Feb. 15, 1966 M. DIETZE ETAL 3,235,231

MIXING DEVICE

Filed Aug. 27, 1963

4 Sheets-Sheet 1

FIG. 1

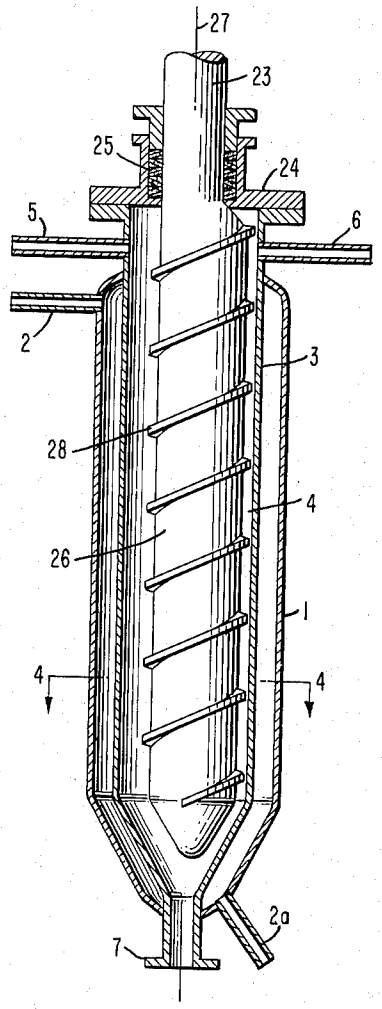


FIG. 4

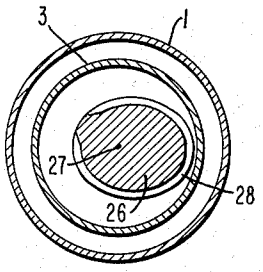
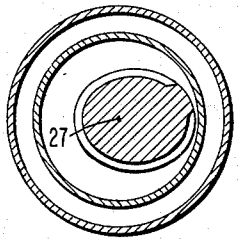


FIG. 7



INVENTOR
MANFRED DIETZE
WOLFGANG KRAFT

BY Bair, Freeman & Molinare

ATTORNEY

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MIXING DEVICE

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FIG. 2

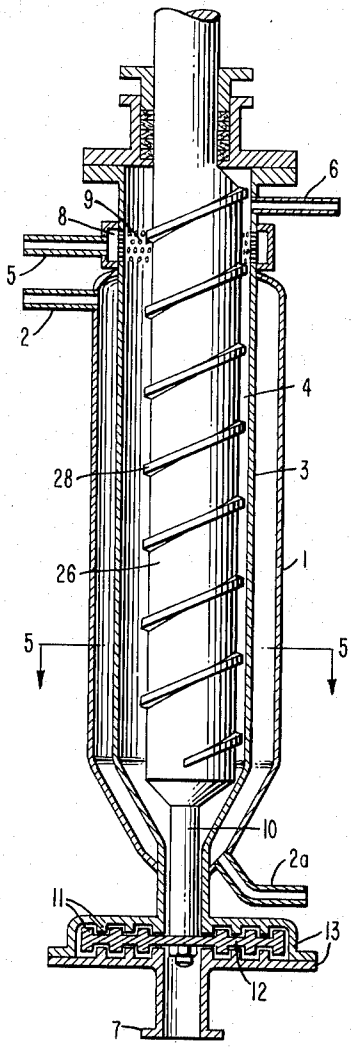
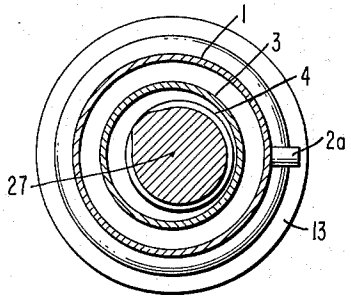


