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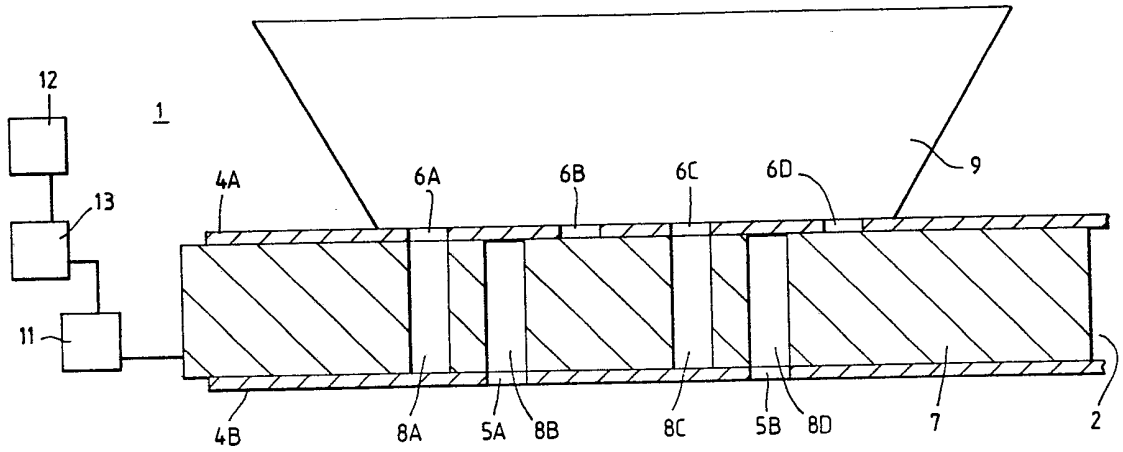
(54) Apparatus for dispensing measured amounts of granular material

(57) Apparatus for dispensing measured amounts of granular material including a reservoir 9 below which is mounted an upper plate 4A having apertures 6A, 6B, 6C and 6D therein. A lower plate 4B has openings 5A and 5B displaced from the apertures and a metering bar 7 is reciprocable between these plates, the metering bar including cavities 8A to 8D which can alternatively be aligned with the apertures to receive a measured quantity of granular material and with the openings so that this quantity can subsequently be discharged.

Fig.1.



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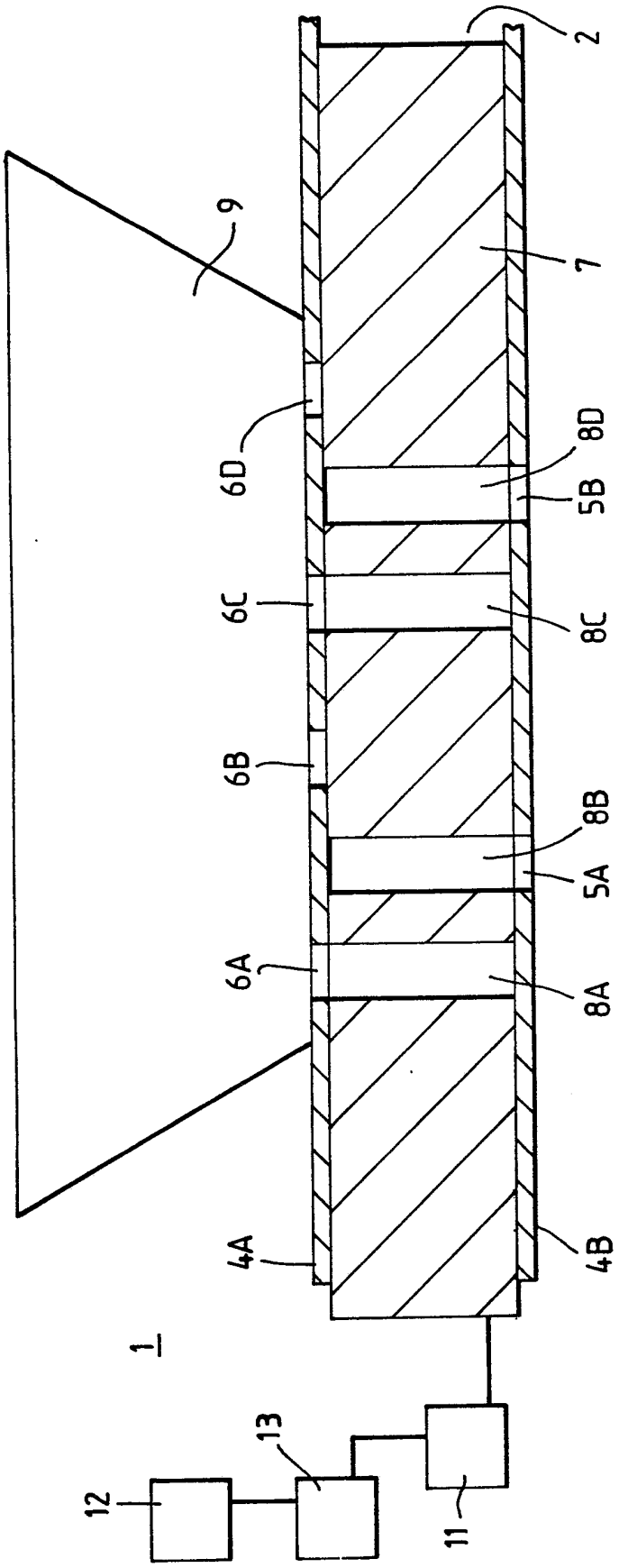

