May 9, 1933. K. S. VALENTINE 1,908,002

MIXING APPARATUS

Filed Oct. 30, 1930 3 Sheets-Sheet 1

Fig. 1.

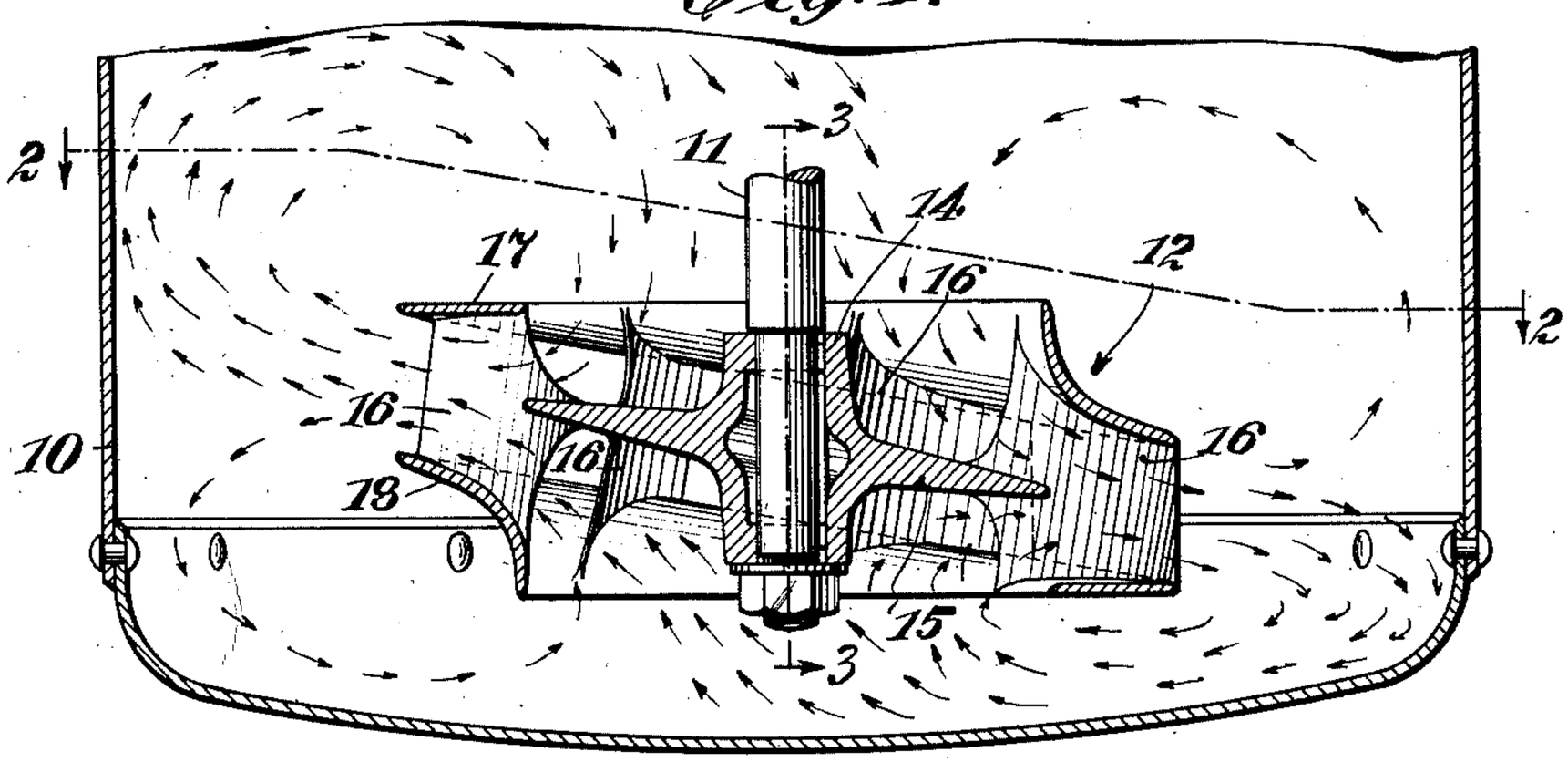
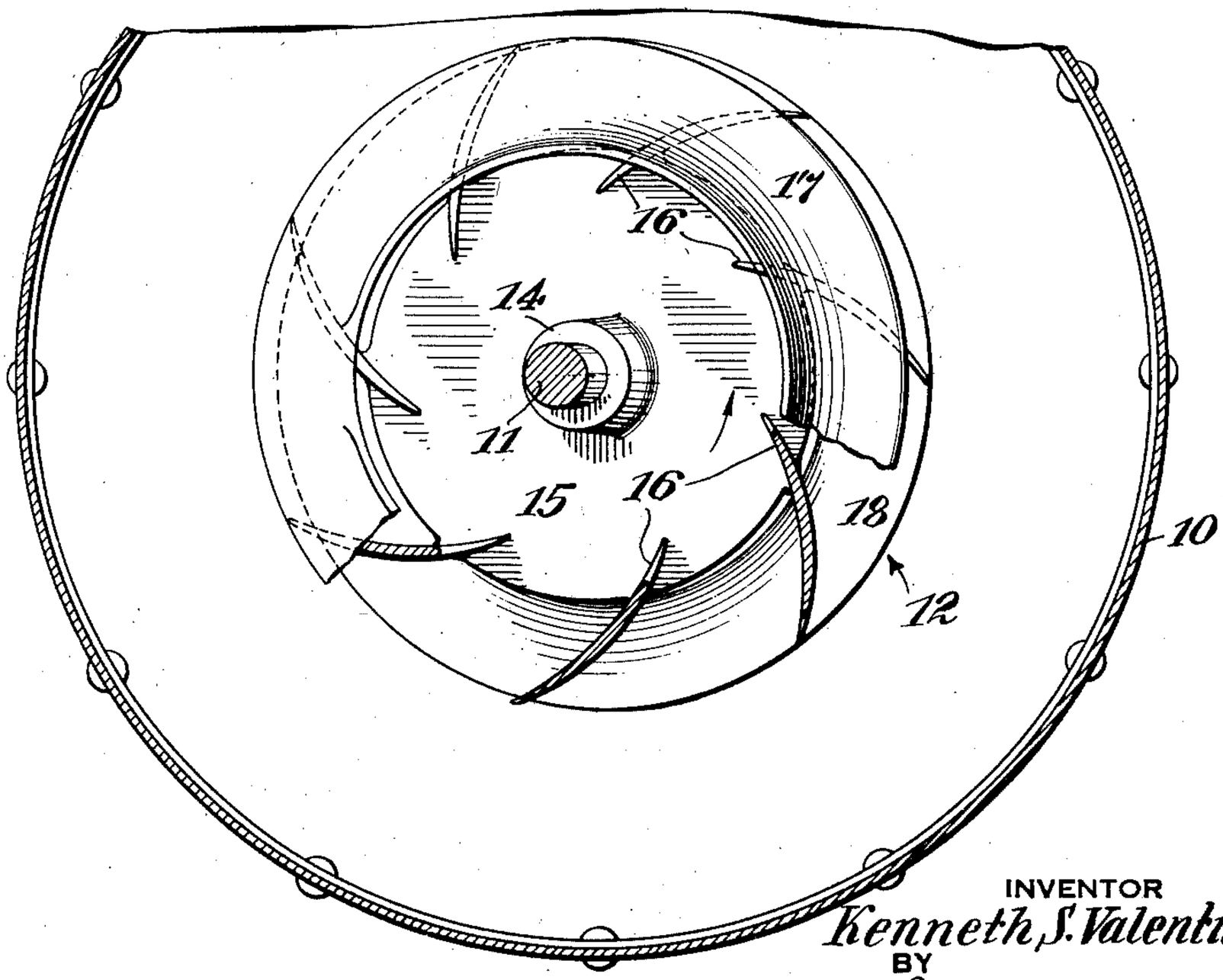


Fig. 2.



