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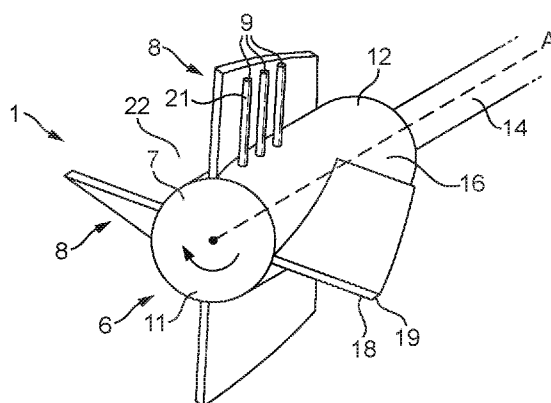


FIG. 1

(57) Abstract: The present invention relates to a rotary cutting apparatus for cutting a product extruded from an extruder into granules. The rotary cutting apparatus comprises a hub rotatable about an axis, an inlet configured to receive a product from an extruder in a direction extending along the axis. The rotary cutting apparatus further comprises a cutting arrangement extending from the hub. The cutting arrangement comprises a plurality of cutting elements. The cutting elements are spaced from one another in the direction along the axis of the hub. The present invention also relates to an apparatus for manufacturing extruded granules.



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Technical Field of the Invention

5 The present invention relates to a rotary cutting apparatus for manufacturing extruded granules from a product extruded from an extruder. More specifically, the present invention relates to a rotary cutting apparatus for manufacturing extruded tobacco based granules from a tobacco based product extruded from a tobacco based product extruder.

10

Background of the Invention

Extruded product can be severed using a rotary cutting apparatus. The extruded product is pushed through a die in order to acquire the required shape. As the product
15 is pushed out of the die, it passes through a plane in which a cutting element of the rotary cutting apparatus rotates so that lengths of product are cut from the extruded product.

The rate at which the product is extruded and the rate at which the rotary cutting
20 apparatus rotates are matched at a predetermined ratio such that the pieces cut from the extruded product have a predetermined length.

However, the rate at which the product is extruded from the die is not constant. This results in some cut pieces of product which are too long or too short and therefore lie
25 outside the required size distribution.

Summary of the Invention

In accordance with some embodiments described herein, there is provided a rotary
30 cutting apparatus for cutting a product extruded from an extruder into granules, the rotary cutting apparatus comprising a hub rotatable about an axis, an inlet configured to receive product from an extruder in a direction extending along the axis, and a cutting arrangement extending radially from the hub, the cutting arrangement comprising a plurality of cutting elements, the cutting elements being spaced from one
35 another in the direction along the axis of the hub.

Each cutting element may be configured to form a cut through a product extruded from an extruder being moved through the rotary cutting apparatus.

Each cutting element may comprise a cutting edge which extends in a plane
5 perpendicularly to the rotational axis of the hub.

The cutting arrangement may comprise a first cutting element located upstream in the direction along the rotational axis from at least one further cutting element.

10 In some embodiments, the at least one further cutting element may be spaced circumferentially from the first cutting element. The at least one further cutting element may be located circumferentially away from the first cutting element in the rotational direction of the hub.

15 Each cutting element that may be located downstream of the previous cutting element in the direction of the rotational axis of the hub is located circumferentially away from the previous cutting element in the direction of rotation of the hub.

The plurality of cutting elements comprise at least one of a cutting blade, a cutting
20 strip, or a cutting rod.

In some embodiments, the first cutting element may comprise a cutting blade. In some embodiments, the at least one further cutting element may comprise the cutting strip or
25 cutting rod.

The cutting rod may be flexible and may be maintained in a linear orientation by centrifugal force during use when the hub is rotated about its axis. In some
embodiments, the cutting rod may comprise a mass located at its radial outer end.

30 Optionally, the distance between adjacent cutting elements in the direction of the axis of the hub is in the range of 0.5 mm to 2 mm. In some embodiments, the distance between adjacent cutting elements in the direction along the axis of the hub may be the same. In some embodiments, the distance between adjacent cutting elements in the
direction along the axis of the hub may vary to produce different sized granules. That is,
35 the distance between a first set of adjacent cutting elements may be different to at least one distance between a second set of adjacent cutting elements.

In an embodiment, the rotary cutting apparatus may comprise a plurality of cutting arrangements located about the hub. In some embodiments, the plurality of cutting arrangements may be located equidistantly about the hub.

5

The rotary cutting apparatus may be configured to cut an extruded tobacco based product from an extruder into tobacco based granules.

10 In accordance with some embodiments described herein, there is also provided a granule manufacturing apparatus comprising an extruder and a rotary cutting apparatus comprising a hub rotatable about an axis, an inlet configured to receive product from an extruder, and a cutting arrangement extending radially from the hub, the cutting arrangement comprising a plurality of cutting elements, the cutting elements being spaced from one another in the direction along the axis of the hub.