Fig.1.

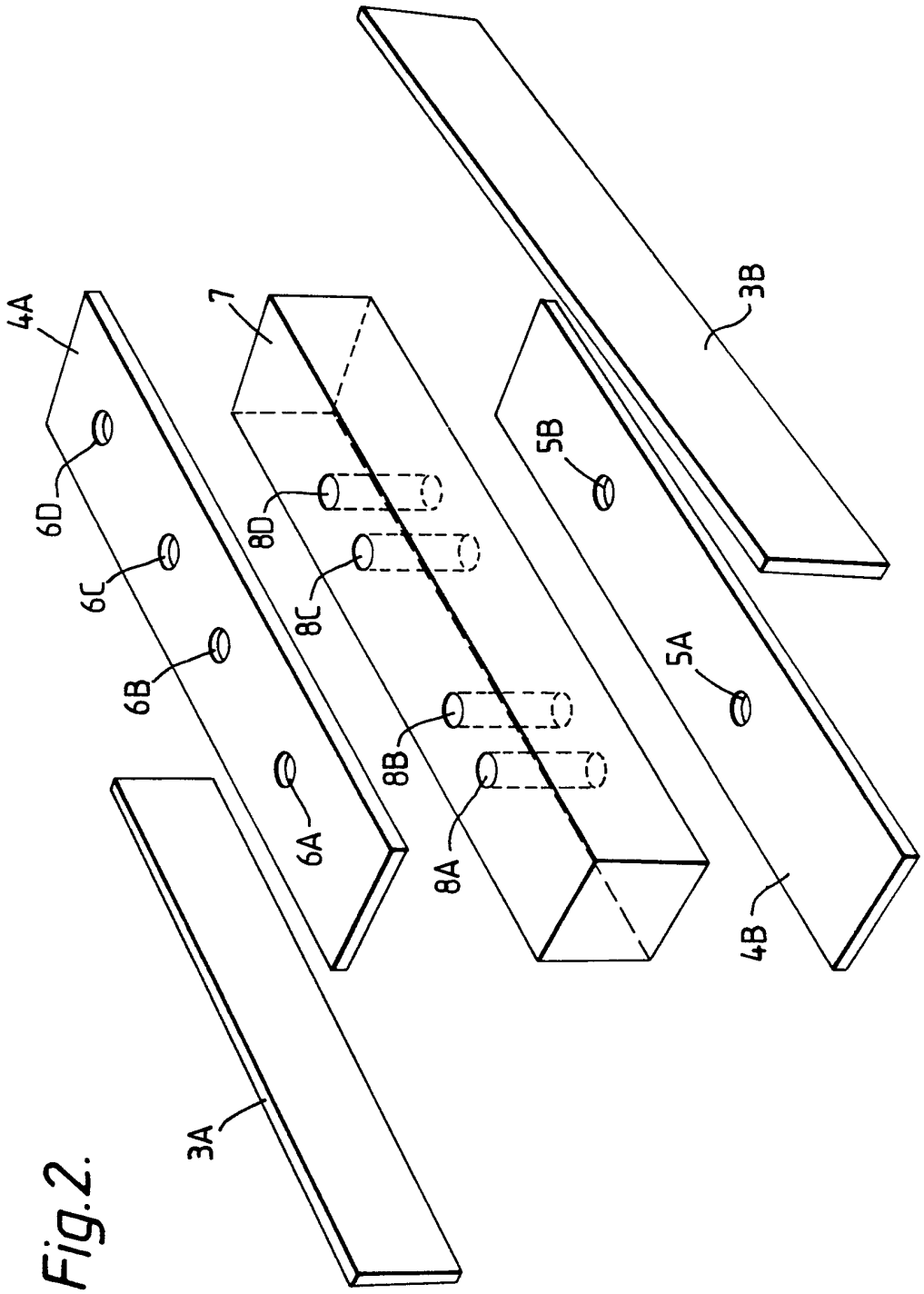

Fig.2.

