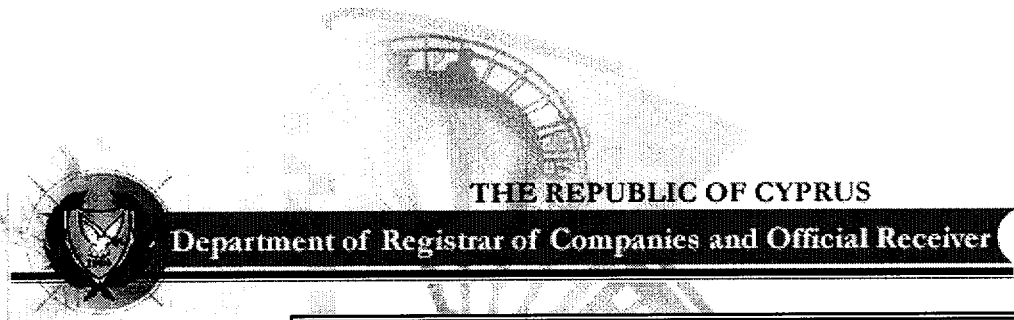




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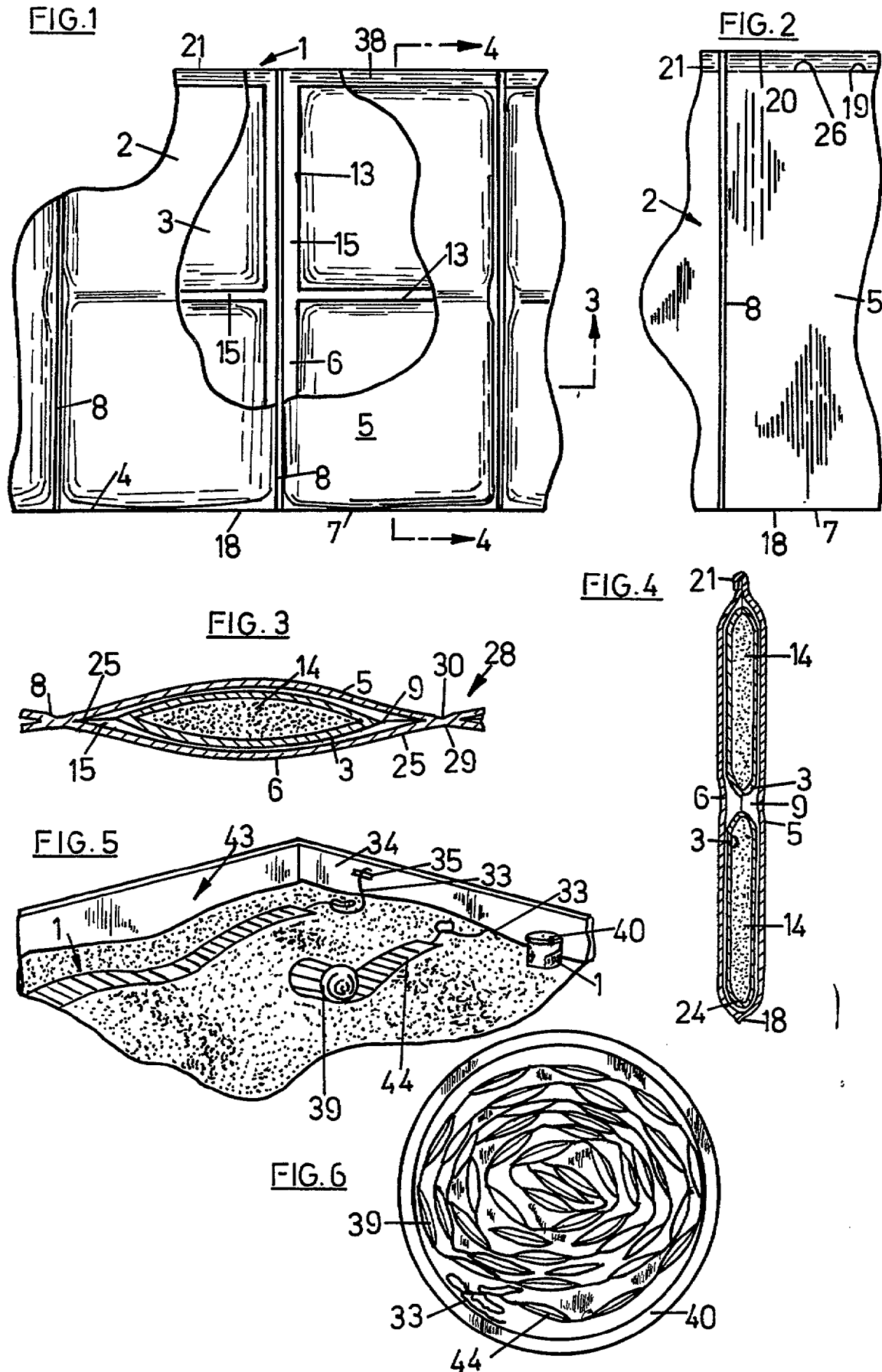
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(54) Method and apparatus for fumigating

