Oct. 26, 1971 F. BONNERIC 3,615,044
DEVICE FOR REDUCING THE CROSS-SECTIONAL AREA OF A STREAM OF MATERIAL
Filed Feb. 12, 1969 4 Sheets-Sheet 1

FIG. 1

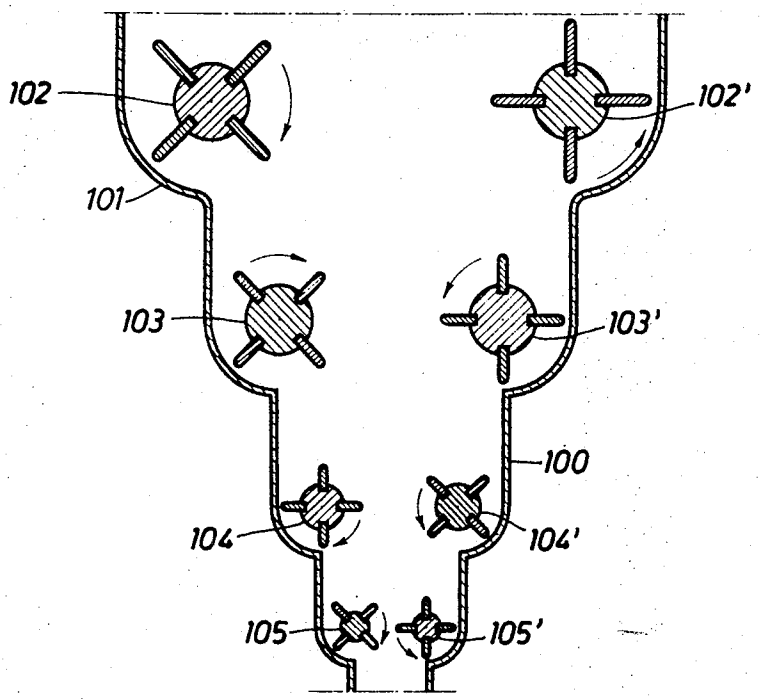

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FIG.2

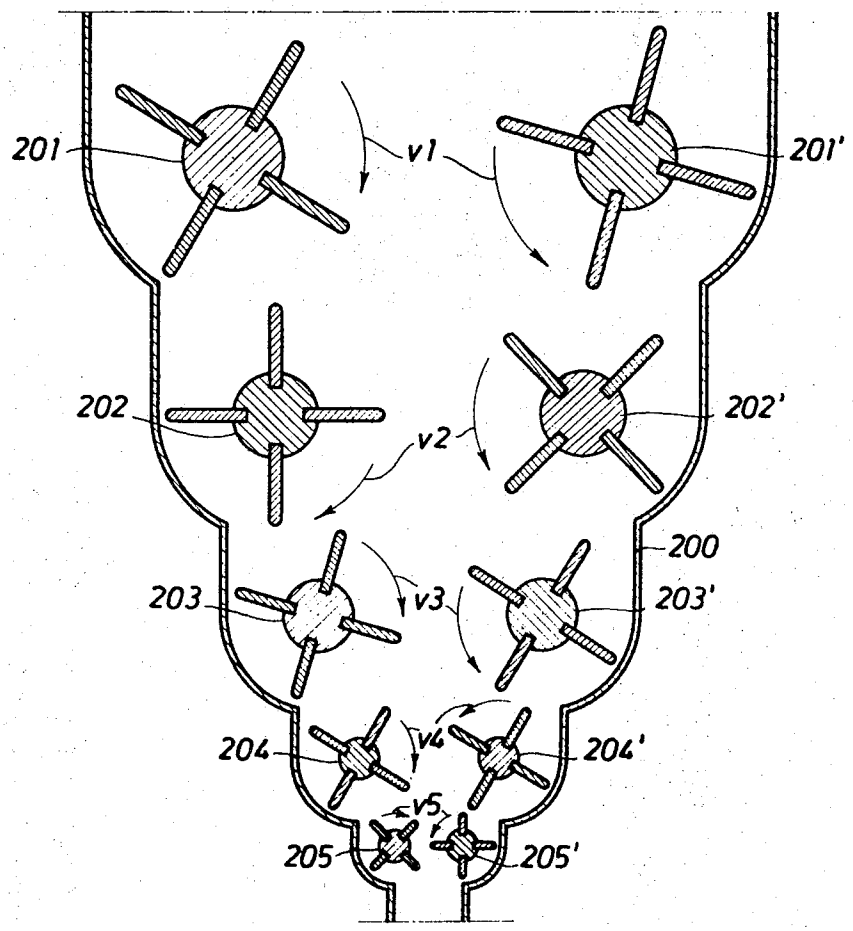

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FIG. 3

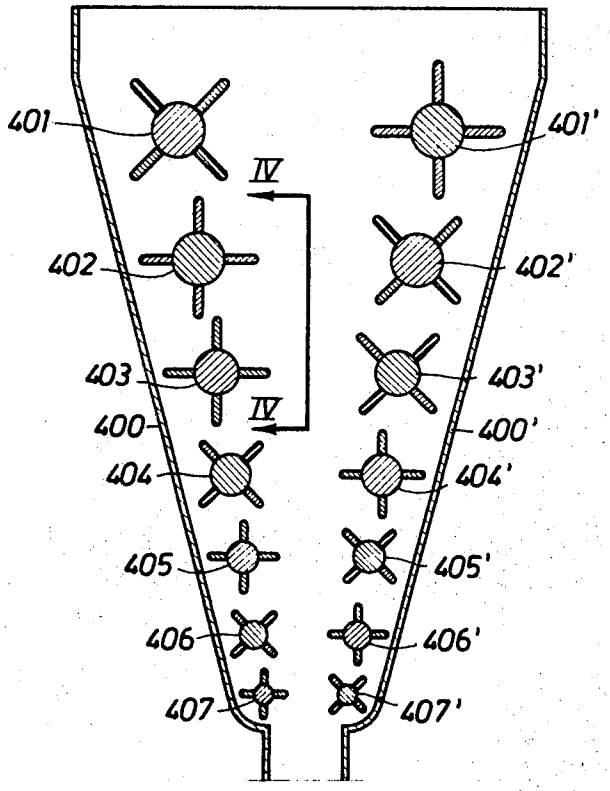

FIG. 4

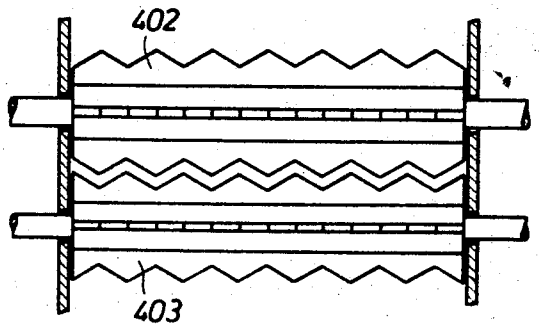

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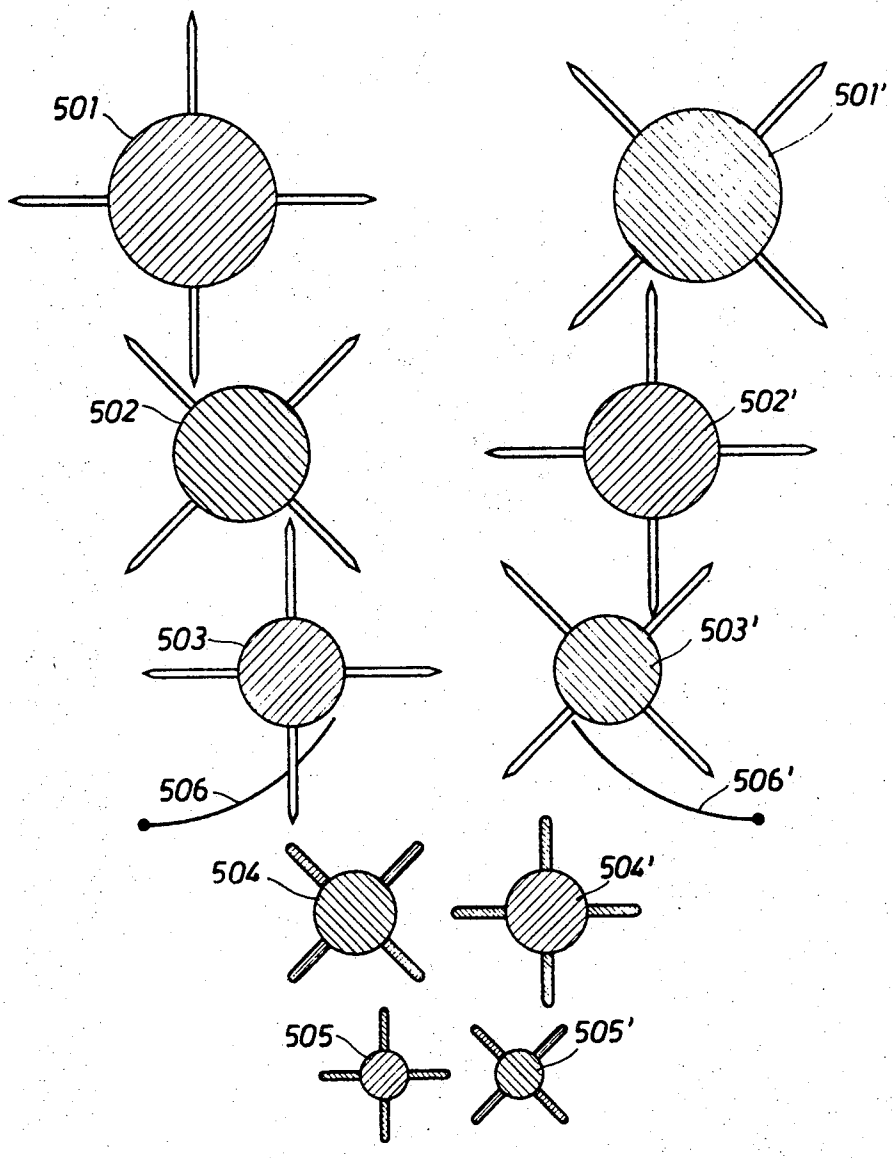
FIG.5



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3,615,044

DEVICE FOR REDUCING THE CROSS-SECTIONAL AREA OF A STREAM OF MATERIAL

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Int. Cl. G01f 13/00; B65g 65/46
U.S. Cl. 222—280 8 Claims

ABSTRACT OF THE DISCLOSURE

Distributor for processing a solid material in the divided state such as tobacco in the form of flakes or shreds and adapted to deliver continuously a uniform outflow of predetermined cross-sectional area starting from a nonhomogeneous input stream, said distributor being of the type comprising a passageway in which pairs of rotary units increase the velocity of the stream of material in proportion to the reduction in cross-sectional area of the