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COMBINED MIXING AND GRINDING MILL

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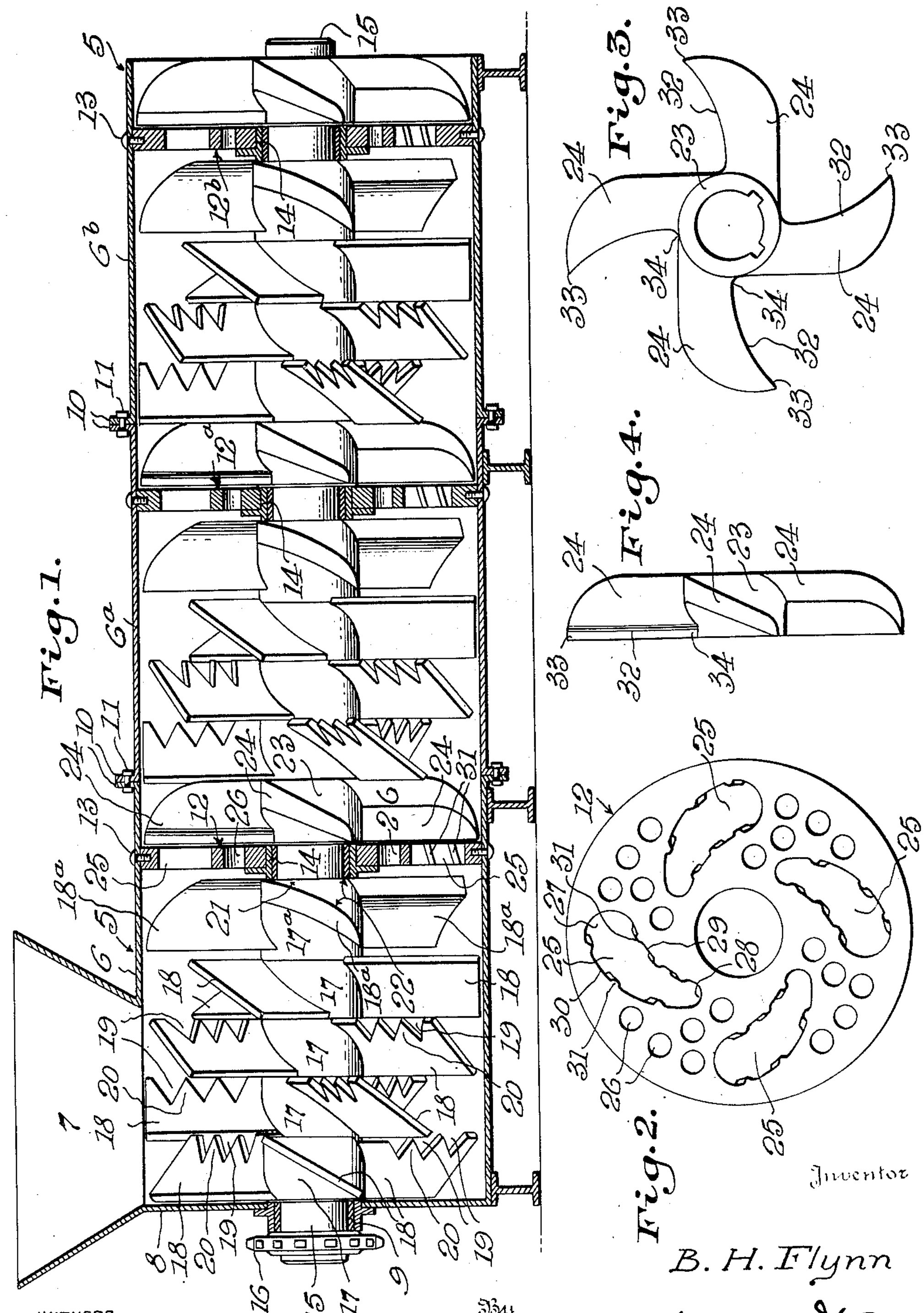


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## COMBINED MIXING AND GRINDING MILL

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7 Claims. (Cl. 83—6)

The invention aims to provide a new and improved combined mixing and grinding mill which will effect a thoroughly homogeneous mixture of any materials passed therethrough, leaving no balls, clods or the like therein, novel provision being made for crushing such balls, clods and the like and for even crushing any stones below predetermined size which may be fed into the mill with other materials being mixed. Not only is the improved mill well adapted for use in the manufacture of vitreous products such as brick and tile, but it finds an important field of use in mixing materials for the construction and/or maintenance of present day roadways.

