Oct. 26, 1965 R. E. OWENS ETAL 3,214,105

REDUCTION MILL

Filed July 18, 1963 2 Sheets-Sheet 1

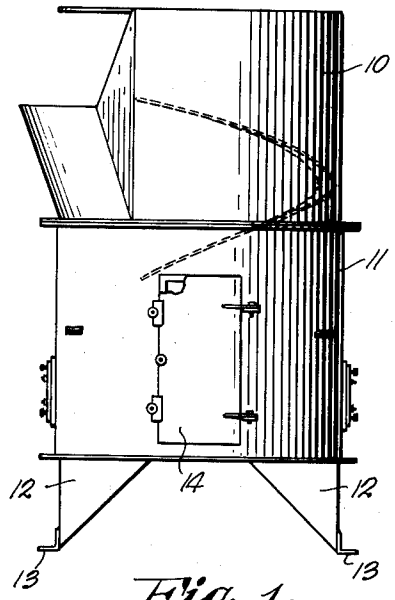


Fig. 1.

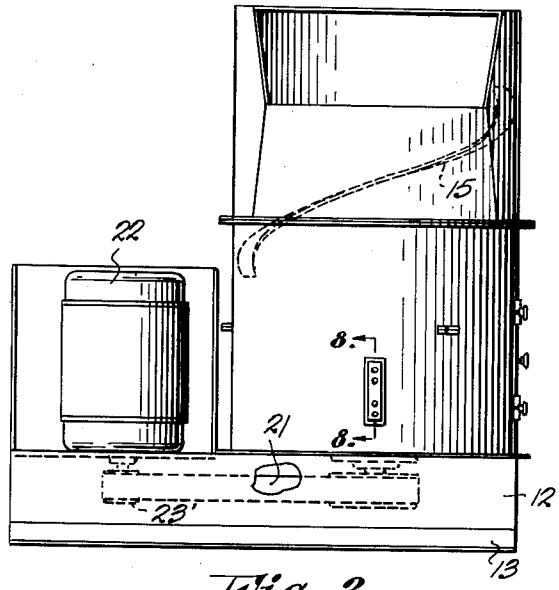


Fig. 2.

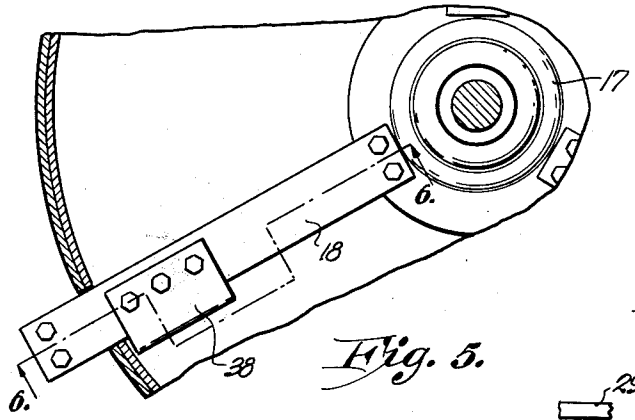


Fig. 5.

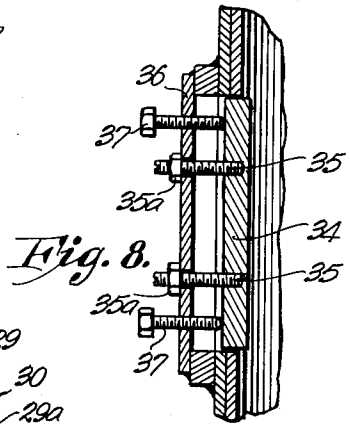


Fig. 8.

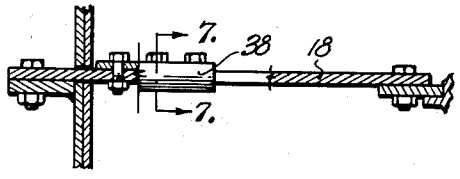


Fig. 6.

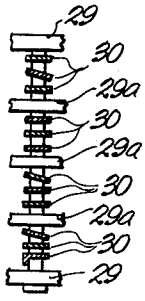


Fig. 9.



Fig. 7.

