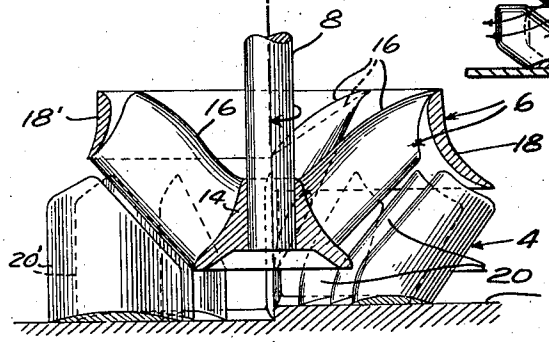
Oct. 5, 1948. J. JOHNSON 2,450,802

MIXER

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Fig. 1.



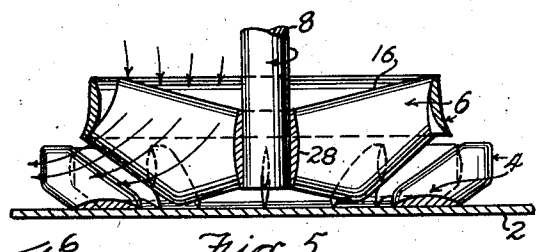
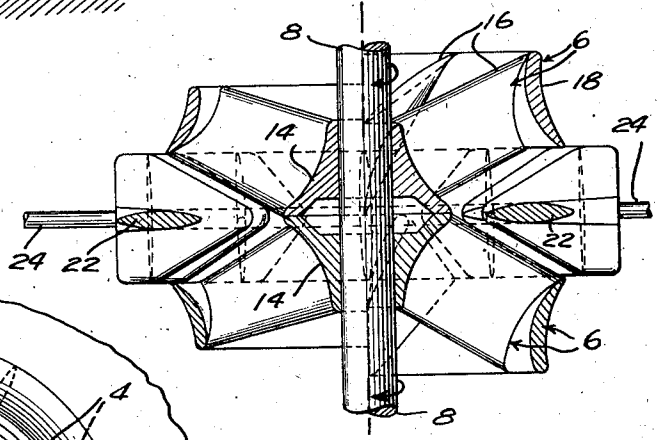


Fig. 5.

Fig. 3.



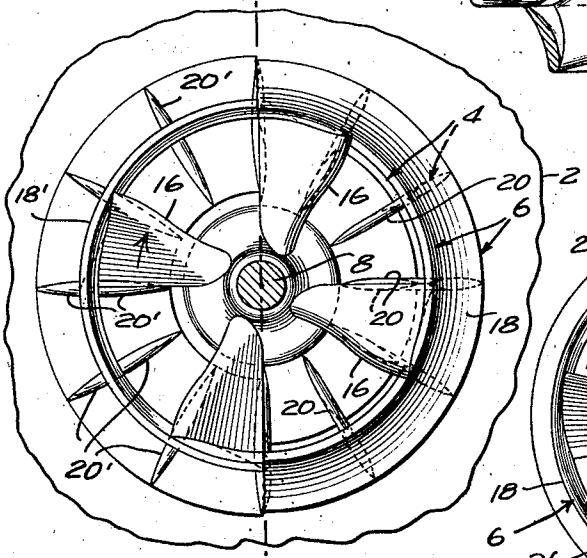


Fig. 2.

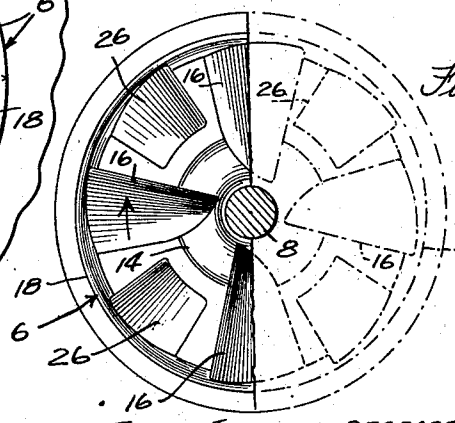


Fig. 4.

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Fig. 6.

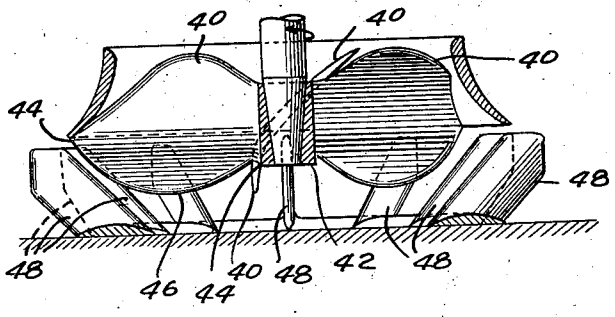


Fig. 7.

