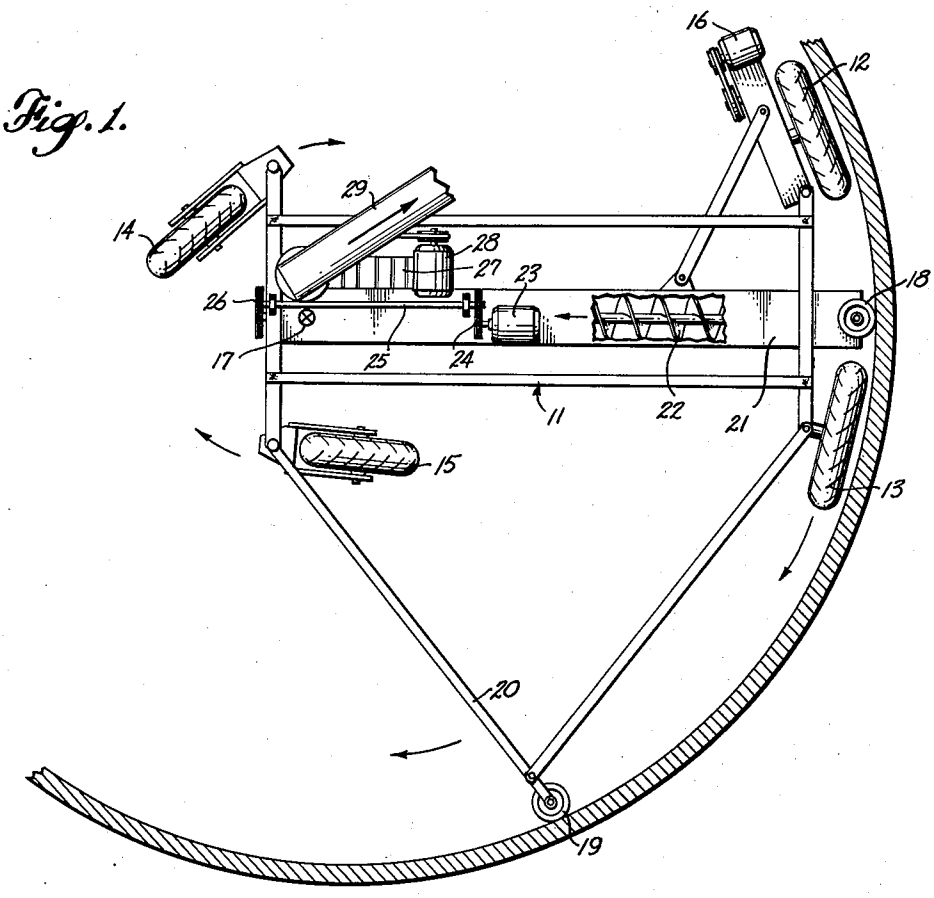
Feb. 7, 1961 G. R. DODSON 2,970,827

SILO UNLOADER

Filed Nov. 17, 1958 3 Sheets-Sheet 1

Fig. 1.



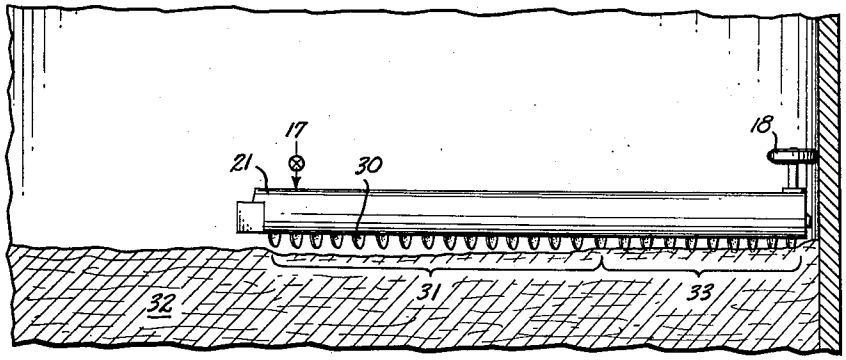


Fig. 2.

