Sept. 20, 1971 K. E. BERGSTEDT 3,606,272

MIXING APPARATUS

Filed March 23, 1970 3 Sheets-Sheet 1

FIG.1

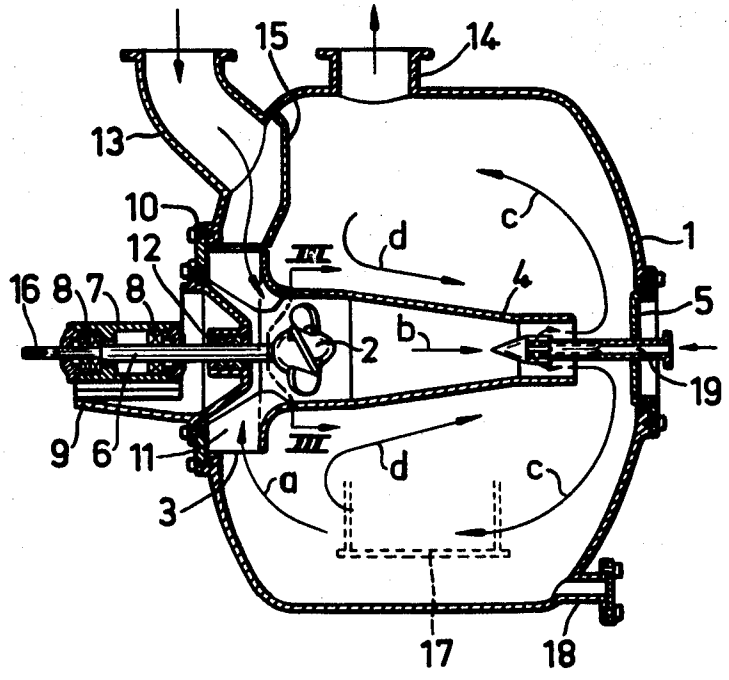


FIG.2

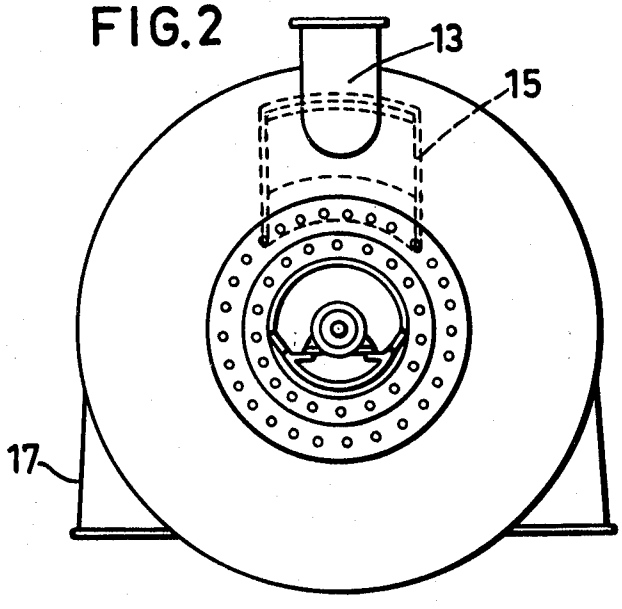


FIG.3

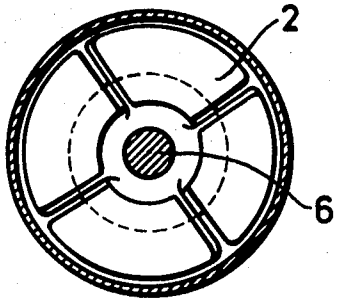


FIG.4

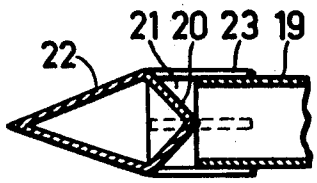


FIG.5

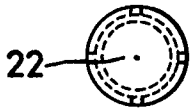
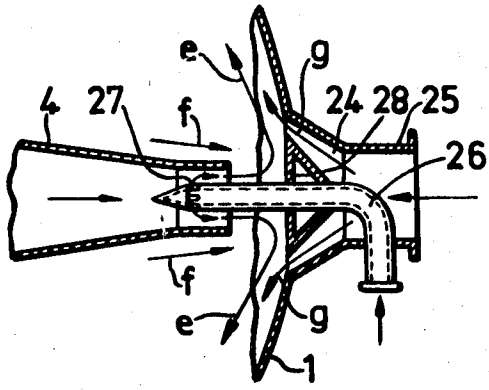