FIG. 5



INVENTOR
MANFRED DIETZE
WOLFGANG KRAFT

BY Bair, Freeman & Molinare

ATTORNEY

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FIG. 3

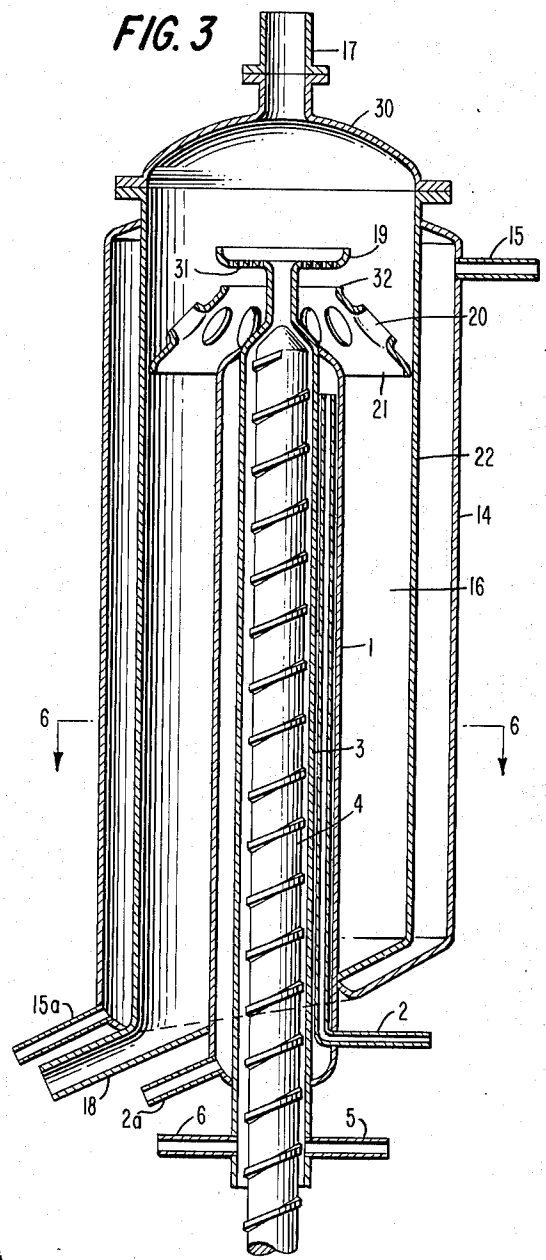
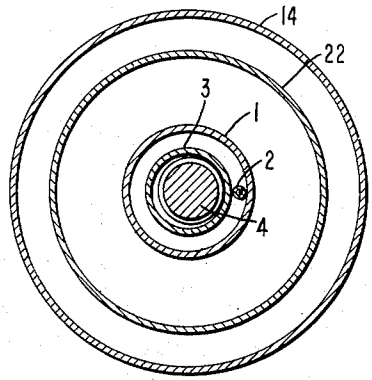


FIG. 6



INVENTOR
MANFRED DIETZE
WOLFGANG KRAFT

BY Bair, Freeman & Molinare

ATTORNEY

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FIG. 8

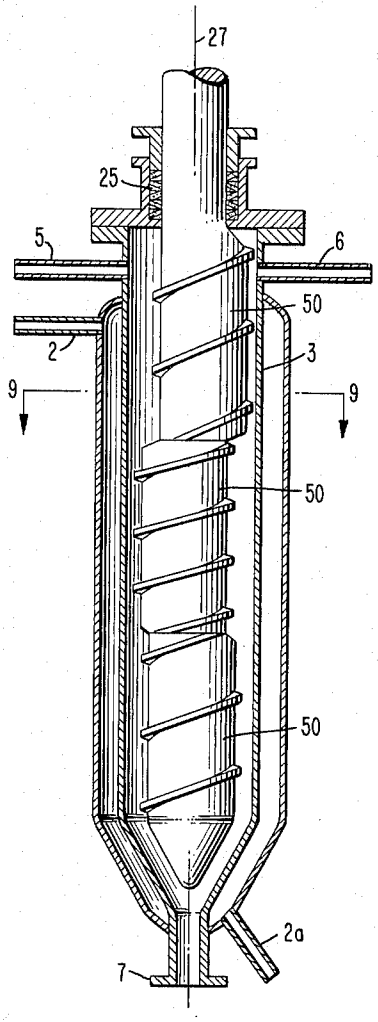
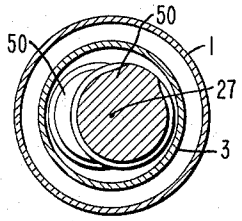


FIG. 9



INVENTOR
MANFRED DIETZE
WOLFGANG KRAFT

BY Blair Freeman & Molinare

ATTORNEY

United States Patent Office 3,235,231 Patented Feb. 15, 1966

3,235,231

MIXING DEVICE

Manfred Dietze, Offenbach (Main), and Wolfgang Kraft, Bad Vilbel, Germany, assignors to Hans J. Zimmer, Verfahrenstechnik, Frankfurt am Main, Germany

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Claims priority, application Germany, Sept. 4, 1962, Z 9,636
9 Claims. (Cl. 259—7)

This invention relates to a device useful for continuously mixing of several substances, in which a mixing screw apparatus is rotatable in a mixer casing.

