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Gronberg et al.

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[54] **APPARATUSES FOR DISINTEGRATION OF STRAW AND SIMILAR MATERIAL**

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[52] **U.S. Cl.** **241/243**, 241/292.1

[51] **Int. Cl.** **B02c 18/18**

[58] **Field of Search** 241/190, 224, 238, 243, 241/292.1

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[57] **ABSTRACT**

A cutting apparatus comprising a rotor on which are mounted discs rotating with the rotor shaft and provided at their periphery with at least one shaft each, said shafts extending in parallel with the rotor shaft and supporting at each end a cutting knife which upon rotation of the rotor pivots in a plane transverse to the axis of said rotor, means being provided on said rotor shaft for enabling the discs mounted thereon to be drawn together axially with the disc hubs arranged end to end in such a manner that said discs will be positioned at a torsional angle relative to one another and the rotor knives be located along a helical line about said rotor.

5 Claims, 6 Drawing Figures

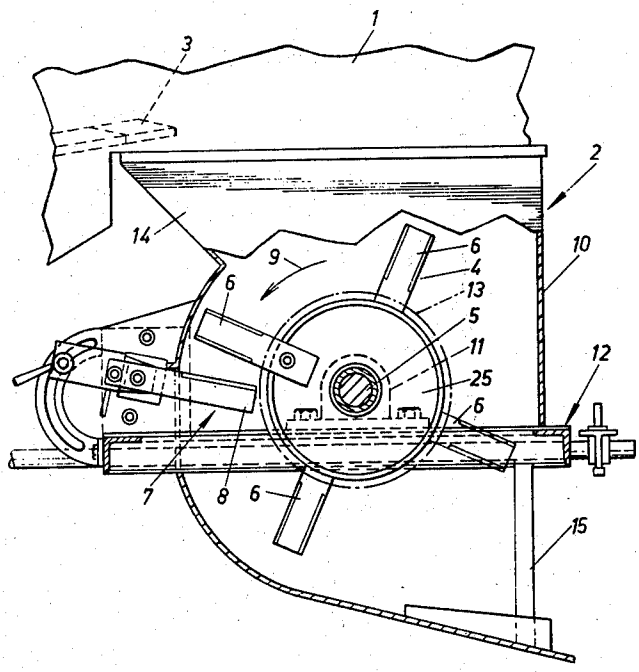

Fig.1

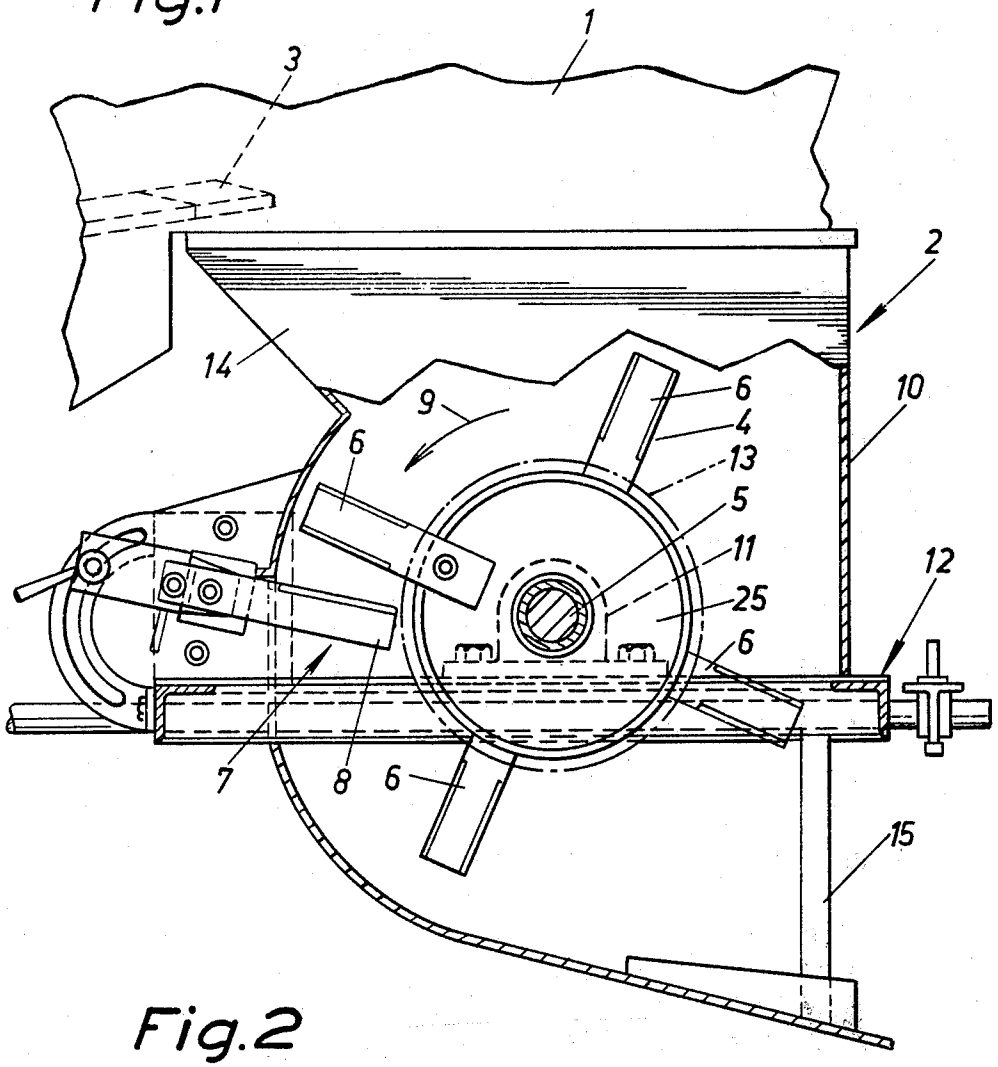
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Fig.2

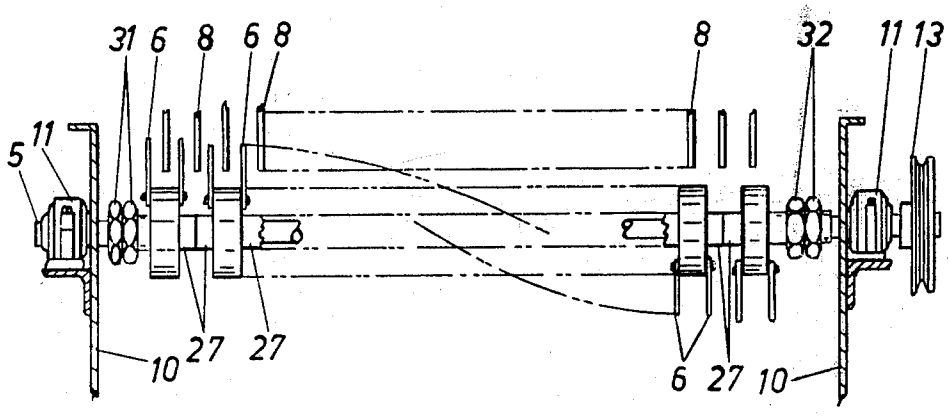
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Fig.3