FIG.6



Sept. 20, 1971 K. E. BERGSTEDT 3,606,272

MIXING APPARATUS

Filed March 23, 1970 3 Sheets-Sheet 3

FIG.7

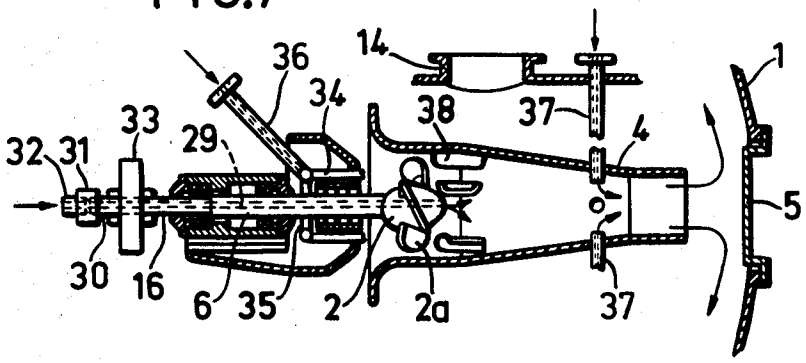


FIG.8

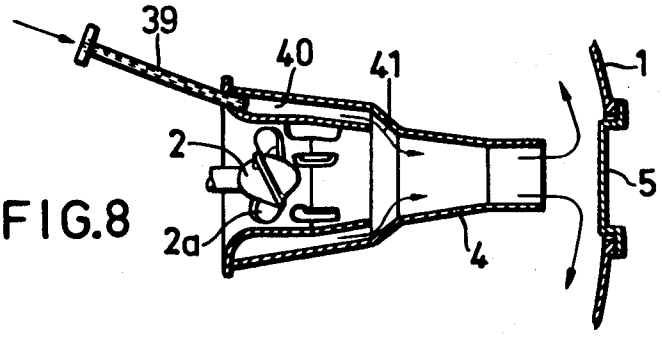


FIG.9

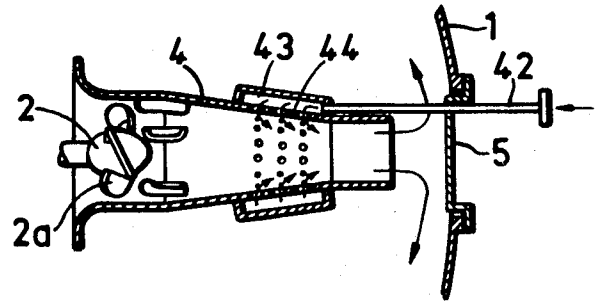
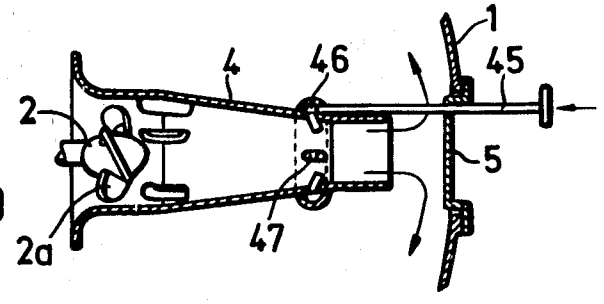


FIG.10



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3,606,272

MIXING APPARATUS

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Continuation-in-part of application Ser. No. 702,580, Feb. 2, 1968. This application Mar. 23, 1970, Ser. No. 21,878
Claims priority, application Sweden, Feb. 27, 1967, 2,701/67
Int. Cl. B01f 7/02
U.S. Cl. 259—25 14 Claims

ABSTRACT OF THE DISCLOSURE

Apparatus for mixing suspensions of materials while admixing additional treating materials therewith in which the suspension is circulated through a sleeve-shaped casing entirely within a container. The treating materials are added to the suspension while it is being impelled through the sleeve-shaped casing. The outlet end of the casing is spaced from the wall of the container which provides a surface for impingement of the treated suspension to provide turbulent mixing thereof.