15

The granule manufacturing apparatus may have a first mode of operation in which the rotational speed of the rotary cutting apparatus is matched to the extruding speed of the extruder such that the first cutting element is configured to cut an extruded product into granules of a predetermined size and the at least one further cutting element is
20 configured to cut an extruded product when the extruding speed of the extruder is accelerated due to pressure fluctuations.

The granule manufacturing apparatus may have a second mode of operation in which the rotational speed of the rotary cutting apparatus is matched to the extruding speed
25 of the extruder such that the first cutting element and at least one of the further cutting elements are configured to cut an extruded product into granules of predetermined sizes and at least one other further cutting element is configured to cut an extruded product when the extruding speed of the extruder is accelerated due to pressure fluctuations.

30

Brief Description of the Drawings

In order that the invention may be more fully understood, embodiments thereof will now be described, by way of example only, with reference to the accompanying
35 drawings, in which:

Figure 1 shows a schematic perspective view of a rotary cutting apparatus according to an embodiment of the present invention;

Figure 2 shows a schematic top view of the rotary cutting apparatus shown in Figure 1;

Figure 3 shows a schematic side view of the rotary cutting apparatus shown in Figures 1
5 and 2;

Figure 4 shows a schematic cross-sectional top view of a granule manufacturing apparatus during use; and

Figures 5a and 5b show schematic views of an extruded product before and after the product is cut by the rotary cutting apparatus.

10

Detailed Description of the Invention

As previously mentioned, to sever pieces of an extruded product using a rotating cutting apparatus. However, there are several problems associated with cutting an
15 extruded product using rotating cutting apparatuses. One of these problems is how to cut the extruded product into pieces which fall within a desired particle distribution range.

The problem of a rotary cutting apparatus cutting pieces or granules of extruded
20 product that are bigger than desired is caused by, amongst other things, a phenomenon termed as “pumping”. “Pumping” occurs when pressure gradients in the product to be extruded in the extruder result in product exiting the extruder at varying speeds. Not only can the speed at which the product is extruded vary with respect to time but also with respect to the spatial location of the product in the extruder die.

25

The source of the pressure fluctuations may originate from the force applied by the extruder or the extruder screws (not shown) on the product, which push the product through the extruder die and out of an outlet in the extruder, or from the frictional forces between the edge of the extruder die and the product being forced through the
30 die.

The pressure fluctuations can cause product to move quickly through the die due to the nature of the transition area from the extruder screws and the die. Acceleration of the product may be due to the restriction in cross-sectional area between the extruder and
35 the die. As the cross-sectional area reduces the product accelerates. However, as the screw rotates, the end of the screw rotates past some of the outlets of the extruder such

that product cannot exit the outlets covered by the end of the screw at that point and the pressure in this area of the product can increase. Therefore, once the end of the screw moves away from that outlet, the speed at which the product exits that outlet of the die may dramatically increase for a short amount of time.

5

The pressure fluctuations are emphasised by the moisture content of the product being extruded, especially if the moisture content of the product is too low. This is particularly relevant in the manufacture of extruded granules for the tobacco products industry. An extruded product whose moisture content is too low is fragile and results
10 in a large amount of dust generation if the rotational speed of the rotary cutting apparatus is too large which cause a large amount of product waste. To overcome dust generation, the rotary cutting apparatus can be rotated at a slower speed but this reduces output.

15 In order to overcome the phenomenon of “pumping” the moisture content of the product to be extruded may be increased. However, where an extruded product contains too high a moisture content, the cut pieces or granules require drying after they have been cut. A disadvantage of a product having too high a moisture content when it is cut is that the product requires drying after it is cut which results in the
20 flashing off of nicotine in the product, reducing the product’s nicotine content.

The present invention aims to solve the above mentioned problems by providing an improved rotary cutting apparatus.

25 Referring to Figure 1, there is shown a first embodiment of a rotary cutting apparatus 1 according to the present invention. The rotary cutting apparatus 1 is for cutting a product 3 extruded from an extruder 4 into granules 2, examples of which are shown in Figure 5a and Figure 5b. The rotary cutting apparatus 1 comprises hub 7 rotatable about an axis A, an inlet 6 configured to receive the extruded product 3 from the
30 extruder 4 in a direction extending along the axis A. The rotary cutting apparatus 1 further comprises a cutting arrangement 8 which extends radially from the hub 7. The cutting arrangement 8 comprises a plurality of cutting elements 9. The cutting elements 9 are spaced from one another in the direction of the rotational axis A of the hub 7.

35 One advantage of such an apparatus is that variations in the product extrusion speed do not result in cut pieces, particles, or granules 2 of product which are too long. That is,

the plurality of spaced cutting elements 9 ensure that the cut granules 2 are within a predetermined particle size distribution regardless of the speed variation of the product 3 due to “pumping”.

