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3,030,083 4/1962 Stiffler..... 416/199
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[54] **BLADE APPARATUS FOR HIGH-SHEAR MIXING**
6 Claims, 5 Drawing Figs.

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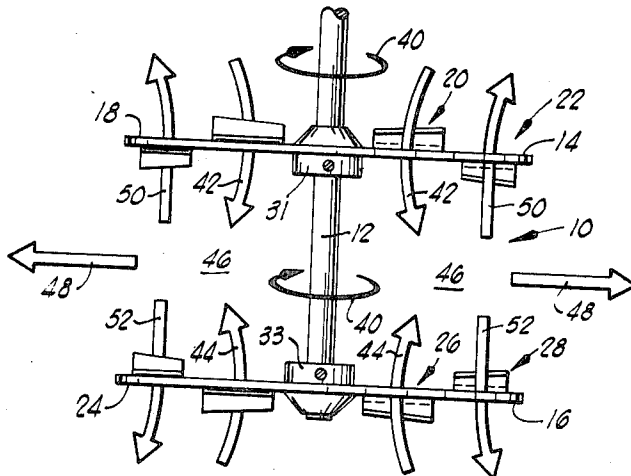
[50] Field of Search.....416/198-202,
 231, 181

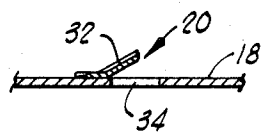
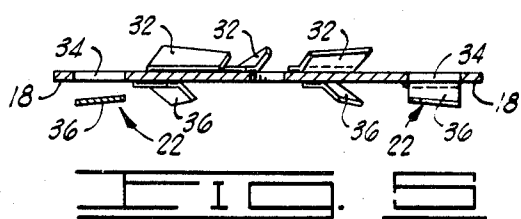
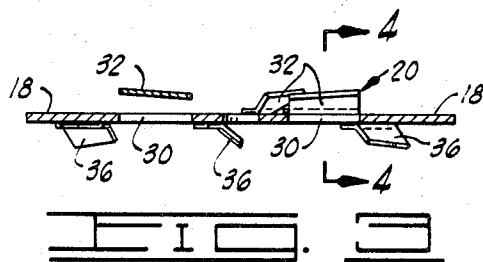
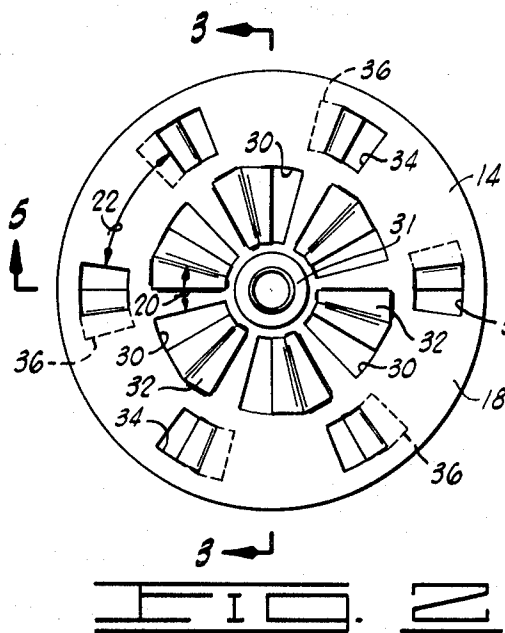
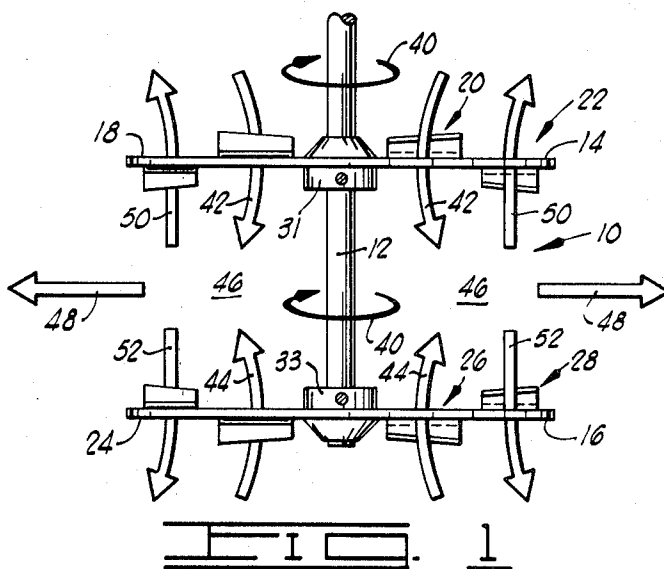
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ABSTRACT: Apparatus for mixing materials at increased shear rate and efficiency which utilizes upper and lower spaced rotary mixer blades each driven in the same direction by a rotary shaft. The upper blade consists of a group of inner material deflectors for moving mix material in one direction through the blade while an outer concentric group of deflectors move mix material in the opposite direction through the mixer blade. The lower mixing blade is then oppositely formed so that the inner circular array of deflector-slot configurations moves mix material through the blade in opposition to material from the upper plate inner deflectors while an outer concentric ring of deflectors move mix material downward through the blade away from the upper blade outer deflectors.





