

Oct. 6, 1936.

M. S. ROBERTSON

2,056,296

MEANS FOR APPLYING SPRAY MATERIALS

Filed April 25, 1934

2 Sheets-Sheet 1

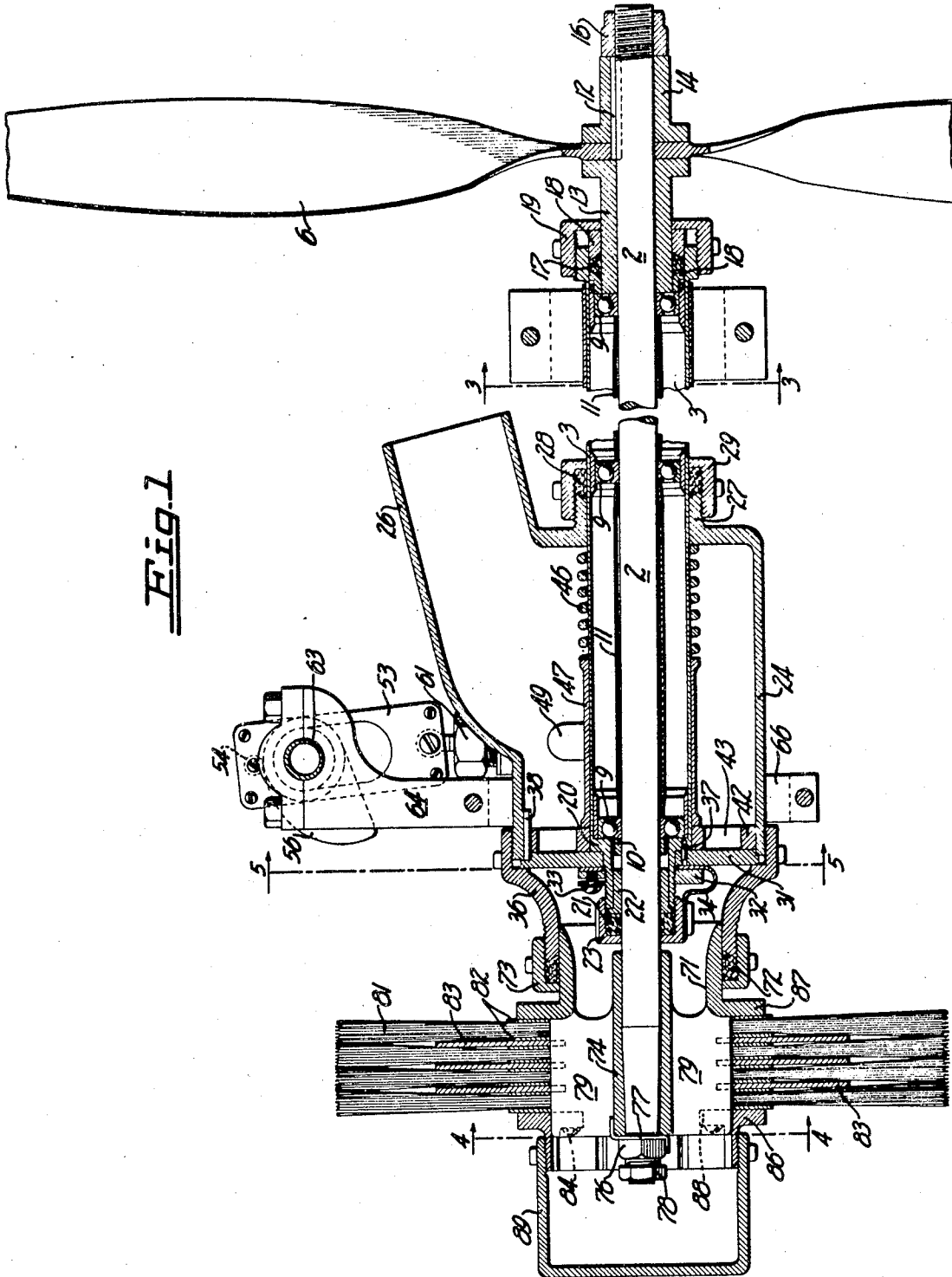


Fig. 1

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2 Sheets-Sheet 2

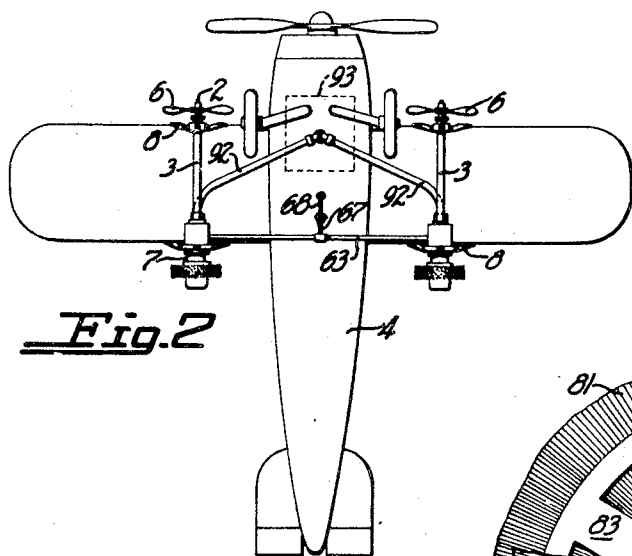


Fig. 2

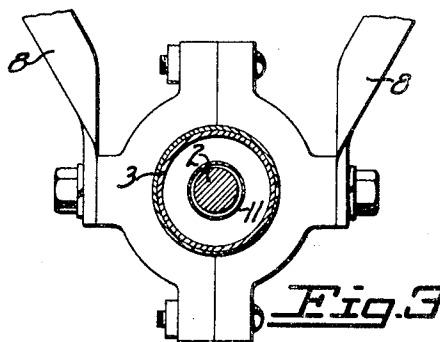


Fig. 3

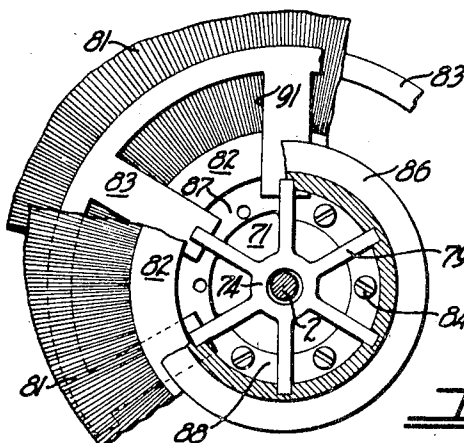


Fig. 4

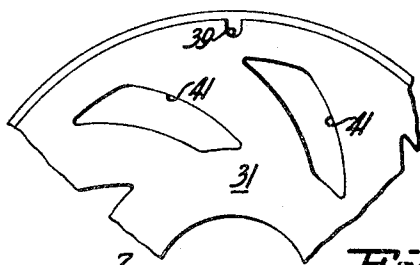


Fig. 6

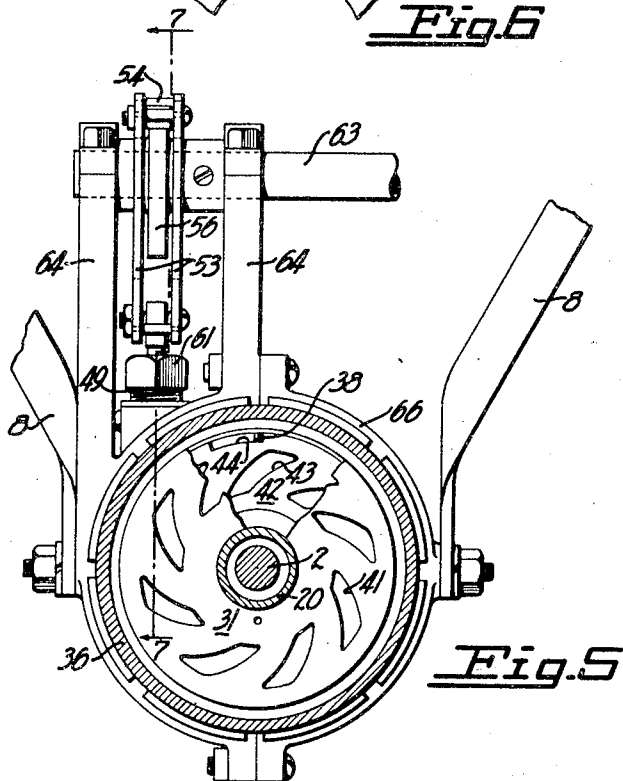


Fig. 5

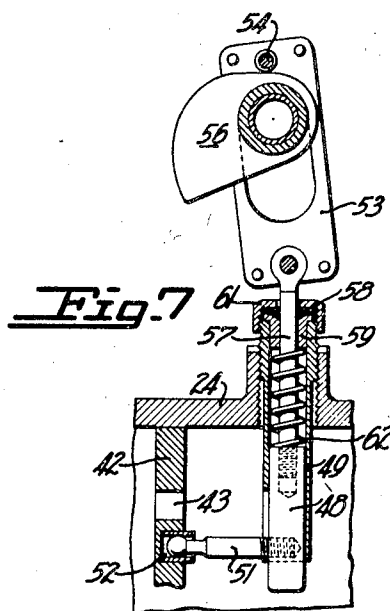


Fig. 7

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UNITED STATES PATENT OFFICE

2,056,296

MEANS FOR APPLYING SPRAY MATERIALS

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Application April 25, 1934, Serial No. 722,222

11 Claims. (Cl. 299—38)

My invention relates to the application of spray materials, and more particularly to the application of materials from airplanes for such uses as the control of pests over infected areas or for controlling fire areas.

