INSECT HARVEST APPARATUS AND METHOD

Background

Insects are raised for a variety of purposes, such as for the production of an insect based food product. Harvesting and/or separating the insects from their own food source is a difficult and time consuming process because the process is messy and generally results in harvest of only a small percentage of the available insects. Accordingly, there is a need for an apparatus and method of mass harvesting such insects that may efficiently and cleanly separate the insects from their food source. Therefore, for these and other reasons, there is a need for the present insect harvest apparatus and method.

Summary

One method and apparatus of the present invention may include containing an insect food source and the growing insects within a dry escape structure whereby the insects nominally will not traverse the dry escape structure, moistening the escape structure thereby allowing the insects to traverse the escape structure and move into a collection structure, and then collecting/harvesting the insects from the collection structure. Accordingly, the method and apparatus of the present invention facilitates controlling the insects self separation from their own food source, and thereby allows efficient mass harvesting of insects without the difficulties of manually separating the insects from their own food source.

Brief Description of the Drawings

FIG. 1 is an exploded view of one example embodiment of an insect harvest apparatus.

FIG. 2 is a detailed cross sectional side view of a grow tray of FIG. 1.

FIG. 3 is an isometric view of another example embodiment of an insect harvest apparatus.

FIG. 4 is a cross sectional side view of a pool bed of FIG. 3.

FIG. 5 is a top view of another example embodiment of an insect harvest apparatus.

FIGS. 6 and 7 are cross sectional side views of two different embodiments of pipes that may be utilized in the apparatus of FIG. 5.

Detailed Description of the Drawings

The present invention relates to a culture method and a hydro-tactic larval harvest, containment and transport system for harvesting of the common housefly, Musca domestica. The culture, harvest and application of the insect derived products and some by-products will be identified and described. An objective of the agriculture effort is maximization of the habitat and efficiency in harvest of the insects.

Husbandry of insect species is regarded as an agricultural endeavor. In particular, insects are raised for their meat, as feeder insects, as well as for the performance of tasks such as pollination or fatal parasitism. Reproduction is sexual with the life cycle progression from egg to larvae to pupae resulting after metamorphosis in adult flies capable of pairing. The fertilized female will lay in excess of five hundred eggs. The time sequence from egg to egg can take place in as little as a few hours, a few weeks or over several months. The larvae of the common housefly are small, weighing approximately one thousand larvae per ounce. The small size of the individual insects may produce a large harvest by growth of the insects in large number, which in the present system are grown at a population density of over ten thousand insects per square foot. Musca domestica may be the most widely dispersed species on the planet that can be seen with the naked eye. Flies are consumed by about everything that can catch them.

The present apparatus and method for culture of common housefly fly larvae, Musca domestica, and related species and other insects using similar locomotion, is based upon controlled biodegradation of organic material and upon containment structure that allows control of the self separation of the insects from their food source. The organic material includes livestock manures and other compostable vegetable and animal wastes or residue. Use of the word organic herein does not refer to foods that have been grown without the use of pesticides and other standard criteria, but instead refers to matter that may decompose.

After harvesting of the insect larvae produced, the bodies of the insect larvae may be used fresh or processed for aquaculture, poultry, pig, pet and, upon appropriate substrates, (entomophagy) human food applications. The agriculture commodity for live stock application would likely be classed with fish meal or blood meal. The insect material could be further processed for producing oils or other fractions, as is done with soy beans. In some example embodiments, the apparatus and method may utilize heat, light and electric current based techniques to harvest the larvae. However, testing and experimentation has determined that fluid, and in particular, water, is the most efficient harvest medium, as will be discussed below.

A breeding colony generally is maintained to provide the insect eggs. An insectary can be configured so that the insect eggs are collected on lay baits which are then transferred to the harvest apparatus. In another embodiment, the adult females flies may oviposit directly onto the harvest apparatus. Accordingly, in both such embodiments, eggs are provided to the harvest apparatus to begin the growth and subsequent harvest operations. A detailed description of the structure of the harvest apparatus is given below.

The following terminology may be used herein. The term "pile" may be used to refer to the entire system, including the physical harvest apparatus, the insects, and the organic food matter contained within the harvest apparatus. The term "medium" may be used to refer to the organic matter used as a physical support, i.e., a habitat, for, and as a food source for, the growing insects. Stated another way, the medium may consist of material to be reduced by biodegradation wherein the insects consume the manure and/or the microorganisms which grow in and on the manure. Typically the food larval grow medium is organic, and may be manure agricultural wastes, offal or virgin food. Many different materials can be used, including livestock manure and offal.

