May 14, 1963 A. HEINZ ETAL 3,089,655

PROCESSING WASTE PAPER OR THE LIKE

Filed Aug. 22, 1960 2 Sheets-Sheet 1

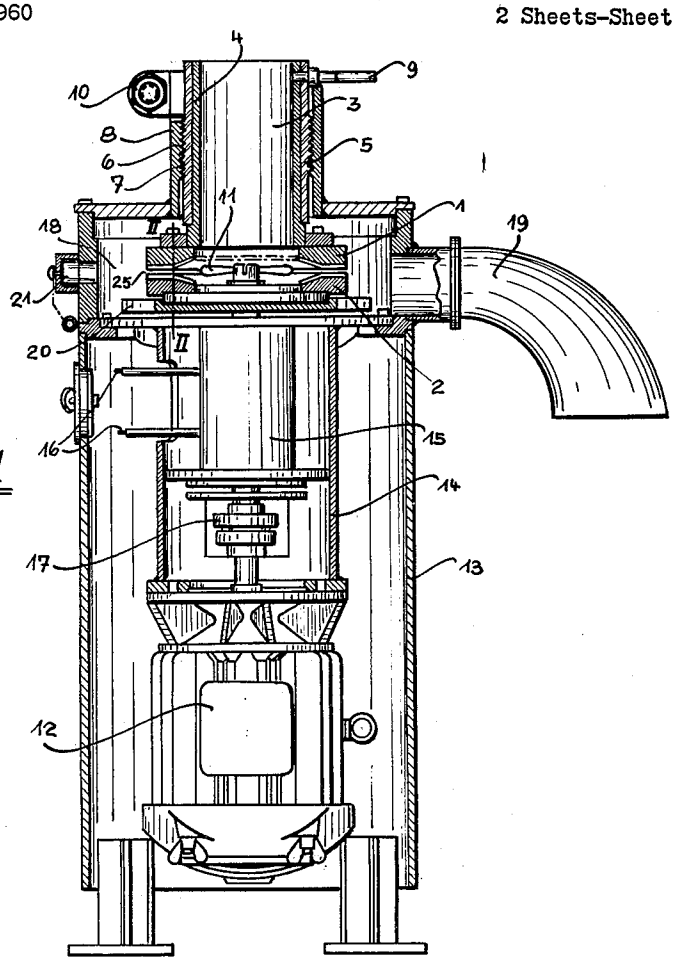



Fig. 1

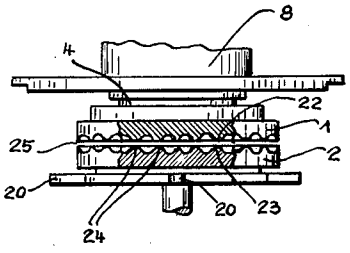



Fig. 2

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Fig. 3

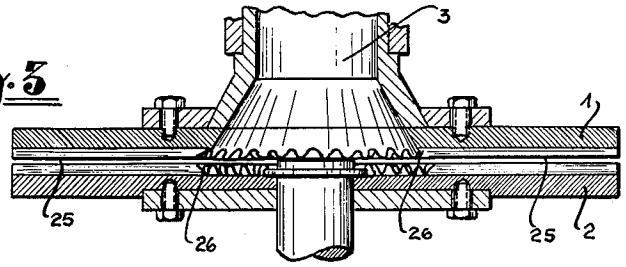



Fig. 4

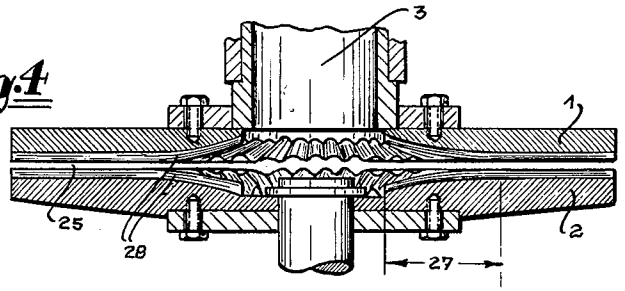



Fig. 5

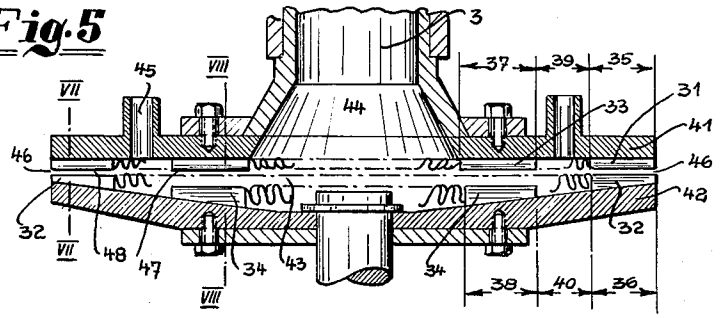



Fig. 6

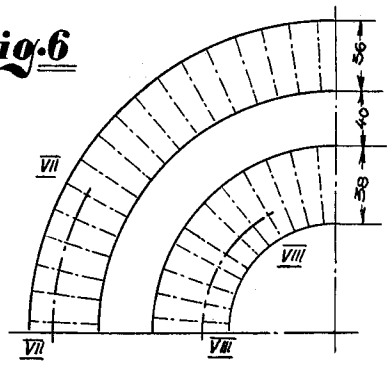



Fig. 7

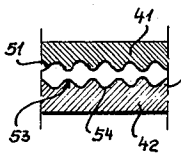
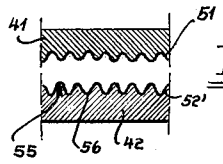



Fig. 8




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# PROCESSING WASTE PAPER OR THE LIKE

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7 Claims. (Cl. 241—260)

This invention generally relates to the processing of waste paper, waste cardboard, and other waste papers, for the purpose of producing fresh paper therefrom. More particularly the invention relates to an attrition disc mill for resolving and pulping such raw materials and for detaching the paper fibres from the size and fillers which bond them together.

The principal purpose envisaged by the invention is the provision of a high capacity disc mill of the aforesaid kind which permits waste paper and the like to be pulped by submitting it to gentle attrition without size reduction or tearing of the individual fibres. In the known methods of pulping waste paper, cardboard, and the like, these raw materials are first coarsely broken up, then ground wet in an edge mill, and finally reduced to a fine pulp in a hollander, the resultant fibre suspension being used for making fresh paper or for admixture to paper pulp of other origin. In this method of pulping the expenditure of power is considerable. The major disadvantage of the conventional processing method is that the paper fibre contained in the raw material is shredded in the course of the treatment, and that the fibre length is thus considerably reduced. Short paper fibres fail to felt and to mat together satisfactorily or to bond with the substances conventionally added to the pulp. Consequently, the paper produced from such waste has a substantially lesser tearing strength. Regenerated waste paper was therefore in the past used exclusively for making papers and cardboards of inferior quality.