A more specific object of my invention is to provide apparatus for treating crops from airplanes by which the treating material is applied to the under surfaces as well as the top surfaces of the crop foliage.

Another object of my invention is to provide means for effecting the better coverage with no greater cost per acre than that required in crop dusting.

Another object of my invention is to provide means of the character described which will handle a wide variety of spray liquids.

Another object of my invention is to provide a system of spraying which utilizes air for diluting a concentrated spray material.

Further objects include the provision of apparatus of the character described which is of light weight, low power consumption, self-cleaning, adapted to resist the stresses imposed by flight conditions, and designed to eliminate interference with plane maneuvering and control.

The invention possesses other objects and features of advantage, some of which, with the foregoing, will be set forth in the following description of my invention. It is to be understood that I do not limit myself to this disclosure of species of my invention, as I may adopt variant embodiments thereof within the scope of the claims.

Referring to the drawings:

Figure 1 is an axial sectional view of my improved spray apparatus, portions of the drive shaft and housing being omitted to shorten the view.

Figure 2 is a bottom view of an airplane showing a method of mounting my apparatus.

Figure 3 is a transverse vertical sectional view taken in a plane along the line 3—3 of Figure 1, and shows the forward bracket mounting.

Figure 4 is a transverse vertical sectional view taken in a plane along the line 4—4 of Figure 1, and shows the spray distributing head assembly with portions of the brushes and spacing disks broken away to disclose their construction and positional relationship.

Figure 5 is a transverse vertical sectional view taken in a plane along the line 5—5 of Figure 1, and shows the valve assembly with portions of the outer valve plate broken away to disclose the inner plate construction.

Figure 6 is a detail view showing the inner face of the outer valve plate.

Figure 7 is a vertical sectional view taken in a plane indicated by the line 7—7 of Figure 5, and shows the valve control mechanism.

