Sept. 15, 1959 M. M. MANNS 2,904,443

METHOD FOR THE INSERTION OF SAMPLING TUBES USED TO DETERMINE THE DISPERSION OF A FUMIGANT IN GRAIN AND APPARATUS THEREFOR

Filed April 17, 1956

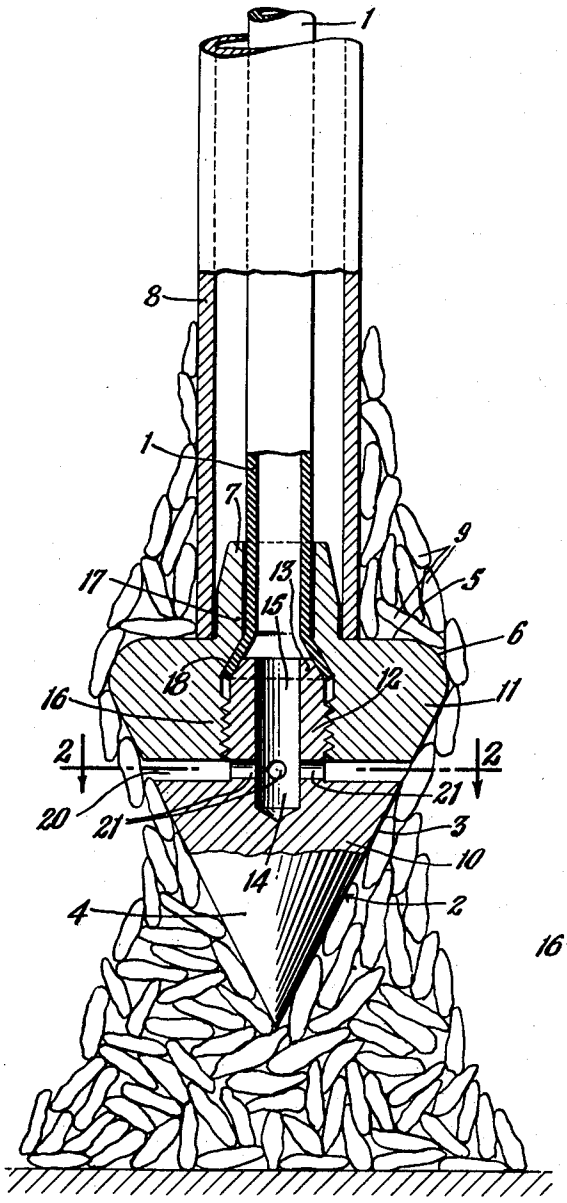


Fig. 1.

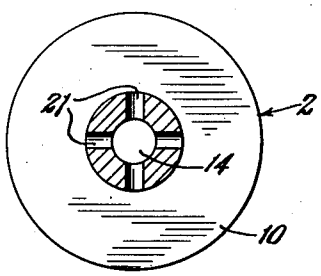


Fig. 2.

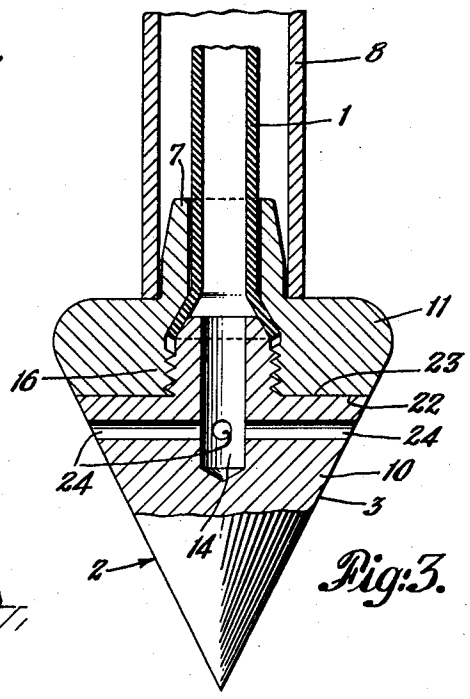


Fig. 3.

