May 20, 1958 S. H. COLLINS 2,835,298

ROTARY CUTTING MECHANISM

Filed Oct. 28, 1955 2 Sheets-Sheet 1

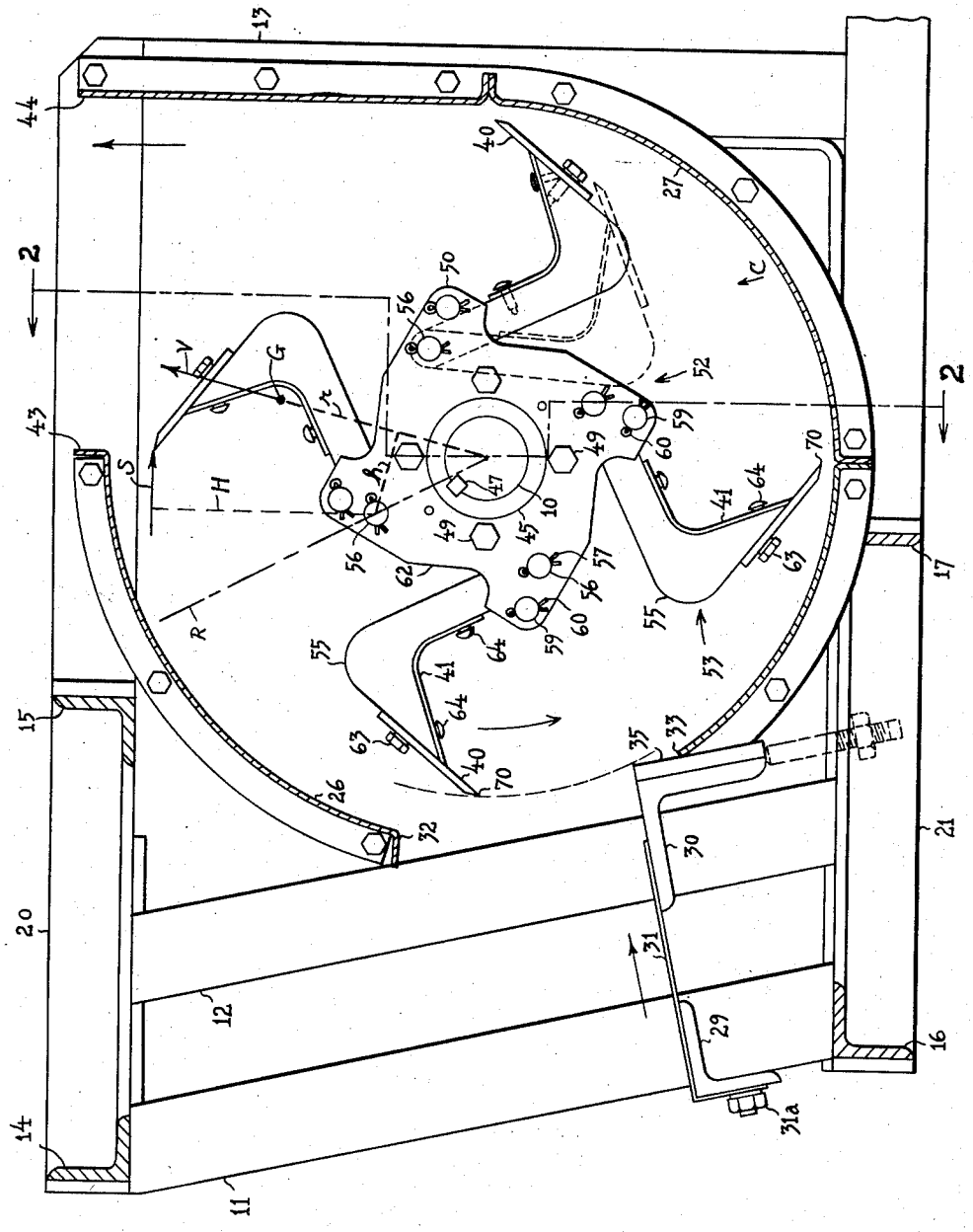

Fig. 1

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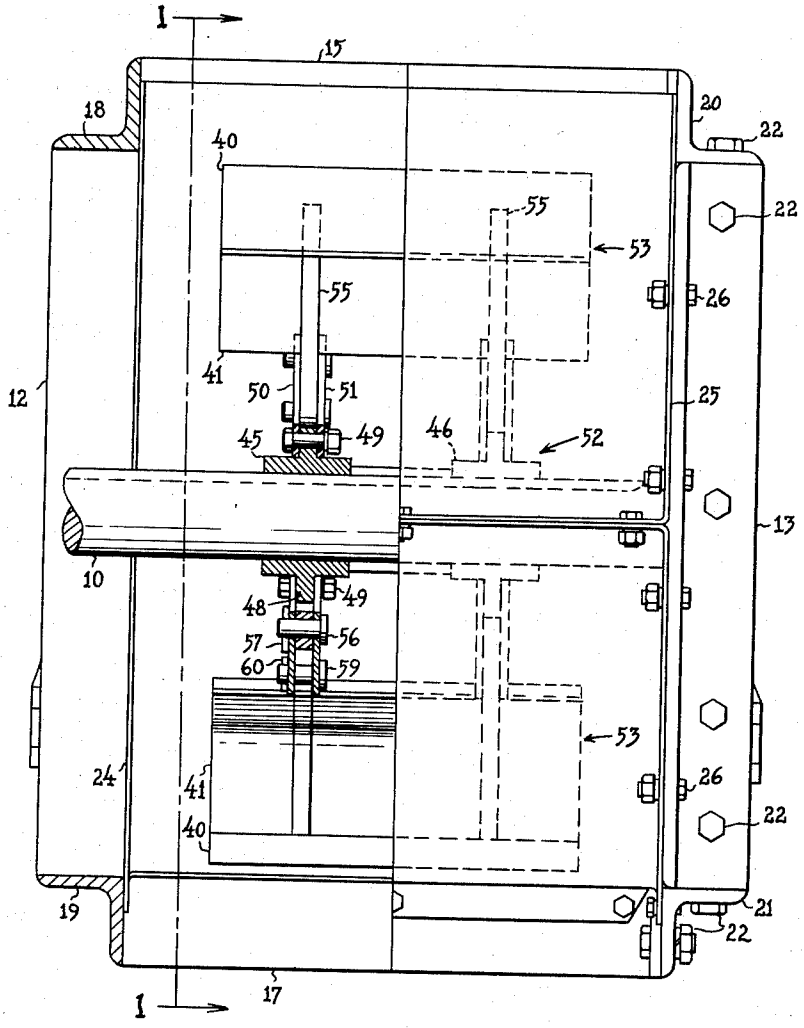

Fig. 2

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United States Patent Office 2,835,298 Patented May 20, 1958

2,835,298

ROTARY CUTTING MECHANISM

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Application October 28, 1955, Serial No. 543,548

3 Claims. (Cl. 146—117)

This invention relates to rotary cutting or chopping mechanisms of the pivoted knife type. It finds particular utility in cylinder type cutters such as are commonly employed in forage harvesters.

In most rotary mechanisms which are used for chopping, grinding or threshing, for example, it is desirable that the mechanism has a large moment of inertia for the obvious purpose of smoothing out variations in power requirements of the power source. This is especially true in a cutting mechanism of a forage harvester because of the large variations in the rate of feed of the material which would otherwise cause fluctuations in the speed of the mechanism. Such speed fluctuations are detrimental to other functions of the mechanism, for example, the delivery of the chopped material therefrom.

