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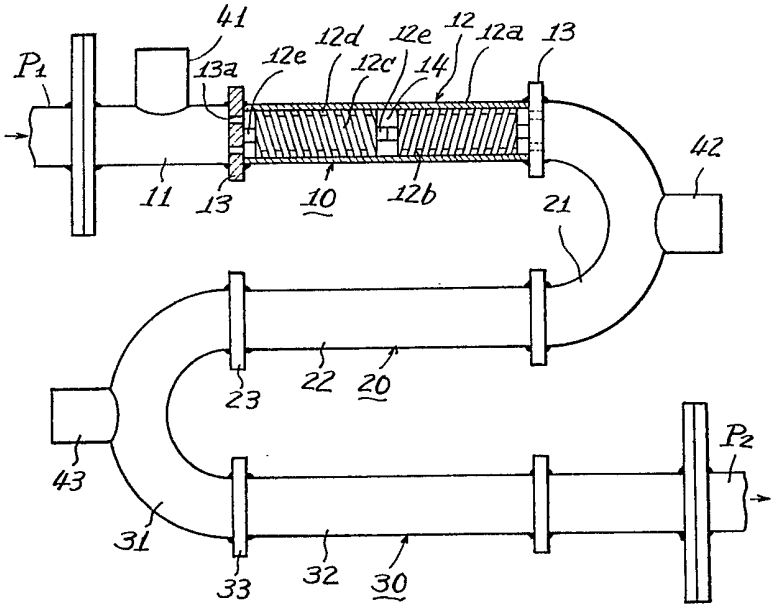
GB A 2030882
GB 1553875
GB 1458878
GB 1449480
GB 1447257
GB 1254179

(58) Field of search
B1C

(54) Mixing a flow

(57) A mixing apparatus comprises an inlet cylinder portion (11) which receives fluids to be mixed and a spiral flow passage member (12) connected to the inlet portion (11). The spiral flow passage member provides a long flow path over a relatively short linear distance thereby improving mixing efficiency while achieving a compact size.