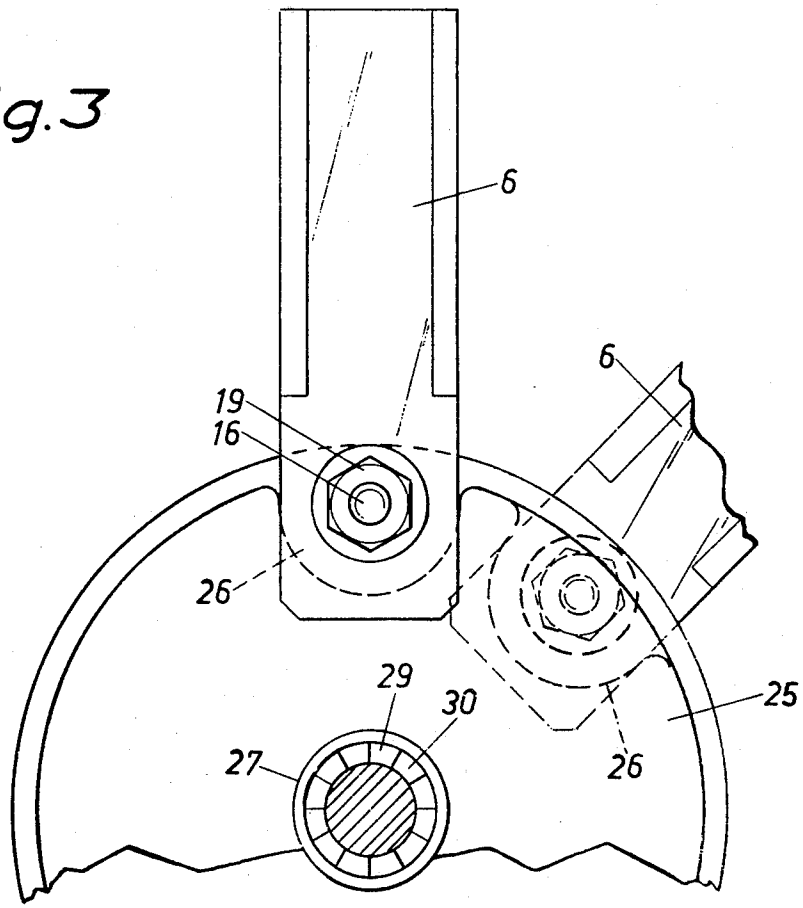


Fig.6

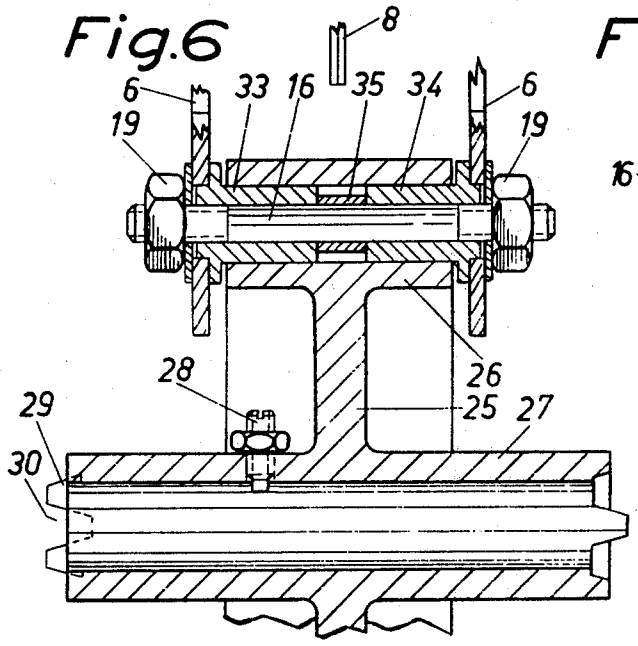