Figure 1 of the accompanying drawing is a longitudinal sectional view partly in elevation showing a three-stage combined mixing and grinding mill constructed in accordance with the invention.

Figure 2 is a side elevation of one of the stationary cutting disks as viewed from the discharge end of the machine.

Figure 3 is a side elevation of one of the rotary cutters as viewed from the discharge end of the machine.

Figure 4 is an edge view of the cutter shown in Fig. 3.

In the drawing above briefly described, a three-stage mill has been illustrated embodying preferred features of construction but variations may of course be made within the scope of the invention as claimed and the features of novelty may be embodied in a mill having one or more stages.

A horizontally elongated casing 5 is provided, preferably consisting of primary, secondary and tertiary sections 6, $6^a$ and $6^b$, the primary section 6 being formed with an inlet 7 for the materials to be mixed, and also having an end wall 8, said end wall being provided with an appropriate central bearing 9. The three sections may well be flanged at 10 and detachably bolted together as shown at 11, permitting the easy removal of any section or sections not necessary for the particular operation to be performed.

Three stationary cutting disks 12, $12^a$ and $12^b$ are removably secured in the three casing sections 6, $6^a$ and $6^b$, respectively, cap screws 13 being shown passed through the side walls of said sections and into said disks for so mounting them that any disk or disks not needed, may be easily removed. All of the disks 12, $12^a$ and $12^b$ are provided with central bearings 14 axially alined with the bearing 9 of the end wall 8. These bearings receive a shaft 15 which may be driven by any suitable means, a portion of a driving means being shown at 16 in the form of a sprocket. A primary assemblage of elements is provided on the shaft 15 within the primary casing section 6; a secondary assemblage is provided on said shaft within the secondary casing section $6^a$; and a tertiary assemblage is provided on said shaft within the tertiary casing section $6^b$. As all of these assemblages are substantial duplicates in the present disclosure, a description of the primary assemblage will suffice.

Suitably keyed upon the shaft 15 are a number of hubs, most of which are denoted at 17, one, however, being indicated at $17^a$, this hub $17^a$ being disposed at the inner side of the stationary cutting disk 12 while the hubs 17 are between said hub $17^a$ and the casing end wall 8. Each hub 17 carries a series of pitched circumferentially spaced blades or paddles 18 to thoroughly mix the materials and at the same time, feed them toward the stationary cutting disk 12. The paddles 18 of each series are advanced circumferentially to some extent beyond the paddles of the immediately preceding series so that no paddles will be in the way of the materials fed toward the disk 12 by the preceding paddles. If desired, any or all of the paddles 18 may be apertured to effect more thorough mixing of the materials and for illustrative purposes, I have shown V-shaped notches 19 in the rear or trailing edges of a number of said paddles, and pointed teeth 20 between said notches. The hub $17^a$ carries circumferentially spaced blades or paddles $18^a$ which not only mix and feed the materials, but force them through apertures in the fixed cutting disk 12. As seen in Fig. 1, the angle 21 between the rear or trailing edge portion of each blade or paddle $18^a$ and the disk 12, is much more acute than the angle 22 between said disk 12 and the front or leading edge of said blade or paddle. Thus, the mixture is wedged between the disk 12 and the blades or paddles $18^a$ as these blades rotate and consequently said materials are forced with great pressure through the apertures of said disk 12, and crushed against said disk.

Another hub 23 is suitably keyed on the shaft 15 at the outer side of the fixed cutting disk 12, said hub 23 being provided with cutting arms 24 which not only cut the materials extruded through the apertures of the disk 12 but feed it toward the delivery end of the machine, producing still further mixing and homogenizing of said materials.

The mixing and feeding means 17, 18, the mixing, feeding and crushing means 17a, 18a, and the cutting and feeding means 23, 24, constitute the assemblage of elements within the primary stage of the mill, and it will be seen that that assemblage is duplicated in the present disclosure for the secondary and tertiary stages. Consequently, a further description of the elements for the latter stages will not be necessary.