INVENTOR
Kenneth S. Valentine
BY
Ramsey & Kent
his ATTORNEYS

May 9, 1933. K. S. VALENTINE 1,908,002

MIXING APPARATUS

Filed Oct. 30, 1930 3 Sheets-Sheet 2

Fig. 3.

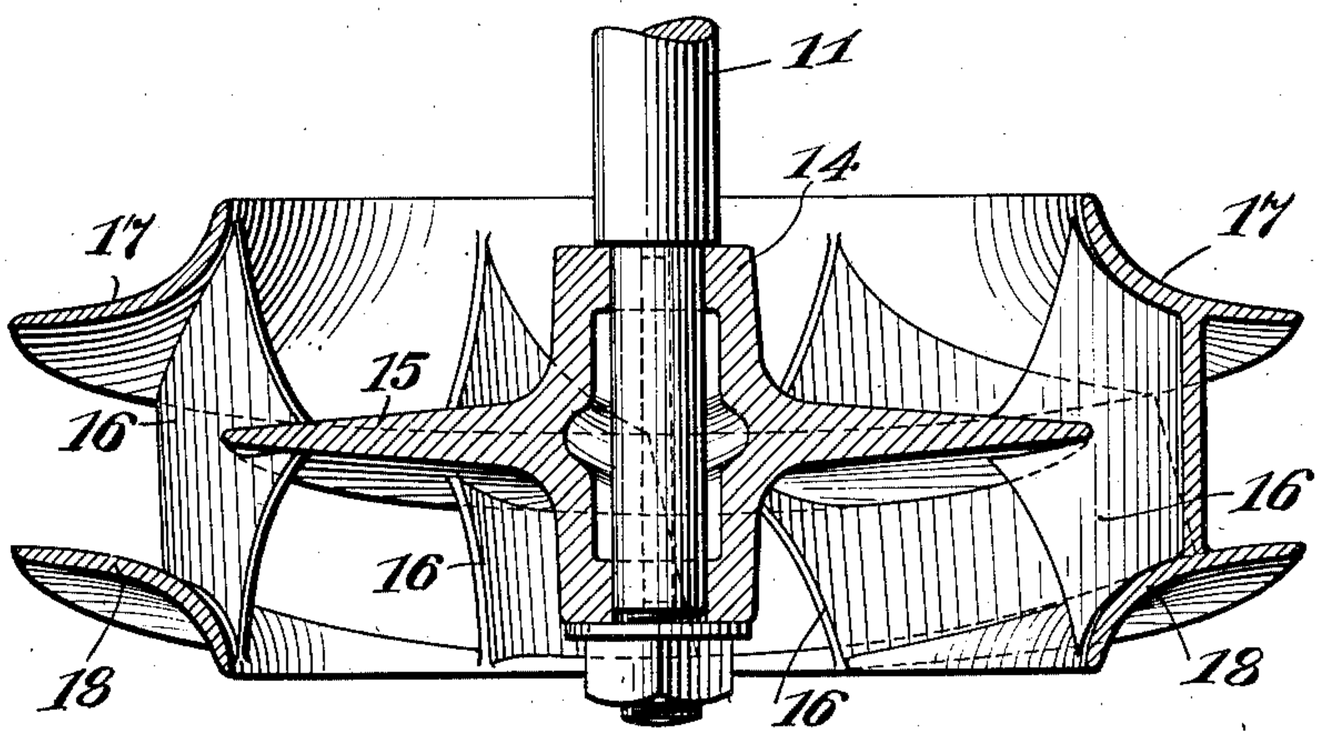
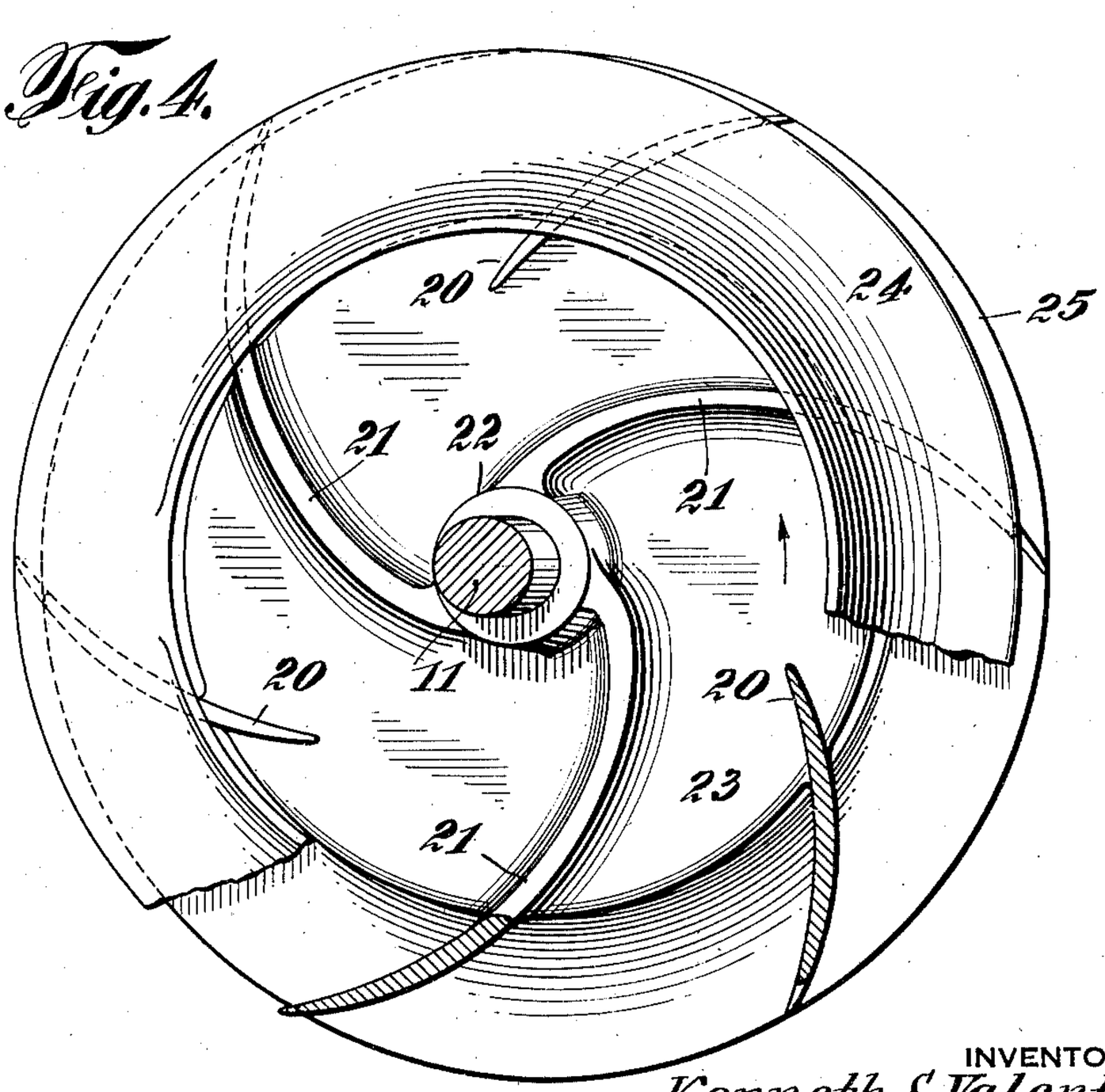


Fig. 4.



