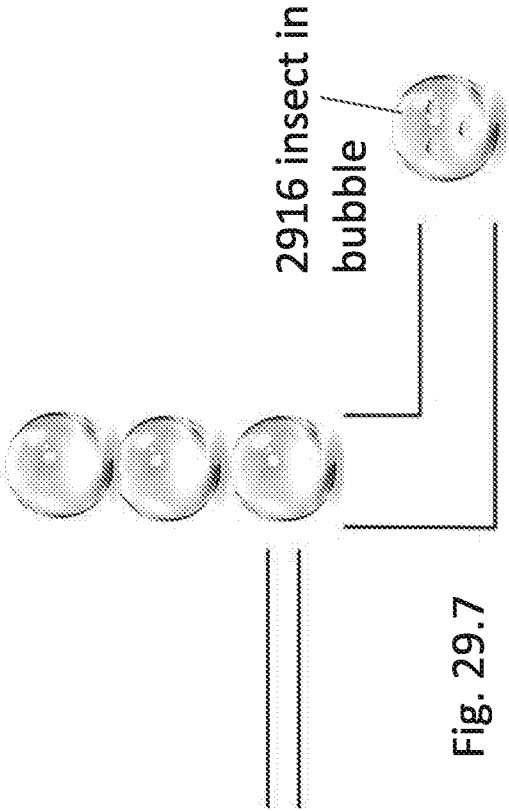
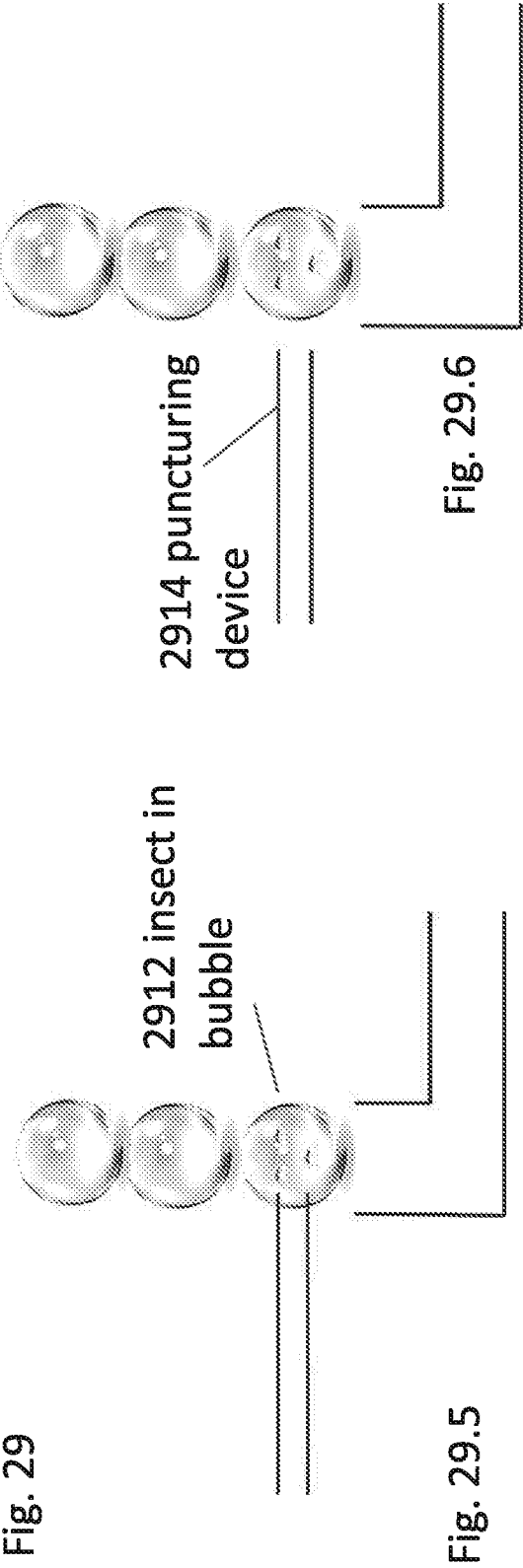