(57) Apparatus for fumigating grain includes an applicator for porous envelopes or sachets of prepackaged pesticides which react with moisture and produce a toxic gas. The applicator comprises a strip of flexible, porous, non-hygroscopic material. The strip has two plies which are in an overlying relationship and interconnected along a side edge and includes seams which extend laterally across to interconnect the plies, and form pockets for receiving prepackaged pesticide sachets. The seams form a flexible hinge between adjacent pockets. A sachet is inserted into each pocket, the pocket is closed, and the filled applicator is deployed onto the surface of grain. Water vapor infiltrates the sachets and reacts to form a gas which permeates the grain and fumigates it. After the sachets have completely degassed, and the grain depository is vented, a free end of the applicator is grasped, and it is longitudinally rolled or folded along the seams, thereby quickly retrieving the sachets, without adulterating the commodity with pesticide residue.



SPECIFICATION

Method and apparatus for fumigating

5 The present invention relates to a method for fumigating a closed space and its contents by releasing toxic phosphine gas generated by the reaction of a hydrolysable metal phosphide pest control agent with atmospheric moisture until the available phosphine content of the agent has been substantially released, the space being kept tightly closed and being opened for the removal of residues of the agent after said substantially complete release and after the gas has been effective for a suitable period of days, and wherein the pest control agent is employed in a plurality of measured separate lots enclosed in a moisture pervious covering.

The invention is of the type which finds application in the fumigation of closed spaces, in particular those which serve for the storage of agricultural commodities such as fodder, grains, beans, ground nuts, tobacco and the like, such as silos, elevators, flour mills, warehouses, feed mills, and is of particular utility in the fumigation of transport means for such commodities, in particular rail cars, barges and ship holds. Known metal phosphide pest control agents contain as an active ingredient suitable hydrolysable metal phosphides such as magnesium phosphide or aluminium phosphide, usually the latter, which reacts with humidity to generate toxic phosphine gas. Phosphine is quite dangerous to humans, and at the end of the fumigation period there remains a residue which may still contain some unreacted metal phosphide.

35 Bulk commodities such as wheat or maize can be fumigated by metering the pelleted or tabletted pesticide directly into the grain as the same is being loaded into the storage depository. However, such a process is acceptable only in certain circumstances. In some circumstances it is necessary to separate the pesticide residue from the commodity prior to consumption or further processing thereof and this is cumbersome and adds to the cost of the procedure.

In a highly successful prior art modification of the method, see for example German patent specification 698 721 the metal phosphide chemical in powdered or granulated form mixed with self-ignition inhibiting agents is pre-packaged in measured amounts into porous crepe paper bags or sachets forming a moisture pervious covering. When these sachets are removed from their shipping container and exposed to atmospheric moisture, phosphine is emitted at a conveniently controlled rate, whilst the solid composition and eventually the powdery residue remaining after the composition has been spent, is safely retained in the sachet. Heretofore these sachets were inserted manually or with the aid of manually operated mechanical devices deeply into the commodity in a uniform pattern after depository had been filled. To facilitate the subsequent removal, the sachets were secured to one or more flexible lines by threading the same through an eyelet disposed in one end of the sachet and tying the line thereto. The method is laborious and time-consuming. Substantial precautions are necessary

to reduce the risk of workers being exposed to the toxic fumigating gases for an unduly long period of time and/or in unduly high concentrations. The sachets begin to emit gas soon after their removal from the airtight shipping container. It is essential that the sachets are introduced so quickly that the workers can vacate the fumigating areas before gas concentrations attain a hazardous or even lethal level. Where very large amounts of bulk commodities such as grain are to be fumigated in large spaces such as in ship holds, a great many sachets must be distributed. It is difficult to do so in a safe period of time.

There also remains the task of reliably removing all the sachets which are deeply buried inside the commodity at the end of the fumigating period without accidentally leaving some of the sachets behind, which could happen for example if a sachet tears loose from a string to which it is attached.

Empty spaces can also be fumigated by suspending a plurality of the aforesaid sachets from strings or cords in the said space. Special applicators for the fumigation of such empty spaces or of bag stacks, but which are unsuitable and not intended for insertion into grain or the like have been proposed.