Fig.5

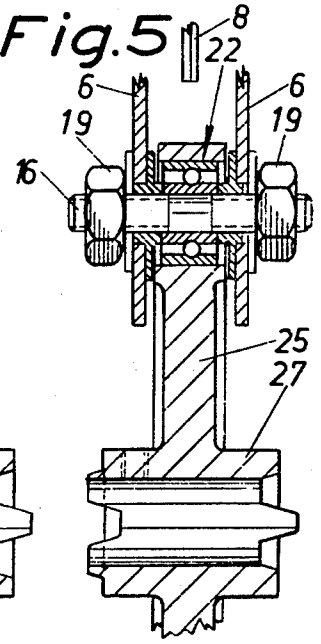
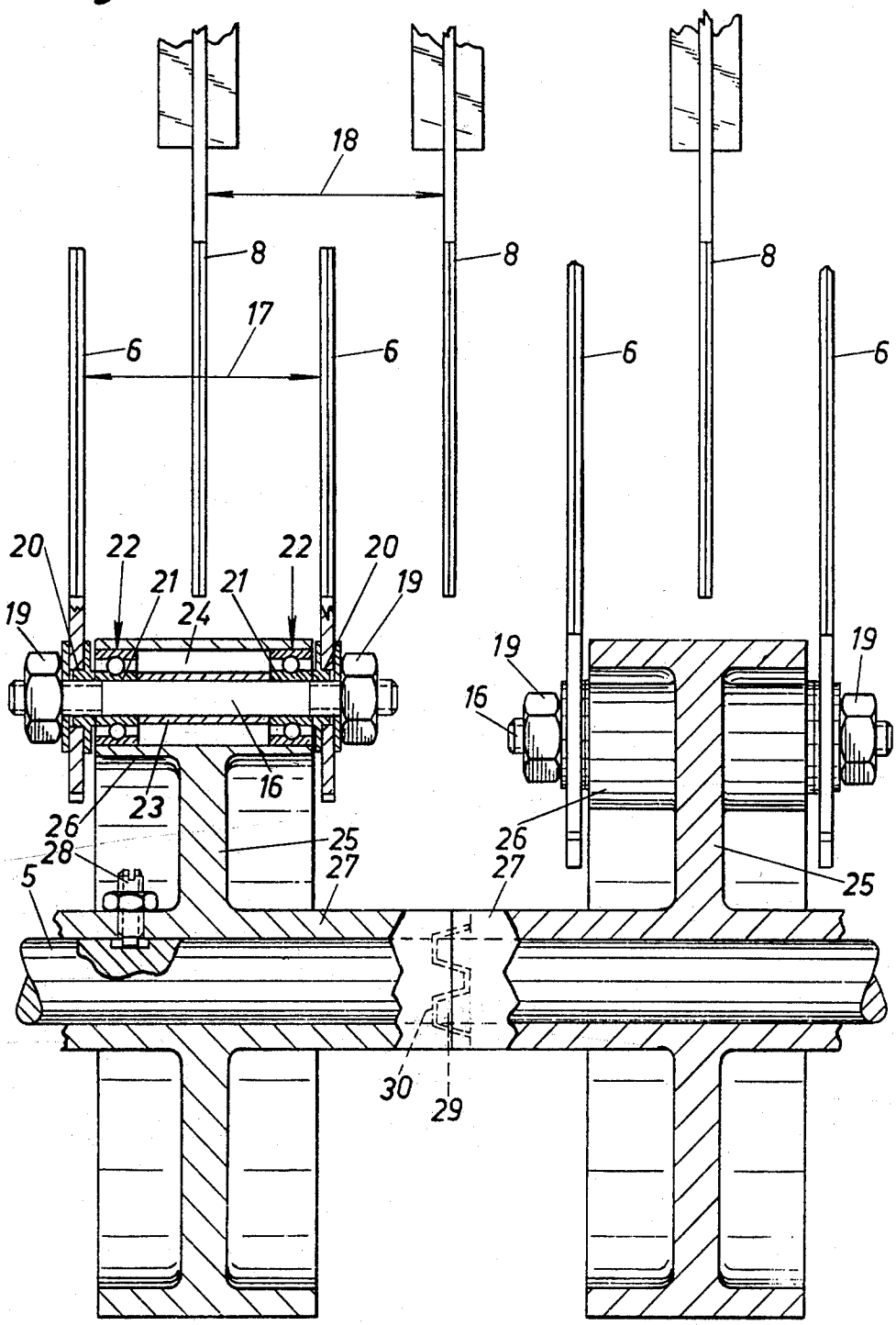


