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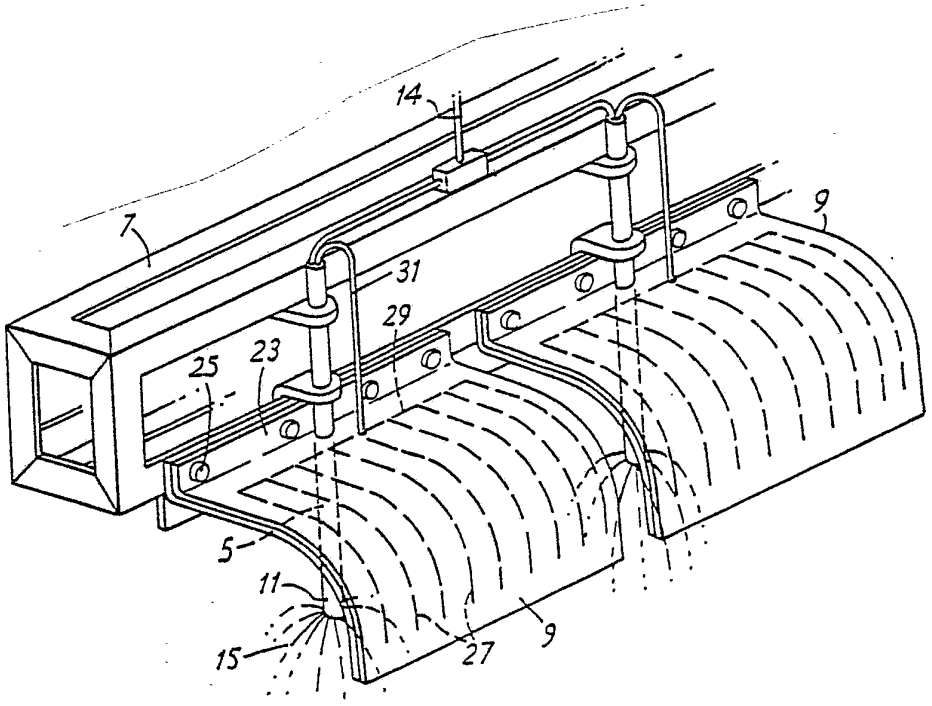
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(54) Title: ELECTROSTATIC SPRAYING APPARATUS



(57) Abstract

An electrostatic spraying apparatus having an electrostatic sprayhead (5) and a deflector (9) comprising an electrically conductive element (19) at least partially shrouded by electrically insulating material (17). The conductive element (19) is charged to an electrical potential of the same sign as the charge applied to the sprayhead and the deflector (9) is so positioned that charged spray droplets (15) are urged away from the deflector towards the crop (3). Leakage of charge from the conductive element is reduced by the presence of the insulating material.

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ELECTROSTATIC SPRAYING APPARATUS

This invention relates to electrostatic spraying apparatus, especially to apparatus for electrostatically spraying agricultural chemicals.

It has been proposed to spray crops and the like with a spraying apparatus which produces a spray of charged droplets (see for example our UK Patent No. 1569707). Such processes have the advantage that the spray droplets are electrostatically attracted to the crop. However, while this is normally advantageous it may create a problem with deep foliage crops in that too much spray is attracted to the surface leaves, thus reducing penetration.

In order to overcome this problem it has been proposed to use a metal air-deflecting surface which creates a down-draft, increasing penetration of the spray into the crop when the spraying apparatus is moved over it. Unfortunately, there is a tendency for the charged spray droplets to be attracted to the deflecting surface, which is at about earth potential, causing excessive waste of spraying liquid.

It has also been proposed to deflect charged spray droplets towards a crop by metal wires which extend horizontally and rearwardly from a spraying boom and which, in use, are charged to a high potential of the same sense as the charge applied to the droplets.

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With this arrangement there is a leakage of charge whenever the wires contact the crop or some other external object. There is also a danger of an operator touching the wires and receiving an electrical shock.

