Oct. 23, 1951 E. M. SKIPPER 2,572,063

PUG MILL

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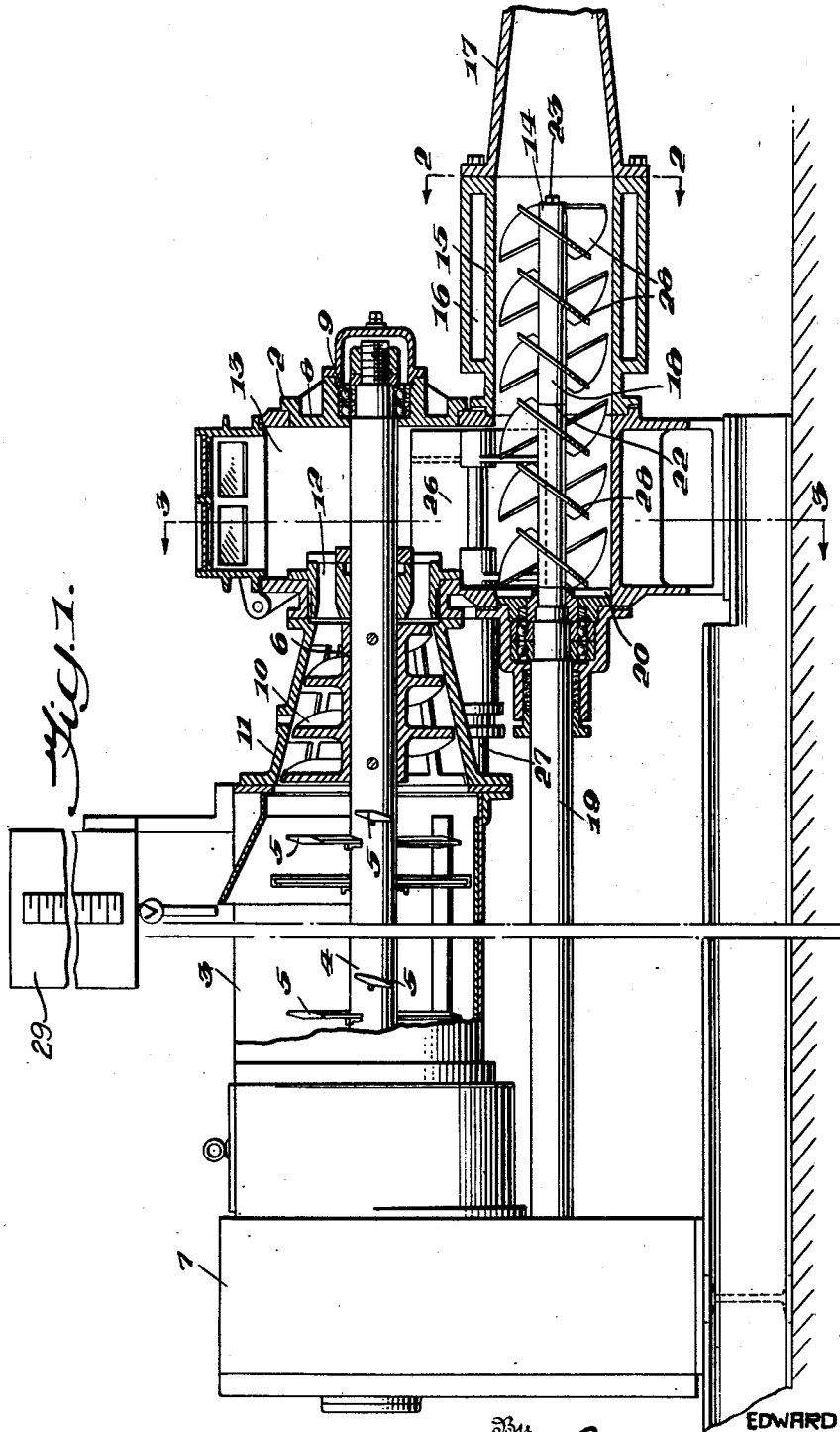

Fig. 1.

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Fig. 3.