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REDUCTION MILL

Filed July 18, 1963 2 Sheets-Sheet 2

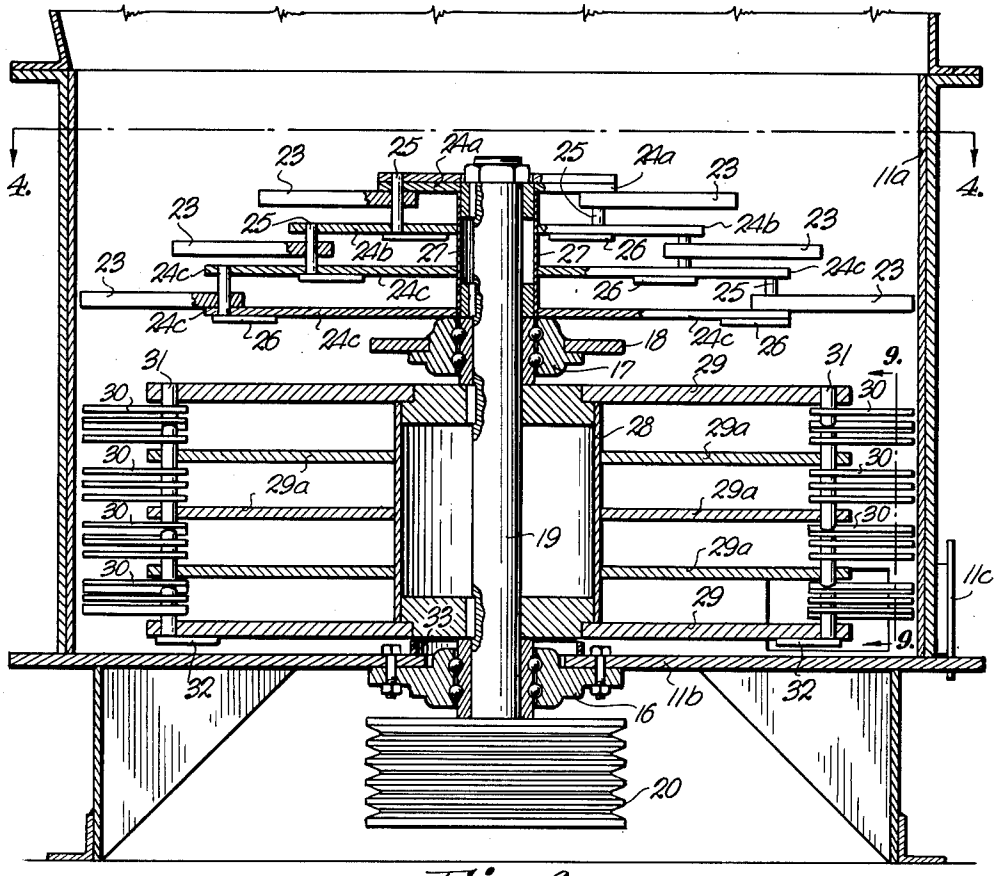


Fig. 3.

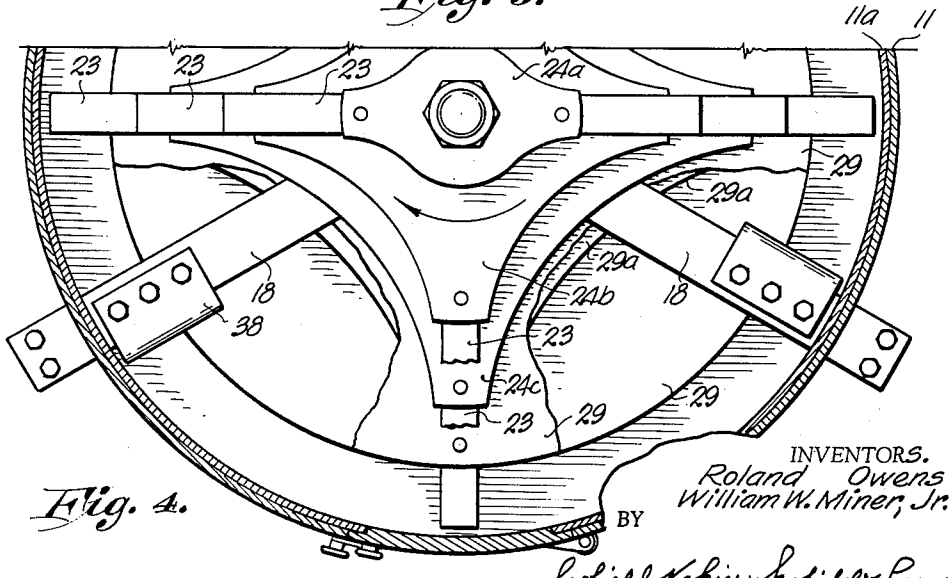


Fig. 4.

