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3,229,964

SPLITTER BLENDER APPARATUS

Filed Jan. 9, 1964

3 Sheets-Sheet 1

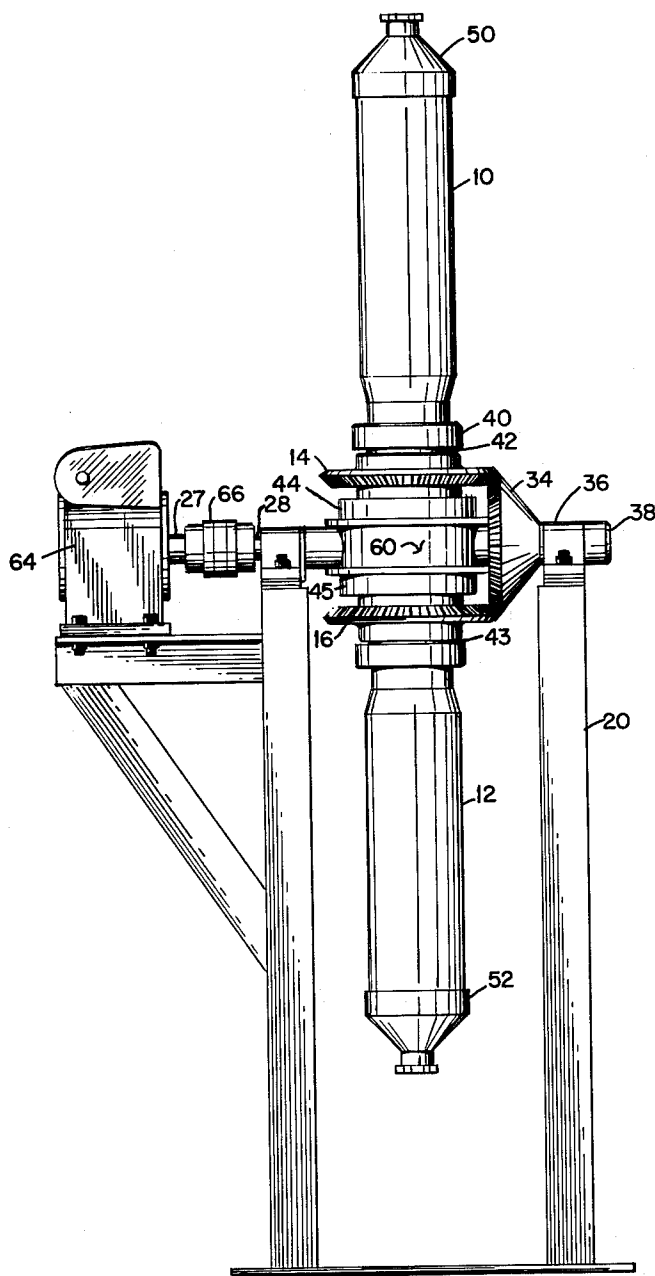


Fig. 1

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3 Sheets-Sheet 2

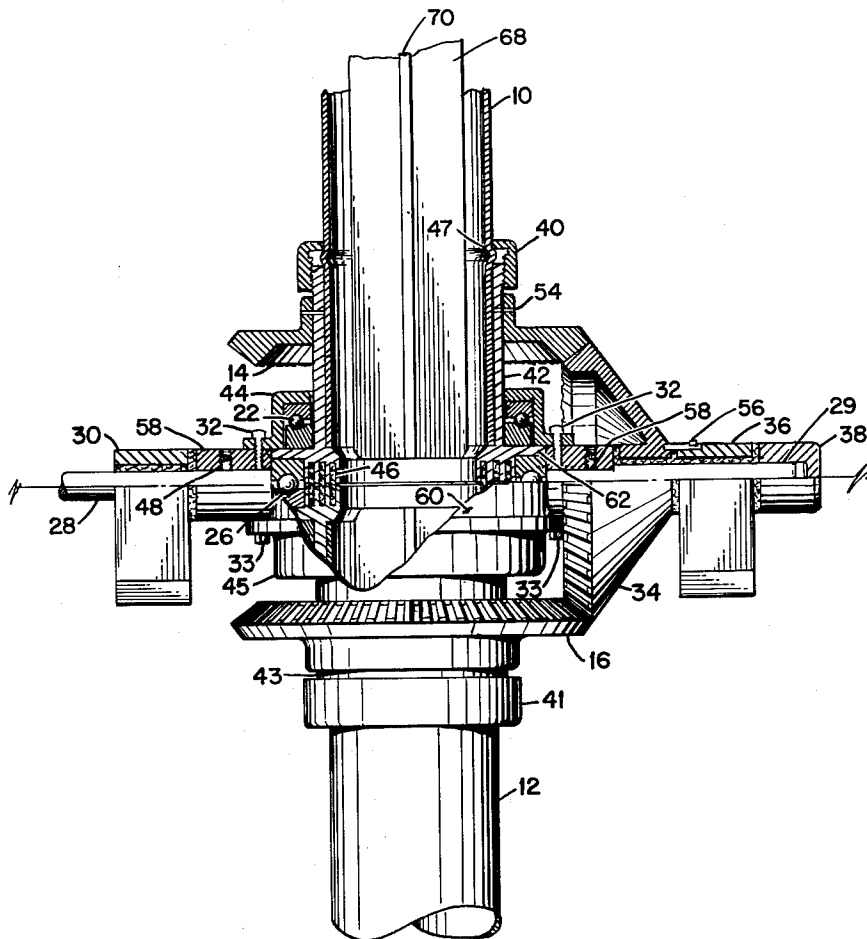


Fig. 2

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3 Sheets-Sheet 3

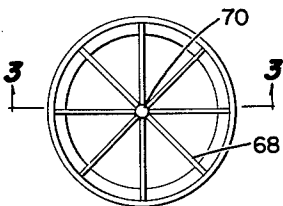


Fig. 4

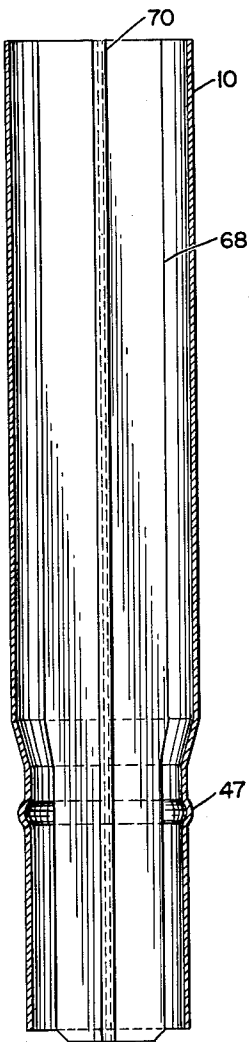


Fig. 3

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SPLITTER BLENDER APPARATUS

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6 Claims. (Cl. 259—57)

This invention relates to an improved apparatus for blending or mixing materials.

Mixing or blending of various materials is an important step in chemical and/or other processes and often is especially difficult with dry particulate materials where uniform composition is essential in the blended product. It is necessary for economy as well as uniformity of the blended mixture, to have an efficient apparatus to perform the mixing or blending operation.

Numerous mixers and blenders have been used and attempts have been made to improve upon known procedures and devices employed in the blending step. However, even in the most modern equipment in some instances considerable time is still required to obtain a uniform blended mixture.

Accordingly, a principal object of this invention is to provide a new and improved apparatus wherein thorough mixing or blending of materials may be readily accomplished.

A further object of this invention is to provide a novel device for mixing or blending heterogeneous systems of particulate materials to provide a uniform mixture.

These and other objects and advantages of this invention will more fully appear from the following description thereof.

The present invention embodies mixing or blending apparatus comprising, in combination, at least two radially-extending cylindrical containers disposed in end-to-end interiorly communicating relationship, each container having at least one sector longitudinal or compartment-defining interior partition disposed longitudinally therein for a major portion of its length, and being simultaneously independently rotatable about its longitudinal axis and said containers also rotatable as a unit about a common axis perpendicular to the longitudinal axes of the containers. It will be appreciated that in use the apparatus generates a dumping of the contents of the cylindrical containers from one into the other while at the same time imparts rotation of the containers in opposite directions thus insuring a repeating splitting-blending action in which the material can not recombine to form the original unevenly mixed charge.

The method of mixing broadly comprises subjecting a container of particulate material to be mixed to a primary motion adapted to permit free falling thereof in the container, while simultaneously subjecting the material to a counter-rotating secondary motion in a plane perpendicular to the plane of the primary motion.