Fig. 4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APPARATUSES FOR DISINTETRATION OF STRAW AND SIMILAR MATERIAL

BACKGROUND OF THE INVENTION

The present invention relates to apparatuses of the kind which are arranged to disintegrate straw and straw-like materials and which are provided with a rotor having several knives positioned adjacent the rotor periphery and arranged for pivotal motion in a plane transverse to the rotor axis, said rotor being rotatably mounted in a machine casing having a row of laterally spaced knives serving as supports or grates to the straw-like material and between which knives the rotor knives pass to disintegrate the straw. The rotor likewise comprises a number of discs each one provided adjacent its periphery with at least two shafts extending in parallel with the rotor axis.

In prior art rotors of this kind wherein the rotor knives are positioned radially and are passed through by tie rods which are parallel to the rotor shaft and also pass through a number of discs which are mounted on the shaft so as to be spaced equal distances apart, it is essential that the rotor is well balanced as the latter is usually driven at a speed exceeding 3,000 r/min. Spacer sleeves are mounted on the tie rods between neighbouring knives. One has found that if the lengths of the spacer sleeves vary by as little as one tenth of a millimeter, which often is the case, and if the number of spacer sleeves in a rotor having a length of appr. 1.5 to 2 meters, exceeds **25,** the overall length of a row of rotor knives mounted between the two discs positioned at the rotor ends may vary by several millimetres. Consequently, when the tie rods are tightened, the rotor shaft will be bent to some extent which results in unbalanced rotation of the rotor. A further disadvantage inherent in this type of rotors having pass-through tie rods and spacer sleeves located between adjacent knives is that exchange of knives that have broken or need resharpening is a rather complicated and time-consuming task. As a rule, this work need to be performed in a factory.

SUMMARY OF THE PRESENT INVENTION

One purpose of the present invention is to remedy the drawbacks outlined in the aforegoing. It is characteristic of the invention that the discs incorporated in the rotor have their hubs positioned end to end on the rotor shaft and are drawn together axially on the rotor shaft, preferably by means of a tightening nut, and in that at least one pair of pivotable knives is associated with each disc, the inner ends of each pair of knives being engaged on the opposite ends of a disc shaft projecting through its disc and extending parallel to the rotor axis, these discs being positioned at such a mutual torsional angle on the rotor shaft that the rotor knives will be positioned along a helical line extending about the rotor.

Because the disc hubs abut against one another end to end on the rotor shaft the latter is made considerably rigid. For this reason it becomes possible to choose a somewhat smaller shaft diameter to make the apparatus lighter. There is no risk that the shaft will bend during assembly or during operation. As one rotor knife of each pair thereof is positioned at each end of the associated disc shaft the latter becomes evenly loaded. The mounting of the shaft is simple. Preferably, one bearing is positioned at each end of the shaft close to the inner face of the associated knife, whereby the stresses become insignificant. The highly unfavourable fan effect which as a rule is experienced in prior art disintergrating apparatuses is minimized. Owing to the fact that the discs are mounted in fixed relation on the rotor shaft with the pairs of rotor knives of adjacent pair of discs circumferentially staggered, there is ample space at the shaft ends for exchange of knives in case of rupture or breakage without disassembly of the rotor. This position of the knives along an imaginary helical line about the rotor circumference also has the advantage of improving the disintegration of the straw-like material as the operation becomes extremely even. Consequently, one has eliminated the thrusts commonly experienced in the disintegrating work of the apparatus when the knives are positioned in rows in parallel to the rotor shaft as is normal.