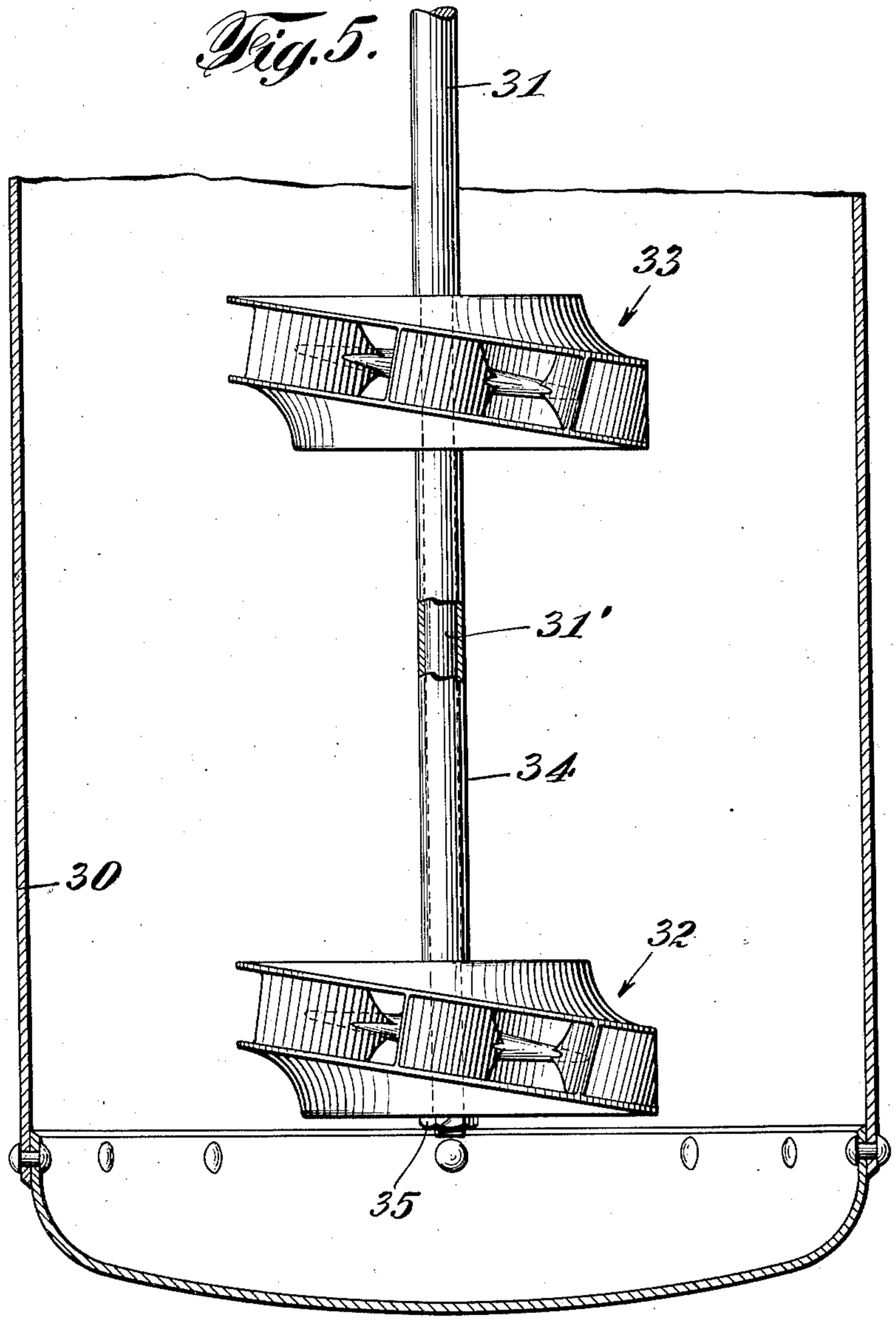
INVENTOR
Kenneth S. Valentine
BY
Ramsey + Kent
his ATTORNEYS

May 9, 1933. K. S. VALENTINE 1,908,002

MIXING APPARATUS

Filed Oct. 30, 1930 3 Sheets-Sheet 3

Fig. 5.