Fig. 29.7

Fig. 30

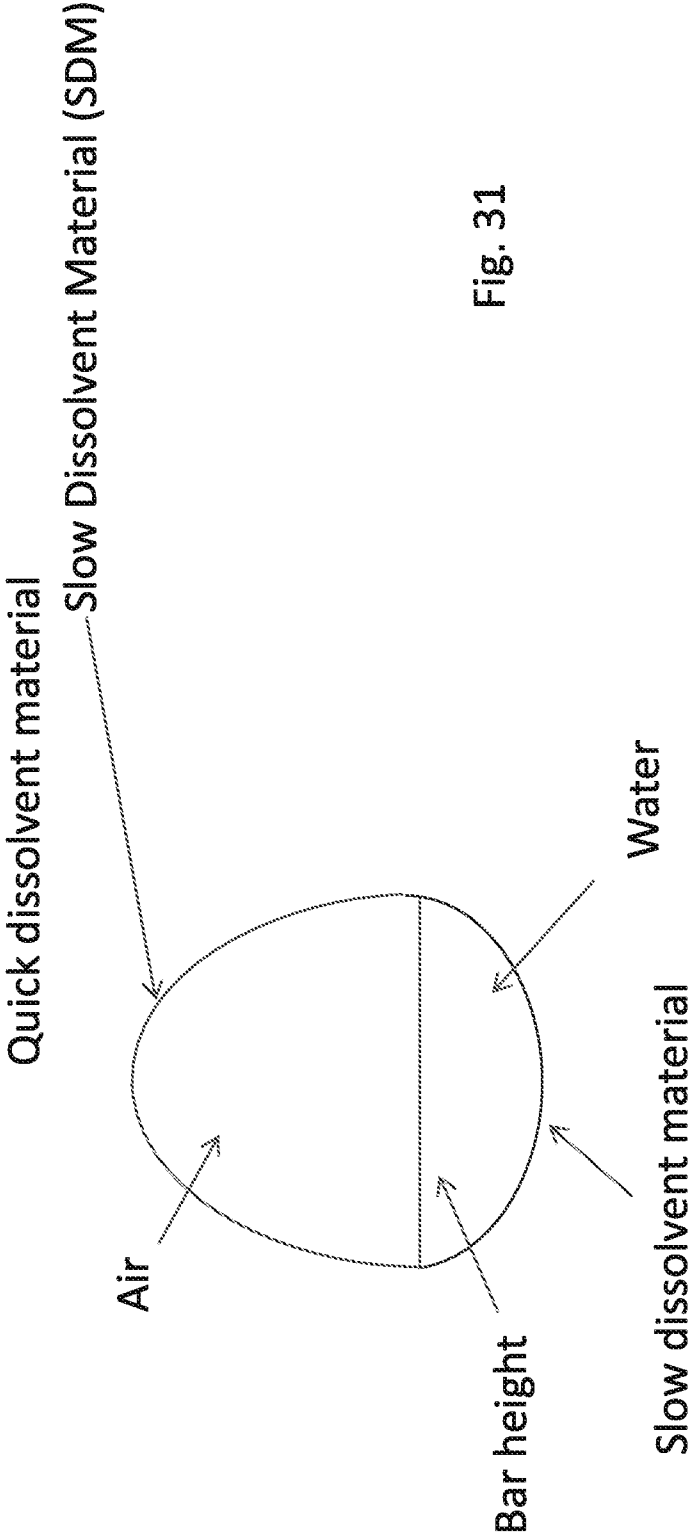
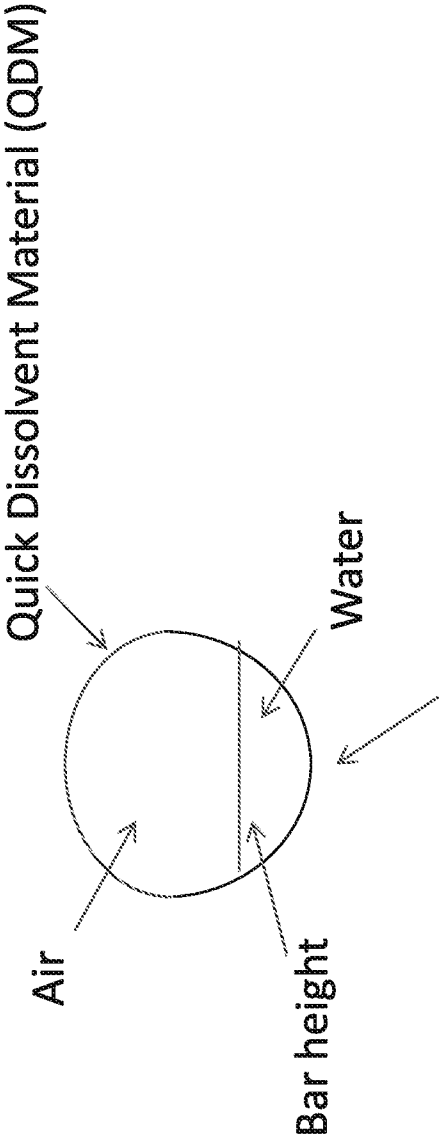


