Dec. 26, 1944. M. F. MORGAN 2,365,897

VIBRATING MILL

Filed Sept. 11, 1943 2 Sheets-Sheet 1

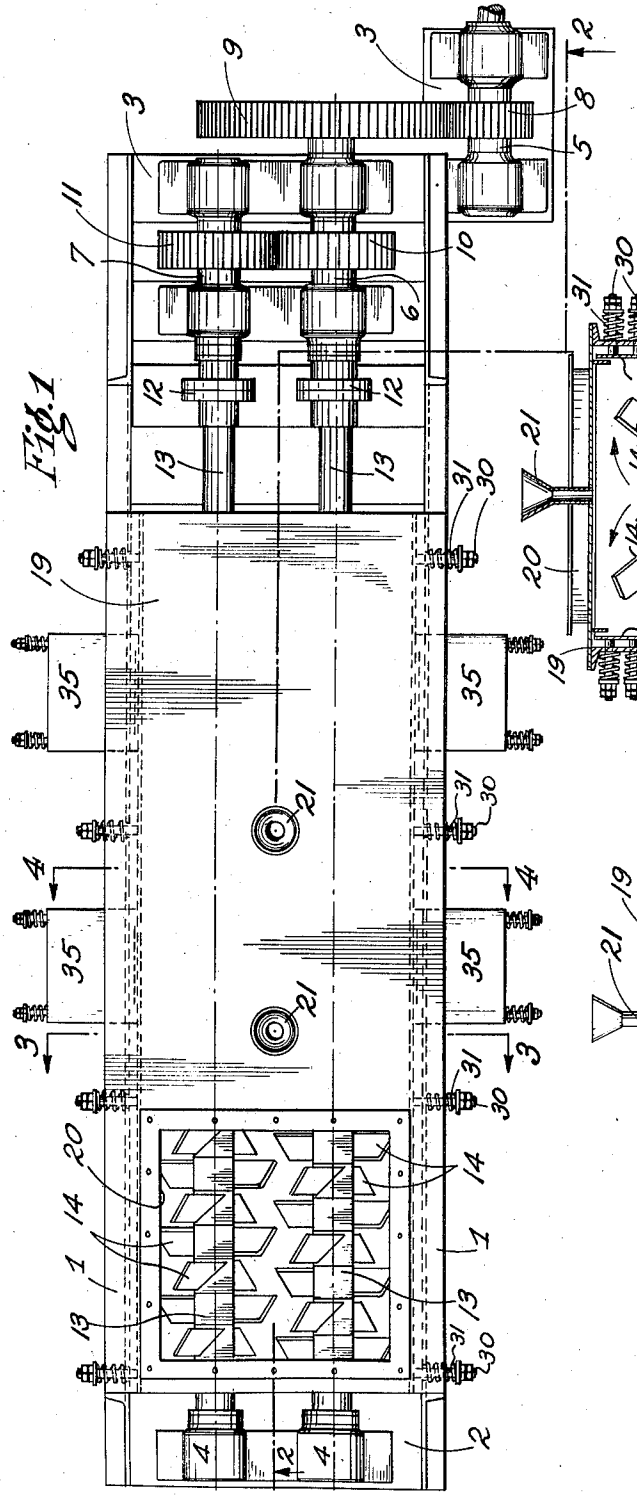


Fig. 1

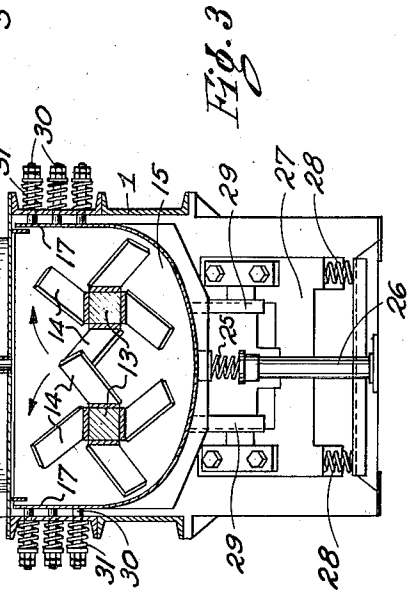


Fig. 3