Such mixing devices are useful primarily in the chemical industry, as in plastics production. In mixing viscous materials, it is particularly important that a good, rapid, and homogeneous mixing of the various materials be provided, as for example, mixing several additives along with the main substance. In particular a string-like formation at the end of the mixer or an inadequate homogeneity of materials is to be avoided.

Various mixers having rotating mixing tools are known. The mixing performance of the known mixers, however, is inadequate for most fields of utilization. In order to improve mixing in known devices, there has been proposed an arrangement of several, partially countermoving worms in a single mixer. However, despite such improvements, the mixing action accomplished by such devices leaves much to be desired. Therefore, it is an important object of this invention to provide a greatly improved mixing device wherein several viscous substances may be mixed with relatively low pressure loss and with a high performance capacity in a very short period of time.

It is also an object of this invention to provide a mixing device in which the mixing screw is positioned to rotate eccentrically in the mixer casing.

It is a further object of this invention to provide a mixing device having a screw or worm body adapted to have various cross-sectional forms.

It is another object of this invention to provide a mixing device which provides good mixing of materials in a direction axial of the mixing worm courses, while, due to the eccentric rotation of the screw, there is provided a mixing of materials circumferentially of the worm or screw.

It is still another object of this invention to provide a mixing device wherein the screw shaft rotates relative to the casing in such a manner that the worm course, at one point, is relatively close to the casing wall, and, at a diametrically opposite point is spaced a greter distance from the casing wall.

It is still a further object of this invention to provide a mixing device having a mixing screw wherein the mixing action of the screw is enhanced by the circumferential movement of the screw along the casing wall.

It is an additional object of this invention to provide a mixing device having a plurality of mixing screw portions, wherein the portions are variously spaced from the casing wall, the screw portions being individually adapted to rotate in the same direction as or in a direction opposite to the product flow.

It is also an additional object of this invention to provide a mixing device to provide distributor means in the casing, through which additives may be directed with pressure into the mixing device or into the previously added substances.

It is also a further object of this invention to provide a mixing device having a second mixing region, either prior to or following the main mixing region, wherein the work shaft is provided with a disc which cooperates with mating portions of the mixer casing.

It is another additional object of this invention to provide a mixing device positioned within an evaporator in order to evaporate solvent additives in the primary component or components, following mixing.

Further purposes and objects of this invention will appear as the specification proceeds.

Particular embodiments of the present invention are illustrated in the accompanying drawings wherein:

FIGURE 1 is a partially sectioned, longitudinal view of a mixing device constructed in accordance with my invention;

FIGURE 2 is a partially sectioned, longitudinal view of an alternate mixing device;

FIGURE 3 is a partially sectioned longitudinal view of another alternate mixing device, shown in combination with an evaporator section;

FIGURE 4 is a sectional view taken along the line 4—4 of FIGURE 1;

FIGURE 5 is a sectional view taken along the line 5—5 of FIGURE 2;

FIGURE 6 is a sectional view taken along the line 6—6 of FIGURE 3;

FIGURE 7 is a sectional view, similar to FIGURE 4, showing an alternate embodiment of the present invention;

FIGURE 8 is a partially sectioned, longitudinal view of an alternate mixing device constructed in accordance with my invention; and

FIGURE 9 is a sectional view taken along the line 10—10 of FIGURE 8.

Referring to FIGURES 1 and 3, a rotatable mixing screw 4 is positioned within a preferably cylindrical mixer casing 3. One end of the mixing screw includes a drive shaft 23, rotatably carried by a casing cover 24. The shaft bearing is packed in the usual manner by a packing box 25. It is, of course, possible to have the mixing screw 4 rotatably mounted at both of its ends.

The casing 3 is surrounded by a heating or cooling jacket 1. For feeding and removing the heating or cooling medium, an entry connecting piece 2 and an exit connecting piece 2a are provided in the jacket 1. In a given use, a heating or cooling system may not be required.

The substances to be mixed together are supplied to the mixer, near one end of the mixing screw 4, through the connecting pieces 5 and 6. In the example shown, connecting pieces are shown for only two media, but any number of inlet connecting pieces may be provided, depending upon the number of media to be mixed. The substances pass longitudinally through the casing 3, and at the opposite end, following intensive mixing by the screw, they are removed through an outlet connecting piece 7.