Another object envisaged by the invention is the provision of a disc mill of the aforesaid kind which has disc surfaces provided with radially extending elevations with rounded longitudinal edges in such manner that the discs form narrow grinding gaps between them and the elevations have an undular cross-section, the crowns of the elevations facing each other cooperating along lines instead of grinding surfaces. The centrifugal forces engendered by the rotation of at least one of the discs cause the material between opposite elevations, instead of being ground, to be submitted in the rounded troughs between neighbouring elevations to continuous and vigorous rolling action which does not tear the fibre but loosens the paper structure.

Another object of the invention consists in providing a disc mill of the aforesaid kind in which the undular radial elevations are located on at least two relatively spaced concentric annular faces. Since the treated material migrates radially from the inside outwards, a disc mill thus contrived presents a plurality of treating zones through which the material passes in succession. Between the treating zones are annular zones in which the material issuing from the preceding treating zone is merely mixed.

Another object envisaged by the invention is the provision of a disc mill of the aforesaid kind comprising a plurality of treating and mixing zones in which the clearance between the elevations in each treating zone is uniform but is less in each treating zone than in the preceding treating zone towards the centre of the disc.

Another object contemplated by the invention is a disc mill of the aforesaid kind in which the clearance in the entry region into the working zone of the discs decreases from the entry clearance to the working clearance. This facilitates the entry of the material into the working zone and avoids abruptly subjecting the material to a comminuting treatment which might cause the paper fibre to be torn as it enters the working gap between the discs.



In a disc mill of the aforesaid kind yet another object of the invention is to contrive the discs in such a way that the clearance between the discs is gradually reduced across the whole width of the disc or over a considerable radial distance towards the outside periphery thereof notwithstanding that the size of the elevations remains completely uniform.