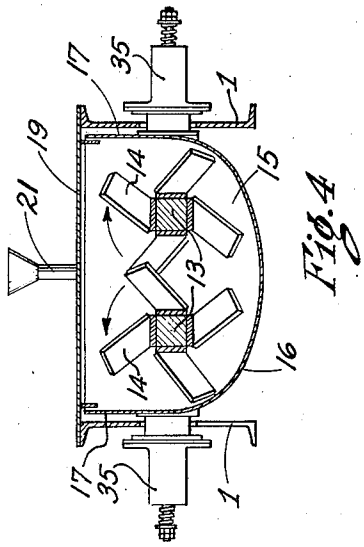


Fig. 4

INVENTOR.
MILTON F. MORGAN

BY

Richey & Watts

ATTORNEYS

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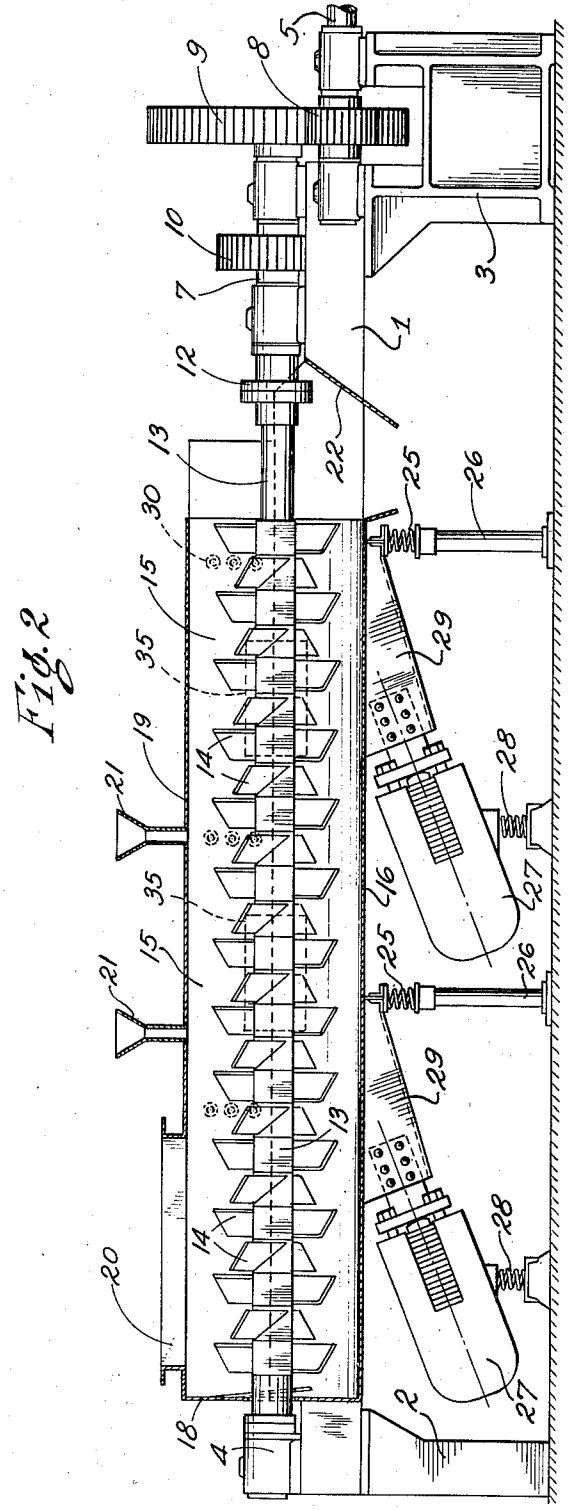