According to the present invention there is provided electrostatic spraying apparatus adapted to be moved across a crop or other target and having an electrostatic sprayhead, and a deflector comprising an electrically conductive element and an element which at least partially shrouds the conductive element, the deflector being so positioned relative to the sprayhead that when the conductive element is charged to an electrical potential in the same sense as the charge applied to the sprayhead spray droplets are urged away from the deflector and towards the target, the shrouding element being formed of a material having a thickness, dielectric strength and resistivity sufficient to prevent an electrical breakdown if the deflector is contacted by an earthed object and to reduce leakage of charge from the conductive element to the earthed object whilst allowing electrical polarisation of the material by the potential applied to the conductive element.

The shrouding element may be made of a material which is conventionally regarded as a high voltage insulating material, such as delrin, nylon or polypropylene. However, there are two primary requirements for the shrouding material, both of which can be met by lower grade materials such as low grade polyvinylchloride having pigments or filling agents therein. First, the material of the

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shrouding element should have a dielectric strength such that a reasonable thickness, say approximately 1 cm., is sufficient to prevent an electrical breakdown and a discharge between the conductive element and an earthed object contacted by the material. For a conductive element at a potential of approximately 40 KV, low grade polyvinylchloride is satisfactory. A second requirement is that the material of the shrouding element has sufficient resistivity to reduce current leakage from the conductive element to the earthed object, thus avoiding any strain on the generator providing the voltage for the conductive element, but sufficient conductivity for the material to be polarised by the voltage applied to the conductive element. This prevents any significant reduction in the magnitude of the electric field established by the potential on the conductive element. Typically, the resistivity of the material may be in the range from 10^6 to 10^{11} ohm cms.

The invention will now be described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a side view of an electrostatic spraying apparatus according to the invention mounted on a tractor;

Figure 2 is a perspective view, partly in section, of a part of the apparatus shown in Figure 1; and

Figure 3 is a section of part of a deflector included in the apparatus of Figures 1 and 2.

Referring to Figure 1 of the drawings, an electrostatic spraying apparatus according to the invention is mounted at the rear

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of a tractor 1 which, in use, moves the apparatus over a crop 3. The apparatus includes a series of electrostatic sprayheads 5 respectively disposed at spaced locations on a boom 7. Associated with each of the sprayheads 5 is a deflector 9 for urging charged spray droplets towards the crop 3.

Referring now to Figures 1 and 2, each sprayhead 5 includes a nozzle 11 which is connected to a tank (not shown) containing spraying liquid. Each nozzle 11 is also electrically connected to a source 13 of high electrical potential via a lead 14. The source 13 charges the nozzles 11 to a high voltage in the range of 10 - 40 KV. Adjacent each nozzle 11 is an earthed or relatively low potential field-adjusting electrode (not shown). Each sprayhead produces a cloud 15 of charged spray droplets which are attracted to the crop 3, which is generally at earth potential.

As shown in Figures 1 and 2 of the drawings, the deflectors 9 extend rearwardly and downwardly from the boom 7. As shown in Figures 2 and 3, each deflector 9 includes a conductive element 19 embedded in a sheet 17 of insulating material, which serves as a shrouding element. The sheet 17 is formed of two layers 21 with the conductive element 19 disposed between the layers in the form of a sandwich.

A major part of each deflector 9 is arcuate in section, typically forming a quadrant of a circle. At a forward end of the deflector 9 there is an upstanding mounting flange 23 which is attached to the boom 7 by bolts 25.

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The conductive element 19 of each deflector 9 includes a series of evenly spaced, parallel arranged wires 27, each connected at its forward end to a cross-wire 29. Each cross-wire 29 is connected to the source 13 via an electrical lead 31 and the above-mentioned lead 14. A typical operating voltage for the wires 27 lies in the range of 2 - 40 KV and has the same polarity as the polarity of the charged spray droplets.

In operation, the tractor 1 is driven over a field so that the boom 7 carrying the sprayheads 5 and deflectors 9 passes over the crop 3, as shown in Figure 1 of the drawings. Each nozzle 11 is supplied with liquid from the tank and with a high electrical potential from the source 13.

As shown in Figures 1 and 2, charged spray droplets emerge from the nozzles 11 to form the clouds 15. Some of the droplets in each cloud 15 move rapidly downwardly on to the crop. In the absence of the deflectors 9, however, there is a danger of many droplets being repelled by other droplets in the cloud and drifting away from the crop 3 into the air.