Fig. 2



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

Fig. 1

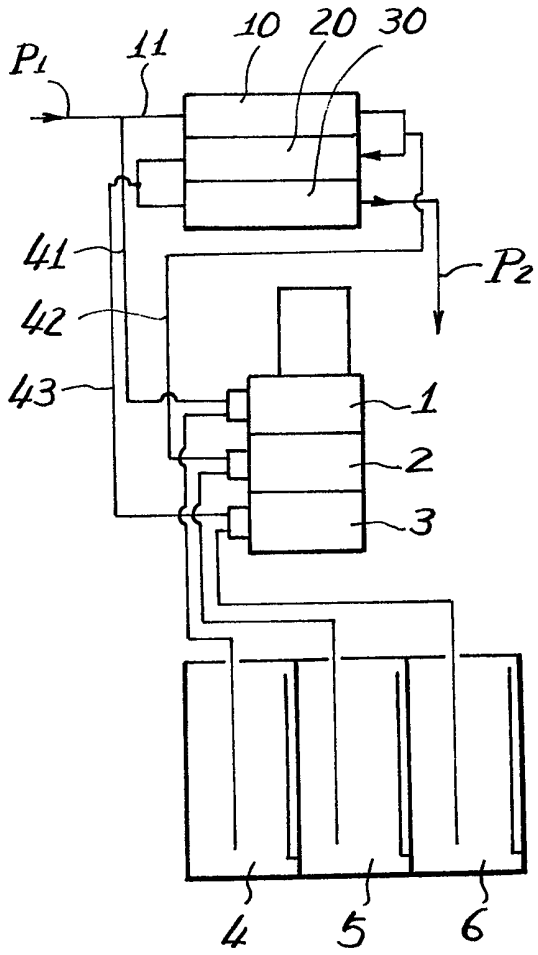


Fig. 2

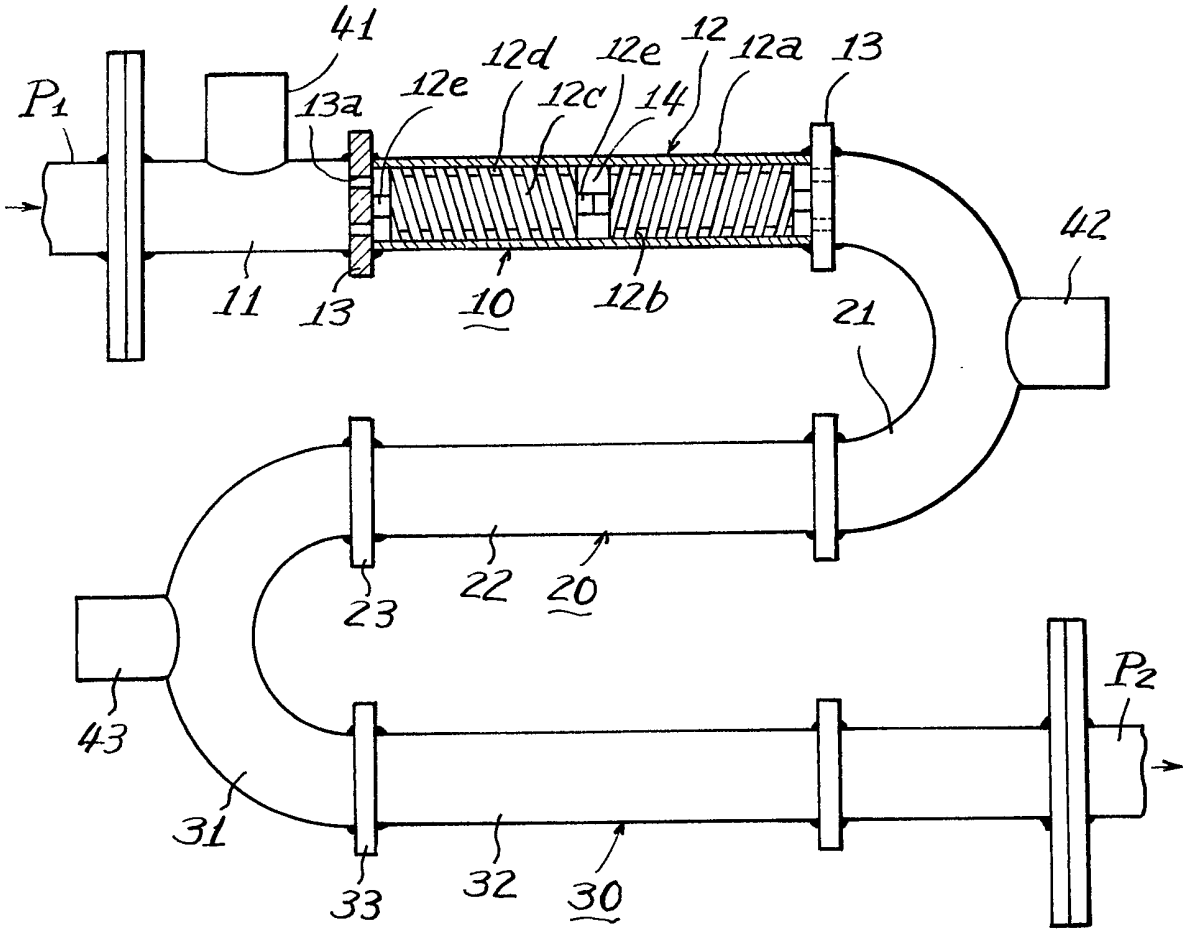

41
P1
13a
12e
12d
12e
12
12a
13
12c
14
42
11
13
10
12b
21
23
22
20
43
P2
31
33
32
30

Fig 3

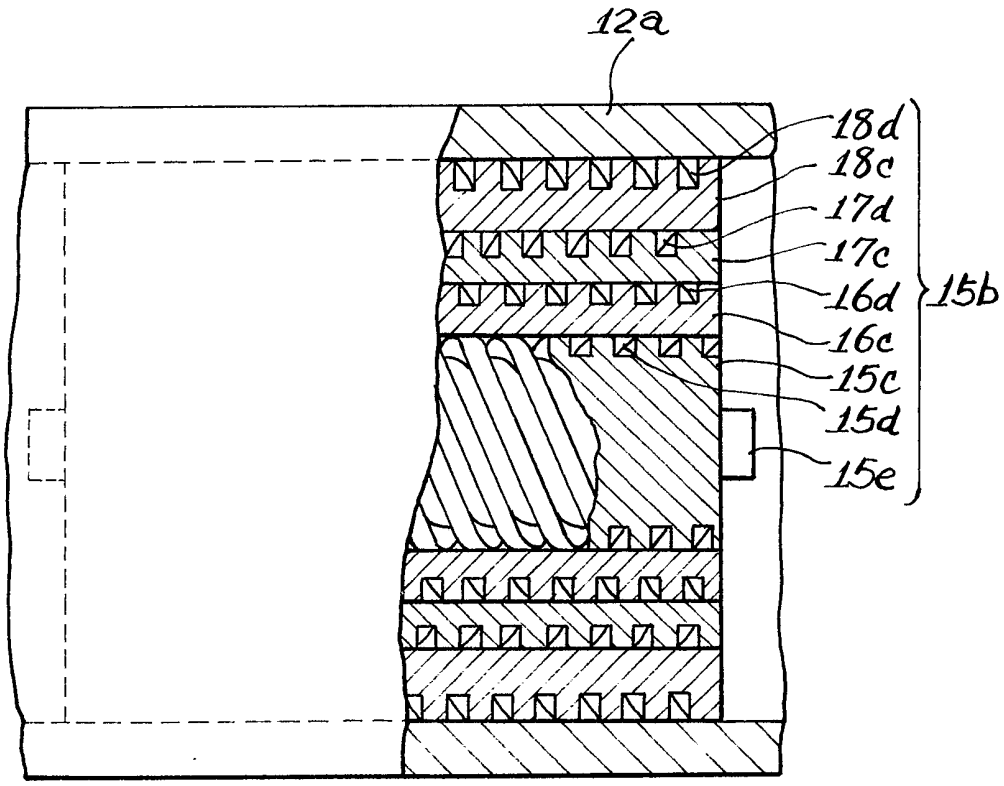