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SILO UNLOADER

Filed Nov. 17, 1958 3 Sheets-Sheet 2

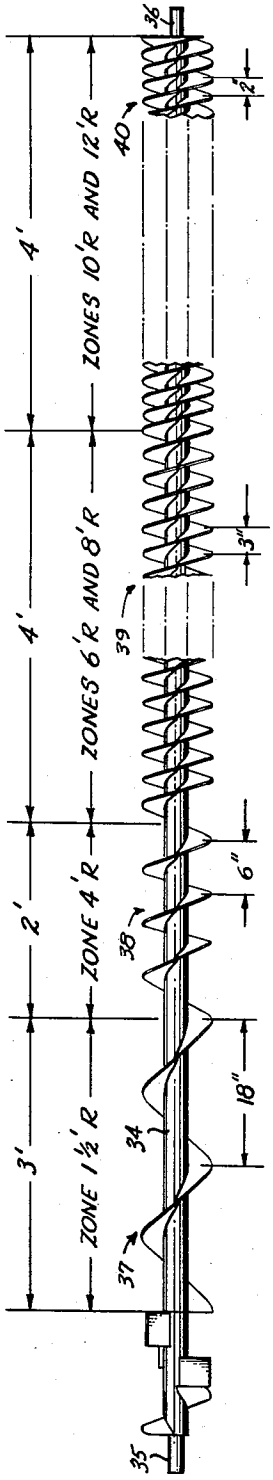


Fig. 5.

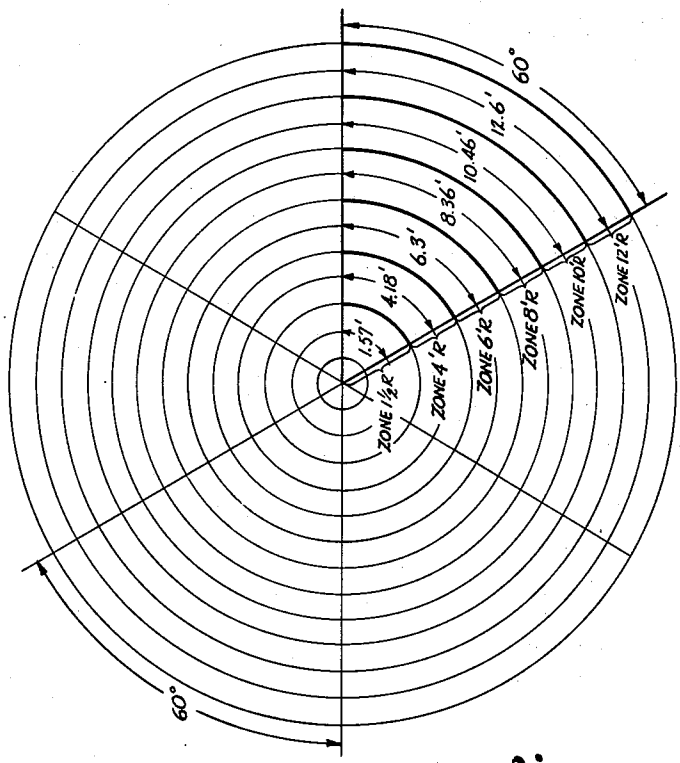


Fig. 3.

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SILO UNLOADER

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FOR 9" DIAMETER AUGER -- 13' CUTTING LENGTH

Cutter blade increments in radial feet outward from pivot point → PIVOT POINT		3'	5'	7'	9'	11'	13'
Cutter blade flights divided into arbitrary Zones →		Zone 1½'R	Zone 4'R	Zone 6'R	Zone 8'R	Zone 10'R	Zone 12'R
1.	Average feet traveled by blade flights in each zone as auger travels through 60° arc about its pivot point.	1.57'	4.18'	6.3'	8.36'	10.46'	12.6'
2.	Percent decrease in feet traveled by blade flights in different zones	62.3% less than Zone 4'R	33.5% less than Zone 6'R	24% less than Zone 8'R	20.8% less than Zone 10'R	17% less than Zone 12'R	
3.	Ideal total cutting edge length (helix) of blade flights in each zone to obtain equal cutting effectiveness. (based on percent decrease in travel by zones)	43"	115"	173"	228"	288"	347"
4.	Best blade pitch arrangement to obtain nearest ideal blade cutting edge lengths for blade flights in each zone	18" Pitch	6" Pitch	4" Pitch	3" Pitch	2½" Pitch	2" Pitch
5.	Blade cutting edge lengths provided for blade flights within each zone by pitch arrangement in Line 4, above	63"	116"	172"	231"	277"	347"
6.	More practical blade pitch arrangement from manufacturer's standpoint	18" pitch-single lead blades	6" pitch-single lead blades	6" pitch-double lead or 3" pitch single lead	6" pitch-double lead or 3" pitch single lead	6" pitch-triple lead or 2" pitch single lead	6" pitch-triple lead or 2" pitch single lead
7.	Blade cutting edge lengths provided for blade flights within each zone by pitch arrangement in Line 6, above.	63"	116"	231"	231"	347"	347"

