Technical Field

The invention relates to a rotor of a separator, a separator including the rotor and a full feed combine.

Background

A separator is a main component of a full feed combine and a thresher which is used to flail the grain from the spikes and separate seeds from straws as many as possible.

The separator generally includes two types: full-feed type and half-feed type. A full feed thresher transmits all the crops into the separator; and during operation of a half feed thresher, the end portions of the stems is clamped and thus only the seeds enter into the separator.

Depending on the characteristics of the separator, the full feed separator includes two types according to the direction along which the crops move in the rotor: tangential-flow type and axial-flow type.

In the tangential flow separator, the crops flows in the rotor along its tangent and flow out, during which threshing is performed between the rotor and the concave plate. The type of these separators includes a rasp bar rotor separator, a spiked rotor separator and a double-rotor separator.

In the axial flow separator, the crops perform rotation and axial motion. Thus compared with the tangential flow separator, the turns or the length the crops make in the separator is more or longer. In this way, the crops can be thresh and separated at the same time, which improves the threshing performance and decreases damage rate.

As shown in Fig. 1, the axial flow rotor separator is composed of a separator rotor 100, a lattice concave plate 200 and a top cover 300, etc. The concave plate 200 and the top cover 300 forms a cylinder enclosing the rotor. During the threshing operation, the crops are fed at the inlet port. With the rotor rotating, the crops perform helical motion under the guidance of the helix. Being beaten and rubbed by the rotor and the concave plate, the grain is threshed and then separated by the sieve-like concave plate. The stems are discharged at the outlet port.

The axial flow rotor separator includes two types according to the direction that the crops are fed into the rotor: a lengthwise axial separator into which the crops are fed and discharged axially; a transverse axial separator; and a tangential axial separator.

The lengthwise axial type is generally used in combines, that is because the rotor is parallel to the moving direction of the machine, which results in easy arrangement. In order for the crops to be fed at one end of the shaft, a helix blade is arranged to provide the crops with intense impact by dragging so that the crops are forcibly fed.

As for the transverse axial separator, the crops are fed at one side of the rotor and threshed along the axial direction, and the trashes are discharged at the other side. Compared with the lengthwise type, feeding in the transverse axial type is easier, the stems are discharged transversely with easy and thrown further, and the entire machine can be easily arranged. Thus, this type is widely used in the conventional thresher. Since the threshing portion of the machine is relatively wide, the harvesting platform and the threshing portion can not be easily arranged symmetrically. And therefore, this type is usually used on large combines.

The transverse axial type is the type that a transverse axial rotor is provided at the front end of the double axial rotor, which makes the crops easy to be threshed be threshed at first.

The rotor of the separator has two types, i.e., the cylinder type and the cone type. The cone angle of the cone type rotor is generally between 10 and 15°. The crops are fed at the small end and are discharged at the big end. The crops flow gradually faster along the axial direction and the circumferential speed thereof increases gradually, and the threshing and separating capability becomes stronger.
The cylinder rotor has a simple shape and thus can be easily manufactured. However, the axial flow can be guaranteed only when a guide is provided in the threshing chamber to guide the crops.

Summary of the Invention

An object of the invention is to provide a rotor of a separator which beats and threshes the crop when introducing the crop into the rotor.

According to the invention, a rotor of a separator is provided which has a rotation axis, the rotor including a frustocone portion and a cylinder portion in the axial direction of the separator along which the crops flow in the separator, the frustocone portion including a frustoconical body, the small diameter end of the frustoconical body positioned at the front end of the rotor, the frustoconical body extending in the direction of rotation axis from the small diameter end, the cylinder portion extending in the rotation axis from the large diameter end of the frustoconical body toward the rear end of the rotor, wherein the frustoconical body is provided with a helix blade and a crop conditioning element.

In another aspect, a rotor is provided, wherein the cone angle of the frustoconical body is between 0°and 50°, preferably, 16.5°.

In another aspect, a rotor is provided, wherein the helix blade is provided in the frustoconical surface of the frustoconical body and extends backward from the front end of the frustoconical body, along a helical path.