BRIEF DESCRIPTION OF THE DRAWINGS

The further characteristics of the invention and the advantages to be obtained thereby will be described more in detail in the following with reference to the accompanying drawings, wherein:

FIG. **1** is a vertical cross-sectional view through a cutting apparatus in accordance with the invention, mounted at the rear end of a combine harvester,

FIG. **2** illustrates on a smaller scale in a side view the rotor and the mounting thereof,

FIG. **3** illustrates on an enlarged scale a partly broken cross-sectional view through the rotor,

FIG. **4** illustrates the rotor in a partly broken longitudinal section, and

FIGS. **5** and **6** are partly broken longitudinal sections showing two various embodiments of the rotor discs.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

In FIG. **1,** reference numeral **1** designates the rear end of a thresher mechanism, e.g. the thresher of a combine harvester. The cutting apparatus **2** is intended to disintegrate the straw supplied from the vibrating screen **3** of the thresher **1,** the straw being cut up into comparatively short pieces. The cutter **2** comprises both a rotor **4** comprising a rotatably driven shaft **5** supporting a number of knives **6** which take part in the shaft rotation, and a support or grate **7** supporting the straw during the disintegration thereof. The support **7** comprises a row of knives **8** spaced apart a distance of e.g. 50 mm. The rotor knives **6** are arranged, during the rotation of the rotor, to pass through the gaps formed between the knives **8.** The rotating direction is indicated by an arrow **9.** The shaft **5** is mounted in bearings **11** in the short sides of a box-like open top and open bottom machine casing **10** on a pivotally mounted support frame **12** at the rear end of the thresher mechanism **1.** The shaft **5** is preferably driven by means of a belt (not shown) from the thresher mechanism via a belt pulley **13** at one end of the shaft **5.** The upper open end of the machine casing **10** is provided with a funnel-like section **14** onto which the straw is advanced from the vibrating screen **3** and slides down towards the rotor **4** where the rotor knives **6** engage the straw and cut it into small pieces against the grate knives **8.** At its bottom, the machine casing **10** is provided with an outlet opening **15** for discharge of the cut straw pieces.

As evident from the drawings the rotor knives **6** are supported at their radially inner ends by means of a

trunnion **16** (see particularly FIG. **4**) in such a manner that the distance **17** separating these two knives equals the distance **18** between two neighbouring grate knives **8.** The trunnion or disc shaft **16,** having at both its ends a nut **19,** passes through two spacer washers **20** and the inner runner ring **21** of two ball bearings **22** as well as spacer sleeve **23** mounted between the bearings. The hubs of the respective spacer washer **20** in addition pass through one aperture each formed in the rotor knives **6.** Upon tightening of the nuts **19** the rotor knives **6** will be securely clamped such that, together with the shaft **16,** the spacer washers **20,** the inner runner ring **21** of the bearings **22** and the spacer sleeve **23,** they may pivot as a unit in a transverse plane relative to axis of the rotor **4.** The bearings **22** are squeezed into a bore **24** extending in parallel with the rotor shaft **5** in a boss **26** positioned at the outer periphery of a disc **25.**

Through the hub **27** of the disc **25** passes the shaft **5** to which the disc hub is secured by means of a locking screw **28.** Both ends of the hub **27** are in the form of a toothed wheel serving as a clevis coupling and having teeth **29** alternating with tooth spaces **30** positioned in such a manner that when a number of discs **25** are threaded in a row end to end on the rotor shaft **5,** the shafts **16** of adjacent discs extend at a definite torsional angle, e.g. an angle of 45° (see FIG. **3**) relative to one another. Through this arrangement the knife pairs **6** will be positioned along a helical line extending about the rotor as is diagrammatically illustrated by the dashed lines in FIG. **2.** The rotor shaft **5** which is supported at its ends by the bearings **11** is provided internally thereof with two tightening nuts **31, 32** by means of which the entire row of discs **25** may be pressed close together with the hubs **27** in an end-to-end position. This considerable tightening of the hubs **27** in an axial direction strengthens the rotor shaft **5** considerably. There is no risk that the shaft will bend as a result of this tightening operation. Consequently, the rotor constructed as indicated will be well balanced.