Other objects, advantages, and features will emerge as the description of embodiments of the invention, shown in the accompanying drawings, proceeds. In the drawings,

FIG. 1 is the general construction of a disc mill according to the invention,

FIG. 2 is a partial section of the discs taken on the line II—II in FIG. 1,

FIGS. 3 to 5 are analogous sections on a slightly larger scale of modified forms of construction of the disc according to FIG. 1,

FIG. 6 is a plan view in diagram form of a quadrant of the bottom disc according to FIG. 5, and

FIGS. 7 and 8 are vertical partial sections taken on the lines VII—VII and VIII—VIII in FIG. 5.

The disc mill according to the invention, of which the general construction is shown in FIG. 1, comprises an upper stationary disc 1 and a bottom disc 2 which is rotatable about a vertical axis. The material is fed into the mill down a vertical tubular shaft 3 rising above the two discs 1 and 2. This tubular shaft 3 simultaneously serves as a means for adjusting the clearance between the two discs 1 and 2. To this end the feeder tube 4 proper which is rigidly secured to the upper disc is surrounded by a tubular shell 5 provided on part of its circumferential surface with a screw thread. This outer thread 6 cooperates with an internal thread 7 in a tubular member 8 which is rigidly affixed to the machine casing. If the feeder tube 4 and its shell 5 are rotated in relation to the tubular member 8 by an adjusting element 9, the fixed disc 1 can be raised or lowered in the machine casing and hence in relation to the bearings of the lower disc 2. Consequently, the clearance between discs 1 and 2 can be readily adjusted in fractions of a millimetre, for instance between 0.5 mm. to a few mm., say 5 mm. For fixing the adjusted clearance the tubular member 8 has an upper portion acting in the manner of a strap adapted to be tightened by nut and bolt 10 in such a way that any further rotation of the feeder tube 4 and of its outer shell 5 in relation to the tubular member 8 can thus be prevented. The feeder tube 4 discharges the feed directly on to the bottom disc 2. For the purpose of delivering the feed into the gap between the discs 1 and 2 of the mill the lower disc 2, at the bottom of the feeder tube 4, carries a distributor 11, substantially contrived in a manner of a twin or multi-bladed propeller, which revolves together with the lower disc 2. The latter is driven by an electric motor 12 located in the bottom portion of the machine casing 13 and suspended from an inner tubular support 14. Tubular support 14 carries the bearings 15 of the shaft of the lower disc 2. In order to provide bearings for the lower disc which are capable of withstanding the effect of major shocks these bearings 15 are relatively long and ruggedly constructed. They can be lubricated through pipes 16. Between the drive shaft of the electric motor 12 and the shaft of disc 2 is an elastic coupling 17. The material which issues from the periphery of the discs first collects in a chamber 18 in the upper part of machine casing 13 and is then discharged through an outlet 19. For discharging the pulp material in a reliable manner rotating clearing

blades 20 are provided. The collecting chamber communicates with the outside through an opening 21 which can be closed but which permits the mill to be cleaned with a jet of water and to be inspected without the need of dismantling the chamber.

As will be seen by reference to FIG. 2, a feature of the disc mill according to the invention is that the faces of the discs are formed with radial undulating elevations 22 and 23 and that the cooperation between opposing crowns 24 is lineal across a narrow gap 25.

Practically the only difference between the embodiments shown in FIGS. 1, 3 and 4 is the shape of the grinding gap 25 in the radial direction. In FIG. 1 this gap 25 near the centre of the discs is relatively wide but narrows quickly radially outwards to the proper working clearance. On the other hand, in FIG. 3 the entry zone 26 into the grinding gap 25 is relatively narrow and also short, whereas the gap 25 in the remaining working region is uniform in width. In FIG. 4 the grinding gap narrows radially outwards along a relatively wide radial region 27. The faces of the discs 1 and 2 approach each other along curved contours representing for instance the branches of a hyperbola.

In the embodiment shown in FIGS. 5 and 6 the undulating elevations 31, 32 and 33, 34 are located on concentric annular faces 35, 36 and 37, 38 which are relatively spaced in the radial direction. The faces of the discs 39 and 40, which intervene between these annular zones 35, 37 and 36, 38 are free from elevations and thereby form a collecting and mixing zone between the working zones 37, 38 and 35, 36. In these collecting and mixing zones the particles of feed are intermixed and their positions changed before they enter the troughs of the following working zone.

In the embodiment shown in FIG. 5 short pipe ends 45 pierce the upper disc 41 and communicate with the collecting and mixing zone. Additional liquid, such as water can be introduced through these pipes and incorporated in the mixing mass of particles in the collecting and mixing zone.