Some materials should be wet and others dry. In particular, the medium may be managed by layering materials such as moist manure and dry straw. The use of moisture bearing materials together with dry layers produces a warm environment which facilitates bioactivity to produce food, bacteria and yeasts, with the by product of heat, which further stimulates the system. For example, the medium may include dry or moist manure, dry or moist grains, dry or moist hay, food byproducts, such as lettuce trimmings or potato peelings, for example, or any other material which may be utilized as a support and/or a food source for the growing insects. The medium is thought to produce micro-organisms that are the growing larvae's main food supply. The biodegradation of the medium also produces heat which may be used to support/accelerate larvae growth. Surplus heat generated from the process may also be available for modest use elsewhere in the facility.

The term "substrate" may be used to refer to the food supply for the insects.

As will be described below, several different embodiments of the harvest method and apparatus are described. Each of these different methods of handling and container designs may all use the same or different mediums. In particular, three different embodiments will be described: the puddle, the pool, and the pond or lagoon, may each be used in the development of larvae culture. These three embodiments refer to differences in size, configuration and techniques of insect husbandry, with each including many similar aspects of the present invention.

The puddle is the smallest scale apparatus and may easily be worked in units of approximately twelve square feet. Typically, the puddle system is constructed of wood faced with fiberglass or paint. Wood may wick away moisture for evaporation, possibly with the use of air from a fan or an air jet. While the puddle configuration apparatus may be built in permanent form, it is also mobile and may be used as a temporary apparatus. The pool apparatus may be made of concrete or brick and raised with supporting outer gutters, drains and piped water. This system may be permanently installed at a particular location. The pond or lagoon may be an earthen structure and may also be permanently installed at a particular location.

The structural aspects of the harvest apparatus and method take into consideration that fly larvae have difficulty traversing dry surfaces and negotiating sharp corners, such as ninety degree angles or angles close to ninety degrees, and fly larvae may more easily traverse a surface that is moist. Accordingly, the walls of the larvae grow beds, in each of the puddle, pool and pond embodiments, contain the insects within unclimbable, dry, generally vertical walls, during the growth phase. After the insect growth phase is complete and harvesting is desired, fluid may be added, such as water, which may disrupt the environment producing their food and simultaneously may provide for their means for escape. In particular, upon the addition of moisture to the system, the larvae transport water with their bodies, using surface tension, to where they need it for laying an escape path. The generally vertical walls of the containment structure may include a rounded upper lip or a rounded top edge to facilitate the insects movement over the lip or edge when the rounded lip or top edge is moist.

In the puddle embodiment, the larvae and medium are contained in wooden grow trays measuring approximately twelve square feet, such as two feet wide and six feet long, for example. The trays are sealed so as to be moisture proof. The trays are placed in a containment tray, that may measure approximately four feet wide by eight feet long, and may include wooden risers to space the grow tray upwardly from the floor of the containment tray. The containment tray may include vertical side walls, approximately eight inches in height. The containment tray may also include a large aperture in the middle such that insects moving along the floor of the containment tray will fall through the hole. The aperture may be one foot in diameter, for example. The containment tray may also be sealed to be water proof, such as a wooden box that is painted. Positioned below the aperture of the containment tray may be another box, such as a collection box, which may be manufactured of unpainted wood. The collection box may be manufactured in a manageable size, such as two feet by two feet in width and length, with an eight inch high side wall. Once the insects are collected in the collection box, the small sized collection box may be removed. Adding water to the grow tray of this system facilitates the insects self mobilizing to leave the grow tray and the medium, falling into the containment tray and then thereafter falling into the collection box, which may then be removed from the system with the insects and without the mess or time of manually separating the insects from their food source in the grow tray. Accordingly, the system facilitates a migration that is controlled by non-return angles, drops, and dry surfaces that may be selectively moistened.

In the pool embodiment, the same actions take place on a much larger scale. The pool structure may be manufactured of wood or concrete. The grow bed may have drains and a water source installed in the floor. With water initiation of the harvest, the larvae may swarm over the lip of the pool and may be washed away in surrounding concrete gutters or a properly sloped floor. Retrieval of the insects may be conducted by filter baskets in the drain system.

In the pond or lagoon embodiment, the pond may be manufactured of any material, including earthen banks. This system could be manufactured on a scale of acres in size. The same medium may be used. The harvest may be hydro-tactic, as with the other two embodiments previously described. In this embodiment, the escape structure including the non-return angles, the drop and the water system, may be a perforated pipe. In one example embodiment of this system, removable pipes may be placed on the pond surface, wherein the pipes include apertures on an upper surface thereof. The apertures may include rounded surfaces so that the insects may traverse the rounded external surfaces and fall into the pipe, when the pipe is moistened. The harvest is initiated by back flushing the pipes with water until they overflow out through the apertures, with enough water adequate to disrupt the environment of the insects in the ponds. When the back flushing of the water is reduced to a trickle, so as to merely moistened the outside of the pipe, the larvae will climb the rounded outer surface of the pipe to escape the wet medium, enter the apertures with the slightly rounded top lip, and fall into the stream within the pipe, and be carried to a collection point by a flowing stream within the pipe. A sharp edge on the inside of the aperture may prevent the larvae from crawling back out, once contained therein.

