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METHOD AND APPARATUS FOR MECHANICALLY CONVERTING SOLID FRIABLE TABLETS AND SHEETS INTO FLAKES

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FIG.1.

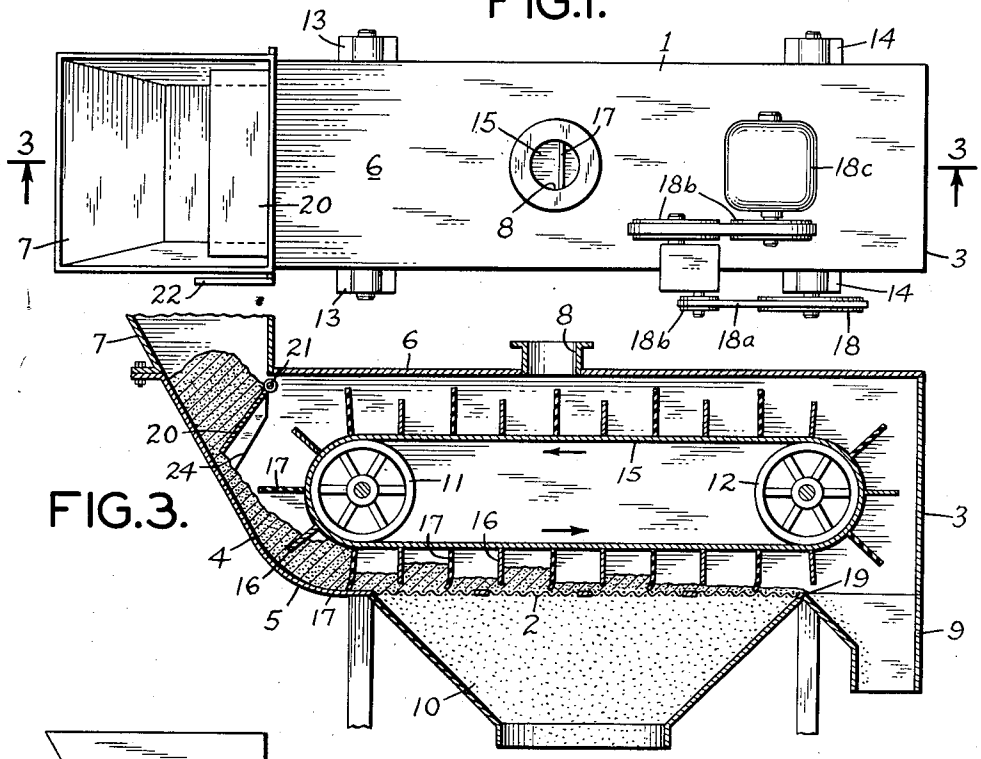


FIG.3.

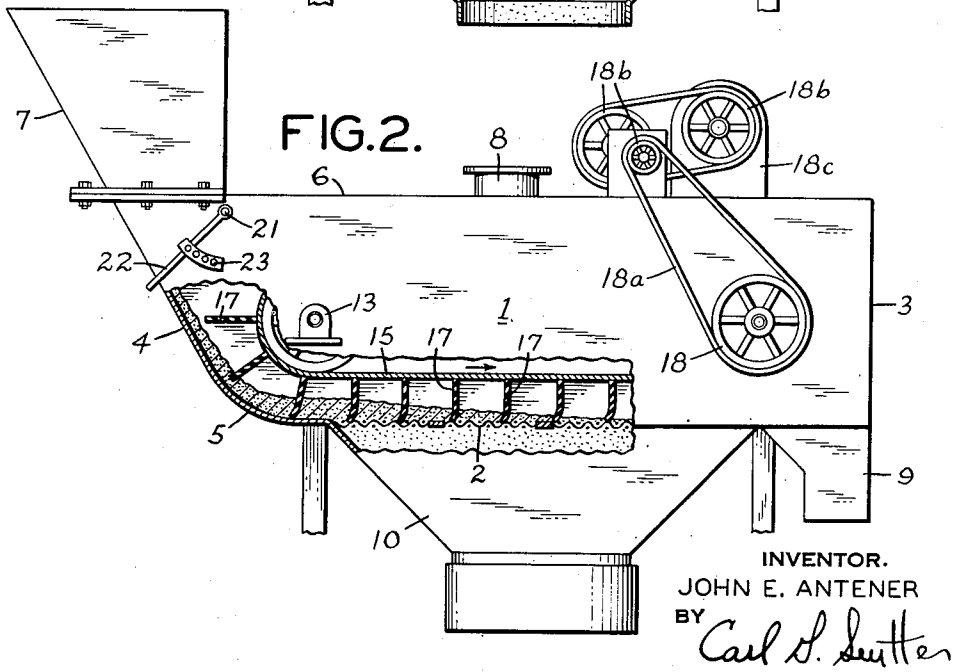


FIG.2.