Referring now to the accompanying drawings,

FIGURE 1 is a front elevational view of apparatus of this invention;

FIGURE 2 is a somewhat enlarged view, partially in section, and with parts broken away for clarity, of the drive portion and of the apparatus shown in FIGURE 1;

FIGURE 3 is an elevational sectional view of one of the cylindrical elements of the apparatus of FIGURE 1; and

FIGURE 4 is an end view of the cylindrical element of FIGURE 3 illustrating the compartment-defining interior partitions.

As the drawings illustrate, the apparatus of this invention comprises a blending device including two end-capped cylinders which are adapted to have imparted thereto cir-

cumferential turning motion in opposite directions about their longitudinal axes and simultaneously as a unit about a central axis perpendicular to the longitudinal axes of the cylinders, the cylinders being capable of receiving unmixed particulate materials at the uppermost ends while the cylinders are in a vertical or near-vertical position.

With the unique dual turning motion provided by the apparatus of this invention, it will be appreciated that a splitting of the particulate material into different sectors as well as an intensive blending or mixing is accomplished.

Referring more particularly to the accompanying drawings, there are disclosed two radially-disposed cylinders 10 and 12 which are closed by threadedly engaged end caps 50 and 52. The cylinders 10 and 12 have rigidly fixed thereon at the inner end threaded surrounding sleeves 42 and 43, respectively; these sleeves are secured to the cylinders 10 and 12 by compression rings 40 and 41 threadedly engaged around the outer ends of the sleeves 42 and 43, respectively. The compression rings are retained in position by outwardly extending shoulder 47 formed in the cylinder wall as illustrated in FIGS. 2 and 3.

Beveled gears 14 and 16 are rigidly fixed to sleeves 42 and 43, respectively, by set screws 54 through the sleeves. A stationary conical beveled gear 34 engages gears 14 and 16 and is machined at its center to receive a horizontal drive shaft 29 and permit it to be extended therethrough. Drive shaft 29 is retained and supported via a pillow block or bearing 36 and is covered by cap 38.

Housings 44 and 45 enclose ball bearing assemblies 22 as shown in FIGURE 2. Housings 44 and 45 are secured to a hub 58 by machine screws or bolts 32 and 33, respectively. A center ball bearing assembly 26 is enclosed by a central housing 60 in which the center bearing assembly 26 is rigidly fixed by shoulder 62 of sleeve 42 and the corresponding shoulder of sleeve 43. As shown in FIGURE 2, sleeves 42 and 43 are provided with concentric cut-out sections in the ends thereof to accommodate packing 46, said packing 46 being utilized to insure against a loss of materials during blending.

A horizontal drive shaft 28 extends through a pillow block or bearing 30 and is rigidly fixed to the hub 58 by a set screw 48. Thus, it will be appreciated that turning of the drive shaft 28 rotates the entire assembly about a horizontal axis (as shown in FIGURE 2) while the stationary gear 34 serves simultaneously to rotate the cylinders in opposite directions. The disposition of sector-defining baffle plates is illustrated most clearly in FIGURE 4. As there shown, eight baffle plates 68 are provided within each of the cylinders 10 and 12 and are there rigidly secured to a centrally disposed core or rod 70.

It will be observed that, although dual directional rotation is simultaneously achieved by rotation of the cylinders about their longitudinal axes and about a central axis perpendicular thereto, an additional advantage in a preferred embodiment of the invention is achieved by placing longitudinal compartment-defining partitions or baffles within the cylinders. These baffles have an extremely small clearance between their adjacent ends, e.g., about .003 inch, and thus serve to split the material as rotation proceeds. The combination of the dual rotation and the splitting of the cascading material to be blended generates a high degree of uniformity in a short time. Thus, in a preferred embodiment of this invention, extremely rapid blending of heterogeneous particulate systems is achieved by the provision of baffles within the cylinders 10 and 12. The baffles are advantageously installed within the cylinders at angles originating at a center of 45° angles from each other, subsequently promoting splitting of the materials being mixed while the

device is in motion. The part that the baffle plays in the blending of the materials is very significant, as in the practice of this invention it allows the mixing material to be dropped from one compartment of one cylinder into two compartments of the other cylinder. The loading or unloading of the apparatus of this invention is accomplished by removing, as by unscrewing, the cap of a cylinder in an upward extending vertical position and introducing the materials to be blended; or in the case of discharge, tilting the open-ended cylinder downwardly and pouring out the contents. Alternatively, of course, the apparatus may be unloaded by appropriate valves.

It will be appreciated that the apparatus of this invention can be formed of any desired material, e.g., carbon steel, stainless steel, plastic, or the like.