The tubes may be manufactured in a variety of shapes. One example tube shape may be hemispherical having a flat bottom for stability so the tube will not roll over, and having a height, i.e., a diameter, sufficient to keep out refuse and to keep in the insects once they have fallen through the aperture. Round, square, triangular, and oval cross-sectional shaped tubes may also be utilized. The tube width may correspond to the desired water volume and in practice, the size of the pipe utilized may be quite small, such as one inch in width. The tubes may be manufactured of plastic or other durable material. The tubes may be connected together to connect multiple ponds together. Moreover, tubes may be connected together by removable connections such that the pipes may be temporarily placed in the ponds, allowing for easy removal and dismantling of the pipes prior to cleaning the ponds of the used medium.

The life cycle of fly is egg, larvae, pupae and adult fly. Harvest of the insects is generally conducted in the second growth stage, i.e., when the insect is in larval form, and before its metamorphosis into the adult fly stage. In particular, the third instar larvae seek a dry place to pupate. The water activation of the present method damages the insect's food stocks, annoys the insects, and gives them traction for self evacuating the grow bed and migrating to a collection structure.

The method and apparatus of the present invention takes into account the following variables: larvae are contained in dry surfaces and can migrate on moist surfaces; larvae must be contained to allow them to grow; and larvae of a class are cultivated to maximize growth and movement/self migration. In other words, the apparatus and method of the present invention facilitates for efficient and near complete harvesting of insects by providing structure and environmental conditions that encourage the insects to self migrate from their food source to a collection structure. Such self migration by the insects is more efficient and clean than mechanically reaching into their environment and attempting to physically lift and remove the insects. The method and apparatus may be referred to as a hydro-tactic expulsion process used in conjunction with selectively traversable exit structure.

The figures will now be discussed.

FIG. 1 is an exploded view of one example embodiment of an insect harvest apparatus 10. Apparatus 10, which may be referred to as the pile, may include a grow tray 12, a collection or guide box 14, and a dry catch box 16. In this embodiment, guide box 14 may measure approximately three feet wide by three feet long, by approximately eight inches tall, for example. Other sizes and dimensions may be utilized. Grow tray 12 may contain the medium 18 on which the insects 19 live and feed, such as dry and moist organic matter. In one embodiment, medium 18 may include a moist manure layer 18b with a dry grain layer 18a positioned thereon. The interface of the moist and dry layers is where the bioactivity of the degradation of the organic matter is believed to take place. Accordingly, at the interface of the moist and dry layers, is where bacteria is believed to grow, which is the food source for the growing insects. In one embodiment the medium 18 may be kept at approximately sixty five degrees Fahrenheit, however, other temperatures may be utilized to facilitate insect growth. In particular, the warmer the medium 18 is kept, the faster the growth phase of the insects may be. For example, at 65 degrees Fahrenheit, the growth phase may last ten days. At one hundred and eight degrees, the growth phase may last ninety hours.

In one embodiment, eggs may be harvested at a distant location and placed on medium 18. In another embodiment, the insect eggs may be directly deposited, i.e., laid, directly on medium 18. Medium 18 may be spread evenly across grow tray 12 but generally will not extend up to or contact a rounded top edge 22 of the grow tray, as will be described in FIG. 2.

FIG. 2 is a detailed cross sectional side view of a grow tray 12. Tray 12 may include a vertical side wall 20 that is kept dry during the growth stage of the insects because dry vertical walls will contain the growing insects and hinder them from exiting the grow tray 12. Vertical side wall 20 generally terminates at its top edge with a rounded or smooth edge 22 that will allow the insects to move over the smooth edge 22 when the edge is moistened during the collection or harvest step of the process. Accordingly, wall 20 and edge 22 may be referred to as selectively transversable surfaces, which may be controlled by the dryness or moisture of the surfaces.

Once the insects on medium 18 reach their third growth stage, right before metamorphosis, the harvest process may begin. During the harvest process, water or another fluid may be sprayed, ladled, or otherwise provided to grow tray 12 to wet medium 18. Moistening of the entirety of medium 18 will disrupt the insect's food source, will give the insects incentive to leave the unpalatable and undesirable medium 18 because the insects will avoid metamorphosis on a moist medium, and will provide a means of escape of the insects from tray 12. In particular, once the insects are wet they will carry moisture on their body surfaces to wall 20 and edge 22 of the tray. After enough insects contact wall 20 and edge 22 with their moist body, the wall 20 and edge 22 will become moist. Once wall 20 becomes moist, the insects are able to climb up moistened wall 20 and over rounded edge 22, and thereafter will fall from rounded edge 22 and into collection box 14.

Once in collection box 14, the insects are contained by the dry vertical side walls 24 of box 14 so that the insects will eventually fall through an aperture 26 in the bottom of collection box 14. Risers 30 on the floor of collection box 14 may ensure that grow tray 12 is spaced upwardly from collection tray 14 such that the insects may walk under grow tray 12 to fall through aperture 26. Moreover, risers 30 may be positioned in collection box 14 to guide the insects to walk toward and fall through aperture 26. After the insects fall through aperture 26, the insects fall into dry catch box 16.