passageway between the upstream and downstream side of the pair considered, wherein the rotary units of at least one pair are so designed as to provide therebetween a free cross-sectional area of flow which is not reached by the rotating components and which decreases in the downstream direction as a direct function of the reduction in overall diameter of the rotary units.

There have already been described in U.S. Pat. 3,450,311 different forms of distributors for processing a material in the divided state such as tobacco in the form of flakes or shreds, distributors of this type being capable of delivering a uniform outflow of predetermined cross-sectional area starting from a mass which may be homogeneous or not. The main common characteristic of these distributors lies in the fact that they comprise a passageway for the flow of the stream and that said passageway has narrowed portions with which flow-accelerating devices are associated. These devices are usually constituted by at least one and preferably two rotary units having axes located on each side of the passageway and substantially at right angles to the direction of the flow and can consist, for example, of two "brushes" such as vane-type paddle wheels which rotate in opposite directions and at the same velocity. The dimensions of the sets of paddle wheels were such that the entire cross-sectional area of the duct was swept. This arrangement is in fact convenient for assisting the process of drawing-out the material by producing an acceleration in the flow between the upstream end and the downstream end (in order to prevent compression of the material, the speed is in fact increased in a radio which is at least equal to the reduction in cross-sectional area). However, the arrangement referred to has the disadvantage of introducing causes of irregularity in the flow as a result of the successive narrowed portions and enlarged portions of the cross-sectional area afforded for the flow of material at the level of the paddle wheel axes. Although an increase in the acceleration pairs and a judicious choice of the ratios of rotational velocities thereof make it possible to attenuate the amplitude of the variations while increasing the frequency thereof, it has been found that even better results from this point of view could be obtained by forming at least in the majority of the pairs a free space outside the zone which is swept by the vanes of the paddle wheels considered, said space being correspondingly larger as the diameter of the paddle wheels is greater.