Motion can be imparted to the mixing cylinders 10 and 12 in various ways. For example, the cylinders 10 and 12 could be made to rotate by means of a system of pulleys or a hand crank. However, a preferred embodiment of the present invention employs an electrical motor (not shown) connected by a drive shaft to a gear-reducing box 64 which is connected through a stub shaft 27 by a coupling 66 to the horizontal shaft 28. Motion, therefore, is imparted through the shafts 27 and 28 to cause the cylinders 10 and 12 to rotate about vertical axes perpendicular to a horizontal axis passing through shafts 27 and 28.

The dual directional rotation of the cylindrical structures of this invention is achieved by imparting rotating motion to horizontal drive stub shaft 28 which causes rotation of hub 58 about a horizontal axis to said shaft 28. Simultaneously, as rotation about said horizontal axis proceeds, motion about the longitudinal axes of the cylinders, i.e., axes perpendicular to said horizontal axis, is imparted to the cylinders 10 and 12. By imparting motion to hub 58, each of the cylinders 10 and 12 is caused to rotate about an axis perpendicular to the horizontal axis passing through shaft 28.

It will be observed that bearing 26 is rigidly fixed in position when the device is at rest or in operation by the shoulder 62 of sleeve 44 with the same condition applying to the shoulder of sleeve 43, not illustrated in FIG. 2. Bearing housing 44 and its counterpart 45 are fixed to hub 58 by bolt 32, and its counterpart 33, respectively.

From the foregoing description, it will be appreciated that this invention embodies apparatus which can be directed to operate in multi-directional planes. Certain advantages are inherent to a multi-directional operating unit which are not normally obtained employing standard blending devices. The baffling construction of the device, as illustrated in FIG. 4 of the accompanying drawings, allows the device to operate not only as a conventional rotating mixing device, but also provides means whereby the materials desired to be blended are split during the rotation of cylinder structures 10 and 12, thereby enhancing free movement of the cylinders 10 and 12 via bearing 26. Damage to said bearing, which otherwise conceivably might result from contamination by the material being blended, is almost entirely eliminated by the positioning of packing 46.

The technique generally employed in determining the intimacy of a mixture obtained by the practice of this invention, is to add to one mixing cylinder glass beads of a predetermined size, and a known quantity of tracer beads which are coated with a water-soluble dye. The tracer beads are not premixed with the other beads already in the cylinder, but are introduced en masse at the uppermost point of the loaded cylinder when the cylindrical structures of the blender are in a vertical position. After counted numbers of revolutions, 5-gram samples are removed from the blender. Removal of the sample from the blender is effected at the opposite end from which the water-soluble tracer beads are initially introduced. This procedure is representative of a very difficult mixing operation. Upon removal, said samples are sprinkled on

a sheet of water-moistened standard laboratory filter paper; the paper is subsequently dried. The beads are then brushed from the paper and the colored spots on the filter paper, resulting from absorption of the dye from the tracer particles, are counted. It is determined statistically from the number of latitudinal revolutions of the cylinders when adequate mixing is achieved. For a thorough discussion reciting a method of establishing the intimacy of mix, reference is made to S. Eisenberg, L. C. Thompson and J. Leichter; *Cereal Science Today*, 7 (4) 106-110 (1962).

In the following examples, the efficiency of mixing operations utilizing the apparatus of this invention is illustrated.

Example 1

A blender, as shown in FIGURES 1-4, and having an internal capacity of 7800.55 cc., is charged to 49.4 percent of capacity with 5,580 grams of glass beads, which have a density of 1.45 gm./cc., and 0.2519 gram of tracer beads, which consist of a water-soluble silica-containing material coated with a water-soluble dye. The concentration of tracer beads is equal to a quantity of about 45 parts per million, based on the initial glass bead charge, assuming theoretical intimacy of mix could be achieved. The following table illustrates the results of sampling the mix after the indicated numbers of revolutions. The following data is obtained by holding the rate of rotation around the horizontal axis at 17.25 r.p.m.