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METHOD AND APPARATUS FOR MECHANICALLY CONVERTING SOLID FRIABLE TABLETS AND SHEETS INTO FLAKES

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6 Claims. (Cl. 241—24)

This invention relates to a new method and apparatus for converting sheets of friable material to flakes of desired size and substantially free from fines which cause dusting.

It is particularly adapted for use in the preparation of commercially utilizable sized particles of materials such as dyestuffs, detergents, etc.

Many dry commercial dyestuffs and detergents such as the alkyl benzene sulfonate or other types, etc., are prepared and shipped as dry flakes. Preparation involves evaporation of a solution or uniform slurry thereof to produce hollow envelopes or sheets, depending upon the type of drying and drier used.

Commercial requirements of dry flake materials are that the flakes

(1) Be not so fine or associated with such quantity of fines that reasonable handling causes irritating dust;

(2) Be of average size such that they dissolve rapidly and uniformly;

(3) Be of relatively high density.

Dust from fines of many of the products demanded in flake form is highly irritating to skin, breathing organs, and eyes of the processer or other user; coarse material causes difficulties by delayed and imperfect solutions under conditions of use; and low density entails higher packing and shipping costs.

As a result of the foregoing market demands, dyestuffs, detergents, and the like, have been reduced from sheet or other larger sized form to the particular "flake" forms required by individual users or groups of users. Reduction to proper size is generally referred to as flaking, and the larger feed particles are said to be agglomerated. However, the preparation of an approved form of flake without simultaneous production of relatively large amounts of "fines" and consequent costly operations to separate and reprocess such fines, has been found difficult. One widely used method for preparing such flakes has been to dry a slurry or solution of the material on a drum or other suitable drier which permits the friable dry material to be recovered as more or less imperfect sheets, tablets or strips or as biscuits or other large agglomerates occurring as irregularly shaped and sized but undesirably large pieces, which then can be reduced into flakes; but an effective, yet simple mode of flaking such agglomerates in order to obtain desirably uniform flakes without simultaneously yielding large amounts of fines, has not been devised hitherto.

One object of this invention is to provide an economical and simple apparatus for automatically producing flake from dry, friable material.

Other objects will be apparent from the following description:

The present invention involves a method and apparatus for continuously reducing the undesirably large agglomerates to uniform flakes without substantial dusting. Charge material, in its undesirably large form, is moved from a supply of the same in successive metered portions laterally across a laterally extending screen having openings of desired size, while being subjected to forces exerted at least predominantly laterally in a direction parallel to the plane of the screen. During such travel each successive metered portion is presented to the screen wires at a metered rate while under a minimum force applied normally to the screen, so that the agglomerates are sheared by the screen wires, to drop through the screen openings while under the little if any more crushing force then determined by the density, packing characteristics, and depth of such portions. Preferably the parallel forces are yieldably applied, for example, by a series of blades, extending across the screen and moved lengthwise thereof, each blade comprising a resilient portion having an edge in yieldable engagement with the screen surface.

A concrete embodiment of the invention is illustrated in the accompanying drawings in which:

Figure 1 represents a plan view of a flaking machine.

Figure 2 represents a front elevation of a machine such as that of Figure 1, and shows in one portion thereof, a vertical section of one arrangement of interior parts.

Figure 3 represents a section taken along the line 3—3 of Figure 1 and shows another arrangement of the interior parts.

In the drawing, the machine comprises a chamber 1 provided for its bottom with a wire screen 2, preferably rectangular and supported in a substantially horizontal position. The chamber end 3 is substantially perpendicular to the bottom and sides of the chamber. The end 4 is substantially perpendicular to the sides, but it slopes outwardly with respect to bottom 2 with which it merges by a curved portion 5. An opening in the chamber top 6, between the upper edge of the end 4, and the adjacent edge of top 6 accommodates a removable hopper 7; another opening 8 in the top 6 provides a vent for the chamber, and leads to an outer pipe or stack (not shown).

The bottom 2 of the chamber is, in effect, an oblong frame. A removable hopper 9 is attachable to frame end, chamber sides and bottom of chamber end 3. Wire screen 2 may consist of a single integral removable screen or several removable screens, inserted as panels between and on suitable supports (not shown). A removable hopper 10 under the frame, completely spans the screened area.

