



**University**

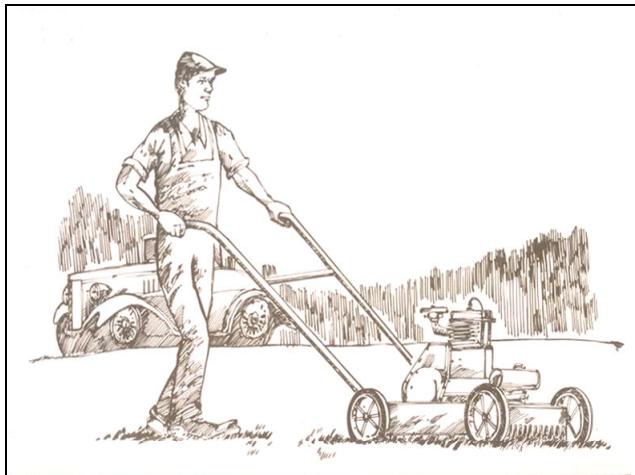
# **Rotary Mower Basics**

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## Historical Background



The first practical concept of a rotary type mower goes back to the 1930's. The concept evolved from the need for a grass maintenance tool that could cut long grass acceptably without the cost and sophistication of a reel mower.



During the 1940's improvements in engines and material brought about increased use of rotaries but it wasn't until after World War II that their use became a common sight.

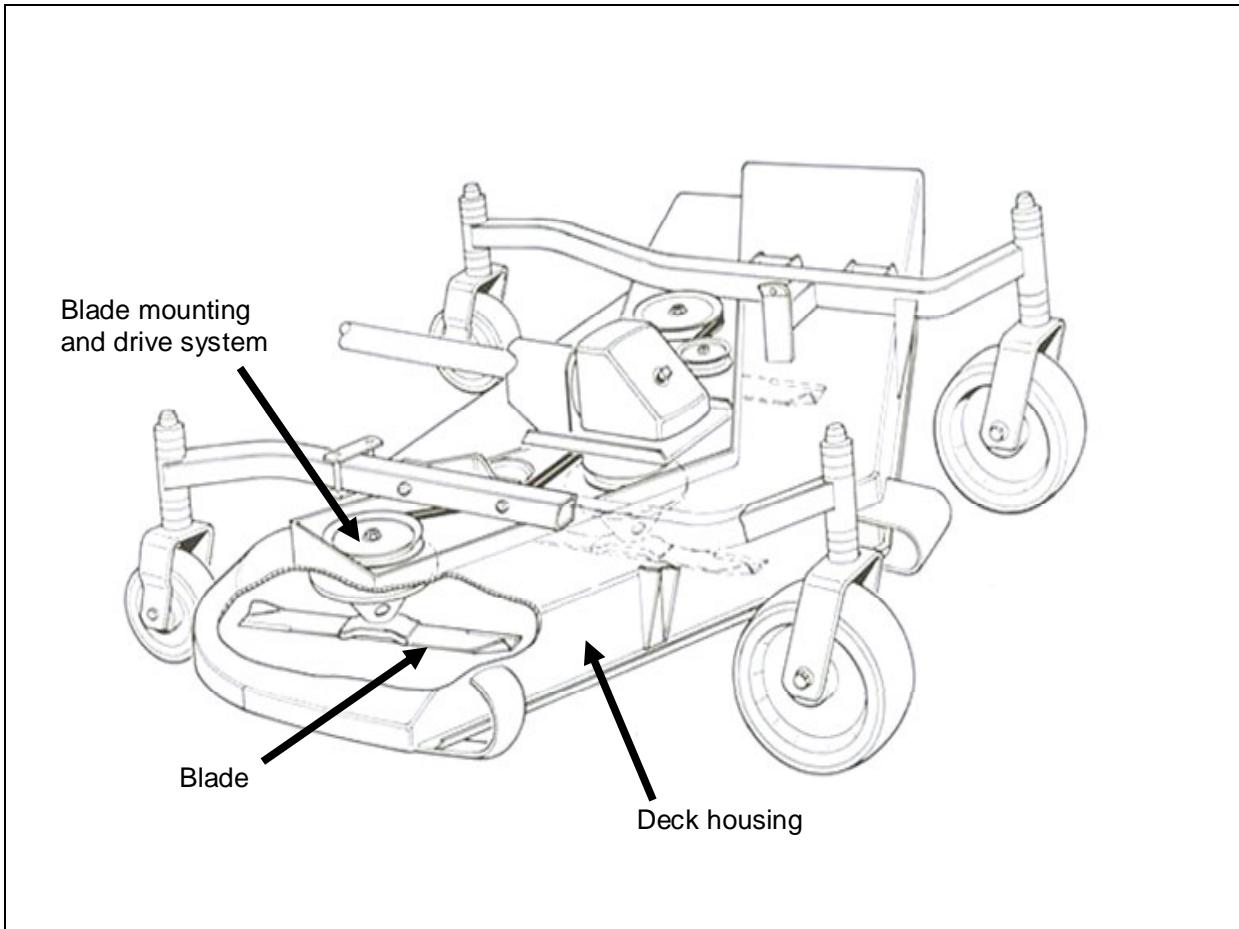


During the 1960's the bagging concept evolved and rotary designs incorporated multi- blade configurations useful for cutting large commercial type areas.