In the present disclosure, some of the apertures through the fixed cutting disk 12 are in the form of elongated slots 25 and others are mere perforations 26. Each slot 25 is provided with a wide outer end 27 and with a narrow inner end 28, the latter being close to the axis of the disk 12 and the former remote from said axis. The inner end 28 of the slot 25 is advanced (in the direction in which the cutting arms 24 rotate) beyond the wide outer end 27 and it will be seen that the longiudinal edges 29 and 30 of the slot converge from said wide end to said narrow end. The inner edge 29 is longitudinally convex and the outer edge 30 is longitudinally concave, and it is preferable to provide both of these edges with transverse ribs 31 which aid in crushing hard pieces of material such as clods or balls of clay, or stones, as hereinafter explained. The ribs 31 are preferably so pitched as to aid in feeding the materials through the slots 25.

The arms 24 of the rotary cutter have their front or leading edges 32 concavely curved, and the outer end 33 of each of these edges is advanced in the direction of cutter rotation, beyond the inner end 34. These edges 32 thus cooperate with the slots 25 in such manner that any hard pieces of the materials projecting partly through the wide outer ends 27 of the slots 25 will be engaged by the cutter edges 32 and moved toward and into the narrow ends 28 of the slots. As the hard pieces are thus moved, there is a tendency to crush them as they are wedged into the narrow slot ends, and the ribs 31 assist in this operation. Also by moving the hard pieces into the inner ends of the slots, if they have not been previously cut by the cutting edges 32, these edges will sever them at points close to the axis of the shaft 15, permitting the severing and crushing to be done with less power than if at points more remote from the shaft axis.

In operation, the materials to be mixed are fed into the inlet 7 with the shaft 15 and parts thereon rotating. The various paddles 18 and 18a mix the materials and feed them toward the fixed cutting disk 12, through the apertures of which they are forced by the paddles or blades 18a. Not only do these paddles or blades 18a perform this function, but they will crush stones, balls or clods against the disk 12 and force the materials on through the disk apertures. The mixed materials extruded through these apertures are thoroughly broken up and thus further mixed by means of the cutting arms 24, and due to the cooperation of these arms with the slots 25 as above described, any hard pieces of the material, such as balls or clods, stones or gravel, will be effectively crushed with the expenditure of little power. When the mill embodies secondary and tertiary units as herein disclosed, or any other desired number of units, the actions occurring within them are duplicates of that occurring within the first stage and the materials are gradually reduced to a greater state of fineness. In order to accomplish this, the apertures of the disks such as 12a and 12b, beyond the primary disk 12, are of course gradually reduced in size.

As previously intimated, one field of use for my improved mill is road or highway construction. At present, roadways are frequently formed by mixing Portland cement, oil, asphalt or other binding materials with the soil on the site of the proposed road. While machines have been devised for scarifying the soil and mixing the binder with the same, the effectiveness of such machines varies considerably owing to the nature of the soil being treated. In some cases, they will not produce entirely satisfactory results, especially with respect to obtaining a thorough mixture of the materials. With the present invention, soils of all kinds whether hard clay, gravelly clay, sand clay, sticky wet gumbo, shale bearing soil, etc., may be treated with the binder to obtain the uniform mixture necessary to produce the best results. The cement, and water or the oil, asphalt, etc., is fed in proper proportions into the hopper 7 together with soil, the latter in some cases being screened to prevent the entrance of rocks and lumps too large to be handled by the mill.

Excellent results may be obtained from the general construction shown and described and it is, therefore, preferably followed. However, within the scope of the invention as claimed, variations may be made as above stated.

I claim:

1. A mill comprising a horizontal cylindrical casing having a material inlet in its top at one of its ends, said casing having an end wall at said one of its ends and also having a stationary apertured cutting disk parallel with said end wall and spaced therefrom beyond said inlet, said end wall and said cutting disk being provided with central alined bearings, a driven shaft mounted in said bearings, a plurality of series of circumferentially spaced pitched mixing and feeding paddles on said shaft for mixing the materials and feeding them toward said cutting disk, a series of pitched circumferentially spaced mixing, feeding and crushing paddles on said shaft between said mixing and feeding paddles and said cutting disk and disposed in close relation with the inner side of said cutting disk, said mixing, feeding and crushing paddles being pitched to crush the materials against said disk and force them through the apertures of said disk, and a rotary cutter on said shaft at the outer side of said disk and having cutting edges facing in the direction of cutter rotation for cutting the materials extruded through said apertures.