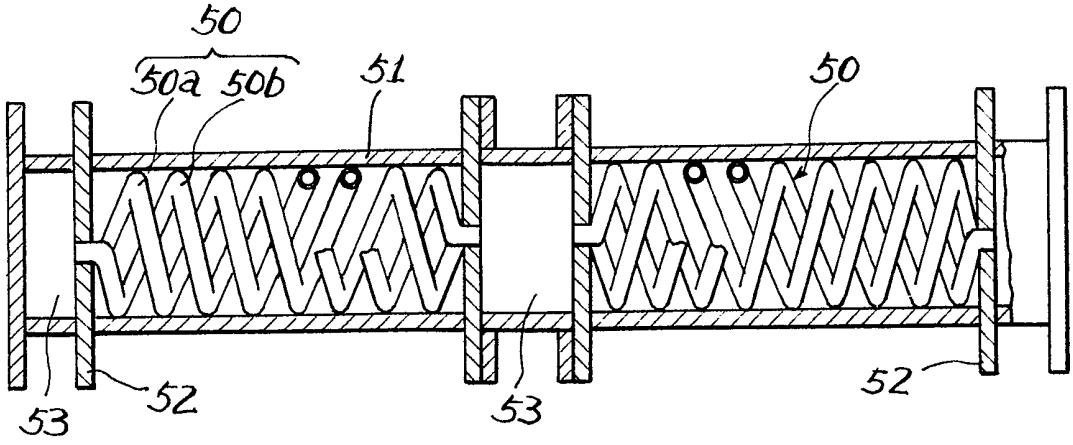

12a
18d
18c
17d
17c
16d
16c
15c
15d
15e
15b

Fig 4


50
50a
50b
51
50
52
53
53
52

SPECIFICATION

A mixing apparatus

The present invention generally relates to mixing equipment and, more particularly, to a mixing apparatus for mixing fluids, that is liquids or a liquid and a gas.