Fig. 4.

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SILO UNLOADER

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4 Claims. (Cl. 262—19)

This invention relates to an improvement in silo unloaders. More particularly it relates to an improved combination silage cutting and delivering unit of the screw or auger conveyor type, as a necessary component of such silo unloaders.

During the ensilage process in an above ground upright silo the moisture laden silage becomes very firmly packed between the time it is placed in the silo and the time it is removed for feeding. In fact, it practically assumes a hardened cake form. Furthermore, in winter when it is most often used as stock feed, the upper portion of the silage mass often freezes solid to a depth of several inches. Such a silage condition makes it very difficult for any conventional mechanical silo unloader to cut, remove and deliver successive layers from the top of the silage mass.

Most conventional silo unloaders embody a radially disposed constant pitch auger type silage cutting and removing unit which is power rotated about its own long axis. Simultaneously the blade is mechanically moved over the surface of the silage about a point near one of its ends as a vertical pivot axis, located near the central axis of the silo, and as it moves in a circular path it cuts successive layers of silage from the top of the mass, delivers the cut silage into a conveyor, which in turn delivers the cut silage to the outside of the silo.

The chief difficulty with the above described type of unloader is that the auger type cutter blade does not cut into the top surface of the silage at the same rate throughout the length of the blade.

It is an inherent characteristic of a right helicoid type constant pitch cutting blade mounted to operate in the above described manner, that those blade flights located nearer the vertical pivot axis about which the entire blade moves will cut into the silage surface at a faster rate than those flights which are spaced outward a greater distance from the vertical pivot point.

This results in "undercutting" of the silage surface in a concentric circular area surrounding the vertical pivot axis of the helical cutter blade. When such undercutting occurs the helical cutter blade bridges the undercut area and its entire weight rests on a portion of the cutter blade near its outer end. This extra weight virtually destroys the cutting effectiveness of the outer portion of the blade, and causes the blade to "walk" or roll along the supporting surface of the silage instead of cutting into and removing a layer from that surface.

It is a primary object of this invention to provide a helical cutter blade unit which will eliminate the above described "undercutting" of any blade traversed portion of the silage surface. It is a further object to provide a helical cutter blade unit which has substantially the same cutting effectiveness throughout its axial length, assuming a substantially equal weight distribution from its vertical pivot axis to its outer end, and which will therefore uniformly cut and remove successive layers of silage from the top surface of the silage mass in a silo, and will follow down on the top surface of the silage mass as successive layers are cut and removed therefrom.

The invention, together with other objects, will be more clearly understood when the following description is read in connection with the accompanying drawings, in which:

Fig. 1 is a top plan view of a silo unloader of the type to which the invention refers, installed in a silo, the silo wall being shown fragmentarily and in section;

Fig. 2 is a side view of the auger type cutter blade in its housing, resting in operative position atop the silage in a silo, the latter being shown fragmentarily and in section; and

Fig. 3 is a diagrammatic top plan view illustrating the relative silage cutting work which must be performed by the various blade flights of an auger type cutting blade as it moves in an arc over the surface of the silage in a cylindrical silo.

Fig. 4 is a design data chart illustrating one manner of designing a silage cutting unit embodying the invention; and

Fig. 5 is a side view of a helical auger type silage cutting unit embodying the invention.

