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(54) A HAMMER MILL

(71) We, SCHMIDT & SØNNER MASKINFABRIK A/S a Danish Joint Stock Company, of Tved, 6000 Kolding, Denmark, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

The present invention relates to a hammer mill of the type comprising a housing having a cylindrical milling chamber which accommodates a rotor carrying hammers.

It is an object of the invention to provide a hammer mill having a high milling output and delivery of a practially uniform milled product coupled with lower power consumption and noise level.

Hammers arranged in offset groups are known. It is likewise known to define the milling chamber by a circumferential screen, and to introduce the material to be milled axially of the rotor.

However, heretofore no attempt has been made to combine these known elements into a single mill. They have been used separately and not more than two at a time in connection with a hammer arrangement or a screen or a location of the inlet for materials different from that selected according to the invention.

The combination of these features unlike numerous other possible and practically employed combinations, provides quite substantial improvement of the milling output coupled with sharply reduced power consumption and generation of noise. The combination specifically provided by the invention causes the mill to operate in a unique manner.

According to the present invention there is provided a hammer mill comprising a cylindrical housing, a stationary cylindrical screen within the housing defining a milling chamber, an inlet for material to be milled, said inlet being coaxial with the screen, distributor means for distributing air taken in through the inlet throughout the chamber, and a rotor within the screen and coaxial therewith, the rotor having a hub and rotor blades, with an axial dimension substantially equal to that of the screen, extending outwardly from the hub, and hammers supported on all the rotor blades, the hammers being attached to hammer supports extending along the free ends of the rotor blades, said hammer supports each having a circular cross-section, the diameter of which is larger than the thickness of the respective blade, and the hammers on one rotor blade being axially offset from hammers on at least one other blade.

The offset arrangement of the hammers avoids the risk of "slicing" of the material processed, which means that the material is effectively disintegrated without any appreciable formation of meal. At the same time, the configuration of the blades of the rotor provides a high carrying effect. According to the invention, the carrying effect is utilized effectively by having a cylindrical screen which defines the milling chamber. Thus milled material may leave the milling chamber by the shortest path. This in turn has the effect of building up a strong pressure effect in the milling chamber with a corresponding vacuum effect in the inlet, which in turn affords the possibility of feeding the material axially towards the centre of the rotor. This produces substantially less dust and noise than the frequently employed feeding of material from above into the chamber. From the centre of the rotor the material is propelled to the peripheral region of the milling chamber where it is milled, as stated, and then removed.

The distributor means makes it possible to control the inflow of air so as to provide good and even distribution of the arriving material across the axial extension of the rotor blades with resultant optimum utilization of the

effective area of the blades. This affords the possibility of obtaining satisfactory milling at a low rotatory velocity of the rotor, which in turn means reduced generation of dust and noise.

It has been found in comparison with known mills that a substantial saving in power is obtained by forming the mill in accordance with the invention coupled with considerably reduced noise level. Additionally the mill provides a milled product which is substantially uniform, has sharp edges and is porous. Furthermore, the occurrence of meal in the milled product may be substantially reduced in comparison with the milled products of other mills. These advantages may be of great importance when the mill is used for making pig feed, for example, as the feed is utilized more efficiently because meal in the feed requires greater quantities of liquid than feed with a low meal content.

The inlet ends of the rotor blades may define a space communicating with the inlet and centred on the axis of the chamber, and the distributor means can be arranged within this space. This means that the distributor means will operate effectively within the rotor.

Advantageous flow conditions may be obtained in a simple manner by the passage and the distributor means having in the axial direction unilaterally decreasing cross-sections of opposite orientation with respect to each other.

The distributor means may be substantially formed as a cone or, e.g. a pyramid, and the surface thereof may be continuous or interrupted. To allow adaptation of the hammer mill to different type materials, the distributor means may be adjustable.

