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A spraying apparatus

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Abstract

The current invention relates to spraying apparatus for agricultural applications. The spraying apparatus of the current invention includes an axial-type fan, a ducting assembly mounted about the fan and including a plurality of ducts formed  
5 by a plurality of vanes that extend from adjacent the perimeter of the fan to an outer edge of the ducting assembly. The vanes are arranged substantially equidistant 360 degrees around the perimeter of the fan providing ducts adapted to receive air directly substantially without the creation of high and low pressure regions within the fan perimeter. The spraying apparatus also includes a spray  
10 supply means for providing ducted air with spray.



## A Spraying Apparatus

### Field of Invention

This present invention relates to agricultural spraying apparatus. This invention has particular but not exclusive application to spraying apparatus for spraying of orchard trees and the like which have a foliage canopy.

### Prior Art

Conventional sprayers comprise a vehicular frame supporting a tank containing liquid to be sprayed, a fan housing with one or more outlets disposed radially thereon, spraying nozzles positioned within the outlet, and a fan within the housing capable of drawing air into the housing and through the outlets. In use air is drawn by the fan and forced through the outlets where spray is released from the spray nozzle thereby creating a fog or mist of spray.

In most conventional sprayers the bottom portion of the fan is blocked to prevent debris disturbed from the ground from being drawn into the fan. Debris is disturbed from the ground largely as a result of fan forced air being discharged from the housing. The blocking of the bottom portion of the fan creates a turbulence problem which interferes with the even distribution of air from the discharge side of the fan.

To minimise the turbulence effects caused by blocking the lower portion of the fan, vane straighteners have been used in an attempt to redirect the fan forced air. However as a result of the blocking of the bottom portion of the fan and the use of vane straighteners, the efficiency of the fan to generate forced air and discharge the air through the outlets is reduced.

### Summary of the Invention

In one aspect the invention broadly resides in a spraying apparatus including:  
a fan having a plurality of blades with each blade positioned at an angle relative to the fan axis;  
an arcuate guide member on which the fan is mounted;  
a ducting assembly mounted about the fan and including a plurality of ducts formed by a plurality of vanes that extend from adjacent the perimeter of the fan to



an outer edge of the ducting assembly, said vanes are arranged substantially equidistant around 360 degrees of the fan perimeter; and

spray supply means for providing ducted air with spray wherein the arcuate guide member guides fan forced air to the ducts.

- 5 The positioning of the vanes adjacent the perimeter of the fan means the vanes are at or closely next to the fan perimeter without the vanes touching the fan blades. The ducts are adapted to receive air directly substantially without the creation of high and low pressure regions within the fan perimeter.

- 10 The bottom portion of the fan intake and the fan outlet surrounding the perimeter of the fan is not blocked. The arrangement of the vanes around the perimeter of the fan preferably provides substantially equal volumes of air to be discharged from each duct. The arrangement of the vanes around the perimeter of the fan preferably provides substantially equal volumes of discharged air to either side of the ducting assembly. Preferably equal volumes of discharged air to either side of the ducting assembly is achieved without substantially narrowing the ducts and thereby not increasing the velocity of the discharging air. The provision of substantially equal volumes of discharged air to either side of the ducting assembly preferably provides the substantially equal distribution of spray either side of the ducting assembly. The distribution of spray preferably relies
- 15 20 substantially on the volume of air discharged rather than the velocity of discharging air thereby creating a less dense spray mist with a relatively small droplet size. A less dense spray at a relatively lower velocity appears to provide a substantially better penetration of foliage canopy.

- 25 In one preferred form the ducting assembly has a vane positioned at the lowest point on the fan perimeter thereby serving as a baffle to direct the generated air to either side of the fan into adjacent ducts.

- 30 Preferably each duct has an internal passage that expands from a duct inlet to a duct outlet. In this way escaping generated air proceeds largely unimpeded and does not cause subsequent turbulence in the fan region. Preferably the duct provides a passage for discharging air without substantially increasing the air velocity between the duct inlet and the duct outlet. More preferably the duct provides a passage for discharging air to maintain volume without substantially increasing the air velocity between the duct inlet and the duct outlet.



Preferably each duct has an internal passage that expands from a duct inlet to a duct outlet, thereby enabling production of a low density spray at a relatively low velocity while maintaining substantially maximum volume.