One of the most recent proposals is in the form of a semi-rigid strip of plastics, dimensioned approximately 12,5 cm by 50 cm, containing a plurality of cup-shaped depressions, each depression containing a metal phosphide tablet and being closed by a moisture pervious covering of tissue paper (see German published specification 2206487). Previous attempts to insert the fumigating compositions deeply into bulk commodities such as grain enclosed in tubular applicator devices were not successful. The tubular bodies had to be of great mechanical strength. These materials not only were expensive, but also contain so much moisture that the pest control agent could not be produced in those devices without decomposition and could not be stored until the reaction had ceased.

As will be shown further below, the present invention provides a novel method and means in which a large quantity of metal phosphide pest control agent can be accommodated without decomposition and can subsequently be stored and shipped safely for long periods prior to actual use and can then be deployed at the fumigating locality and rendered operative in a minimum of time and using a minimum of labour, whilst permitting the rapid and safe retrieval of the spent fumigant residue at the end of the required fumigating period. It will be shown that the invention can result in substantial savings in time, substantial improvements in safety and satisfies the highest hygienic standards.

In accordance with the present invention there is provided a method for fumigating wherein separate lots of composition are enclosed in a plurality of moisture pervious pockets disposed over the length of a moisture free non-hygroscopic, flexible, tear-resistant band-shaped applicator, the applicator including the pest control agent being enclosed as a continuous length in coiled or folded up form in an airtight, substantially moisture-free storage container, the applicator being removed from the container immediately prior to use, whereafter the

applicator is unfolded or uncoiled and in its extended state is deployed in the said space containing the atmospheric moisture and wherein after the gas has been effective and after the space has been opened, the applicator containing the residues of the pest control agent in the pocket thereof is totally removed from the space, again rolled up or folded up and transported to a remote locality for disposal.

In practice the said flexible applicator has a substantial length of several meters, limited only by such factors as the convenience of handling, the weight of the filled applicator, the length which can be conveniently accommodated in airtight storage containers of convenient size and the practically occurring dimensions of spaces for the fumigation of which the applicator is intended. A convenient length is between 3 and 25 meters, say between 3 and 10 meters, preferably 4 1/2 meters, over which length said pockets are distributed, preferably in a uniform pattern.

In the preferred method a suitable number of said applicators for releasing a calculated amount of gas adapted to the space and a commodity contained therein is deployed on an exposed upper surface of the commodity, and the gas is released with the applicator deployed in that position whereby the gas diffuses downwards into the commodity and into all parts thereof. In other words, in contrast to the prior art methods, the applicator need not be embedded deeply inside the commodity at all. Surprisingly it is found that the phosphine gas has the capability of diffusing downward and penetrate all parts of the commodity in sufficient concentration to attain the required pest control effect, e.g. where the commodity is bulk grain such as maize or wheat and where the commodity is heaped to a depth of between 1 and 60 meters, preferably between 2 and 40 meters.

Normally a plurality of said applicators is deployed in spaced apart relationship distributed over said surface, more particularly such that the pest control agent is distributed reasonably uniformly over the entire surface.

Where the commodity forms a heap, the applicator may be applied from the top of the heap, one end being held from said top directly or attached to a flexible line, whilst the other end is dropped down the slope of said heap. The method is particularly convenient if the applicator is initially coiled up and is thus able to roll down the said slope and to become uncoiled in the process.

In the preferred embodiments the applicator is made of a moisture pervious, flexible, tear-resistant tissue of substantially moisture free non-hygroscopic, preferably hydrophobic plastics, e.g. a polyolefin plastics, preferably polypropylene. Because of the high tear strength of polypropylene the tissue can be comparatively thin and light.

In accordance with preferred embodiments, the pest control agent is prepacked in dust-proof, moisture pervious expandible sachets, more particularly the type of sachets referred to further above in the context of the prior art, and these sachets in turn are inserted in the said pockets of the applicator. In these circumstances it is unnecessary for the material of the applicator proper to be dust proof, since the sac-

het material will prevent the escape of pesticide residue.

Preferably the applicator material is thermoplastic and the pesticidal composition, e.g. prepacked as aforesaid, is heat-sealed into the said pockets.

The pest control agent is usually employed in powder form and includes a self-ignition inhibiting agent in a manner known per se. It is packaged in isolated lots to reduce the risk of auto-ignition, say of between 5 and 50 grammes of metal phosphide each, more preferably between 7 and 25 grammes of metal phosphide each, which lots are out of direct contact with one another in said applicator.

In the preferred method one end of the applicator is releasably attached, e.g. by means of a flexible line to stationary means associated with the space being fumigated at a locality from where said end is readily accessible for the eventual withdrawal of the applicator when being removed from the space.

In accordance with certain embodiments the composition is enclosed by welding between two layers of plastics forming the applicator, the one layer consisting of a moisture pervious, flexible, tear-resistant tissue, whilst the other layer is formed by a substantially moisture-impervious, flexible, tear-resistant foil, weldable to the former. The applicator is deployed on the surface of a commodity to be fumigated with the moisture-pervious layer facing downwards.