Improvements in engines and drive systems have resulted in the very effective commercial type rotary mowers that are presently available.

## Theory of Operation



There are three basic structural members to a rotary cutting unit.

### Cutter Deck Housing

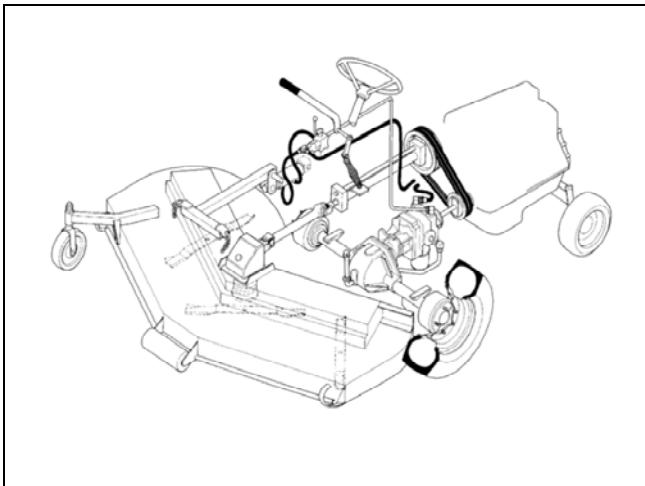
The deck housing supports the blade hubs with their drive mechanism and is shaped to carry the cut grass clippings away from the deck in an effective manner.

### Blade mounting and drive system

The blade is normally driven directly by the engine crankshaft, a hydraulic motor or through a belt pulley system to each blade hub.

### The blade

The blade has a sharpened cutting edge at each end with a curved up sail area to create an air flow. This air flow will whip the grass blades exposing them to the blade cutting edge. The air flow also assists in carrying the cut grass blades out the discharge.



Power transfer from the engine to the blades is typically done by way of belts and transfer shafts. Belt drives typically transfer a high percentage of the available horsepower to the blade and generally produce much less noise than hydraulic drive systems.

## Blade spindle assembly

### Large Diameter Ductile Cast Iron Spindle Support

Ductile cast iron, stronger than aluminum or regular cast iron

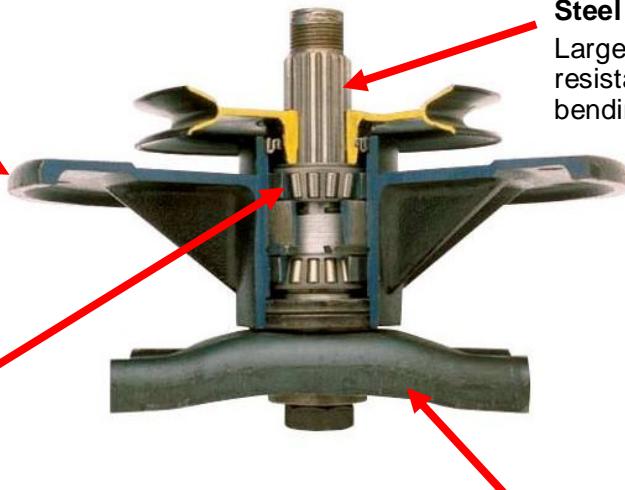
### Solid Cold Finished Steel Spindle Shaft