Referring to Fig. 1, the unloader illustrated is conventional in general design. It includes a rigid horizontal frame 11, supported at its outer end on wheels 12 and 13, and at its inner end on castering wheels 14 and 15. Wheel 12 is driven by a motor or engine 16 through a suitable drive mechanism. The wheel supported frame is guided to rotate about the vertical central axis 17 of the silo by guide wheels 18 and 19, the latter being mounted on an outrigger frame 20.

Unloader frame 11 supports a cutter blade housing 21. A helical auger type blade 22 is journalled in the housing for rotation about its own long axis. The blade is rotated about its own long axis by a motor or other suitable power unit 23 through suitable drive mechanism 24, 25 and 26. The periphery or helix of the blade is machine ground to provide a good cutting edge.

Silage cut by blade 22 is moved by the helical blade flights toward the center of the silo and delivered into a high speed centrifugal type blower housing 27. The blower is driven by a motor or engine 28 which forces the cut silage through a delivery duct 29 to the outside of the silo. The outer end of duct 29 (not shown) projects through an opening in the silo wall. The inner end of the duct is pivotally secured to the blower outlet so that the duct 29 remains substantially stationary while the unloader proper travels about the axis 17 as if it was actually pivotally mounted at that point.

Fig. 2 illustrates the undercutting of the silage by a conventional constant pitch auger type cutter blade 30. The inner flights of the blade, in the vicinity of the area marked 31, have cut down into the upper surface of the silage 32 at a faster rate than the silage has been cut by the blade flights in the area marked 33. Consequently, the blades in the area 33 are resting directly upon the adjacent surface of the silage, and since the inner end of the auger housing 21 is supported by the unloader frame 11, the blades in the area 31 are no longer in actual contact with the adjacent surface of the silage 32, and are performing virtually no cutting work. This condition causes the outer end of the auger cutter to tend to "walk" or roll along the silage surface with which it is in contact, instead of cutting into that surface, as is desired.

This phenomenon of undercutting will be more clearly understood by reference to the diagram shown in Fig. 3. The diagram shows the top surface of the silage in a 26 foot diameter silo. The surface is divided into annular areas which lie between the 13 foot and 11 foot radii, between the 11 foot and 9 foot radii, between the 9 foot

and 7 foot radii, and similarly inward toward the center of the silo. It has also been divided into 60° sectors.

The term "flight" or "blade flight" is used herein to designate that portion of a continuous helical blade strip which lies between correspondingly located points on the blade helix, and between which points the blade pitch is measured. In a constant diameter helix the two points are located on a line parallel to the central axis. The helix of the blade is the peripheral helical cutting edge. Hence, in a right helicoidal constant pitch blade the helix of one blade flight is equal in length to the helix of each other blade flight, measured along their respective peripheries.

If a helical cutter is of sufficient length to extend from the central pivot point **17** radially outward **13'**, it is evident from Fig. 3 that when the auger is moved through a 60° arc the blade flights located between the **11'** and **13'** radii circles (in zone **12'R**) will have traveled an average lineal distance of approximately 12.6' (measured along the 12' radius), while the blade flights located between the 9' and 11' radii circles (in zone **10'R**) will have traveled an average lineal distance of only 10.46' (measured along the 10' radius). Similarly the blade flights between the 3' and 5' radii circles (in zone **4'R**) will have traveled an average lineal distance of only 4.18' (measured along the 4' radius). The average distances traveled by the blade flights in other zones are similarly indicated in the diagram.

From the above it is evident that if the blade flights located in zone **12'R** are provided with a selected practical maximum length cutting edge (measured along the blade helix), and if the helical cutting edges of the blade flights in each succeeding smaller radius zone are reduced in length substantially in proportion to the reduced average lineal distance they must respectively travel, then the blade flights in all zones will perform their silage cutting function at substantially the same rate, and there will be no undercutting of the silage in any zone. From the standpoint of the manufacturer, however, it is not believed practical to produce an auger type silage cutting blade in which the lengths of the cutting edges of the various blade flights are varied exactly in proportion to the differences in average distance traveled by the blade flights in the respective zones.

The chart identified as drawing Fig. 4 illustrates one method of determining one practical blade flight arrangement—one which will accomplish the desired results, yet which is not too difficult or expensive to manufacture. It is believed that the chart will be clear to those familiar with this art without further detailed explanation, and that it clearly illustrates one manner of properly determining the most practical blade pitch and lead arrangement for any constant diameter auger type cutting blade, in accordance with the invention.