5 The duct inlets in one preferred embodiment have an internal passage that can allow a stream of air to move in a direction along a line extending radially from the fan axis to the duct outlet without interference or deflection by the duct vanes thereby limiting the creation of air turbulence. The radially extending line is preferably in-line with a fan blade. In a more preferable form all of the ducts have a passage that can allow a stream of air to move in a direction along a line  
10 extending radially from the fan axis to the duct outlet without interference or deflection by the duct vanes.

In one preferred form the spraying apparatus has a fan with a plurality of vanes extending from the fan perimeter and positioned substantially equidistant around the fan perimeter and with each duct formed by the vanes having an  
15 internal passage that expands from the duct inlet to the duct outlet. In this preferred form the duct outlets face outwardly either side of the fan.

Each of the plurality of ducts preferably has an individual duct inlet and duct outlet.

20 The ducting assembly preferably has a plurality of upper and lower ducts. Preferably the upper duct outlet is upwardly spaced from the fan and the lower duct outlet is laterally spaced from the fan and lower duct outlet is horizontally disposed from the fan further than the upper duct outlet.

25 The spray supply means preferably includes a spray means which releases spray from fluid stored in a reservoir. Spraying means is preferably a nozzle the amount of spray released from the nozzle may be controlled by a valve. The nozzle is preferably located substantially at or within the duct outlet. Preferably the duct outlets are both the upper and lower ducts each have a spray nozzle. Alternatively the spray nozzle may be located in only the duct outlets of either the upper ducts or lower ducts.

30 It appears that conventional fan sprayers which block the bottom portion of the fan create a compression effect in the bottom third of the fan as the air tries to



escape from the right and left hand side of the fan housing above the blocked off portion. When the fan turns in a clockwise rotation, the air escaping from the right hand side is compressed further by air generated by the rotating fan causing a high pressure region and a low volume of discharging air. In contrast the escaping  
 5 air on the left hand side of the fan is aided by the rotating fan causing a high volume of air to be discharged from the left hand side of the fan. The high volume of air discharging from the left hand side of the fan creates a low pressure region and a venturi effect in the region around the point of discharge.

Further it appears that the control of compression is related to the control of  
 10 velocity.

In the current spraying apparatus it is preferable to have a ducting assembly and fan that avoids the creation of compression points. Compression points within the fan region causes the horsepower ratings to be increased for operation of the sprayer.

15 Also compression points in the fan region subsequently increases velocity which affects the density of the discharged spray. It is desirable to produce a spray that is of low density and relatively low velocity while maintaining substantially maximum volume. Therefore the current invention includes within its scope any design of a ducting assembly and fan that avoids the creation of  
 20 compression points and a spraying apparatus that is able to produce a low density spray at a relatively low velocity while maintaining substantially maximum volume.

In another aspect the invention broadly resides in a spraying apparatus for spraying a foliage canopy including:

- a fan;
- 25 a ducting assembly mounted about the fan, said ducting assembly having a duct inlet and duct outlet formed by a plurality of vanes that extend from adjacent the perimeter of the fan to an outer edge of the ducting assembly; and
- spray supply means for providing ducted air with spray;
- wherein air is passed with minimal air turbulence from the fan to the duct  
 30 inlet.

Preferably there are a plurality of ducts. Preferably there are upper and lower ducts as described above.



The vanes are preferably arranged around the perimeter of the fan so that the fan can operate efficiently. Preferably the vanes are positioned equidistant around the perimeter of the fan. Preferably the vanes are arranged 360 degrees around the fan.

5 Each duct preferably has an expanding internal passage from the duct inlet to the duct outlet. Each duct preferably has an internal passage that produces a minimal amount of air turbulence as air is ducted therethrough.

The present invention in a further aspect resides in a spraying apparatus for spraying plants that have a foliage canopy including:

10 a fan;  
 a ducting assembly adapted to receive air from said fan, said ducting assembly includes an upper duct outlet and a lower duct outlet; and  
 spray supply means for providing ducted air with spray;  
 wherein in use the upper duct outlet may be arranged such that it faces a  
 15 proximal outer side of the foliage canopy and the lower duct outlet faces a distal inner side of the foliage canopy.

The present invention in another aspect resides in a spraying apparatus including:

20 a fan;  
 a ducting assembly adapted to receive air from said fan, said ducting assembly includes an upper duct outlet upwardly spaced from said fan and a lower duct outlet laterally spaced from said fan; and  
 spray supply means for providing ducted air with spray;  
 wherein the duct outlet faces outwardly.

25 The upper duct outlet preferably substantially faces a proximal outer side of the foliage canopy and the lower duct outlet substantially faces a distal inner side of the foliage canopy.