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United States Patent Office 2,904,443
Patented Sept. 15, 1959

2,904,443

METHOD FOR THE INSERTION OF SAMPLING TUBES USED TO DETERMINE THE DISPERSION OF A FUMIGANT IN GRAIN AND APPARATUS THEREFOR

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Application April 17, 1956, Serial No. 578,690

5 Claims. (Cl. 99—225)

This invention relates to an improved method for the fumigation of grain and of similar food materials and to a device for use in this method to determine the completeness with which the fumigation has been carried out.

In the storage of large bodies of grain and similar food materials, ducts are usually installed along the floor of the storage area before the area is filled with the grain. These ducts are for use in the periodic fumigation of the grain by the introduction of a gaseous fumigant, such as, for example, methyl bromide, through-out the body of the grain either by pulling it down from the top or pushing it up from the bottom. The purpose of such fumigation is to destroy insects which may infest the mass and to be effective the fumigating gas must penetrate all parts of the grain.

In connection with such fumigation, it is the usual practice to take air-samples from systemmatically spaced locations within the mass of grain and to measure the concentration of the fumigant in each air-sample, thereby determining the extent and uniformity with which the fumigant has permeated the grain. The locations at which such air-samples are taken are spaced apart at both horizontal and vertical intervals. Thus, air-samples may be taken at horizontally spaced locations which are vertically spaced to be near the bottom of the mass of grain, near the mid-point of its depth and near its surface, respectively.

The apparatus required to take samples of air from a mass of grain being fumigated must be installed prior to the release of a fumigant, such as methyl bromide, which is highly toxic to human beings. The apparatus heretofore used for taking an air-sample from a given location in a mass of grain has included a metal pipe of suitable length having a diameter of one-half inch or even smaller, which has a closed conical end which is inserted into the grain. This conical end is provided with a plural of perforations spaced around its conical surface through which air can be sucked.

This pipe is forced downwardly into the body of grain to a depth which places its conical end at the location from which it is desired to take the sample of air. The upper end of the pipe extending above the surface of the grain is connected by a conduit through which air is sucked to an instrument which measures its content of fumigant. The number of such pipes which are used in fumigation of a given body of grain is, of course, determined by the total volume of grain involved. The taking of samples from as many as forty-eight or more locations in a single body of grain is not unusual, and, as can be readily appreciated, the total length of metal pipe required to obtain the samples is large.

It is necessary to fumigate grain and other foodstuffs which are stored in bulk only at periodic intervals. Such fumigation requires considerable skill and specialized equipment and is usually done by crews which travel with their equipment to the various locations at which the grain is stored. The transportation of the large amount

of pipe required to obtain the air-samples is a time-consuming and expensive part of such operations. It creates a difficult problem in moving between remotely located grain storage locations because of its bulk and weight. Where commercial transportation is required, it can be prohibitively expensive, as in the case of air travel.

Now, it is the object of this invention to provide a method for the fumigation of grain and of other food materials having similar physical characteristics, which does not require the use of large amounts of metal pipe and utilizes equipment which is convenient to transport from one location to another.

It is another object of this invention to provide a device for obtaining air-samples in connection with the fumigation of grain, and similar food materials which are stored in bulk, which requires a total length of pipe only a few feet greater than the depth of body of material to be fumigated.

It is a further object of this invention to provide a device for obtaining air-samples in connection with the fumigation of grain which is relatively light in weight, and is readily transported from one location to another.

The method, in accordance with this invention, for the fumigation of a stored body of grain or of a similar vapor-permeable body of a food material includes a series of steps, the first of which comprises the positioning of a length of pipe around a flexible tube, the end of which is connected through the base of a conical suction-head to perforations in the head through which air can be drawn into the tube and firmly attached to the said head, forcing the suction-head downwardly into the body of the said food material to a predetermined depth by applying force to its flat base-section through the metallic pipe, withdrawing the pipe from the body of the food material and from around the flexible tube, while leaving the said conical suction-head at the predetermined location within the body of food material and connected to the flexible tube, now extending upwardly through the food material and out of its surface.