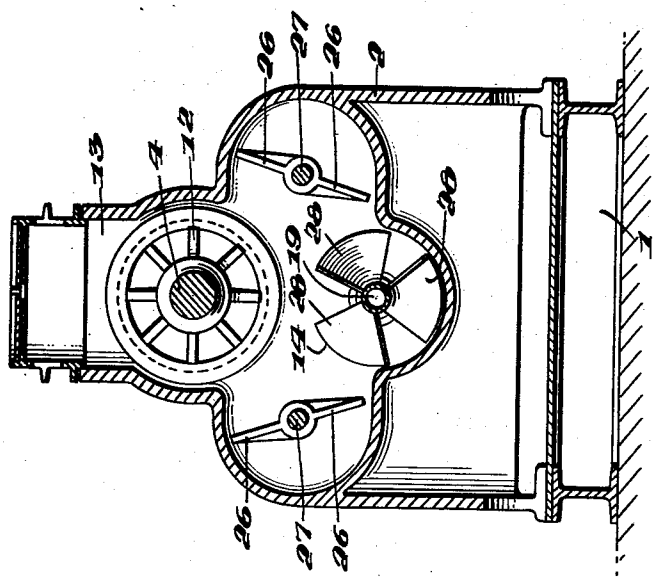

Fig. 2.

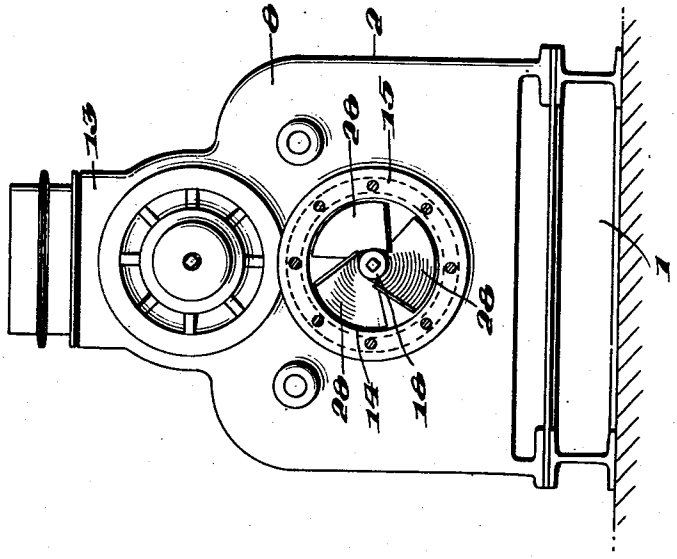

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Fig. 4.

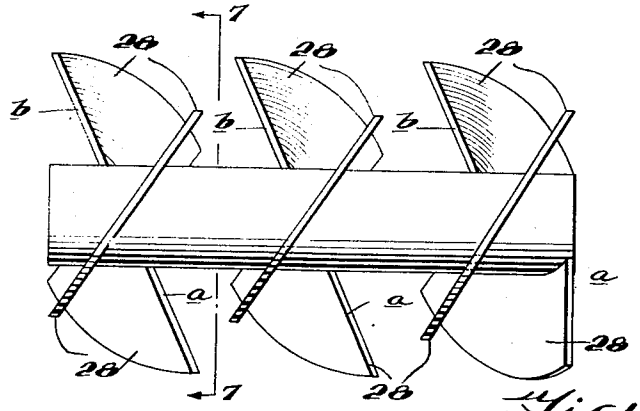


Fig. 5.

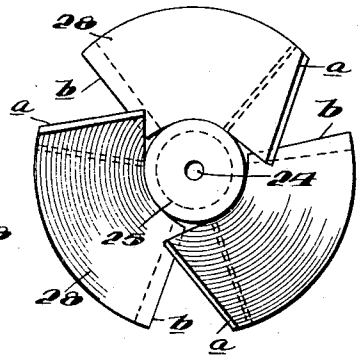


Fig. 6.