5 The rotary cutting apparatus 1 and the extruder 4 form a granule manufacturing apparatus 10, as illustrated in Figure 4, when the rotary cutting apparatus 1 is mounted in position relative to the extruder 4. In the present embodiment that is described, the rotary cutting apparatus 1 is configured to cut an extruded tobacco based product 3
10 extruded from a tobacco based product extruder 4 into granules. However, it will be appreciated that in an alternative embodiment, the rotary cutting apparatus 1, and extruder 4, may be configured to cut granules 2 from a different extruded product 3. The hub 7 of the rotary cutting apparatus 1 is rotatable about its rotational axis A which coincides with a longitudinal axis of the hub 7. The rotational axis A of the hub 7 extends through the centre of the hub 7. Preferably, the rotational axis A of the hub 7
15 extends substantially parallel to the direction of movement of the extruded product 2, as will be described in more detail hereinafter. In the present embodiment, the hub 7 of the rotary cutting apparatus 1 is cylindrical, although it will be appreciated that the hub may be some other shape in an alternative embodiment.

20 The hub 7 comprises a first end 11 and an opposing second end 12. The first end 11 is configured to be located proximate the inlet 6, as will be described in more detail hereinafter, and the second end 12 is configured to be located distal to the inlet 6. That is, the first end 11 of the hub of the rotary cutting apparatus 1 is to be located proximate to an outlet 13 of the extruder 4, shown in Figure 4.

25 The hub 7 further comprises a side or joining surface 16. The joining surface 16 connects the first and second ends 11, 12 of the hub 7. The hub 7 may comprise as many joining surfaces 16 as the number of sides of the first and second ends 11, 12. In the present embodiment, the first and second end 11, 12 are the same size and centred on
30 the rotational axis A of the hub 7 so that the cylindrical joining surface 16 is parallel to the rotational axis A. In other embodiments, joining surfaces 16 may extend at an angle to the rotational axis A when the first and second ends 11, 12 of the hub 7 are different sizes.

35 The first end 11 of the hub 7 is configured such that its diameter is less than the distance between opposing outlets 13 of the extruder 4. The hub 7 may be positioned in between

the outlets 13 of the extruder 4 when the rotary cutting apparatus 1 and the extruder are connected to form the granule manufacturing apparatus 10. In this way, the first end 11 of the hub 7 does not prevent product 2 to be cut into granules 3 from exiting the outlets 13 of the extruder 4. Such a configuration of the hub 7 allows outlets 13 of the extruder 4 to be arranged in an annular pattern around the hub 7 which maximises output.

In the present embodiment, the second end 12 of the hub 7 of the rotary cutting apparatus 1 is connected to a shaft 14. The shaft 14 and the hub 7 have a common central rotational axis A about which they both rotate. The shaft 14 is connected to a motor which drives the hub 7 in its rotational movement. In an alternative embodiment, the rotatable hub 7 may be connected directly to the motor.

The first end 11 of the hub 7 is configured to be placed against a surface 15 of the extruder 4, as shown in Figure 4, or at least substantially against the surface 15 of the extruder 4. The hub 7 may comprise a bearing (not shown) mounted on its first end 11 to reduce friction between the first end 11 of the hub 7 and the surface 15 of the extruder 4.

Preferably, the first end 11 of the hub 7 is located as close to the surface 15 of the extruder 4 as possible such that the first end 11 of the hub 7 and the surface 15 of the extruder extend in substantially the same plane. In some embodiments, the first end 11 of the hub 7 may extend in a plane parallel to and spaced from the plane in which the surface 15 of the extruder 4 extends by a predetermined distance. This predetermined distance may be as small as possible to minimise the distance between the hub 7, and therefore the cutting arrangement 8, and the extruder, i.e. within a given tolerance.

In the present embodiment, the rotational axis A of the hub 7 extends substantially perpendicularly to the surface 15 of the extruder 4 in which the outlets 13 are located. Therefore, the direction in which the product 3 is extruded and the rotational axis A of the hub 7 are substantially parallel.

Referring back to Figure 1, the rotary cutting apparatus 1 further comprises the cutting arrangement 8. The cutting arrangement 8 extends radially from the hub 7 relative to the rotational axis A. The cutting arrangement 8 extends from a joining surface 16 of the hub 7. That is, the cutting arrangement 8 may extend radially from the hub 7 by

either extending perpendicularly to the axis A about which the hub 7 rotates or, alternatively, by extending at an angle to the axis A about which the hub 7 rotates.

5 As illustrated in Figures 1 to 3, the rotary cutting apparatus 1 may comprise a plurality of cutting arrangements 8. The plurality of cutting arrangements 8 are spaced around the hub 7 such that they are spaced angularly from each other about the rotational axis A of the hub 7. In some embodiments, the plurality of cutting arrangements 8 may be equidistantly spaced around the hub 7 such that the plurality of cutting arrangements 8 are spaced equally about the rotational axis A of the hub 7.