In this method, this first step is ordinarily repeated a number of times to position a series of the suction-heads at spaced intervals throughout the body of food material. The number of such suction-heads which are positioned within a given body of a food material and their relative positions is determined by the size and shape of the body and are selected so that the presence of the minimal content of fumigant required to destroy insects, in air-samples drawn through each of the suction-heads, indicates with reasonable certainty that such a minimal content of the fumigant is present in all parts of the body of food material.

In repeating this first step of the method, the same pipe is used in each repetition, so that the total length of pipe required is only that length necessary to force one of the suction-heads to a location of maximum depth within the body of the food material. I have found that it is generally convenient and frequently essential in the case of bodies of food material which have limited head room between its upper surface and the roof of the storage area, to utilize a series of relatively short sections of the pipe which are provided with suitable couplings, to thread the individual sections onto the flexible tube separately and successively, and then to successively couple the lengths of pipe as the preceeding length of pipe has been largely forced into the body of the food material. The short lengths of pipe also have the advantage of being more convenient to transport than a single long length of pipe. In general, I have found that pipe having an internal diameter of about ⅜ to about ⅝ inch in sections of about 4 to about 6 feet in length are convenient for this purpose.

The pipe which I use for this purpose may be made

of any structural material which has the strength and stiffness required to force the suction-head into the body of the food material. Ordinary iron or steel pipe is suitable for this purpose and aluminum pipe is convenient from the standpoint of its light weight.

A length of pipe formed from a series of short sections coupled together also offers an advantage when it is withdrawn from around the flexible tube, while leaving the suction-head at its predetermined position within the body of the food material. As each section is raised above the surface of the food material it may be disconnected from the length of the pipe still in the food material and separately removed from around the flexible tubing, thereby progressively lessening the friction between the tubing and the pipe which tends to displace the suction-head upwardly from its predetermined location. As this friction is lessened by the removal of successive lengths of pipe in this manner, progressively less care is required to raise the remainder of the pipe without displacing the suction-head.

After the desired number of suction-heads are placed in their predetermined locations, their connecting tubes are attached to apparatus located outside the fumigation area, which is adapted to suck air through each suction-head and its connecting tube, and to measure the content in the air of the particular fumigant which is to be used.

The fumigant is then released within the body of the stored food material, allowed to permeate throughout its mass and the quantity of fumigant in samples of air sucked through each of the suction-heads measured. In carrying out this measurement, air is usually sucked through each of the suction-heads and its connecting tube at the rate of one cubic foot per hour.

After the fumigant has been shown by these measurements to have penetrated all portions of the body of stored food material and the fumigation area is cleared of the fumigant, each of the flexible tubes and its attached suction-head is pulled from the food material. Each length of tubing is then coiled with its suction-head still attached, for convenience in transporting the equipment to the site at which it is to be next used.

The device, in accordance with this invention, is adapted for use in the foregoing method to determine the completeness of the fumigation of a stored food material and comprises a suction-head having a main body section which is generally conical in shape and has an interior chamber and a flexible tube which is firmly attached to this suction-head with its passageway opening into the interior chamber of the suction-head. This interior chamber of the suction-head is connected to its outer conical surface by at least one perforation and preferably by a plurality of perforations.

The accompanying drawing, in which like reference characters are used to designate like parts, illustrates preferred alternative embodiments of this invention. In the drawings:

Figure 1 is a view of an embodiment of the device in accordance with this invention in partial longitudinal cross-section,

Figure 2 is a cross-sectional view taken along the section line 2—2 of Figure 1, and

Figure 3 is a longitudinal cross-sectional view of an alternative embodiment of this device.