This application is a continuation-in-part of my prior application, Ser. No. 702,580, filed Feb. 2, 1968, now Pat. No. 3,503,591.

U.S. Patent No. 3,334,868 discloses an apparatus for mixing different materials with each other, said apparatus substantially comprising on one hand a container for receiving the materials to be mixed, said container having laterally located outlet means and centrally located inlet means, and comprising on the other hand pump means, the inlet of which is connected to said outlet means and the outlet of which is connected to said inlet means. In the apparatus in question there are provided members for directing the jet of material, which is to be returned to the container, in a free jet in a path, which is, at least approximately directed at right angles to the container. Due to the fact that the pump assembly in the apparatus in question is located outside the container for the material to be treated and due to the existence of external pipe lines the apparatus requires rather much space and also is rather expensive to manufacture.

The present invention relates to a mixing apparatus which requires less space and is cheaper to manufacture than the apparatus mentioned above. Also, in the new apparatus the conditions of flow and the technical-mixing properties are extremely good. The apparatus is particularly well suited for suspensions, sludges or the like, preferentially with the simultaneous admixing of gaseous or liquid chemicals to a suspension of cellulose pulp having a consistency of 0.5–5%.

The apparatus according to the invention comprises a container for receiving the material, said container being provided with at least one inlet for supplying material into the interior of the container and at least one outlet for treated material. The principal features of the apparatus consist therein that within the container there is provided, on the one hand, at least one pump means, preferentially in the shape of a pump wheel, said pump means communicating with the inlet for the material, and on the other hand, a casing, entirely or substantially entirely enclosing the pump wheel and preferably being in the shape of a sleeve, said casing being adapted to receive and to direct the flow of material, generated by the pump wheel, towards a plate-like surface, provided within the container or formed in the wall proper of the container, said surface extending substantially at right angles to the direction of movement of the flow of material and/or to the axial direction of the sleeve-like casing, and also at least one means extending into the container and serving for supplying chemicals to the material introduced into the container.

These and other characteristic features of the invention will appear from the following detailed description of several embodiments, reference being had therein to the accompanying diagrammatical drawing figures.

FIG. 1 illustrates a longitudinal cross sectional view of a mixing apparatus according to one embodiment,

FIG. 2 showing an end view of said same apparatus when viewed from that side on which the material to be treated is supplied to the apparatus,

FIG. 3, on an enlarged scale, shows a section taken through the pump wheel of FIG. 1 and

FIG. 4 shows a longitudinal cross sectional view of the fore end of one means for supplying chemicals to the material to be treated.

FIG. 5 illustrates an end view of the apparatus according to FIG.4 and

FIG. 6 shows a longitudinal cross sectional view of a modification of the apparatus.

FIG. 7 shows in longitudinal cross section a modification of the apparatus representing three variations by which the treating material may be admixed with the suspension.

FIGS. 8, 9 and 10 each show in longitudinal cross section different means for introducing the treating material into the suspension.