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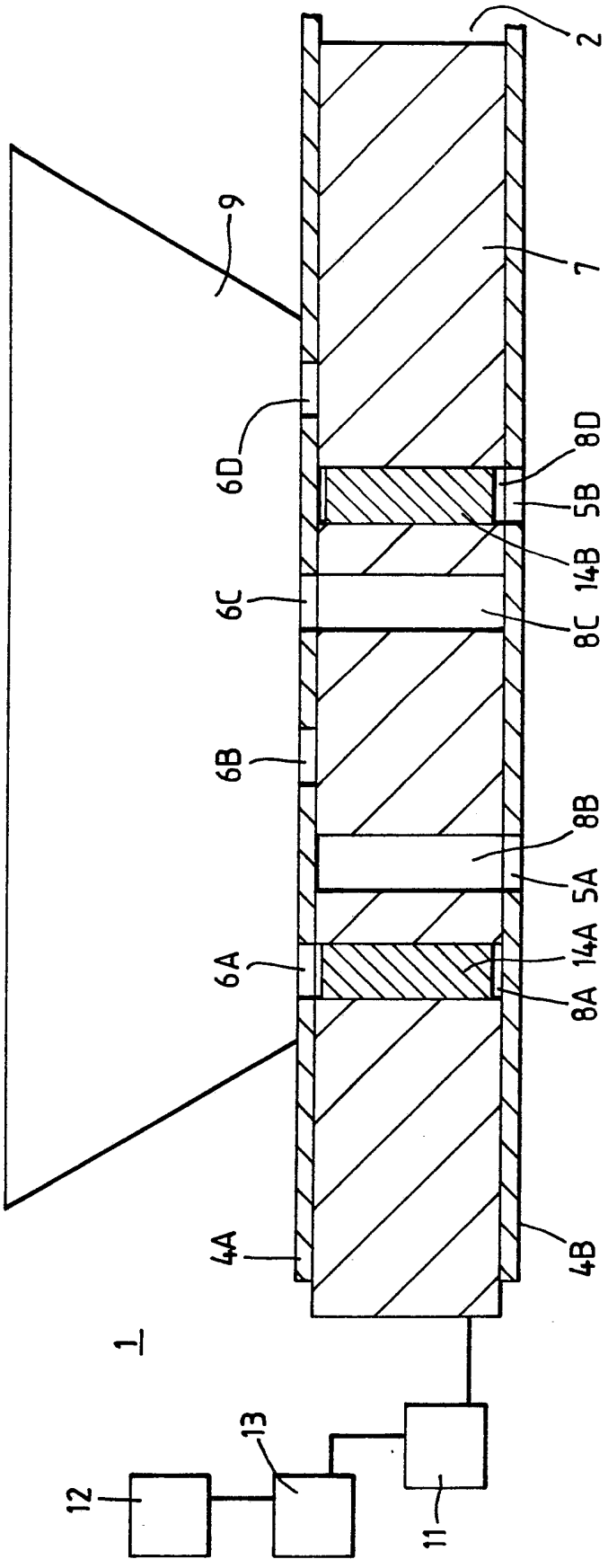