Large diameter shaft is resistant to torsion and bending failure

### Timken® Tapered Roller Bearings

Support spindle shaft better than ball bearings

50% more load carrying capacity than ball bearings

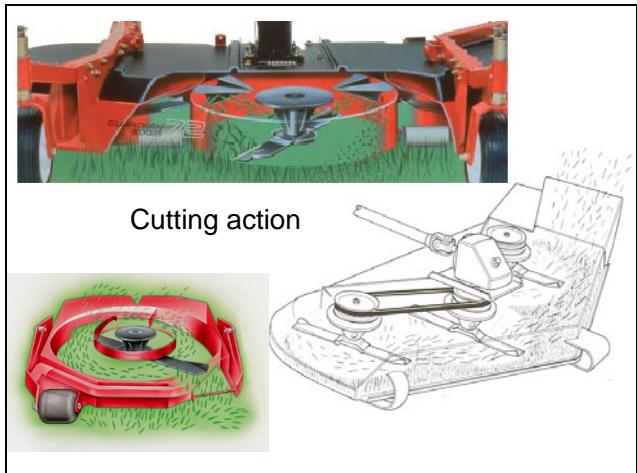


### Blade Retainer & Anti-Scalp Cup

Eliminates blade slippage and protects turf from damage

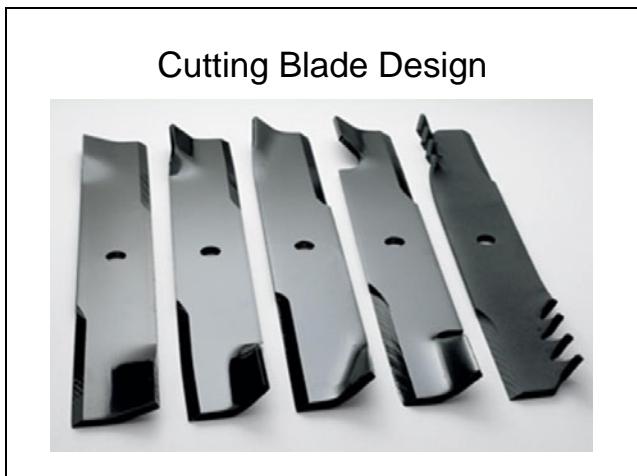
The deck spindles usually run at approximately 2000 to 2500 RPM. They feature tapered roller bearing for impact resistance and durability. The bearings can be greased, and if done properly can ensure long life while also purging contaminants from the assembly.

## Cutting Action



A rotary mower cuts grass by impacting the blade cutting edge against the grass blades at a very high velocity. This cutting action requires that the blade cutting edge is sharp and rotating at an adequate speed.

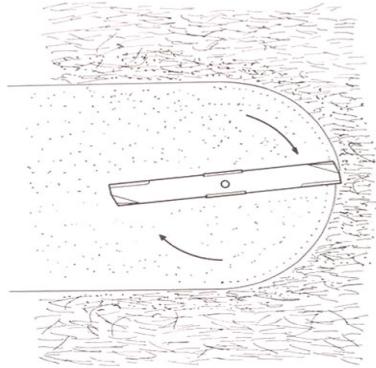
Three types of cutting decks are shown here; a recycler deck, side discharge and contour deck.



**Cutting Blade Design**

From left to right. Low sail, high sail, medium sail, recycler sail, and atomic mulching blade. Higher sails, generate higher lift within the cutting chamber. The type of blade utilized, depends on cutting deck design and turf conditions.

### Rotary mower clip



To understand rotary cutting theory you must understand the concept of clip.

Clip can be defined as the forward distance traveled by the cutting unit during one revolution of the blade. This distance is divided by the number of blade tips to arrive at the clip dimension. The dotted lines represent the cut path by the previous blade tip.

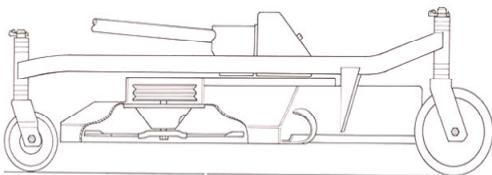
Although the blade cutting edge may be 3" - 4" long the very tip is the primary contact point with the grass blades on each pass.

The remaining portion of the cutting edge will tend to cut off the stragglers from the previous blade pass. The blade tips are normally lower than the rest of the blade to avoid any drag on the turf absorbing rotating horsepower and damaging the grass.

Factors which affect clip:

- Blade speed
- Ground speed

### Requirements for acceptable performance



Three basic requirements for acceptable performance:

The blade must be straight with sharp cutting edges. The blade must have the proper attitude in relation to the ground surface.

The blade must rotate at the proper speed with an accommodating ground speed to get an acceptable clip.

## Equipment Application

Rotary mowing equipment is designed for a specific application. The misapplication of rotary mowing equipment can only result in abuse, poor qualities of cut and costly downtime. The following application factors will affect the equipment requirements.

Turf areas maintained with rotary mowers



### Type of Grass to be cut

Most types of grass can be cut with a rotary mower. Rotary mowers are generally used for cutting semi-formal and rough turf areas at heights of cut 2-inches and above.

Due to the rotary mower having the capacity to cut off greater lengths of grass than a reel type, the less frequent cuttings with a rotary can result in grass damage due to the excessive length of the grass that is removed. It is best to cut only about 1/3 of the grass blade. Cutting more than that is not recommended unless grass is sparse, or it is late fall when grass grows more slowly.

Type of terrain



### Type of Terrain

The type of terrain that would limit a reel mower's performance would generally apply to rotary mowers also. Rough and bumpy turf can be cut acceptably with a rotary due to its wider individual width not being affected by the bumps as readily as a reel type.

Rotary mowers can be more prone to scalping than reel type mowers. The shorter individual reel cutting units conform to uneven terrain better than the wider rigid individual rotary cutting unit. Contour rotary mowers with multiple independent cutting decks are better able to deliver good after cut appearance in these conditions.

If there are numerous trees and obstacles, maneuverability and trimability are a prime importance. Hilly terrain requires a high degree of stability and traction.