10

Advantageously, by having a plurality of cutting arrangements 8 spaced about the hub 7, the number of pieces, particles, or granules 2 cut from an extruded product 3 during one full rotation of the hub 7 can be greatly increased. Furthermore, a greater number of pieces, particles, or granules 2 can be cut from the extruded product 3 without
15 having to greatly increase the rotational speed of the hub 7. In addition, the length of product which passes out of the extruder 4 between each passing cutting arrangement 8 is less. Therefore, size of the pieces, particles, or granules 2 can be reduced without having to greatly increase the rotational speed of the hub 7 or reduce the extrusion speed due to less product 3 exiting an outlet 13 of the extruder 4 in the time it takes for
20 an adjacent cutting arrangement 8 to be rotated past said outlet 13.

A cutting arrangement 8 comprises a plurality of cutting elements 9. The cutting elements 9 are spaced from one another in the direction of the rotational axis A of the hub 7, as shown in Figure 2. That is, the cutting elements 9 are located at different
25 distances from the first end 11 of the hub 7 in the longitudinal direction.

Each of the cutting elements 9 is configured to form a cut through an extruded product 3 which is moved through the rotary cutting apparatus 1. As the extruded product 3 is moved through the rotary cutting apparatus 1 parallel to the rotational axis A of the hub
30 7 and the cutting elements 9 extend radially from the hub 7. That is, each cutting element 9 may extend perpendicularly to the axis A about which the hub rotates 7, such that the cut formed through the extruded product 3 also extends perpendicularly to the axis A of the hub 7, or each cutting element 9 may extend at an angle to the axis A of the hub 7.

35

Therefore, if the extruded product 3 exits an outlet 13 of the extruder 4 at an accelerated speed, the cutting elements 9 spaced further from the first end 11 of the hub 7 can cut the extruded product 3. Therefore, the extruded product 3 is not only cut from the product 3 exiting the extruder 4 but is also subdivided into smaller pieces, particles, or granules 2.

This results in cut pieces, particles, or granules 2 of product 3 which are not too long and that are more likely to fit within a predetermined particle size distribution regardless of the speed variation of the product 3 due to "pumping".

10

Each of the cutting elements 9 comprises a cutting edge 18. In the present embodiment, each cutting edge 18 is configured to extend in a plane which extends substantially perpendicularly to the rotational axis A of the hub 7. Therefore, the cut formed in the extruded product 3 is perpendicular to the rotational axis A of the hub 7. The cutting edge 18 of a cutting element 9 is formed by a leading edge of the cutting element 9 in the rotational direction of travel about the rotational axis A of the hub 7.

Preferably, the cutting edge 18 extends from the hub 7 to a radially outer end 19 of each cutting element 9. Therefore, the length of each cutting element 9 can be used to sever pieces, particles, or granules 2 from the extruded product 3.

In the present embodiment, the distance between adjacent cutting elements 9 in the direction of the rotational axis A of the hub 7 is in the range of 0.5 mm to 2 mm. However, it will be appreciated that in an alternative embodiment, the distances between adjacent cutting elements 9 may be different to those stated depending on the product 3 being extruded and the particle size distribution of the pieces, particles, or granules 2 required.

Advantageously, the distances between the cutting elements 9 can be chosen so as to produce granules 2 of a predetermined, required size. The required size of the granules 2 may be the same or a variety which can be achieved by adapting the spacing between adjacent cutting elements 9 accordingly.

In the present embodiment of the rotary cutting apparatus 1, the extruded tobacco based granules 2 can be used in a hybrid NGP. Therefore, granules 2 in the range of 0.5 mm to 2mm can be used to contribute to a smooth vapour flow and tobacco taste.

In some embodiments, the distance between adjacent cutting elements 9 in the direction of the rotational axis A of the hub 7 may be the same. In some embodiments, the distance between adjacent cutting elements 9 in the direction of the rotational axis A of the hub 7 may vary to produce different sized granules 2. That is, the distance
5 between a first set of adjacent cutting elements 9 may be different to at least one distance between a second set of adjacent cutting elements 9. Advantageously, different distances between the cutting elements 8 allows all the granules 2 needed for a NGP device can be cut using a single rotary cutting apparatus 1.

10

Referring to Figure 2, the cutting arrangement 8 of the rotary cutting apparatus 1 comprises a first cutting element 21. The first cutting element 21 is located upstream from at least on further cutting element 9. The first cutting element 21 is located the furthest upstream of the cutting elements 9, or the cutting element 9 closest to the first
15 end 11 of the hub 7 and closest to the outlets 13 of the extruder 4 in use. That is, the cutting edge 18 of the first cutting element 21 is located the furthest upstream of the cutting edges 18 of the cutting elements 9.