Fig.3.

APPARATUS FOR DISPENSING MEASURED AMOUNTS OF GRANULAR MATERIAL

Commercial application of various granular pesticides is currently accomplished by using granular applicators which rely on two basic methods of rate calibration. One method relies on a variable orifice, and the other on positive displacement. These two methods are used to apply a continuous flow of granular material from the applicator to the target. Adjustments can be made to these metering units which alter the flowrates emitted such that various desired application rates can be achieved. Generally, granular applicators which rely on these two metering methods to apply a continuous flow of material are attached to machines that are propelled by tractors. Such continuous flow machines are most suitable for applying bands of pesticides to general agricultural row crops and mature tree crops, such as citrus.

Another type of metering device is designed to deliver intermittent doses of granular materials when properly attached to manually propelled applicators such as units built by Carpi (Italy) and Swissmex (Mexico). The unit provides accurate measurement of granular materials by means of an oscillating disk which has cavities for positive measurement, the disk being moved manually.

Methods presently used for applying pesticides to young citrus trees include manually operated applicators or metering orifice type granular applicators such as that sold

under the Trade Mark GANDY SUPER row crop unit. Manually operated methods further include labourers using a small metering device such as that sold under the Trade Mark PERFECTA-FEED physically placing the pesticide at three or four points at each young tree and simultaneously covering the granules with soil. Measuring spoons are also used. Such hand application methods increase worker exposure to the pesticide.

The purpose of this invention is to provide a machine that accurately and rapidly measures individual doses of granular materials, and which is activated by means of automatic or manual control. These features enable the invention to be fitted on vehicles that can be used on a variety of agronomic tree and vine crops and deliver individually measured doses of the granular products while travelling at a groundspeed which results in a relatively high production rate.

Workers at Ohio State University have developed a sprayer assembly which is activated when an infra-red light beam directed to a reflector attached to the assembly is broken by the presence of the plant to be sprayed. The reflector is attached to the assembly by an arm which extends away from the assembly and to the side of the target opposite the assembly. In order to position the reflector, the arm must extend over the target, and therefore the assembly is primarily useful for application of sprays to small plants.

U.S. Patent No. 4,635,829 describes a dispensing apparatus for dispensing discrete measured amounts of fluent material, wherein a dispenser body defines a horizontal tubular chamber. One inlet port communicates with the top of the tubular chamber, and one outlet port communicates with the bottom. Rotation means and displacement regulating means of the pistons are used to transfer fluent material from the inlet port to the outlet port.

According to the present invention there is provided apparatus for dispensing measured amounts of granular material, said apparatus comprising a reservoir for granular material, an upper generally horizontal plate mounted below said reservoir, a lower plate mounted parallel to and spaced from said upper plate, a horizontally movable metering member, having upper and lower surfaces in sliding contact with the lower face for the upper plate and the upper face with the lower plate, respectively, at least two spaced cavities having a predetermined volume extending through said metering member and each opening into the upper and lower surfaces thereof, said cavities being spaced apart along the line of movement of said metering member, at least two apertures formed in said upper plate at locations whereby said cavities pass below the apertures, at least two openings in said lower plate at locations different from the locations of the apertures in the upper plate, but so that said cavities pass above the openings, and means to move said metering member intermittently from positions in which

at least one cavity can receive granular material from an aperture in the upper plate to a position in which this granular material can fall out through an opening in the lower plate and at the same time granular material can pass into another of said cavities through an opening in the upper plate.