## Capabilities and limitations

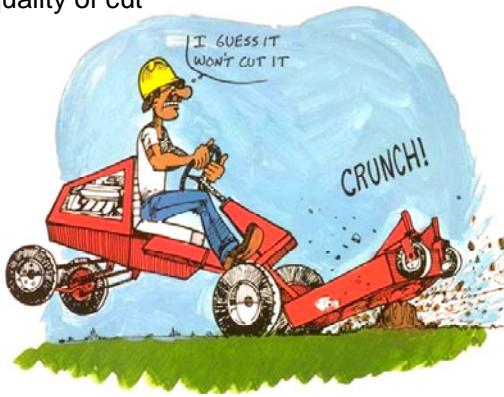


## Capabilities and limitations

Rotary mowers will not give the manicured cut appearance of a reel mower, but will give an acceptable appearance in more varied and adverse conditions.

Rotary mowers are capable of cutting much higher grass than reel mowers. When an excessive amount of grass is removed, the cut appearance can become unsightly due to the discharged grass building up in clumps and ridges. If the grass is allowed to grow longer than normal, or if it contains a high degree of moisture, raise the cutting height higher than usual and cut the grass at this setting. Then, cut the grass again using the lower, normal setting.

## Mower abuse and quality of cut



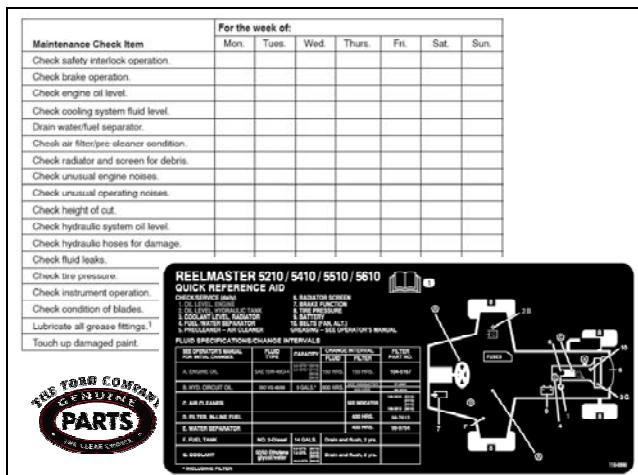
The tolerances within a rotary cutting unit are not nearly as critical as a reel type cutting unit. Therefore, a rotary mower can withstand more abuse than a reel type and maintain an acceptable quality of cut.

## The Importance of the Operator and Equipment Manager

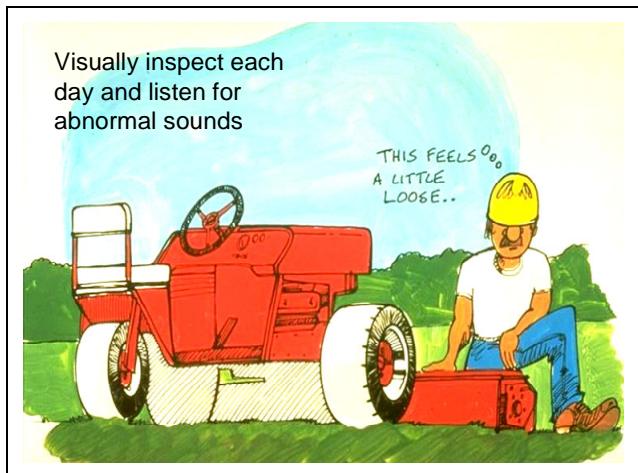
The large investment in specialized cutting equipment cannot be jeopardized by unqualified operators. Before an operator can be considered qualified to operate a piece of equipment, there should be a significant effort by the supervisor towards their training and familiarization with each product. All too frequently this procedure is not followed, with the end result being costly repairs, down time and a decrease in equipment life. Cost for these types of repairs far exceeds the cost expanded in training and familiarization of the operator.



# Productive Equipment Operation



Experience has shown that a high percentage of the problems that develop on turf equipment do not require an overhaul or disassembly type correction. In many cases a problem has developed over a period of time and it could have been corrected by adjustment, lubrication, or similar required maintenance. This requires that turf equipment be checked on a regular basis and not operated until a major breakdown occurs.



The operator and mechanic should make a thorough visual examination of the product each day to include listening for any abnormal sounds. Equipments reliability, effectiveness and maintenance costs are directly affected by how it is operated.



The maintenance schedules and owners manuals should be used for reference to identify specific areas requiring ongoing maintenance.

The following operating characteristics on rotary mowers should be made aware to operators and practiced during their mowing routines.

### Wheel traction and hill climbing



### Wheel traction

Tire pressure in the traction wheels is critical for maximum traction capability. Over-inflated tire pressure can cause spinning and tearing out of the turf in adverse conditions. If lowering the tire pressure does not correct or stop a spinning condition, adding liquid to the tires may be required.

Avoid quick acceleration while operating mowing equipment because a spinning tire can seriously damage the turf. Try to maintain a constant speed while going through turns and climbing hills to avoid a spin out which would damage the turf.



### Engine RPM

The correct engine speed is important for the effective performance of a rotary cutting unit. Most professional mowing equipment is designed to operate at full engine RPM. All engine RPM information is contained in the owner's manual for each product. The engine speed should be checked with a tachometer periodically.