Therefore, extruded product 3 exiting through an extruder outlet 13 within a full
20 rotation of the rotary cutting apparatus 1 can be cut. Furthermore, equally sized granules 2 can be cut from the extruded product 3 throughout the full rotation of the rotary cutting apparatus 1.

Preferably, the cutting edge 18 of the first cutting element 21 of the cutting arrangement
25 8 is located in the plane in which the first end 11 of the hub 7 extends. That is, the cutting edge 18 of the first cutting element 21 is “flush” with the first end 11 of the hub 7. Therefore, when the first end 11 of the hub 7 is placed substantially against the surface 15 of the extruder 4, as described above, the cutting edge 18 of the first cutting element 21 is also placed substantially against the surface 15 of the extruder 4. This
30 allows the cutting arrangement 8 to sever the extruded product 3 from the point at which it exits the outlets 13 of the extruder 4.

Furthermore, a gap 22 between the first cutting elements 21 of adjacent cutting arrangements 8, as shown in Figures 1 to 3, defines the inlet 6 of the rotary cutting
35 apparatus 1. Therefore, the inlet 6 to the rotary cutting apparatus 1 is located at the end of the apparatus 1 proximate to the extruder 4 when in use. More specifically, the inlet 6

to the rotary cutting apparatus 1 is located in the plane of the first end 11 of the hub 7. Furthermore, the inlet 6 is the plane extending between the first cutting elements 21 of adjacent cutting arrangements 8.

5 The inlet 6 is configured to receive the extruded product 3 from at least one of the outlets 13 of the extruder 4 so that the product 3 may extend far enough into the rotary cutting apparatus 1 beyond the first cutting element 21 to be severed by at least one of the plurality of cutting elements 9 of a cutting arrangement 8.

10 As shown in Figure 2, the cutting arrangement 8 comprises at least one further cutting element 23. The present embodiment, illustrated in Figure 2, shows that the cutting arrangement 8 comprises three further cutting elements 23. Each of the further cutting elements 23 are located downstream of the first cutting element 21, i.e. the cutting edges 18 of the further cutting elements 23 are located further from the first end 11 of
15 the hub 7 than the cutting edge 18 of the first cutting element 21.

In the present embodiment, the cutting edges 18 of the first cutting element 21 and the further cutting elements 23 are only spaced in direction along the axis A of the hub 7, i.e. the longitudinal direction. However, in an alternative embodiment, at least one of
20 the cutting elements 23' may be spaced circumferentially from the first cutting element 21. The circumferentially spaced cutting elements 23' are shown in dotted lines in Figure 2.

Preferably, the at least one further cutting element 23' is located circumferentially away
25 from the first cutting element 21 in the rotational direction of the hub 7. Therefore, the cut can be performed by the at least one further element 23' whilst the product 3 is still attached to product 3 being extruded from the extruder 4. Therefore, the product 3 is anchored at the outlet 13 of the extruder 4 and a clean cut can be performed without too much dust generation.

30 Even more preferably, as shown in dotted lines in Figure 2, each further cutting element 23' that is located downstream of the previous cutting element 21, 23' in the direction of rotational axis A of the hub 7 is located circumferentially away from the previous cutting element 21, 23' in the direction of rotation of the hub 7. The
35 circumferential spacing of the cutting elements 8, 21, 23, 23' helps to prevent the gaps

between the cutting elements from becoming clogged by cut pieces 2 of extruded product 3.

5 The cutting elements 8 may be formed by for example, but not limited to, a cutting blade, a cutting strip with a rectangular cross section, or a cutting rod with a circular cross section. As illustrated, the first cutting element 21 of the present embodiment is a cutting blade. The cutting blade of the first cutting element 21 extends at an angle to the rotational axis A of the hub 7 and is configured to direct granules 2 towards a storage or collection container (not shown).

10

Furthermore, in the present embodiment, the further cutting elements 23, 23' are cutting rods. The cutting rods of the further cutting elements 23, 23' are thin cylindrical rods. The at least one further cutting elements being formed by cutting strips or cutting rods helps to minimise the risk of a gap between adjacent cutting elements becoming
15 clogged.

The cutting rods of the further cutting elements 23 may be flexible, especially due to their thin physical dimensions. Therefore, in use, the cutting rods of the further cutting elements 23, 23' are kept in straight or linear orientation by centrifugal force from the
20 rotation of the hub 7. In some embodiments, the cutting rods of the further cutting elements 23, 23' may further comprise a mass 25, shown in Figure 4, located on the radially outer end 19 of the cutting element 23, 23'. The mass 25 located on the radially outer end 19 of the cutting elements 23, 23' helps to keep the cutting rod in a linear orientation during use. The centrifugal force ensures that the cutting rod follows the
25 same path on each rotation of the hub and therefore, cuts identically sized pieces of extruded product.

It will be appreciated that in an alternative embodiment, any of the cutting elements 8 may be one of at least, a cutting blade, a cutting strip, or a cutting rod.