30 Preferably there are upper duct outlets on either side of the spraying apparatus or fan relative to each other so that foliage on either side of the spraying apparatus can be sprayed.

In a similar manner there is preferably a lower duct on either side of the fan so that foliage on either side of the spraying apparatus can be sprayed.



In one form the spraying apparatus includes a wheeled frame with a fan, fan housing, ducting assembly and spray supply means mounted thereto. The spray supply means may include a reservoir for storing the spraying fluid.

5 In a further aspect the invention broadly resides in a kit including a ducting assembly adapted to be mounted about a fan of conventional sprayers to form the spraying apparatus as described above. Preferably the ducting assembly is fastened around the perimeter of the fan.

In another aspect the invention broadly resides in a spraying apparatus including:  
a fan;

10 a ducting assembly mountable adjacent the fan and adapted to receive air from the fan, said ducting assembly includes an upper duct outlet upwardly spaced from said fan and a lower duct outlet laterally spaced from said fan, the lower duct outlet is horizontally disposed from the fan further than said upper duct outlet, an inlet duct that is positioned equidistant around the perimeter of the fan; and



15 spray supply means for providing ducted air with spray and including a spray nozzle at or within one or more of the duct outlets.



The spraying apparatus preferably includes a ducting assembly that has a plurality of ducts, each of the ducts has an internal expanding passage extending from an inlet duct to the outlet duct, the inlet duct is adjacent the perimeter of the fan so that air is forced directly into the inlet duct with minimal turbulence.



20 In a further aspect the invention broadly resides in a method of spraying using the aforementioned spraying apparatus including:

generating forced air from said fan;

25 ducting the forced air through said ducting assembly to said upper and lower outlets;

releasing spray to the ducted air from said spray supply means.

Preferably where the spraying apparatus has a upper and lower ducts the proximal outer side and distal inner side of the foliage canopy is sprayed.

30 In the above method the velocity of the forced air is controllable. It is preferable to have discharged air with a relatively low velocity to produce a low density spray while maintaining a substantially maximum volume.

Preferably the fan is as described above and operates efficiently to produce a relatively large volume of ducted air at a relatively lower velocity. Air-suspended

spray that has not coated a surface is preferably extracted from around and in the canopy as the spraying apparatus moves forward and reused. The extracting of air-suspended spray may coat foliage surfaces as it is drawn towards the fan.

5

#### **Brief Description of the Drawings**

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention and wherein:

10

Fig 1 is a diagrammatic view of the preferred embodiment of the spraying apparatus of the present invention;

Fig 2 is an exploded view of the preferred embodiment of the spraying apparatus;

Fig 3 is a rear view of the preferred embodiment of the spraying apparatus;

15

Fig 4 is a diagrammatic view of the preferred embodiment of the spraying apparatus showing in (a) the flow of ducted air and spray from the duct outlets and in (b) the drawing of air suspended spray from around the tree canopy when the spraying apparatus has moved forward.

20

#### **Detailed Description of the Preferred Embodiment**

With reference to Fig 1 there is shown a spraying apparatus 10 which includes a ducting assembly 11, a fan housing 12, a tank 13 for storing liquid to be sprayed and a trailer frame 14. The ducting assembly 11, fan housing 12 and tank 13 are mounted to the trailer frame 14 so that the spraying apparatus can be towed by a tractor or the like up and down rows of trees such as in an orchard or vines such as in a vineyard.

25

The ducting assembly 11 includes two vertically disposed wings 15 and two horizontally disposed wings 16. With reference to Fig 3 the horizontally disposed wings 16 can be pivoted upwardly when not in use and in transit to the site of use.

30

There are a plurality of duct outlets 17, 18 in the vertically disposed wings 15 and horizontally disposed wings 16 respectively. Each of the duct outlets 17, 18 have at least one spray nozzle 19 which releases spray into the ducted air.

Each spray nozzle 19 is regulated by valve 20 adjacent spray nozzle 19. Spray is supplied to the spray nozzle 19 from tank 13 through lines 21, 22, 23.

Fan housing 12 surrounds fan 24 which is shown in figures 2 and 3. The open face 25 of the fan housing 12 allows air to be drawn into the fan 24 without  
 5 substantial hindrance. Conventional sprayers block a lower section of the fan outlet adjacent to the orchard floor to prevent disturbance of the ground cover. This avoids introduction of disturbed debris by the fan intake. By blocking this area of the fan exhaust, turbulence is created in the bottom third of the fan. The blocking of the fan in this manner is used throughout the spraying industry.