Referring to Figures 1 and 3, it will be seen that each of the alternatives illustrated by these figures consists of a flexible tube 1 and a suction-head 2. The tube 1 may be made of any flexible material which is relatively tough and is resistant to chemical attack by the fumigating gas. This tube should have a wall thickness such that its internal passageway is not readily closed by kinking and a tensile strength which will withstand a longitudinal pull of several pounds without permanent deformation or parting of the tubing. A variety of different polymeric materials are suitable materials for this tubing and I have found that tubing made of vinylidene-vinylchloride copolymer or of polyethylene is entirely satisfactory.

The suction-head 2 is generally conical in shape, with a conical surface 3 which forms a blunted point 4, and an annular surface 5 which corresponds to a portion of the base of its generally conical shape. The annular surface 5 is joined to the conical surface 3 by a rounded shoulder surface 6. The rounded shoulder surface 6 facilitates the removal of the device from a food material and is of importance in connection with the use of the device in the fumigation of a food material, such as, beans and field peas which are damaged by a tearing or cutting of their outer skins.

The annular surface 5 surrounds a centrally positioned guide section 7 which is slightly tapered and adapted to receive the end of a pipe without binding or wedging. As shown by Figure 1, this section 7 serves to center and to position the end of the pipe 8 squarely on the annular surface 5, and to keep it squarely centered on that surface as the suction-head is forced into a body of stored food material, even though a non-uniform resistance by the food material may tend to defect the suction-head 2 from a linear path. Further, the section 7 protects the flexible tube 1 from being abraded, pinched or cut by the end of the pipe 8 as the suction-head is forced into the body of a food material.

The protection given to the flexible tube 1 by the section 7 is an important feature of this device. Any abrasion or cutting of the flexible tube 1 by the end of the pipe 8 during the insertion of the suction-head into a body of food material can materially reduce its tensile strength and render it liable to parting when it is subjected to the tensile pull necessary to remove the suction-head from the food material, with the consequent loss of the suction-head in the body of food material.

The annular surface 5 is wider than the thickness of the wall of pipe 8, and as illustrated by Figure 1, extends outwardly from the outer circumference of the pipe 8 to prove a bearing surface on which the food material, indicated schematically at 9 in Figure 1, rests and provides resistance to the withdrawal of the suction-head 2 from the body of food material 9, when the pipe 8 is withdrawn from around the flexible tube 1. I have found that an annular surface 5 which extends radially from the outer edge of the bottom of the pipe 8 a distance within the range of about 1/16 inch to about 1/8 inch provides adequate resistance to the upward displacement of the suction-head 2 during the withdrawal of the pipe 8 from a food material, such as, for example, wheat.

Still referring to Figures 1 and 3, it will be seen that in these preferred embodiments of my invention, the suction-head 2 is comprised of two sections 10 and 11. Section 10 is a generally conical section and has an externally threaded section 12 which terminates in a truncated conical section 13. This section 10 has an internal chamber 14 which extends through the threaded section 12 and has a centered opening 15 in the top of the truncated conical section 13.

The section 11 of the suction-head 2 has the general external shape of a truncated cone and a centered perforation consisting of an internally threaded section 16 and an outer section 17 of a smaller diameter than section 16 and one which approximates the external diameter of the flexible tube 1. The internally threaded section 16 and the section 17 of this perforation are joined by internal truncated conical surface 18 and the internally threaded section 16 is adapted to receive the externally threaded section 12 of section 10.

As will be seen by reference to Figures 1 and 3, the threads of section 12 engage the threads of section 16 to attach the sections 10 and 11 firmly, but detachably together. The flexible tube 1 passes through the section 17 of the perforation through section 11 and its end is

stretched over the surface of the truncated conical section 13 and firmly clamped between the surface of that section and the conical surface 18 of section 11. This clamping of the end of the flexible tube 1 between the surface of section 13 and surface 18 firmly attaches to flexible tube 1 to the suction-head 2 as a whole and places its internal passageway in direct communication with the internal chamber 14 of the suction-head.