Dry catch box 16 includes dry vertical walls 32 that will contain the insects within box 16. Dry catch box 16 may be smaller in size than collection box 14 so that the catch box 16 may be easily, periodically removed to harvest the insects contained therein. After harvesting, the insects may be killed, then dried, frozen and palletized, for example. Final products may also include the live insects themselves, or a liquified insect product.

FIG. 3 is an isometric view of another example embodiment of an insect harvest apparatus 10 that may include a plurality of pool beds 34. Each of pool beds 34 may measure approximately ten feet wide by twenty feet long, by approximately eight inches tall, for example. Other sizes and dimensions may be utilized. Each of the pool beds 34 functions as a grow tray, similar to that shown in FIG. 1. Each pool bed 34 may be manufactured of wood and may define a vertical side wall 20 having a rounded upper edge 22 that extends around all four sides of pool bed 34. During the growth stage, vertical side wall 20 and edge 22 is kept dry, and during the harvest phase, vertical side wall 20 and rounded upper edge 22 are moistened to allow the insects to exit pool beds 34 and fall downwardly from rounded upper edge 22.

Each of the pool beds 34 may be placed or manufactured within a collection box 14 that may be manufactured, for example, as a cement floor with a vertical cement wall 24 around three sides of the collection box 14, wherein the front vertical wall is not shown in this figure for ease of illustration. A catch structure 16, such as a gutter 34, may extend along the fourth side of collection box 14. As the insects exit pool beds 34, the insects will fall into collection box 14 and will be retained in the box 14 by vertical walls 24. The floor 36 of collection box 14 may be sloped downwardly toward gutter 34 such that when water is added to collection box 14, the insects will be washed into gutter 34 and may thereafter be collected by a filter mechanism 38, such as a filter basket, for example.

FIG. 4 is a cross sectional side view of a pool bed 34 of FIG. 3 showing medium 18, vertical side walls 20 and rounded top edges 22.

FIG. 5 is a top view of another example embodiment of an insect harvest apparatus 10 that may include a plurality of earthen lagoons 40, wherein only one lagoon 40 is shown for ease of illustration. Each of lagoons 40 may be approximately one acre in size, with an earthen side wall 20 approximately twelve inches tall, for example. Other sizes and dimensions may be utilized. Each of the lagoons 40 functions as a grow tray, similar to that shown in FIG. 1. Each lagoon 40 may be manufactured of dirt and may define a vertical side wall berm 20 having a rounded upper edge 22 that extends around all four sides of lagoon 40. During the growth stage and during the harvest stage, vertical side wall 20 and edge 22 is kept dry to retain the insects within lagoon 40.

Apparatus 10 may further include a collection system of pipes 42 that is shown large compared to the size of lagoon 40, for ease of illustration. Pipes 42 may be manufactured in any size or shape as desired, and may be an inch or less in width in one embodiment, and may be ten inches or more in width in another embodiment, for example. Collection system 42 may include one or more inlets 44 that may branch to several pipe runs 46 positioned within lagoon 40. Each of pipe runs 46 may include, in an upper surface of the pipe, a plurality of apertures 48 that function to allow passage of insects therethrough during the harvest phase of the process. In the embodiment shown, collection system 42 includes several example embodiments of aperture 48 shapes and sizes such as curved apertures 48a, large rectangular apertures 48b, narrow rectangular apertures 48c, and circular apertures 48d.

FIGS. 6 and 7 are cross sectional side views of two different embodiments of pipes 42 that may be utilized in the apparatus 10 of FIG. 5. FIG. 6 shows a circular shaped cross section of pipe 42 having a rounded vertical side wall 20, a rounded upper edge 22, and an aperture 48 defined by rounded upper edge 22. The round external shape of pipe 42 allows ease of manufacturing of the pipe. However, if the pipe is not buried within medium 18 to at least a midway point, a lower region 52 of the exterior surface of the pipe 42 may be exposed above the medium 18 and may be difficult for insects to climb. In other words, lower region 52 will define an overhang that the insects must climb up. However, if the pipe 42 is buried within medium 18 to at least its midpoint, then the exterior, generally vertical wall 20 provides a slope that is navigable by the insects such that the insects may climb wall 20, climb around edge 22 and fall through aperture 48 and into water 50 within pipe 42. The water 50 may then be used to carry the insects to a filter mechanism 38 (FIG. 3). Accordingly, in this embodiment, pipe collection system 42 functions as the collection box 14, similar to the apparatus of FIG. 1.