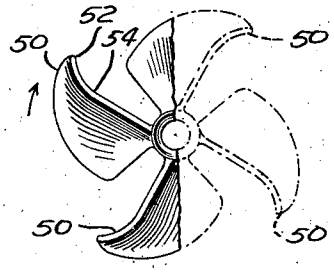
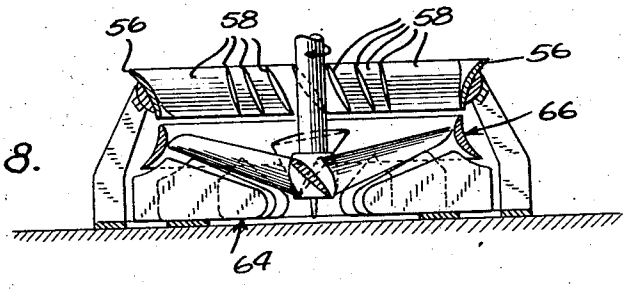


Fig. 8.



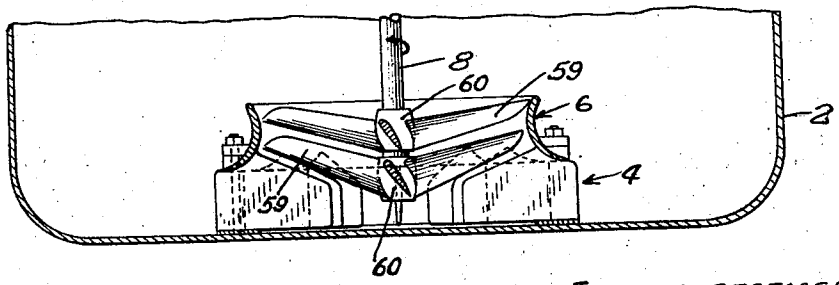


Fig. 9.

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Patented Oct. 5, 1948 2,450,802

UNITED STATES PATENT OFFICE

2,450,802

MIXER

John Johnson, deceased, late of Morristown, N. J., by Ethel H. Johnson, executrix, Morristown, N. J., assignor to John E. Johnson, Morristown, N. J.

Application November 15, 1944, Serial No. 563,500

3 Claims. (Cl. 259—96)

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This invention relates to mixing apparatus of the general type in which a liquid circulating rotor having propeller or impeller blades, or both, so discharges the materials to be mixed against suitably arranged blades of a cooperating stator that a thorough commingling of the materials and also a substantially definite circulation thereof, both through the mixing apparatus and throughout the container in which the mixing apparatus is located, are brought about. Mixing apparatus of this general type is shown in prior patents of this inventor: No. 1,353,165, granted September 21, 1920; No. 1,354,489, granted October 5, 1920; No. 1,525,449, granted February 10, 1925; No. 1,757,197, granted May 6, 1930; No. 1,768,956, granted July 1, 1930.

In mixers of the general type disclosed in the prior patents above identified, the bladed rotor may comprise a liquid-impelling device of the propeller type or the blades of the rotor may be arranged in the manner of the blades of a turbine or the blade arrangement may combine features of both types of liquid circulators.

A general object of the present invention is to provide an improved mixer, of the general type disclosed in the prior patents above identified, which is simpler and more compact in its construction and which neverthless compares most favorably in efficiency with the more complicated mixers shown in the prior art.

As will be seen from a study of the prior art, mixing apparatus of the general type to which this invention is directed has usually comprised a stator having its blades arranged about the rotor, immediately outside the periphery thereof. To insure direction of the liquid through the blades of the rotor and against and between the blades of the stator various types of flow directors have been employed in the mixers of the prior art. In some of these prior art mixers the flow director has been carried by the stator, in others it has been carried by the rotor and in some the flow director has been made in two parts, one part carried by the stator and the other part by the rotor. Whether or not the flow director be carried by the stator, by the rotor or partly by each, it is important, in order to insure thorough mixing, that the liquid, as it is discharged from the rotor, be thrown directly against the blades of the stator with a considerable force of impact, that its direction of movement be sharply changed by the blades of the stator and that it be not permitted merely to flow through the stator without subsantial change in the interrelations of the materials to be mixed.