Inside the chamber two rolls 11 and 12, each slightly shorter than the width of the chamber, are supported by transverse horizontal shafts, the ends of which may pierce the sides of the chamber to rest in pillow blocks 13 and 14 suitably mounted outside the chamber. As shown, a wide endless belt 15 extends and passes over the rolls. To the outer face of the belt are fastened a plurality of transverse blades 17. The blades 17 are formed of sheets of resilient, or flexible but relatively stiff material such as rubber, each blade being wide enough to ride with its free edge slightly flexed and pressing down upon the screen area, so as to exert gentle but yielding pressure against the screen. These blades may alternatively be formed of an upper non-resilient portion, to which is secured at the lower edge thereof, a resilient portion, the latter being in operative contact with the screen 2. The blades are set apart at a convenient distance from each other.

It has been found desirable under certain circumstances described in more detail hereinafter, to intersperse rigid spreader blades 16 among certain of the resilient blades 17 as shown in Figure 3. The blades 16 are flat metal sheets which reach down close to but do not touch the screens when the blades are carried by the belt in the lower portion of its circuit of travel, over the bottom of the chamber.

Roll 12 is rigidly attached to and is rotated by its axial shaft, which is connected through one extended end

fitted with a pulley or sprocket **18**, to a conventional variable-speed drive represented by belt or chain **18***a*, subsidiary pulleys **18***b* and motor **18***c*. Roll **12**, when rotated, actuates belt **15** to turn roll **11**. The pillow blocks supporting roll **11** are mounted on movable plates by which the roll can be moved towards or away from roll **12** to adjust the tension in belt **15**. Roll **11** is placed with its axis very near to or in the plane perpendicular to the line in which the curved portion **5** of end **4** merges with the bottom of the chamber. The axis of roll **12** is so located between chamber wall **3** and the perpendicular plane passing through the inner transverse edge **19** of the hopper **9** as to provide for contact of blades **17** with the end of screen **2**. The height of the axes of the two rolls is such as to permit the blades **16** and **17**, in the embodiment of Figure 3, to travel over the screens respectively spaced from and in contact with the same as noted above. When in operation the rolls turn in a manner to cause the belt **15** to carry the blades on the low portion of its circuit from end **4** toward end **3** of the chamber.

Inside the chamber below hopper **7**, there is a feed flow regulator adapted to admit controlled amounts of charge to the flaking machine. The regulator may be in the form of a flap **20** suspended on pivot supports **21**. These supports pierce the opposite side of the chamber in a horizontal transverse line which is immediately below the level of the lower opening of hopper **7** when in place, and outside the area under that opening but in the area below the chamber-top, close to the chamber top end which bounds the opening for hopper **7**. The regulator extends substantially across the width of the chamber with sufficient clearance on each side to permit the said regulator to be moved easily without binding its side edges with the chamber sides. The regulator is longer than the perpendicular distance between its pivotal line and the chamber end **4**. A handle and indicator **22** attached rigidly to one pivot end outside the chamber enables the regulator to be swung away from or towards chamber end **4**, to control or shut off the flow of agglomerate charge. A "stop" member or holding bar **23** on the chamber side in the area over which the regulator handle moves, furnishes means for holding the handle **22** and flap **20** in a position determined by the desired size of passage past the said regulator. Within the chamber, are narrow aprons **24**, placed on the end **4** and adjacent to the sides thereof to converge inwardly so as direct the flow of metered charge away from these side walls.

When the machine is operating, the agglomerates to be flaked are fed by metered gravity flow through regulator **20**, and move onto the curved lower portion of end **4**, and into the path of the moving blades **17**, or **16** and **17** as the case may be. The metered material as it reaches the curved area of end **4** is caught as successive portions or aliquots between adjacent traveling blades which push the material from the said curved portion to and over the screen-fitted chamber floor towards hopper **9**.

The necessity or desirability for blades **16** such as shown in the embodiment in Figure 3 or for omission of such blades as shown in the embodiment of Figure 2 is determined by the flaking characteristics of the particular charge to be flaked, considering also its degree of friability and the form, compactness, and packing characteristics of the agglomerate to be subjected to the flaking operation. If the charge is in the form of readily crushable sheets of approximately one sixteenth inch thick, such as are normally found in the case of drum-dried, vat dyestuffs, it is easily disrupted and accordingly the stiff blades **16** are not needed. Under these conditions, the flaking rate of the machine may be markedly increased by removing blades **16** and spacing the resilient blades **17** more closely. Thus also it is preferred that the charge be so metered from flow regulator **20** that it forms a relatively thin layer of say up to 2 inches on the curved bottom portion **5** of the feed end of the machine so that the successive aliquot portions of charge moved into and over screen **2** by blades **17** are relatively small. By appropriately close spacing of blades **17**, say of the order of about 4 inches up to a foot apart, a high rate of flaking of the compact material per unit area of screen **2** may be achieved.