10 With the preferred embodiment of the spraying apparatus of the current invention it is desirable to draw in the maximum amount of air as possible. The bottom portion of neither the fan intake or the fan outlet surrounding the perimeter of the fan is blocked. As a result the rotation of the fan is balanced. The increased efficiency is utilized by the horizontally disposed wings to spray the  
 15 distal foliage.

To support the vertically disposed wings 15, bracing 27 (as shown in figure 3) may be used to maintain their position.

20 With particular reference to figure 2, the vertically disposed wings 15 and the horizontally disposed wings 16 have a plurality of ducts 28 defined by vanes 29 and front panels 30 and rear panels 31. The vanes 29 define an internal expanding passage so that there is a minimal amount of air turbulence as air is ducted there through. Duct inlet 32 receives forced air as the blade 33 of the fan 24 passes the inlet 32. Arcuate guide member 33a also guides generated fan forced air to the duct inlets 32. The fan blades 33 and the arcuate guide member  
 25 33a guide fan forced air to the ducts. The vanes 29 at the duct inlet 32 extend adjacent to the perimeter of the fan 24. The vanes 29 at the duct inlet 32 extend adjacent the perimeter of the fan 24 so that air can pass into the duct inlet 32 substantially without air turbulence. The vanes 29 are positioned at a substantially equal distance around the perimeter of the fan 24. The fan 24 acts as an air pump  
 30 that sequentially passes forced air into each duct as the blades 33 rotate. As the fan 24 rotates at a considerable speed ducted air flowing from duct outlets 17 and 18 provide the appearance that ducted air flows constantly from each of the duct outlets 17, 18 at any one time.



The efficiency created by the above mentioned procedure eliminates the requirement of vanes in the inlet or discharge side of the fan housing used by many conventional sprayers to control the rotational effect on the exhaust from the fan. By the elimination of these devices the fan is no longer choked thus requiring  
 5 less horsepower to operate and providing a substantial saving in use and thus cost in fuel during the spraying of an orchard.

In one preferred form the spraying apparatus is formed with a kit including the ducting assembly 11 that can be mounted about a fan of conventional sprayers.

10 In use, air is drawn in through the open face 25 of fan housing 12 by fan 24 and directed into duct inlets 32, forced along the internal passage of ducts 28 and flowing outwardly from duct outlets 17, 18. Spray from the spray nozzle 19 is suspended in the ducted air as it flows outwardly.

15 With reference to figure 4, air-suspended spray from duct outlets 17 are directed to the closest outer surface of the foliage canopy whereas air-suspended spray from the duct outlets 18 is directed to the under side of the foliage canopy on the other side of the tree. The air-suspended spray coats surfaces exposed on the inner side of the foliage canopy.

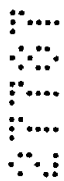
20 As the spraying apparatus moves forward the air-suspended spray is drawn towards the fan. Exposed surfaces may be coated as the fan 24 draws air-suspended spray. Air-suspended spray from within the canopy is drawn into the fan 24. Air-suspended spray that had been locked out by the outer surface of the canopy is drawn into the fan 24. The air suspended spray forced above the canopy is drawn towards the fan 24 either directly or moving around the outer  
 25 surface of the foliage canopy on the other side of the tree.

Air spraying mixture from the vertically disposed wings acting upon the proximal side of the tree canopy brings into effect tree lockout. This in conjunction with the orchard floor creates the effect of a three-sided tunnel. As the sprayer moves forward the volume of air being removed by the fan creates an imploding  
 30 effect to generate the above mentioned condition.

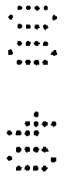
In this way any spray that has not been used can be drawn into the spraying apparatus for re-use. This is possible as the efficiency of the fan is maximised for volume as opposed to velocity of ducted air and the majority of air-

suspended spray is within reach of being drawn back to the spraying apparatus. As a consequence less spray needs to be used for treating trees and vines. There is minimal wind drift of spray as the spray is not forced out at a comparatively high velocity and thus largely remains within the reach of being drawn back into the spraying apparatus. Furthermore the use of the ducting assembly targets specific areas of the tree or vine that is to be treated with spray compared with indiscriminate release of spray with some conventional sprayers. This minimizes the amount of spray chemical required and so reduces the cost of spraying an orchard.

10 The outer canopy surface on the other side of the tree and the inner surfaces of the foliage canopy on the side of the tree closest to the spraying apparatus have largely not been subjected to the spray, but are subjected to the spray when the spraying apparatus moves along the adjacent row and they become the treated proximal outer foliage surface and distal inner foliage surfaces respectively



15 It will of course be realised that while the foregoing has been given by way of illustrative example of this invention, all such and other modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as is herein set forth.