Fig. 31

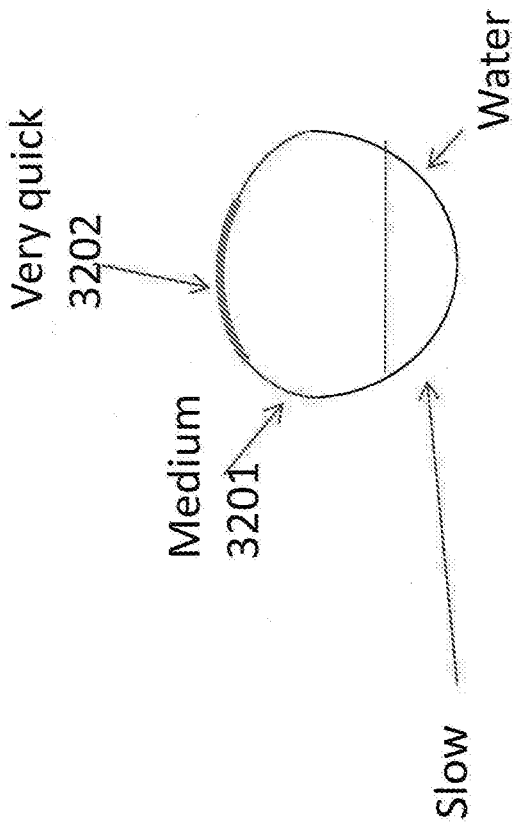


Fig. 32