The chart is based on a 9" constant diameter auger, 13' or less in length, and it was assumed that a 2" blade spacing (pitch) is the minimum practical spacing from the manufacturer's standpoint. The blade flight design specified in lines **6** and **7** is deemed more practical because it is much easier to fabricate blade flights of constant pitch than to attempt to vary the pitch of each different blade flight, as in the line **4** blade design. The line **6** blade arrangement gives cutting edge lengths which closely approach the ideal cutting edge lengths for the blade flights in the respective zones, as shown in line **3**, with the exception of the total cutting edge lengths in zones **6'R** and **10'R**, which are greater in helical length than the ideal. Nevertheless the line **6** blade arrangement provides an auger type cutter for silo unloaders which will cut and remove caked silage from the top surface of the mass evenly over the entire surface area traversed by the cutter, the blade flights in each zone cutting to the same depth at substantially the same rate, which is a primary object of the invention.

It will be understood by those familiar with this art that blade pitch and lead will be varied for auger cutters of larger or smaller constant diameter, as well as for auger cutters of greater length than 13'. Whatever the total length and diameter of the auger cutter to be used, it is best to first determine the most practical minimum pitch for the blade flights in the outermost radial zone, nearest that end of the cutter remote from the vertical axis about which the cutter travels. The maximum practical cutting edge length (helix) for those blade flights is then determined, and each succeeding inner radial zone (any desired length increments) is provided with lesser length cutting edges so that the cutting edges of the blades in each zone cut and remove silage at substantially the same rate as the cutting edges of the blades in each of the other zones.

Fig. 5 illustrates an auger type silage cutter and mover in which the blade flights are arranged in accordance with the invention, and substantially in accordance with the design data given in lines **6** and **7** of Fig. 4.

The helical blade flights of the auger illustrated are of constant diameter, and are rigidly secured by welding to an elongated centrally disposed core or body **34**, which is preferably in the form of a rigid thick walled tube having aligned stub shafts **35** and **36** fixed rigidly in its opposite ends for journalling the auger in the unloader frame **11**. A plurality of sections of cooperating helical blade flights encircle the body **34** and are welded rigidly to the outer surface thereof. The different blade flight sections are indicated by the numerals **37** through **40**, inclusive. The blade sections are arranged end to end, as shown, and they extend from a point near the outer end of the body **34** to a point near the location of the vertical axis **17** about which the entire unit swings during operation.

The difference in pitch of the blade flights in each section are indicated by the respective associated dimension lines and numerals. The 2 inch pitch indicated for the blade flights in section **40** may be obtained by forming a continuous 2 inch pitch helical blade. For ease in manufacture, however, the 2 inch pitch is preferably provided by forming three 6 inch pitch blades and associating them on the body **34** to provide a triple lead screw.

Similarly the 3 inch pitch for the blade flights in section **39** is provided by forming two 6 inch pitch blades of the proper length and arranging them in the same relationship as the threads on a double lead screw. The blade flights in sections **37** and **38** are continuous single lead helical blades of 18 inch and 6 inch pitch respectively. Actually, then, the manufacturer can fabricate the entire helical silage cutting and moving unit by forming continuous blades having only two different pitches, i.e.—6 inch and 18 inch. This blade design conforms to line **6** of the Fig. 4 design data chart.

With the blades formed and arranged as described, it is evident from line **7** of the Fig. 4 design data chart that the blade flights in section **40** will have a combined helical cutting edge length of 694 inches (zones **10'R** and **12'R** combined), measured along the helical peripheries of the blades; that the blade flights in section **39** will have a combined cutting edge length of 462 inches, in section **38**—116 inches, and in section **37**—63 inches.

The differences in the combined total cutting edge length of the blade flights in the respective sections is thus substantially proportional to the differences in the average distances traveled and surface areas traversed by the blade flights in the respective sections as the silage cutting unit is moved in a circular path about its axis **17**. Consequently the blade flights in each section perform their silage cutting and moving function at substantially the same rate as that function is performed by the blade flights in each other section, and there is no undercutting of the silage in any zone or region.