In terms of broad inclusion, the apparatus embodying my invention comprises a rotatable distributing head mounted on the plane for reducing and dispersing the spray material. Power for driving the distributing head is preferably derived from a propeller mounted on the plane and rotatably connected with the head. The distributing head comprises a porous rotor having a hollow core; an annular brush having radially extending bristles being preferably used. Means are provided for feeding the material to be sprayed into the core of the brush, and impeller means are preferably provided for driving the materials under pressure between the bristles of the brush.

In greater detail, and referring particularly to Figures 1 and 2 of the drawings, the spray apparatus embodying my invention comprises a shaft 2 journaled in a bearing tube 3 and arranged to extend longitudinally of an airplane 4. A propeller 6 is mounted on the leading end of the shaft 2, and a distributing head 7 is mounted on the trailing end of the shaft. The spray unit is preferably suspended under the airplane wing, and suitable brackets 8 are preferably provided for the mounting. One or more of these units may be provided. Two units are shown in Figure 2, one mounted on each side of the fuselage, but it is understood that this is merely for purposes of illustration.

As best shown in Figure 1, the shaft 2 is journaled in suitable bearings 9 mounted in bearing stations spaced along the bearing tube 3. The bearing stations reenforce the tube and space the bearings from the latter so that the bearings may be easily withdrawn from the tube. A thrust collar 10 is provided behind the rear bearing, and spacing tubes 11 are preferably provided for holding the bearings in position. The propeller 6 is locked to the shaft by a suitable key 12, and is positioned between a pair of sleeves 13 and 14; the inner sleeve 13 projecting into the bearing tube 3 to space the propeller from the forward bearing 9. The whole is then held together by a nut 16 threaded on the end of the shaft. A packing 17 is interposed between the sleeve 13 and the bearing tube, and is held between a pair of retainer rings 18 and compressed by a nut 19 surrounding the sleeve and threaded on the end of the tube. This packing operates to seal the bear-

ing tube so that the latter will retain a lubricant.

The rear end 20 of the bearing tube is preferably reduced to provide a shoulder adjacent the forward bearing 9, and this end of the tube is sealed by a packing 21 compressed between a bushing 22 and a nut 23 threaded on the reduced portion of the tube.

The rear portions of the bearing tube project into a casing 24. This casing is provided with an inlet duct 26 and forms a chamber for receiving the spray liquid. The forward end of the casing is provided with a neck portion 27 fitted on the bearing tube, and this end of the casing is sealed by a packing 28 held by a nut 29 surrounding the tube and threaded on the neck portion of the casing. This arrangement forms a sealed joint between the casing and bearing tube and at the same time provides a degree of flexibility between these elements.

The rear end of the bearing tube is supported in the casing by a plate or disk 31 mounted on the reduced portion 20 of the bearing tube and held by a nut 32 threaded on the tube. The nut is preferably split and provided with a screw 33 so that it may be locked to the threads. A washer is preferably interposed between the nut 32 and plate 31, and is provided with a spring finger 34 engaging flutes on the packing nut 23 for holding the latter in a selected position of adjustment. The peripheral portions of the plate 31 are preferably grooved to provide a seat for the rear end of the casing 24, and the plate is secured by a retainer bell 36 threaded on the casing and abutting the plate.

The spray fluid introduced into the casing 24 through the duct 26 is fed rearwardly by a valve mechanism of which the plate or disk 31 comprises a part. The latter disk is locked against rotation by a pin 37 projecting into the bearing tube, and is further locked by a key 38 formed on the casing and engaging a socket 39 cut in the peripheral portions of the disk. Note Figure 6. As also shown by the latter figure, the fixed plate 31 is provided with a series of valve apertures 41.