Referring specifically to Figures 1 and 2, it will be seen that in the alternative embodiment of this device illustrated by those figures, the threads on section 16 are interrupted near the base of the section and the section is of a length such that the conical surface 3 formed by sections 10 and 11 is interrupted by a groove 20, between the adjacent circumferential edges of the sections 10 and 11. The perforations 21, 21 extend from the bottom of this groove through the unthreaded portion of section 12 into the internal chamber 14. Thus, a continuous passageway for air is provided from the groove 20, through the perforations 21, 21 and the chamber 14 to the inside of the tube 1.

Referring specifically to the alternative form of this device illustrated by Figure 3, it will be seen that conical surface 3, formed by its sections 10 and 11 is not interrupted by a groove and that the adjacent edges 22 and 23, respectively, come together to form a flush joint which forms no substantial interruption in the conical surface. In this embodiment of the device four perforations 24, 24 extend from the conical surface of section 10 at positions near its edge 22 to the internal chamber 14. These perforations 24, 24 and the chamber 14 provide a direct passageway for air from the conical surface 3 to inside of the tube 1.

The diameters of the perforations 21, 21 or 24, 24, as the case may be, are smaller than the smallest diameter of the individual particles of the particular food material with which the device is to be used, to avoid sucking the food material into the chamber 14 during the use of the device. I have found perforations having a diameter of about 1/16 of an inch are satisfactory for use with wheat. Since the volume of air which must be sucked through these perforations is relatively small, perforations of this approximate diameter are generally satisfactory.

The suction-head 2 may be made of any suitable structural material, such as, for example, a plastic or a metal. However, I have found that it is desirable to include at least enough of a magnetic metal in its structure to enable it to be picked up by a tramp-metal magnet and in general I prefer to fabricate it from a ferrous metal. It is highly desirable to have the suction-head reactive to a tramp-metal magnet, particularly for use in connection with the fumigation of wheat and other grains which are subjected to milling operations, since a lost suction-head in such a grain can seriously damage the milling equipment, if not picked up by a tramp-metal magnet.

The method and the device adapted for use in carrying out this method are useful in the fumigation of a wide variety of food materials which are stored in bulk, such as, for example, the various grains including wheat, barley, rye, oats and corn and various species of beans and peas. It is useful with a variety of different fumigant gases, and is particularly well suited for use with methyl bromide, which is extensively used for the fumigation of such food materials.

In the foregoing, specific details as to carrying out the method, in accordance with this invention, have been described to fully and completely explain the method. It will be obvious to those skilled in the fumigation of food materials that these details can be varied in a number of respects and that minor adaptions must be made in the application of the method with a particular food material under specific circumstances.

Similarly, two specific embodiments of the device in accordance with this invention have been described by the foregoing for the purpose of fully and completely explaining the nature of the device. These embodiments have been described to specifically illustrate the invention and it will be understood that the many variations can be made in the details of the construction of this device.

I claim:

1. A method for determining the dispersion of a fumigant within a body of a vapor-permeable food material which includes the successive steps of positioning a pipe around of flexible tube the end of which is connected to a suction-head through which air can be drawn into the said flexible head, forcing the said suction-head downwardly into the body of food material to a predetermined depth by applying force to it through the said pipe, withdrawing the said pipe from around the flexible tube while leaving the said suction-head at the predetermined location within the body of the food material and still connected to the flexible tube now extending upwardly through the food material and out of its surface, and after a fumigant gas has been released within the said body of food material, sucking air through the said suction-head and the said flexible tube and measuring the amount of the fumigant gas contained in the air, and withdrawing the said flexible tube and the suction-head from the said body of food material.