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United States Patent Office 3,214,105
Patented Oct. 26, 1965

3,214,105

REDUCTION MILL

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Filed July 18, 1963, Ser. No. 295,875
9 Claims. (Cl. 241—154)

This invention relates to reduction mills and refers more particularly to mills of the swing hammer or impact type, wherein the disintegration and crushing of materials takes place in a two-compartment housing, the upper compartment containing chopping stages and the lower compartment the final disintegrating stage.

Conventional impact or hammer mills used for crushing solids, such as coal or ore, have proved relatively unsatisfactory when used for grinding, decorticating and reducing wet, sticky, fibrous products such as bagasse, corn stalks, weeds, tree bark, garbage, coarse sewage screenings, stockyards waste and the like.

The instant invention provides a construction which will reduce waste products of this character whether wet or dry, besides being capable of processing large quantities of such material over relatively short periods without clogging or injury to the disintegrating mechanism.

Another object is to provide a construction whose intake or charging port is substantially the diameter of the mill itself, thereby eliminating to a great extent the necessity of preseparating or preworking the material to be processed.

A further object is to provide a two-stage reduction mill, the first stage a chopping stage in which a series of rotary beaters of progressively increasing diameter are followed by macerating or disintegrating beaters in the second stage where the impacting units are of substantially the same diameter.

Still another object is to provide a mill which is rugged in construction, easily serviced and repaired and affords long, uninterrupted, economical service, besides being a compact unit with its driving mechanism mounted on a common base and portable, since both the mill and prime mover or motor are supported upon a single skid rail base.

An embodiment of the invention is shown in the accompanying drawings which form a part of the instant specification and are to be read in conjunction therewith and in which like reference numerals are used to indicate like parts in the various views.

In the drawings, FIG. 1 is an end elevational view of the unit.

FIG. 2 is a front elevational view showing the motor and drive transmission mechanism.

FIG. 3 is a central section taken through the mill showing the chopping and grinding compartments and mechanisms.

FIG. 4 is a view taken along the line **4**—**4** in FIG. 3 in the direction of the arrows.

FIG. 5 is a detail of one of the bearing supports or struts placed 120° apart in the housing to carry the upper bearing.

FIG. 6 is a view taken along the line **6**—**6** in FIG. 5 in the direction of the arrows.

FIG. 7 is a view taken along the line **7**—**7** in FIG. 6 in the direction of the arrows.

FIG. 8 is a view taken along the line **8**—**8** in FIG. 2 in the direction of the arrows.

FIG. 9 is a view taken along the line **9**—**9** in FIG. 3 in the direction of the arrows.

Referring to the drawings, the reduction mill or crusher comprises a hopper **10** having side and top openings of a size substantially the diameter of the mill, for the introduction or charging of material to be disintegrated or crushed. The hopper is mounted upon the mill housing **11**, which in turn is supported by legs **12** and angle iron skids **13**. An inspection door **14** is hinged in the side of the housing to give access to the crushing mechanism. A spiral vane or baffle **15** is welded to the inside surface of the hopper and extends into the top of the upper compartment of the mill. This baffle serves to prevent accumulation and clogging of the charged material in the hopper portion of the mill. The hopper **10** and housing **11** are fastened together to form a unitary structure by flanging the lower edge of the hopper and the upper edge of the mill housing and welding or otherwise uniting the two parts together.

The mill is preferably lined with a shell of hardened steel shown best in FIG. 3 at **11***a*, better to withstand the impact of material thrown by centrifugal force by the crushing mechanism and friction and abrasive action of the material being reduced.