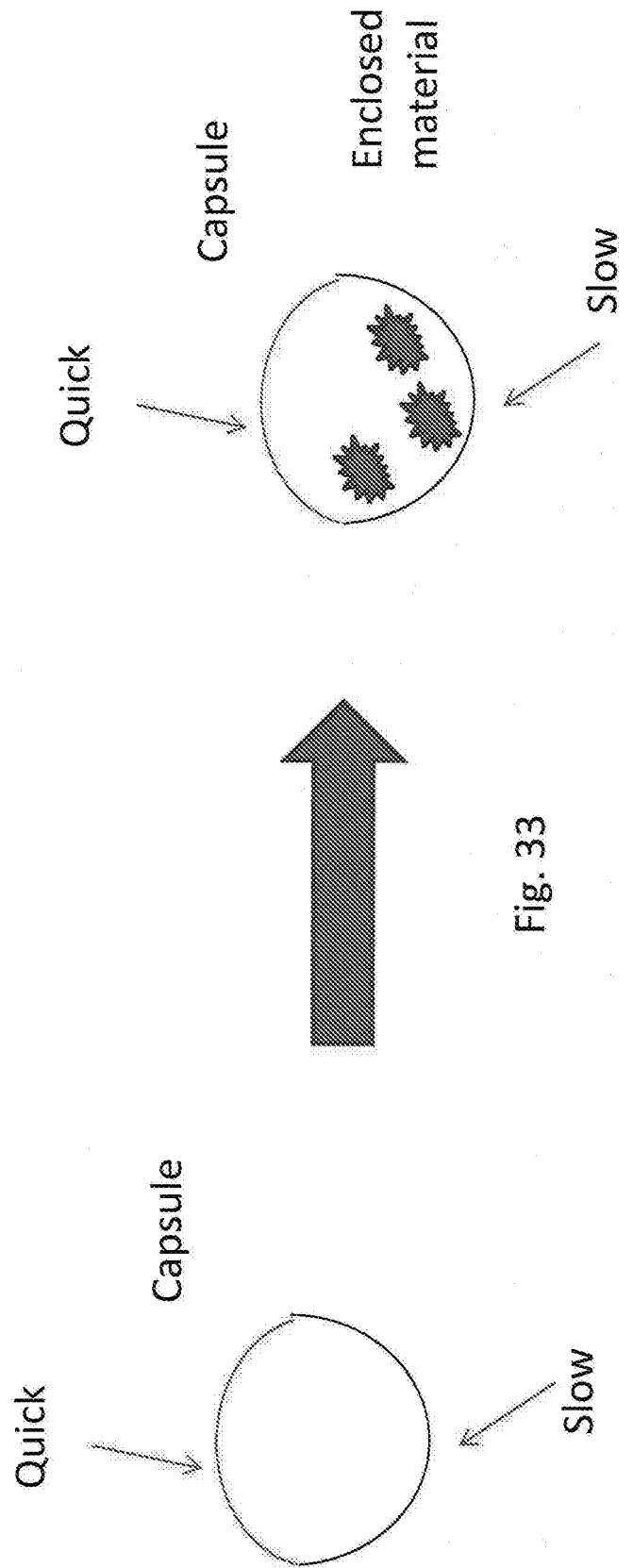


Fig. 33

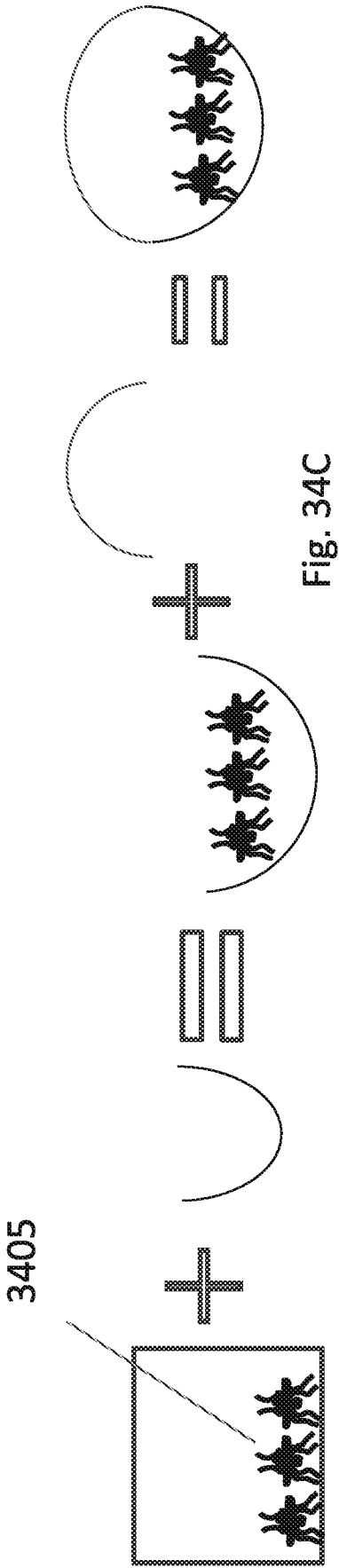