Foreign obstacles, such as pieces of wood or stones, are frequently fed into the cutting mechanism with the crop material. The impact load imposed on the mechanism when it encounters such an obstacle increases directly with the moment of inertia of the rotating mechanism. If the mechanism is made heavier to minimize damage thereto, the moment of inertia is also increased and the problem is aggravated. It is impossible, due to practical considerations, to design a cutting mechanism of sufficient rigidity and strength which will prevent damage thereto regardless of the nature of the obstacle presented to it.

In view of the above it is an object of the present invention to provide a chopping mechanism of the pivoted knife type, in which the pivoted knife assembly is of relatively low inertia, and the location of the pivot point is such as to provide sufficient motion of the knife to give adequate clearance for foreign obstacles and at the same time provide a sufficient forward couple, due to centrifugal force, so as to hold the knife fixed under normal shearing forces.

It is another object of the invention to provide a chopping mechanism of the pivoted knife type, in which the relationship between the location of the center of gravity of the knife assembly and the position of its pivot point, each relative to one another and to the center of the entire unit, are such that a highly efficient cutting mechanism is obtained which is economical to manufacture and maintain.

It is an object of this invention to provide a pivotal knife type cutting mechanism in which the angular momentum of the swinging knife assembly is very small in comparison to the angular momentum of the entire cylinder assembly, and in which the location of the center of gravity of the knife assembly and the position of its pivot point are such that the knife accurately maintains its position under any normal shearing force and the cutting action is therefore clean and positive.

Other objects and advantages of this invention will become more apparent from the following detailed

description and attached sheets of drawings wherein a form of the invention is illustrated.

Figure 1 is a side elevational, cross sectional view of the chopping mechanism, taken on the line 1—1 of Figure 2.

Figure 2 is a rear elevational view, partially in section, of the chopping mechanism shown in Figure 1.

Cutting mechanisms of this type are commonly employed in forage harvesters that are adapted to be moved over a crop which is severed from the ground, fed into the harvester, chopped into variable lengths and blown or thrown into a trailing wagon by the cutting mechanism. Frequently rocks or other foreign obstacles are picked up with the crop material and fed unnoticed into the chopping mechanism, causing severe damage thereto, often in the form of broken knives.

Referring more particularly to the drawings the chopping cylinder C is rotatably mounted on its shaft **10** in any suitable support structure. A sprocket or pulley (not shown) is usually secured to shaft **10** for transmitting power from a power source (not shown) and driving the cylinder at high speeds. The support structure which is shown here comprises vertical angle iron members **11**, **12** and **13** located on either side of the cylinder; transverse members **14**, **15**, **16** and **17**; and four longitudinal angle iron members **18**, **19**, **20** and **21**. These members may all be rigidly secured together by bolt means **22**. A sheet metal housing is provided for the cylinder comprising end walls **24**, **25** and the scroll housing portions **26**, **27** which enclose a substantial portion of the periphery of the cylinder. As shown in Figure 1, two transversely arranged angle members **29**, **30** are rigidly secured at either end to members **11** and **12** and have a feed plate **31**, secured by bolt means **31***a*, across their upper surfaces. Crop material is fed across plate **31** as indicated by the arrow, and through the inlet opening formed by the adjacent edges **32**, **33** of housing portions **26**, **27** respectively. A conventional shear bar **35** is shiftably secured to angle **30** and is adjustable by the bolt means shown in dotted lines in Fig. 1, and cooperates with the knives **40** of cylinder C to cut the crop material as it passes over the shear bar. The cut material is then carried by the knives **40** and scoop-shaped transverse plates **41**, more fully referred to hereinafter, along housing portion **27** and is then thrown through the discharge opening formed by the adjacent edges **43**, **44** of housing portions **26**, **27** respectively. The discharge opening may be in communication with a delivery spout (not shown) which guides the material, which at this point is now moving at a high speed, into a receptacle.