A very important result produced by the above described helical auger type silage cutting unit is that it permits a considerable reduction in the rate at which the

unit is rotated about its own long axis as it moves over the surface of the silage, and also permits a considerable reduction in power necessary to rotate the unit about its own long axis at the reduced r.p.m.

Before conceiving this invention this applicant manufactured silo unloaders commercially which embodied an auger type cutting unit having constant pitch blades. In order to cut into the top surface of the silage in a silo it was necessary to rotate the auger-cutter about its own long axis at 430 r.p.m. Since adopting a cutter unit embodying the invention the rotational speed of the unit has been reduced to only 217 r.p.m. Furthermore the horsepower required has been reduced from 10 H.P. to 7½ H.P.—a reduction of 25%, yet the later machine has a greater and faster cutting capacity than the old one. This is all due to the increased silage cutting efficiency of the type of cutter unit described herein.

Having described the invention with sufficient clarity to enable those familiar with this art to construct and use it, what is claimed is:

1. In an elongated helical auger type silage cutting unit for power driven silo unloading machines in which the cutting unit has fixed helical cutting blade flights of substantially uniform diameter extending substantially throughout its length, and is moved in a circular path over the substantially horizontal surface of the silage with a point near one of its ends as a vertical axis, and is simultaneously rotated about its own central longitudinal axis to perform its silage cutting function, the improvement which consists in increasing the pitch dimensions of the blade flights from the outer end of the unit toward the said vertical axis, the increase in pitch dimensions being such that the differences in the total peripheral cutting edges of the blade flights extending longitudinally along the unit are substantially proportional to the differences in the average translational distances traveled and silage surface areas traversed by the respective blade flights as the unit is moved about said vertical axis, whereby all blade flights cut into the traversed surface of the silage at substantially the same rate.

2. In a silage unloading machine in which an auger is journaled to rotate about its own axis and is moved in a circular path over the substantially horizontal surface of the silage with a point near one of its ends as a vertical axis, and in which the peripheral edges of the auger blade flights serve to cut successive layers of material from the top surface of the silage as the auger is so moved, an auger construction for such machine comprising: an elongated centrally disposed rigid blade carrying body having aligned means at its inner and outer ends to facilitate journalling the body to rotate about its own central longitudinal axis; a plurality of sections of helical blade flights arranged end to end and encircling said body substantially throughout its length, all said blade flights being rigidly secured to the body, the blade flights in that section nearest the outer end having a relatively small dimension pitch to provide a relatively large total peripheral cutting edge length for the blade flights in that section, the blade flights in respective successive sections toward the inner end of the body having progressively larger dimension pitch to provide successive sectional decreases in the total peripheral cutting edge length or helix for the blade flights in the respective sections, the difference in the pitch of the blade flights in the respective sections being such that the differences in the total peripheral cutting edge length of the blade flights in the respective sections are substantially proportional to the differences in the average translational distances traveled and surface areas traversed by the blade flights in the respective sections when the cutting unit is rotated in a horizontal plane about a point near its inner end as a vertical axis.

3. The cutting unit described in claim 2 in which the outside diameter of the unit, measured normal to its long axis and at the peripheries of the blade flights is constant.

4. In an elongated helical auger type silage cutting unit for power driven silage unloading machines in which the cutting unit has fixed helical cutting blade flights of substantially uniform diameter extending substantially throughout its length, means for rotating the cutting unit about its longitudinal axis, means for moving the unit in a circular path about a vertical axis near one end thereof, said cutting unit comprising successive end-to-end connected sections, the helical cutting flights of each section being of constant pitch through that section, the pitch dimensions of the flights of the successive sections being correlated respectively with the average translational distance traveled and silage surface areas traversed by the respective sections of the cutting unit and producing differences in length of total peripheral cutting edges of the flights of the respective sections which are functions of the distance of the respective sections from the pivotal axis of the auger whereby all blade flights cut into the surface traversed by the unit at substantially the same rate.

References Cited in the file of this patent

UNITED STATES PATENTS

1,277,573	Hanneborg	Sept. 3, 1918
2,677,474	Long et al.	May 4, 1954
2,719,058	Van Dusen	Sept. 27, 1955

FOREIGN PATENTS

685,589	France	Apr. 1, 1930