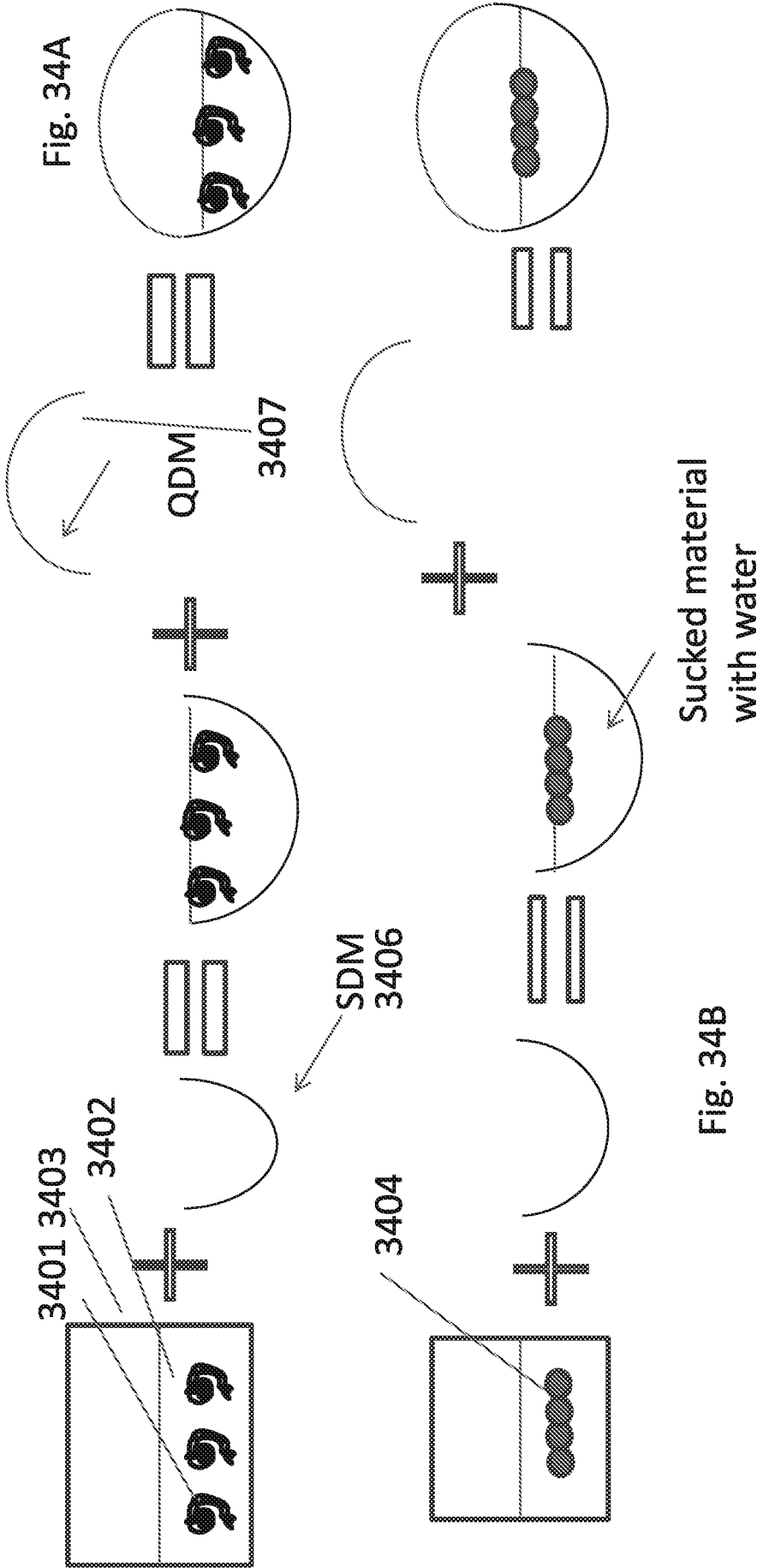
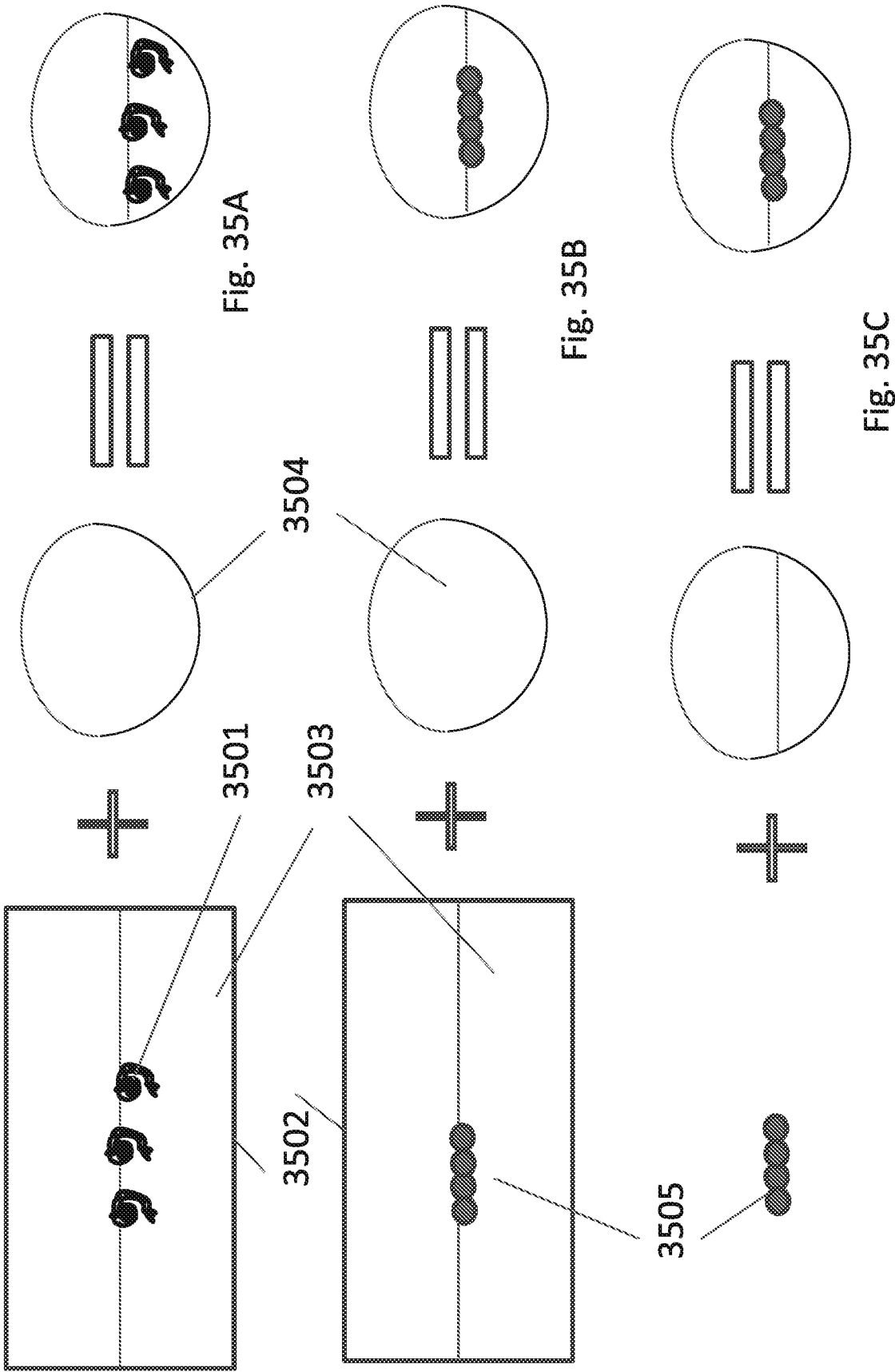