30

The present embodiment is a rotary cutting apparatus for manufacturing extruded tobacco based granules from a tobacco based product extruded from a tobacco based product extruder. However, it will be appreciated that in alternative embodiment, the rotary cutting apparatus may be for manufacturing extruded pieces, particles, or
35 granules from another type of product extruded from an extruder.

Referring briefly to Figure 4, the granule manufacturing apparatus 10 is shown with the rotary cutting apparatus 1 and extruder 4 placed relative to one another.

5 The granules manufacturing apparatus 10 may be operated in a first mode. In the first mode of operation, the rotation speed of the rotary cutting apparatus 1 may be matched to the extruding speed of the extruder 4 such that only the first element 21 is configured to cut the extruded product 3 into granules of a predetermine size. That is, the first cutting element 21 is configured to be rotated past an outlet 13 after a predetermined length of product 3 has been pushed out of the outlet 13.

10

In such a mode of operation, the at least one further cutting element 23, 23' is configured to cut the extruded product 3 only in the event of pumping, i.e. when the length of product 3 pushed out of the outlet 13 of the extruder 4 is more that the predetermined length. In such a situation, the further cutting elements 23, 23' will
15 subdivide the length of product 3 into granules 2 which will fall inside the required particle size distribution.

The granules manufacturing apparatus 10 may also be operated in a second mode. In the second mode of operation, the rotation speed of the rotary cutting apparatus 1 is
20 match to the extruding speed of the extruder 4 such that the first cutting element 21 and at least one of the further cutting elements 23, 23' are configured to cut the extruded product 3 into granules 2. That is, the first cutting element 21 and at least one further cutting element 23 are configured to be rotated past an outlet 13 after a predetermined length of product 3 has been pushed out of the outlet 13 to sever
25 granules 2 from the product 3.

In such a mode of operation, at least one other further cutting element 23, 23' is configured to cut the extruded product 3 only in the event of pumping, i.e. when the length of product 3 pushed out of the outlet 13 of the extruder 4 is more that the
30 predetermined length. In such a situation, the at least one other further cutting element 23, 23' will subdivide the length of product 3 into granules 2 which will fall inside the required particle size distribution. Such a mode of operation is shown in Figure 4, with the first cutting element 21 omitted for clarity.

35 The extruder 4 of the granule manufacturing apparatus 10 comprises a trough which is configured to receive the product 3 to be extruded. The trough may comprise an inlet so

that product can be continuously fed into the extruder 4. The extruder 4 further comprises a pump, powered by a motor. The pump is configured to urge the product 3 along the trough. The pump may be, for example, a screw. The extruder 4 may further comprise an extruder head. As the screw rotates, it urges product along the trough,
5 through the extruder head into a die. The die comprises a plurality of outlets through which the product is forced to be cut by the rotary cutting apparatus 1.

In one embodiment, the product 3 may be an aerosolisable material. An aerosolisable material, which also may be referred to herein as aerosol generating material, is
10 material that is capable of generating aerosol, for example when heated, irradiated or energized in any other way. Aerosolisable material may, for example, be in the form of solid, liquid or gel which may or may not contain nicotine and/or flavourants. In some embodiments, the aerosolisable material may comprise an “amorphous solid”, which may alternatively be referred to as a “monolithic gel” (i.e. non-fibrous). In some
15 embodiments, the amorphous solid may be a dried gel. The amorphous solid is a solid material that may retain some fluid, such as liquid, within it. In some embodiments, the aerosolisable material may for example comprise from about 50wt%, 60wt% or 70wt% of amorphous solid, to about 90wt%, 95wt% or 100wt% of amorphous solid.

20 The various embodiments described herein are presented only to assist in understanding and teaching the claimed features. These embodiments are provided as a representative sample of embodiments only, and are not exhaustive and/or exclusive. It is to be understood that advantages, embodiments, examples, functions, features, structures, and/or other aspects described herein are not to be considered limitations
25 on the scope of the invention as defined by the claims or limitations on equivalents to the claims, and that other embodiments may be utilised and modifications may be made without departing from the scope of the claimed invention. Various embodiments of the invention may suitably comprise, consist of, or consists essentially of, appropriate combinations of the disclosed elements, components, features, parts, steps,
30 means, etc, other than those specifically described herein. In addition, this disclosure may include other inventions not presently claimed, but which may be claimed in the future.

