Aug. 23, 1966 O. C. BLOMGREN, SR., ETAL 3,267,870

COMBINED CENTRIFUGAL PUMP AND DISTRIBUTOR

Filed June 10, 1964 2 Sheets-Sheet 1

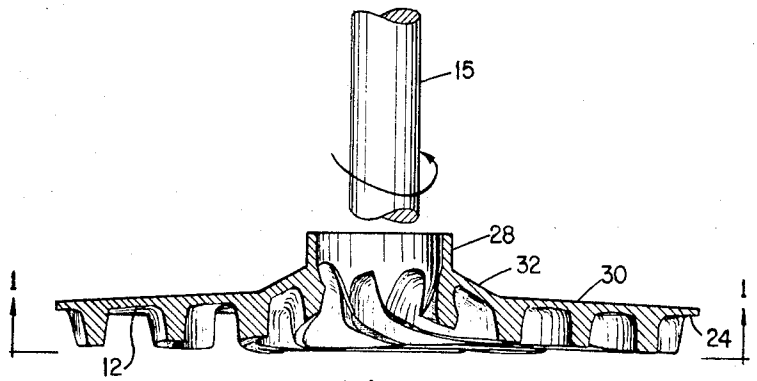

Fig. 2

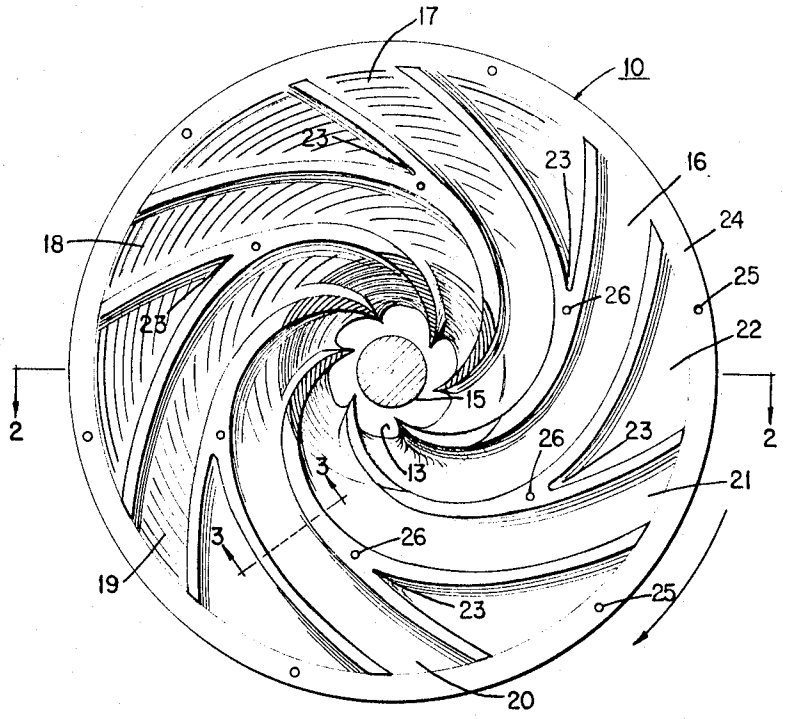

Fig. 1

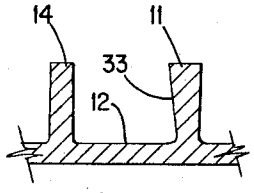

Fig. 3

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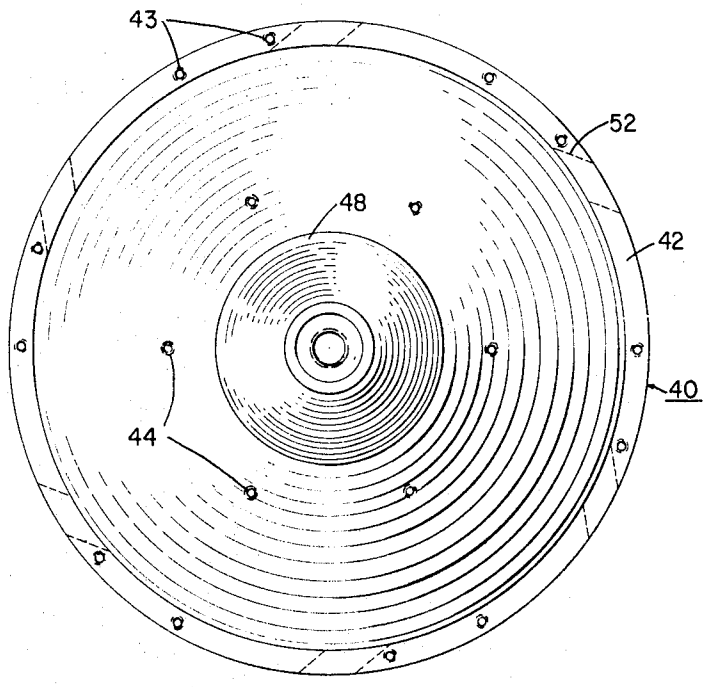