### Ground speed



### Ground Speed

There are three basic problem areas resulting from too fast a ground speed. It is unsafe, damaging to the equipment and will result in a poor quality of cut.

The ground speed of a rotary mower must be limited to a point that the blade can cut and discharge the grass effectively while maintaining a good quality of cut. If the cutting unit is becoming overloaded, the ground speed must be lowered and/or the cutting width should be reduced so the engine can regain its normal operating speed.



## Mowing patterns

It is normally beneficial to cut a given area in a pattern that will allow the grass to re discharged onto the previously cut grass area. If this is not done, the horsepower requirement increases due to the blade having to cut the discharged grass again.



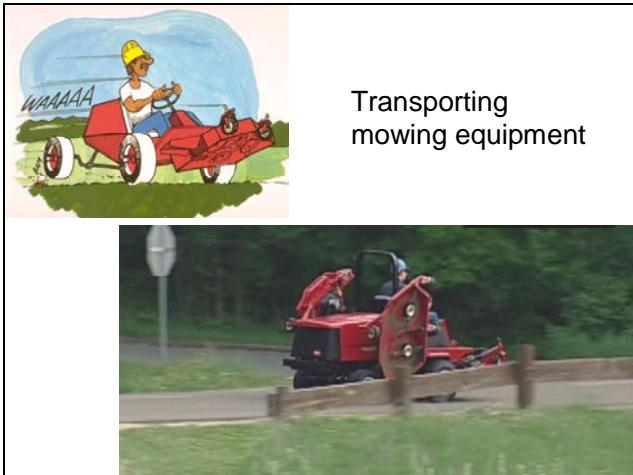
## Debris on the Turf

All debris should be removed from areas where rotary mowing equipment is being used to avoid serious damage to the cutting unit resulting in costly repairs and downtime. The operator should be constantly watching for foreign objects in the turf and when he sees an object, he should stop the mower and pick it up.



## Noise Level

The noise level of equipment is a good indication of its condition. The operator and mechanic should continually be aware of changes in noise levels as an indication of a problem developing.



Transporting  
mowing equipment

#### Transporting mowing equipment

Transporting mowing equipment requires discipline and knowledge to reduce downtime and increase equipment life. Operating the equipment in an abusive manner while transporting can only reduce its mowing efficiency.

#### Safety

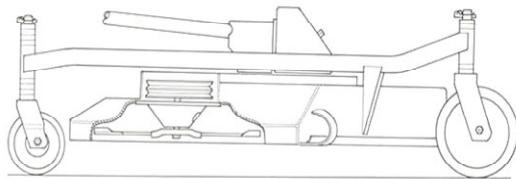
## Keep Thinking and Be Aware

Mowing equipment is designed for a specific application and should be operated keeping those restrictions in mind, accidents and personal injuries can be minimized if persons will think and be aware in their every day work habits.



## Cutting Unit Adjustments

### Height of cut and attitude



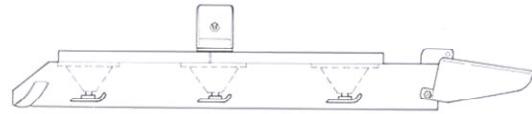
#### Height of cut adjustment and attitude

The height of cut is usually set by the placement of spacers on the castor wheel shafts or with the height of the rollers on contour type cutting units. The effective height of cut can be checked on the turf. This can be accomplished by inserting a narrow ruler down into the turf.

Rotary cutting units are normally  $1/8"$  -  $1/4"$  lower at the front than in the back. This attitude or slope of the deck cuts down the horsepower requirement to turn the blades due to the blade only cutting on for the forward  $180^\circ$  of its rotation. If the deck has multi-blades and this attitude is too far down at the front the center will cut lower than the sides due to the center blade being farther forward.

The attitude can be checked by measuring from a flat surface up to the forward blade tip. Rotate the forward tip to the rear and take the measurement at the back. The difference in dimension is the attitude.

### Consistent blade height



If the cutting unit has multi-blades, the blade tips should be checked for height to see that they are all at the same level to avoid mismatch. This can be accomplished by pointing all the blade tips forward, measuring up from a flat surface to each blade tip. Different height readings could be caused by:

Bent or warped blades.

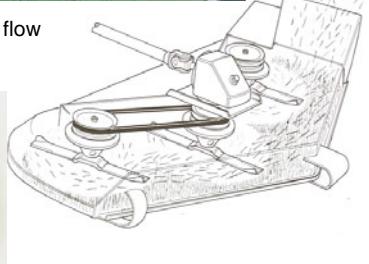
Bent blade spindles.

Height of cut adjustment different on each side.  
The attitude or slope of the cutting unit deck being incorrect.

## Inspection Maintenance and Repairs



Cutting efficiency and air flow



The efficiency of a rotary cutting unit is directly related to the air flow within the deck.

Inspect and clean out periodically to maintain air flow



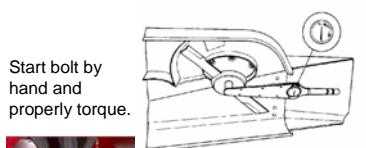
The underside of the cutting deck should be examined periodically. The air flow is significantly affected if the deck is not cleaned out periodically.