As one example of mixing machine, there has conventionally been proposed an arrangement wherein fluids to be mixed or blended to each other are caused to flow through a cylinder in which a large number of baffle plates are disposed. The prior art system as described above, however, has such disadvantages that it is not very favorable as to mixing efficiency, and moreover, requires a long linear distance, with a consequent increase in the length of the mixing machine itself.

According to the present invention there is provided a mixing apparatus for mixing fluids, the apparatus comprising an inlet portion for receiving fluids to be mixed, and a spiral flow passage member defining a spiral flow path having more than one turn and communicating with a downstream part, in the direction of flow of received fluid, of the inlet portion.

According to one embodiment of the present invention, there is provided an arrangement which includes an inlet cylinder portion for receiving fluids to be mixed as introduced thereinto, and spiral flow passage members having spiral flow passages directed therearound through more than 360° and connected to a forward end of said inlet cylinder portion.

Since the spiral flow passages are formed within the mixing apparatus, the flow passages are elongated even within the short linear distance to provide a long mixing process as desired. Accordingly, not only the mixing efficiency is enhanced, but it becomes possible to achieve a compact size for the mixing apparatus as a whole. Thus, embodiments of the invention provide a mixing apparatus in which long flow passages are formed within a short linear distance so as to prolong a mixing process for improving mixing efficiency and simultaneously achieving a compact size, through elimination of disadvantages inherent in the conventional mixing apparatus of this kind.

For a better understanding of the present invention, and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:-

Figure 1 is a systematic diagram showing an arrangement according to one preferred embodiment of the present invention,

Figure 2 is a top plan view, partly broken away, showing on an enlarged scale the construction of a mixing apparatus according to the present invention,

Figure 3 is a fragmentary top view partly broken away, showing the construction of a mixing apparatus according to another embodiment of the present invention, and

Figure 4 is a fragmentary top sectional view showing the construction of a mixing apparatus according to a further embodiment of the present invention.

Referring now to the drawings, one preferred embodiment of the present invention will be described based on an oil component flocculating arrangement taken as an example.

In Figure 1, there is shown the oil component flocculating arrangement which includes a mixing unit wherein an inorganic flocculant mixing apparatus 10, an alkali agent mixing apparatus 20 and a high polymeric flocculant mixing apparatus 30 are connected in series to each other, an inorganic flocculant pump 1, an alkali agent pump 2, a high polymeric flocculant pump 3, and a chemical agent tank in which an inorganic flocculant tank 4, an alkali agent tank 5 and a high polymeric flocculant tank 6 are accommodated. The respective mixing apparatuses as described above are connected in series to each other according to flow passages of a liquid from an upstream side to a downstream side in the order of the inorganic flocculant mixing apparatus 10, alkali agent mixing apparatus 20 and high polymeric flocculant mixing apparatus 30.

Subsequently, the construction of each of the above mixing apparatuses will be explained only with respect to the inorganic flocculant mixing apparatus 10, and detailed descriptions of the other two mixing apparatuses 20 and 30 will be abbreviated, since they have constructions generally similar to that of the mixing apparatus 10.

As is seen from Figures 1 and 2, at a fluid inlet side of the inorganic flocculant mixing apparatus 10, there is connected an open end of a supply pipe 41 of the inorganic flocculant fed from the tank 4 through the pump 1. As is most clearly shown in Figure 2, the inorganic flocculant mixing apparatus 10 includes an inlet cylinder portion 11 which receives fluids to be mixed as introduced thereinto, and a spiral flow passage member 12 connected to the downstream side of the inlet cylinder portion 11 through an end plate 13 having a fluid port 13a, with the supply pipe 41 being connected to open into the inlet cylinder portion 11 as described above. The spiral flow passage member 12 further includes an outer cylinder 12a, and a spiral groove member 12b concentrically disposed within the outer cylinder 12a, with the inner circumferential surface of the cylinder 12a being held in contact with the outer circumferential surface of the spiral groove member 12b.