20



1. A spraying apparatus including  
 a fan having a plurality of blades with each blade positioned at an angle relative to the fan axis;  
 5 an arcuate guide member on which the fan is mounted;  
 a ducting assembly mounted about the fan and including a plurality of ducts formed by a plurality of vanes that extend from adjacent the perimeter of the fan to an outer edge of the ducting assembly, said vanes are arranged substantially equidistant around 360 degrees of the fan perimeter; and  
 10 spray supply means for providing ducted air with spray, wherein the arcuate guide member guides fan forced air to the ducts.

2. A spraying apparatus as claimed in claim 1 wherein there is a baffle at the lowest point on the fan perimeter to direct fan forced air into adjacent ducts.

3. A spraying apparatus as claimed in claim 1 or claim 2 wherein each duct has an internal passage that expands from a duct inlet to a duct outlet said spray supply means includes a nozzle from which spray is released substantially at or within the duct outlet, thereby enabling provision of a low density spray at a relatively low velocity.

DATED THIS FOURTEENTH DAY OF SEPTEMBER 2000.

RADAK SYSTEMS PTY LTD

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FIG. 1

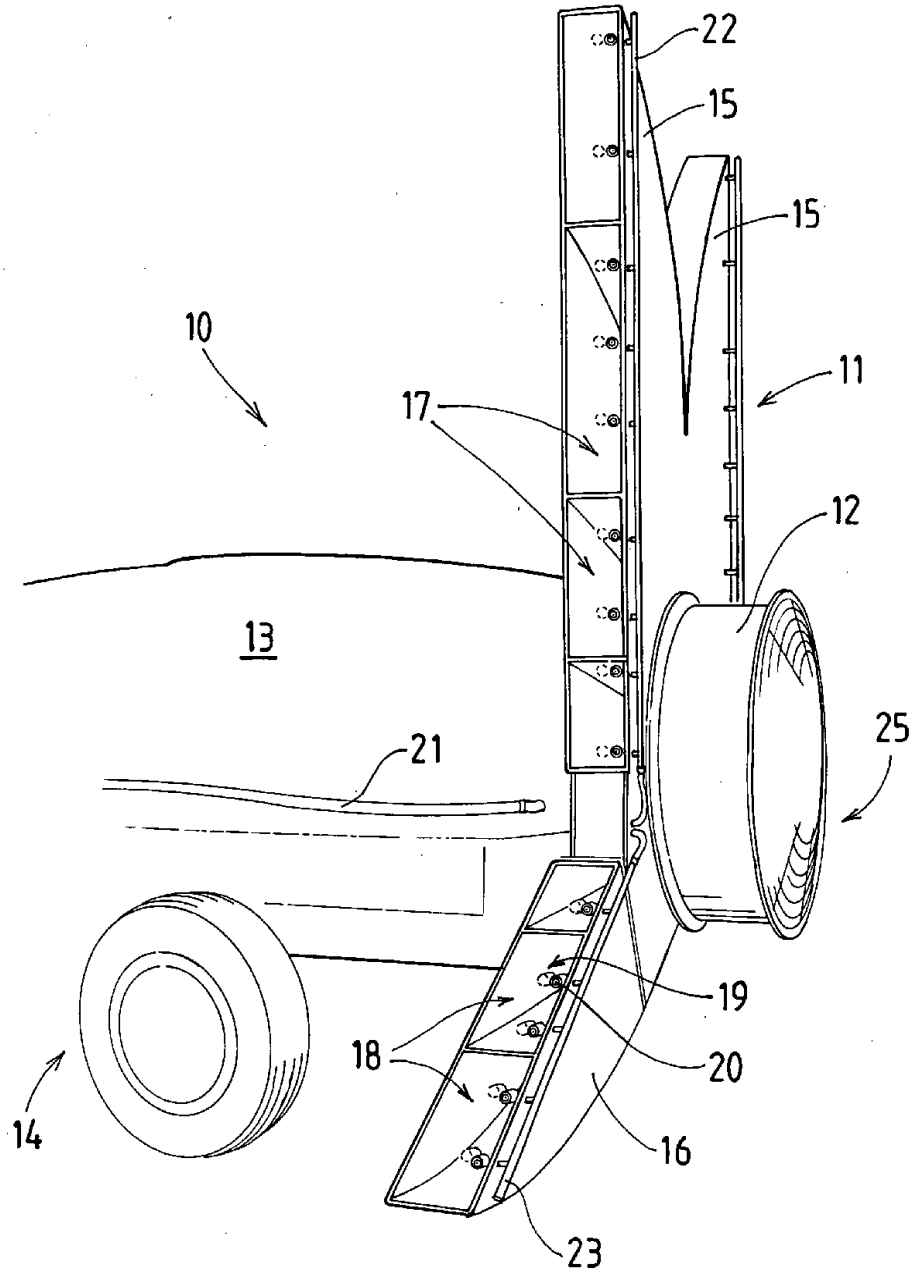


FIG. 1

2 6 00 2723

2/5

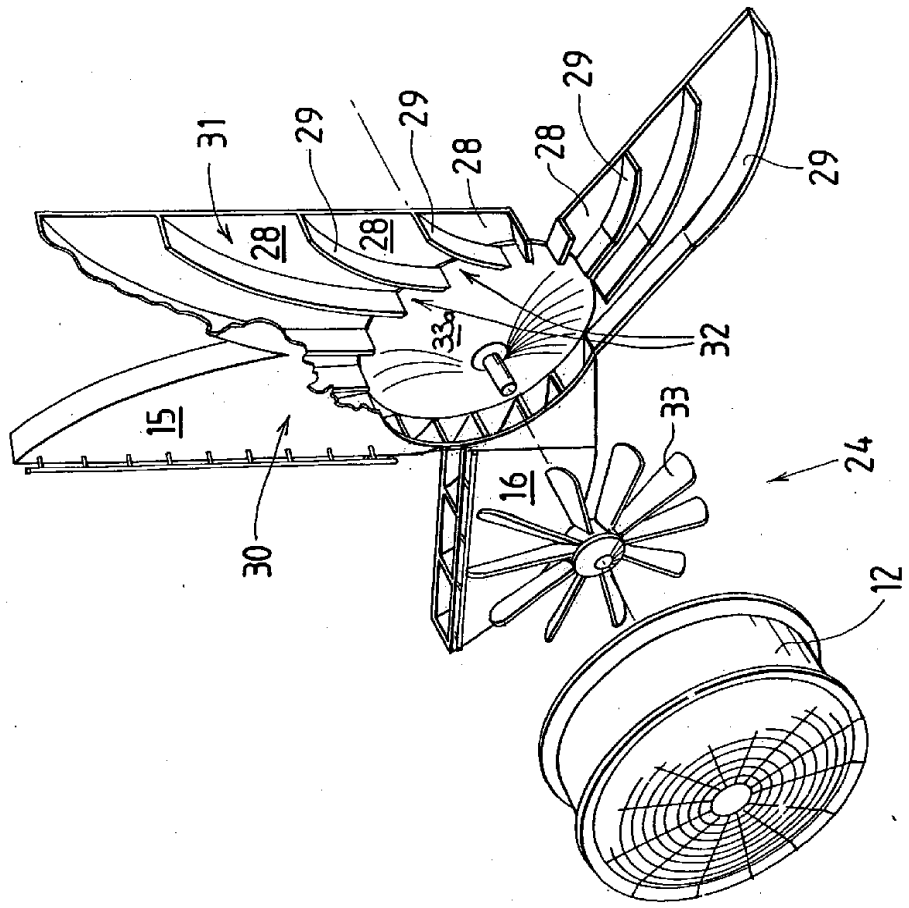


FIG. 2

14 04 00 2703

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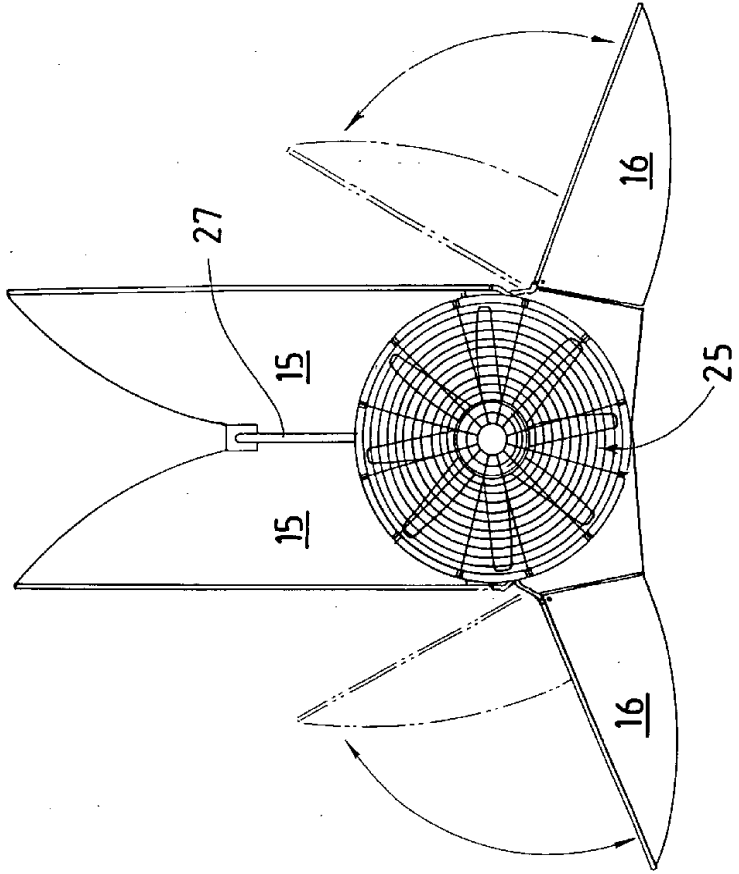