By forming between the upper pairs of paddle wheels a

space in which the stream of material is not subjected to any shearing, the need to retain "tranquilizing" zones between two successive pairs of paddle wheels is accordingly dispensed with. The advantage provided by these portions of duct which were usually of substantially constant cross-sectional area were twofold: on the one hand, they permitted a fluctuation in the level of material between two successive acceleration units and, on the other hand, they made it possible to prevent tearing as a result of a possible tractive force exerted on the long shreds of material which might otherwise be engaged with the paddle of two successive pairs. It can readily be understood that, by providing the material with a passageway which is free of any rotating component, these precautions no longer serve any useful purpose and can accordingly be dispensed with. The successive pairs of paddle wheels can even be brought together until the end trajectories of their components are made secant. It is apparent that, by reason of their different peripheral velocities, the paddle components will be in the form either of combs with interengaged teeth or of studs.

By making use of rotary components of the types last mentioned, any interruptions of the stream and compressions which are detrimental to stability of flow can be totally dispensed with and the material is drawn-out in a more satisfactory manner.

In a particularly advantageous form, it is possible to employ for the upstream portion of the distributor "secant" studded wheels having a low rotational velocity and ensuring drawing-out of the material without either compression of degradation, the wheels of one stage being intended to strip the upper stage and being stripped by the following stage whilst the last stage of this upstream section can in turn be stripped by means of comb-shaped scrapers.

In order to prevent degradation of the material paddle wheels having tangent vanes will be retained in the downstream section of the distributor in which the wheels are of small diameter and rotate at a high velocity.

If rotary components which are located on the same side of the duct and form part of two successive pairs sweep secant or even slightly distant volumes of revolution, the flow of material between the bottom portion of the upstream component and the wall of the duct will be prevented by the stripping action of the downstream component. In the case of wheels having a fairly large number of vanes or studs, it has been found that the effect of continuity was remarkable. It is therefore no longer necessary to ensure that the acceleration units are placed within shouldered portions formed by reductions in cross-sectional area of the duct. Narrowing of the duct need therefore be no longer provided in successive steps. Those walls of the duct which are adjacent to the end trajectories of the rotary components or "side walls" can be constituted by flat elements, for example. A simple and wholly continuous constructional assembly in thus obtained and particularly well suited to the distribution of heterogeneous material such as shredded tobacco.

It is thus apparent that the side walls need only have the function of a casing for the device as a whole in order to ensure cleanness and protection and need not be subjected to the direct pressure of the material.

In the case in which the wheels of the upstream section of the distributor are studded wheels, it is even possible to dispense with the side walls entirely.

In the event that the paddel wheels are all of the vane type, it can be an advantage to fabricate the side walls from a deformable material having a fairly high degree of flexibility in order to remain applied against the ends of the rotary components during at least a part of the inac-

tive trajectory of these latter. The material chosen can have a low coefficient of friction with respect to the material employed for the paddle vanes.

A number of forms of construction of distributors according to the invention are shown without any implied limitation in the accompanying drawings, in which:

FIG. 1 is a diagrammatic view in diametrical section showing a paddle wheel distributor of a type similar to that which is described in U.S. Pat. 3,450,311;

FIG. 2 is a view which is similar to the view of FIG. 1 but in which the paddles of the wheels which are located on the same side of the central flow path have substantially tangent end trajectories;

FIG. 3 is a view which is similar to the view of FIG. 2 but in which the casing has converging walls;

FIG. 4 is a detail sectional view taken along line IV—IV of FIG. 3, and

FIG. 5 is a view in diametrical section showing a distributor in which the casing has flat parallel walls and comprises secant studded paddle wheels.