On the other hand, if the charge is fed at a high rate, or is of a sticky or lumpy character (resulting from e. g. defects in processing), such as may become rubbed down by the resilient blades into a compact mass which is overridden by the resilient blades, it is preferred to employ distributing blades **16** preceding each resilient blade **17** or preceding each of a succession of groups of two or more blades **17**. Blades **16** permit effective utilization of the entire or substantially entire area of screen **2** for flaking of this type of material which in terms of its bulk volume tends to be very rapidly flaked. When handling material under these conditions, it is preferred as indicated diagrammatically in Figure 3, to adjust flow regulator **20** to provide a metered charge rate such that the sheet-like charge forms a continually replenished pile above curved bottom **5** of sufficient depth that each successive blade **16** and **17** moves out of the pile and onto screen **2**, an aliquot portion of substantial depth. Then each blade **16** delivers its respective aliquot ahead of the adjacent following blade **17** at a metered rate which is a function of the space between the end of the blade **16** and screen **2**.

When the two types of blades are used, resilient blades **17** subject the agglomerate in the same manner as when they are used alone, to the shearing forces of the screen wire with a minimum of applied force normal to the screen.

In operation of either of the embodiments shown, flaked material of a desired size discharges from hopper **10** into a suitable receptacle, and any excess material carried entirely across the screen falls through chute **9**. Such excess, because of its history in the machine, is relatively free of dust and readily reworkable.

The machine, when in operation, also functions as a classifier to separate large agglomerates, e. g., crusts, which are not readily sheared. Such lumps are moved by the blades across the screen to the end chute and hopper which receive material that escapes flaking.

The number and arrangement of blades, the clearance between the ends of the "spreader" blades and the screen, the length of screen travelled, the rate of travel of the blades, and the rate of feed of material may be varied according to the requirements of the material to produce the desired flake form. For general use in the preparation of synthetic detergents and dyestuff compositions in the form of flakes, the apparatus of Figure 3 functions most satisfactorily when the spacing between the ends of the spreader blades and the screen is between one quarter inch and one inch, when flaking material through a screen of 2 mesh to 10 mesh per linear inch.

In general operation, the speed with which the belt travels can be varied, preferably between 1 foot per minute and 20 feet per minute. A slower speed than this is inefficient; a faster speed may carry too great an amount of material to the end chute and hopper and tends to form more fines. In all cases the nature of the material is a factor which must be taken into account in the adjustment of the machine.

In practice of the invention to flake a solid dry friable Carbanthrene Blue BCF (an anthraquinone vat dye of the chlorinated indanthrone type—C. I. 1113) in the form of biscuits the largest of which were about 2 inches long and about 1 inch thick, the apparatus provided four sections of 18" wide 4-mesh screen mounted in the bottom of a chamber of 8'–2½" overall length, the screens occupying approximately four feet of that length. The rolls **11** and **12**, each about 12" in diameter and 18" wide

were positioned with their center lines approximately one foot above the screens.

Flaking blades **17**, formed of ¼" thick rubber and in their unflexed state about 5½" wide and spaced about 12" apart, were mounted upon a neoprene coated belt which was suspended between the rollers. A ½ horsepower motor mounted on the frame, moved the belt at a speed of 15 feet per minute.

The agglomerate charge was admitted to the inlet chute of the machine as metered layer which as picked up by the successive blades had depth of about 1" to 2". The flaked material which passed through the screen-like floor of the machine into containers was sampled and examined for size by screening. A separate portion of the unflaked dye was hand expressed from a layer through a three-mesh screen of the same area. A sample of expressed material was also subjected to a screen test.

The machine flaked 800 lbs. material per hour through a 4-mesh screen, compared with 100 lbs. per hour through the same area of a 3-mesh screen by the expressing operation.

The results obtained by the screen tests were as follows:

Percent material retained on test screens

Mesh	Machine Ground	Hand Ground
6	2.0	1.6
8	13.8	5.6
10	27.4	9.8
14	49.6	18.2
20	75.6	39.3
80	98.4	95.9

MATERIAL THROUGH 80 MESH

	Percent
Machine ground	1.6
Hand ground	4.1

In the above table, a larger amount of material retained on a given mesh of screen is desirable, since this is a measure of production of desirably sized salable product to meet market demand. Thus, it may be observed that almost twice as much of the product is retained on a 20-mesh screen when the material is machine ground than when it is hand ground.