Reference numeral **1** indicates a closed, or substantially closed, container having mounted therein a pump device in the shape of an axial pump wheel **2**. The suction duct of the pump consists of an annular chamber or slot **3** located within the container, the opening of said chamber or slot having the same size along its whole extension so as to provide for an entirely symmetrical suction. The outlet of the pump is shaped as a tube or a sleeve-like casing **4** surrounding the pump wheel **2**. The tube **4** preferably is located centrally in the container **1** having its axis coinciding with the axis of the pump wheel and/or with that of the container and, furthermore, is shaped with a narrowing outlet opening, in order that the velocity of the jet of material pumped through the tube shall be accelerated towards said outlet. In front of the outlet opening of the tube **4** there is provided a surface having a circular circumference, the jet leaving the tube being directed against said surface. Said surface, which may consist of a circular or anular plate **5**, preferably is secured to the wall of the container, and the length of the tube **4** preferably is adapted in such a manner that the distance between the outlet end of the tube and the plate **5** amounts to 0.2–2, for example to 0.5–1.5 and preferably to about 1.0 times the diameter of the outlet end of the tube. The surface **5** may also be formed from the very wall of the container. The pump wheel **2** is supported by a shaft **6**, resting in the bearings **8** mounted in a bearing housing **7**. The bearing housing **7** is, in its turn, supported by a bracket **9**, which by way of a flange **10** is screwed fast to one end flange of the container **1**. By means of guide rails **11** the flange **10** is rigidly connected with the tube **4** surrounding the pump wheel **2** and, consequently, serves as a supporting flange for said tube. In order to provide for a seal between the shaft **6** of the pump and the end wall of the bracket **9** there is provided a packing member **12** of a conventional kind. The pump wheel (the impeller) **2** is adapted to be driven by means of a drive means, now shown, said drive means being adapted to be connected to the free end **16** of the shaft **6**, said free end being provided with key way grooves. Preferably the container **1** may be provided with two supporting brackets **17** and one short pipe **18** for cleaning.

If also chemicals are to be supplied to the material in connection with the treatment in the container **1**, the

mixing apparatus may be provided with a separate means serving this purpose. One arrangement comprises a tube **19** extending through the wall of the container and through the plate **5** opposing the tube **4**, said tube, with its end located within the container, opens into the tube **4**. In order to facilitate the flowing, when the flow of material within said tube **4** meets the flow of chemicals from the tube **19**, there is provided a conical guide wall **20** on the latter (FIG. 4), so that the outflow of chemicals from the tube **19** is caused to take place through a peripheral slot **21**. Also the flow of material moved forward by the pump wheel **2** should encounter a guide surface which is suitably shaped in point of flow. For that purpose it is suitable to terminate that end of the tube **19**, which is turned towards the pump wheel, by a conical portion **22**, which together with the guide wall **20** is supported by plate steel members **23** secured to the tube **19**.

In the first place the mixing apparatus according to the invention is meant to be operated continuously, in which case non-treated material is supplied to the container **1** through a pipe **13** and is removed from the container through a pipe **14**. The supply pipe **13** is located in the end wall of the container **1** near the suction duct **3** of the pump means. Between the inlet of the pipe **13** and said suction duct there is provided an intermediate wall **15** forming a duct or passage arranged on one hand to guide the entering material directly into the pump means and, on the other hand, to prevent any part of the material from flowing directly to the outlet-pipe **14**. The pipes **13** and **14** may be located in one and the same radial plane, by which the flow in a plane, perpendicular to the axis of the container **1**, becomes fully symmetrical.

The mode of operation of the apparatus is as follows: The material supplied through the pipe **13** is first mixed, within the pump means, with the material circulating within the container **1**, as indicated by the arrows *a–b–c–d*, by the action of the pump means. At the outlet end of the tube **4**, or at some distance from the pump wheel (the impeller) **2**, the chemicals are added and there is generated, at the said outlet, due to the velocity of the jet of material and the diversion thereof against the plate **5**, a strong turbulence which causes effective mixing of the material and the chemicals with each other. On diverting the jet against the plate **5** also surrounding material is sucked in and a circulation, as indicated by the arrows *d*, is obtained. The capacity of the pump wheel (the impeller) **2** should be of an order amounting to 1–10 times, preferably 3–7 times and preferentially 4–6 times the amount of material flowing through the pipes **13** and **14**. The material entering the container is then caused to circulate a great number of times before leaving the container through the pipe **14**.