FIG. 7 shows a triangular shaped cross section of pipe 42 having a flattened vertical side wall 20, a rounded upper edge 22, and an aperture 48 defined by rounded upper edge 22. Due to the generally flat bottom 54 of the triangular pipe, the pipe 42 may sit on top of, or be buried slightly within, medium 18 to provide for an easily navigable climb for the insects from medium 18. Moreover, the generally flat bottom 54 of the pipe provides stability for the pipe and correctly positions apertures 48 at a top position. Accordingly, in this embodiment the sloped triangular vertical wall 20 provides a slope that is navigable by the insects such that the insects may climb wall 20, climb around edge 22 and fall through aperture 48 and into water 50 within pipe 42. The water 50 may then be used to carry the insects to a filter mechanism 38 (FIG. 3). Accordingly, in this embodiment, pipe collection system 42 functions as the collection box 14, similar to the apparatus of FIG. 1.

During the harvest phase, water 50 may be back flushed into lagoons 40 by pipes 42 and through apertures 48, or water may be sprayed directly onto medium 18. Use of back flushing may be desirable to clear any debris from pipes 42 prior to collection of the insects therein. Moreover, use of back flushing may be preferable because spraying may create a hardened outer surface of medium 18 which may trap insects within the medium, and inhibit exit of the insects from the medium. Moreover, back flushing water into medium 18 from pipe 42 may moisten medium 18 from the bottom up, thereby controlling the insects to move upwardly out of the medium 18 and toward pipes 42, rather than spraying which may result in the insects moving downwardly into medium 18 and away from collection pipes 42. Moistening of medium 18 will disrupt the food source of the insects, will give the insects incentive to leave the moist environment to undergo metamorphosis, and will moisten the pipes 42, thereby providing an exit path for the insects. In particular, the insects will exit the moistened medium 18 by climbing up the moistened sides of vertical side wall 20 and moistened rounded upper edge 22, to allow the insects to exit lagoons 40 and fall downwardly from rounded upper edge 22 through aperture 48 and into pipe 42. Thereafter, pipes 42 function as the catch structure 32 of the system.

Other enhancements may be made to the product and process described herein wherein such variations and modifications of the concepts described herein fall within the scope of the claims below.

I claim:

1. A method of harvesting insects, comprising:

providing a growth region bounded by a dry sidewall in a pre-harvest condition;

providing an exit structure including a rounded top edge;

providing moisture to said growth region; and

providing a collection structure adapted to capture insects that fall from said rounded top edge.

2. An apparatus for harvesting insects, comprising:

a growth region bounded by a dry sidewall in a pre-harvest condition;

an exit structure including a rounded top edge;

structure for providing moisture to said growth region; and

a collection structure adapted to capture insects that fall from said rounded top edge.

Abstract

An apparatus for harvesting insects includes a growth region bounded by a dry sidewall in a pre-harvest condition, an exit structure including a rounded top edge, structure for providing moisture to the growth region, and a collection structure adapted to capture insects that fall from the rounded top edge.