2. A mill comprising a horizontal cylindrical casing having a material inlet in its top at one of its ends, said casing having an end wall at said one of its ends and also having a stationary apertured cutting disk parallel with said end wall and spaced therefrom beyond said inlet, said end wall and said cutting disk being provided with central alined bearings, a driven shaft mounted in said bearings, a plurality of series of circumferentially spaced pitched mixing and feeding paddles on said shaft for mixing the materials and feeding them toward said cutting disk, a series of pitched circumferentially spaced mixing, feeding and crushing paddles on said shaft between said mixing and feeding paddles and said cutting disk and disposed in close relation with the inner side of said cutting disk,

said mixing, feeding and crushing paddles being pitched to crush the materials against said disk and force them through the apertures of said disk, each paddle of said additional series being at a much more acute angle to said disk at its trailing edge than at its leading edge to forcibly crush the materials against said disk and force them through the disk apertures, and a rotary cutter on said shaft at the outer side of said disk and having cutting edges facing in the direction of cutter rotation for cutting the materials extruded through said apertures.

3. A mill comprising a horizontal cylindrical casing having a material inlet in its top at one of its ends, said casing having an end wall at said one of its ends and also having a stationary apertured cutting disk parallel with said end wall and spaced therefrom beyond said inlet, said end wall and said cutting disk being provided with central alined bearings, a driven shaft mounted in said bearings, a plurality of series of circumferentially spaced pitched paddles on said shaft for mixing the materials and feeding them toward said cutting disk, a series of pitched circumferentially spaced mixing, feeding and crushing paddles on said shaft in close relation with the inner side of said cutting disk and effective to crush the materials against said disk and force them through the apertures of said disk, and a rotary cutter on said shaft at the outer side of said disk and having cutting edges facing in the direction of cutter rotation for cutting the materials extruded through said apertures; at least some of said disk apertures being in the form of slots, said slots each having a wide outer end remote from the cutter axis and a narrow inner end close to the cutter axis, said narrow inner end being advanced beyond said wide outer end in the direction of cutter rotation, the outer longitudinal edge of each slot being concavely curved and the inner longitudinal edge convexly curved, said outer and inner curved edges converging from the wide slot end to the narrow end; each of said cutting edges being concavely curved and having its outer end advanced beyond its inner end in the direction of cutter rotation; whereby the outer ends of said cutting edges will reach said wide outer ends of said slots before the inner ends of said cutting edges reach said narrow inner ends of said slots, causing the curved edges of the slots and cutting edges to cooperate in forcing hard pieces of material from said wide outer ends of the slots into said narrow inner ends thereof, tending to crush the pieces as they are wedged between said converging slot edges and positioning the pieces close to the cutter axis for easier cutting.

4. A structure as specified in claim 1; at least some of the first mentioned series of paddles being provided with alternate notches and teeth on their rear or trailing edges to engage the materials as they slide from the paddles to attain more thorough mixing.

5. A structure as specified in claim 1; together with at least a secondary fixed apertured cutting disk secured in said casing beyond and parallel with the first named cutting disk and having a central bearing through which said shaft is extended, secondary series of mixing and feeding paddles on said shaft between said cutter and said secondary disk for further mixing the materials and feeding them toward said secondary disk, a secondary series of pitched mixing, feeding and crushing paddles on said shaft associated with said secondary mixing and feeding paddles and said secondary disk in substantially the same manner as the first mentioned mixing, feeding and crushing paddles are associated with said first named disk, and a secondary rotary cutter on said shaft cooperating with said secondary disk in substantially the same manner as the first named rotary cutter coacts with said first named disk.

6. In a combined mixing and grinding mill, a fixed cutter disk provided with apertures through which a mixture of materials is extruded, at least some of said apertures being in the form of elongated slots; and a rotary cutter at the outer side of said disk and having cutting edges facing in the direction of cutter rotation; said slots each having a wide outer end remote from the cutter axis and a narrow inner end close to the cutter axis, said narrow inner end being advanced beyond said wide outer end in the direction of cutter rotation, the outer longitudinal edge of each slot being concavely curved and the inner longitudinal edge convexly curved, said outer and inner curved edges converging from the wide slot end to the narrow end; each of said cutting edges being concavely curved and having its outer end advanced beyond its inner end in the direction of cutter rotation; whereby the outer ends of said cutting edges will reach said wide outer ends of said slots before the inner ends of said cutting edges reach said narrow inner ends of said slots, causing the curved edges of the slots and cutting edges to cooperate in forcing hard pieces of material from said wide outer ends of the slots into said narrow inner ends thereof, tending to crush the pieces as they are wedged between said converging slot edges and positioning the pieces close to the cutter axis for easier cutting.

7. A structure as specified in claim 6; said edges of said slots being provided with transverse pitched ribs which aid in crushing the hard pieces of material and in feeding the material through said slots.

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