Such an apparatus can accurately measure granular materials in an intermittent fashion, can be activated in a manner which allows high speed operation and delivery of granular material to a target and allows various desired granular application rates to be achieved.

While the metering member can take many forms, for example, a circular disc with one or more circular arrays of cavities therein, and this can be intermittently indexed forward, according to a preferred construction, the metering member is in the form of a metering bar which can be reciprocated axially of the length of the bar. In one preferred construction the metering element includes four cavities, the upper plate including four apertures and the lower plate two openings.

In order that the present invention can more readily be understood, the following description is given merely by way of example, reference being made to the accompanying drawings in which:-

Figure 1 is a side elevation in cross section of one embodiment of apparatus according to the invention;

Figure 2 is a perspective exploded view of the

metering bar and the upper and lower plates as well as two side plates forming a housing for the metering bar; and

Figure 3 is a view similar to Figure 1 showing the openings partially plugged.

The dispensing apparatus 1 illustrated in Figure 1 includes a substantially horizontal chamber 2, which is illustrated as being rectangular in cross section, but could be of other cross section. The chamber 2 is defined by side plates 3A, 3B and by an upper plate 4A and a lower plate 4B. The upper plate 4A has four inlet apertures 6A, 6B, 6C and 6D communicating with the top of the chamber and the lower plate 4B has two outlet apertures 5A and 5B communicating with the bottom of the chamber, each inlet aperture being offset from each outlet opening along the length of the chamber. The inlet apertures and outlet openings are illustrated as circular but could be of any other suitable cross section.

A metering member in the form of a bar 7 is disposed within the chamber 2 and is illustrated as having four substantially cylindrically shaped cavities 8A, 8B, 8C and 8D. The upper and lower surfaces of the metering bar 7 are in sliding contact with the lower faces of the upper plate 4A and the upper face of the lower plate 4B. As will be explained below, the metering bar is axially reciprocable between positions in which the cavities 8 alternatively communicate with the inlet apertures 6 and the outlet openings 5 as the bar is linearly displaced. A reservoir 9

is mounted on top of the upper plate and communicates with the inlet apertures 6.

The cavities 8 are of a predetermined capacity so that the volume of granular material dispensed from the reservoir 9 per reciprocation of the metering bar 7 is determined by the volumes of these cavities. In the construction illustrated, when the cavities 8A and 8C communicate with the inlet apertures 6A and 6C, cavities 8B and 8D simultaneously communicate with the outlet openings 5A and 5B and when the cavities 8B and 8D communicate with the inlet apertures 6B and 6D the cavities 8A and 8C communicate with outlet openings 5A and 5B.

In order to reciprocate the metering bar, a pneumatic or hydraulic cylinder 11 is provided, this being provided with a control valve 13 which is activated by a switch 12. This switch may be a manually operated electrical switch, an electromechanical arm, a photoelectric switch, such as an infra-red light beam or an ultrasonic switch using high frequency sound waves and these switches may each have manual overide systems. A shock absorbing buffer (not shown) may be provided at the end of one or both strokes of movement of the bar.

The apparatus described is designed to deliver measured amounts of granular material by moving the metering bar 7 in the manner described above. If one wishes to vary the volume of material dispensed, plugs may be inserted in the cavities in the metering bar to reduce the volume or

indeed completely to close the volume. In this context, Figure 3 represents a construction in which plugs 14A and 14B fill the cavities 8A and 8D, thereby reducing the application rate for granular material. As an alternative, interchangeable metering bars 7 may be provided which are equipped with various cavity diameters for specific dosages. Furthermore, interchangeable bushings may be inserted into the metering bar in order to achieve a specific dispensing of the granular material. Provision may also be made for blocking certain of the inlet apertures in the top plate.