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BLADE APPARATUS FOR HIGH-SHEAR MIXING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to rotationally driven shear mixing devices and, more particularly, but not by way of limitation, it relates to improved mixing apparatus utilizing plural mixing blades of opposite formation to set up an intermediate shear interface between oppositely flowing mix materials.

2. Description of the Prior Art

The prior art includes a great many different types of mixing devices, many of which utilize rotational shaft input to drive one or more mixing elements. One form of rotary mixer utilizing dual, spaced mixing blades simply employs like propeller-type blades having opposite pitch thereby to set up an action whereby mix material is forced into a central position to seek outer return flow. The U.S. Pat. No. 2,736,537, discloses this type of rotary mixing device in full detail. A U.S. Pat. No. 3,215,409, employs mixing discs having a plurality of radial slot elements to set up a mixing action. Still another and different teaching as to the double-bladed mixing devices is characterized by U.S. Pat. No. 2,172,017, which teaches the use of concentric rotary drives each turning one of the mixing blades in opposite directions.

SUMMARY OF THE INVENTION

The present invention contemplates a high-shear mixing device wherein a rotary shaft rotates upper and lower mixing blades each of which include oppositely disposed slot-deflector means arranged in concentric circular disposition. Thus, an upper mixing blade includes an inner slot-deflector array which directs mixed material downward therethrough while an outer, concentric array of slot-deflector elements directs mixed material upward therethrough. The lower mixer blade is then driven in synchronism with the upper mixing blade but the inner and outer arrays of slot-deflector elements are oppositely disposed to move mixed material in the opposite direction from the flow set up by the upper mixing blade thereby to set up a shear region between the upper and lower blades with mixer flow proceeding radially outward along an interface as set up and aided by centrifugal force.

Therefore, it is an object of the present invention to provide an improved rotary mixing device which is capable of creating a high shear between particles of mix material while requiring minimal horsepower input.

It is also an object of the invention to provide a rotary mixing apparatus which effects efficient mixing of abrasive materials, such as encountered in mixing of fertilizer materials, without undue stress and wear to pump housings, enclosed impeller, etc. normally required in such mixing processes.

Finally, it is an object of the present invention to provide an improved mixing apparatus which blends mix materials more thoroughly as well as more rapidly, with less power input requirement.

Other objects and advantages of the invention will be evident from the following detailed description when read in conjunction with the accompanying drawing which illustrates the invention.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a partially schematic side view of a mixing device constructed in accordance with the invention showing mix material flow;

FIG. 2 is a plan view of a mixer blade constructed in accordance with the invention;

FIG. 3 is a section taken along lines 3—3 of FIG. 2;

FIG. 4 is a section taken along lines 4—4 of FIG. 3; and

FIG. 5 is a section taken along lines 5—5 of FIG. 2.

DETAILED DESCRIPTION OF THE INVENTION

As shown in FIG. 1, a mixing device 10 consists of a rotary shaft 12 having mounted thereon in spaced, parallel relationship an upper mixing blade 14 and a lower mixing blade 16. The upper mixing blade 14 and lower mixing blade 16 are similar in construction although mounted in reversed relationship on rotary shaft 12 to set up the desired opposite mix material flows as indicated by the outline arrows.

Upper mixing blade 14 consists of a circular blade or disc 18 having an inner array of radially disposed slot-deflector elements 20 as well as an outer concentric array of slot-deflector elements 22. Noting the outline arrows, inner slot-deflector elements 20 are formed to force mix material downward through disc 18 while outer slot-deflector elements 22 are formed to move mix material upward through the disc 18. The lower mixing blade 16 is similarly constructed but oppositely disposed such that a disc 24 includes an inner array of slot-deflector elements 26 for moving mix material upward therethrough, and disc 24 also includes an outer array of slot-deflector elements 28 for moving mix material downward. Each of upper and lower discs 18 and 24 include a central bushing member 31 and 33, respectively, which provide secure affixture to rotary shaft 12. The bushings 31 and 33 may be fastened to rotary shaft 12 by conventional fasteners, e.g., setscrew shaft locking as shown.

As previously stated, the upper and lower mixing blades 14 and 16 are of similar construction with respective slot-deflector elements disposed to effect opposite mixing flows. Thus, the structure is more particularly described with respect to upper mixing blade 14 but it should be understood that the general structural principles apply to lower mixing blade 16 as well.

Referring to FIGS. 2 through 5, the upper mixing blade 14 consists of a disc 18 having the inner and outer slot-deflector elements 20 and 22 arranged in concentric relationship around disc 18. The inner array consists of a plurality of circularly equispaced radial slots 30. A deflector element 32 is then secured as by spot welding along the trailing edge of each slot 30 as is shown in FIG. 4. There is a deflector element 32 so secured on the upper surface of disc 18 adjacent each slot 30. The construction for the outer array of slot-deflector elements 22 is similar to that shown in FIG. 5 with the exception of its being disposed in opposite orientation. That is, the array consists of plural, equispaced slots 34, each having a deflector 36 secured as by welding to the underside of disc 18 adjacent the trailing edge of respective slots 34. The deflectors 36 are secured adjacent the outer slots 34 in the same manner as deflectors 32 shown in FIG. 4.