In another aspect, a rotor is provided, wherein the radial margin of the helix blade is provided with wearable material.

In another aspect, a rotor is provided, wherein the number of the helix blade is two to six (2-6), preferably three (3).

In another aspect, a rotor is provided, wherein the crop conditioning *elements are provided in the frustoconical surface and spaced from each* other in a general helical path, and the crop conditioning elements are positioned behind the helix bade in the axial direction.

In another aspect, a rotor is provided, wherein the crop conditioning elements are provided along 2-6 helical paths.

In another aspect, a rotor is provided, wherein the crop conditioning elements are provided along 3 helical paths.

In another aspect, a rotor is provided, wherein each of the helical paths is provided with 2-6 crop conditioning elements.

In another aspect, a rotor is provided, wherein each of the helical paths is provided with 3 crop conditioning elements.

In another aspect, a rotor is provided, wherein the crop conditioning element is attached to the frustoconical body via a crop conditioning element bracket.

In another aspect, a rotor is provided, wherein a cylindrical extending portion is provided between the frustocone portion and the cylinder portion, which is extended from the frustocone portion in the axial direction, said extending portion is provided with crop conditioning elements and separating teeth.

In another aspect, a rotor is provided, wherein the cylinder portion includes lengthwise poles, which parallel the axial direction and are spaced from each other circumferentially, said lengthwise poles including separating teeth.

A separator for threshing and separating is also provided, including a rotor, a top cover and a concave plate, with a threshing space formed between the outer wall of the rotor and the inner walls of the top cover and concave plate, wherein said rotor is a rotor according to the invention.

A full feed combine is also provided, including: a harvesting apparatus for harvesting crops from a field; a feeding apparatus for transmitting the crops harvested by the harvesting apparatus; a separator according to the invention, which receives the crops transmitted by the feeding apparatus and performs the threshing function; a cleaning apparatus, positioned below the separator and receiving and sieving the threshed crops to separate the grain from the threshed mixture; a grain auger for transferring the grain to a grain tank; and a tailing auger for transferring the tailing to the separator, or transferring it to the cleaning apparatus after re-threshing.

In another aspect, a full feed combine is provided, wherein the separator, the cleaning apparatus, the grain auger and the tailing auger are mounted on a frame.

In another aspect, a full feed combine is provided, which further includes a moving apparatus, on which the frame is mounted.

In another aspect, a full feed combine is provided, wherein the moving apparatus is a pedrail apparatus.

In another aspect, a full feed combine is provided, wherein an axis of the rotor of the separator is substantially parallel to the moving direction of the moving apparatus.

In another aspect, a full feed combine is provided, wherein an axis of the rotor of the separator is perpendicular to the moving direction of the moving apparatus.

In another aspect, a full feed combine is provided, which is a lengthwise axial small full feed combine.

As for the rotor, the separator and the combine according to the invention, the rotor uses the helix blade on the frustocone portion to axially guide the crops and at the same time uses the crop conditioning elements on the frustocone protion to thresh the crops and beat the straws. The rotor can prevent the crops from twisting and has better threshing effect.

Brief Description of the Drawings

The invention will be better understood on reading the following detailed description and referring to the accompanied drawings. The components in the drawings are not required to comply with the specific scales; conversely, it is emphasized to illustrate the principle of the invention. Moreover, in the drawings, like reference numbers represent like components in different views.

Fig. 1 diagrammatically shows a prior art axial flow separator;
Fig. 2 shows an assembled separator with the top cover opened;
Fig. 3 illustrates a partial view of the rotor and the concave plate;

Fig. 4 illustrates a front view of the rotor;
Figs. 5a and 5b show a crop conditioning element and a crop conditioning element bracket;
Fig. 6 is a view similar with Fig. 3, wherein another crop conditioning element; and
Fig. 7 shows a small combine including a rotor according to the invention.