In an aperture centrally of the housing bottom **11***b* is bolted or otherwise fastened roller bearing **16**, which, with bearing **17** supported by struts **18**, carry shaft **19** upon which the crushing mechanism is mounted. Attached to the bottom end of the shaft **19** is a V-belt pulley **20** over which runs a V-belt **21** shown in dotted lines of FIG. 2. Power is transmitted from the motor **22** through its pulley **23'** and V-belt **21** to pulley **20** on shaft **19**.

A discharge opening **11***c*, shown in FIG. 3, is supplied in the side of the housing adjacent bottom plate **11***b*. The crushing mechanism of the mill is located in two compartments separated by bearing struts **18** and roller bearing **17**. In the upper compartment is located the chopping mechanism comprising flails or hammers **23** pivoted to rotor plates or arms **24***a* and **24***b* and **24***c* by means of pins **25**. These pins are held in place by stop plates **26** located beneath the arms and positioned below the ends of the pins **25**.

The arms are fixedly attached to a torque tube **27** having reinforcement rings at the top and bottom which are fixedly keyed to the shaft **19**. The upper rotor arm **24***a* has a circular body with short diametrically opposed extensions projecting outwardly therefrom. Pivot pins **25** near the ends of these extensions carry the upper bank of hammers **23**. The next rotor plates or arms below numbered **24***b* and **24***c* are roughly star shaped, the blunt ends or points of the stars being 90° apart as shown in FIG. 4. Hammers or flails **23** are attached to the plates on pins **25**. The two lower arms **24***c* are of the same diameter and of somewhat greater diameter than arm **24***b*, as shown in FIGS. 3 and 4. Thus we have in succession from top to bottom three banks of flails or hammers, two diametrically opposite in the upper bank and four 90° apart in the second and third bank. The diameter of each bank of hammers **23** increases from top to bottom, the ends of the upper hammers extending substantially one-half of the radius of the housing, the ends of the second bank of hammers about one-half the distance between the ends of the first bank and the inside of the housing and the ends of the lower bank extending almost to the housing lining with sufficient clearance for free rotation.

In the lower disintegrating compartment below the bearing **17** and fixedly attached to the lower portion of the shaft **19** is torque tube **28** constructed similarly to tube **27** but of larger diameter. Fixedly attached to the periphery of the torque tube **28** at the top and bottom are two disk-shaped arms **29** and three intermediate star-shaped arms **29***a* positioned between the upper and lower disks **29** as shown in FIGS. 3, 4 and 8. Near the ends of these arms are pivoted hammers or flails **30** upon pins **31**, which extend through the arms from top to bottom

and are held against displacement by stop plates **32** beneath the lower disk **29**. The ends of the hammers **30** have about the same clearance with the inside of the housing as do flails **23** in the upper compartment. A spacer ring **33** is located around the bearing **16** between the housing and bottom of the torque tube to prevent the entry of dirt and grit into the lower bearing.

In order to supply a rigid support for the bearing **17**, the struts **18** are extended through the housing, and are bolted or otherwise fastened to brackets outside of the housing, as shown in FIGS. 4, 5 and 6. Upon these struts or bearing supports **18**, which separate the upper and lower compartments, are attached deflectors **38**, shown in FIGS. 4, 5, 6 and 7. These deflectors are positioned just inside of the housing on the leading edge of the struts, as shown in FIGS. 4, 6 and 7, and serve to deflect the partially crushed and separated material chopped in the upper compartment into the lower grinding compartment.

It has been found that improved results may be obtained particularly in the lower disintegrating or grinding compartment of the mill and when crushing or distintegrating certain types of materials to contour or distort some of the flails or hammers by twisting them axially, as shown in FIG. 9. Also a down turned flange formed on the bottom row of hammers, as shown in FIG. 9, assists in moving the ground material toward the discharge outlet **11***c*. A similar result may be obtained by fastening a sweep strip, not shown, radially across the underside of the lower disk arm **29***a*.

To govern the particle size of the material crushed and ground in the lower compartment, adjustment plates **34** are fitted diametrically opposite in the housing as shown in FIGS. 2 and 8. The plates are preferably rectangular in shape, of hardened steel and located opposite the ends of hammers **30**. They are adjustable inwardly or outwardly with respect to the inside surface of the housing by adjusting screws **35**, threaded to fit nuts **35***a*, attached to holding plates **36** and hex-headed set or back up screws **37**.