OPERATION

The mixer blades 14 and 16, upper and lower respectively, are suitably secured along rotary shaft 12 at predetermined spacing depending upon the viscosity and/or granule size and still other considerations which may be peculiar to certain materials. Rotational input is then supplied from a suitable drive source such as an electric motor (not shown) of the necessary or requisite horsepower, and the rotary shaft 12 is driven in the direction of arrow 40, a counterclockwise shaft rotation.

Upon application of rotary input, the rotary shaft 12 is driven to cause inner slot-deflector elements 20 to pull mix material downward through upper mixing blade 14 along arrows 42 and, simultaneously, inner slot-deflector elements 26 of lower blade 16 cause the opposite effect with mix material being drawn upward therethrough along arrows 44. The ascending and descending flows of mixed material then meet in a shear region, designated generally at 46, whereupon an abrading interface is set up between the two flows as the flows progress outward in the direction of radial arrows 48.

Additional selective separating and eddy effect is caused by the respective upper and lower outer slot-deflector elements 22 and 28. Thus, the outer slot-deflector elements 22 of upper

mixer blade 14 tend to draw mix material from the shear region 46 upward in the direction designated generally by the arrows 50. In like manner, the outer slot-deflector elements 28 of lower mixing blades 16 draw mix material downward therethrough in the direction shown by arrows 52.

The action of the mixer is to produce two streams of fluid material moving in opposite directions thereby creating a friction interface between them. The frictional agitation along the interface results in complete mixing and shear of more coarse materials and suspending agents within the mix material. In addition to the mixing which takes place in the shear region 46 there is still to be relied upon the normal and usually expected mixing reactions due to eddy flow against the base of the outer container, circulating flow against the sidewalls of the container, and other minor order circulating flows set up due to the consistency and granulation of the particular mixed material.

It should be understood that the mixer blades may vary in diameter, slot size, deflector size and pitch, and other dimensions of construction. Primary in formulating the basic specifications will be a consideration of the rotary input speed and various characteristics of the materials to be mixed. In addition, it is contemplated that certain materials may benefit from the use of additional gangs of mixing blades, e.g., gangs of four, six and even eight parallel-disposed mixing blades, each successive pair operating toward a central shear region.

The foregoing discloses a novel mixing apparatus which is capable of high-shear mixing with none other than normal rotary input of nominal power. The mixer device realizes additional advantages from the fact that mixing can be effected without deleterious side effects to such as pump housings and impeller assemblies utilized in association with the mixing process. This is especially true with respect to various forms of mixing apparatus which are normally used in connection with liquid fertilizer mixing processes.

Changes may be made in the combination and arrangement of elements as heretofore set forth in the specification and shown in the drawings; it being understood that changes may be made in the embodiments disclosed without departing from the spirit and scope of the invention as defined in the following claims.

What is claimed is:

1. Mixing apparatus of the type which is driven by rotary input, comprising:
 - shaft means for receiving said rotary input;
 - first blade means secured to said shaft and including first and second spaced concentric arrays of oppositely directed slot-deflector means which move mix material

oppositely through said blade means; and
 second blade means affixed to said rotary shaft means and axially spaced from said first blade means and including first and second spaced concentric arrays of oppositely directed slot-deflection means which move mix material in opposite directions through said blade means; said opposite directions being opposite from those directions of movement of mix material through said first blade means such that a shear interface is set up between said first and second blade means.

2. Apparatus as set forth in claim 1 wherein said first blade means comprises:

circular disc means including a central bushing receiving said rotary shaft therethrough in secure affixture, said disc means including an inner plurality of circularly arrayed radial slots formed about said disc means and an outer plurality of circularly arrayed radial slots formed concentric to said inner slots about said disc means;

a first plurality of deflector means each secured on the top surface of said disc adjacent the trailing edge of each of said inner radial slots to force mixed material downward through the slots; and

a second plurality of deflector means each secured to the under side of said disc adjacent the trailing edge of each of said outer radial slots.

3. Apparatus as set forth in claim 2 wherein said second blade means comprises:

second circular disc means including a second central bushing receiving said rotary shaft therethrough in secure affixture, said second disc means also including an inner plurality of circularly arrayed slots and an outer plurality of circularly arrayed slots formed thereabout;

a first plurality of deflector means each secured on the bottom surface of said second disc means adjacent the trailing edge of each of said inner slots; and

a second plurality of deflector means each secured to the top side of said disc means adjacent the trailing edge of each of said outer slots.

4. Apparatus as set forth in claim 2 wherein each of said inner and outer radial slot arrays consist of four or more equispaced radial slots.

5. Apparatus as set forth in claim 3 wherein each of said first and second blade means has said inner and outer slots formed so that the blade means is approximately 25 percent open.

6. Apparatus as set forth in claim 5 wherein the open area of said inner slots is approximately twice the open area of said outer slots.

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