The method is of particular value in the context of fumigating bulk commodities whilst being transported between a locality of loading and a locality of unloading and wherein the required number of applicators is deployed after said loading and is removed before said unloading.

Also, in accordance with the invention there is provided an applicator for use in a fumigating method employing a hydrolysable metal phosphide pest control agent which releases toxic phosphine on contact with atmospheric moisture, contained in measured lots in a moisture pervious covering, having first and second overlying plies to form pockets for the lots of pest control agent, interconnected by flexible connecting means.

According to the present invention, such an applicator comprises an elongate strip of lightweight, tear-resistant, flexible, substantially moisture-free, non-hygroscopic thermoplastic material forming the said two plies of which at least one ply is porous and moisture pervious, the plies being intimately interconnected by welding seams, said welding seams and plies forming a plurality of closely sealable pockets for accommodating said portions of pest control agent, the regions between adjacent pockets forming a flexible hinge along which the applicator folds for rolling up or folding up accordion style with the pest control agent contained in the pockets for transport and for unfolding or uncoiling with the pockets filled with pest control agent for deploying the applicator on a surface in a space to be fumigated and to be coiled or folded up again after completion of the fumigation for the retrieval of the residue of the pest control agent without contaminating the commodity with said residue.

Certain preferred features of the applicator have already been disclosed in the context of the method in accordance with the invention and require no repetition. The light weight thermoplastic material preferably is in a form of a porous tissue of interadhering polyolefin fibres, having minimal moisture retention, preferably polypropylene and preferably including fibres oriented generally longitudinal of the strip for increased tear strength in the longitudinal direction. The invention extends to the applicator wherein the pockets already contain the pest control agent, preferably contained in the aforesaid sachets, the pockets being shut closed to retain the pest control agent in the pockets. Preferably the pockets are sealed closed after insertion of the pest control agent, e.g. sachets by a heat-formed weld.

Preferably the pockets are sealed closed after insertion of the pest control agent by a heat-formed weld.

According to a modification of the invention only one of the two plies is composed of said porous, moisture-pervious plastics, preferably the aforesaid tissue, whilst the other ply is in the form of a substantially moisture-impervious plastics foil. The latter is preferably transparent.

Further preferred features of the invention will be apparent from the description of certain preferred embodiments with reference to the accompanying drawings and from the claims which are to be considered as part of the present disclosures.

In the drawings:

Fig. 1 is a side elevational view of an apparatus embodying the present invention and including an applicator with pesticide sachets sealed therein, with portions of the applicator broken away to reveal internal construction.

Fig. 2 is a fragmentary side elevational view of the applicator with an open unsealed pocket.

Fig. 3 is a cross-sectional view of the applicator taken along the line 3-3, Fig. 1.

Fig. 4 is a cross-sectional view of the applicator taken along the line 4-4, Fig. 1.

Fig. 5 is a partially schematic, perspective view of the applicator shown applied to the surface of a stored agricultural commodity.

Fig. 6 is a top plan view of the sachet filled applicator folded into a coil and positioned within a container.

For purposes of description herein, the terms "upper", "lower", "right", "left", "rear", "front", "vertical" and "horizontal", and derivatives thereof, shall relate to the invention as oriented in Figs. 1 and 5, however, it is to be understood that the invention may assume various alternative orientations, except where expressly specified to the contrary.

The reference numeral 1 generally designates an apparatus for fumigating closed spaces and stored agricultural commodities, such as fodder, wheat, corn, rye, and other types of grains, and includes an applicator 2 for porous envelopes or sachets 3 of prepackaged metal phosphide pesticide of the type which react with moisture in the air and produce toxic phosphine gas. The applicator 2 comprises a ribbon 4 constructed of a flexible, porous, non-

hygroscopic material. The ribbon forms two overlying plies 5 and 6 interconnected along a side edge 7 thereof, and includes a plurality of seams 8 which extend across the ribbon 4, regularly interconnect the plies 5 and 6, and form pockets 9 for receiving the pre-packaged pesticide sachets 3 therein.

The dustproof sachets 3 directly retain the pesticide chemical therein in either powdered or pellet form, and are constructed of a material which will not react with the pesticide. The illustrated sachets are constructed of a crepe paper, and have a substantially square shape with creased side edges 13 which form a pillow shaped cavity in which the pesticide is retained. In this example, the pesticide 14 is in a powdered form, and two sachets are positioned in each one of the pockets 9. The length and the width of each of the sachets is sized to provide a margin 15 between the side and end edges of the pocket, as well as between adjacent sachets, to facilitate insertion of the two sachets into each pocket.