It was also clearly evident that hand expressing caused formation of much fine dust which results in an exceedingly unpleasant, dusty atmosphere in the vicinity of the grinding operation; but in contrast with this, the machine had no such dusty atmosphere about it during a period of eight hours of continuous operation.

The above specific example is only illustrative of the favorable production of flake form materials by means of one embodiment of this new method and apparatus. It is possible by the use of this process to efficiently reduce unsized particles of other friable materials such as other dyestuffs, dry detergents, etc., to suitable sized particles without the simultaneous production of any significant amount of fines. Another desirable result which follows from the successful operation of this process is the substantial elimination of the health hazard caused by dusty atmosphere.

I claim:

1. Apparatus for flaking agglomerated friable solid material which comprises a wire-screen containing surface, a support spaced from said surface, a plurality of stiff blades on said support extending therefrom toward said screen containing surface, the furthermost extensions of said stiff blades being spaced from said surface, a plurality of resilient blades on said support interspersed among said stiff blades and extending from said support to said surface to be in yieldable engagement therewith, and means to move said blades laterally across said surface.

2. Apparatus for flaking agglomerated friable solid material which comprises a flat wire-screen containing surface, an endless conveyor disposed above said surface and parallel thereto, a plurality of stiff blades extending from said conveyor toward said surface and terminating thereabove, a plurality of resilient blades on said conveyor interspersed among said stiff blades, said resilient blades extending from said conveyor to and being in yieldable engagement with said surface, and means to move said conveyor and blades across said surface.

3. Apparatus for flaking agglomerated friable solid material which comprises a feeding hopper for material to be flaked providing an inclined bottom surface, metering means cooperating with said surface to permit flow of said material as a layer of controlled depth between said metering means and said surface and into said machine, an outlet for residual unflaked material laterally spaced from the lowest portion of said inclined surface, a wire flaking screen extending between said inlet and outlet, a continuous conveyor disposed above and substantially parallel to said screen extending between said inlet and said outlet from above the lower portion of said inclined surface to above said outlet, a plurality of resilient blades mounted on said conveyor and extending toward said screen to be in yieldable engagement therewith, stiff blades mounted on said conveyer in interspersed relation with said resilient blades to extend toward but terminate above said screen, means for moving said conveyor and blades from said inlet to said outlet and a hopper below said screen for receiving flaked material.

4. Apparatus for flaking agglomerated friable solid material which comprises an enclosed flaking chamber provided with an inclined feed chute for material to be flaked, said chute being at one end of said chamber and terminating at the bottom thereof, an outlet for residual unflaked material disposed at the other end of said chamber and also within the chamber bottom, wire-screen containing means extending between the lower end of said chute and the upper end of said outlet to provide the remainder of said chamber bottom, a hopper disposed below said screen containing means for receiving flaked material, a continuous belt having a portion parallel to and above said chamber bottom to extend at least from said chute to said outlet, a series of resilient blades mounted on said belt portion and extending to said chamber bottom to be in yieldable engagement with said screen while substantially normal thereto, a stiff blade mounted on said belt between each pair of resilient blades to extend toward but terminate above said screen, means for moving said belt and blades from said inlet toward said outlet, and feed metering means associated with said chute for controlling the quantity of material to be flaked and delivered by the chute to said chamber bottom.

5. Apparatus for flaking agglomerated solid friable material which comprises a laterally extending wire screen, means for providing a continuous supply of such material including an apron substantially at the level of said screen and adjacent to one end thereof, mounting means parallel to and above said apron and screen to extend across the width thereof adapted for movement from said apron, thence lengthwise of said screen and parallel thereto, blades having a flexible lower edge suspended from said mounting means, said blades being of slightly greater width than the distance between said mounting means and said screen and being disposed substantially normal to said screen to have said lower edge slightly turned under, whereby upon movement across said screen said blades exert with respect to friable material before them a force predominantly parallel to said screen with but a small component normal thereto and against the wires thereof, and stiff blades suspended from the mounting means to extend toward and terminate above said screen, said stiff blades being interspersed between said first mentioned blades.

6. The process of flaking agglomerated friable material without substantial dusting of the same comprising pro-

viding a laterally extending wire screen surface, continuously feeding adjacent one end of said surface a bulk supply of agglomerated friable material of larger particle size than the openings of said screen, moving aliquot portions of said material from said supply across said screen and distributing such portions thereon as a layer of metered thickness, moving additional aliquot portions from said supply intermediate the movement of said first named aliquot portions, and moving the material of the last named aliquot portions together with such material within said layer across said screen by yieldable force predominantly parallel to said screen with but a small component normal to said screen, to form flakes by the shearing action of the screen wires, and recovering flaked material from below said screen.

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