An alternative embodiment, shown in FIGS. 5 and 6, involves that the material to be treated is introduced into the container around the outlet end of the tube **4**, i.e. on the outside of the pipe. In that case there is, in the end wall of the container and at a distance from said outlet end, provided an annular slot **24**, which is coaxial with the tube **4**. The material is supplied to the slot through the short pipe **25** and the chemicals are supplied through the pipe **26**. The pipe **26** extends some distance into the tube **4** and is provided with discharge openings **27**. The portion **28**, located inside the slot **24**, has the same function as that of the plate **5** in the embodiment shown in FIG. 1. The flow within the container will take place substantially in the way indicated by the arrows *e–f–g–*.

Additional modifications of the apparatus for introducing the treating materials to the suspension materials are shown in FIGS. 7, 8, 9 and 10.

Chemicals, gas or liquid, or suspensions of additional treating materials, preferably are added to the sleeve-shaped casing **4** within a zone located after the impeller in the direction of flow, i.e. between the vanes of the impeller **2** and the outlet of the sleeve-shaped casing **4**. This may take place by means of the members **19** and **26**, as shown in FIGS. 1 and 6. FIG. 7 discloses alternative means for supplying additional material to said zone within the sleeve-shaped casing **4**. Thus, the shaft **6** may have a duct provided therein, which preferably consists of a centrally extending bore **29**, opening into the sleeve-shaped casing **4** at that end of the boss of the impeller **2** facing towards the outlet end of the sleeve-shaped casing **4**. The opposite end of the shaft has an extension **30**, which is sealingly connected to the stationary supply pipe **32** by means of the sealing member **31**. Other types of sealing means may, of course, be used. On the free end portion **16** of the shaft **6** there is provided a belt pulley **33**. The embodiment, described above, brings about the advantage of the material or the chemicals being supplied at an early stage within the sleeve-shaped casing **4** so that a good preparatory admixing is obtained.

It is possible also to supply the additional materials just before the impeller, for instance, by means of pipes **34**, which are fed from an annular duct or manifold **35** and the supply pipe **36** as shown in FIG. 7. Hereby a still better preparatory admixing is obtained.

FIG. 7 shows still further supply means, i.e. the pipes **37**, opening into the interior of the sleeve-shaped casing **4**. The distance between each pipe opening and the axial line of the sleeve-shaped casing preferably is chosen to be approximately equal to one half the radius or to define a half of the cross sectional area of the casing **4**. It may also be of advantage to let the pipes open directly into the wall of the sleeve-shaped casing **4** and, thus, not extend into the interior of the casing at all. In order to obtain a good distribution within the cross sectional area it may be advantageous to supplement such pipes by pipes extending into the sleeve-shaped casing as described above. In the embodiment shown the pipes **37** are meant to be four in number. According to need, one, two or, for example, three or more than four pipes may be provided.

The three different types of supply members **29**, **34** and **37**, shown in FIG. 7, may exist in one and the same mixing apparatus but it is preferred to use only one of the three types, because one system usually provides a satisfactory mixing. The guide members **38** shown serve the purpose of counteracting the rotary motion, created by the impeller **2**, due to which good conditions of turbulence are obtained in connection with the phase decisive of the mixing effect (degree of mixing) that is the deviation of the flow against the plate-like surface **5**.

FIG. 8 shows another alternative embodiment of the means for supplying a fluid, such as chemicals, to the zone located between the vanes **2***a* of the impeller **2** and the outlet end of the sleeve-shaped casing **4**. The treating material is supplied through the pipe **39**, the annular chamber **40** surrounding the sleeve **4** and the circumferentially extending slot **41**. The guide surfaces of said slot are adapted to provide for a flow, which is directed obliquely with respect to the direction of movement of the main flow. It is not excluded that the slot may, alternatively, be directed in such a manner that it will provide for a flow directed obliquely with respect to said direction of movement at about the same cone angle.

A similar embodiment is shown in FIG. 9. In this embodiment the fluid is supplied through the pipe **42**, the chamber or manifold **43** and the perforated or slotted wall **44** into the casing in a direction normal to direction of flow within the sleeve-shaped casing **4**.