In the example each sachet contains 17 or 34 g powdered pesticide having the following composition:

70 weight % technical grade aluminium phosphide (approximately 70% AlP, 30% Al_2O_3)
26 weight % ammonia- and carbon dioxide forming chemicals
4 weight % Aluminium stearate.

The ribbon forms plies 5 and 6 is folded in approximately half, with a crease 18 forming the longitudinal edge 7, and free edges 19 and 20 (Fig. 2) positioned opposite the crease 18, the free edge 20 extending slightly beyond the other free edge 19 to form a flap 21 for closing the pockets.

Each of the pockets 9 preferably has an elongate shape which is oriented laterally with respect to the longitudinal axis of the strip. The pockets have a length and width in the range of 3 to 30 centimeters and 3 to 15 centimeters respectively, and are interconnected in very long chains of as many as say 300 pockets which corresponds to a total length of several meters, and up to 45 meters, preferably 3 to 10 meters, in particular 4 1/2 meters, e.g. containing 50 pockets. Each of the pockets has a closed end 24, disposed at the longitudinal edge 7 of the plies, a pair of substantially parallel side edges 25 formed by adjacently disposed seams 8, and an open end 26, located between the free edges 19 and 20 of the plies. The open end 26 of the pocket is shaped to receive one of the sachets 3 therethrough, and is closable with the flap member 21 to retain the sachet in the pocket. The illustrated pockets are each of an identical length and width, and receive standard size sachets therein.

The material from which the ribbon 4 is constructed is non-hygroscopic, i.e. it has negligible moisture absorption and retention properties. This serves to avoid inadvertent gas generation by the pesticide in the closed storage container by reaction of the pesticide with moisture. In earlier attempts a hygroscopic material was used such as conventional textiles. This renders the product initially unsuitable for storage, because of premature gas generation. Thereby the effectiveness of the pesticide is reduced, and a safety hazard results, because when the con-

ainers are opened, the workers are exposed directly to an initial discharge of fumigant gas. Because the workers are bending down to open the containers, such fumigant discharges are in close proximity to the mouth and nose of the worker. The high concentrations of the phosphine gas have a tendency to ignite spontaneously when the cans are opened, thereby creating a fire hazard. In the present invention, the strip material is non-hygroscopic. Suitable materials include non-hygroscopic synthetic fibres, e.g. polyolefins and their copolymers, polyesters, mixtures of polyolefin(s) and polyester(s) and modified non-hygroscopic cellulose materials. A preferred material having very low water retention properties, as well as other advantageous characteristics as discussed hereinafter, is polypropylene.

Although the strip material is non-hygroscopic, the same must also be porous and pervious to water vapor and the fumigant gas, such that when the applicator 2 is positioned over the commodity, water vapor in the air within the depository will infiltrate the applicator, react with the pesticide, and allow the fumigate gas to pass outwardly into the commodity. The preferred material is a lightweight, polypropylene in the shape of a thin, porous tissue having a translucent appearance, with the extrusion direction oriented longitudinally along the material for increased strength in that direction so that the applicator will not break under pulling forces. The polypropylene material may comprise woven fibers or a web of matted, adhered fibers, as in the present example, where it includes extruded longitudinally oriented fibers, with shorter, randomly oriented fibers adhered thereto. The polypropylene material has water vapor absorption/retention capability of less than 1% by weight, in particular 0.2-0.4%. The illustrated film has a thickness of for example between 0.08 and 0.25, say 0.1 mm, and a density of 20-100 grammes per square meter, say 30 g/m².

Preferably, the plies 5 and 6 are constructed of a heat fusible material, and the seams 8 are heat formed so as to produce a flexible hinge 28 (Fig. 3) between the pockets. In the illustrated example, the polypropylene plies 5 and 6 are integrally welded by parallel, heat formed seams which are regularly spaced along the entire length of the material, and extend uninterrupted across the material from the crease 18 to the outer free edge 20. The seams may be formed by a straight, heated tool, such as a platen bar, or the like, and in the structure illustrated in Fig. 3, have a heat-moulded area 29 of reduced thickness, having on one side a recess or groove 30.

Alternatively the individual pockets may be spaced apart, separated by pairs of seams and an interposed strip region, serving as a mere connection between one pocket and the next. In that case it is particularly easy to cut across the strip between the pair of seams if it is desired to use a length of applicator which is shorter than the full supplied length.

Finally it is also possible to provide such potential cutting regions only as specific intervals, e.g. at intervals of say 1 meter.

The applicator 2 may be provided at one end with a fixing means, e.g. a hook, tape, string or similar flexible line 33 (Fig. 5) to aid in the retrieval of the

applicator and spent sachets and pesticide residues therein. The line 33 is particularly useful in the fumigation of grains stored for transport such as in barges, ships, rail cars and the like, which generate vibrations and other motions during shipment which tend to bury the applicator in the commodity. The free end of the line is adapted to be attached to a readily accessible stationery portion of the transport by means such as the illustrated adhesive strip 35.