FIG. 3

14 04 00 27787

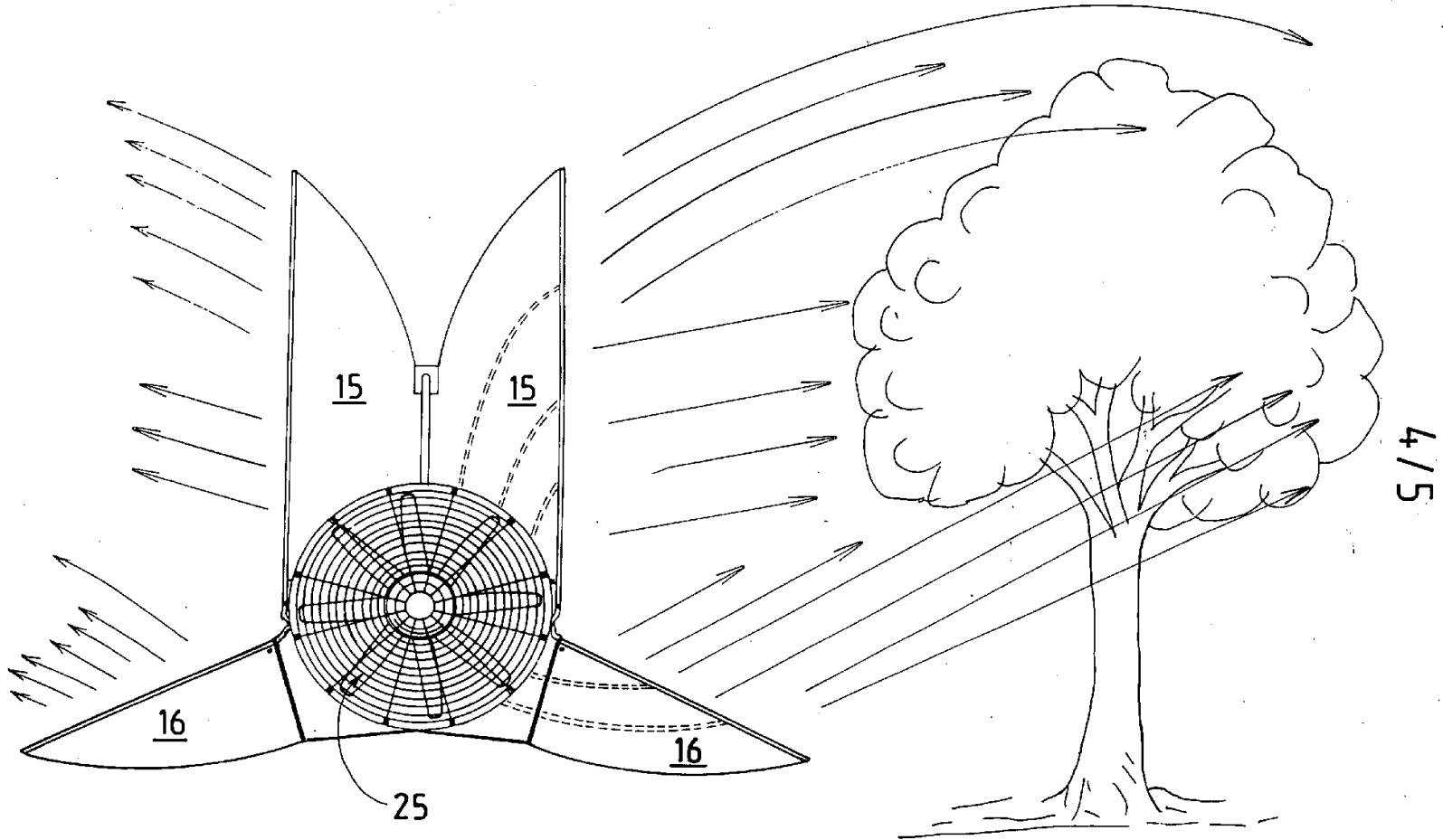