In order to provide an exceptionally high degree of mixing, the mixing screw 4 is rotated eccentrically. The cross-section of the screw base body 26 may have various forms, and for example, may be made in circular form as seen in FIGURES 4–6 with an eccentric location of the axis 27 of rotation; also, the cross-section may be elliptical as seen in FIGURE 7 so that the axis of rotation runs through one of the foci of the ellipse. However, other cross-sectional forms of the screw body 26 may be provided. On the screw base body 26, the thread courses 28 are arranged in a conventional manner, either in the same or in an opposite direction to the direction of movement of the substances being mixed.

Advantageously, the dimensional relation between the screw and the mixer casing 3 is such that the maximum radius of the screw body 26, inclusive of the thread courses 28, is only slightly less than the inside radius of the mixer casing 3, so that upon rotation of the screw 4,

the threads 28 move circumferentially along the inner wall of the mixer casing 3. The result of this construction is mixing of the substances in two directions. Through the thread channels between the courses 28, the axially directed intermixing of substances is achieved; additionally, a circumferential mixing of substances is accomplished by the eccentric rotation of the screw base body 26.

The mixing device of FIGURES 2 and 5 is similar to that of FIGURE 1, and like or equivalent elements are provided with the same reference numbers. In order to provide preliminary mixing of the substances, in the mixer of FIGURE 2, individual substances are fed into the mixer at a distance from one another. Thus, the entry connecting piece 6 for the main substance is positioned at the outer end of the casing 3, and the entry connecting piece 5 for an additive is positioned a short distance from the entry connecting piece 6. The entry connecting piece 5 does not pass directly into the casing, but rather into an annular circulation channel 8, positioned around the casing shell 3. In the region of the circulation channel 8, the mixer casing 3 includes a perforated portion 9, having a number of openings therein. The additive to be introduced is passed, under pressure, into the circulation channel 8 and through the openings or bores of the perforated portion 9. Thus, the additive substance passes in fine distribution into the casing 3 or into the main flow of substances introduced through the connecting piece 6, and this effects a certain amount of mixing of the substances. This mixing is in addition to the mixing accomplished within the casing, as described in connection with the embodiment of FIGURE 1.

To further enhance the mixing of substances there is provided at the exit end, before the connecting piece 7, a plate 12 which is secured to and rotatable with the screw 26. The plate 12 and mating casing 13 are provided with nubs or projections 11, which are adapted to be located in the depressions or grooves between nubs 11. The casing 13 may include a heating or cooling jacket (not shown). The mixed materials emerging from the mixer casing 3 radially enter the spaces between the profiled plate 12 and the profiled casing 13, and, under constant mixing, move past or around the rotating plate 12 and into the discharge connecting piece 7. In order to increase the mixing effect of the plate 12, additional mixing plates may be provided along the shaft extension. Similarly, mixing plates may be located before the entry connecting pieces 5 and 6 in order to effect pre-mixing of feed material.

Often, substances to be added to the main flow must, for reasons of dosage, be fed as a suspension and/or as a solution. There then arises a requirement of removing the excess solvent or suspension medium directly following mixing, since otherwise the continuous operation of the process would, under some circumstances, be disturbed. Such a requirement occurs, for example, in the plastics industry when plastics, in viscous form, are to be provided with a suitable color pigment. A specific example of this is the mixing of a matting substance, for example titanium dioxide suspended in ethylene glycol, with a polyester plastic, such as polyethylene terephthalate; here, it is necessary to immediately evaporate the ethylene glycol fed in with the titanium dixode, following mixing. FIGURES 3 and 6 illustrate the combination of a mixing device along with an evaporator whereby immediately after mixing, the excess ethylene glycol is evaporated.