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An important feature of the present invention is the construction and arrangement of the rotor and the stator of a mixer of the aforementioned general type in such manner not only that the entire assembly is much more compact and of considerably smaller overall diameter than mixers of the prior art of the same capacity, but also that the liquid flow produced by the novel construction and arrangement of the rotor and stator is so directed and controlled that the mixing action is fully as effective as in any of the mixers of the prior art and that, in most cases, it is more effective.

Compactness of the mixer in one embodiment of the present invention is obtained by so inclining the liquid discharge edges of the rotor blades to the axis of its rotation that stator blades, having correspondingly inclined liquid receiving edges, may be placed substantially directly beneath or above the discharge edges of the rotor blades and immediately adjacent to their path of travel and thus directly receive the liquid discharged from the rotor in such manner as to obtain the full impact and direction changing effect desired. In this embodiment of the invention the liquid flow is so directed through the mixer that the said inclined liquid discharge and receiving blade edges lie at substantially right angles to the flow of the liquid across them.

In another embodiment of the invention compactness is obtained by arranging the liquid receiving edges of stator blades directly below or above the liquid discharge edges of the rotor blades but in such manner that both said discharge and receiving edges are substantially normal to the axis of rotation, the desired outward flow for return circulation being obtained either by directing the flow against the container bottom or by providing a conoidal flow director in the stator.

As above suggested, the effectivenss of any wet mixer depends upon the thoroughness with which it effects the commingling of the particles of the different materials to be mixed. This necessarily involves breaking up any tendency to full stream or bodily flow of the liquid or liquids and the setting up of numerous cross currents, local swirls, countercurrents, etc., in order to insure intermingling of all parts of the materials to be mixed. To do this it is important not only to break up the stream entering the mixer into numerous small streams or currents but also frequently to change abruptly the directions of movement of these small streams or currents in order to cause them to cross and recross each other in all direc-

tions and in all dimensions until there has been a thorough distribution of each constituent throughout the mass.

In the present invention the foregoing results are attained in a mixer in which the extreme of compactness is also attained by providing for an immediate, substantially three-dimensional action upon the liquid as it passes from the rotor to the stator, without permitting any opportunity for any part of the liquid to lose its impetus or to move into a zone in which it will not be subjected to major disturbances.

An important feature of the invention, therefore, is the combination with a rotor having liquid circulating blades shaped to effect a movement of the liquid lengthwise of the rotor axis, of a stator having blades the greater part of the liquid receiving edges of which are located substantially within the coaxially projected perimeter of the path of travel of the liquid discharge edges of the rotor blades and are substantially immediately adjacent to and parallel to the surface generated by the rotation of the liquid discharge edges of the rotor blades.

Another important feature, in one embodiment of the invention, is the provision of a conoidal hub for the rotor to which the blades are attached and the provision of a cooperating shroud carried by said blades whereby an inclined flow of the liquid through the rotor is obtained.

Other objects and important features of the invention to which reference has not specifically been made hereinabove will appear hereinafter when the following description and claims are considered in connection with the accompanying drawings, in which—

Figure 1 is a composite sectional view through the rotor and stator elements of mixing apparatus embodying the present invention;

Figure 2 is a plan view of the parts shown in Figure 1;

Figure 3 is a composite sectional view through a duplex mixer embodying the present invention;

Figure 4 is a plan view of a modified rotor embodying the present invention;

Figure 5 is a section similar to Figure 1 showing a slight modification of the mixing apparatus shown in Figure 1;

Figure 6 shows still another modification of the rotor construction in which the liquid circulating blades of the rotor have the greater parts of their effective surfaces shaped to produce a screw propeller effect but have their discharge edges so bent as to increase the centrifugal component of the force imparted to the liquid by the rotor;

Figure 7 shows a modification of the rotor in which the outer ends of the propeller blades are bent forward to prevent centrifugal force from forcing the liquid off the periphery of the rotor, thus permitting its use without a shroud or other flow director. This construction also tends to increase the overall whirling motion of the propelled liquid;

Figure 8 shows in section other means for increasing the whirling motion of the propelled liquid; and

Figure 9 shows in section still other means for increasing the whirling motion of the propelled liquid.

In the illustrative embodiment of the invention the mixing apparatus is shown as located in a tank 2 or other container in which the materials to be mixed, including one or more liquids, are contained. The stator 4 of the mixer may be attached to the tank bottom or secured in its concentric relation to the rotor 6 in any other suitable manner. To avoid bearings exposed to the tank contents the rotor 6 is preferably carried on a shaft 8 which has its bearings 10 outside the tank and which may be driven by an electric motor 12 or other suitable driving means.