FIG. 10 shows still another embodiment, in which the supply pipe is indicated at **45** and the chamber or manifold at **46**. The fluid is supplied to a zone located some distance into the sleeve-shaped casing **4** taken in the radial direction, by means of pipes **47** extending obliquely with respect to the direction of flow within the sleeve-shaped casing **4**. Both as regards the pipes **37** (FIG. 7) and the pipes **47** (FIG. 10) each such pipe may extend differene distances into the casing, or all of the pipes may extend equal distances inwards from the shell of the casing **4**. Hereby the fluid may be supplied to a zone, which is

located adjacent the wall of the casing **4**, alternatively, to the central part of the casing **4** or to a zone which is about half-way between in all cases taken in the radial direction of the casing **4**. Under certain circumstances it may, moreover be suitable to supply the fluid through a duct, passing through the passage formed by wall **15** or through the pipe **13**, in which case the distributing preferably takes place in any of the ways or by means of any of the arrangements hereinbefore described.

It should be pointed out in particular that the sleeve-shaped member **4** need not extend from one end of the container to the opposite end thereof. It may be curved and deviate for example, at an angle of about 90 degrees, having its outlet directed towards the wall as at **17** as shown in FIG. 1, said wall being then embodied with the plate-like member **5**.

As already mentioned the apparatus according to the invention presents extremely good properties in respect of flow and mixing. Primarily this is due to the fact that material pumped into the container, while circulating therein is wholly or partly, returned to the pump means.

I claim:

1. An apparatus for mixing suspensions of materials while admixing additional treating materials therewith comprising a container inlet means for supplying the suspensions of materials to said container, outlet means for withdrawing treated material therefrom, a sleeve-shaped casing located within said container and having an inlet and an outlet at opposed ends thereof in communication with the inside of said container, the outlet being spaced from a surface on the inside of said container, a pump means including an impeller rotatably mounted within the inlet end of said sleeve-shaped casing for impelling the suspension from the inlet to the outlet thereof and against said surface a supply pipe for the treating material passing into said container, inlet means communicating with said pipe disposed circumferentially about said sleeve-shaped casing for uniformly introducing said treating material in a circumferential pattern into said sleeve-shaped casing for uniformly distributing said treating material into said suspension while said suspension is being impelled through said sleeve-shaped casing.

2. Apparatus as claimed in claim **1** wherein the inlet means includes at least one port through the wall of said casing and means for distributing said treating material to said at least one port.

3. Apparatus as claimed in claim **2** wherein the distributing means comprises a manifold and wherein the at least one port comprises an annular slot communicating between the manifold and the inside of said sleeve-shaped casing.

4. Apparatus as claimed in claim **2** wherein the distributing means comprises a manifold and wherein the at least one port comprises a plurality of openings in the wall of the sleeve-shaped casing communicating between the manifold and the inside of said sleeve-shaped casing.

5. Apparatus as claimed in claim **4** wherein the plurality of openings comprises a plurality of perforations.

6. Apparatus as claimed in claim **4** wherein the plurality of openings comprises a plurality of slotted openings.

7. Apparatus as claimed in claim **2** wherein the at least one port comprises a plurality of pipes projecting through the wall of the sleeve-shaped casing.

8. Apparatus as claimed in claim **7** wherein the projecting pipes extend to a point substantially at the midpoint of the radius of a cross-section of the sleeve-shaped casing.

9. Apparatus as claimed in claim **7** wherein the projecting pipes extend obliquely with respect to the axis of the sleeve-shaped casing and in the general direction of flow of suspension therethrough.

10. Apparatus as claimed in claim **2** wherein the at least one port is disposed between impeller and the outlet of said sleeve-shaped casing.

11. Apparatus as claimed in claim **2** wherein the at least one port is disposed substantially at the midpoint of the sleeve-shaped casing.

12. Apparatus as claimed in claim **2** wherein the at least one port is disposed adjacent the outlet end of the sleeve-shaped casing.

13. Apparatus as claimed in claim **2** wherein the at least one port directs the introduced treating material radially into the sleeve-shaped casing.

14. Apparatus as claimed in claim **1** and further comprising guide members mounted on the inside of the sleeve-shaped casing forward of the impeller to reduce rotary motion caused by the impeller.

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U.S. Cl. X.R.

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