In the example of FIG. 1, the apparatus is enclosed within a casing **101** having a shape which is similar to that of the apparatus described in the U.S. Pat. 3,450,311 although the reductions in cross-sectional area mainly concern only one of the transverse dimensions in the embodiment now under consideration. However, in this embodiment, a space is reserved between the points reached by the paddles of the wheels of a same pair such as **102, 103, 104** in the rotational motion of these latter in the direction of the curved arrows. Only the paddles of the pair **105** generate two tangent volumes of revolution and can thus serve as obturators in the inoperative condition. By reason of the high speed of rotation of said paddles, they accordingly exert a constraining action on the material during normal operation and cause the material to penetrate into the discharge duct of the device even if said duct is relatively narrow. On the other hand, the space reserved between the upper pairs of paddle wheels permits the flow of a central stream of material which has a decreasing cross-sectional area inasmuch as said space becomes smaller from the upstream end to the downstream end. However, the velocity of said stream increases since the speed of rotation of the successive pairs increases at a higher rate than the reduction in total cross-sectional area.

The apparatus which is illustrated in FIG. 2 differs from the apparatus shown in FIG. 1 in the fact that the paddles of the wheels which are located on the same side of the central stream have practically tangent end trajectories. These trajectories are partially surrounded by the bosses of the general casing **200** of the apparatus. The paddle wheels **201** and **201'** of the uppermost stage rotate in the direction of the arrows at the speed v_1 while leaving a free space therebetween which is a predetermined fraction of the diameter of the circle generated by the rotational motion of the paddles. Similarly, the paddle wheels **202** and **202'** rotate at the speed v_2, the paddle wheels **203** and **203'** rotate at the speed v_3 and the paddle wheels **204** and **204'** rotate at the speed v_4 while leaving between each pair spaces which decrease in the same ratio as the diameter of the circles generated by the paddles decrease from the upstream end to the downstream end. The corresponding diameters of the lowermost paddle wheels **205** and **205'** which rotate at the speed v_5 are even smaller but the volumes of revolution which surround the rotational path of the paddle tips are tangent. The speeds v_1 to v_5 increase in this order; for example, if v_1 is chosen as a basic speed, v_2 can be equal to $1.7v_1$, v_3 can be equal to $3.1v_1$, v_4 can be equal to $7.9v_1$ and v_5 can be equal to $51v_1$. Another range of possible speeds is v_1; $v_2=1.9v_1$; $v_3=3.7v_1$; $v_4=8.7v_1$ and $v_5=61v_1$. Passing from the first range to the second, drawing-out of the material is facilitated and any danger of clogging is prevented. In both cases, regulating intervals are suppressed by choosing numbers

which are incommensurable with each other in order to prevent any possible interference in the action of the paddle on the stream of material.

In the example of FIG. 3, the distributor comprises a moving system consisting of paddle wheels which have the same characteristics as those of the example of FIG. 2. In this example, however, there is on the one hand a convergence of the planes of the walls **400** and **400'** with the planes which virtually contain the axes of the paddle-type wheels **401** to **406** on the one hand and **401'** to **406'** on the other hand. Only the axes of the paddle wheels of the lowermost stage **407** and **407'** are located slightly inside the dihedron which is formed by the two planes last mentioned. The walls **400** and **400'** are preferably formed of semi-rigid polyamide which offers a degree of elasticity so as to provide for the possible event of a small quantity of tangled material being passed between the paddles of a high-speed wheel (lower stages) and a closely adjacent wall element. The paddle wheels of two adjacent stages **402** and **403** can have secant trajectories even when rotating at velocities which are independent of each other.

Starting from a tangled mass which is supplied intermittently, a distributor of this type which is employed for cut tobacco makes it possible to deliver a uniform outflow of constant density at a rate which can readily be controlled.

In the example of FIG. 5, the distributor comprises three stages with studded wheels having a low speed of rotation as designated by the references **501, 501'–502, 502'** and **503, 503'**, the paddle wheels of one stage being "secant" with respect to the corresponding, paddle wheels of the lower stage, two stages comprising paddle wheels with tangent paddles and having a high speed of rotation as designated by the references **504, 504'** and **505, 505'** and scrapers having comb-like teeth **506, 506'**.