The movable portion of the valve mechanism comprises a second disk 42 journaled on the bearing tube 3 immediately ahead of the fixed plate 31. The movable plate 42 is provided with valve apertures 43 adapted to move into registration with the apertures 41 of the fixed plate. The apertures of both valve plates are preferably arcuately shaped, as shown. This shape of aperture will pass a large quantity of fluid in the wide open position and at the same time will permit a gradual opening and cut off to give the operator accurate control over the liquid flow. Movement of the plate 42 is limited by a slot 44 cut in its periphery and engaging the key 38 of the casing. The movable valve plate is held tightly against the fixed plate by a spring 46 compressed between the forward end of the casing and a sleeve 47 slidable on the bearing tube and bearing against the movable plate.

As best shown in Figure 7, the position of the movable valve plate is controlled by mechanism comprising a plunger 48 slidable in a tube 49 threaded in the casing 24, and carrying a pin 51 projecting into a seat 52 provided in the valve plate. The eccentric arrangement of the plunger with respect to the disk, as better shown in Figure 5, causes the disk to rotate when the plunger is reciprocated, as will be readily understood. The position of the plunger 48 is controlled by a yoke 53 having a follower roller 54

riding on a cam 56. The yoke is connected to the plunger by a rod 57 projecting downwardly into the tube 49 and threaded into the plunger. The casing is sealed at this point by a packing 58 compressed between a bushing 59 and a packing nut 61 threaded on the tube 49.

The position of the valve disk is such that the valve is closed when the plunger 48 is in its down position, the valve being held normally closed by a spring 62 surrounding the rod 57 and bearing against the plunger 48. Adjustment to time the opening of the valve with respect to the movement of the cam is effected by screwing the rod 57 into or out of the plunger 48. As best shown in Figures 1 and 5, the cam 56 is mounted on a shaft 63 journaled in supports 64 formed on the bracket mounting 66. Where a plurality of units are provided, as shown in Figure 2, the cam shaft is extended to carry the cams of the several units. Movement of the cam shaft is controlled by a lever 67 connected with a suitable lever in the pilot's compartment by a connecting rod 68.

The distributing head for reducing the spray material to a finely divided state of subdivision is carried on the rear end of the shaft 2. Referring again to Figure 1, the distributing head preferably comprises a hollow rotor mounted on the end of the shaft 2 with a neck or mouth portion 71 slidable within the rear end of the retainer bell 36. This joint between the bell and rotor is sealed by a packing 72 held by a packing nut 73 threaded on the bell. The hub 74 of the rotor is preferably tapered to fit a complementary tapered portion of the shaft, and is held by a nut 76 threaded on a reduced end of the shaft. A washer 77 having outturned lips for engaging the rotor and nut respectively is preferably interposed between these elements so that any tendency toward relative rotation causes the nut to tighten and force the rotor more tightly on the shaft. A cupped nut 78 threaded on the shaft and seated over the nipped end of the nut 76 operates to lock the latter.

As best shown in Figure 4, a plurality of radially extending fins or impellers 79 are provided in the rotor. By this arrangement the rotor is in effect a centrifugal pump, and when the shaft is rotating the impellers operate to draw the fluid through the mouth 71 and throw the same radially of the rotor. A porous casing is provided about the impeller blades for subdividing the fluid and dispersing the resulting minute particles in the surrounding atmosphere. This porous casing structure enclosing the impellers is mounted for rotation with the latter, and preferably comprises a plurality of circular wire brushes 81 having radially extending bristles. The brushes are of the hollow core type with the base portions of the bristles clamped between retaining rings 82.

The brushes are preferably separated by spacing disks 83, and the whole assembly is secured together by suitable screws 84 passing through a compression flange 86 and threaded into a buttress flange 87 on the rotor. In order to prevent relative rotation the compression flange 86 is provided with lip portions 88 projecting inwardly between the impeller blades 79. The rear end of the rotor is sealed by means of a hub cap 89 threaded on a rearwardly extending neck portion of the compression flange 86.