The cylinder shown here for illustrative purposes is of relatively narrow width, however, the invention is equally applicable to the wider type cylinder cutters or to the extremely narrow flywheel type chopping mechanisms. A pair of hubs **45**, **46** are spaced axially along shaft **10** and fixed thereto by keys **47**. As the hubs **45**, **46** and their respective associated parts are identical, only one will be described. Secured to an annular central flange **48** of hub **45**, by bolt means **49** is a pair of parallel, spaced plates **50**, **51** and shaft **10**, hubs **45**, **46** and the two pairs of plates **50**, **51** form an elongated rotatable body **52**. Between plates **50**, **51** are swingably mounted four identical knife assemblies **53**. The arms **55** are pivotally mounted at their inner ends on pins **56** which extend through aligned apertures in plates **50**, **51** and are held captive therein by cotter keys **57**. The pins **56** thus form pivots which are located at points spaced radially outwardly from the axis of rotation of the body **52**. A pair of arms **55** is provided for each assembly, each arm

being identical as previously mentioned, and the points of pivotal connection of each arm of the assembly are axially spaced as clearly shown in Fig. 2. The cylinder rotates in the direction indicated by the curvilinear arrow in Figure 1 and the knife assemblies 53 are limited in their movement in this direction, relative to body 52, by stop pins 59 which also extend through aligned apertures in plates 50, 51 and held therein by cotter keys 60.

Plates 50, 51 are cut away as at 62 so as to permit the knife assembly to swing backwardly farther, as shown in dotted lines in Figure 1, than it would otherwise be able to and thereby obtain more clearance between knife 40 and shear bar 35 when an obstacle is encountered.

Corresponding arms 55 on hub 45, 46 are held together by knives 40 which are secured to the outer ends of the arms by cap bolts 63 threadably engaged in arms 55. Scoop plates 41 also are rigidly secured to corresponding pairs of arms by screws 64 which are threadably engaged in arms 55. The scoop plates not only makes the knife assembly extremely rigid, due to its curved cross sectional shape, but also ensures positive delivery of the chopped material and precludes any material from passing over the back of the blade and thereby losing its maximum velocity. This plate can be made relatively heavy and rigid while the knife 40 can be made of lighter material for purposes which will hereinafter appear.

In many cutting or pulverizing mechanisms, the impact members are simply pivoted from positions whereby the center of gravity of the swinging member is radially outward from the pivot when the device is in the operative position. Any tangential force on the impact member causes it to rotate about its pivot and away from the work.

The knife assembly 53 can be considered as a single integral unit comprising members 40, 41 and 55. The center of gravity through a cross section of this particular shape assembly is at the point G, shown in Figure 1. It will be noted that in the cutting position shown, i. e., when arms 55 are against their respective stop pins 59, the center of gravity is a considerable angular distance behind a radius R extending through the pivot point (pin) 56. The cutting edge 70 of the knife is also a considerable angular distance behind radius R, or in other words, a distance behind the pivot point 56. The distance of the center of gravity G from the center of the entire cylinder is shown as the dotted radius line r. In operation the centrifugal force acting on the knife assembly is represented as to direction, by the vector V, and the magnitude determined by the formula $Mr(2\pi N)^2$ where M is the mass of the knife assembly and N is the speed of the mechanism in revolutions per second. The perpendicular distance of this centrifugal force line of action from the point 56 is shown by the broken line h. Therefore, the couple which acts on the knife assembly, due to centrifugal force, and which holds the knife in cutting position is of the magnitude $Mr(2\pi N)^2h$. The shearing force indicated generally by the vector S produces an opposite couple about the assembly pivot point 56 of the magnitude SH where H is the moment arm of the force S from the pivot point 56.

In designing a mechanism of this type for maximum efficiency and economy, it is desirable to provide a swinging knife of low inertia, sufficient clearance of the knife when necessary, and having a forward couple (due to centrifugal force) sufficient to hold the knife edge in cutting position under normal shearing force. The primary factors, therefore, to be considered in such a design are the mass of the knife assembly, the radial distance of the pivot point 56 from the axis of rotation, the radial distance of the center of gravity G from the axis of rotation, and the angular distance of the center of gravity G and the knife edge from a radius R passing through pivot point 56.