The inflow of air may be further controlled by providing in the flow direction in front of the inlet a vacuum box with adjustable air inlet openings to allow control of the inflow of air in connection with the distributor means, as desired. The vacuum box may also be adapted for screening entrained heavy particles such as stones, sand and pieces of metal.

For effectively removing the milled product the screen may be surrounded by a discharge conduit for milled material having passed the screen.

The screen itself may be composed of a plurality of screen units rigid *per se* and having a curvature corresponding to that of the milling chamber, being at the same time adapted to be releasably arranged in the housing. This makes possible easy exchange of worn screens and swift and easy replacement of one or more or all screen units of different mesh or size of openings. This may be advantageous in milling special products, e.g. for feeds.

Each screen unit may consist of a separate, structurally rigid frame composed of opposing side elements which follow the curvature of the chamber, cross elements interconnecting said side elements, and a screen plate or screen netting arranged on the frame, the free end surfaces of the former extending beyond said cross elements of the frame, and where the housing includes releasable retaining means for securing said end surfaces.

Thus there is no risk of the screen plate or screen netting losing more or less its configuration corresponding to the curvature of the housing. This enables another screen unit to be inserted in the housing without any further fitting, which, moreover, may be effected with extreme speed and reliability by the screen plate or screen netting being secured at its end surfaces to the housing outside the cross members of the frame element.

The retaining means may consist of means abutting the end surfaces and of clamping means such as eccentric members for clamping the end surfaces to the abutting means. The retaining connection may be combined with engaging means associated with the cross elements of the frame for releasable engagement with abutting means associated with the housing, whereby the screen is supported and guided by the cross members during insertion into and removal from the housing, being secured after insertion by way of said first releasable retaining means.

The invention will now be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a schematic cross-sectional view of a hammer according to the invention;

Figure 2 is an axial sectional view along the line II-II of Figure 1; and

Figure 3 shows on a larger scale a cross-sectional view of part of the housing of a second embodiment of a hammer mill according to the invention.

The hammer mill illustrated in Figures 1 and 2 comprises a cylindrical housing 1 having a cylindrical internal screen formed of three screen units 2. The screen is surrounded by a discharge conduit 3. The milling chamber enclosed by the screen accommodates a rotor 4 carrying four 90° arcuately spaced blades 5*a*, 5*b*, 5*c* and 5*d*, the extreme ends of which carry hammers 6. The blades 5*a* and 5*b* form one group with an identical arrangement of hammers, and the blades 5*c* and 5*d* another group likewise with an identical arrangement of hammers. However, the hammers of group 5*a*, 5*b* and group 5*c*, 5*d* are offset with respect to each other in the direction of the axis of rotation of the rotor 4. The blades 5*a* and 5*c* may alternatively form one group and the blades 5*b* and 5*d* another group, or the hammers on all the other blades. An axial inlet 7 for material to be milled is arranged adjacent the axis of the

rotor 4. The lower end of the discharge conduit 3 terminates in an outlet 8.

Each screen unit 2 consists of a rigid frame with side members 9 following the curvature of the housing, cross member 10 interconnecting the side members 9 and being in releasable displaceable engagement with support means 11 of the housing. The frame 9 is covered with a perforated screen plate or screen netting 12. End faces 13 of the plate or netting 12 extend beyond the cross elements 10. At the end faces 13 by means of clamping means in the form of eccentric members 14, the plate or netting 12 is releasably clamped to abutting means 15 of the housing, said abutting means being in the form of angle irons.

The flow of material through the housing produced during operation of the hammer mill is indicated by arrows. Fresh material introduced through the inlet 7 is propelled by the carrying effect produced by the blades 5 of the rotor 4 towards the periphery of the milling chamber proximate the screens 2 where the hammers 6 will mill or crush the material. Sufficiently milled or crushed material is rapidly discharged from the milling chamber through the screens 2 into the discharge conduit 3 and from there to the outlet 8.