### Blade Removal and Installation

Impact gun - blade removal only!

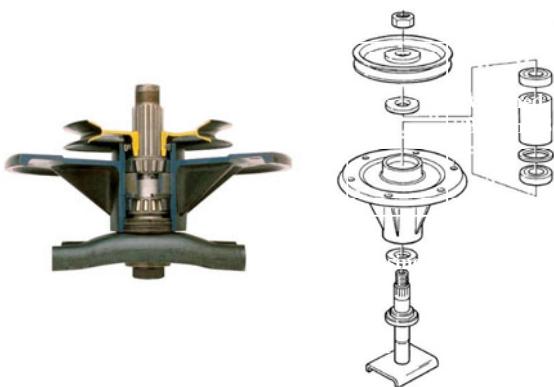


Start bolt by hand and properly torque.



It is very important that the blade retainer nut/bolt be properly tightened.

If the retainer is not tight enough, the blade may loosen during operation. If the retainer is too tight, thread damage may occur and compromise the integrity of the fastener.

**Spindle assembly**

The deck spindles usually run at approximately 2000 to 2500 RPM. They feature tapered roller bearing for impact resistance and durability. The spindles can be disassembled and repaired, or a complete assembly may be installed.

The spindle assemblies should be greased as part of a regularly scheduled maintenance program. If done properly this will ensure long life while also purging contaminants from the assembly.

#### The Spindle Housing.

This component is usually reused when a spindle is rebuilt unless it was damaged when the spindle failed.

#### The Shaft

Running up through the center of the housing is the shaft. This is the component that runs in the bearings and the blade is fastened to it. This component can usually be reused also unless it was damaged during the failure or is possibly bent by the blade contacting something. Before reassembling the spindle assembly, the shaft should be checked to see if it is bent, the areas on the shaft where the bearing run needs to be examined, as well as any areas where seals contact the shaft.

#### Matched Bearing Set

The matched bearing set includes the bearing races, bearing cones (Roller bearings) and a set of spacers. This must be replaced in a set.

#### Seals

The spindle assembly also includes two seals. The orientation of these seals is also important to the overall performance and longevity of the spindle assembly.

Greasing a bearing after every use and after any washing not only lubricates, but purges water which is responsible for the majority of bearing failures on this type of equipment.

**Castor Wheels, Rollers, Lift Arms**

### Inspecting drive belts and pulleys

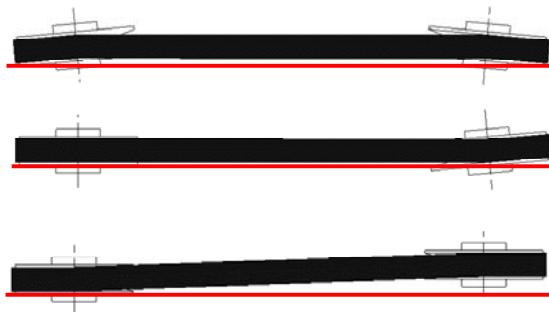
- Oil or grease contamination
- Debris in pulleys
- Damaged or rusted pulleys
- Proper installation and tensioning



Periodically inspect drive belts and pulleys. A good time to do this is after cleaning the machine.

- Oil or grease contamination
- Debris in pulleys
- Damaged or rusted pulleys
- Proper installation and tensioning

### Drive belt failures

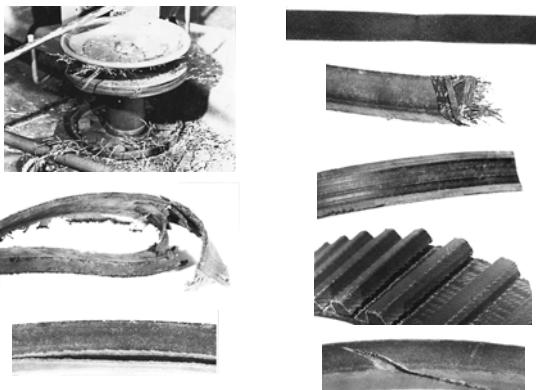


The most common causes of belt failures:

- Alignment
- Contamination
- Loading
- Installation Issues

Alignment refers to the alignment of one pulley in relationship to the other. If this alignment is not correct the belt may show excessive wear to one of both sides of the belt. Some of the cords in the belt may be broken or the belt may actually flip over.

### Drive belt failures



Contamination refers to some other substance coming in contact with the belt. This may be oil, grease or other some other foreign object.

Loading refers to excessive loads or shock loading the drive system.

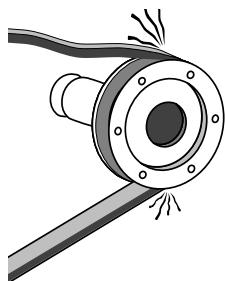
The last one is installation issues. The belt is actually damaged during installation.

By inspecting the failed belt the user can get a good idea as to the cause of the belt failure and can correct it when the new belt is installed.