The radial location of pivot point 56 may be varied so as to give the desired relationship between good knife clearance at obstacle impact and sufficient centrifugal force to hold the knife only under normal shearing forces.

The angular momentum of the pivoted knife assembly is relatively small as compared to that of the entire cutting cylinder and any damage due to striking a foreign obstacle is minimized or eliminated. However, clean and positive cutting action is not sacrificed because the knife will maintain its cutting position under normal shearing forces.

With a cutting mechanism made in accordance with this invention, light weight and relatively inexpensive knives may be utilized because the damaging impact to the knives decreases as their weight decreases. Frequency of knife replacement as well as sharpening is correspondingly reduced. Alternately, the knives may be heavy for heavier work, but the body portion of the cylinder may be of light weight construction because impact forces are not of as much consequence with a mechanism made in accordance with this invention.

What is desired to be secured by Letters Patent is:

1. In a rotary chopping mechanism, a knife assembly comprising, in combination, a rotatable body adapted to be journaled for high speed rotation, an arm pivoted at its inner end to said body about an axis parallel to and spaced from the axis of said body, a knife blade secured to the outer end of said arm and having a cutting edge extending parallel to the axis of said body and facing forwardly of said arm, a stop member secured to said body in position for engaging said arm and limiting the latter's forward swinging movement to a point where the center of gravity of said arm and blade is spaced rearwardly of a radial line from the axis of said body through said pivotal axis of said arm, whereby rotation of said body will cause centrifugal force to urge said arm against said stop for positioning of the knife edge at a cutting position at a predetermined radial distance from the axis of said body while permitting the knife blade and arm to be free to swing rearwardly upon striking an obstruction.

2. In a rotary chopping mechanism, a knife assembly comprising, in combination, a rotatable body adapted to be journaled for high speed rotation, an arm pivoted at its inner end to said body about an axis parallel to and spaced from the axis of said body, a knife blade secured to the outer end of said arm and having a cutting edge extending parallel to the axis of said body and facing forwardly of said arm, a stop member secured to said body in position for engaging said arm and limiting the latter's forward swinging movement to a point where the center of gravity of said arm and blade is spaced rearwardly of a radial line from the axis of said body through said pivotal axis of said arm, whereby rotation of said body will cause centrifugal force to urge said arm against said stop for positioning of the knife edge at a cutting position at a predetermined radial distance from the axis of said body while permitting the knife blade and arm to be free to swing rearwardly upon striking an obstruction, said knife blade being positioned on said arm with said cutting edge spaced rearwardly of said radial line from the axis of said body through said pivotal axis of said arm, so that when said knife blade strikes an obstruction and swings rearwardly, the knife blade will immediately move inwardly toward said body so as to clear the obstruction, and said body having a relieved area permitting rearward swinging movement of said arm and knife blade.

3. In a rotary chopping mechanism, a knife assembly comprising, in combination, a rotatable body adapted to be journaled for high speed rotation, an arm pivoted at its inner end to said body about an axis parallel to and spaced from the axis of said body, a knife blade secured to the other end of said arm and having a cutting edge extending parallel to the axis of said body and facing forwardly of said arm, a scoop-shaped plate rigidly mounted on said arm beneath said knife blade and opening forwardly of the arm, a stop member secured to said body

in position for engaging said arm and limiting the latter's forward swinging movement to a point where the center of gravity of said arm, blade, and plate is spaced rearwardly of a radial line from the axis of said body through said pivotal axis of said arm so that upon rotation of said body centrifugal force causes the cutting edge to assume a cutting position at a fixed radial distance from the axis of said body while permitting the knife blade and plate to be free for swinging rearwardly upon striking an obstruction.

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