It will be appreciated that the apparatus of the invention is suitable for semi-automatic, automatic or manual control. This may be achieved by solenoid controlled pneumatic or hydraulic double acting control valves and/or by the use of a pilot pressure signal to actuate the valve resulting in reciprocal motion of the meter bar. Actuation of the control valves may occur in several ways for example manually with a machine operator using his own judgement to determine the relative position of the metering device to the target, by an electromechanical switch, e.g. a mechanical arm which actually contacts the target to establish the relative position of the metering device to the target. Upon contact the control valve is actuated. The electromechanical switch is preferably used in conjunction with a latching relay which is designed to alternate the actuating of the two solenoids that are on a control valve and prompt reciprocating motion of the

metering bar.

The control valve may alternatively be actuated by a photoelectric switch which may use a modulated infra-red light to establish the relative position between the apparatus and the target or alternatively operated by an ultrasonic switch whereby when sound waves are emitted from a transmitter they contact the target and are bounced back to a receiver thereby actuating the control valve.

Any electromechanical, photoelectric, ultrasonic switching devices are preferably capable of being overridden by a manual switch which allows the operator to overide the automatic switching, this being preferable if extraneous targets such as weeds or tall grass are present.

The metering bar 7 and the housing formed by the plates 3 and 4 may be formed from various types of rigid materials which are desirably impermeable to the granular material being applied. In one embodiment of the present invention, a metering bar is constructed of acetal sold under the Registered Trademark DELRIN and the housing is constructed of stainless steel.

The present invention provides an intermittent volumetric measurement of a granular pesticide. The theorectical accuracy of a properly dimensioned meter bar is controlled by the consistency of the granular product bulk density. Consistency of the granular product bulk density may generally be about $\pm$ 3 percent for granular materials useful in the present invention. Other materials having greater bulk density variation may be used in the present

invention as long as application rate variation caused by such bulk density variation is not critical to effectiveness of the rate of application of the granular material, such as material having low active ingredient level. The volumetric measurement and application principle of the invention delivers a substantially constant rate of active ingredient that is not affected by vehicle ground speed. In contrast, application rates from variable orifice or continuous flow metering devices can easily vary by as much as $\pm$ 25% due to variations in vehicle ground speed.

Reciprocating motion of the meter bar occurs rapidly (less than .25 seconds per dose) due to the high speed operation that is possible by using a small bore pneumatic or hydraulic cylinder and a properly sized solenoid or pilot operated control valve. Response time of the suggested automatic switches is extremely fast (less than .1 second per dose). Thus, the metering unit effectively operates on a vehicle travelling at speeds as great as 6.25 km per hour, and greatly increases machine efficiency.

Adaptability of the metering device to automatic control relieves the vehicle operator from the task of intermittently activating the metering device. Automation reduces operator fatigue and increases potential vehicle ground speeds from less than 2 km per hour (manual operation) to greater than 6.25 km per hour (automatic operation). Of course, automatic operation may be maintained at lower vehicle ground speeds such as those used

during manual operation.

Example 1

The metering device shown in the drawings was used to apply aldicarb pesticide sold under the Trademark TEMIK this being a systemic pesticide useful for treating insects for up to 120 days after application to citrus crops. Newly planted areas with young trees requires applicators that can accurately and efficiently apply individual dosages.

The metering unit was designed to be mounted on a standard "belly boom" assembly of a grove tractor of 35 house power. The assembly was equipped with a Lilliston four gang rolling tine cultivator mounted behind the meter bar and hopper. The cultivator was used to incorporate the granular material into the soil. Compressed air to operate the system was supplied by a small displacement single cylinder compressor. The compressor along with an air reservoir was mounted on the three point hitch of the tractor. The compressor was driven from the tractor power source.

In a laboratory test, the metering unit was operated over an extended period using 5539 kg of inert gypsum. This material was identical to aldicarb pesticide except for the lack of active ingredient. Under typical field use conditions, this laboratory test would be equivalent to 439 hectares of application. The meter bar proved to be extremely accurate in these tests with an average of 40.9

grams per dose and a Coefficient of Variation of $\leq$ 3%. No significant wear on the meter bar or housing was observed.