Detailed Description of the drawings

Throughout the following description, the "longitudinal direction" corresponds to the moving direction of the combine; "rear" corresponds to the moving direction along which the crops travel in the rotor in the rotation axis AA' (see Fig. 4), and "front" corresponds to a reverse direction to "rear"; "left" and "right" correspond to the left and right of the driver; and "up" corresponds to the direction vertically opposite to the ground and "down" corresponds to the direction vertically facing to the ground.

The following features described in the invention can be used separately or in combination.

Fig. 2 shows a separator 1000 with the top cover 4 opened. Fig. 3 illustrates a partial view of the rotor 2 and the concave plate 3. For clarity, the top cover 4 is omitted. Fig. 4 illustrates a front view of the rotor 2.

The separator includes a frame 1 supporting a rotor 2, a concave plate 3 and a top cover 4. The rotor 2 is arranged rotatably along the longitudinal direction of the combine, that is, the rotation axis AA' of the rotor 2 is parallel to the moving (harvesting) direction of the combine. The top cover 4 is provided above the rotor 2 along the length of the rotor 2; while the concave plate 3 is provided below the rotor 2 along the length of the rotor 2. The surfaces of the top cover 4 and the concave plate 3 form a substantial cylinder concentric with the rotor 2. A threshing space is formed between the surfaces of the cylinder and the rotor 2. The rotor 2 rotates about the

rotation axis AA' relative to the concave plate 3 and the top cover 4. The inlet port 30 is provided at the front of the separator. A feeding apparatus 3000 is connected to the inlet port so as to transmit the harvested crops into the threshing space via the inlet port.

As shown in Fig. 4, the rotor 2 includes a frustocone portion 7 and a cylinder portion 8. The frustocone portion 7 is positioned at the front end of the separator, and the cylinder portion 8 extends in the rotation axis AA' from the rear portion of the frustocone portion 7.

The frustocone portion

The frustocone portion 7 includes a frustoconical body 9, helix blades 10 and crop conditioning elements 11.

The frustoconical body 9 supports the helix blade 10 and the crop conditioning elements 11. A small diameter end of the frustoconical body 9 is positioned at the front of the rotor 2. And the frustoconical body 9 extends backward from the small diameter end along the axis AA' for about 500-600mm. The cone angle of the frustoconical body 9 (the angle between the two generating lines in the axial section of the cone) is between 0°and 50°, preferably 16.5°.

The helix blade

The helix blades 10 are provided on the conical surface of the frustoconical body 9 and extend along the helical paths from the front end of the frustoconcial body 9. The helical direction of the helix blades 10 is arranged so that the crops are guided backward during the rotation of the rotor 2.

The number of the helix blades is more than 2 and less than 6, preferably 3.

The helix blades 10 are connected to the surface of the frustoconcial body 9 by welding or other method.

In one embodiment, stiffening ribs may be provided between the helix blades 10 and the frustoconical body 9 so as to increase the joining strength between the helix blades 10 and the frustoconical body 9 and the stiffness of the blades.

Since the radial margin of the helix blades 10 is prone to be damaged due to the friction with the crops, the radial margin may be provided with wearable material, such as some additional wearable plates. Wear-resisting treatment may also be performed on the radial margin, such as heat treatment.

The crop conditioning element

The crop conditioning elements 11 are provided in the conical surface of the frustoconical body 9 and spaced from each other in a general helical path to beat the crop stems so that they can be easily fed and then further threshed. Meanwhile, the crop conditioning elements 11 also thresh the crops. That is, compared with the prior art wherein the crops are integrally fed, the crops are beaten and threshed in the frustoconical body 7 by the crop conditioning elements 11, resulting in the reduction of the power required by the apparatus and better threshing effect of the beaten and partially threshed crops by the cylinder portion 8. Moreover, due to the above effects obtained by the crop conditioning elements 11 provided in the frustocone portion 7, the axial length of the entire rotor 2 is decreased and thus it is adapted to be used with small combines. In addition, the crop conditioning elements 11 are positioned at the rear portion of the helix blades 10 in the axis AA'. The crop conditioning elements 11 cooperate with the guide plate 12 (see Fig. 2) on the top cover 4 to move the crops backwards and perform threshing.