Claims

1. A rotary cutting apparatus for cutting a product extruded from an extruder into granules, the rotary cutting apparatus comprising:
 - 5 a hub rotatable about an axis;
 - an inlet configured to receive product from an extruder in a direction extending along the axis; and
 - a cutting arrangement extending from the hub,
 - the cutting arrangement comprising a plurality of cutting elements, the cutting
 - 10 elements being spaced from one another in the direction along the axis of the hub.
2. The rotary cutting apparatus according to claim 1, wherein each cutting element is configured to form a cut through a product extruded from an extruder being moved through the rotary cutting apparatus.
- 15 3. The rotary cutting apparatus according to claim 2, wherein each cutting element comprises a cutting edge which extends in a plane perpendicular to the axis of the hub.
4. The rotary cutting apparatus according to any preceding claim, wherein the
- 20 cutting arrangement comprises a first cutting element located upstream from at least one further cutting element.
5. The rotary cutting apparatus according to claim 4, wherein the at least one further cutting element is spaced circumferentially from the first cutting element.
- 25 6. The rotary cutting apparatus according to claim 5, wherein the at least one further cutting element is located circumferentially away from the first cutting element in the rotational direction of the hub.
- 30 7. The rotary cutting apparatus according to claim 6, wherein each cutting element that is located downstream of the previous cutting element in the direction along the axis of the hub is located circumferentially away from the previous cutting element in the direction of rotation of the hub.

8. The rotary cutting apparatus according to one of claims 4 to 7, wherein the plurality of cutting elements comprises at least one of a cutting blade, a cutting strip, or a cutting rod.

5 9. The rotary cutting apparatus according to claim 8, wherein the first cutting element comprises a cutting blade.

10. The rotary cutting apparatus according to claim 8 or claim 9, wherein the at least one further cutting element comprises the cutting strip or the cutting rod.

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11. The rotary cutting apparatus according to one of claims 8 to 10, wherein the cutting rod is flexible and is maintained in a linear orientation by centrifugal force during use when the hub is rotated about its axis.

15 12. The rotary cutting apparatus according to claim 11, wherein the cutting rod comprises a mass located at its radial outer end.

13. The rotary cutting apparatus according to any one of the preceding claims, wherein the distance between adjacent cutting elements in the direction of the axis of
20 the hub is in the range of 0.5 mm to 2 mm.

14. The rotary cutting apparatus according to claim 13, wherein the distance between adjacent cutting elements in the direction along the axis of the hub is the same.

25

15. The rotary cutting apparatus according to claim 13, wherein the distance between adjacent cutting elements in the direction along the axis of the hub vary to produce different sized granules.

30 16. The rotary cutting apparatus according to any one of the preceding claims, comprising a plurality of cutting arrangements located about the hub.

17. The rotary cutting apparatus according to claim 16, wherein the plurality of cutting arrangements are located equidistantly about the hub.

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18. The rotary cutting apparatus according to any preceding claim, wherein the rotary cutting apparatus is configured to cut an extruded tobacco based product from an extruder into tobacco based granules.

5 19. A granule manufacturing apparatus comprising a product extruder and a rotary cutting apparatus according to any one of the preceding claims.

20. The granule manufacturing apparatus according to claim 19, wherein in a first mode of operation the rotational speed of the rotary cutting apparatus is matched to the
10 extruding speed of the extruder such that the first cutting element is configured to cut an extruded product into granules of a predetermined size and the at least one further cutting element is configured to cut an extruded product when the extruding speed of the extruded product is accelerated due to pressure fluctuations.

15 21. The granule manufacturing apparatus according to claim 19, wherein in a second mode of operation the rotational speed of the rotary cutting apparatus is matched to the extruding speed of the extruder such that the first cutting element and at least one of the further cutting elements are configured to cut an extruded product into granules of predetermined sizes and at least one other further cutting element is
20 configured to cut an extruded product when the extruding speed of the extruded product is accelerated due to pressure fluctuations.

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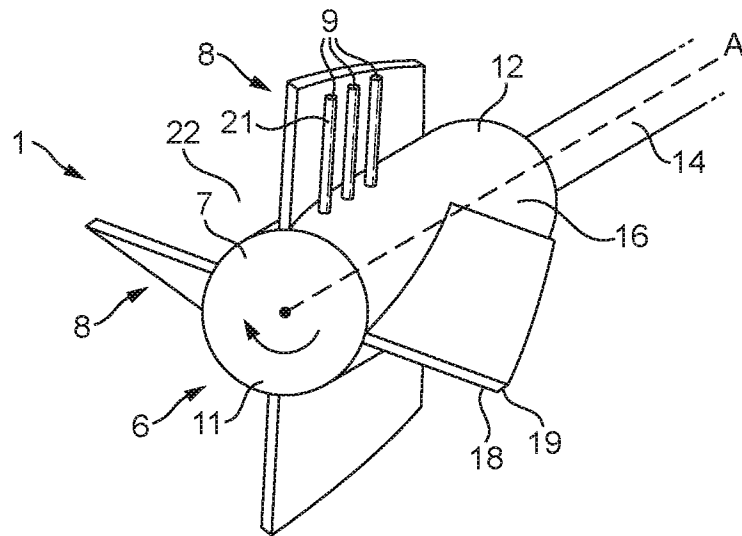