It is to prevent such drift that the wires 27 of the deflectors 9 are connected to a high electrical potential of the same polarity as the charge on the spray droplets. The potential difference between each deflector 9 and the crop 3, which is generally at earth potential, produces an electrostatic field having lines of force which emerge from a deflector in a direction generally perpendicular to the surface thereof and which enter the crop in a direction

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generally perpendicular to the ground. The effect of the electrostatic field is therefore to repel charged spray droplets away from the deflectors 9 and towards the crop 3. Since the wires 27 of the conductive element 19 are completely shrouded by the sheet 17 of insulating material, the wires do not come into contact with the crop 3 or with other external objects which would tend to earth the wires and cause excessive leakage of charge. A very modest power source is thus sufficient to maintain the conductive element 19 at a high potential. Moreover, the presence of the sheet 17 prevents an operator touching the element 19 and receiving an electrical shock, and it also prevents charge leakage when the apparatus is operated in wet conditions.

During forward movement of the apparatus over the crop 3, the deflectors 9 produce a downdraft of air which further increases the penetration of spray into the crop. This is especially beneficial when it is desired to treat the lower regions of a crop against, say, fungal spores. The deflectors 9 may also be inclined to the direction of forward movement so as to produce a sideways movement of air.

Operating variables such as dimensions, shapes and air speeds will naturally depend upon a variety of factors such as the structural characteristics of the materials used, the crops being sprayed and the capacity of the vehicle on which the apparatus is mounted.

For example, with a tractor speed of 2 metres per second and nozzles 0.4 metres above the crop, the deflectors may extend a

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horizontal distance of 0.4 metres behind the sprayheads. Each deflector curves downwards towards the target crop, and depending upon the desired level of penetration may terminate above, at or below crop height (with narrow-leaf crops such as cereals or broad-leaf crops such as soya). The forward ends of the deflectors would normally be attached to the boom a few centimetres above the nozzles.

Generally the optimum horizontal extent of the deflector will increase with tractor speed and height of nozzles above crop.

With tractor speeds in the range up to 5 metres per second (very high according to present practice) and nozzle heights up to 0.6 metres above the crop, a horizontal extent of deflector up to 3.0 metres would be appropriate but at this length structural problems are likely.

It is found that a downdraft of air of up to about 0.9 times the forward speed of the vehicle may be obtained subject to other operating variables.

In the apparatus of Figures 1 to 3 the wires 27 are copper and the layers 21 of the sheet 17 are made of delrin. Instead of delrin it is possible to use some other material which is not degraded by exposure to sunlight or chemical solvents, for example nylon.

The series of parallel wires 27 can be replaced by a network of wires or by a metal sheet or foil. The sheet 17 can be formed of a single layer having the conductive element moulded therein.

The deflectors 9 may extend rearwardly and horizontally

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rather than rearwardly and downwardly from the boom 7. Instead of the series of deflectors 9 there may be a single deflector which extends over the full length of the boom. In this case, it may be necessary to provide one or more ground engaging wheels for supporting a rear end of the deflector.

It will be appreciated that the conductive element need not be embedded in the insulating material, it being sufficient in some instances to arrange the insulating material so as to shroud the element sufficient to prevent contact with the crop.

Instead of connecting each conductive element 19 to the source 13, the deflectors 9 can also be charged by means of a pointed electrode in the vicinity of the nozzle, say, directed at the deflector and maintained at a high potential. The electrode produces a corona discharge which rapidly charges the deflector by ion bombardment.

Although the invention has been described with reference to the spraying of agricultural chemicals from a tractor-mounted boom it will be apparent to those skilled in the art that other vehicles could be used e.g. airplanes and that the apparatus could be adapted for the spraying of other fluids whether in powder, liquid or other fluid form.

Forms of electrostatic sprayhead other than that described (e.g. those operating by indirect induction charging) may also be employed.

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CLAIMS:

1. Electrostatic spraying apparatus adapted to be moved across a crop or other target and having an electrostatic sprayhead, and a deflector comprising an electrically conductive element and an element which at least partially shrouds the conductive element, the deflector being so positioned relative to the sprayhead that when the conductive element is charged to an electrical potential in the same sense as the charge applied to the sprayhead spray droplets are urged away from the deflector and towards the target, the shrouding element being formed of a material having a thickness, dielectric strength and resistivity sufficient to prevent an electrical breakdown if the deflector is contacted by an earthed object and to reduce leakage of charge from the conductive element to the earthed object whilst allowing electrical polarisation of the material by the potential applied to the conductive element.