The spiral groove member 12b referred to above is formed with a plurality of rows of spiral grooves 12d (two rows in the drawing) so that a plurality of spiral flow passages may be formed on the outer peripheral surface at one axis right-angled cross section of a columnar member 12c. These spiral grooves 12d are directed around the columnar member 12c at least more than one time (360°C) (four times in the drawing).

The columnar member 12c is provided, at its opposite ends, with projections 12e, and a plurality of the spiral groove members 12b (two members 12b in the embodiment) are disposed in series side by side, with the projections 12e being held in contact with each other as illustrated. Accordingly, at the outer peripheral portions of the respective

projections 12e, spaces are formed so as to serve for liquid mixing chambers 14. It is to be noted here that the neighboring spiral groove members 12b are arranged to be formed with the spiral grooves or threads directed in directions opposite to each other.

The downstream side of these spiral groove members 12b is sectioned by another end plate 13 so as to be connected to an inlet cylinder portion 21 of a subsequent alkali agent mixing apparatus 20.

It should be noted here that in Figure 1, a symbol P1 represents a liquid supply pipe from a separating tank and the like to the mixing apparatus, and a symbol P2 denotes a transport pipe to a subsequent step, while numerals 41, 42 and 43 represent chemical agent supply pipes for the respective mixing apparatuses.

For the inorganic flocculant, for example, polyaluminum, chloride is employed, and for the alkali agent, caustic soda and the like is used. Meanwhile, as the high polymeric flocculant, there may be suitably employed an agent mainly composed of acrylic polyamide such as Aronflock A-101 (Trade name of an agent manufactured by Toa Gosei Chemical Industry Co., Ltd.), and an organic agent of polyacrylic amide group.

By the above arrangement, the state of functionings thereof will be explained hereinbelow.

In the respective mixing apparatuses 10, 20 and 30, when the respective agents are introduced into the corresponding cylinder portions 11, 21 and 31, such agents are each mixed within the mixing apparatuses so as to flow down according to the order of disposition. Therefore, since the spiral flow passages are formed within the mixing apparatuses, long flow passages may be obtained by a short linear distance, and thus, due to the prolongation of the mixing process, the mixing efficiency is improved, while it becomes possible to form the mixing apparatus into a compact size. Moreover, since each of the spiral groove members includes a plurality of rows of grooves, the flow passages may be divided into small areas for improvement of the mixing efficiency. Meanwhile, in the mixing chambers 14 provided between the plurality of the above spiral groove members, an overall mixing is expedited. Furthermore, since the rotating direction of the fluid is changed over in the reverse direction by forming the directions of threading for the spiral grooves, to be opposite to each other between the neighbouring spiral groove members in the axial direction, turbulent flow is produced thereby for a still further improvement of the mixing efficiency.

By repeating the mixing and blending as described so far, water and chemical agents are uniformly mixed so as to expedite the flocculation of the suspended material for contribution to purification of filthy water.

Figure 3 shows a spiral groove member 15b according to another embodiment of the present invention, in which the number of flow passages in one axis cross section is increased so as to increase the flow passage area on the whole. More specifically, the spiral groove member 15b includes an outer cylinder 12a, more than one inner cylinders 16c, 17c and 18c (three inner cylinders in the drawing) engaged with each other and fitted into the inner peripheral surface of the outer cylinder 12a, and a columnar member 15c concentrically fitted into the inner side of the smallest inner cylinder 16c. In the outer circumferential surfaces of the respective parts, spiral grooves 15d, 16d, 17d and 18d are provided as shown. The directions of threading of the spiral grooves are arranged to be opposite to each other between the neighboring members in the radial direction. Meanwhile, in the case as illustrated the spiral grooves 15d of the columnar member 15c and the spiral grooves 16d of the smallest inner cylinder 16c are of four-threaded screws, those of the intermediate inner cylinder 17c are of six-threaded screw, and those of the largest inner cylinder 18c are of eight-threaded screw. It may be so modified that the spiral grooves as described above are provided in the inner circumferential surfaces of the inner cylinders and outer cylinders. In this case, no spiral grooves are provided in the columnar member. The modification of the arrangement according to the present invention also includes the case in which the spiral grooves are not provided in some of the inner cylinders, with flow passages such as grooves, etc. being formed along the axial direction, or the case in which no flow passages are provided at all. In other words, it may serve the purpose if the spiral grooves are provided in at least one outer circumferential surface or inner circumferential surface of the inner cylinders and the columnar member.