FIG. 1

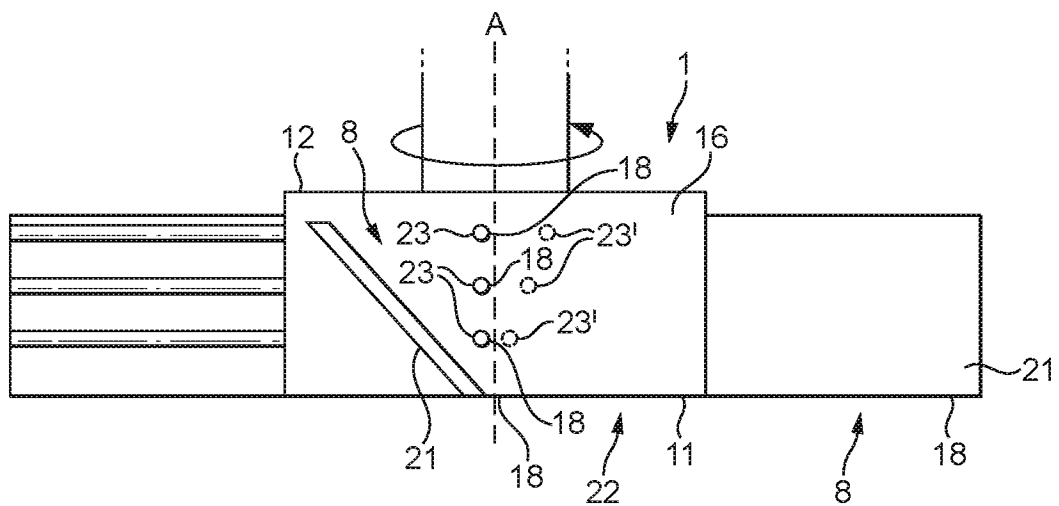


FIG. 2

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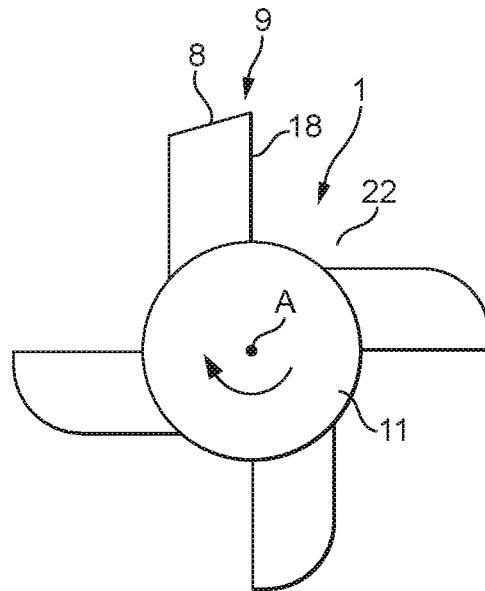


FIG. 3

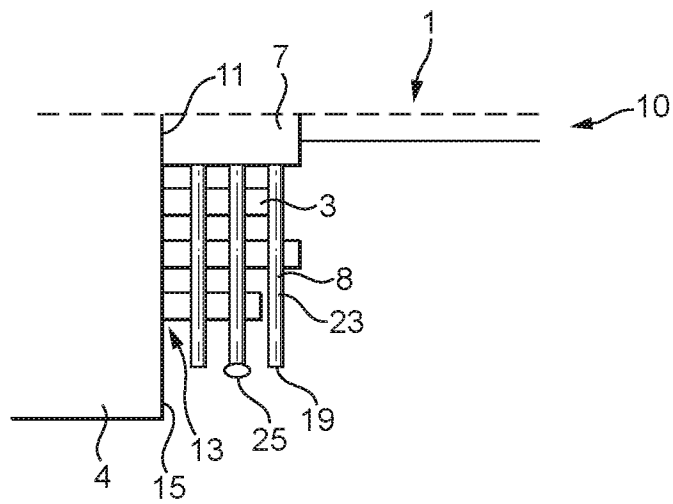


FIG. 4

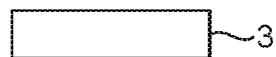


FIG. 5a

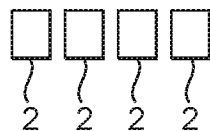


FIG. 5b

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2020/050993

A. CLASSIFICATION OF SUBJECT MATTER

INV. B26D1/28 B26D3/16 B29B9/06
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

B26D B29B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	DE 10 77 190 B (LONZA AG) 10 March 1960 (1960-03-10) abstract; figures	1
A	US 4 514 165 A (BUSSEY JR HARRY [US]) 30 April 1985 (1985-04-30) abstract; figures	1
A	US 2014/306370 A1 (DISPENZA MATTHEW JOSEPH [US] ET AL) 16 October 2014 (2014-10-16) abstract; figure 2	1



Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

10 July 2020

Date of mailing of the international search report

05/10/2020

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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