2. A method for determining the dispersion of a fumigant within a body of a vapor-permeable food material which includes the successive steps of positioning a metal pipe around a flexible tube the end of which is connected through the base of a conical, metal suction-head to perforations in the said head through which air can be drawn into the said flexible tube, forcing the said conical suction-head downwardly into the body of the said food material to a predetermined depth by applying force to its flat base section through the metal pipe, withdrawing the said metal pipe from around the said flexible tube while leaving the said conical suction-head at the predetermined location within the body of the food material and connected to the flexible tube now extending upwardly through the food material and out of its surface, and after a fumigant gas has been released within the said body of food material, sucking air through the said perforations in the conical suction-head and the said flexible tube and measuring the amount of the fumigant gas contained in the air and then withdrawing the said flexible tube and the suction-head from the body of food material.

3. A method for determining the dispersion of a fumigant within a body of a vapor-permeable food material which includes the successive steps of positioning a metal pipe around a flexible tube the end of which is connected through the base of a conical, metal suction-head to perforations in the said suction-head through which air can be drawn into the flexible tube, forcing the said conical suction-head downwardly into the mass of the said food material to a predetermined depth by applying force to its flat base section through the metal pipe, withdrawing the said metal pipe from around the said flexible tube while leaving the said suction-head at the said predetermined location in the body of food material and connected to the flexible tube now extending upwardly through the food material and out of its surface, repeating the foregoing steps utilizing the said metal pipe to position a plurality of such suction-heads and connecting flexible tubes within the body of the food material with the said suction-heads positioned at locations which are systematically spaced apart within the said body of food material, and after a fumigant gas has been released within the said body of food material, sucking air through each of the said suction-heads and the connecting flexible tubes and measuring the amount of the fumigant gas contained in the air sucked through each of the suction-heads, and then withdrawing each of the flexible tubes and the suction-heads attached thereto from the body of the food material.

4. A method for determining the dispersion of a fumi-

gant within a body of a vapor-permeable food material which includes the steps of positioning a plurality of sections of pipe around a flexible tube the end of which is connected through the base of a conical suction-head to perforations in the suction-head through which air can be drawn into the flexible tube, forcing the said conical suction-head downwardly into the mass of the said food material by applying force to its flat base section through the first of the said sections of metal pipe positioned around the flexible tube until a substantial proportion of the length of the said section of metal pipe is positioned within the body of food material, attaching the end of the second section of pipe to be positioned around the said flexible tube to the upper end of the first section of pipe and continuing to force the suction-head downwardly through the body of food material by the application of force through the joined sections of pipe and repeating this step of adding a section of pipe and moving the suction-head downwardly into the body of the food material until the said suction-head is positioned at a predetermined location within the body of the food material, withdrawing the said joined sections of pipe from around the said flexible tube while leaving the said suction-head in its predetermined location and connected to the flexible tube now extending upwardly through the food material and out of its surface, while disconnecting each of the said sections of pipe as soon as its full length is above the surface of the food material and removing it to a position such that it no longer contributes a frictional force on the said flexible tube which tends to displace the said suction-head in an upwardly direction, and after a fumigant gas has been released within the said body of food material, sucking air through the said suction-head and the said flexible tube and measuring the amount of the fumigant gas contained in the air, and withdrawing the said flexible tube and the suction-head from the said body of food material.

5. A device for determining the completeness of the fumigation of a body of stored food material which comprises a flexible tube and a suction-head which is generally conical in shape and is composed of a cone section and a base section; the said cone section being generally conical in shape and having an internal chamber, a plurality of perforations extending from the said chamber to its conical surface, an externally threaded cylindrical section terminated by a truncated conical section and a perforation extending through the said cylindrical section and into the said chamber; and the said base section having generally the shape of a truncated cone with its conical surface connected to its base by a rounded shoulder, a tapered guide section centered on the base with a flat annular bearing surface around the said guide surface, a centered cylindrical perforation extending through the said guide section and the remainder of the section, which consists of an internally threaded inner section, the threads of which engage the threads of the external threads of the cone section, a smaller outer section in which the end section of the flexible tube is positioned, and an internally conical surface connecting the two cylindrical sections which cooperates with the truncated conical section in clamping the end of the flexible tube stretched over the truncated conical section with its passageway communicating with the perforation extending through the externally threaded portion of the cone section.

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