INVENTOR
Kenneth S. Valentine
BY
Ramsey & Kent
his ATTORNEYS

Patented May 9, 1933

1,908,002

UNITED STATES PATENT OFFICE

KENNETH S. VALENTINE, OF HOLLIS, NEW YORK, ASSIGNOR TO THE TURBO-MIXER CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK

MIXING APPARATUS

Application filed October 30, 1930. Serial No. 492,196.

This invention relates to mixing apparatus. It may be used for mixing true liquids, but is particularly adapted for mixing materials of a class that have been recently denominated "pseudo-plastics". As illustrative of pseudo-plastic, mention may be made of heavy flat white paint, asphalt emulsions, and clay slurries. Paper pulp also exhibits some of the characteristics of "pseudo-plastics".

To effect rapid and thorough mixing, it is necessary that currents shall be caused to flow in such manner that the currents intermingle with one another and effect a complete shifting and intermingling of all of the elementary volumes that make up the entire volume of material. For efficient operation the currents must be induced smoothly and flow smoothly, without the formation of areas of vacuum and without splashing or churning; otherwise a heavy braking action is imposed on the moving parts of the apparatus, thus requiring the expenditure of a large amount of power.

A general object of the invention is to provide mixing apparatus which will quickly and thoroughly mix a quantity of material with a minimum expenditure of power.

Another object of the invention is to provide mixing apparatus particularly suited for mixing pseudo-plastics and suspensions of fibrous solids in water or other liquids.

A further object of the invention is to provide simple, effective and efficient mixing apparatus which will operate smoothly, without vibration.

Other objects of the invention will be obvious from the following description taken in connection with the accompanying drawings.

In the forms of the invention disclosed, a rotary shaft carries one or more impellers comprising a circular flow directing plate concentric with the shaft and carrying involute impeller blades. The flow directing plate is inclined with respect to a plane perpendicular to the shaft, so that as the impeller rotates, wave motion is set up in the mass of material. This wave motion greatly accelerates the mixing action with the result that a thorough mixing is obtained in a very short time. The impellers specifically disclosed are provided with shrouding, which is advantageous in mixing certain materials. For mixing other materials (e. g. paper pulp) the shrouding is preferably omitted.

Fig. 1 of the drawings is a fragmentary vertical section showing one form of the present invention.

Fig. 2 is a section taken on line 2—2 of Fig. 1.

Fig. 3 is a section, showing the impeller only, taken on line 3—3 of Fig. 1.

Fig. 4 shows a modified form of impeller viewed from the direction indicated by line 2—2 of Fig. 1.

Fig. 5 is a vertical section showing the mixing impellers in elevation.

Reference will now be had to Figs. 1, 2 and 3 of the drawings. A suitable tank or container 10, has depending therein a shaft 11, on which is mounted a mixing impeller designated as a whole by 12. Impeller 12 may be made up of several separate parts, but is shown as cast in one piece. The impeller comprises a hub 14, surrounded by a circular flow directing plate 15, from which projects a series of involute impeller blades 16. Carried by the blades is shrouding, as at 17 and 18.

As best shown in Fig. 1, flow directing plate 15 is inclined with respect to a plane perpendicular to shaft 11. As the impeller rotates, the discharge along any given radius of the tank gradually shifts from a downward inclined direction to an upwardly inclined direction and then back to a downwardly inclined direction. This shifting of the direction of discharge of the impeller takes place gradually and cyclically, thereby causing a smooth vertical wave motion in the material being mixed. This wave motion greatly accentuates the mixing action, without placing any substantial braking force on the impeller.

In the form of impeller shown in Figs. 1, 2 and 3, all of the impeller blades start at a distance from the hub and extend to a considerable distance beyond the edge of flow directing plate 15. The impeller shown in Fig. 4 differs in that only alternate blades 20 are similar to the blades 16 in Figs. 1 to

3, while the intermediate blades 21 begin at the hub 22 and extend clear across and beyond plate 23. Shrouding is provided at 24 and 25. For mixing some materials, the form of impeller shown in Figs. 1 to 3 is preferable, and for mixing other materials the form shown in Fig. 4 is preferable.