Fig. 4

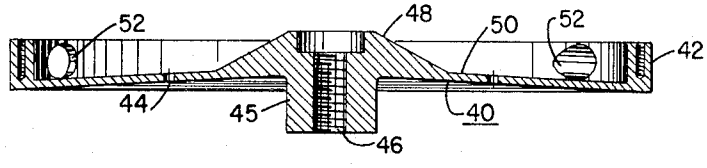

Fig. 5

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COMBINED CENTRIFUGAL PUMP AND DISTRIBUTOR

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Filed June 10, 1964, Ser. No. 374,058
4 Claims. (Cl. 103—115)

This invention relates to a centrifugal pump and, more particularly, to a combined centrifugal pump and distributor which is particularly adapted to distribute a liquid, especially a liquid mixture, such as an emulsion, without modifying the consistency thereof.

Priorly, numerous devices have been employed to distribute a liquid spray of a given material, such as a plant toxicant, over a given area. Preferably, these sprays employ an emulsion in which an oil-like toxicant is emulsified, or otherwise dispersed, in a diluent such as water; or the dispersion may be one of the water-in-oil type commonly referred to as an invert emulsion. One of the problems involved in spraying toxicants is that of preventing drift, due to wind currents, from the prescribed area of application. The problem of drift can be solved by distributing relatively large droplets, namely, droplets of the order of one-eighth to three-fourths inch in diameter, or a highly viscous water-in-oil (invert) emulsion. In the prior art distributors, however, it is difficult to discharge droplets of uniform diameter and the type of impeller, or distributor, heretofore used causes the droplets to disintegrate and form a fine spray which readily drifts due to air currents at or near the ground level. One solution of this problem is disclosed in our concurrently filed application, Serial No. 374,057, filed June 10, 1964, directed to an in-transit invert emulsion mixer-applicator and method therefor. In this application, the distributor for the invert emulsion includes a centrifugal impeller having radially directed vanes and discharge ports having an effectively controllable cross-sectional area.

Briefly, in accordance with aspects of the present invention, an apparatus is employed in which a centrifugal pump and a distributor are advantageously combined into a single unitary device in such a way that the device comprises an enclosed centrifugal impeller having a single suction eye, the impeller including a housing and a rotor plate or shroud, which carries vanes forming channels of uniform cross-section and having a negative rake, i.e., the vanes are generated by straight lines inclined at an angle in the direction of rotation of the rotor axis so as to provide a component of force in the direction of rotation; advantageously, the vanes are arranged so as to define fluid channels which are uniform in cross-section throughout their length to avoid loss of mixture consistency. Also advantageously, this uniformity in width of the fluid channels accelerates the movement of fluid thereby increasing pressure toward the periphery of the impeller where the impeller joins a distributor member having angularly disposed apertures therein aligned with the fluid channels. The channel cross-sectional uniformity avoids loss of the desired invert emulsion consistency, prevents aeration of the liquid emulsion, prevents the emulsion from losing the "rope" effect, or formation of a cylinder of liquid as it is discharged from the nozzle, and enhances the formation of uniform droplets. Preferably, the long axes of the fluid-carrying channels in the impeller define angles with the tangent to the periphery of the impeller in a range of the order of 30 to 35 degrees for maximum pumping efficiency, and the negative rake of the impeller vanes is of the order of at least 5 degrees with respect to the axis of the pump. Also advantageously, the liquid-contacting surfaces of the shroud,

vanes, and housing are sloped in such a manner as to conduct the liquid downwardly away from the suction eye, thereby, among other advantages, to permit the use of similarly contoured vanes on the distributor orifices for the purpose of directing the spray downwardly, and to increase the pumping capacity of the impeller-distributor.

These and various other objects and features of the invention will be more clearly understood from a reading of the detailed description of the invention in conjunction with the drawing in which:

FIGURE 1 is a plan view, from below the suction eye, of a centrifugal impeller forming a part of this novel pump and distributor combination of the invention;

FIGURE 2 is a view in vertical section, taken along the line 2—2 of FIGURE 1, and looking in the direction of the arrows;

FIGURE 3 is a detailed view, of a liquid-conducting channel of the impeller, to an enlarged scale, taken along the line 3—3 of FIGURE 1;

FIGURE 4 is a top plan view of the impeller housing; and

FIGURE 5 is a view in section of the housing of FIGURE 4, taken along the line 5—5 thereof.