2. Electrostatic apparatus as claimed in claim 1, wherein the shrouding element is formed as a sheet and the conductive element is embedded in the sheet.

3. Electrostatic apparatus as claimed in claim 1 or 2, wherein the conductive element comprises a series of evenly spaced, parallel arranged wires, a network of wires or a sheet or foil.

4. Electrostatic apparatus as claimed in any one of the preceding claims, wherein the deflector is so arranged as to create

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a current of air which also urges the charged spray droplets towards the target as the deflector is moved across the target.

5. Electrostatic apparatus as claimed in claim 4, wherein at least part of the deflector is arcuate in section.

6. Electrostatic apparatus as claimed in any one of the preceding claims, wherein a source of high voltage is electrically connected to the conductive element.

7. Electrostatic apparatus as claimed in any one of claims 1 to 5, wherein an electrode is disposed adjacent to the deflector and is connected to a source of high voltage, whereby, in use, the conductive element is charged to the said electrical potential by a corona discharge between the electrode and the deflector.

8. Electrostatic apparatus as claimed in any one of the preceding claims, comprising a spray boom, a series of sprayheads respectively mounted at mutually spaced locations on the spray boom, and at least one deflector so arranged as to extend rearwardly and downwardly from the boom as the boom is moved across the target.

9. Electrostatic spraying apparatus constructed, arranged and adapted to operate substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawings.