Figure 4 shows a further embodiment according to the present invention, in which sets of a plurality of spiral tubes 50a and 50b disposed side by side within a cylinder 51 as a spiral flow member, are extended through end plates 52 so as to be secured thereat. The plurality of sets of the spiral tubes turned in directions opposite to each other, are coupled in series to each other through mixing chambers 53, with the respective spiral tubes being open into said mixing chambers 53. It may be so modified, in correspondence to Figure 3, that the spiral tubes are provided in plurality in the spiral radial direction. The above embodiment also displays the function and effect similar to those in the previous embodiment in which the spiral grooves are provied.

It should be noted here that the present invention is not limited in its application only to the mixing between liquids as described earlier, but may readily be applied to the mixing (including dissolving) between a liquid and a gas such as water and air, or the like.

CLAIMS

1. A mixing apparatus for mixing fluids, the apparatus comprising an inlet portion for receiving fluids to be mixed, and a spiral flow passage member defining a spiral flow path having more than one turn and communicating with a downstream part, in the direction of flow of received fluid, of the inlet portion.

2. A mixing apparatus as claimed in claim 1, wherein the spiral flow passage member includes an outer cylinder and a spiral groove member coaxially

disposed within the outer cylinder.

3. A mixing apparatus as claimed in claim 2, wherein the spiral groove member is formed with a plurality of rows or spiral grooves on an outer peripheral surface thereof.

4. A mixing apparatus as claimed in claim 2, wherein the spiral groove member includes more than one inner cylinder and a columnar member coaxially fitted into the inner side of the innermost cylinder, and the spiral groove is provided on at least one outer circumferential surface or inner circumferential surface of each inner cylinder and the columnar member.

5. A mixing apparatus as claimed in claim 2, 3 or 4, wherein the spiral groove member is provided at its opposite ends with a respective projection, and a plurality of the spiral groove members are disposed in series side by side with the projections being held in contact with each other, at the outer peripheral portions of respective projections, spaces being formed thereby which serve as fluid mixing chambers.

6. A mixing apparatus as claimed in claim 2, 3 or 4, wherein a plurality of such spiral groove members are disposed in series in an axial direction, and neighbouring spiral groove members are arranged to be formed with the spiral grooves directed in directions opposite to each other.

7. A mixing apparatus as claimed in claim 4, wherein the directions of threading of the spiral grooves are arranged to be opposite to each other between the neighbouring members in the radial direction.

8. A mixing apparatus as claimed in claim 2, 3 or 4, wherein the spiral groove member is formed with a plurality of rows of spiral grooves so that a plurality of spiral flow passages may be formed on one cylindrical peripheral surface.

9. A mixing apparatus as claimed in claim 1, wherein the spiral flow passage member comprises a plurality of spiral tubes and end plates extending through and secured to opposite side of the tubes.

10. A mixing apparatus as claimed in claim 9, wherein the plurality of the spiral tubes and associated end plates are disposed side by side in an axial direction with a space forming a fluid mixing chamber.

11. A mixing apparatus as claimed in claim 9, wherein the plurality of spiral tubes and associated end plates are disposed in an axial direction in series, with the spiral tubes turned in a direction axially opposite to each other.

12. A mixing apparatus as claimed in claim 9, wherein the plurality of spiral tubes are disposed in a spiral axial direction with the spiral tubes turned in a direction opposite to each other in a radial direction.

13. A mixing apparatus as claimed in claim 9, wherein each spiral tube is formed with a plurality of rows so that a plurality of spiral flow passages may be formed on a cylindrical peripheral surface thereof.

14. A mixing apparatus, for mixing liquids or a liquid and a gas, comprising

an inlet cylinder portion for receiving fluids to be mixed as introduced thereinto,

a spiral flow passage member having spiral flow passage directed therearound through more than 360° and connected to a forward end of said inlet cylinder portion.

15. A mixing apparatus substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

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