Fig. 34C



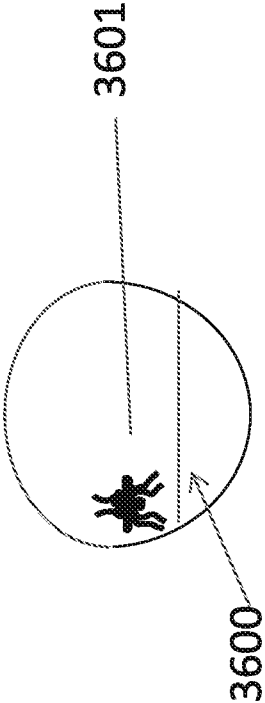


Fig. 36A

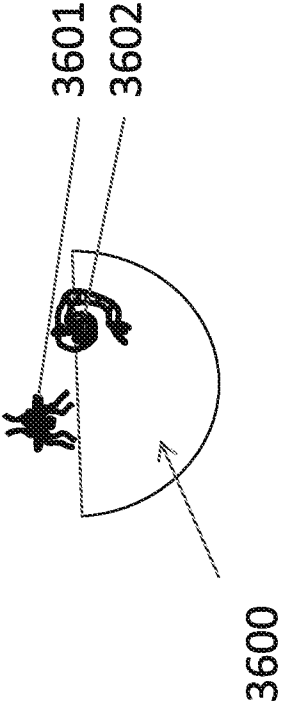


Fig. 36B

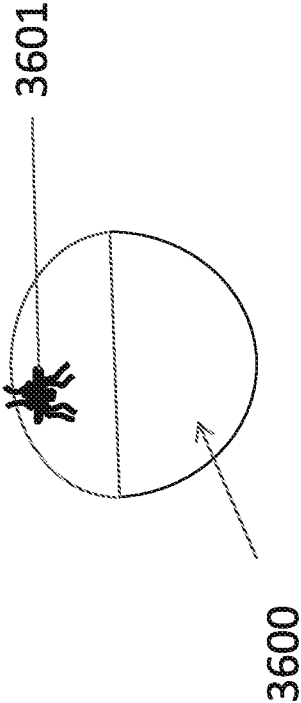


Fig. 36C

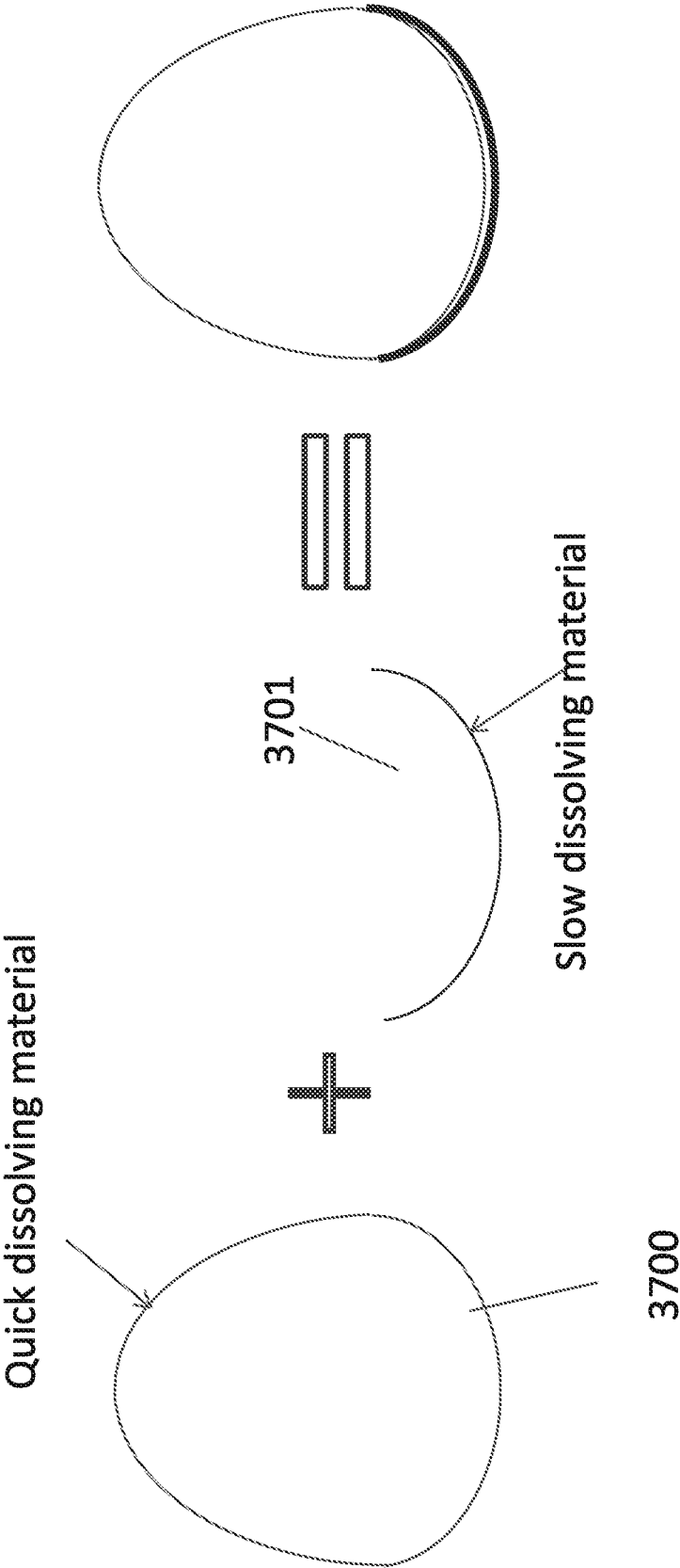


Fig. 37



Fig. 38A

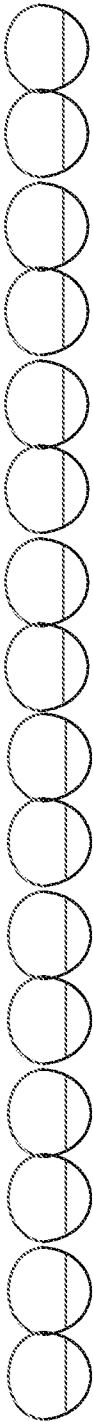


Fig. 38B

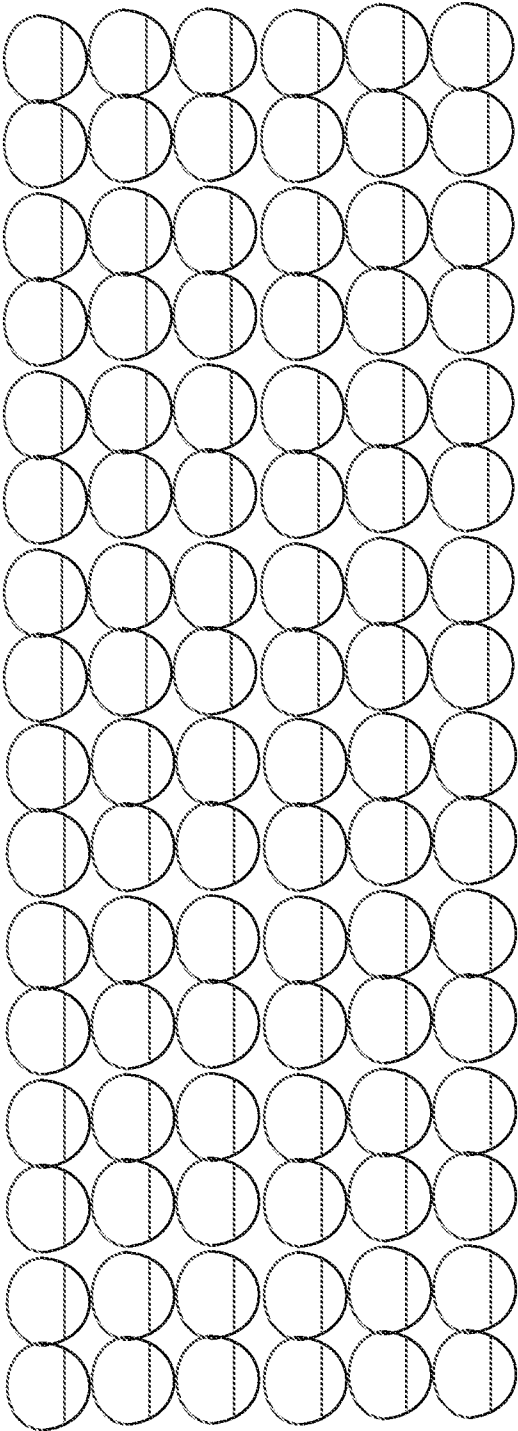


Fig. 38C

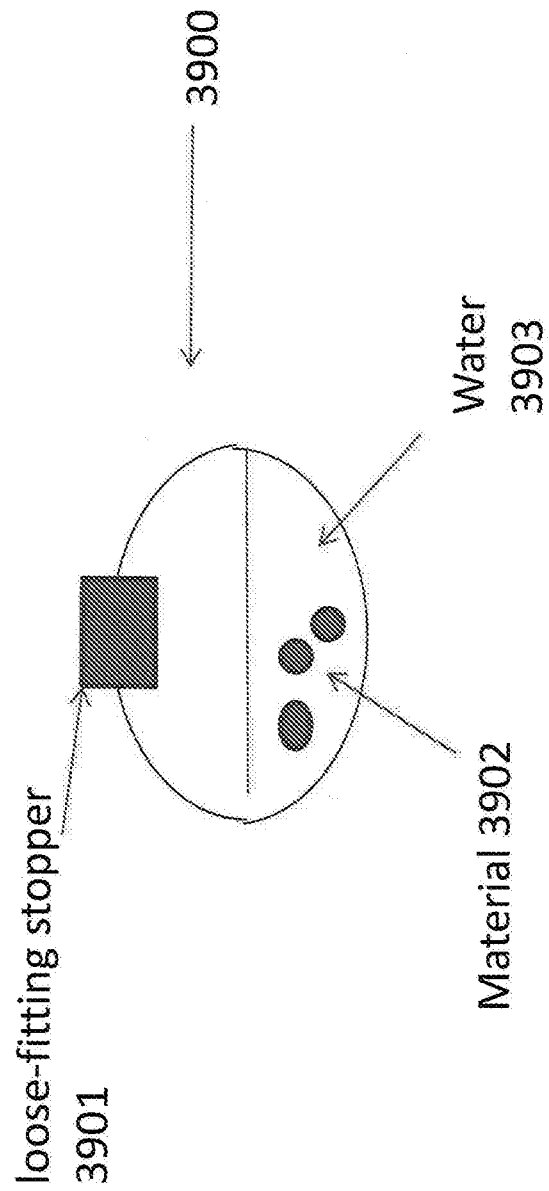


Fig. 39

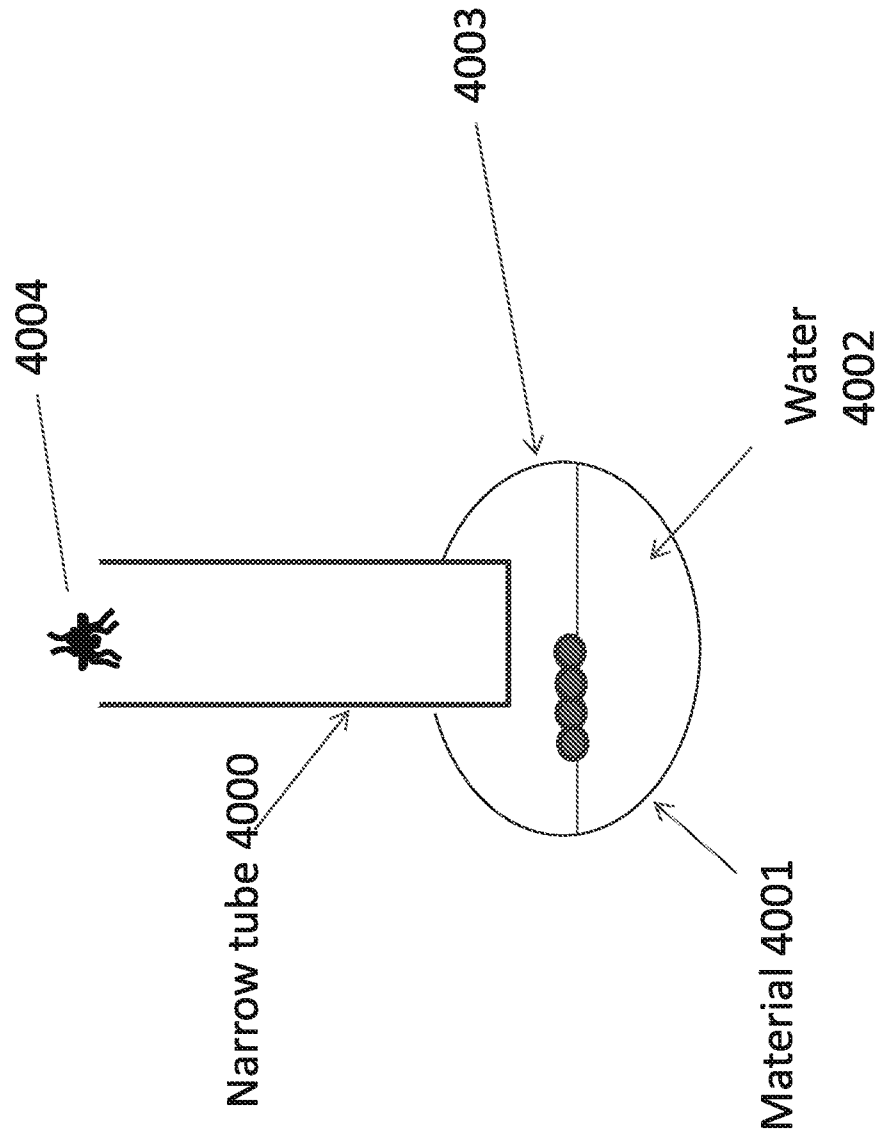


Fig. 40

INTERNATIONAL SEARCH REPORT

International application No

PCT/IL2015/051180

A. CLASSIFICATION OF SUBJECT MATTER
 INV. B64D1/16 A01K67/033
 ADD.

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)

B64D A01K

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|-----------|--|-----------------------|
| X | WO 2014/086932 A1 (CT UNIVERSITAIRE JEAN FRANCOIS CHAMPOLLION [FR]; CT INTERNAT D ETUDES) 12 June 2014 (2014-06-12) page 4 - page 18 ----- | 43,44 |
| A | US 5 794 847 A (STOCKER RUSSELL [US]) 18 August 1998 (1998-08-18) column 3 - column 10; figures 1-6 ----- | 1-42 |