The crop conditioning elements 11 are provided in three rows in the direction of the axis AA' and each row is provided with three crop

conditioning elements along the circumferential direction. That is, the crop conditioning elements 11 are provided along helical paths; each path is provided with three crop conditioning elements 11, and there are three paths in all. In one embodiment, they may be arranged in two, four, five or six rows, and each path may be provided with 2, 4, 5 or 6 crop conditioning elements 11. In one embodiment, each row may be provided with 2, 4, and 5 crop conditioning elements 11, i.e. 2, 4, 5, or 6 helical paths.

In one embodiment, the helix angle of the helical path is between 20°and 40°, preferably 10°.

In other embodiment, the crop conditioning elements 11 is not required be provided along the helical path. For example, they may be arranged linearly along the direction parallel to the axis AA'.

Figs. 5a and 5b illustrate perspective views of the crop conditioning elements 11. The crop conditioning elements 11 are attached to the frustoconical body 9 via the crop conditioning element brackets 13. The crop conditioning element brackets 13 are attached to the surface of the frustoconical body 9 by welding a steel plate. The crop conditioning elements 11 are releasably secured to the top surface of the threshing element brackets via bolts for example. The crop conditioning elements 11 may be attached by other means, such as clips, clampers and so on, as long as the crop conditioning elements 11 can be replaced after damage and provide firm attachment during the threshing operation.

The crop conditioning elements 11 include concavo-convex separation (teeth) 14 and protrusions 15 to comb and beat the crop in order to perform threshing effect. The concavo-convex separations 14 are provided at the front of the protrusions 15 along the helical paths in which the crop conditioning elements 11 are disposed. The concavo-convex separations

14 comb the crops to thresh them. And the protrusions 15 beat and rub the crops so that the crops are threshed and crashed.

In one embodiment, the concavo-convex separation may have four teeth.

In one embodiment, the crop conditioning element 11 may have three protrusions 15.

In one embodiment, Fig. 6 shows another form of the crop conditioning element 11'. The crop conditioning element 11' has two protruding triangle pieces which are arranged in a plane substantially perpendicular to the axis AA'. The triangle pieces may be mounted on the crop conditioning element brackets 13 and extend outward from the top surface of the crop conditioning element bracket 13.

The cylinder portion

Referring to Fig. 4, the cylinder portion 8 includes lengthwise poles 16, which parallel the axis AA' and are spaced from each other circumferentially. The poles are supported by a radial supporting plate 17 which is approximately at the middle between the front end plate 18 and the rear end plate 19 of the rotor 2 along the axis AA'. The number of the poles may be between 3 and 10, preferably 6.

The lengthwise poles 16 are provided with separating teeth 20 which protrude outwards in the radial direction of the rotor 2. The teeth 20 may be in form of nail teeth. Depending on the types of the threshed crops, the teeth 20 may also be in other forms, such as nail teeth, pole teeth, plate teeth and bow teeth, and have a parallelepiped, conical or plate shape or else a curved shape. The teeth 20 are not required to extend in the radial direction of the rotor 2, but form an angle with the radial direction.

The separating teeth 20 may be attached to the lengthwise poles 16 by threads so as to allow the replacement if damaged.

The lengthwise poles 16 may be provided with separating blades 21 to guide the crops to be discharged from the separator. The separating blades 21 are provided at the rear end of the lengthwise poles 16. One separating blades 21 may be provided on each lengthwise pole 16 or one separating blade 21 may be circumferentially provided on every two lengthwise poles 16.

In one embodiment, a cylindrical extending portion 22 (see Fig. 4) is provided between the frustocone portion 7 and the cylinder portion 8, which is extended from the frustocone portion along the axis AA'. Said extending portion is provided with crop conditioning elements 11 and separating teeth 20.