In Fig. 5 a tank or container has depending therein a shaft 31, provided with two impellers designated as a whole by 32 and 33, respectively. The lower portion of the shaft may be reduced as at 31; the impellers separated by a spacing sleeve 34 and clamped by a nut 35. Each of the impellers shown in this figure is of the same construction as the impeller shown in Figs. 1, 2 and 3, inclusive. The impellers are preferably mounted on shaft 31 in corresponding rotative position as shown in the drawings, but may be mounted 180° apart. Both impellers rotate in the same direction and at the same speed. Each of the impellers sets up a vertical wave motion in the material being mixed; and the inter-action between the two sets of waves results in an exceedingly rapid and thorough mixing. Since both impellers rotate in the same direction, the inter-action between the two wave motions takes place smoothly, without agitation or churning.

As clearly shown in Fig. 1, material is drawn into the impeller from both top and bottom, and is directly outwardly by the flow directing plate 15, and blades 16. The discharged material is not released by the impeller until it has passed a considerable distance beyond the periphery of the flow directing plate 15. Thus the streams coming from the top and bottom of the tank will so mix that some of the material from the bottom of the tank will be discharged to the top of the tank, and vice versa.

This action is greatly accentuated by the tilt of flow directing plate 15. Consider the right hand side of the impeller for the instant shown in Fig. 1. Half of the intake of the impeller comes from the top of the tank and half comes from the bottom of the tank; but since the direction of discharge is inclined downwardly, the major portion of the instantaneous discharge is to the bottom of the tank. Conversely for the left hand side of the impeller for the instant shown in Fig. 1. Half of the intake is from the top of the tank, and half from the bottom of the tank; but since the direction of discharge is inclined upwardly, the major portion of the instantaneous discharge is to the top of the tank. Thus the net result for the entire impeller is that a very large portion of the material drawn from the bottom of the tank is discharged to the top of the tank, and vice versa.

The amplitude of the vertical wave motion is determined by the angle of inclination of the flow directing plate 15. The optimum angle of inclination varies somewhat with the particular material being mixed, but I found that for most purposes an angle between 4° and 7½° is preferable. If the angle be too great, churning action results, which places a heavy braking action upon the impeller. I have found if the angle be increased beyond 25°, this churning action becomes very objectionable.

To obtain smooth action the impeller should be balanced, both statically and dynamically. The dynamic balance should take into consideration, the kinetic energy of the currents moving against the impeller, so that there will be no tendency for the impeller to vibrate, shift its center of rotation, or place a bending moment on the shaft, when the impeller is in operation.

It is realized that the present invention may be embodied in forms other than those particularly disclosed, and hence the present disclosure is merely illustrative in compliance with the patent statutes and is not to be considered as limiting.

What I claim is:

1. Non-churning mixing apparatus comprising a shaft; a flow directing plate carried by said shaft, said plate being inclined approximately 6 degrees with respect to a plane perpendicular to the shaft; and a plurality of involute impeller blades projecting from opposite sides of said plate.

2. Non-churning mixing apparatus comprising a shaft; a flow directing plate carried by said shaft, said plate being inclined approximately 6 degrees with respect to a plane perpendicular to said shaft; and a plurality of impeller blades projecting outwardly beyond the edge of said plate.

3. Non-churning mixing apparatus comprising a shaft; a flow directing plate carried by said shaft, said plate being inclined approximately 6 degrees with respect to a plane perpendicular to said shaft; a plurality of impeller blades projecting outwardly beyond the edge of said plate; and shrouding carried by said blades.

4. Non-churning mixing apparatus comprising a shaft; a flow directing plate carried by said shaft, said plate being inclined from 4 to 25 degrees with respect to a plane perpendicular to the shaft; and a plurality of involute impeller blades projecting from opposite sides of said plate.