| A | US 2002/050659 A1 (TOREKI WILLIAM [US] ET AL) 2 May 2002 (2002-05-02) page 1 - page 3; figures 1-2c ----- | 1-42 |
| A | US 2014/246545 A1 (MARKOV MICHAEL BEAUGAVIN [US]) 4 September 2014 (2014-09-04) abstract; figures 4b,5b,12-13b ----- -/- | 1-42 |



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

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Date of the actual completion of the international search

21 April 2016

Date of mailing of the international search report

29/04/2016

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2
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 Fax: (+31-70) 340-3016

Authorized officer

Moeremans, Benoit

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2015/051180

| C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | |
|--|--|-----------------------|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| A | FR 2 583 256 A1 (LIMAGRAIN [FR]) 19 December 1986 (1986-12-19) page 1 ----- | 1-42 |
| A | WO 03/000047 A2 (UNIV CATHOLIQUE DE LOUVAIN [BE]; HANCE THIRRY [BE]; DEBATTY-MESTDAGH) 3 January 2003 (2003-01-03) the whole document ----- | 43,44 |
| A | EP 0 210 447 A1 (KOPPERT PETRUS CORNELIS [NL]; KOPPERT PAULUS ADRIANUS [NL]; OOSTHOEK H) 4 February 1987 (1987-02-04) the whole document ----- | 43,44 |
| A | WO 2011/076773 A1 (BIOBEST BELGIUM NV [BE]; VANGEEL MARLIES [BE]; LAUWENS NADY [BE]; JANS) 30 June 2011 (2011-06-30) the whole document ----- | 43,44 |

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2015/051180

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IL2015/051180

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
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| US 2014246545 A1 | 04-09-2014 | US 2014246545 A1 US 2015122950 A1 US 2015151325 A1 | 04-09-2014 07-05-2015 04-06-2015 |
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| WO 2011076773 A1 | 30-06-2011 | EP 2515636 A1 NL 1037575 A WO 2011076773 A1 | 31-10-2012 23-03-2010 30-06-2011 |

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-42

methods for distributing fragile insects or material

2. claims: 43, 44

method for forming a capsule