Sample No.	Revolutions	Absorbed dye spot count	Average
1	17	13, 11, 15, 7	11.5
2	69	26, 17, 20, 18	20.25
3	108	18, 19, 27, 32	24.00
4	138	22, 40, 27, 21	27.5
5	172	35, 39, 37, 36	36.75
6	207	29, 38, 31, 48	36.5
7	241	33, 34, 26, 38	32.75
8	310	41, 35, 26, 35	34.25

EXAMPLE 2

The same procedure, using the same quantities of materials as in Example 1, is repeated and the following data are obtained:

Sample No.	Revolutions	Absorbed dye spot count	Average
1	17	22, 23, 22, 26	23.25
2	69	27, 35, 28, 34	31.0
3	108	39, 38, 39, 43	39.75
4	138	33, 39, 38, 29	34.75
5	172	26, 30, 34, 35	31.25
6	207	37, 46, 51, 41	43.75
7	241	41, 46, 42, 38	41.75
8	310	29, 43, 34, 45	37.75

In the above Examples 1 and 2, it is readily observed that four samples are taken at each arbitrarily predetermined interval of revolution. Sampling consists of stopping the blender, discharging four samples containing 5 grams of the glass beads, tracer bead blend, placing said bead blend on a sheet of standard laboratory filter paper, washing the bead blend with water and counting the number of dye spots on the paper. An average of the four 5-gram samples is found for the numbers of spots absorbed on the filter paper and is so indicated in the column titled "Average."

In Example 2, in order to establish that intimacy of mixing is achieved, it is concluded that the average spot count in an example should not vary from 33.2 by more than 5.8. Statistically, this would satisfy reasonable upper and lower limits and result in 95 percent confidence. The number 5.8 is calculated by finding the average of those numbers recorded under the column titled "Average" in Samples 4 through 8 and obtaining the square

root of said average as illustrated in the following calculation:

$$X\sqrt{\frac{199.25}{6}} = \sqrt{33.2}$$

$$X = 5.8$$

All numbers under the column titled "Average," that fall within the range of 33.2 ± 5.8 , may be considered in light of the above to indicate that end, and it is therefore concluded that intimacy of mixing is achieved in Sample 5 after 172 revolutions. The same procedure can be applied to obtaining the calculated values of Example 2.

The foregoing examples illustrate the effectiveness of the apparatus of this invention in blending two dissimilar particulate materials. Obviously, the utilization of the device permits obtaining highly uniform mixtures in relatively short periods of time.

It is to be understood that although the invention has been described with specific reference to particular embodiments thereof, it is not to be so limited since changes and alterations therein may be made which are within the full intended scope of this invention as defined by the appended claims.

What is claimed is:

1. Mixing apparatus comprising, in combination, at least two containers in end-to-end interiorly communicating relationship, and being simultaneously rotatable about their longitudinal axes and also rotatable as a unit about a common axis.

2. Mixing apparatus comprising, in combination, at least two containers in end-to-end interiorly communicating relationship, each container having at least one longitudinal compartment-defining interior baffle disposed longitudinally therein for a major portion of its length, said container being simultaneously independently rotatable about its longitudinal axis and also rotatable as a unit about a common axis perpendicular to the longitudinal axis of the containers.

3. Mixing apparatus comprising, in combination, two cylinders in end-to-end interiorly communicating relationship, each container containing a plurality of interior partitions disposed longitudinally therein for a major portion of its length, the cylinders being simultaneously independently rotatable, in opposite directions, about their respective longitudinal axes and also rotatable as a unit

about an axis perpendicular to the aforesaid longitudinal axes of the containers.

4. Mixing apparatus comprising, in combination, cylindrical end-capped containers disposed in end-to-end interiorly communicating relationship along a common longitudinal axis, each container having at least one longitudinal compartment-defining interior partition disposed longitudinally therein for a major portion of its length, and each container being simultaneously rotatable about its longitudinal axis and also the two containers being rotatable as a unit about a common axis perpendicular to the longitudinal axis of the containers.

5. A splitter-blender comprising, in combination, drive means, at least two interiorly longitudinally baffled containers disposed in end-to-end interiorly communicating relationship, each container having gear means thereon operatively engaging a common stationary gear whereby motion of the said drive means imparts a rotation of the gear means about the axis of the drive means and a simultaneous turning of the containers in opposite directions via engagement of the said turning gear means in said stationary gear.

6. A splitter-blender apparatus comprising, in combination, at least two radially-extending containers joined in end-to-end interiorly communicating relationship along a common longitudinal axis, each of said containers having therein a plurality of equi-spaced interior partitions disposed longitudinally for substantially the entire length of the container and substantially abutting relationship, and said containers being simultaneously rotatable in opposite directions about their longitudinal axes and also as a unit about an axis disposed between said containers and perpendicular to the longitudinal axis of the containers.

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