### Belt noise

#### Belt Chirp

- Chirp occurs on all types of belts.
- Caused by momentary slippage.
- Dust can be a contributing factor.
- Never apply belt dressing.
- Chirps or squeaks will not harm belts.



#### Belt Squeal

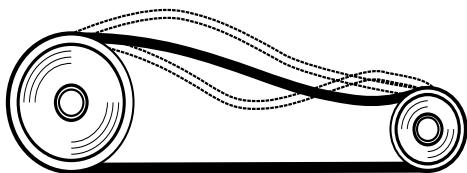
- Occurs during shaft acceleration.
- Result of insufficient Tension.
- Requires prompt attention.

A belt chirp is a small chirp or squeak that happens during start-up of an implement. It is caused by normal slippage and is completely normal. Never instruct the customer to use belt dressing to prevent chirps or squeaks. Do not recommend belt dressing actually for any belt problem. Belt dressing is only a band-aid and not a fix.

A belt squeal occurs during rapid shaft acceleration or it can also occur under heavy load conditions. It is usually caused by insufficient tension. A squealing belt requires prompt attention because as the belt squeals an extremely large amount of heat is generated on the pulley. This heat will very rapidly damage the belt and the pulley.

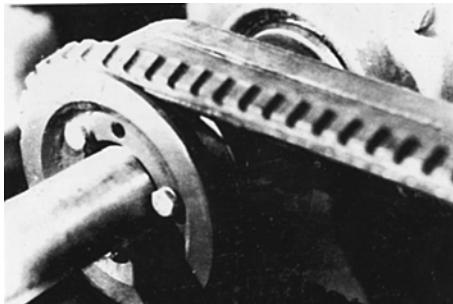
There are a few operational problems that the customer may notice. These include, belt squeal, a belt chirp or squeak, and vibrations or whipping.

### Belt vibration or whipping



Whipping or vibrations are usually caused by insufficient belt tension. The belt is too loose and it will vary its position in the pulley groove. To address this problem adjust the belt according to the manufacturers guidelines. If this situation is not addressed, the belt and/or surrounding components may be damaged.

### Belt turnover

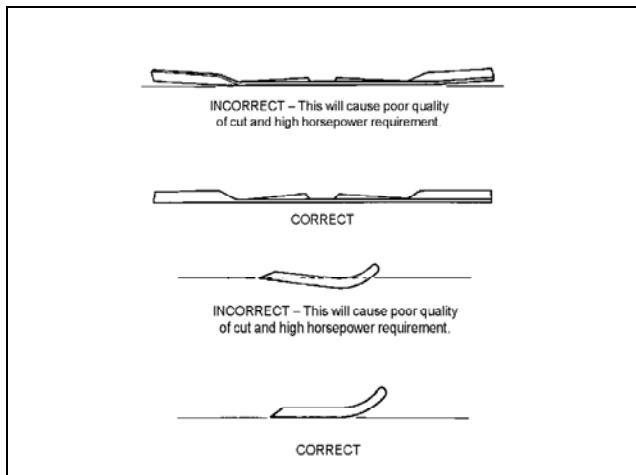


If you ever experiences a belt that flips or turns over on the pulley, the belt must be replaced. As the belt flips the cords in the belt will be stretched and the belt will not want to run true again. The belt will continuously turn over after that.

## Rotary Blade Inspection and Sharpening



To assure a quality of cut. The cutting edge of the blade must be kept in a sharp condition. A dull blade will produce a ragged cut and will require an excessive amount of engine horsepower to rotate the blade.



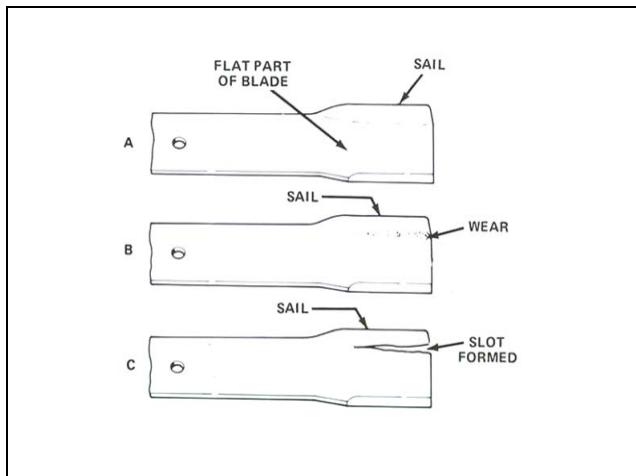
The most common causes for rotary mowers not giving a good quality of cut are due to dull cutting edges and/or bent blades.

**Caution:** Check cutter blade daily or before mower is used or stored and whenever mower is serviced. If bolt holding blade is loose, tighten it before using mower.

If the blade is bent, the blade should be replaced. A bent blade will cause two problems. The most noticeable problem is an increase in horsepower that is required to operate the mower. This is caused by the fact that when the grass is cut at the outer edge of the blade it is higher than the next area of the blade. The grass is then cut again and again until the height is the same as the lowest cutting edge. The same grass blade could be cut several times. This can take a considerable amount of power to repeatedly cut the same grass blade.