The metering device shown in the drawings was then used to apply aldicarb pesticide to newly set, i.e. transplanted or bare root young citrus trees. The device was used to place a dose of TEMIK 15 G gypsum brand aldicarb pesticide intermittently at each young tree at rates that ranged from less than 28 g to about 56 g formulated product. The rate of 56 g per dose corresponded to application of 2.8 kg active ingredient/hectare. The intermittent doses provided economical and efficient pesticide application.

Example 2

The metering unit of Example 1 was tested in both ridge and bedded groves. During these tests, automatic switching was accomplished using an ultra-sonic sensing device.

Drop tubes attached to the meter bar outlet reduced the distribution area of applied material and provided two narrow bands rather than a wide one. It was also found that removal of two of the rolling tines from the incorporation tool provided a banded and covered application rather than full incorporation. Removal of the tines eliminated the problem of linear movement of the incorporation device. Addition of a roll compactor or commercially available rolling basket smoothed and/or compacted the area of application. The roll compactor assisted in the complete covering of material and minimized disturbance of residual

herbicides used on the trees.

Example 3

A photoelectric cell (a "Multi beam Scanner Block," Banner Engineering Corp. (Minneapolis, MN.)), having a modulated infrared beam, was installed to replace the ultra-sonic sensing device tested in Example 2. The photoelectric cell worked well and was more economical than the ultra-sonic sensing device.

Field trials of the metering device were conducted in Florida citrus groves. The standard protocol for these trials consisted of the following treatments: 1) 56 g of formulated product on one side of each young tree; and 2) 28 g of product on each side of each young tree. These trials provided an excellent opportunity to test the device of the invention in a commercial application setting. The device was able to place TEMIK 15 G brand aldicarb pesticide in a location of the young tree's root zone that allows very effective pest control. Production capacity in area per day ranged from 10-12 hectares on very young trees (about 1 year) to 34-36 hectares per day on larger trees (about 2-3 years).

CLAIMS

1. Apparatus for dispensing measured amounts of granular material, said apparatus comprising a reservoir for granular material, an upper generally horizontal plate mounted below said reservoir, a lower plate mounted parallel to and spaced from said upper plate, a horizontally movable metering member, having upper and lower surfaces in sliding contact with the lower face for the upper plate and the upper face with the lower plate, respectively, at least two spaced cavities have a predetermined volume extending through said metering member and each opening into the upper and lower surfaces thereof, said cavities being spaced apart along the line of movement of said metering member, at least two apertures formed in said upper plate at locations whereby said cavities pass below the apertures, at least two openings in said lower plate at locations different from the locations of the apertures in the upper plate, but so that said cavities pass above the openings, and means to move said metering member intermittently from positions in which at least one cavity can receive granular material from an aperture in the upper plate to a position in which this granular material can fall out through an opening in the lower plate and at the same time granular material can pass into another of said cavities through an opening in the upper plate.

2. Apparatus according to claim 1, wherein said

metering member is in the form of a metering bar having a number of cavities equal to the number of openings in the lower plate, means being provided to reciprocate said bar longitudinally thereof.

3. Apparatus according to claim 2, wherein the housing has four apertures in the upper plate and two openings in the lower plate, and wherein the metering bar has four cavities.

4. Apparatus according to claim 2 or 3, wherein the means for reciprocating the metering bar is a pneumatic or hydraulic control valve that directs pneumatic/hydraulic fluid to its cylinder.

5. Apparatus according to claim 4 wherein the pneumatic hydraulic control valve is solenoid controlled.

6. Apparatus according to claim 4 wherein the pneumatic hydraulic valve is pilot operated.

7. Apparatus according to claim 4 wherein the control valve is manually operated.

8. Apparatus according to claim 4 wherein the control valve is electromechanically operated.

9. Apparatus according to claim 4 wherein the control valve is photoelectrically operated.

10. Apparatus according to claim 4 wherein the control valve is ultrasonically operated.

11. Apparatus for dispensing measured amounts of granular materials substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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