As shown in Figure 1, the rotor 6 of the mixing unit comprises a hub 14 to which the liquid circulating blades 16 are attached, the hub shown in Figure 1 of the drawings being of substantially conoidal shape so that it tends to direct the flow of the liquid downwardly and outwardly, that is, at an inclination to the axis of rotation.

As shown in Figure 1, the blades of the rotor are of the screw propeller type and tend to effect a circulation of the liquid lengthwise of the axis of rotation except as this circulation is modified by the novel blade shape, by the hub 14, and by the shroud 18 supported upon the outer ends of the blades 16 and having an inner conoidal surface which cooperates with the hub 14 to combine and direct the flow of the liquid through the rotor 6.

It will be seen that the discharge edge of each blade 16 of the rotor shown in Figure 1 is inclined to the axis of rotation of the rotor, the illustrated inclination being such that the discharge edges of the blades 16 are substantially perpendicular to the surface of the hub 14. This construction and arrangement of the blades 16 of the rotor 6 has the practical advantage that it permits the location of the stator blades 20 with their liquid-receiving edges beneath and substantially entirely within the periphery of the path of travel of the discharge edges of the rotor blades 16. This reduces very materially the overall diameter of the mixing unit without in any way impairing its efficiency.

By so constructing the blades of the stator that their liquid receiving edges are substantially immediately adjacent to and parallel to the surface generated by the rotation of the discharge edges of the rotor blade 16 the full impact and direction-changing effect upon the liquid discharged from the rotor, which is desired for thorough mixing, is obtained. It will further be seen, from a study of Figure 1, that, with the direction of discharge produced both by the inclined propeller blades 16, and by the flow-directing hub 14 and the cooperating shroud 18, the discharge edges of the blades 16 cut across the stream in directions perpendicular to this direction of discharge flow and thus insure the maximum mixing effect in a mixer of substantially minimum overall diameter and of substantially minimum overall height.

In the composite sections shown in Figures 1 and 3, which show at the right one form of rotor shroud and stator and at the left a modified form of rotor shroud and stator, it will be seen that with a shroud 18, such as shown at the right, which extends over the lateral or outside edges of the stator blades 20, a very positive direction of flow of the liquid through the stator, as well as through the rotor, can be insured. In such a case relatively narrow stator blades have been found to be efficient. In the form shown at the left the shroud 18' is shown as not extending beyond the discharge edge of the blade 16. In such cases it is sometimes advantageous to use the wider form of stator blade 20' shown at the left of Figures 1 and 2.

In Figure 3 of the drawings, the invention is shown as embodied in a duplex mixer in which two rotors 6 such as shown in Figure 1 are arranged upon a common shaft 8 with the bases of the conoidal hubs 14 in abutting relation to each

other, the rotor construction being substantially identical with that shown in Figure 1. The stator construction, however, is modified so that the stator may be supported at a point above the bottom of the tank in which the mixer is located, each rotor having cooperating stator blades arranged substantially in the same relation thereto as the stator blades of Figure 1. In the duplex mixer shown in Figure 3 the blades are connected to a flow-directing ring **22** which may be so shaped in cross section, if desired, as to insure separation of the streams coming from the two rotors into upwardly directed and downwardly directed streams. As shown in Figure 3, the duplicate stators are supported by rods **24** connected in any suitable manner to the supporting ring **22** and extending to the sides of the container.

In Figure 4 is shown a modification of the rotor illustrated in Figures 1 and 2. In the rotor shown in Figure 4 additional circulating blades are provided to increase the circulating effect of the rotor but it has been found advantageous not to extend these blades to the hub **14** thereby avoiding the close spacing of the blades and consequent interference with free flow which would result at the hub. These additional blades **26** are, therefore, shown as carried by the shroud **18**.

In the modification of the rotor shown in Figure 5, an ordinary hub **28** has been substituted for the conoidal hub of Figure 1, thus permitting some cross circulation of the liquid beneath the rotor and preventing any chance of the formation of a dead spot at this point when the hub is spaced from the container bottom. The angle flow of Figure 1 is still obtained by reason of the conoidal shape of the inner surface of the shroud **18** and the inclination of the discharge edges of the rotor blades **16**.