When the rotor is rotating and fluid is fed into the open core of the brushes, centrifugal force tends to drive the fluid outwardly through the brushes 81. This outward driving of the fluid is

of course assisted by the action of the impeller blades 79, as will be readily understood. The entrance of the fluid into the porous structure of the brushes is facilitated by apertures or recesses 91 extending radially in the spacing plates 83. These recesses provide open passages between the brushes, and serve to conduct the fluid past the compressed base portions of the brushes and into the open fiber structure. Once introduced between the bristles the fluid passes outwardly along the bristles and is thrown radially from the peripheral portions of the brushes.

By this mechanism the fluid is thoroughly broken up, and is thrown from the distributing head in minute liquid particles. The dispersion of these liquid particles in the air creates a light fog or mist, which will readily follow the course of disturbed air currents.

The spray material is fed to the spray units 20 by suitable ducts 92 leading from a common tank 93 preferably mounted in the fuselage of the plane. Note Figure 2. If desired, a shut-off valve may be provided in connection with the tank 93 for cutting off the fluid from the units. Such a valve of course would be secondary to those in the separate units.

In use, the pilot operating the plane makes his flight over the crop area to be treated in a manner similar to that now practiced in crop dusting. As the plane travels over the ground it creates a downward draft which is known in the art as "down wash". This downdraft compresses the air in a strata adjacent the ground and enveloping the crop. After the plane passes, and the source of the downdraft thereby removed, the air in the compressed strata expands to create a final upward current. If the spray material is introduced into this downdraft it will be carried downwardly to wet the upper surfaces of the crop foliage in a manner similar to the deposit of dust on the upper in the process of crop dusting. The added feature of my process however is to take advantage of the final upward air movement during expansion of the compressed air strata to carry the spray material into contact with the under surfaces of the crop foliage.

This is accomplished by reducing the liquid to such a finely divided state of subdivision that it remains suspended in the air until after the period of expansion and upward air movement. I have found that the distributing head of my spray apparatus produces a fog or mist in which the particles are held suspended for the desired period of time. By actual tests it has been found that the under surfaces as well as the top surfaces of the crop foliage are thoroughly wetted. Being of liquid nature the spray material adheres to the under surfaces.

The spray apparatus of my invention will deliver the large quantities of fluid necessary for coverage by airplane application, and will handle the heavier as well as the lighter fluids. The apparatus has been used to apply water solutions, paste emulsions, oils, oil suspensions, and other combinations of liquids and suspended solids. The apparatus is adapted for use with gaseous as well as liquid fluids. The spray material employed may be in a highly concentrated form, because the thorough breaking up of the material and distribution in the air operates to dilute the material. The large quantities of diluting water ordinarily used in spray methods therefore become unnecessary.

A very accurate control of liquid particle size is had by the distributing head of my invention.

By dispensing with the spacing disks entirely, and using the brushes only, an extremely finely divided spray will result. By using the spacing disks to facilitate the liquid passage into the outer and more open portions of the brush structure, a heavier mist is produced. Still heavier fog-like particles may be produced by increasing the number or thickness of the disks. The latter of course would be desirable in conjunction with the heavier liquids. Where little breaking up of the liquid is necessary, such as is the case where oil is coated over marsh areas for mosquito control, both the brushes and spacing disks may be dispensed with, allowing the oil to be discharged directly into the atmosphere from the pump impellers.

Other advantages of my improved apparatus are that it is of light weight, low in power consumption, and is substantially self-cleaning. Furthermore, the degree of flexibility provided in the units adapts them to resist the stresses imposed by flight conditions. Still further, a plane equipped with apparatus of my invention feels little interference in maneuvering and control. The latter is due to the light weight of the rotating head and the consequent low gyroscopic action of the apparatus. This not only minimizes the interference with maneuvering, but also reduces the stresses in the unit itself. A feature of the light weight of the apparatus as a whole is that the units may be mounted out close to the tips of the wings, which has the advantage of introducing the spray material in the disturbed air currents at these points. These currents are known as "tip vortices" and have a turning motion which aids to increase and give a more uniform wetting over the width of the swath.