For the sake of clarity, the mixing device itself is only generally indicated in FIGURE 3, the structure corresponding generally to the embodiment of FIGURES 1 and 2. The entire mixing device is positoned within an evaporator 16, whose evaporator wall 22 is surrounded by a heating jacket 14. The heating jacket 14 has an inlet connecting piece 15 and an outlet connecting piece 15*a* for feeding and withdrawing a suitable heating medium. The substances to be mixed, that is, the main product and the additive components provided with a solvent, are fed into hte mixer in the lower zone, through the connecting pieces 5 and 6 and are adapted to flow upwardly. The mixer casing terminates at its upper end in a distributor plate 19, which divides the mixed substances into two partial streams, delivering one stream to a liquid guide baffle 21. This liquid guide baffle 21 is preferably designed in frusto-conical form having an open top and a plurality of vapor passage openings 20 distributed circumferentially. The edges of the vapor passage openings 20 are raised upwardly, so that the liquid running along the outer surface of the guide plate or baffle 21 does not flow through the vapor passage openings 20. The stream running down the outer surface of the liquid guide baffle 21 is conducted to the evaporator wall 22 and runs down along the wall in a thin film of liquid. The vapors formed escape through the vapor passage openings 20 and then through an exit connecting piece 17 located in the upper closing cover 30.

A second stream of liquid from the distributor plate 19 passes through the holes 31, located in the base of the plate 9 and then passes through the upper central opening 32 of the guide plate 21, to thus contact the outer surface of the heated jacket 1 of the mixing device. Here the liquid runs down in a thin layer and the vapors escape in the manner previously described. Thus, mixture passes in two paths of flow, with evaporation of the solvent, into the lower region of the evaporator 16 and is then discharged through the discharge connecting piece 18. Therefore, the outer surface of the heated mixer wall is simultaneously used as an evaporator surface. If, however, heating of the mixer during the mixing of the substances is not desired, the evaporation may be accomplished solely on the evaporator wall 22. In this case, the holes 31 in the bottom of the distributor 19 are omitted, so that all the mixed substances are conducted along the conical liquid guide plate 21. The location of a mixer within an evaporator is thus highly advantageous, it also being possible to position other types of mixers within an evaporator.

FIGURES 8 and 9 illustrate a further embodiment of the invention. The mixing screw shown therein includes a plurality of contiguous, offset portions 50 having a geometrical axis. Each geometrical axis of each offset portion 50 is offset from and substantially parallel to the axis of rotation 27, which is also co-axial with the central axis of the casing.

While in the foregoing, there has been a detailed description of particular embodiments of the present invention, it is to be understood that all equivalents obvious to those having skill in the art are to be included within the scope of the invention as claimed.

What we claim and desire to secure by Letters Patent is:

1. A device useful for continuously mixing several materials, said device comprising a casing wherein said materials are mixed having a central axis, and a mixing screw having a geometrical axis and being mounted within said casing and rotating about an axis of rotation, said axis of rotation being co-axial with said central axis and said geometrical axis being offset from and substantially parallel to said axis of rotation.

2. The device of claim 1 wherein said casing is substantially circular in cross-section.

3. The device of claim 2 wherein said mixing screw is substantially circular in cross-section.

4. The device of claim 2 wherein said mixing screw is substantially elliptical in cross-section.

5. A device useful for continuously mixing several materials, said device comprising a substantially cylindrical casing wherein said materials are mixed having a central axis, inlet and outlet means for introducing and removing said materials to and from said casing, and a mixing screw having a geometrical axis and being mounted within

said casing and rotating about an axis of rotation, said axis of rotation being co-axial with said central axis and said geometrical axis being offset from and substantially parallel to said axis of rotation.

6. The device of claim 5 wherein said inlet means includes perforations circumferentially spaced about said casing so that at least one of said materials passes in fine distribution through said perforations so as to effect a preliminary mixing of said materials.

7. A device useful for continuously mixing several materials, said device comprising a casing wherein said materials are mixed having a central axis, a mixing screw having a geometrical axis and being mounted within said casing and rotating about an axis of rotation, said axis of rotation being co-axial with said central axis and said geometrical axis being offset from and substantially parallel to said axis of rotation, outlet means for passing said mixed materials from said casing, and mixing means positioned at said outlet means for further mixing said materials.

8. The device of claim 7 wherein said further mixing means comprises a profiled mixing plate affixed to said mixing screw and said casing is profiled to rotatably receive said profiled mixing plate and to cooperate therewith for further mixing said materials passing through said outlet means.

9. A device useful for continuously mixing several materials, said device comprising a substantially cylindrical casing wherein said materials are mixed having a central axis, and a mixing screw mounted with said casing and rotating about an axis of rotation, said mixing screw having a plurality of contiguous offset portions, each of said portions having a geometrical axis, said axis of rotation being co-axial with said central axis and each of said geometrical axes being offset from and substantially parallel to said axis of rotation.

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CHARLES A. WILLMUTH, *Primary Examiner.*