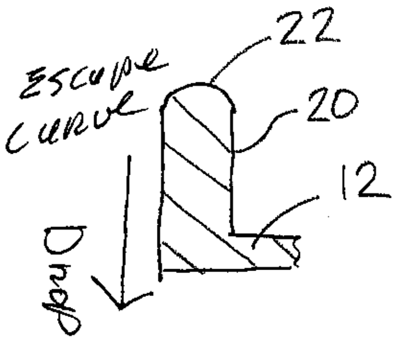
22
Escape curve
20
12
Drop

FIG. 2

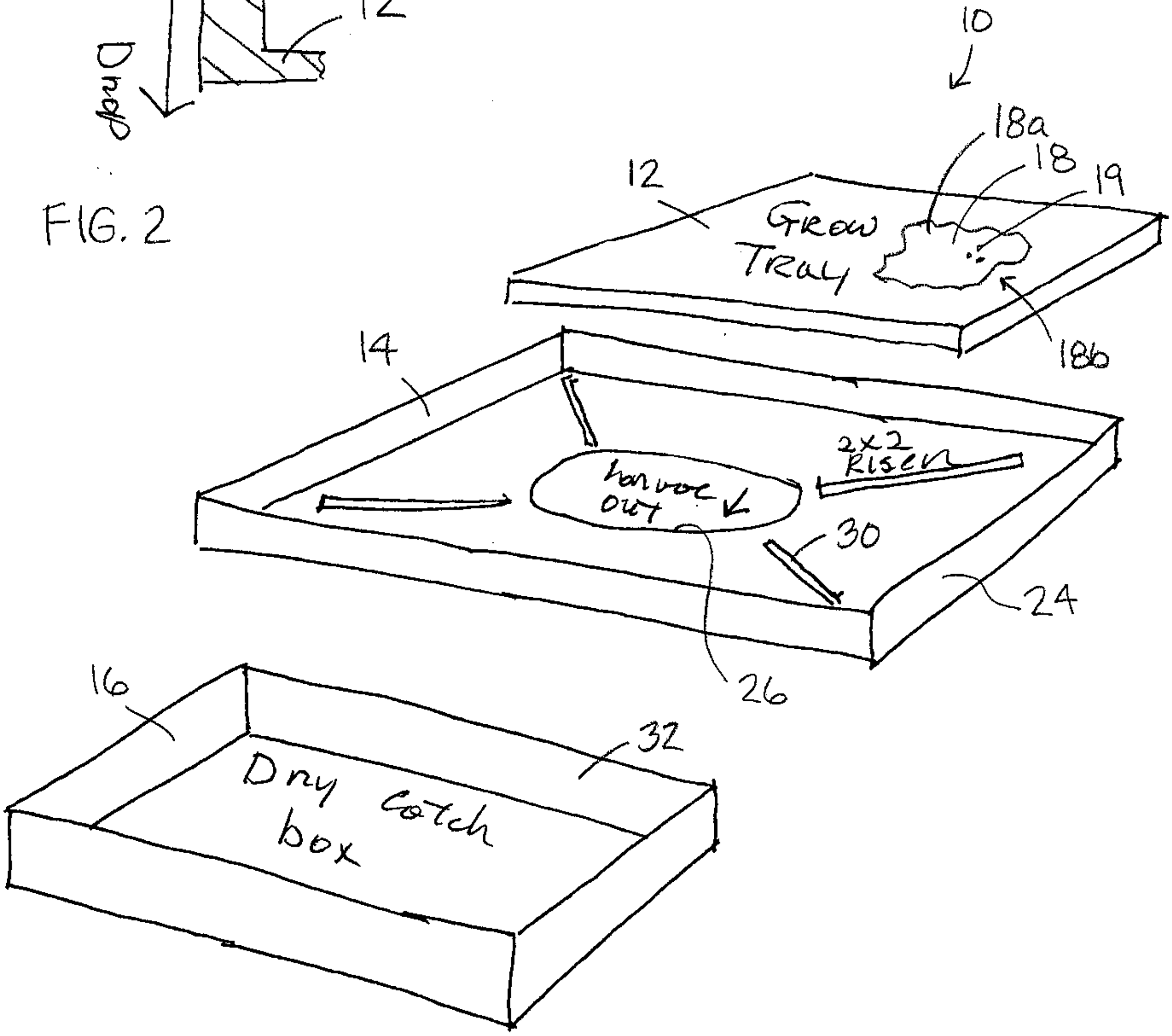
10
18a
18
19
12
Grow Tray
18b
14
2x2 Riser
larvae out
30
24
26
16
32
Dry catch box