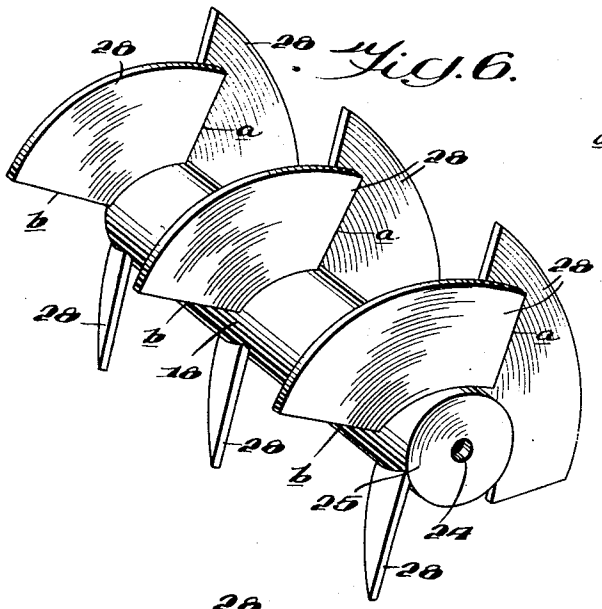
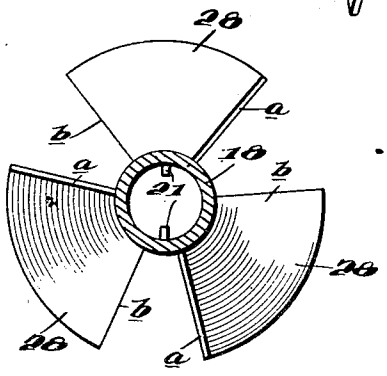


Fig. 7.



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Patented Oct. 23, 1951

2,572,063

UNITED STATES PATENT OFFICE

2,572,063

PUGMILL

Edward M. Skipper, Baltimore, Md., assignor to General Electric Company, a corporation of New York

Application June 6, 1947, Serial No. 753,021

4 Claims. (Cl. 25—14)

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This invention relates to a pug mill and is a continuation-in-part of my co-pending applications, Serial No. 499,676, filed August 23, 1943, now abandoned, and Serial No. 708,455, filed November 7, 1946, now abandoned.

As stated in the aforementioned applications, manufacturers of ceramic materials and particularly of porcelain insulators, have long been confronted with large loss factors in the forming and firing of ceramic bodies. These losses I have discovered to be attributable to the manner in which the clay is mixed and extruded, usually in a pug mill. I have found the principal sources of loss to be the lack of homogeneity and the existence of lines of force in the clay as extruded from the mill, for both of which I described solutions at length in my co-pending applications.

The pug mills heretofore employed for mixing ceramic materials have been of two general types. In one the mill has but a single chamber for both mixing and extruding the material. In the other these functions are performed in separate chambers, this type being the one most generally used in the insulator industry. However, in both cases the mixing and extruding augers have either been mounted on the same shaft or driven through gearing at fixed relative speeds. As a result, a given pug mill has been capable of handling only relatively small variations in the consistency or moisture content of the starting material. Accordingly, it has been customary to adapt one mill for use with so-called "soft" pugs and to use a separate machine for "hard" pugs. I have now found that by making provision for both individual and relative variations in the speeds at which the several augers and paddles are driven, in conjunction with my aforementioned discoveries, a single pug mill can be used to pug starting materials of a wide range of consistencies.

The primary object of the invention is to provide an improved apparatus for producing homogeneous stress-free ceramic mixtures from starting materials of a wide range of consistencies.

Another object of the invention is to provide an improved apparatus for pugging ceramic materials having means for varying the individual and relative speeds of the mixing and extruding augers and means within the vacuum chamber whereby a homogeneous pug is obtained from starting materials of different consistencies.

An additional object of the invention is to provide an improved pug mill having means for controlling the moisture and air content and eliminating lines of force in starting materials of different consistencies whereby the resulting pug is homogeneous in density and moisture content and free from stresses.

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Other objects and advantages of the invention will appear hereinafter in the detailed description and be particularly pointed out in the appended claims. In the drawings illustrating a preferred embodiment of the apparatus of this invention:

Figure 1 is a longitudinal sectional view of a pug mill embodying my invention.

Figure 2 is a view partly in end elevation and partly in section taken on line 2—2 of Figure 1.