It is understood of course that the principles embodied in my improved spray distributor head may be incorporated in other types of apparatus. For example, the head may be incorporated in spray apparatus for use on the ground. The ability of the head to discharge large quantities of finely divided spray material in the atmosphere and without creating a heavy blast of the material makes it especially suitable for ground work. The ideal condition for good coverage is a slow moving air current heavily saturated with minute particles of the spray material, and this is just what is secured by my distributor head.

It is also understood that the porous casing structure about the impeller blades of the distributor head may be of a structure other than brushes. For example, a series of screen disks could be employed, placed side by side to build up the porous ring structure. The desired characteristic in this casing about the impellers is its porosity, since the multiplicity of intercommunicating passages provided thereby, and through which the spray fluid must pass to reach the periphery of the spray wheel, perform the function of reducing the fluid to the desired state of finely divided subdivision.

I claim:

1. Spray apparatus comprising a plurality of circular brushes having a hollow core, means for spacing the brushes to provide passages between the core and the intermediate portions of said brushes, means for rotating the brushes, said brushes being parallel and having substantially straight bristles extending radially of the axis of rotation of said brushes, and means for feeding the material to be sprayed into said core.

2. Spray apparatus comprising a shaft, a plurality of impellers radially mounted on the shaft,

- a plurality of annular brushes mounted on the peripheral portions of said impellers, disks for spacing said brushes and having apertures providing passages between said impellers and the intermediate portions of said brushes, means for rotating the shaft, and means for feeding material to be sprayed to said impellers.
3. Spray apparatus comprising a shaft, a plurality of impellers radially mounted on the shaft, an annular porous member mounted on the peripheral portions of said impellers, means for rotating the shaft, and means for feeding material to be sprayed to said impellers.
4. Spray apparatus comprising a shaft, a plurality of impellers radially mounted on the shaft, a plurality of annular porous members mounted on the peripheral portions of said impellers, means for spacing said members, means for rotating the shaft, and means for feeding material to be sprayed to said impellers.
5. The combination with an airplane having a fuselage and wing, of a spray apparatus comprising a distributing head, and means for mounting the head beneath the wing in a position laterally spaced from the fuselage and adjacently behind the trailing edge of the wing.
6. Spray apparatus comprising a bearing tube, a distributing head adjacent one end of the tube, a shaft in the tube for driving the head, bearings for the shaft and insertably mounted in the tube, and means on the shaft for holding the bearings in spaced relation.
7. Spray apparatus comprising a bearing tube, a shaft journaled in the tube and projecting therefrom, a distributing head mounted on the projecting end of the shaft, a casing mounted on the end of the bearing tube and connected with the distributing head for feeding spray material to the distributing head, and means for sealing the end of the bearing tube against the entrance of the spray material.
8. Spray apparatus comprising a duct for spray material, a hollow distributing head rotatably mounted on the duct, a packing gland for sealing the rotor connection between said head and duct, radially extending impellers in the head, and means for driving the head.
9. Spray apparatus comprising a duct for spray material, a shaft, a distributing head on the shaft and rotatably mounted on the duct, impellers in the head, and a propeller on the shaft for driving the head.
10. Spray apparatus comprising a shaft, a hollow cylindrical rotor mounted on the shaft, a plurality of annular brushes mounted on the peripheral portions of the rotor, spacers between the brushes, impellers in the rotor, means for rotating the shaft, and means for feeding material to be sprayed to the impellers.
11. Spray apparatus comprising a plurality of annular brushes arranged side by side, means for rotating the brushes about their central axis, said brushes having bristles extending radially outwardly from the axis of rotation so that they rotate in planes substantially perpendicular to said axis, the bristles being compacted adjacent their inner ends and loosely disposed adjacent their outer ends, means for feeding material to be sprayed into the hollow core of the brushes, and means for spacing the brushes to provide passages for flow of spray material past the compacted inner ends of the bristles and into the loosely disposed outer portions of the bristles.

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