FIG. 1

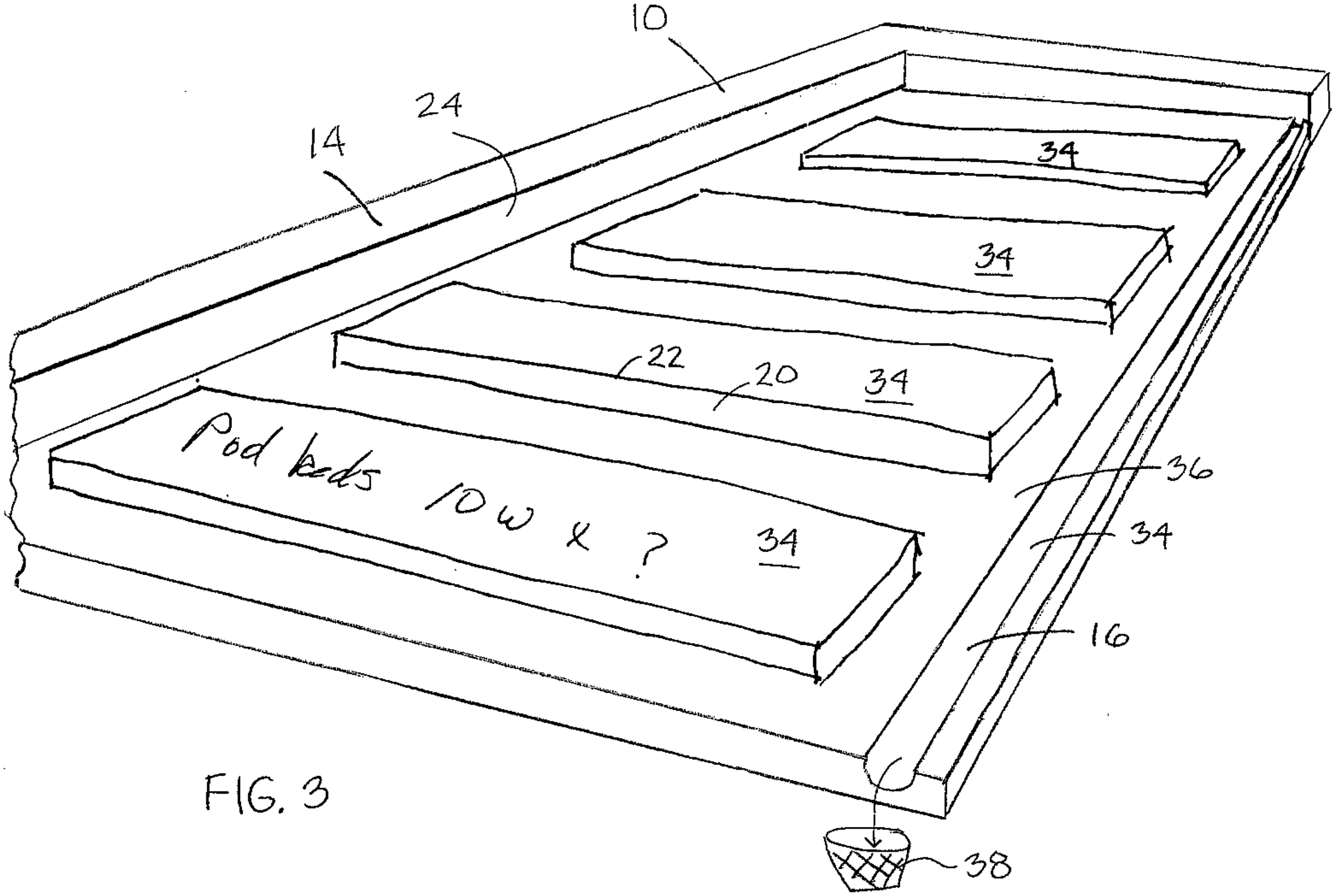

FIG. 3

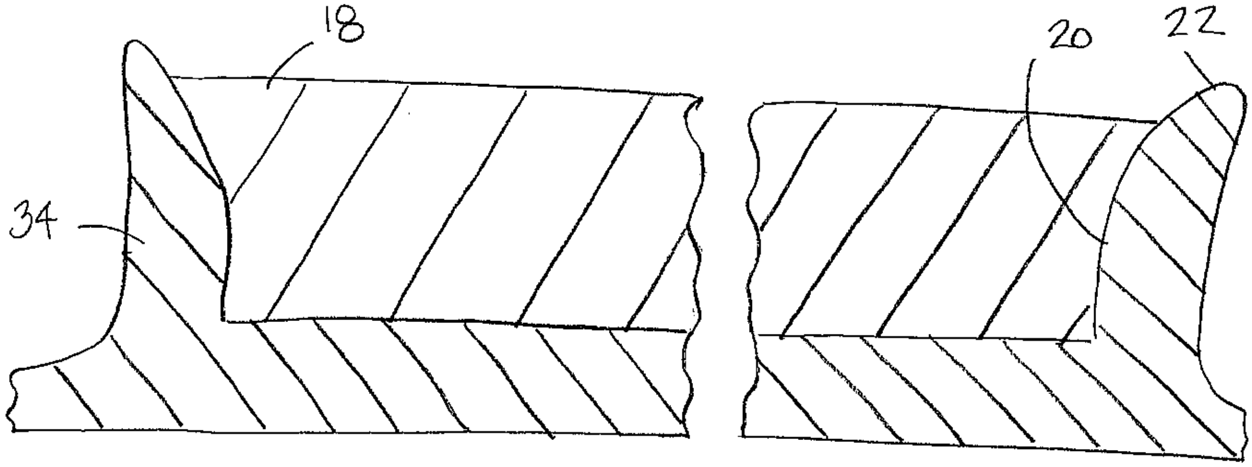

FIG. 4