Figure 3 is a vertical sectional view taken on line 3—3 of Figure 1.

Figure 4 is a side elevational view of the outer end portion of the extruding auger.

Figure 5 is an end elevational view of the extruding auger.

Figure 6 is a perspective view of the outer end portion of that auger.

Figure 7 is a sectional view taken on line 7—7 of Figure 4.

Referring now in detail to the drawings in which like reference characters designate like parts, 1 indicates a suitable base on which the pug mill, designated generally as 2, is mounted.

The mixing portion of the pug mill comprises a hopper 3 into which the clay or other ceramic material to be worked or pugged is dumped. Extending longitudinally through the hopper is a mixing shaft 4 carrying, within the hopper, a plurality of substantially radial arms or blades 5 for mixing and mascerating the clay introduced into the hopper and feeding it forward to an upper auger 6 also attached to the shaft 4.

The inner end of the shaft is mounted within a casing or the like 7 housing suitable gearing (not shown) driven by a variable speed motor of the usual type (not shown) for imparting rotation to the shaft over any desired range of speeds. The shaft preferably extends continuously to the front wall 8 of the machine and is rotatably supported at its front end by a suitable bearing 9 mounted in the wall.

The upper or mixing auger 6 is pinned or otherwise secured to the shaft 4. This auger has a single continuously extending helical vane or blade 10, the diameter of which progressively decreases toward its forward end. The forepart of the mixing chamber in which the auger is housed is formed as a tubular casing or housing 11 of frusto-conical configuration which progressively decreases in diameter toward its forward end in the same degree as the helical blade 10.

Mounted on the shaft 4 in advance of the auger 6 is a rotatable member 12 for shredding or slicing the clay. On passing through this member the clay enters a chamber 13 which is air-sealed by suitable gaskets, except at inlet and outlet, and in which substantially all of the air entrapped within the clay is removed or exhausted by the application of a vacuum. Since no mechanical means are provided for sealing the inlet and outlet of the vacuum chamber, a sufficient quantity of clay must be maintained in the pug mill to effectively seal both openings and thus prevent air from being drawn into the chamber when suction is applied.

From the vacuum the clay is fed into the extrusion device or outlet portion of the pug mill. Forming a part of this device is a lower or extruding auger 14 which extrudes the clay from the mill and the inner end of which is arranged within the lower portion of the vacuum chamber in substantially vertical alignment with the shaft 4. The forward end of this auger is housed within a cylindrical casing or extrusion chamber 15 which is preferably provided with a water-cooled jacket 16. Bolted or otherwise secured to the forward end of the casing is a nozzle or die 17 of truncated cone-shape through which the clay is discharged from the mill.

The extruding auger 14 is formed with a shaft or hub portion 18 which is removably splined or otherwise keyed to an aligned with a drive shaft 19, as by inwardly projecting ribs 21. At its forward end the shaft 19 is rotatably journaled in the rear wall 20 of the vacuum chamber through suitable bearings. The rear end of the shaft 19 extends into and is journaled within the casing 7. As in the case of the shaft 4, the shaft 19 is adapted to be driven through suitable gearing (not shown) by a variable speed motor of the usual type (not shown), separate motors being provided for the two shafts to enable their relative speeds to be varied at will. Keyed to the shafts 4 and 19, respectively, the mixing and extruding augers are thus enabled to be driven at varying relative speeds within the ranges of their associated motors.

As indicated at 22, the auger 18 may advantageously be made in sections. So constructed, the sections may be restrained from longitudinal movement relative to the shaft by the provision of a bolt 23 which extends through an aperture 24 in the outer end wall 25 of the auger and is screw-threaded into the end of the shaft 19.

The shredded clay forced into the vacuum chamber 13 by the upper auger 6 is driven down toward the lower auger 14 by a pair of laterally spaced paddles or the like 26. These paddles may be mounted on the forward ends of the shafts 27, the rear ends of which extend into the casing 7 and are there connected to a suitable source of power (not shown) through which the desired rotation is transmitted to the paddles. The paddles are preferably connected through suitable gearing (not shown) to a single source of power, the latter desirably being a variable speed motor of the usual type (not shown) to enable the speed of the paddles relative to the mixing and extrusion augers to be controlled at will.