Fig. 2

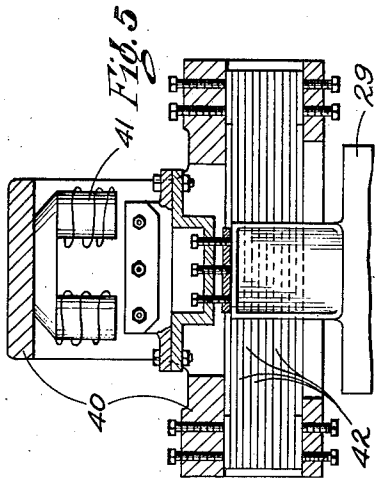


Fig. 5

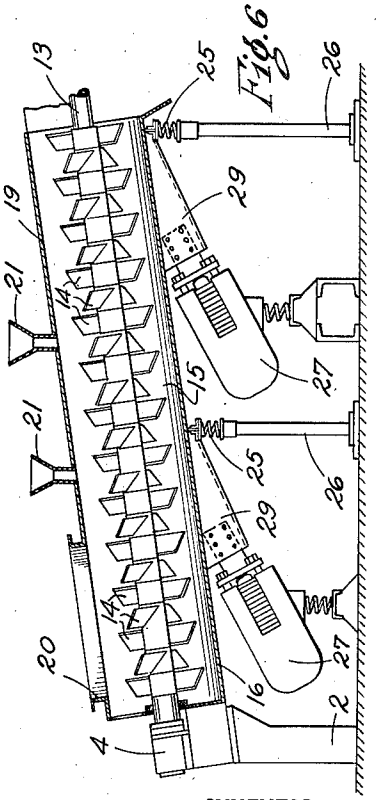


Fig. 6

INVENTOR.
MILTON F. MORGAN
BY
Richey & Watts
ATTORNEYS

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UNITED STATES PATENT OFFICE

2,365,897

VIBRATING MILL

Milton F. Morgan, Shaker Heights, Ohio

Application September 11, 1943, Serial No. 502,054

6 Claims. (Cl. 259—93)

This invention relates generally to the art of handling materials, and particularly to new and improved apparatus for mixing or separating solids, or mixing solids with liquid or separating solids in the presence of a liquid.

The prior mixing machines of the type known as "pug mills," wherein solids were mixed with water, or moist solids were mixed, consumed large quantities of power when the mixing blades were new and the power required increased considerably as the blades wore away. Such wear was rapid and necessitated frequent replacement of the worn blades. Also the efficiency of the mixer decreased rapidly as the blades wore down.

By the present invention I am able to avoid the previous rapid rate of wear of mixing blades and thereby to prolong the length of life of such blades and decrease their maintenance costs, to mix the same or similar materials with much less consumption of power than has been required heretofore, and to maintain the efficiency of the mixer at a much higher standard than has been done heretofore. I am also able to mix dry materials with high efficiency.

The prior "log washers," that is, machines generally resembling "pug mills" but used to separate two solids in the presence of a liquid, had shafts with long blades and a long trough. The present invention makes it possible to provide a machine which is much smaller than, and yet has as great a capacity as, the prior art washers.

This invention is predicated on the discovery that when the trough of a mixing machine is reciprocated endwise in short, quick strokes, materials therein may be mixed and moved therealong with exceptionally little wear on the mixing means and with a surprisingly low consumption of power and with high efficiency. It is also predicated on the discovery that the separation of solids may be increased to an unexpected extent by combining agitation of the materials and the reciprocation of the trough.

In the drawings accompanying and forming a part of this specification,

Figure 1 is a top plan view of one form of apparatus embodying the present invention;

Figure 2 is a vertical view taken on line 2—2 of Fig. 1;

Figures 3 and 4 are transverse sectional views taken on lines 3—3 and 4—4 of Fig. 1;

Figure 5 shows diagrammatically a vibrator of Figs. 1 and 2; and,

Figure 6 shows a modified apparatus embodying the present invention for separating soluble and insoluble materials.

The mixer shown in the figures includes a frame consisting of side members 1 supported at their ends on pedestals 2 and 3. Pedestal 2 is provided with bearings 4 for mixing shafts about to be described. Pedestal 3 supports shafts 5, 6 and 7 in suitable bearings. Gears 8 and 9 on shafts 5 and 6 serve to transmit rotary motion from shaft 5 to shaft 6, and meshing gears 10 and 11 on shafts 6 and 7 respectively transmit motion from shaft 6 to shaft 7. Shafts 6 and 7 are connected by couplings 12 to mixing shafts 13 whose opposite ends are rotatably mounted in bearings 4 on pedestal 5. These shafts 13 carry a plurality of mixing blades 14 within the mixing trough 15.