Referring now to FIGURE 1, there is depicted a bottom plan view, or view from below toward the suction eye of a single suction impeller **10** having a plurality of substantially axially extending vanes **11** therein, which vanes are joined by a full shroud **12** or its equivalent in the form of a circular shroud which extends radially to the length of the vanes. As viewed in FIGURE 1, the impeller is designed to rotate in a clockwise direction and to deliver fluid from its intake or suction eye **13** between the inner portion of the impeller **10** and the shaft **15** which is connected to the impeller housing **40** shown in FIGURES 4 and 5, and this fluid is directed through fluid channels as at **16**, defined by uniformly-spaced-apart vanes **11** and **14**. These channels are designated **16, 17, 18, 19, 20** and **21** and are of substantially uniform cross-section. Preferably, for maximum efficiency, the long axes of channels **16** through **21** define angles of the order of 30 to 35 degrees with a tangent to the periphery of the impeller **10**. Each leading edge of vanes **11** may be separated at its outer portion from the next trailing edge of vanes **14** by means of a V-shaped notch-like portion **22** having its vertex **23** generally inwardly from the periphery such that the fluid channels are uniform in cross-section and width throughout their length between the suction eye **13** and the periphery of the impeller. Advantageously, this uniformity of the channel width and cross-section avoids loss of the correct invert emulsion consistency when the device is used for pumping an invert emulsion. Further, this arrangement of the vanes providing uniform cross-section also prevents the impeller from unnecessarily aerating the liquid emulsion and prevents the loss of "rope" effect in discharging the emulsion from the nozzles or orifices **52**.

The periphery of the impeller **10** is provided with a flange portion **24** extending beyond the end of vanes **11** and **14** and a plurality of apertures **25** is drilled or otherwise formed in the flange **24** for the purpose of receiving fasteners which secure the impeller to its housing **40** which is to be described. Also, the impeller **10** is provided with a second group of apertures **26** at the vertex of each V-shaped notch-like portion **26** which defines a junction between a leading and a trailing edge of vanes **11** and **14**, which apertures are also employed to receive fasteners for securing the impeller **10** to the housing.

As best seen in FIGURE 2, the innermost portions of the vanes **11** and **14** are preferably inclined upwardly, and receive the oppositely inclined central portion **48**

of housing 40 which is inclined downwardly to the same degree as the innermost portions of the vanes.

Also, as shown in FIGURE 2, the inner portion of the shroud of impeller 10 terminates in a short axially extending cylindrical section 28 adapted to be coupled to a source of liquid, such as invert emulsion, with the section 28 retained in a suitable fluid sealing relationship so that the impeller may be rotated by the shaft 15, shown in section in FIGURE 1, and shown partially broken away in FIGURE 2. The impeller 10 may be constructed so as to include a tapering frusto-conical outer surface 30 which may be connected to the short cylindrical section 28 by means of an intermediate but more steeply inclined frusto-conical section 32. This combination of frusto-conical sections gives the impeller 10 an overall downwardly sloping configuration such that the fluids pumped by the impeller will be directed downwardly and outwardly through the distributor orifices which are to be described.

FIGURE 3 is a detailed view, on an enlarged scale, taken along the lines 3—3 of FIGURE 1, in section, of a liquid-conducting channel showing the negative rake of the leading edge of vanes 11, i.e., the vanes are generated by straight lines inclined away from the pump axis to give the pumped fluid a component of force in the direction of rotation. Thus, the leading edge of vanes 11 has a surface 33 which slopes to the left, as viewed in FIGURE 3, and because the impeller 10, as shown in FIGURE 1, rotates in a clockwise direction, the surface 33 gives the fluid passing along this channel and engaging the surface 33 a component of force in the direction of rotation of the impeller 10 to reduce breakup of the droplets.

Referring now to FIGURES 4 and 5, there are shown views in plan and in sectional elevation, respectively, of the impeller housing 40 which cooperates with the previously described impeller 10 to define a combined pump and distributor in accordance with one illustrative embodiment of this invention. The housing 40 is of generally cylindrical configuration having a vertically projecting cylindrical edge portion 42 which surrounds the periphery of the impeller and engages the horizontally projecting impeller flange 24 in fluid sealing relationship. The flange 42 is held in engagement with the peripheral flange 24 by suitable fastening means such as threaded fasteners passing through the impeller flange 24 and engaging the threaded apertures 43. Also, the housing 40 is provided with a plurality of apertures 44 intermediate the axis and the periphery thereof to receive fasteners which engage the threaded apertures 26 in the impeller 10. The housing 40 is also provided with a cylindrical extension 45 which serves as a hub for the impeller or may be referred to as an impeller drive shaft base, and may have a threaded inner cylindrical surface 46 for threadably engaging a suitable drive shaft, such as the shaft 15 described in conjunction with FIGURES 1 and 2. The inner surface of the housing 40 is preferably frusto-conical, as indicated at 48, and tapers outwardly to join a more gently tapering frusto-conical surface 50, which surface extends to the housing periphery. These sloping surfaces, together with the correspondingly contoured vanes of the impeller, provide a downward and outward component of force to the liquid stream and thus improve the spray-distribution pattern.