As described in my aforementioned co-pending application, Serial No. 499,676, the extruding auger is provided with a plurality of spaced sets of flat blades 28, the radii of rotation of which are substantially equal to the inner radius of the extrusion chamber 15. Each of the blades lies normally to the axis of the shaft 18 of the auger

and within each set the blades are diagonally or obliquely disposed such that each lies in a plane intersecting the other blades of the set. Additionally, the blades of each set are positioned to interrupt the flights of the blades of the next preceding set. In each set, with the exception of the outermost set, the trailing edge *a* of each blade is spaced laterally from and in advance of the leading edge *b* of the next adjacent blade of its set. In the outermost set the trailing and leading edges, *a* and *b*, respectively, of the adjacent blades overlap in part.

Utilizing an extruding auger of the above construction, the clay extruded from the pug mill is driven at a substantially uniform speed throughout the free area of the extrusion chamber. At the same time any lines of force or cleavage set up in the clay by the flights of the blades of each set are cut or interrupted by the blades of the next succeeding set such that the clay, as extruded, is in substantially stress-free condition. By enlarged the leading and trailing edges of the blades of the outermost set the clay is prevented from backing up into the extrusion chamber.

As previously mentioned, the apparatus of the present invention is designed to handle ceramic materials or clays of different consistencies and is particularly adapted to handle clays in which the moisture content is controlled. Accordingly, instead of utilizing the usual filter cake as the starting material, there is preferably employed the controlled moisture content mixture of my aforementioned co-pending application, Serial No. 708,455. As therein described, the starting material is a "bone-dry" ceramic mixture. As preferred, water may be added to this mixture either immediately preceding or as the mixture is introduced into the hopper 3, in the latter case by such means as a dispenser indicated at 29 in Figure 1. In either case a measured quantity of water relative to the weight of the clay is added, the exact quantity depending on the consistency desired in the clay as extruded from the mill. The ceramic materials and added water are then thoroughly mixed by both the paddles 5 and the mixing auger blade 10 into a mass of homogeneous moisture content which, after shredding by the member 12, is fed into the vacuum chamber 13. Utilizing the variable speed motor, previously described, the speed at which the materials are mixed and fed forward by the mixing auger 10 will be controlled depending upon the amount present and its consistency. After entering the vacuum chamber the ceramic mixture or clay is freed of its entrapped air and driven downwardly by the paddles 26 at the speed required to keep the mouth or entrance of the extrusion chamber filled and the vacuum chamber sealed against the entrance of outside air, the paddles also serving to agitate the clay and expose a maximum of its surface to the vacuum. Thereafter, the clay is driven through the extrusion chamber and extruded from the mill by the extruding auger 14, the speed of the latter being controlled relative to that of the mixing auger 6 and the paddles 26, to ensure both the desired density and homogeneity of the extruded mass.

By controlling the moisture content of the clay, eliminating any entrapped air, utilizing an extruding auger which prevents the building up of stresses by reason of lines of force, and driving the clay through the different sections of the mill at varying speeds determined by its quantity and consistency, it is possible to obtain from start-

ing materials of different consistencies an extruded mass or pug which is both stress-free and homogeneous. Thereby, the use of different mills as well as the high percentage of losses, under present practice in the subsequent drying and firing stages as the result of non-control of these factors, are practically eliminated.

It will be apparent from the above detailed description that there has been provided an improved apparatus for mixing clay which, while particularly suited for the production of ceramic insulators, is of wide application in clay mixing. It should be understood that the described and disclosed apparatus is merely exemplary of the invention and that all modifications are intended to be included which do not depart either from the spirit of the invention or the scope of the appended claims.