In order to rotate the rotor 2, a spindle 23 is provided in the centre of the rotor along the axis AA'. The spindle 23 causes the rotor 2 to rotate through the front end plate 18, the rear end plate 19 and the radial supporting plate 17 secured to the spindle. Though not shown, a driving apparatus may be provided at the end of the spindle 23 so as to transmit the rotating power to the rotor 2, such as a belt apparatus, a cogged belt apparatus, a chain pulley apparatus, a gear apparatus and so on.

The concave plate

Referring to Fig. 3, the concave 3 are substantially concentrically arranged below the rotor 2 and fixed to the frame 1. The concave plate 3 includes a lattice structure composed of a transverse grid board 24 and longitudinal sieve bars 25 parallel to the axis AA'. It cooperates with the rotor 2 so as to thresh the crops and leaks the threshed mixture into the cleaning apparatus (not shown) from the lattice structure of the concave plate 3.

Typically, the wrap angle of the concave plate 3 is between 150°and 240°, preferably 180°.

In other embodiments, the concave plate 3 may be in form of a stamped sieve, a woven sieve and so the forth, as long as it can cooperate with the rotor 2 so as to thresh the crops and leaks the threshed mixture.

The top cover

The top cover 4 (see Fig. 2, in which the top cover is opened) is provided above the rotor 2 and extends along the length of the rotor 2 and the top cover together with the concave plate 3 forms a threshing space of a substantial cylinder. The top cover 4 may be articulated to the frame along the axis AA' so that it can be opened in order to clean and check the inside the separator.

The inner wall of the top cover 4 is provided with a guide plate 12 so as to control the axial moving speed of the crop. The helix angle of the guide plate 12 is between 5°and 30°, preferably 10°.

The threshing operation

The operation of the separator will be described as follows. The harvested crops enter into the threshing space of the separator via the inlet port 5 (see Fig. 5), travel toward the rear portion of the separator under the guidance of the helix blades 10 provided on the frustoconical body 7 of the rotor 2, and then are threshed under the threshing effect of rippling and beating when passing the crop conditioning elements 11. The crops partially threshed continue moving to the rear portion of crop conditioning elements 11 and are further separated under the effect of the separating teeth 20 of the cylinder portion 8 of the rotor 2 and the lattice of the concave plate 3; and the threshed mixture leaks through the lattice of the concave plate 3 so as to be cleaned by the cleaning apparatus. The guide plate 12 provided on the inner wall of the top cover 4 of the upper portion of the separator

cooperates with the rotor 2 to axially guide the crops. The separated stems are discharged out of the separator under the effect of the separating blades 21 provided at the end of the rotor 2.

The full feed combine

Fig. 7 diagrammatically shows a full feed combine including the separator 1000 according to the invention. The full feed combine includes: a harvesting apparatus 2000 for harvesting crops from a field; a feeding apparatus 3000 for transmitting the crops harvested by the harvesting apparatus 2000; a separator 1000, which receives the crops transmitted by the feeding apparatus 3000 and performs the threshing function; a cleaning apparatus 4000, positioned below the separator 1000 and receiving and sieving the threshed crops to separate the grain from the threshed mixture; a grain auger (not shown) for transferring the grain to a grain tank; and a tailing auger (not shown) for transferring the tailing to the separator 1000, or transferring it to the cleaning apparatus 4000 after re-threshing.

In one embodiment, the separator 1000, the cleaning apparatus 4000, the grain auger and the tailing auger are mounted on a frame 1.

The full feed combine may further include a moving apparatus 5000, on which the frame 1 is mounted. In one embodiment, the moving apparatus is a pedrail apparatus.

In one embodiment, the axis of the rotor 2 of the separator 1000 is substantially parallel to the moving direction of the moving apparatus. In another embodiment, the axis of the rotor 2 of the separator 1000 is substantially perpendicular to the moving direction of the moving apparatus.

A full feed combine according the invention may be a lengthwise axial small full feed combine.

While various embodiments have been illustrated and described, the above description is merely illustrative and does not intent to be limitative. Many embodiments and implementations can be made within the scope of the invention by those skilled in the art. Thus, the invention shall not be limited except by the teachings of the claims and its equivalents. In addition, various modifications and changes can be made within the scope defined by the claims.