The mixing trough is elongated, has a curved bottom 16, substantially parallel sides 17, and may be closed at one end 18. It is preferably provided with a top 19 having an inlet opening 20. One or more inlets 21 may be provided in top 19 for entry of liquid. At its discharge end trough 15 is preferably open and is provided with a hopper 22 to receive and direct mixed material discharged from the trough.

The trough 15 is supported partly on springs 25 which engage the bottom wall of the trough and which rest on posts 26. These springs permit a limited amount of movement of the trough in directions transverse to and lengthwise of the shafts 13 and also a limited amount of movement at acute angles to the shafts.

Beneath the trough 15 vibrators 27 are mounted on springs 28 and are attached to the bottom wall of the trough by connections 29. Any suitable vibrator may be employed which is capable of reciprocating the trough 15 in short, quick strokes. It will be understood that while the vibrators 27 are shown as making an acute angle of about 15° with the bottom of the trough 15, this angle may be considerably increased or decreased, as desired, to obtain the desired or preferred amount and direction of reciprocating movement of the trough. Such angularity may also be varied depending on the speed with which it is desirable to move the materials along the trough and also depending on the nature of the materials in the trough, especially the extent or nature of the adherence of those materials to the surfaces of the trough.

The sides 17 of trough 15 are positioned relative to the side members 1 preferably by attaching rods 30 to the outer sides of walls 17 and extending the rods thru enlarged holes in members 1 and mounting springs 21 on the rods to press against the outer sides of members 1. In this manner lateral movement of walls 17, as well

as longitudinal movement of trough 15, may take place relative to side members 1.

When it is desirable that the sides 17 of the trough 15 be vibrated, as for example to break the adherence between the walls of the trough and materials in the trough, additional vibrators 35 may be attached to one or both sides 17. These vibrators may be of any suitable construction so long as they are capable of rapidly reciprocating the sides 17 in short strokes.

Fig. 5 shows diagrammatically a vibrator which is suitable for use in carrying out the present invention. This vibrator comprises a housing 40 which is attached to the trough by connections 29 and carries a magnet 41. Within the housing 40 a plurality of resilient bars of magnetic material 42 are connected together at their ends and to the housing with their middle portions adjacent to the magnet. Space is provided in which the middle portions of these bars may flex without contacting with the housing or the magnet. When the magnet is energized with pulsating current, the bars are alternately flexed toward the magnet and then flex in the opposite direction with a rapidity comparable to that of the fluctuation in the current and with the result that the casing is vibrated, as well as whatever is attached thereto. When the vibrator is mounted on springs, as shown in Figs. 2 and 3, it may reciprocate with the trough.

The general operation of the above described apparatus will be understood from the foregoing description by those skilled in the art, but when that apparatus is employed to mix moist clay or similar material with additional liquid, it may be operated substantially as follows:

When power is applied to shaft 5 and the shafts 13 are rotating, and the vibrators 27 and 35 are energized, the moist clay is introduced into trough 15 thru opening 20. The oppositely moving blades 14 on the rotating shafts 13 cut and mix the moist clay and propel it toward the discharge end of the trough. Simultaneously, the trough is rapidly reciprocated on a line making a small acute angle with the center line of the shafts, such reciprocation also serving to advance the mixture toward the discharge end of the trough. The desired amount of additional liquid is introduced into the moist clay thru one or more of the pipes 21 and is promptly and thoroughly mixed with the clay. When vibrators 35 are energized the side walls 17 of the trough are also vibrated and the mixture is prevented from adhering to those walls.

The conjoint rotation of the mixing shafts and reciprocation of the trough results in unexpected and unpredictably low consumption of power as compared with prior mixing devices operating on the same materials and unexpected, unpredictable and greatly extended lengths of life of the mixing blades. When the side vibrators 35 are employed these advantages are increased somewhat.