Account can be taken of the gradual separation and resolution of the coarsely broken particles on their way to the periphery of the discs by the gradual tapering reduction of the gap 43 between the discs 41 and 42 from the entry 44 to the periphery of the discs whence the material issues at 46. Nevertheless, the working clearances 47 and 48 between the discs in the several annular zones 37, 38 and 35, 36 are uniform. Consequently, the greater clearance in the annular zone nearest the entry permits the initially coarser particles to be reduced in stages as they travel towards the disc periphery. The particles are gripped in the narrower clearance in the zones nearer the disc periphery and their size is reduced as they pass between the elevations without, however, the fibres being torn. In principle, it is possible to provide the several annular zones 37, 38 and 35, 36 with elevations of similar height. However, for gently treating the coarser particles during their passage between the elevations it is preferred, as shown in FIG. 5, to adapt the height of the elevations on the entry side 44 to the size of the particles and to reduce it from one annular zone to the next.

FIGS. 7 and 8 again show the effect of the decreasing height of the elevations approaching the periphery. A comparison between FIGS. 7 and 8 reveals that the height of the elevations 51 on the upper disc 41 has remained unchanged. Their closer spacing in FIG. 8 is merely due to the fact that FIG. 8 represents a section which is radially further inwards than that represented by FIG. 7. Moreover, the position of section VII—VII through annular zone 36 is further outwards than the position of section VIII—VIII in zone 38. It follows that the elevations 52 on disc 42 in FIG. 7 are substantially flatter than the elevations 52' of disc 42 in FIG. 8. The crowns 53 of the elevations 52 in FIG. 7 are therefore located



in a plane, whereas the troughs 54 between them follow the cone-shaped outline of disc 42. Similarly the crowns 55 of the elevations 52 in FIG. 8 are located in a plane, whereas the troughs 56 become shallower owing to the coned outline of disc 42 radially outwards.

It is a feature shared by all the elevations, as clearly shown in FIGS. 7 and 8, that the cooperation of the crowns of the elevations 51, 52 and 51, 52' of both discs is only by lineal and not by grinding surface action. The troughs are likewise rounded and they may have an approximately sinusoidal shape, so that the troughs 54 and 56 likewise have no direct grinding action, the material being gently pushed through the troughs and over the crowns to free the fibres without destroying them.

In the operation of a disc mill as proposed by the invention the feed is forced through the gap between the discs by centrifugal forces. Opposing elevations do not grind the material but roll it over in the troughs between neighbouring elevations and thus gradually resolve its structure without tearing action. According to the moisture content of the feed a crumbly to pasty mass is thus formed comprising small rolls, noodles, and like formations, which contain the paper fibre in its original length though loosened and freed from the size and the filler materials. During their passage towards the disc peripheries these particles are pressed through the gaps between opposing elevations. Since the cooperation of the crowns of the elevations is nearly lineal, the passage of the particles of feed between the crowns from one trough to the next merely causes the particles to be divided and by the repetition of this process the fibres to be bared along their length and freed from the size and fillers which envelop them.

The disc mill according to the invention is therefore capable of completely freeing the paper fibers from their bonds in normal waste paper feeds. Even if the initial material is particularly long-fibred and contains large quantities of size, at least 90% of the fibres are thus laid bare and freed from their bond, a result which is fully satisfactory for the production of fresh paper. In such a case a disc mill according to the invention permits the fibres to be completely freed without any injury by adding to the mass, after this has passed once through the mill, further liquid, such as water, and by passing the diluted mass through the mill a second time.

Although reference has been made in the above description exclusively to embodiments of the invention in which only one disc revolves, it will be readily appreciated that rotation can be imparted also to the second disc, and that for increasing the rate of relative motion between the discs the rotation of the second disc may be contrary to that of the first disc.

The above described embodiments of the proposed disc mill are merely illustrative and intended to explain the manner in which the invention can be performed. It is an essential feature of the invention that the elevation on the cooperating faces of the discs have an unbroken rounded shape free from edges and that the cooperation of the crowns of these elevations is nearly lineal, no cooperating flat grinding surfaces being formed.