In this embodiment in which the outer casing may be dispensed with, the studded wheels of one stage strip the uppermost stage and are in turn stripped by the lower stage whilst the lowermost stage **503, 503'** is in turn stripped by the comb teeth **506, 506'**.

In this first stage, drawing-out of the tobacco is carried out without compression and without degradation. In the second stage, drawing-out the tobacco is carried out by means of paddle-type wheels **504, 504', 505, 505'** in which the tobacco is drawn-out by means of compression surfaces having a very small separation interval.

What is claimed is:

1. A distributor for processing a solid material in the divided state such as tobacco in the form of flakes or shreds, said distributor being disposed to deliver continuously a uniform out flow of predetermined cross-sectional size, said out flow starting from a non-homogeneous input stream, said distributor comprising a passageway having a non-uniform cross-sectional area, said passageway having an upstream and a downstream portion, said area decreasing from said upstream portion to said downstream portion, a plurality of pairs of rotary units located respectively on each side of said passageway, said pairs of units disposed for increasing the velocity of said stream of material in proportion to said decrease of said cross-sectional area of said passageway between the upstream side and the downstream side of said pairs of units, and at least two pairs of said units providing therebetween a free cross-sectional area of flow, said area having a size such as not to be reached by the rotating components of said units and said area of flow disposed to decrease in the downstream direction in direct proportion to the decrease of the outside diameter of said rotary units.

2. A distributor according to claim **1**, and said decrease of said free cross-sectional area of flow having at least over the major part of said distributor a lower rate than the rate of said increase of said velocity of said pairs of said rotary units.

3. A distributor according to claim **1**, and at least one pair of studded paddle wheels disposed in said upstream portion on each side of said passageway.

4. A distributor for processing a solid material in the divided state such as tobacco in the form of flakes or shreds, said distributor being disposed to deliver continuously a uniform outflow of predetermined cross-sectional size, said outflow starting from a non-homogeneous input stream, said distributor comprising a passageway having a non-uniform cross-sectional area, said passageway having an upstream and a downstream portion, a plurality of pairs of rotary units located respectively on each side of said passageway, said pairs of rotary units disposed for increasing the velocity of said stream of material in proportion to said decrease of said cross-sectional area of said passageway between the upstream side and the downstream side of said pairs of units, at least two pairs of said units providing therebetween a free cross-sectional area of flow, said area having a size such as not to be reached by the rotating components of said units, said area of flow disposed to decrease in the downstream direction in a direct proportion to the decrease of the outside diameter of said rotary units, and at least two pairs of studded paddle wheels in said upstream portion, said paddle wheels having secant end trajectories and a low speed of rotation and being disposed on one stage to strip said paddle wheels of the preceding stage.

5. A distributor according to claim **4** said distributor comprising scraper elements mounted in such a manner as to strip the last stage of said upstream portion.

6. A distributor for processing a solid material in the divided state such as tobacco in the form of flakes or shreds, said distributor being disposed to deliver continuously a uniform outflow of predetermined cross-sectional size, said outflow starting from a non-homogeneous input stream, said distributor comprising a passageway having a non-uniform cross-sectional area, said passageway having an upstream and a downstream portion, a plurality of pairs of rotary units located respectively on each side of said passageway, said pairs of rotary units disposed for increasing the velocity of said stream of material in proportion to said decrease of said cross-sectional area of said passageway between the upstream side and the downstream side of said pairs of units, at least two pairs of said units providing therebetween a free cross-sectional area of flow, said area having a size such as not to be reached by the rotating components of said units, said area of flow disposed to decrease in the downstream direction in a direct proportion to the decrease of the outside-diameter of said rotary units, at least one pair of studded paddle wheels in said upstream portions and tangent paddle wheels in said downstream portion, said tangent paddle wheels having a small diameter and disposed for rotating at high speeds.

7. A distributor according to claim **3**, and comprising a protective casing having side walls, said casing being not subjected to the direct pressure of the material.

8. A distributor according to claim **7**, wherein said side walls of said casing are fabricated from a flexible deformable material so that said walls should remain applied against the ends of some rotary units during at least a part of the inactive rotation thereof.

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ROBERT G. SHERIDAN, Primary Examiner