It will be understood that this invention is not limited to the use of two mixing shafts but that, on the contrary, it may take various cross-sectional shapes depending on the number of mixing shafts employed with it. It will further be understood that one or more springs 25 may be replaced by two or more springs, depending upon such things as the size of the trough and the weight of material to be mixed therein. It will also be understood that the trough and shafts need not be substantially horizontal, as herein illustrated, but that they may be inclined to the horizontal and that the discharge end may be either higher or lower than the other end.

It will also be understood that dry solids may be mixed by the above described apparatus.

In Fig. 6 the apparatus of Figs. 1 to 4 has been modified slightly to adapt it to the separation of mixed solids in the presence of a liquid. The apparatus of Fig. 6 is like that of Fig. 2 except that the trough and shafts are inclined at a small angle to the horizontal and the lower end of the trough is partly closed by an end wall whose upper edge is preferably slightly below a horizontal plane passing thru the bottom wall of the trough at its higher end. When a mixture of solids, for example iron ore and clay, is charged into the trough and sufficient water is maintained in the trough to overflow the lower end wall, the blades on the shafts will break up the clay, dissolving parts of it, and the dissolved and floating clay particles will be carried out with the overflowing water. The iron ore thus freed from the contaminating clay will travel toward the upper end of the trough and will be discharged at that end more or less free from the clay.

Having thus described the invention so that others skilled in the art may be able to understand and practice the same, I state that what I desire to secure by Letters Patent is defined in what is claimed.

What is claimed is:

1. A machine of the class described comprising an elongated trough, a rotatable shaft therein and extending lengthwise thereof, blades on said shaft, yieldable means for maintaining the trough in operative position relative to the shaft and permitting limited, angular movement of the trough relative to the shaft, and means for reciprocating the trough endwise and angularly relative to the shaft within the limits permitted by said supporting means.

2. A machine of the class described comprising a frame, an elongated trough supported within said frame for limited endwise and angular movement relative thereto, a rotatable shaft in and extending lengthwise of said trough, blades on said shaft, and means for reciprocating the trough endwise and angularly relative to said frame and shaft in short rapid strokes.

3. A machine of the class described comprising an elongated trough, a rotatable shaft therein and extending lengthwise thereof, blades on said shaft, a frame support for said trough, spring means associated with the frame and trough for permitting limited, angular endwise movement of the trough relative to the frame and shaft, and means for reciprocating the trough endwise of and angularly relative to said frame and shaft.

4. A machine of the class described comprising an elongated trough, a rotatable shaft therein and extending lengthwise thereof, blades on said shaft, a frame support for said trough, spring means associated with the frame and trough for permitting limited, angular movement of the trough endwise relative to the frame, and a vibrator attached to the trough at an acute angle thereto for vibratingly reciprocating the trough endwise and angularly relative to said frame and shaft.

5. A machine of the class described comprising a frame, an elongated trough in said frame and comprising a bottom wall and side walls, a rotatable shaft in and extending lengthwise of said trough, blades on said shaft, spring means resiliently supporting the bottom wall of said trough and permitting limited endwise and angular

movement of the trough, vibrating means connected to the trough for vibratingly reciprocating the trough endwise and angularly relative to said frame and shaft, and means for positioning the sides of the trough relative to the adjacent parts of said frame and for permitting limited endwise movement of the trough relative to said frame when the trough is being reciprocated endwise.

6. A machine of the class described comprising a frame, an elongated trough in said frame and comprising a bottom wall and side walls, a rotatable shaft in and extending lengthwise of said trough, blades on said shaft, spring means resiliently supporting the bottom wall of said trough and permitting limited endwise and angular movement of the trough, vibrating means connected to the trough for reciprocating the trough endwise and angularly relative to the shaft and frame, means for positioning the sides of the trough relative to the adjacent parts of said frame for limited lateral movement of the sides of the trough relative to said shaft and frame, and vibrating means connected to a side wall of the trough for vibratingly reciprocating the side wall in short rapid strokes laterally relative to said frame and shaft.

MILTON F. MORGAN.