I claim:

1. A pug mill adapted to handle ceramic materials of different moisture consistency whereby so-called "soft" pugs and "hard" pugs can be obtained from the same pug mill, said pug mill comprising a mixing chamber, a vacuum chamber, and an extrusion chamber, said respective chambers being connected in serial relation whereby material fed into said mixing chamber will be discharged from said extrusion chamber, a mixing auger positioned in said mixing chamber, means positioned in said vacuum chamber for impelling material therefrom into said extrusion chamber, an extrusion auger positioned in said extrusion chamber, and a variable speed drive means connected to each of said augers and the impelling means, there being an independent drive means for each of said augers and the impelling means whereby any one of said augers or the impelling means may be driven at a predetermined rate of speed as desired, the relative rates of speed of said auger drives and the impelling means drive being determined in accordance with the consistency of the ceramic materials fed into said mixing chamber to permit discharge of said materials from said extrusion chamber without breaking the vacuum in the vacuum chamber.

2. A pug mill adapted to handle ceramic materials of different moisture consistency whereby so-called "soft" pugs and "hard" pugs can be obtained from the same pug mill, said pug mill comprising a mixing chamber, a vacuum chamber, and an extrusion chamber, said respective chambers being connected in serial relation whereby material fed into said mixing chamber will be discharged from said extrusion chamber, a mixing auger positioned in said mixing chamber, an extrusion auger positioned in said extrusion chamber, a paddle positioned in said vacuum chamber for impelling material from said vacuum chamber into said extrusion chamber, and a variable speed drive means connected to each of said augers and the paddle, there being an independent drive means for each of said augers and the paddle whereby said augers and paddle may be driven at independent rates of speed, said rates of speed being determined in accordance with the consistency of the material fed into the mixing chamber to permit discharge of said material from the extrusion chamber without breaking the vacuum in the vacuum chamber.

3. A pug mill adapted to handle ceramic materials of different moisture consistency whereby so-called "soft" pugs and "hard" pugs can be obtained from the same pug mill, said pug mill

comprising a mixing chamber having a discharge opening, a vacuum chamber having an inlet opening and a discharge opening, and an extrusion chamber having an inlet opening, means connecting said vacuum chamber to said mixing chamber whereby the inlet opening of said vacuum chamber is positioned in registry with the discharge opening of said mixing chamber, means connecting said extrusion chamber to said vacuum chamber whereby the inlet opening of said extrusion chamber is positioned in registry with the discharge opening of said vacuum chamber, means positioned in said mixing chamber to feed material into the inlet opening of said vacuum chamber to keep said opening filled, means positioned in said vacuum chamber to force material therefrom into the inlet opening of said extrusion chamber to keep said opening filled and thus prevent loss of vacuum, and means to feed material through said extrusion chamber, said mixing chamber feed means, vacuum chamber forcing means, and extrusion chamber feed means each having connected thereto an independent variable speed drive means whereby, depending upon the consistency of the material fed into said mixing chamber, the rate of feed of said material through the pug mill can be adjusted so that vacuum is maintained in said vacuum chamber.

4. A pug mill adapted to handle ceramic materials of different moisture consistency whereby so-called "soft" pugs and "hard" pugs can be obtained from the same pug mill, said pug mill comprising an elongated mixing chamber having a discharge opening at one end thereof, a mixing auger positioned axially of said chamber, a shredder connected to said mixing auger and positioned at the discharge opening of said mixing chamber, a vacuum chamber positioned in extension of said mixing chamber, said vacuum chamber having an inlet opening positioned in registry with the discharge opening of said mixing chamber, means connecting said respective openings, said vacuum chamber also having a discharge opening positioned substantially at right angles to the inlet opening of the vacuum chamber and opening downward from the vacuum chamber, a plurality of paddles positioned in said vacuum chamber, said paddles being constructed and arranged to impel material within said vacuum chamber toward the discharge opening thereof, an extrusion chamber having an inlet opening positioned below and in registry with the discharge opening of said vacuum chamber, an extrusion auger positioned in said extrusion chamber and adapted to force material from the inlet opening of said extrusion chamber, and variable speed drive means connected to said paddles whereby said paddles may be driven at a rate of speed sufficient to keep the discharge opening of said vacuum chamber filled and thus prevent loss of vacuum in said vacuum chamber.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,614,526	Lambie et al.	Jan. 18, 1927
1,879,367	Lotz	Sept. 27, 1932
1,987,358	Bonnot	Jan. 8, 1935
1,987,359	Brown	Jan. 8, 1935