To assemble the applicator 2, the strip 4 is first folded, with the free edge 19 of the top ply 5 positioned inwardly of the free edge 20 of the bottom ply 6. The strip is then creased along the closed longitudinal edge 7, and the heat formed seams 8 are applied regularly along the length of the strip thereby integrally welding the plies 5 and 6 therealong and forming the pockets 9. Two prepackaged sachets 3, each prefilled with the powdered pesticide 14, are inserted in an end-to-end fashion into each of the pockets 9. The flap 21 is then folded about the edge 19 of the upper ply 5, and means such as a heat formed weld 38 connects the flap with the plies and securely closes the open end of each pocket. The sachet filled applicator is then rolled or folded into a substantially cylindrically shaped coil 39, which is in turn positioned into and sealed within an airtight container 40, preferably a tin can, for safe, prolonged storage and transport. The applicator is preferably folded and unfolded with the hinge recesses 30 oriented inwardly.

In a modification of the aforesaid example additional welding seams are applied in the longitudinal direction of the band between the two sachets 3 of each pocket at the time of sealing the pockets. Each pocket is thereby subdivided in such a manner that the two sachets can no longer slide one over the other.

It is also possible for the two plies 5, 6 of the apparatus in accordance with the invention to be provided initially as two separate ribbons. Appropriately a welding stamp tool is used adapted to produce for each pocket in one stroke three sides, i.e. two welding seams in the longitudinal direction of the ribbons and one transverse seam. The composition 14 or the sachet 3 is then introduced into the pocket which has its opening facing longitudinally. The next application of the welding stamp then seals the filled pocket by forming the next transverse seam and simultaneously forming a new pocket. If, as in the example of Fig. 1, it is intended to seal up two sachets at a time next to one another but separated by a welding seam, an E-shaped welding tool is used. Preferably the transverse seam is applied as a double seam formed by two parallel seam lines adapted for the easy cutting of the applicator between said seamlines without causing opening of the pockets.

The above mode of manufacture from two separate ribbons is particularly appropriate if the one ribbon 6 is to be moisture pervious, i.e. composed of the aforesaid plastics tissue whilst the other ply is a substantially impervious foil of a plastics weldable to that of the tissue. Preferably both plies consist of the same plastics, in particular polypropylene. An impervious foil as aforesaid is much more readily

printed upon for the application of trade mark matter, description of contents and directions. Such printing is unnecessary if the foil is transparent and printing is present on the sachets 3.

- 5 To fumigate a depository e.e. for an agricultural commodity, such as the illustrated ship hold 43, each compartment of the ship hold is first filled to the desired level. The fumigant, still stored and sealed in the containers 40, is transported to the ship hold.
- 10 The containers 40 are then carefully opened, and the applicator is deployed onto the free surface of the commodity, and positioned into a flat, fully extended position thereover. In the illustrated example, the coil 39 is pulled telescopically from the container 40
- 15 and placed with the free end 44 of the coil downwardly, and secured by line 33 in a position accessible through the hatch. The coil 39 is then rolled out in an unraveling or unfurling manner onto the surface of the commodity. The number of sachets
- 20 required to properly fumigate the commodity is preselected in accordance with the amount and nature of commodity to be fumigated, and the shape and volume of the depository. The principal guiding factor is the volume of the space, usually regardless of
- 25 the extent to which it is filled. Dosages may vary between 1 sachet per 3 m³ and 1 sachet per 20 m³ of space, a preferred dosage being 1 sachet (yielding 11 g phosphine) per 10 cubic meters. If required, additional filled applicators are deployed onto the surface of the commodity in a similar manner as the
- 30 first applicator, and the same are arranged in spaced apart rows as illustrated in Fig. 5. Because the sachets are preassembled in the applicator and the same are arranged in a coil, a great number of sachets may be evenly and uniformly distributed on the
- 35 surface of the commodity in a very quick and efficient manner by simply rolling out the coil along a substantially straight line on the commodity. To fumigate grain fills, the apparatus may be applied by
- 40 simply securing the free end of the coil with respect to the storage container 40, and allowing the coil to roll down the slope side of the grain under gravitational forces.

This operation is completed within minutes whereas the conventional operation, employing loose sachets, would require several hours.

After the applicator has been arranged on the grain, the depository is then closed substantially airtight. The moisture in the air, captured within the depository, infiltrates the applicator 2 and reacts with the pesticide within the sachet, thereby producing toxic phosphine gas which permeates the commodity and disinfects the same.