What we claim is:

1. In a disc mill for pulping waste paper and other paper wastes comprising two coaxial circular discs upon which are formed radially extending elevations with rounded longitudinal edges, the spacing of said discs leaving a narrow gap between said opposing elevations, the provision of means for rotating at least one of said discs in relation to the other of said discs, means for feeding the material into the central region of the gap between said discs, and said discs each having an annular surface directed toward said gap between said discs and being adapted for gently pushing and rolling said fiber material through and between said gap, said surfaces being of undular cross section, all portions of said undulated surfaces being smooth and of such a kind that each elevation

is free of flat surface portions parallel to the plane of rotation of the discs, and has a crown line extremity from which side surfaces continually incline toward adjacent valley lines.

2. In a disc mill for pulping waste paper and other paper wastes, comprising two coaxial circular discs upon which are formed radially extending elevations with rounded longitudinal edges, the spacing of said discs leaving a narrow gap between said opposing elevations, the provision of means for rotating at least one of said discs in relation to the other of said discs, means for feeding the material into the central region of the gap between said discs and said discs each having an annular surface directed toward said gap between said discs and being adapted for gently pushing and rolling said fiber material through and between said gap, said surfaces being of undular cross section, all portions of said undulated surfaces being smooth and of such a kind that each elevation is free of flat surface portions parallel to the plane of rotation of the discs, and has a crown line extremity from which side surfaces continuously incline toward adjacent valley lines, and said undular elevations on both said discs being located on a plurality of radially spaced concentric annular faces in such manner that the annular faces of one disc oppose corresponding annular faces on the other.

3. In a disc mill for pulping waste paper and other paper wastes comprising two coaxial circular discs upon which are formed radially extending elevations with rounded longitudinal edges, the spacing of said discs leaving a narrow gap between said opposing elevations, and at least one of said discs having a radially cone-shaped surface to form a radially narrowing gap in relation to the corresponding cone-shaped surface of the other of said discs, the provision of means for rotating at least one of said discs in relation to the other of said discs, means for feeding the material into the central region of the gap between said discs and said discs each having an annular surface directed toward said gap between said discs and being adapted for gently pushing and rolling said fiber material through and between said gap, said surfaces being of undular cross section, all portions of said undulated surfaces being smooth and of such a kind that each elevation is free of flat surface portions parallel to the plane of rotation of the discs, and has a crown line extremity from which side surfaces continuously incline toward adjacent valley lines, and said undular elevations on both said discs being located on a plurality of radially spaced concentric annular faces in such manner that said annular faces of one disc oppose corresponding annular faces on the other, the clearance between said opposing annular faces being uniform across the entire radial zone occupied by each pair of annular faces.

4. A disc mill as claimed in claim 3 in which the clearance between each pair of said annular faces decreases from the centre of the disc to the periphery of the disc from one annular zone to the next.

5. In a disc mill for pulping waste paper and other paper wastes, comprising two coaxial circular discs upon



which are formed radially extending elevations with rounded longitudinal edges, the spacing of said discs leaving a narrow gap between said opposing elevations, the provision of means for rotating at least one of said discs in relation to the other of said discs, means for feeding the material into the central region of the gap between said discs and said discs each having an annular surface directed toward said gap between said discs and being adapted for gently pushing and rolling said fiber material through and between said gap, said surfaces being of undular cross section, all portions of said undulated surfaces being smooth and of such a kind that each elevation is free of flat surface portions parallel to the plane of rotation of the discs, and has a crown line extremity from which side surfaces continuously incline toward adjacent valley lines and said gap gradually decreasing radially outwards from an enlarged entry gap at the centre to the working clearance.

6. In a disc mill for pulping waste paper and other paper wastes, comprising two coaxial circular discs upon which are formed radially extending elevations with rounded longitudinal edges, the spacing of said discs leaving a narrow gap between said opposing elevations, the provision of means for rotating at least one of said discs in relation to the other of said discs, means for feeding the material into the central region of the gap between said discs, and said discs each having an annular surface directed toward said gap between said discs and being adapted for gently pushing and rolling said fiber material through and between said gap, said surfaces being of undular cross section, all portions of said undulated surfaces being smooth and of such a kind that each elevation is free of surface portions parallel to the plane of rotation of the discs, and has a crown line extremity from which side surfaces continuously incline toward adjacent valley lines and the provision of an outer annular working zone between said discs and an inner annular entry zone between said discs, the clearance in said entry zone being gradually reduced radially outwards to the working clearance along a curve, whereas the relative height of said elevations in relation to the adjacent undular troughs in said discs is uniform also in the entry zone of said discs.

7. A disc mill as claimed in claim 6, in which the reduction of the clearance in the entry zone between the discs is produced by a radial contour of both said discs representing the branches of a hyperbola.

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