In the modified form of the rotor construction shown in Figure 6 of the drawings, the rotor blades **40** are carried upon a hub **42** in the same manner as the blades of the rotor shown in Figure 5, but at their lower ends the blades **40**, which are of the screw propeller type, are curved downwardly, as shown, from the point **44** to the point **46**. This curving of each of the blades **40** changes the lower part of the blade from a propeller type to a centrifugal impeller type and thus tends to increase the centrifugal component of the liquid circulating action of the propeller, thus driving the liquid as it is discharged from the lower edges of the blades **40** substantially directly out toward the blades **48** of the stator of the mixer shown in Figure 6.

In the modified rotor construction shown in Figure 7 two objects are attained—first, the possibility of securing suitable direction of the liquid flow through the rotor without the use of a shroud or other flow directing means and, secondly, the construction of the rotor in such manner that it increases the whirling motion of the liquid as it is propelled by the rotor. As shown in Figure 7, the peripheral margins of the propeller blades **50** of the rotor there shown are curved forward, this curved forward part extending from **52** to **54** across the blade and modifying the screw form of the propeller to that extent. The propeller, as shown, may be used with a stator **4** such as shown in Figure 1.

In Figures 8 and 9 there are shown other means for increasing the whirling motion of the propelled liquid. By setting up a whirl in the liquid on its way to the propelling rotor it is possible to drive the same rotor at higher speed without either causing it to propel the liquid too rapidly

or needlessly using up energy in overcoming the resistance of the liquid. This permits direct connection of the rotor to the driving motor or at least use of a reduction gear having a lower speed ratio. As shown in Figure 8, there is placed above or at the entrance to the rotor a flow director comprising an annular guide ring **56** having vane-like blades **58** extending halfway to the rotor shaft. The guide ring **56** may have its inner surface of conoidal contour and may, as shown in Figure 8, extend also over the stator **64**. As also shown in Figure 8, the rotor **66** may be of the form shown in Figure 6. In Figure 9 the vane-like blades **59** extend to a central hub portion **60** which serves as a bearing for the rotor shaft **8**.

In each of the illustrative embodiments of the invention it will be noted that the liquid-receiving edges of the blades **20** of the stator **4** are substantially immediately adjacent to the liquid discharge edges of the blades **16** of the rotor **6**. The slight spacing between these edges will vary somewhat with the viscosity of the liquid constituents of the materials to be mixed. If the liquid constituent or constituents of the materials to be mixed be quite fluid, so that the resistance to shearing is small, it is obviously advantageous to bring these edges as close together as possible to insure the most effective mixing action.

Although Figure 6 shows merely one form of rotor blade for increasing the centrifugal action in a rotor of the propeller type, it will be understood that the invention is not limited to the particular change in the shape of the blade there shown nor to a bend on the discharge edge of the blade.

What is claimed as new is:

1. In a mixer, the combination with a rotor having liquid circulating blades the discharge edges of which are inclined to the axis of rotation of said rotor, of stator blades having inclined receiving edges which are parallel to and immediately adjacent to the path of travel of said rotor blade discharge edges and the greater part of which are located substantially within the coaxially projected perimeter of said path of travel, the coaxial overlap of the rotor and stator blades being such that at least 30 percent of the active liquid circulating part of the rotor is surrounded by the stator and a flow directing shroud being carried by the rotor blades.

2. In a mixer, the combination with a rotor having liquid circulating blades the discharge edges of which are inclined to the axis of rotation of said rotor, of stator blades having inclined receiving edges which are parallel to and immediately adjacent to the path of travel of said rotor blade discharge edges and the greater part of which are located substantially within the coaxially projected perimeter of said path of travel, the coaxial overlap of the rotor and stator blades being such that at least 30 percent of the active liquid circulating part of the rotor is surrounded by the stator and a flow directing conoid constituting the hub of the rotor and carrying the blades, said blades extending radially and having substantially straight discharge edges which are substantially perpendicular to the conoidal surface of the hub.

3. In a mixer of the type in which a bladed rotor and a bladed stator cooperate to effect an agitation and commingling of the liquid and any other contents of a container in which said mixer is located, the combination with a rotor having liquid circulating blades shaped to effect a movement of the liquid lengthwise of said rotor axis,

of a stator having blades the greater part of the liquid receiving edges of which are located substantially within the coaxially projected perimeter of the path of travel of the liquid discharge edges of said rotor blades and are substantially immediately adjacent to and parallel to the surface generated by the rotation of the said liquid discharge edges of said rotor blades, the rotor being provided with a flow directing shroud.

ETHEL H. JOHNSON,
Executrix of the Estate of John Johnson, Deceased.

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