After the sachets have fully gassed and after an adequate period for the gas to take effect, the depository is opened and vented. The gassed sachets are then removed from the commodity by grasping a free end of the applicator, and longitudinally rolling or folding the same accordion-style

60 along the seams until reaching the other end of the applicator. In this manner, each and every one of the sachets is retrieved without damaging the same in a manner which would tend to disperse pesticide residue from the sachets into the commodity and contaminate the same. The coiled applicator is then removed

from the depository and transported to a remote location for disposal.

In the application of the applicator having only one moisture pervious ply and one moisture impervious ply, the pervious ply 6 is directed downwards, facing the commodity. The impervious ply 5 faces upwards. If the deployment takes place in an open loading hatch, the impervious ply 5 will thus protect the pest control agent against rain until the hatch is closed.

Some of the advantages are illustrated by the following results:

The conventional fumigation of a grain-filled (20,000 tons) storage space having a volume of 24 000 m³ and covering a surface area of 7 000 m² requires 40 000 sachets. To insert these into the grain requires 400 man hours.

Using 100 workers and provided the grain surface is covered immediately with foil, the phosphine concentration in the operating area may rise to 1 ppm (parts per million) before this operation is completed. Such concentration can result in symptoms of poisoning if inhaled for several hours.

Using only 50 workers the work will take longer, causing the phosphine concentration in the operating area to rise to values up to 30 ppm. Such concentrations are dangerous if inhaled for more than 30 minutes. Gas masks must be worn to enter such a space without serious danger.

At the end of the fumigating period (at least 5 days, preferably 10 days), the space must be thoroughly ventilated (for a period of 6 hours) before workmen can enter the space for the retrieval of the spent sachets. The retrieval work itself takes 40 man hours, in an atmosphere which is by no means entirely phosphine-free. To deploy the required quantity of pesticide in the manner according to the invention can be achieved by 40 workers in a few minutes. The concentration of phosphine released during that period is still below the detectability level using standard testing equipment. In storage spaces of a type where subsequent covering with foil is necessary, this as well takes place so rapidly that max. values (of 0.1 ppm) are never exceeded. If the strings attached to the applicator are fastened to the hatch opening of the storage space, it is not even necessary to enter the space for the retrieval of the spent pesticide. The applicators are simply pulled out, rolled up and removed for disposal.

The downward diffusion of phosphine into commodities such as grain when the applicators are deployed on the surface of the commodity is surprisingly effective and quick. Accordingly, using the above recommended dosage, it takes only about 2 to 3 days for highly effective gas concentrations such as 800-1000 ppm to be reached at depth such as 20 m below the surface of heaped grain.

CLAIMS

1. Method for fumigating a closed space and its contents by releasing toxic phosphine gas generated by the reaction of a hydrolysable metal phosphide pest control agent with atmospheric moisture until the available phosphine content of the agent has been substantially released, the space being kept tightly closed and being opened for the removal of residues of the agent after said substantially com-

plete release and after the gas has been effective for a suitable period of days, and wherein the pest control agent is employed in a plurality of measured separate lots enclosed in a moisture pervious covering, wherein separate lots of compositions are enclosed in a plurality of moisture pervious pockets disposed over the length of a moisture free non-hygroscopic, flexible, tear-resistant band-shaped applicator, the applicator including the pest control agent being enclosed as a continuous length in coiled or folded up form in an airtight, substantially moisture-free storage container; the applicator being removed from the container immediately prior to use, whereafter the applicator is unfolded or uncoiled and in its extended state is deployed in the said space containing the atmospheric moisture and wherein after the gas has been effective and after the space has been opened, the applicator containing the residues of the pest control agent in the pocket thereof is totally removed from the space, again rolled up or folded up and transported to a remote locality for disposal.

2. Method according to claim 1, wherein said applicator is deployed over its full length of several meters over which length said pockets are distributed.

3. Method according to claim 1 or 2, wherein a suitable number of said applicators for releasing a calculated amount of gas adapted to the space and a commodity contained therein is deployed on an exposed upper surface of the commodity and wherein the gas is released with the applicator deployed in that position whereby the gas diffuses downwards into the commodity and into all parts thereof.

4. Method according to claim 3, wherein a plurality of said applicators is deployed in spaced-apart relationship distributed over said surface.

5. Method according to claim 3 or 4, wherein a commodity in bulk form heaped to a depth of between 2 and 40 meters is fumigated, the phosphine gas being generated on the surface of the commodity and caused to diffuse downwards into the commodity.

6. Method according to any one of claims 3 to 5, wherein said commodity is bulk grain.

7. Method according to any one of claims 3 to 6 wherein the commodity forms a heap and the applicator is applied from the top of the heap, one end being held from said top whilst the other end is dropped down the slope of said heap.

8. Method according to any one of claims 1 to 7 wherein the pest control agent is wrapped in a moisture-pervious flexible tear-resistant tissue of substantially moisture-free non-hygroscopic plastics, forming said applicator.