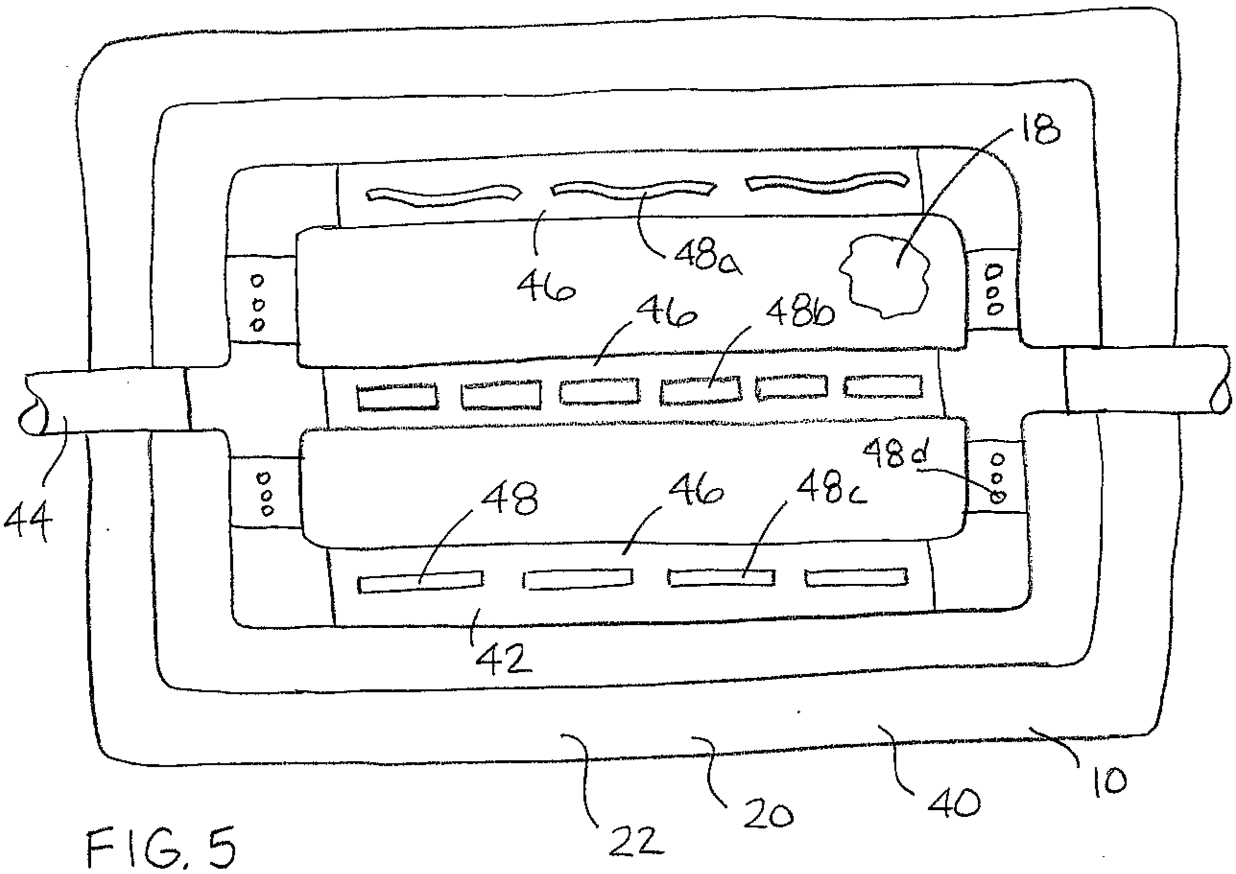

FIG. 5

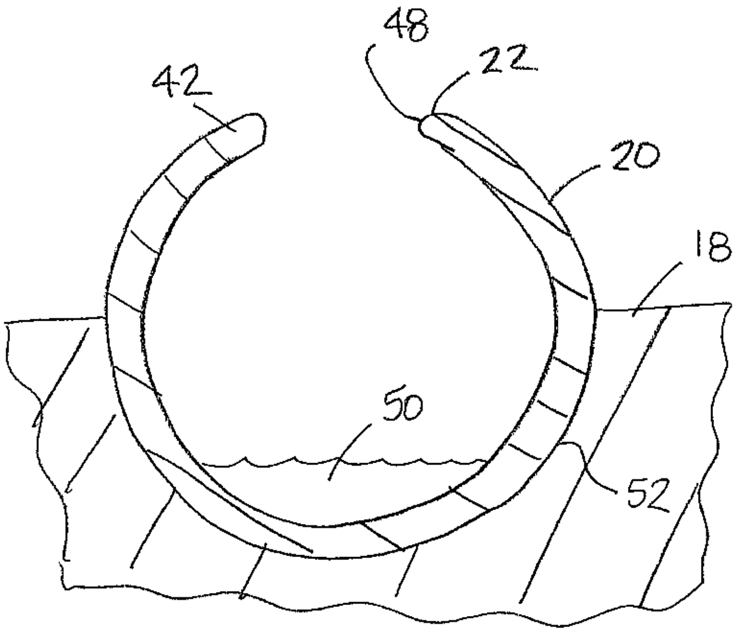

FIG. 6

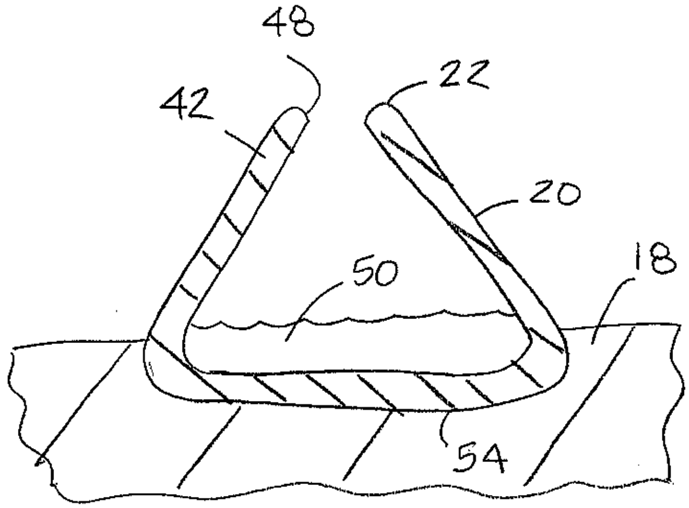

FIG. 7