We claim:

1. A rotor of a separator for threshing and separating, which has a rotation axis, the rotor including a frustocone portion and a cylinder portion in the axial direction of the separator along which the crops flow in the separator, the frustocone portion including a frustoconical body, the small diameter end of the frustoconical body being positioned at the front end of the rotor, the frustoconical body extending in the direction of rotation axis from the small diameter end, the cylinder portion extending in the rotation axis from the large diameter end of the frustoconical body toward the rear end of the rotor,
wherein the frustoconical body is provided with a helix blade and a crop conditioning element.
2. The rotor of Claim 1, wherein the cone angle of the frustoconical body is between 0-50°.
3. The rotor of Claim 1, wherein the cone angle of the frustoconical body is 16.5°.
4. The rotor of Claim 1, wherein the helix blade is provided in the frustoconical surface of the frustoconical body and extends backward from the front end of the frustoconical body, along a helical path.
5. The rotor of Claim 1, wherein the radial margin of the helix blade is provided with wearable material.
6. The rotor of Claim 1, wherein the number of the helix blade is 2-6.
7. The rotor of Claim 5, wherein the number of the helix blade is 3.
8. The rotor of Claim 1, wherein the crop conditioning elements are provided in the frustoconical surface and spaced from each other in a general helical path, and the crop conditioning elements are positioned behind the helix bade in the axial direction.

9. The rotor of Claim 8, wherein the crop conditioning elements are provided along 2-6 helical paths.
10. The rotor of Claim 8, wherein the crop conditioning elements are provided along 3 helical paths.
11. The rotor of Claim 8, wherein each of the helical paths is provided with 2-6 crop conditioning elements.
12. The rotor of Claim 8, wherein each of the helical paths is provided with 3 crop conditioning elements.
13. The rotor of Claim 1, wherein the crop conditioning element is attached to the frustoconical body via a crop conditioning element bracket.
14. The rotor of Claim 1, wherein a cylindrical extending portion is provided between the frustocone portion and the cylinder portion, which is extended from the frustocone portion in the axial direction, said extending portion is provided with crop conditioning elements and separating teeth.
15. The rotor of Claim 1, wherein the cylinder portion includes lengthwise poles, which parallel the axial direction and are spaced from each other circumferentially, said lengthwise poles including separating teeth.
16. The rotor of Claim 1, wherein said separating teeth are selected from nail teeth, pole teeth, plate teeth and bow teeth.
17. A separator for threshing and separating, including a rotor, a top cover and a concave plate, with a threshing space formed between the outer wall of the rotor and the inner walls of the top cover and concave plate,
wherein said rotor is a rotor of any one of Claims 1-16.
18. A full feed combine, including:
a harvesting apparatus for harvesting crops from a field;
a feeding apparatus for transmitting the crops harvested by the harvesting apparatus;
a separator of Claim 17, which receiving the crops transmitted by the feeding apparatus and performing the threshing function;
a cleaning apparatus, positioned below the separator and receiving and sieving the threshed crops to separate the grain from the threshed mixture;
a grain auger for transferring the grain to a grain tank; and

a tailing auger for transferring the tailing to the separator, or transferring it to the cleaning apparatus after re-threshing.

19. The full feed combine of Claim 18, wherein the separator, the cleaning apparatus, the grain auger and the tailing auger are mounted on a frame.

20. The full feed combine of Claim 19, further including a moving apparatus, on which the frame is mounted.

21. The full feed combine of Claim 20, wherein the moving apparatus is a pedrail apparatus.

22. The full feed combine of Claim 20, wherein an axis of the rotor of the separator is substantially parallel to the moving direction of the moving apparatus.

23. The full feed combine of Claim 20, wherein an axis of the rotor of the separator is perpendicular to the moving direction of the moving apparatus.

24. The full feed combine of Claim 18, which is a lengthwise axial small full feed combine.

Dated: 23rd June, 2010

Deere & Company
By their Authorized Signatory

(Neeraj Panchal)