The cylindrical flange 42 of the housing 40 is provided with a plurality of apertures 52 which are preferably circular, but may be elliptical, or rectangular in cross-section, and positioned such that when the housing 40 is secured to the impeller 10, the apertures 52 are each aligned with one of the fluid passages 16 through 21. Advantageously, these apertures 52 have a cross-sectional area which is substantially equal to the cross-sectional area of the fluid channels in the impeller. With this arrangement, unnecessary aeration or air entrainment of the liquid emulsion is obviated and a rope effect, as described heretofore, prevails whereby the fluid issues from the apertures 52 as a continuous rope-like stream. Because the impeller 10 and the housing 40 are secured together and rotate as a unit and because the openings 52 have a cross-sectional area substantially equal to the uniform cross-sectional fluid channels 16 through 21 of the impeller, the combination acts as both a pump and a distributor for fluids such as liquid mixtures and emulsions to distribute droplets relatively large not subject to drift under customarily prudent application conditions.

This invention is especially useful in those situations which require distribution in the form of a spray of relatively large volumes of liquid within a relatively short period of time and is especially useful in the spray application of non-Newtonian fluids which may take the form of water-in-oil emulsions having an almost jelly-like consistency, or those having thixotropic properties. For example, this invention may be employed as the distributor for apparatus of the type disclosed in our application Serial No. 319,069, filed October 25, 1963 for Pre-Emulsified Applicator. Further, this invention is especially adapted for spraying the components of such fluids and emulsions from vehicles adapted for travel on land, water, or in the air for the treatment or eradication of vegetation. The advantages of this latter type of application, in employing the device of the present invention in combination with the in-transit mixer of our previously mentioned copending application, reside in that the thixotropic fluid, or the water-in-oil emulsion, may be formed while the vehicles are moving over the sites where the vegetation is to be treated or eradicated, and the thixotropic fluid is evenly distributed in the form of relatively large droplets which do not drift in moderate wind currents and where a relatively large volume of liquid material is to be applied within a relatively short time.

While we have shown and described one illustrative embodiment of this invention, it is understood that the concepts thereof may be employed in other embodiments without departing from the spirit and scope of this invention.

What is claimed is:

1. A combination pump and distributor comprising:
a centrifugal impeller;
a shroud coextensive with said impeller;
a suction eye on the inner edge of said shroud in fluid communication with said impeller;
said impeller including a plurality of vanes defining fluid conducting passages of uniform width extending from said eye to the outer edge of said shroud; and
a cylindrical housing secured to said impeller and said shroud and having a plurality of apertures in fluid communication with said passages, said apertures having cross-sectional areas substantially equal to the cross-sectional areas of said fluid passages.

2. A combination pump and distributor comprising:
a centrifugal impeller including
an annular shroud, and
a plurality of vanes defining fluid passages of uniform width between the inner and outer edges of said shroud, each of said vanes defining an angle in the range of 30 to 35 degrees with the tangent to said outer edge; and
circular housing means engaging said impeller in fluid sealing relationship and having a cylindrical periphery with a plurality of ports therein, each port communicating with one of said fluid passages and having a cross-sectional area substantially equal to the communicating fluid passage.

3. A combination pump and distributor comprising:
a closed centrifugal impeller including
an annular shroud, and
a plurality of vanes defining fluid passages between the inner and outer edges of said shroud, cer-

tain of said vanes having negative rakes; and

a circular housing secured to said impeller in fluid sealing relationship and having a plurality of ports in the periphery thereof, each of said ports communicating with one of said fluid passages and having a cross-sectional area substantially equal to the communicating fluid passage.

4. A distributing device comprising:

a circular centrifugal impeller having an aperture in the center thereof defining a suction eye and a peripheral flange and a plurality of vanes defining fluid passages of uniform cross-section between said aperture and said flange, each of said vanes terminating at said peripheral flange and defining an angle in the range of 30 to 35 degrees with the tangent to said flange, certain of said vanes having a negative rake of at least five degrees; and

a housing including a circular portion and a cylindrical peripheral portion projecting in the direction of said impeller for engaging said impeller flange in fluid sealing relationship, said housing having ports

in the periphery thereof communicating with said fluid passages, said ports having an outward taper at an angle in the range of 30 to 35 degrees to the tangent of said housing and having a cross-sectional area substantially equal to the communicating fluid passage.

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