5. Non-churning mixing apparatus comprising a shaft; a plurality of impeller blades rotatable with said shaft, said blades being disposed with their center lines in a plane inclined at an angle of 4 to 10 degrees with respect to a plane perpendicular to the shaft; and shrouding carried by said blades.

6. Non-churning mixing apparatus comprising a shaft, a flow directing plate carried by said shaft, said plate being inclined at an angle of 4 to 7½ degrees with respect to a

plane perpendicular to the shaft; a plurality of involute impeller blades projecting from opposite sides of said plate; and shrouding carried by said blades.

7. Mixing apparatus comprising a hub; a substantially circular plate concentric with said hub, said plate being inclined with respect to a plane perpendicular to the axis of said hub; and a plurality of involute impeller blades projecting from said plate, certain of said blades extending to said hub and other of said blades terminating short of said hub.

8. Mixing apparatus comprising a hub; a substantially circular plate concentric with said hub, said plate being inclined approximately 6 degrees with respect to a plane perpendicular to the axis of said hub; and a plurality of involute impeller blades projecting from said plate, certain of said blades extending to said hub and other of said blades terminating short of said hub.

9. Non-churning mixing apparatus comprising a hub; a substantially circular plate concentric with said hub, said plate being inclined approximately 6 degrees with respect to a plane perpendicular to the axis of said hub; and a plurality of involute impeller blades projecting from opposite sides of said plate and substantially perpendicular thereto.

10. Non-churning mixing apparatus comprising a shaft; a plurality of flow directing plates mounted in spaced relation on said shaft for rotation in the same direction, each of said plates being inclined with respect to a plane perpendicular to the axis of the shaft; and a plurality of impeller blades projecting from each of said plates.

11. Non-churning mixing apparatus comprising a shaft; a plurality of flow directing plates mounted in spaced relation on said shaft for rotation in the same direction, each of said plates being inclined with respect to a plane perpendicular to the axis of the shaft and the plates being parallel to one another; and a plurality of impeller blades projecting from each of said plates.

12. Non-churning mixing apparatus comprising a shaft; a plurality of flow directing plates mounted in spaced relation on said shaft for rotation in the same direction, each of said plates being inclined with respect to a plane perpendicular to the axis of the shaft; and a plurality of involute impeller blades projecting from opposite sides of each of said plates.

13. Non-churning mixing apparatus comprising a shaft; a plurality of flow directing plates mounted in spaced relation on said shaft for rotation in the same direction, each of said plates being inclined with respect to a plane perpendicular to the axis of the shaft and the plates being parallel to one another; and a plurality of involute impeller blades projecting from opposite sides of each of said plates.

14. Non-churning mixing apparatus comprising a shaft; and a plurality of impellers mounted in spaced relation on said shaft for rotation in the same direction, each of said impellers comprising a plurality of blades having their center lines located in a plane which is inclined with respect to a plane perpendicular to said shaft, and shrouding carried by said blades.

15. The method of mixing a body of fluid material without churning the same which comprises drawing two main streams of the material toward one another from opposite directions, subdividing each of the main streams into a plurality of secondary streams, discharging the secondary streams in directions outwardly of the main streams while commingling the secondary streams from one main stream with respective secondary streams from the other main stream, and gradually and cyclically shifting the angle between the secondary streams and the main streams.

16. The method of mixing a body of fluid material without churning the same which comprises establishing an annular generally horizontal mixing zone; drawing two main streams of material to the zone, one from above the zone and the other from beneath the zone; mixing material from one stream with material from the other stream in proportions varying in different parts of the mixing zone; discharging obliquely upwardly the elemental streams of the mix containing a preponderance of material drawn from beneath the mixing zone; and discharging obliquely downwardly the elemental streams of the mix containing a preponderance of material drawn from above the mixing zone.

17. Non-churning mixing apparatus comprising a shaft; a flow directing plate carried by said shaft, said plate being inclined at an angle of 4 to 10 degrees with respect to a plane perpendicular to the shaft; and a plurality of involute impeller blades projecting from opposite sides of said plate.

KENNETH S. VALENTINE.