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FIG. 1

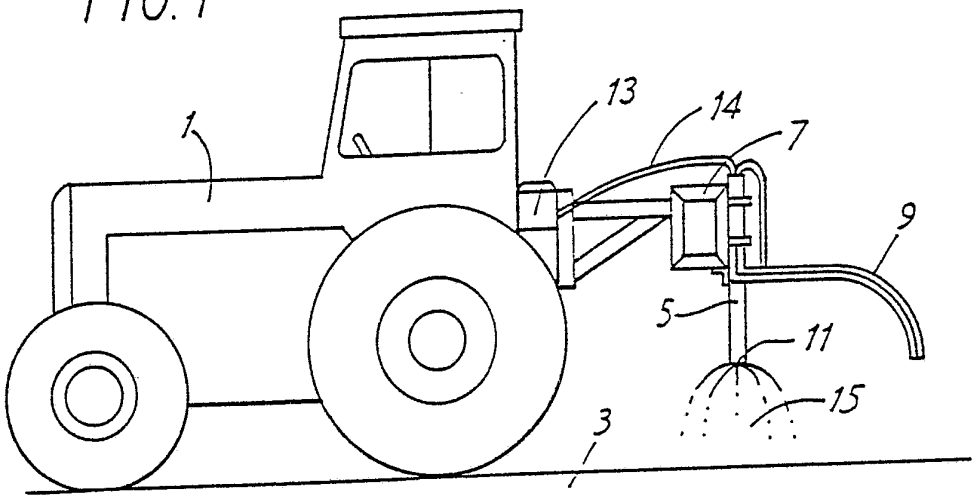


FIG. 2

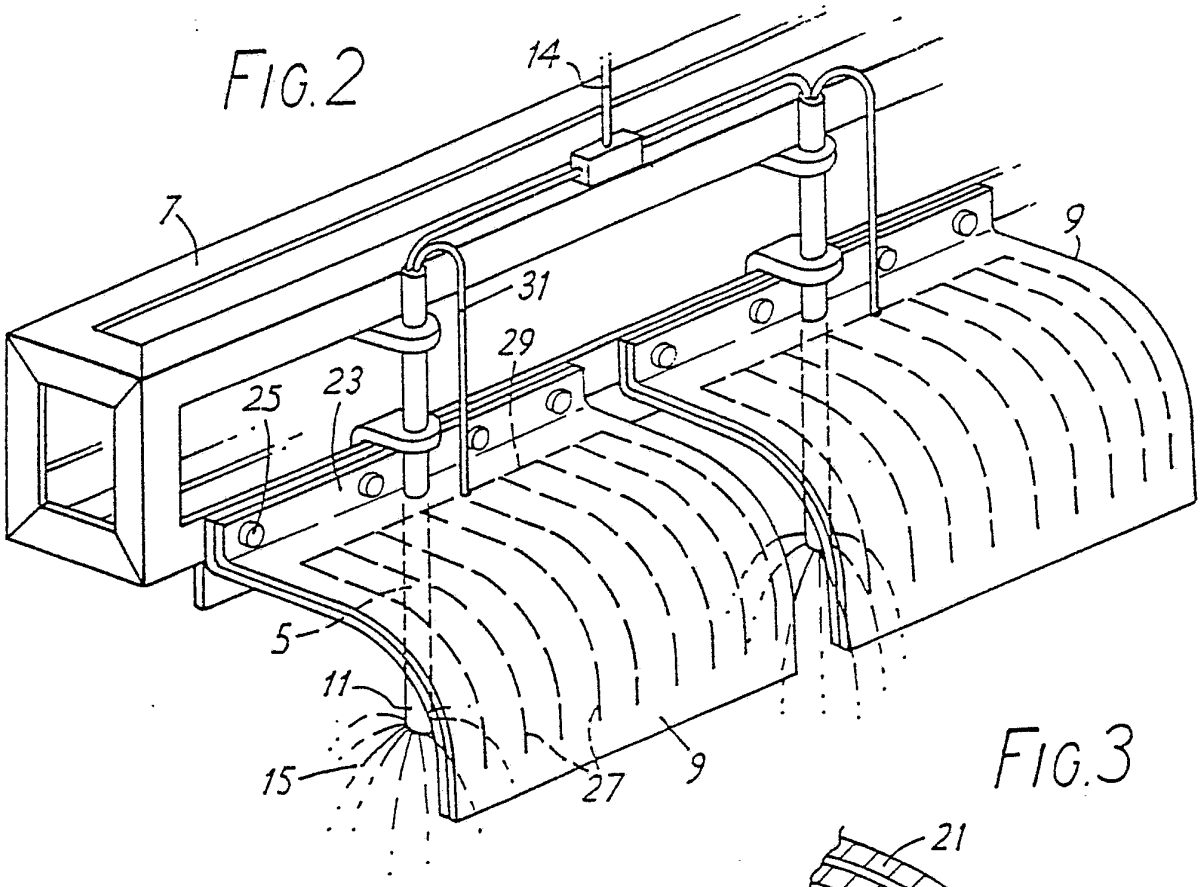
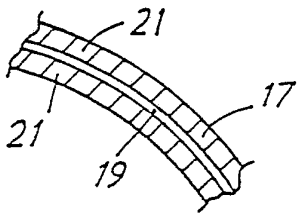


FIG. 3



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INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 84/00089

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[3]: B 05 B 5/02; A 01 M 7/00

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC[3]	B 05 B; A 01 M

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	GB, A, 2092478 (IMPERIAL CHEMICAL INDUSTRIES PLC.) 18 August 1982 see page 1, lines 54-90; page 2, lines 1-38; figures 1,2	1,6
A	FR, A, 2370525 (ONODA CEMENT CO. LTD.) 9 June 1978 see page 3, lines 1-20; page 7, lines 1-28; page 8, lines 6-36; figure 1	2,3
A	AU, B, 506398 (AUSTRALIAN AGRICULTURAL MACHINERY PTY. LTD.) 20 December 1979 see page 2, lines 23-32; figure 2	4,5,8
A	DE, C, 960526 (SIEMENS-SCHUCKERTWERKE AG) 21 March 1957	

* Special categories of cited documents: [15]

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [1]	Date of Mailing of this International Search Report [2]
26th June 1984	11 JUIL. 1984
International Searching Authority [1]	Signature of Authorized Officer [20]
EUROPEAN PATENT OFFICE	G.L.M. Kruydenberg

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON

INTERNATIONAL APPLICATION NO. PCT/GB 84/00089 (SA 6833)

This Annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 05/07/84

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Patent document cited in search report	Publication date	Patent family member(s)		Publication date
GB-A- 2092478	18/08/82	FR-A-	2499430	13/08/82
		DE-A-	3203729	16/09/82
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		AU-A-	7985182	19/08/82
		OA-A-	7018	31/08/83
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		AU-A-	3044877	17/05/79
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		AU-B-	506726	24/01/80
		CA-A-	1093393	13/01/81
		US-A-	4377603	22/03/83
AU-B- 506398	20/12/79	None		
DE-C- 960526		None		