The inlet 7 comprises a tubular inlet duct 16 extending into the housing 1. The inlet ends of the blades 5*a*, 5*b*, 5*c* and 5*d* define a space 17 communicating with the duct 16 and centred on the axis of the chamber. A conical distributor means 18 is arranged in the space 17 which is likewise of conical cross-sectional configuration but with opposite orientation in relation to the cone. The distributor means 18 is axially adjustable by means of a spindle 19 mounted in a sleeve 20 which by way of support means 21 is disposed in the tubular duct 16.

In the flow direction in front of the inlet duct 16 there is provided a vacuum box 22 with adjustable dampers 23 and 24 for adjustment of the volume of air required for various materials. The vacuum box 22 has a lower compartment 25 for the collection of heavy particles screened out.

The arrows shown indicate that by means of the distributor means 18 it is possible to provide an air flow which will distribute the arriving material across the axial extension of the blades 5*a*, 5*b*, 5*c* and 5*d* so as to utilize their entire effective area for conveyance of material.

Additionally, the mill is constructed to allow an optional change in the direction of rotation of the rotor.

According to the embodiment shown in Figure 3 the entire screen consists of six screen units 2.

The clamping means 14 are shown in their released position while the clamping means 14′ are shown in their locked position. The cross elements 10 have engaging means formed as projecting flanges 26 in displaced engagement with grooves 27 in the support members 11 of the housing 1.

Any one of the screen units 2 is exchanged merely by loosening and moving the clamping means from position 14′ to 14 and thereafter pulling the screen unit axially from the housing. This operation requires no further manipulations of the mill, and the same screen unit or another screen unit may then be inserted without any further adaptation to the cylindrical shape of the chamber and swiftly and safely secured by turning the clamping means from 14 to 14′.

During operation, the means 15 serve as an obstruction interrupting the screen area in the milling chamber to thereby offset too vigorous rotation of the milling material in the chamber.

The hammer supports 28 each have a circular cross-section, as can be seen in the figures 1 and 3 of the drawings. The diameters of the supports are larger than the thickness of the blades attached to the supports. The supports 28 distribute air taken in through the inlet throughout the chamber.

WHAT WE CLAIM IS:-

1. A hammer mill comprising a cylindrical housing, a stationary cylindrical screen within the housing defining a milling chamber, an inlet for material to be milled, said inlet being coaxial with the screen, distributor means for distributing air taken in through the inlet throughout the chamber, and a rotor within the screen and coaxial therewith, the rotor having a hub and rotor blades with an axial dimension substantially equal to that of the screen extending outwardly from the hub, and hammers supported on all the rotor blades, the hammers being attached to hammer supports extending along the free ends of the rotor blades, said hammer supports each having a circular cross-section, the diameter of which is larger than the thickness of the respective blade, and the hammers on one rotor blade being axially offset from hammers on at least one other rotor blade.

2. A hammer mill as claimed in Claim 1, wherein the inlet ends of the rotor blades define a space communicating with the inlet and centred on the axis of the chamber, and the distributor means are arranged within this space.

3. A hammer mill according to Claim 2, wherein the space and the distributor means have in the axial direction unilaterally decreasing cross-sections of opposite orientation with respect to each other.

4. A hammer mill according to any one of the preceding claims, wherein the distributor means is substantially formed as a cone.

5. A hemmer mill according to any one of the preceding claims, wherein the distributor means is adjustable.

6. A hammer mill according to any one of the preceding claims, wherein the flow direction in front of the inlet there is provided a vacuum box having adjustable air inlet openings.

7. A beater mill according to any preceding claim, wherein the screen is composed of a plurality of screen units each providing a part of the total circumference of the cylindrical screen, and being releasably mounted in the housing, and each comprising a rigid frame formed by opposing side elements which follow the curvature of the chamber, cross elements being provided for interconnecting said side elements, and screening plate of screening netting arranged on the frame, the free ends of the plate or netting extending beyond said cross elements, said housing including releasable retaining means for securing said free ends in position.