9. Method according to claim 8 wherein the plastics is a polyolefin.

10. Method according to claim 9 wherein the polyolefin is polypropylene.

11. Method according to any one of claims 1 to 10 wherein the pest control agent is prepacked in dust-proof, moisture-pervious expandible sachets which in turn are inserted in the said pockets of the applicator.

12. Method according to any one of claims 1 to 11 wherein the applicator material is thermoplastic and wherein the pesticidal composition is heat-sealed into said pockets.

13. Method as claimed in any one of claims 1 to 12, wherein the pest control agent is in powder form and includes a self-ignition inhibiting agent and is packaged in isolated lots of between 5 and 50 g of metal phosphide each, which lots are introduced out of direct contact with one another into said applicator.

14. Method according to any one of claims 1 to 13, wherein an end of the applicator is releasably attached to stationary means associated with the space being fumigated at a locality from where said end is readily accessible for the eventual withdrawal of the applicator when being removed from the space.

15. Method according to anyone of claims 1 to 14 wherein the composition is enclosed by welding between two plastic plies from which the applicator is formed, the one ply being a moisture pervious, flexible tear-resistant tissue and the other a substantially moisture impervious, flexible, tear-resistant foil, weldable to the former.

16. Method according to claim 15, wherein the applicator is deployed on the exposed upper surface of a commodity to be fumigated with the moisture pervious ply facing downwards.

17. Method as claimed in any one of claims 1 to 16 wherein a bulk commodity is fumigated whilst being transported between a locality of loading and a locality of unloading and wherein the required number of applicators is deployed after said loading and is removed before said unloading.

18. An applicator for use in a fumigating method according to claim 1 employing a hydrolysable metal phosphide pest control agent which releases toxic phosphine on contact with atmospheric moisture, contained in measured lots in a moisture pervious covering having first and second overlying plies to form pockets to the lots of pest control agent, interconnected by flexible, substantially moisture-free, non-hygroscopic thermoplastic material the said two plies of which at least one ply is porous and moisture pervious, the plies being intimately interconnected by welding seams, said welding seams and plies forming a plurality of closely sealable pockets for accommodating said portions of pest control agent, the regions between adjacent pockets forming a flexible hinge along which the applicator folds for rolling up or folding up accordion style with the pest control agent contained in the pockets for transport and for unfolding or uncoiling with the pockets filled with pest control agent for deploying the applicator on a surface in a space to be fumigated and to be coiled or folded up again after completion of the fumigation for the retrieval of the residue of the pest control agent without contaminating the commodity with said residue.

19. Applicator as claimed in claim 18, wherein said strip has a length of between 3 and 10 meters.

20. Applicator according to claim 18 or 19, wherein the one ply consists of porous, moisture pervious plastics and the other of substantially mois-

ture impervious plastics.

21. Applicator according to claim 20, characterized in that the moisture impervious ply is transparent.

5 22. Applicator according to anyone of claim 18 to 21 wherein the pervious ply or plies are constructed of a porous tissue of interadhering polyolefin fibres having minimal moisture retention.

23. Applicator as claimed in claim 22, wherein
10 the polyolefin material is polypropylene and includes fibres oriented predominantly longitudinally of said ribbon.

24. Applicator as claimed in any one of claims 18 to 23, including a flexible line having one end thereof
15 attached to an end of the applicator and the other end thereof being adapted for connection with a stationary means in a readily accessible locality in a space to be fumigated to facilitate retrieval of the applicator and residues of pest control composition
20 contained therein at the end of a fumigation.

25. Applicator as claimed in any one of claims 18 to 24, wherein the pockets contain sachets of a dust-proof moisture pervious, substantially moisture-free, stretchable sheet material, filled with
25 metal phosphide pest control agent, the pockets being shut closed to retain the sachets in the pockets.

26. Applicator as claimed in claim 25, wherein the receiving end of each of said pockets is sealed
30 closed after insertion of the sachets by a heat formed weld.

27. Applicator as claimed in any one of claims 18, 19 or 22 to 26 wherein both plies are constructed of a single sheet of said material and the one side edge
35 thereof is folded and wherein one ply extends on the opening side of the pockets beyond the other to form a flap for closing such pocket.

28. Applicator as claimed in any one of claims 18 to 27, wherein the pockets are charged with pest
40 control agent, the strip being folded up or rolled up into a compact body which in turn is sealed inside a moisture proof container.

29. Method of fumigating a closed space and its contents, substantially as herein described.

45 30. Method according to claim 1, substantially as herein described and exemplified.

31. An applicator for use in a fumigating method according to claim 1, substantially as herein described.

50 32. Applicator according to claim 18 substantially as herein described and exemplified.

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