In the reduction of waste products such as city garbage, coarse sewage screenings, fibrous materials of wood, cardboard, box board or the like, the products to be ground are tossed into the hopper **10** and fed to the chopping and crushing mechanism in the upper compartment of the mill. By scaling the separate stages in the compartment from a small diameter impact device at the top to successively larger diameter stages below, the materials processed are progressively disintegrated without excessive stress, strain or duty upon the impact mechanism. The design of the arms and hammers in this upper chopping or crushing compartment presents and aids the products being processed to move smoothly and rapidly downward through the upper compartment where they are delivered by the actions of the deflectors **38** to the grinding or disintegrating compartment below.

In the distintegrating compartment they are again subjected to an efficient impact mechanism or hammer mill of unique design and rugged construction which again reduces the materials to the size desired for disposal by incineration or further processing such as composting or the like.

The mill is of rugged construction with parts that are easily accessible for replacement and can be operated continuously with a minimum of down time.

From the foregoing it will be seen that the invention is well adapted to attain all of the ends and objects hereinbefore set forth together with such other advantages as are obvious and which are inherent to the structure.

As many possible embodiments may be made of the invention without departing from the scope thereof, it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having thus described our invention, we claim:

1. A a reduction mill of the character described comprising

a rotor housing having top inlet and bottom discharge openings,

partition bars separating said housing into upper chopping comparment and a lower disintegrating compartment,

a vertical shaft positioned centrally of the compartments and rotatable in bearings supported in the housing,

driving means mounted on the lower end of the shaft,

a series of banks or stages in the upper chopping compartment including rotor plates rotatable with the shaft and flails pivoted peripherally to said plates, each successive chopping stage of greater diameter than the one above,

distintegrating elements in the lower compartment including rotor arms rotatable with the shaft,

a series of flail members pivoted at the extremities of the rotor arms,

the overall diameter of said disintegrating members being less than the interior diameter of the housing and substantially that of the lower bank of flails in the upper chopping compartment.

2. A reduction mill as in claim **1**, including

a torque tube fixedly attached to the shaft in both the upper and lower compartments, said tubes providing intermediate mountings between the shaft and rotor plates in the upper compartment and the shaft and rotor disks in the lower compartment.

3. A reduction mill as in claim **2**, in which

the torque tube in the lower compartment is of greater diameter than the torque tube in the upper compartment.

4. A reduction mill as in claim **2**, wherein

an upper shaft bearing is positioned between the upper and lower torque tubes and

a lower shaft bearing is positioned beneath the lower torque tubes.

5. A reduction mill as in claim **1**, wherein

the flails of the chopping stages in the upper compartment are individually pivoted to the rotor plates while

the disintegrating flail elements in the lower compartment are pivoted at the extremities of the arms in groups upon single pivots.

6. A reduction mill as in claim **1**, with deflectors on the partition bars between the upper and lower compartments.

7. A reduction mill as in claim **1**, in which

the flails of the upper bank in the chopping compartment extend substantially one-half of the radius of the housing,

the flails of the intermediate bank extend about one-half the distance between the ends of the flails of the upper bank and the inside surface of the housing, and

the flails of the lower bank extend almost to the interior housing surface or lining with sufficient clearance for free rotation.

8. A reduction mill of the character described comprising

a rotor housing having top inlet and bottom discharge openings,

partition bars separating said housing into an upper chopping compartment and a lower disintegrating compartment,

a vertical shaft positioned centrally of the compartments and rotatable in bearings supported in the housing,

driving means mounted on the lower end of the shaft,

a series of banks of flail elements rotatable with the shaft in the upper chopping compartment, each of said banks being of increased diameter from top to bottom, and

a series of banks of flail elements rotatable with the shaft in the lower disintegrating compartment, said banks of disintegrating flails being of like diameter and corresponding to the lowest bank of flail elements in the chopping compartment.

9. A reduction mill as in claim 8, including adjustment plates inset into the interior wall surface of the disintegrating compartment opposite the ends of the flail elements and

means for radially adjusting said plates from the exterior of the housing for governing the particle size of the material processed.

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