8. A hammer mill according to Claim 7, wherein said retaining means consists of abutting means for the free ends and clamping means adapted to clamp the free ends to the abutting means.

9. A hammer mill according to Claim 7 or 8, wherein the cross elements of the frame include engaging means for releasable engagement with abutting means of the housing.

10. A hammer mill substantially as hereinbefore described with reference to and as illustrated in Figures 1 and 2 and Figure 3 of the drawings.

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1568394 COMPLETE SPECIFICATION

2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*

Sheet 1

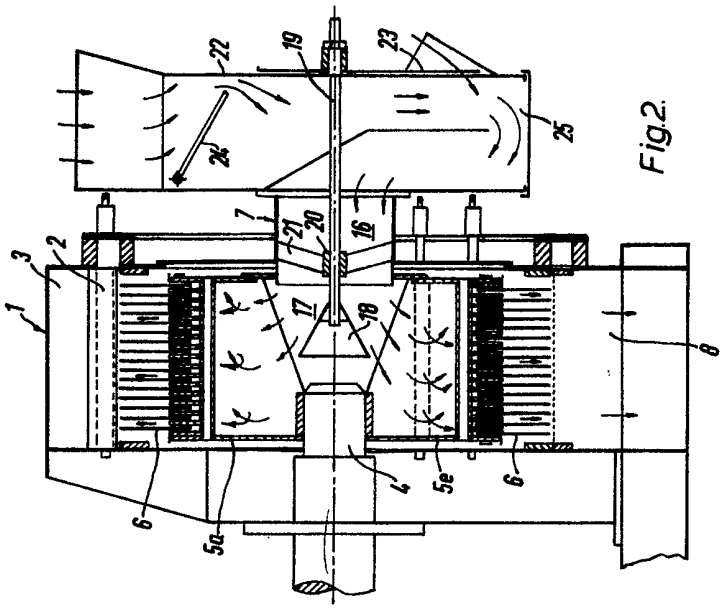

Fig.2.

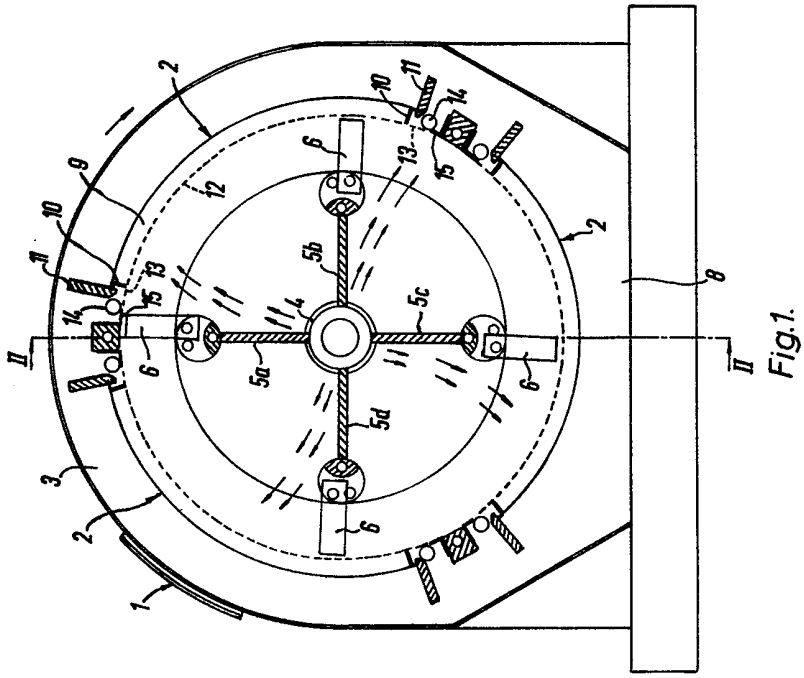

Fig.1.

Fig. 3