FIG. 4

14 04 00 27787

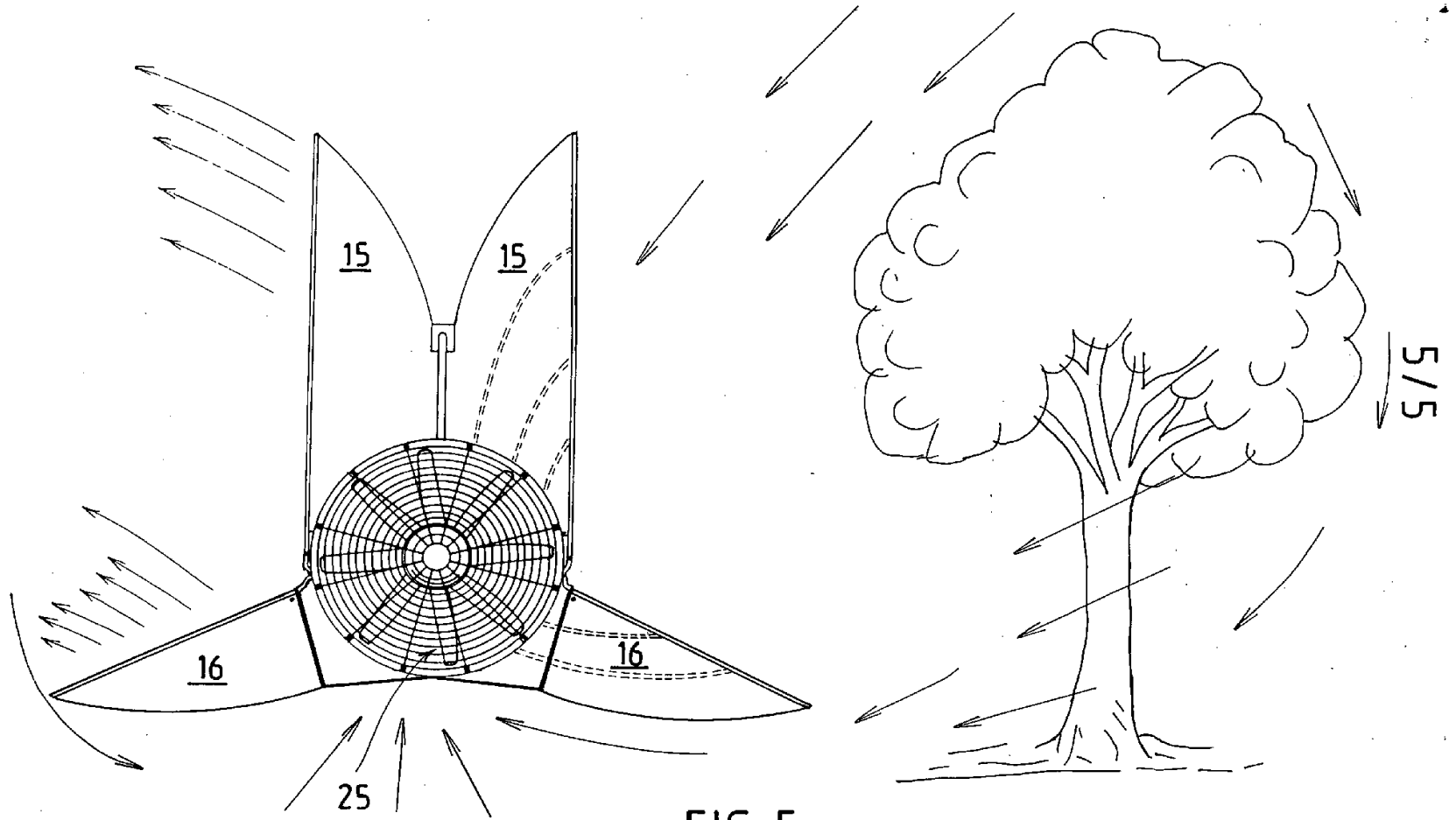


FIG. 5