In case any one of the rotor knives **6** need be replaced or resharpened, one need only loosen the nuts **19** which are easily accessible at the periphery of the rotor.

In rotors (see FIG. **5**) of the kind where the distance between the rotor knives **6** is to be comparatively small, only one ball bearing **22** is needed. Otherwise the bearing construction is essentially identical with the one illustrated in FIG. **4.**

Although ball bearings are preferred on account of their advantage in that such bearings provide excellent lateral guidence of the rotor knives **6,** slide bearings may also be used. In FIG. **6** is illustrated a bearing structure of this kind. In this case the shaft **16** passes through two bearing sleeves **33, 34** serving as slide bearings and supporting at their outer ends one rotor knife **6** each between which knives a spacer sleeve **35** is mounted. Upon tightening of the nuts **19** the rotor knives **6** are clamped against the bearing sleeves **33, 34** and in turn these are clamped against the spacer sleeve **35** in such a manner that all these parts together with the shaft **16** become movable as one single unit.

The discs **25** are imagined made through die-casting of aluminum or some other suitable metal alloy, such as Silumin. The discs may be arranged so as to support only one pair of knives **6** but also two diametrically opposite pairs of rotor knives are possible. In case large rotors are used even three or four pairs of rotor knives, positioned symmetrically, may be used.

The embodiments as illustrated and described are to be regarded as examples only and the arrangements for supporting the rotor knives **6** as well as the configuration of these knives may be constructively altered in a variety of ways within the scope of the appended claims. Other types of ball bearings **22** than roller bearings are applicable. Preferably the follower means **29** consist of cylindrical pins extending in parallel with the rotor shaft **5** and engaging in the end surfaces of the hubs **27.**

What we claim is:

1. Apparatus for disintegrating straw or like material comprising in combination:

a casing having an upper opening for receiving material to be disintegrated and a lower opening for discharging disintegrated material;

a row of laterally spaced knives mounted in said casing;

a rotor assembly journalled in spaced parallelism to said row of knives within said casing, said rotor assembly comprising a rotor shaft, a plurality of discs each having a hub portion and a peripheral portion, the hub portions being hollow and slidably engaged on said rotor shaft and tightening means on at least one end of said rotor shaft for tensioning the rotor shaft and compressing said hub portions to integrate said rotor shaft and discs as a single rotatable unit in which said discs are aligned opposite individual knives of said row of knives, at least one pair of rotor knives disposed in straddling relation to the peripheral portion of each disc so as to extend therefrom and pass in straddling relation to that knife of said row of knives with which the corresponding disc is aligned and mounting means for rotatably and detachably securing one end of each knife of each pair to the corresponding disc, and means interlocking adjacent hub portions of said discs so that the pairs of rotor knives thereof are circumferentially staggered whereby to provide clearance to allow removal and replacement of individual rotor knives while said rotor shaft and discs remain integrated as said single rotatable unit; and

means for rotating said rotor assembly.

2. An apparatus in accordance with claim **1,** wherein said means interlocking are cylindrical pins extending in parallel with said rotor shaft and engaging in end faces of said hub portions.

3. Apparatus as defined in claim **1** wherein said means interlocking adjacent hub portions effects a circumferential angular displacement of 90° between the pairs of rotor knives of adjacent discs.

4. Apparatus as defined in claim **1** wherein said mounting means comprises, for each disc, a disc shaft rotatably carried by the peripheral portion of each disc and having opposite end portions projecting therebeyond, the rotor knives of each pair being engaged on the opposite ends of a corresponding disc shaft and securing nut engaged on each end of each disc shaft to secure said rotor knives in place.

5. Apparatus as defined in claim **4** wherein said means interlocking adjacent hub portions effects a circumferential angular displacement of 90° between the pairs of rotor knives of adjacent discs.

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