The other problem is that this will adversely affect the quality of cut. In this scenario, a very small amount of grass is cut from the grass blade frequently. This can cause the top of the grass blade to fray and it leaves the grass blade with an unhealthy cut edge. This will usually show up as a brown die-back from the top of the grass blade.

In this situation the blade should be replaced. NEVER straighten a Bent Blade as this could weaken the blade and cause the blade to break.



Carefully examine cutting ends of blade, especially where the flat and sail parts of the blade meet. When mowing in dry or sandy areas, sand and abrasive material can wear away the metal that joins the sail and flat part of the blade. For safety, it is important that when any wear is noticed, the blade must be replaced. If the condition is not corrected and wear continues, a slot will form. Eventually a piece of the sail may break off and be thrown from under the housing, possibly resulting in serious injury to yourself or bystander.

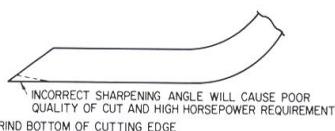
## OEM Blades

- Specifically designed for the intended deck.
- Meets all of the required tests.
  - Hardness
  - Object expulsion
- Meets the mowing and quality demands.
- Life expectancy.

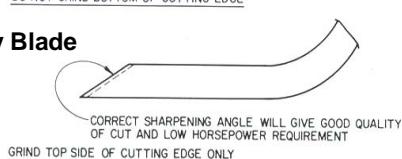
When discussing rotary blades, keep in mind that OEM blades are designed specifically to perform on the intended deck. They have been thoroughly tested to insure that they are hard enough to provide the desired life, but not so hard as to be brittle and risk breakage in the event that they contact a foreign object. They are specifically designed to insure that a foreign object that is hit by the blade is not expelled from the deck in an unsafe manner.

The blades are also designed to insure the best quality of cut and clippings dispersion from the deck. The blade sail angle and height is specifically designed to insure that the mower performs up to the desired level.

And lastly, while the cost may be slightly higher in some instances, the increased life expectancy, coupled with all of the work that has gone into the safety design of the blade makes original OEM blades a value.



**Typical Rotary Blade  
Cutting Edge**



Keep the blade cutting edges as sharp as possible. It is important that the sharpening process be done correctly. The four items that must be checked if a blade is removed for sharpening are:

The blade must be checked to assure that it is not bent and has the correct attitude in relation to the housing and ground surface.

The blade must be sharpened in the correct manner. The blade balance must be checked each time the blade is reground.

It is very important that the blade retaining nut be sufficiently tightened to assure that it will not loosen during operation.

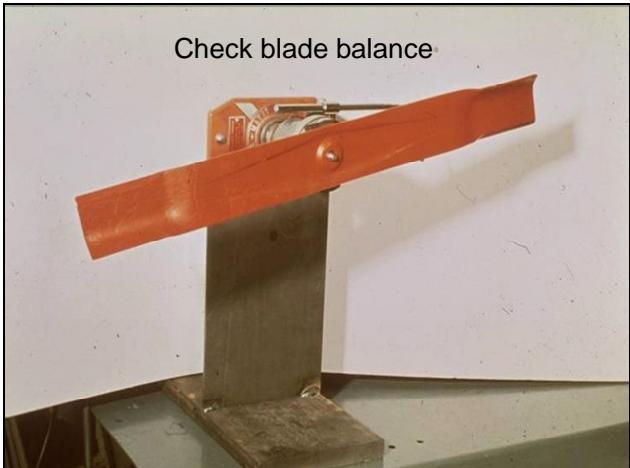
Prior to sharpening the blade, it should be checked for straightness. This can be checked by laying the blade on a flat surface.

### Caution:

Do not try to straighten a blade that is bent, and never weld a broken or cracked blade. Always use a new TORO blade to assure continued safety certification of the product.

Grind the top surface of the blade only, trying to maintain the original cutting edge angle. Do not grind the bottom surface or a chisel shape will be the result.

The lowest portion on the blade that contacts the grass must be the cutting edge or the grass will not be cleanly cut and excessive horsepower will be needed.

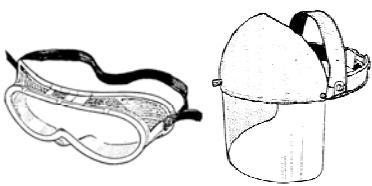


Check blade balance

After the blade has been sharpened the balance must be checked. This can best be accomplished using a commercial balancer. An unbalanced blade causes vibration damaging to adjoining parts.

### WARNING !

Always wear a face shield or safety glasses when grinding or sharpening.



Warning: Always wear face shield or safety glasses when grinding or sharpening is being done.



Turf mowing equipment has unique characteristics giving it the capability to maintain turf in a well groomed manner.

Understanding and reacting to these characteristics will significantly affect the equipments operating costs, downtime and productivity.







**University**